XI
3

PLANT KINGDOM

SYLLABUS

Salient features and classification of plants into major groups-Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms (three to five salient and distinguishing features and at least two examples of each category); Angiosperms- classification up to class, characteristic features and examples).

KEY CONCEPTS

PLANT CLASSIFICATION SYSTEMS

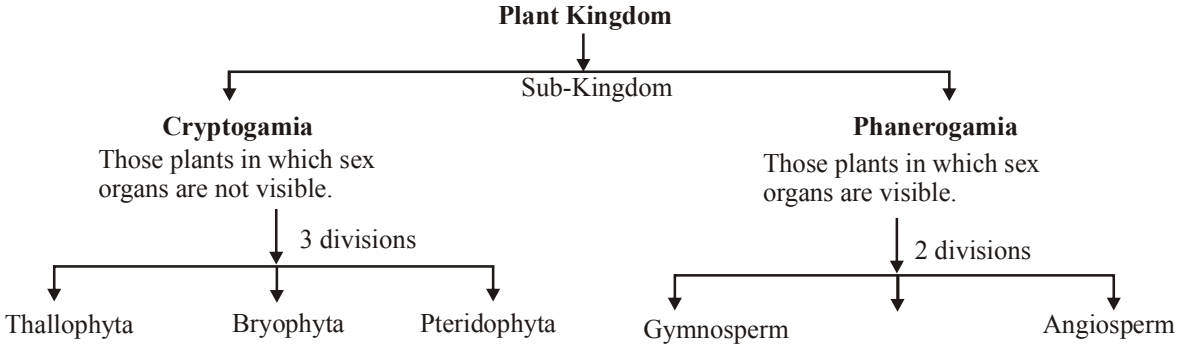
* Traditionally plant kingdom has been divided into two sub-kingdoms named as **phanerogamae** and **cryptogamae.**

(a) Cryptogamae (kryptos-concealed, gamos-marriage) :

* All non flowering plants such as algae, fungi, lichen, mosses and ferns are included in this sub-kingdom.
* The cryptogams are further classified into three divisions-thallophyta, bryophyta & pteridophyta.

(b) Phanerogamae (phaneros-visible, gamos-marriage) :

* All flowering plants which bear seeds are included in this group. They are also known as **spermatophytes (sperma-seed, phyton-plant),** since they produce seeds.
* These seed bearing plants are further divided into two divisions gymnospermae and angiospermae.



* Gymnosperms have naked ovules or seeds. The angiosperms (covered seed) include all the flowering plants which produce seed and have ovules enclosed in ovary or fruit.

A. Early attempts for classification

* **Aristotle** and other Greek philosophers divided living organisms into two groups: plants and animals.

* **Aristotle** also divided plants into 3 groups- herbs, shrubs and trees.
* **Charaka** (the father of Ayurveda), in 1 st century A.D., listed 200 kinds of animals and 340 kinds of plants in his book **'Charaka Samhita'.**

B. Artificial System of Classification

* It is based on a few morphological characters of vegetative nature for grouping of organisms.
* **Theophrastus** proposed the first system of artificial classification of plants on the basis of habit and classified plants into herbs, shrubs, undershrubs and trees.
* **Carolus Linnaeus** (1707-1778) proposed the artificial system of classification based exclusively on nature and number of stamens and carpels. It was called as Sexual System of Classification.

Drawbacks :

* This system was based on one or a few characters, hence the diverse plants were placed into limited number of groups.
* Natural affinities and phylogenetic relationships were not considered.
* The artificial system gave equal weightage to vegetative and sexual characters; this is not acceptable and since we know that often the vegetative characters are more easily affected by environment.

C. Natural System of Classification

* Also known as **horizontal system** of classification or 2 **D system.**
* Organisms in this system are classified on the basis of natural affinities.
* This system uses as many taxonomic characters as possible to group organisms.
* This classification is mainly based on forms, relationship realising all information available at the time of collection of plants. This also considers internal features like ultrastructure, anