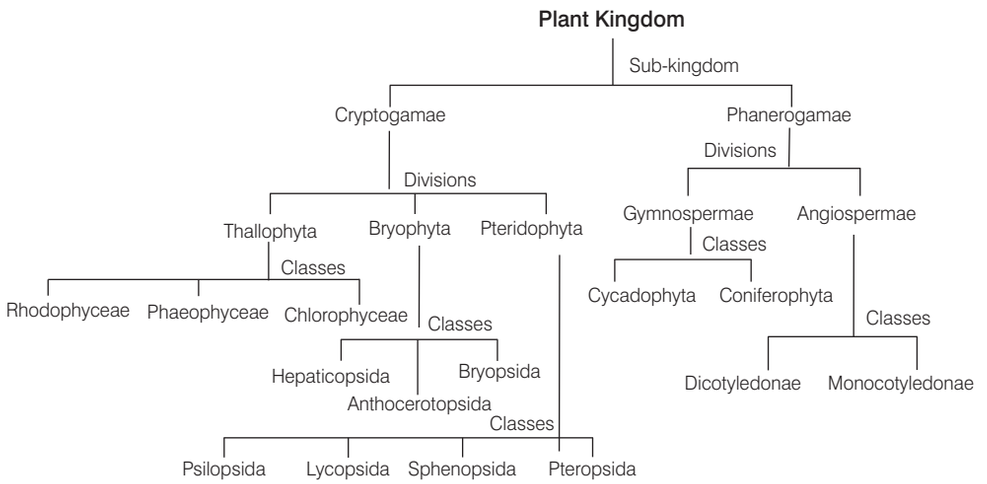
DAY TWO

Plant Kingdom

Learning & Revision for the Day

- Algae
- Bryophytes
- Pteridophytes
- Gymnosperms
- Angiosperms
- Alternation of Generations

- Plant kingdom is composed of multicellular and photoautotrophic organisms. They have cell wall made up of cellulose, exhibit indefinite growth and reserve food mainly as starch.
- Kingdom–Plantae has been further classified into following divisions namely–Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.
- Eichler (1883) divided plant kingdom into two sub-kingdoms, mainly on the basis of the presence or the absence of seeds.
  1. **Cryptogamae** (Gr. *Cryptos*—hidden; *gamous*—marriage) are lower plants in which sex organs are hidden and seeds and flowers are absent. It includes thallophytes algae, bryophytes and pteridophytes.
  2. **Phanerogamae** (Gr. *Phaneros*—visible/evident; *gamous*—marriage) are higher plants in which sex organs are evident and seeds are present. It includes gymnosperms and angiosperms.



Algae

Salient features of algae are as follows

- These are chlorophyll bearing, simple thalloid, autotrophic and largely aquatic (both freshwater and marine) organisms.
- Algae occur in a variety of habitats like moist stones, soils and wood. Some of them also occur in association with fungi (lichens) and animals (e.g. on sloth bear).
- The size of algae ranges from the microscopic unicellular forms like *Chlamydomonas* to colonial forms like *Volvox* and to the filamentous forms like *Ulothrix* and *Spirogyra* and herb forms like *Chara*.
- Reproduction in algae occurs by vegetative, sexual and asexual methods.
- Life cycle is of various types in algae, i.e. haplontic (*Ectocarpus*), diplontic (*Fucus*) and haplo-diplontic (*Polysiphonia*).
- Algae are of paramount importance as these are primary producers which form the basis of the food cycles of all aquatic animals.

Divisions of Algae and their Main Characteristics

Class (Example)	**Common Name**	**Major Pigment**	**Stored Food**	**Cell Wall**	**Flagellar No. and Position of Insertion**	**Habitat**
Chlorophyceae (*Ulothrix*)	Green algae	Chlorophyll-*a* and *b*	Starch	Cellulose	2-8, equal and apical	Freshwater, brackish water/salt water
Phaeophyceae (*Laminaria*)	Brown algae	Chlorophyll-*a, c* and fucoxanthin	Mannitol and laminarin	Cellulose and algin	2, unequal and lateral	Freshwater (rare) brackish water/salt water
Rhodophyceae (*Batrachospermum*)	Red algae	Chlorophyll-*a*, *d* and phycoerythrin	Floridean starch	Cellulose, pectin and polysulphate esters	Absent	Freshwater (some), brackish water/salt water (most)

Some important algae are described below

1. *Ulothrix*

It is a member of class–Chlorophyceae. It occurs in freshwater bodies but *Ulothrix flacca* is marine and *U. implexa* is lithophytic alga.

- The thallus is unbranched filament consisting of basal elongated and colourless cell called **holdfast,** the uppermost apical cell and row of rectangular cells (broader than longer).
- Each cell contains single nucleus, band-like or collar-shaped chloroplast with one or more pyrenoids, a large central vacuole and cell wall of cellulose impregnated by pectin is found.
- Vegetative reproduction occurs by fragmentation and asexual reproduction occurs by zoospores under favourable conditions.
- The nucleus of each cell except holdfast divides mitotically into 2-64 nuclei followed by accumulation of protoplasm around these nuclei resulted in development of bi or quadriflagellate zoospores.
- During unfavourable conditions, the *Ulothrix* reproduces asexually by hypnospores, akinetes and palmella stage.
- Sexual reproduction is **isogamous** type involving fusion of two similar biflagellate gametes to produce zygospore.
- The zygospore after a resting period undergoes meiosis to produce haploid meiozoospores, which under favourable conditions germinate to produce new filament.
- In *Ulothrix*, life cycle is of haplontic type.

2. *Batrachospermum* (Frog Spawn Alga)

It is a freshwater filamentous rhodophycean alga.

- It's filament gives a branched beaded appearance, due to the presence of beads at the regions of nodes, where whorls of short branches or glomerulus occur. Long branches occur at some places.
- Internodes are made up of single long cells. A loose cortex is also found around them.
- Cells of short laterals are small and elliptical.
- The alga can multiply vegetatively (by fragmentation and gemmae) and **asexually** (by monospores).
- Male sex organs are called **spermatangia,** while female sex organs are called **carpogonia**.
- Meiosis occurs immediately after fertilisation and a haploid carposporophyte or **cystocarp** is formed, which produces carpospores.
- Carpospore forms a highly branched filamentous **chantransia stage**. It is juvenile stage, which can multiply by monospores. The adult alga grows over the chantransia stage.

Economic Importance of Algae

- Carbohydrates, inorganic compounds and vitamins are found in algae hence, they are used as food, e.g. *Porphyra* (containing 30-35% protein, 40-45% carbohydrate, vitamin-A and C), *Ulva*, *Alaria, Chlorella* (containing 30% carbohydrate, 30% proteins, 15% lipid), *Chondrus, Codium,* etc.
- *Chlorella* (green alga) and *Spirulina* (blue-green alga) are rich in proteins. They can be used as food supplements even by space travellers.
- **Agar-agar** (polysaccharide consists of agarose and agaropectin) is obtained commercially from species of *Gelidium*, *Gracilaria* and *Gigartina*. It is used in the manufacturing of processed cheese, pudding, creams, jellies and culture media.
- **Carrageenan** (polysaccharide colloid) is obtained from cell wall of *Chondrus crispus* and *Gigartina stellata,* which is used in stabilisation of emulsions in paints and cosmetics and in alcohol and sugar industry.
- **Alginate** (salts of alginic acid) is extracted from *Laminaria, Ascophyllum, Fucus, Macrocystis* and useful as thickener, emulsifier and gelling agent.
- **Diatomite** (deposits of diatoms) is insoluble and chemically inert, therefore used as filtre, insulator in boilers and blast furnaces and an absorbant of nitroglycerine.
- *Laminaria* and *Fucus* are source of iodine and bromine.
- Blue-green algae like *Nostoc, Anabaena, Aulosira, Oscillatoria,* etc., act as nitrogen-fixing agent.
- The antibiotic **chlorellin** is obtained from *Chlorella*.
- *Chlorella, Chlamydomonas, Euglena*, *Scenedesmus, Pyrobotrys*, etc., are used for disposal of sewage.
- Some algae however also have negative effects such as *Microcystis, Chroococcus, Oscillatoria, Anabaena,* etc. which cause water bloom in water reservoirs.
- *Cephaleuros* sp. are parasitic on leaves of tea and coffee.

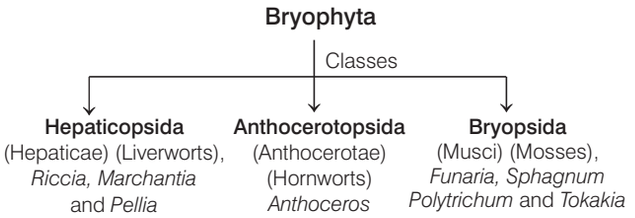
Bryophytes

General characteristics of bryophytes are as follows

- Bryophytes are also called amphibians of plant kingdom because they live in soil but depends on water for sexual reproduction.
- Their plant body is thallus-like, attached to the substratum by unicellular or multicellular rhizoids.
- Bryophytes lack true roots, stem or leaves.
- The main plant body of the bryophyte is haploid and produces gametes, hence is called a **gametophyte.**
- The male sex organ is called **antheridium.** They produce biflagellate antherozoids. The female sex organ is called **archegonium,** which produces a single egg.
- An antherozoid fuses with the egg to produce a zygote. Zygotes do not undergo reduction division immediately. They produce a multicellular body called a **sporophyte.**
- The sporophyte is not free-living but attached to the photosynthetic gametophyte and derives nourishment from it.
- The sporophyte produces haploid spores by meiosis, which germinate into gametophyte.

Classification of Bryophytes

According to the most accepted classification system, bryophytes are classified into three main classes,



1. Liverworts

- They grow in moist and shady places, like *Marchantia*.
- The thallus is dorsiventral and closely appressed to the substrate.
- **Gemmae** are green, multicellular and asexual buds, which develop into small receptacles called **gemma cups** present on the furrow of dorsal side of thallus.
- The sporophyte is differentiated into a foot, seta and capsule. Spores are produced within the capsule and germinate to form free-living gametophytes.

Marchantia

- It is a liverwort with thalloid, green, dorsiventral and dichotomously branched plant body. On the dorsal side of the thallus, a median longitudinal groove and rhomboidal or polygonal areas are present.
- Scales and rhizoids are borne on the ventral side of the thallus. Rhizoids are colourless, unicellular structures. These are of two types, i.e. smooth-walled and tuberculate.
- Sex organs are dioecious with similar male and female thalli. Sex organs are borne on gametophores which are developed in localised areas called **receptacles.**
- The mature antheridium has an ovoid body supported on a short, multicellular stalk. The body of the antheridium has a jacket layer, i.e. one cell in thickness. It encloses a mass of androcytes. Each androcyte gives rise to a biflagellate sperm.
- The archegonia of *Marchantia* has a short but distinct stalk, which attaches the venter to the receptacle.
- There is a collar-like structure at the base of the venter of each archegonium, called **perigynium**.

- In addition, there is a two-lipped curtain-like perichaetium with the fimbriated margins around each series of archegonia.
- The sporophyte is differentiated into foot, seta and capsule. It hangs freely from the undersurface of the female receptacle surrounded by the **perigynium** and the perichaetium.
- The foot is well-developed and broad. It functions as an attaching and absorbing organ.
- The short seta elongates rapidly but slightly, just to push the mature capsule through the surrounding protective sheaths.
- At maturity, the capsule is an oval-shaped yellow body concerned with the production and distribution of spores.

2. Mosses

- They also grow in similar conditions as liverworts.
- In the life cycle of mosses, the predominant stage is **protonema**, which directly develops from a haploid spore. It is creeping, green, branched and frequently filamentous stage.
- The second stage is leafy stage, which develops from the secondary protonema as a lateral bud.
- Mosses are attached to the soil through multicellular and branched rhizoids.
- Reproduction occurs by vegetative and sexual means. The sporophyte in mosses is more elaborate than in liverworts. Common examples of mosses are *Funaria, Polytrichum* and *Sphagnum*.

Funaria

- The main plant body is small yellowish green gametophore. The gametophore consists of slender, erect, branched or unbranched stem-like structure called **axis,** small spirally arranged leaf-like structures called **phylloids** and multicellular, branched, thin root-like structure called **rhizoids,** which have oblique cross walls.
- Internally, the cells are arranged in three distinct regions, i.e. epidermis, cortex and central cylinder.
- Vegetative reproduction takes place by fragmentation, formation of secondary protonema, tubers (on rhizoids), gemmae (bud-like structure formed from the terminal cells of protonema), bulbils (resting buds arise from protonema) and by apospory.
- The gametes are produced in highly differentiated antheridia and archegonia at the apex of same plant, i.e. **monoecious**.
- The main axis acts as male shoot (antheridiophore) bearing many antheridia while lateral branch acts as female shoot (archegoniophore) bearing many archegonia.
- Each antheridium consists of stalk and club-shaped body surrounded by jacket. Numerous elongated, spirally coiled, biflagellate antherozoids are formed inside it.
- Each archegonium is flask-shaped structure consisting of short multicellular stalk, lower swollen portion (venter) and upper tube-like neck.
- A venter has two-layered wall and contains a large ovum or egg cell. Above the egg lies a Venter Canal Cell (VCC).
- The jacket of neck consists of single layer of cells arranged in six vertical rows. Neck contains 6-9 Neck Canal Cells (NCC).
- A multicellular, uniseriate sterile structure called **paraphysis** is present in between the antheridia and archegonia.
- The antherozoids are released by bursting of antheridium which swim in water and reach up to archegonium by being attracted to sugar substance released by antheridium (chemotaxis).
- The zygote formed by fusion of antherozoid and egg develops a thick protective wall and is known called **oospore.**
- The diploid oospore divides and develops into a sporophyte, which obtains nourishment from the parent gametophyte. Sporophyte consists of foot, seta and capsule.
- The **capsule** is differentiated into operculum (a circular cup-shaped structure with 2-3 layered lid), annulus (ring-like layer of thickened cells at the base of operculum), peristome (32 tooth-like projections arranged in two rings of 16 each), collumella (solid sterile column containing water and food), spore sac and **apophysis** (green photosynthetic region).
- The stoma is surrounded by single ring-like guard cell.
- The diploid spore mother cells undergo meiosis to form thousands of haploid single-celled **spores**.
- Under dried condition the capsule dehisces and the spores on getting favourable conditions germinate into a green, much branched, filamentous protonema (juvenile stage).

NOTE Protonema is a vegetative and transitory stage. It has non-green rhizoidal branches as well as green prostrate branches. Prostrate branches develop buds which grow to form moss plants.

Economic Importance of Bryophytes

- Bryophytes in general are of little economic importance. Some mosses provide food for herbaceous mammals, birds and other animals.
- Mosses along with lichens are the first organisms to colonise rocks. They decompose rocks making the soil suitable for the growth of higher plants.

- Species of *Sphagnum* (moss), provide peat that have long been used as fuel, and as packing meterial for trans-shipment of living material because of their capacity to hold water.

Pteridophytes

Salient features of pteridophytes are as follows

- They are first terrestrial plants having vascular tissues, i.e. **xylem** and **pholem**. Commonly known as **fern** or **vascular cryptogams**.
- Pteridophytes are found in cool, damp and shady places and flourish well in sandy soil conditions.
- In pteridophytes, the main plant body is a sporophyte, differentiated into true root, stem and leaves.
- The sporophytes bear sporangia that are subtended by leaf-like appendages called **sporophylls.** In some cases, sporophylls may form distinct compact structures called **strobili** or **cones** (*Selaginella* and *Equisetum*).
- Ferns or pteridophytes are primitive vascular plants without seeds.
- The gametophytes bear male and female sex organs called **antheridia** and **archegonia**, respectively. In majority of pteridophytes, all the spores are of similar kinds, such plants are called **homosporous**.
- Pteridophytes, which produce two kinds of spores by meiosis macro (large) and micro (small) spores are called **heterosporous**, e.g. *Selaginella* and *Salvinia.*
  The spores germinate to give rise to multicellular prothallus or gametophyte which bears male and female sex organs called antheridia and archegonia, respectively.
- The fusion of male and female gametes to produce zygote is facilitated by water. The development of zygote into young embryo takes place within the female gametophytes. This event is a precursor to the **seed habit** and is considered as an important step in evolution.
- Pteridophytes have vascularised root, stem and leaves but they could not achieve desired success in establishing terrestrial land conditions due to the following reasons
  (i) Requirement of moist, wet place for germination of spore.
  (ii) Susceptibility of prothallus (gametophytes) to dessication.

Classification of Pteridophyta

- Pteridophyta is classified into following four main classes
  (i) Psilopsida (e.g. *Psilotum*)
  (ii) Lycopsida (e.g. *Selaginella* and *Lycopodium*)
  (iii) Sphenopsida (e.g. *Equisetum*)
  (iv) Pteropsida (e.g. *Dryopteris, Pteris* and *Adiantum*).

Some important pteridophytes are described below

1. *Adiantum*

- It is also known as the **maiden hair fern,** which has sporophytic (diploid) main body. It is differentiated into root, stem and leaves.
- The stem is perennial, dichotomously branched and thickly covered with scales called **paleae.**
- The primary root is short lived and is replaced by adventitious roots.
- The leaves are compound and arise alternately or spirally on the rhizome. The leaflets are called **pinnules.** The veins spread in fan-like manner in the lamina of leaflet.
- Vegetative reproduction occurs by fragmentation of rhizome and growth of adventitious buds. The latter occurs at the leaf tip of *Adiantum caudatum*. *Adiantum* is known as **walking fern** because of its ability to form new plants, whenever the leaf tip happens to come in contact with soil.
- A fertile leaf bearing sporangia, is called **sporophyll**. In *Adiantum*, any vegetative leaf can develop sporangia and become a sporophyll.
- The margin of pinnule blade is folded towards the lower side to form the false indusium. It covers the groups of sporangia called **sori** (sing. sorus).
- The sori are sub-marginal in position. These may be continuous in the form of coenosorus or in the form of small and separate sori. Each sorus may show different developmental stages of sporangium, to produce spores by meiotic divisions.
- On maturity of spores, the indusium shrivels and exposes the sporangia. Annulus dries up, shortens and breaks the sporangial jacket in the region of stomium. The spores are thrown out like a catapult. They are dispersed by wind.
- On reaching a suitable substratum, each spore produces gametophyte or **prothallus**. It is attached to the substratum by means of unicellular rhizoids, on its ventral side, it also possesses antheridia and archegonia.
- Archegonia develop behind the apical notch in an area called **apical cushion**. Each archegonium is a flask-shaped structure with an embedded venter and protruding neck. Venter encloses a venter canal cell and an egg or oosphere.
- Antheridia occur scattered among rhizoids. They are sessile and hemispherical.
- Each antheridium has a jacket of 3-cells and 32-48 androcytes. An androcyte produces a single multiflagellate sperm or spermatozoid.
- Cross fertilisation generally occurs due to the protandry of prothallus. A thin film of water is required for spermatozoid to swim up to archegonia (chemotactically).

The sperm and egg on fusion form a diploid structure known as zygote.

- Zygote undergoes mitotic divisions and produces an embryo that has a foot for obtaining nourishment from prothallus, a stem apex, a root and the first leaf. Embryo grows in size and becomes an independent fern plant.
- Life history is haplodiplontic with heteromorphic or heterologous alternation of generations.

2. *Dryopteris*

- It is commonly known as fern. Main plant body is sporophytic (2*n*). Stem is underground and shoot system is well-developed.
- Leaves (fronds) appear as tightly coiled structure during early stages.
- Vegetative reproduction occurs *via* formation of adventitious buds and fragmentation of rhizome and asexually by spores which develop on ventral surface of leaves.
- Sporophytes bear sporophylls (leaf-like) with sporangia. It produces spores that germinate into gametophyte (prothallus).
- Gametophytes possess antheridia and archegonia and water is required for thier fertilisation.
- **Heterospory** is the production of spores of two different size and two different development patterns, the small spores are called **microspores** (males spores) and the larger spores as megaspores (female spores).
- The development of zygote into embryo after fertilisation continues on the gametophyte, this type of development is very important in the evolution of vascular plants because it leads to the development of seed habit.

Gymnosperms

Salient features of gymnosperms are as follows

- These are plants in which the ovules are not enclosed by any ovary wall and remain exposed, both before and after fertilisation. Thus, the seeds that develop post-fertilisation are not covered, i.e. are naked.
- Gymnosperms include medium-sized trees or tall trees and shrubs.
- Roots are generally tap roots. In some genera, roots have fungal association in the form of **mycorrhiza** (*Pinus*). In some others (*Cycas*) small specialised roots called **coralloid** roots are associated with N_2-fixing cyanobacteria.
- In gymnosperms, fertilisation occurs by siphonogamy that eliminates the dependence on water as medium. The stems are branched (*Cycas*) or unbranched (*Pinus* and *Cedrus*).
- The leaves may be simple or compound. In conifers, the needle-like leaves reduce the surface area. Their thick cuticle and sunken stomata also help to reduce water loss.
- The male or female cones may be borne on the same tree (*Pinus*) or on different trees (*Cycas*).
- The cones or strobili bearing microsporophylls and microsporangia are called **microsporangiate** or male strobili.
- The microspores develop into a male gametophytic generation, which is a highly reduced male gametophyte called **pollen grain**.
- The cones bearing megasporophylls with ovules or megasporangia are called **macrosporangia** or female strobili.
- 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 pollen grain is released into air from the microsporangium. The pollen tube carrying the male gametes grows towards archegonia in the ovules and discharge their contents near the mouth of the archegonia. Zygote develops into an embryo and the ovules into uncovered seeds.

Classification of Gymnosperms

Chamberlain (1934) divided gymnosperms into two classes, i.e. Cycadophyta and Coniferophyta.

1. **Class–Cycadophyta** It includes both living and extinct forms, e.g. *Cycadeoidea, Lyginopteris* (extinct), *Cycas* and *Zamia.*
2. **Class–Coniferophyta** It also include both extinct and living species, e.g. *Cordaites, Ginkgo biloba*, *Pinus*, *Gnetum* and *Ephedra.*

Some important gymnosperms are discussed below

1. *Cycas*

- It is also called a **living fossil** because it possesses many characters of extinct pteridosperms and cycads.
- It is an evergreen gymnosperm. Main plant body is sporophytic (2*n*) and divided into true roots, stems and leaves.
- Roots arise from lower part of the stem and are of two types, i.e. primary roots are **tap roots** and coralloid roots are dichotomously branched, apogeotropic and bluish green in colour. These roots are inhabituated by blue-green algae (e.g. *Anabaena*) and help in fixing nitrogen.

- Stem is thick, cylindrical and columnar. It is aerial and unbranched. The older parts of the stem remain covered with an armour of persistent woody leaf bases. Vascular bundles in stem are conjoint, collateral and open.
- Stem bears adventitious buds, called **bulbils** at its base.
- The wood of *Cycas* is monoxylic (non-porous) and polyxylic (multiple xylem).
- *Cycas* shows dimorphism in leaves. There are two types of leaves, i.e. foliage leaves and scale leaves.
- A **transfusion tissue** is present in leaflets between spongy and palisade parenchyma which helps in lateral conduction of water.
- Reproduction takes place vegetatively (by bulbils) as well as sexually. *Cycas revoluta* is extensively propagated vegetatively by means of adventitious buds or bulbils.
- *Cycas* are dioecious with distinct male and female plants. Male cone develops at the stem apex in between crown of foliage leaves. It has densely crowded spirally arranged microsporophylls.
- The upper tip of microsporophyll is pointed and sterile (apophysis) while lower part is wedge-shaped and fertile, which bears a number of microsporangia or pollen sacs arranged in sori.
- The megasporophylls are loosely arranged on a female strobilus. About 2-4 pairs of ovule are found to be present on a megasporophyll.
- The ovules of *Cycas* are large, naked and orthotropous (erect). They are unitegmic, i.e. enclosed in a thick coat.
- The integument consists of outer and inner fleshy layers with middle stony layer.
- Pollination is anemophilous and direct. The exine of pollen ruptures and intine elongates to form pollen tube, which acts as haustorium and absorbs nutrients.
- The generative cell divides to form a stalk cell and body cell. The body cell divides and form antherozoids.
- The megaspore undergoes repeated divisions and forms multicellular female gametophyte, which serves as endosperm (haploid).
- The archegonial initials (peripheral cells) develop into **archegonia**. Each archegonium has a short, two- celled neck, a large egg and a venter canal cell (neck canal cells are absent).
- Fertilisation is **siphonogamous.** The diploid zygote develops into embryo. The embryo consists of radicle, plumule, haustorium, suspensor and two cotyledons.

2. *Pinus*

- It is a coniferous gymnosperm. Mature plant of *Pinus* is large tree and is differentiated into thick columnar stem, evergreen leaves and roots.
- The main trunk represents the stem, which is cylindrical and branched. The branches are confined to upper part of the stem and are of two types, i.e. long shoot that exhibits unlimited growth and dwarf shoot (spur).
- The dwarf branches possess 1-5 needle-like foliage leaves, which inturn are surrounded at the base by a sheath of scaly leaves.
- The male cone develops below the apical bud on long shoot in cluster. Each male cone has 60-125 microsporophylls arranged spirally and each microsporophyll has microsporangium that bears microspores (pollen grains).
- Female cone is present in axile of scale leaf. On the central axis are borne two kinds of paired scales in spiral fashion (megasporophylls). Two naked ovules are borne on the upper surface of ovuliferous scales (upper scale of megasporophyll), towards the end, which is near the central axis.
- Distal sterile, broad part of ovuliferous scale is called **apophysis**.
- Pollination is anemophilous. About 15 months are required between pollination and fertilisation.
- *Pinus* plants are sources of different commercial products like timbers, resins, chilgoza, etc.

Angiosperms

Salient features of angiosperms are as follows

- In angiosperms, the seeds are enclosed by fruits. The pollen grains and ovules are developed in special structures called **flowers**.
- Angiosperms (or the flowering plants) constitute the largest group with about 12,500 genera and 250000 species that occupy a very wide range of ecological habitats. Their size varies from tiny (*Wolffia*) to tall trees like *Eucalyptus.*
- Angiospermic plants can be herbs, shrubs or trees based on their habitat. Plant body is sporophytic (2*n*) and differentiated into root, stem and leaves.
- Vascular bundles consist of prominent xylem and phloem.
- The male sex organ in a flower is the stamen. Each stamen consists of a slender filament with an anther at the tip.
- The female sex organ in a flower is the pistil or carpel. Pistil consists of an ovary enclosing one to many ovules. Within ovules are present highly reduced female gametophytes termed as embryo sac.
- The embryo sac formation is preceded by meiosis. Each embryo sac has a three-celled egg apparatus (i.e. one egg cell and two synergids), three antipodal cells and two polar nuclei.

- 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 to form a zygote. The other male gamete fuses with the diploid secondary nucleus to produce the triploid **Primary Endosperm Nucleus** (PEN). This event is called **double fertilisation**, which is unique to angiosperms.
- Zygote develops into an embryo and the **PEN** develops into endosperm, which provides nourishment to the developing embryo. The synergids and antipodals degenerate after fertilisation.
- During these events, the ovules develop into seeds and the ovaries develop into fruit.
- Angiosperms provide food, fodder, fuel, medicines and several other economical important products.

Classification of Angiosperm

- The earliest system of classification used only gross superficial morphological characters such as habit, colour, number and shape of leaves, etc. Such systems were **artificial**.
- The **natural systems** developed were based on natural affinities among the organisms and consider not only the external features but also internal features, like anatomy, embryology and phytochemistry. The most accepted system was given by **George Bentham** and **Joseph Dalton Hooker.**
- At present, **phylogenetic classification systems** based on evolutionary relationships between the various organisms are acceptable.

A Comparison of Three Main Systems of Classification

Bentham and Hooker's System	Hutchinson's System	Engler and Prantl's System
System of classification is natural. It is helpful for practical purposes.	System of classification is phylogenetic.	System of classification is phylogenetic.
Seed plants are divided into dicots, gymnospermae and monocots.	Seed plants are divided into gymnospermae and angiospermae.	Seed plants are divided into monocots, dicots and gymnosperms.
Dicotyledons have been kept before monocotyledons.	Dicotyledons have been kept before monocotyledons.	Monocotyledons have been kept before dicotyledons.
202 families are recognised.	411 families are recognised.	280 families are recognised.
Evolutionary criteria not followed.	According to this system, the primitive polypetalous forms diverged from the very beginning along two lines. In one, the tree-like habit of ancestral type is retained, while in the other, herbaceous habit has been adopted.	Families are arranged according to increasing complexity of flower, primitive forms being represented by naked flowers or those having bract-like perianth.

Division-Angiospermae is subdivided into following two classes

1. **Class-Dicotyledonae** Dicotyledonous plants possess two cotyledons in their seeds, reticulate venation in leaves, various types of phyllotaxy, vascular bundles open and present in a ring, also exhibit secondary growth.

   Dicotyledons have three sub-classes

   (i) **Polypetalae** Sepals and petals are distinct, petals free, e.g. mustard, pea, etc.

   (ii) **Gamopetalae** Sepals and petals are in distinct, petals are partially or completely fused, e.g. sunflower, potato, etc.

   (iii) **Monochlamydeae** Incomplete due to the non-distinction of sepals and petals, e.g. cucumber.

2. **Class-Monocotyledonae** Monocotyledonous plants possess one cotyledon, parallel venation in leaves, phyllotaxy alternate or spiral, vascular bundles scattered and closed (due to the absence of combine), adventitious roots very common, e.g. onion, grasses, etc.

Alternation of Generations

It occurs during the life cycle of any sexually reproducing plant. In this process, there is an alternation of generations between gametes producing haploid gametophyte and spore producing diploid sporophyte.

1. **Haplontic life cycle** is represented by only one-celled zygote. The haploid spores divide mitotically and form the gametophyte.

   The dominant, photosynthetic phase in such plants is the free-living gametophyte, e.g. many algae such as *Volvox, Spirogyra* and some species of *Chlamydomonas.*

2. **In diplontic life cycle**, diploid sporophyte is the dominant, photosynthetic and independent phase of the plant. The gametophytic phase is represented by the single to few-celled haploid gametophyte.

All seed-bearing plants, i.e. gymnosperms and angiosperms follow this pattern.

3. In **haplo-diplontic life cycle**, both phases are multicellular. Bryophytes and pteridophytes exhibit, this intermediate condition. They differ in their dominant phase.
   (i) In bryophytes, a dominant, independent, photosynthetic and thalloid or erect phase is represented by a haploid gametophyte which alternates with the short-lived multicellular sporophyte totally or partially dependent on the gametophyte for its anchorage and nutrition.
   (ii) In pteridophytes, the diploid sporophyte is a dominant, independent, photosynthetic and vascular plant body. It alternates with multicellular, saprophytic/autotrophic independent but short-lived haploid gametophyte.

NOTE Most algal genera are haplontic, some of them such as *Ectocarpus, Polysiphonia* and kelps are haplo-diplontic, whereas *Fucus* is diplontic.

DAY PRACTICE SESSION 1

FOUNDATION QUESTIONS EXERCISE

1 Which one of the following is not a characteristic of members of kingdom–Plantae?
(a) Presence of chlorophyll
(b) Presence of cellulosic cell wall
(c) Alternation of generations
(d) None of the above

2 The members of class—Phaeophyceae is/are
(a) *Dictyota* (b) *Ectocarpus*
(c) *Ulothrix* (d) Both (a) and (b)

3 *Porphyra* is a member of class
(a) Phaeophyceae (b) Chlorophyceae
(c) Rhodophyceae (d) None of these

4 In which class of algae, the flagella are totally absent?
(a) Phaeophyceae (b) Rhodophyceae
(c) Chlorophyceae (d) Cyanophyceae

5 *Spirogyra* and *Ulothrix* are found in
(a) marine water (b) both in sea and freshwater
(c) freshwater (d) on soil

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

7 Which one of the following shows isogamy with non-flagellated gametes? ➞ CBSE-AIPMT 2015
(a) *Sargassum* (b) *Ectocarpus*
(c) *Ulothrix* (d) *Spirogyra*

8 Which of the following groups represents the all members of Phaeophyceae?
(a) Chara, *Spirogyra* and *Fucus*
(b) *Ectocarpus*, *Laminaria* and *Sargassum*
(c) *Dictyota*, *Polysiphonia* and *Porphyra*
(d) *Gracillaria*, *Gelidium* and *Volvox*

9 Which green alga shows heterotrichous habit and may have given rise to terrestrial (land) habit?
(a) *Chlamydomonas* (b) *Fritschiella*
(c) *Vaucheria* (d) *Ulotrhix*

10 *Ulothrix* can be described as a
(a) non-motile colonial alga lacking zoospores
(b) filamentous alga lacking flagellated reproductive stages
(c) membranous alga producing zoospores
(d) filamentous alga with flagellated reproductive stages

11 Sexual reproduction in *Spirogyra* is an advanced feature because it shows ➞ CBSE-AIPMT 2003
(a) physiologically differentiated sex organs
(b) different size of motile sex organs
(c) same size of motile sex organs
(d) morphologically different sex organs

12 Which one is incorrectly matched? ➞ NEET 2018
(a) Gemma cups — *Marchantia*
(b) Biflagellate zoospores — Brown algae
(c) Uniflagellate gametes — *Polysiphonia*
(d) Unicellular organism — *Chlorella*

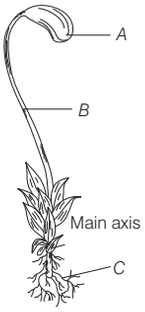
13 Spore dissemination in some liverworts is aided by
(a) elaters
(b) indusium
(c) calyptra
(d) peristome teeth

14 In bryophytes, organs are referred to as leaf-like and stem-like and not the true leaf and stem because
(a) they lack vascular tissues
(b) they are non-green
(c) they do not function as leaf and stem
(d) All of the above

15 *Sphagnum* is used as a packing material for transporting living plants because of its
(a) acidic nature, it does not undergo decay
(b) creeping capacity
(c) water absorbing capacity
(d) Both (a) and (c)

16 In archegonium of *Funaria*, the number of neck canal cells are
(a) 2 (b) 3 (c) 5 (d) 8-10

17 The given figure represents the plant body of *Funaria*. Identify *A*–*C*.



	A	B	C
(a)	Capsule	Seta	Rhizoids
(b)	Gametangium	Neck	Roots
(c)	Capsule	Stem	Rhizoids
(d)	Indusium	Seta	Corralloid roots

18 An important character from evolutionary view point in *Selaginella* is

(a) heterosporous nature (b) rhizophore
(c) strobili (d) ligule

19 In mosses, the sex organs are present in the

(a) protonema stage (b) sporophytic stage
(c) leafy stage (d) None of these

20 In which of the following groups would you place a plant which produces spores and embryos but lacks seed and vascular tissue?

(a) Bryophyta (b) Pteridophyta
(c) Ferns (d) Algae

21 Bryophytes are dependent on water because

(a) water is essential for fertilisation for their homosporous nature
(b) water is essential for their vegetative propagation
(c) the sperms are transported easily to egg in the archegonium
(d) archegonium has to remain filled with water for fertilisation

22 The plant body of moss (*Funaria*) is

(a) completely sporophyte
(b) completely gametophyte
(c) predominantly sporophyte with gametophyte
(d) predominantly gametophyte with sporophyte

23 The sporophyte in *Funaria* is

(a) the dominant and main phase of the plant body
(b) differentiated into distinct foot, seta and capsule
(c) parasite on the gametophyte
(d) Both (b) and (c)

24 Sperms of both *Funaria* and *Pteris* were released together near the archegonia of *Pteris*. Only *Pteris* sperms enter the archegonia as

(a) *Pteris* archegonia repel *Funaria* sperms
(b) *Funaria* sperms get killed by *Pteris* sperms
(c) *Funaria* sperms are less mobile
(d) *Pteris* archegonia release chemical to attract its sperms

25 Bryophytes resemble algae on which of the following basis?

(a) Differentiation of the plant body into root, stem and heterotrophic mode of nutrition
(b) Thallus-like plant body; lack of vascular tissue; absence of root and autotrophic mode of nutrition
(c) Thallus-like plant body; presence of roots and heterotrophic mode of nutrition
(d) Filamentous body; presence of vascular tissue and autotrophic mode of nutrition

26 The sporangia of *Selaginella* are aggregated in

(a) strobilus
(b) gametophyte
(c) prothallus
(d) None of the above

27 Besides paddy fields, cyanobacteria are also found inside vegetative part of → NEET 2013

(a) *Cycas* (b) *Equisetum*
(c) *Psilotum* (d) *Pinus*

28 Common characteristics between bryophytes and pteridophytes is

(a) vascularisation
(b) terrestrial habit
(c) need of water for fertilisation
(d) independent sporophytes

29 In pteridophytes, spores germinate to give rise to

(a) thalloid gametophytes called prothallus
(b) thalloid sporophytes called prothallus
(c) thalloid sporocarp
(d) thalloid, photosynthetic sporophyte

30 In case of heterosporous pteridophyte, the gametophyte is

(a) always dioecious
(b) monoecious
(c) may be monoecious or dioecious
(d) vascular

31 Which of the following pteridophytes belongs to class–Pteropsida?

(a) *Equisetum* and *Psilotum*
(b) *Lycopodium* and *Adiantum*
(c) *Selaginella* and *Pteris*
(d) *Pteris* and *Adiantum*

32 Gametophyte of pteridophyte is

(a) short-lived, free-living and sexual organ bearing
(b) heart-shaped, dependent on sporophyte and sex organ bearing
(c) fibre-like and dependent on sporophyte
(d) semiparasite on sporophyte

33 Sex organs in pteridophytes are formed on the

(a) multicellular sporophyte
(b) specialised cells originating from sporophyte
(c) photosynthetic, free-living gametophyte
(d) parasitic gametophyte

34 Possible advantage of antheridia occurring on the under surface for fern prothallus is
(a) protection from wind
(b) protection from direct rays
(c) easy diffusion of nutrients from prothallus
(d) accumulation of capillary water

35 A well-developed archegonium with neck consisting of 4-6 rows of neck canal cells, characterises
(a) gymnosperms only
(b) bryophytes and pteridophytes
(c) pteridophytes and gymnosperms
(d) gymnosperms and flowering plants

36 For the classification of ferns, which character among those given below will be utmost important?
(a) Number of pinnae
(b) Number of pinnules
(c) Shape of leaf
(d) Position of sori and form of indusium

37 Select the correct sequential arrangement of reproductive structures for pteridophytes.
(a) Sporophyll → Strobilli → Sporangia → Spore mother cell → Spores
(b) Strobilli → Sporophyll → Sporangia → Spores
(c) Spores → Sporophyll → Sporangia → Strobili
(d) Spores → Sporangia → Sporophyll → Strobili

38 Which of the following is correct about heterospory?
(a) *Selaginella* and *Salvinia* are heterosporous
(b) Heterosporous pteridophytes have macro (large) and micro (small) spores
(c) The development of zygote within female gametophyte is the precursor to the seed habit
(d) All of the above

39 *Selaginella*, a pteridophyte shows some advances towards the seed habit. Consider the following statements.
I. Development and retention of embryo inside megasporangium.
II. Homospory
III. Formation of several megaspores within a megasporangium.
IV. Enhancement in the size of male gametophyte.
Choose the incorrect statements with regard to prerequisites for seed habit.
(a) I and III (b) I and IV
(c) II, III and IV (d) None of these

40 Gymnosperms produce neither flower nor fruit because they do not possess
(a) embryo (b) ovary
(c) ovule (d) seed

41 Roots in some gymnospermic genera form fungal association in the form of …*A*… in …*B*… . Here, A and B refer to
(a) *A*–mycorrhiza; *B*–*Pinus* (b) *A*–mycorrhiza; *B*–*Cycas*
(c) *A*–lichen; *B*–*Pinus* (d) *A*–lichen; *B*–*Cycas*

42 Coralloid roots, which host a symbiotic relationship between an alga and host plant are features of → CBSE-AIPMT 2012
(a) *Cycas* (b) *Pinus*
(c) *Pteris* (d) *Funaria*

43 A fern-like character shown by *Cycas* leaves is
(a) circinate venation (b) furcate venation
(c) lateral veins (d) All of these

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

45 From which of the following plants is a medicine for respiratory disorders obtained?
(a) *Ephedra* (b) *Eucalyptus*
(c) *Cannabis* (d) *Saccharum*

46 Winged pollen grains are present in → NEET 2018
(a) mango (b) *Cycas* (c) mustard (d) *Pinus*

47 Microsporangia in gymnosperm are produced
(a) on the middle portion of microsporophyll
(b) on the lower side of microsporophyll
(c) on the middle portion of megasporophyll
(d) at the extreme tip of microsporophyll

48 Which one of the following statements is correct?
→ NEET 2018
(a) Horsetails are gymnosperms
(b) *Selaginella* is heterosporous, while *Salvinia* is homosporous
(c) Ovules are not enclosed by ovary wall in gymnosperms
(d) Stems are usually unbranched in both *Cycas* and *Cedrus*

49 Gymnosperms are also called softwood spermatophytes because they lack → CBSE-AIPMT 2012
(a) cambium (b) phloem fibres
(c) thick-walled tracheids (d) xylem fibres

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

51 In which of the following features, *Cycas* resembles with angiosperms?
(a) Presence of vessels
(b) Circinate venation
(c) Dichotomously branched leaves
(d) Pollen tube is the carrier of male gametes

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

53 Angiosperms have dominated the land flora primarily because of their
(a) power of adaptability in diverse habitat
(b) property of producing large number of seeds
(c) nature of some pollination
(d) domestication by man

54 Female gametophyte in angiospermic plants is
(a) endosperm (b) carpel (c) ovule (d) embryo sac

55 A feature peculiar to angiosperms only is
(a) presence of archegonia (b) vascular tissue
(c) fruit formation (d) anemophily

56 Fusion of male gamete with diploid secondary nucleus produces …… and it is known as …… .
(a) PEN, triple fusion (b) PEN, syngamy
(c) zygote, syngamy (d) zygote, triple fusion

57 *Eucalyptus* differs *Cedrus* in the presence of
(a) syngamy (b) seeds
(c) archegonia (d) triple fusion

58 In angiosperm ovule, central cell of the embryo sac prior to the triple fusion contains
(a) a single haploid nucleus
(b) one diploid nucleus
(c) two haploid polar nuclei
(d) one diploid and one haploid nuclei

59 Which of the following is the difference between a monocotyledonous and a dicotyledonous plant?
(a) Monocot have two reticulate venation, while dicot have parallel venation
(b) Monocot have two cotyledons whereas dicot have one cotyledon
(c) Monocot have one cotyledon whereas dicot have two cotyledons
(d) Monocot have one egg cell in embryo sac whereas dicot have two egg cells in embryo sac

60 Compared with the gametophytes of the bryophytes, the gametophytes of vascular plants tend to be
➞ CBSE-AIPMT 2011
(a) larger but to have smaller sex organs
(b) larger and to have large sex organs
(c) smaller and to have smaller sex organs
(d) smaller but to have larger sex organs

61 In …*A*… gametophytic phase is dominant, while in …*B*… sporophytic phase is dominant.
(a) *A*–pteridophytes; *B*–algae
(b) *A*–bryophytes; *B*–pteridophytes
(c) *A*–gymnosperms; *B*–fungi
(d) *A*–angiosperms; *B*–algae

62 Which of the following statements is correct about the gametophytic stage in the alternation of generations within the life cycle?
(a) Generation that produces the gametes
(b) Generation that produces the spores
(c) Generation that produces vascular tissue
(d) The diploid generation

63 Match the following columns.

	Column I		Column II
A.	Peritrichous flagellation	1.	*Ginkgo*
B.	Living fossil	2.	*Macrocystis*
C.	Rhizophore	3.	*Escherichia coli*
D.	Smallest flowering plant	4.	*Selaginella*
E.	Largest perennial alga	5.	*Wolffia*

Codes

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

64 Match the following columns.

Column I	Column II
A. Haplontic life cycle	1. Bryophytes and pteridophytes
B. Diplontic life cycle	2. Gymnosperms and angiosperms
C. Haplo-diplontic life cycle	3. *Volvox, Spirogyra* and *Chalmydomonas*

Codes

	A	B	C
(a)	3	1	2
(b)	1	2	3
(c)	2	3	1
(d)	3	2	1

Directions (Q. Nos. 65-69) *In each of the following questions a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as*
(a) If both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(c) If Assertion is true but Reason is false.
(d) If both Assertion and Reason are false.

65 **Assertion** Green algae are ancestors of land plants.
Reason This is because of similar chlorophyll–*a* and *b*, carotenoids, cellulose and pectin in cell wall, starch, flagella in motile forms.

66 **Assertion** The life cycle of *Funaria* is called diplo-haplontic.
Reason In *Funaria*, there is alternation of haploid gametophytic and diploid sporophytic phases, one becoming parent of the other.

67 **Assertion** Mosses have evolved from algae.
Reason Protonema of mosses is similar to some green algae.

68 **Assertion** Fertilisation in *Cycas* is called zooidogamy.
Reason Fertilisation in *Cycas* takes place by the formation of pollen tube.

69 **Assertion** Female gametophyte in angiosperms is 8-nucleate and 7-celled.
Reason Double fertilisation occurs in angiosperms.

DAY PRACTICE SESSION 2

PROGRESSIVE QUESTIONS EXERCISE

1 Plants having little or no secondary growth are
(a) conifers (b) deciduous angiosperms
(c) grasses (d) cycads

2 Presence of chlorophyll-*a*, *c*, fucoxanthin with mannitol and laminarin as reserve food material are the characteristics of
(a) Chlorophyceae (b) Cyanophyceae
(c) Rhodophyceae (d) Phaeophyceae

3 In which of the following gametophyte is not independent free-living?
(a) *Funaria* (b) *Marchantia*
(c) *Pteris* (d) *Pinus*

4 Prothallus in the life cycle of pteridophyte represents
(a) the gametophytic phase
(b) the sporophytic phase
(c) the neutral phase
(d) no phase

5 People recovering from long illness are often advised to include the alga *Spirulina* in their diet because it
(a) makes the food easy to digest
(b) is rich in proteins
(c) has antibiotic properties
(d) restores the intestinal microflora

6 Classification proposed by Bentham and Hooker is mainly based on
(a) genetical characters (b) external visible characters
(c) phylogenetic characters (d) None of these

7 Conifers are adapted to tolerate extreme environmental conditions because of
(a) broad hard leaves (b) superficial stomata
(c) thick cuticle (d) the presence of vessels

8 Pteridophytes were well-adapted and advanced for survival on land but they cannot be much successful and widespread as gymnosperms and angiosperms because they lack
(a) large bodies with secondary growth
(b) freedom from water for fertilisation
(c) integumented megasporangia
(d) None of the above

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

10 Vascular bundles in monocotyledons are considered closed because
(a) a bundle sheath surrounds each bundle
(b) cambium is absent
(c) there are no vessels with perforations
(d) xylem is surrounded all around by phloem

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

12 As tracheophytes, ferns and seed plants have one thing in common.
(a) Nourishing embryo from endosperm
(b) Having phloem in vascular bundles
(c) Producing eggs in ovaries
(d) Producing pollen grains

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

14 Chief merit of Bentham and Hooker's classification is that
(a) it is a system mostly based on evolutionary concepts
(b) it is a natural system of classification of all groups of plants
(c) the description of the taxa are based on actual observation of the specimen
(d) it also considers the phylogenetic aspects

15 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 of which it belongs to.
(a) Pteridophyta
(b) Gymnosperm
(c) Monocot
(d) Bryophyta

16 The members of Chlorophyceae usually have a rigid cell wall made up of
(a) cellulose (outer layer) and algin (inner layer)
(b) pectose (inner layer) and peptidoglycan (outer layer)
(c) cellulose (inner layer) and pectose (outer layer)
(d) chitin (inner layer) and pectose (outer layer)

17 In the prothallus of vascular cryptogams, the antherozoids and eggs mature at different times. As a result

(a) there is no change in success rate of fertilisation
(b) there is high degree of sterility
(c) one can conclude that the plant is apomictic
(d) self-fertilisation is prevented

18 In pteridophytes, spores germinate to give rise to inconspicuous, small multicellular, free-living, photosynthetic, thalloid gametophyte called

(a) protonema
(b) prothallus
(c) archegonia
(d) ovule

19 Which one of the following is a primitive gymnosperm that produces motile sperms, bears ovulate and microsporangiate cones on different plants and has foul-smelling, fleshy seeds?

(a) *Pinus* (b) *Cycas*
(c) *Ginkgo* (d) *Gnetum*

20 Mosses and ferns are found in moist and shady places because both

(a) require presence of water for fertilisation
(b) do not need sunlight for photosynthesis
(c) depend for their nutrition on microorganism, which can survive only at low temperature
(d) cannot compete with sun-loving plants

21 In bryophytes, the male sex organ (antheridium) consists of

(a) somewhat elongated, swollen sac borne on a more or less slender stalk
(b) flask-shaped structure, the swollen basal portion of, which is termed the venter and the upper portion is the neck
(c) single microspore mother cell
(d) an annulus

22 Monoecious plant of *Chara* shows occurrence of

(a) antheridiophore and archegoniophore on the same plant
(b) stamen and carpel on the same plant
(c) upper antheridium and lower oogonium on the same plant
(d) upper oogonium and lower antheridium on the same plant

23 Which of the following is not correct about algae?

(a) *Porphyra*, *Laminaria* and *Sargassum* are edible algae
(b) Agar-agar, which is used to grow microbes in culture media, is obtained from *Gelidium* and *Gracilaria*
(c) Algin is obtained from red algae, while carrageenan from brown algae
(d) *Chlorella* and *Spirulina* are unicellular algae rich in protein

24 Read the following five statements (I to V) and select the option with all correct statements:

I. Mosses and lichens are the first organisms to colonise a bare rock.
II. *Selaginella* is a homosporous pteridophyte.
III. Coralloid roots in *Cycas* have VAM.
IV. Main plant body in bryophytes is gametophytic, whereas in pteridophytes it is sporophytic.
V. In gymnosperms, male and female gametophytes are present within sporangia located on sporophyte.

(a) I, III and IV
(b) II, III and IV
(c) I, IV and IV
(d) II, III and IV

25 How many of these features are correct for gymnosperms?

Heterosporous, Homosporous, Bisporangiate, Zooidogamy, Entomophily, Siphonogamy, Roots with Mycorrhizae, Ramenta, Circinate, Vernation

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

26 Match the following columns.

	Column I		Column II
A.	Liverworts	1.	*Funaria*
B.	Hornworts	2.	*Anthoceros*
C.	Mosses	3.	*Riccia*
D.	Gnetales	4.	*Ephedra*

Codes

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

27 Match the following columns.

	Column I		Column II
A.	Protonema	1.	Numerous neck canal cells in the capsule
B.	Collumella	2.	Bryophyte of economic importance
C.	*Sphagnum*	3.	Haploid structure of *Funaria*
D.	*Funaria*	4.	Middle sterile region in moss capsule

Codes

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

Directions (Q. Nos. 28 and 29) *In each of the following questions a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as*

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

28 **Assertion** Bryophytes are amongst land plants.

Reason Fixation occurs by means of rhizoids in bryophytes.

29 **Assertion** Bryophytes, pteridophytes and spermatophytes are also collectively called embryophyta.

Reason All their members possess an embryo stage.

ANSWERS

SESSION 1

1 (d)	**2** (d)	**3** (c)	**4** (b)	**5** (c)	**6** (c)	**7** (d)	**8** (b)	**9** (b)	**10** (d)
11 (a)	**12** (c)	**13** (a)	**14** (c)	**15** (c)	**16** (d)	**17** (a)	**18** (a)	**19** (c)	**20** (a)
21 (c)	**22** (d)	**23** (d)	**24** (d)	**25** (b)	**26.** (a)	**27** (a)	**28** (c)	**29** (a)	**30** (a)
31 (d)	**32** (d)	**33** (c)	**34** (a)	**35** (b)	**36** (d)	**37** (a)	**38** (d)	**39** (c)	**40** (b)
41 (a)	**42** (a)	**43** (a)	**44** (d)	**45** (a)	**46** (d)	**47** (d)	**48** (c)	**49** (d)	**50** (b)
51 (d)	**52** (b)	**53** (a)	**54** (d)	**55** (c)	**56** (a)	**57** (d)	**58** (c)	**59** (c)	**60** (c)
61 (b)	**62** (a)	**63** (a)	**64** (d)	**65** (a)	**66** (b)	**67** (a)	**68** (b)	**69** (b)	

SESSION 2

1 (c)	**2** (d)	**3** (d)	**4** (a)	**5** (b)	**6** (b)	**7** (c)	**8** (b)	**9** (b)	**10** (b)
11 (a)	**12** (b)	**13** (c)	**14** (c)	**15** (d)	**16** (c)	**17** (d)	**18** (b)	**19** (c)	**20** (a)
21 (a)	**22** (d)	**23** (c)	**24** (c)	**25** (c)	**26.** (c)	**27** (b)	**28** (b)	**29** (a)	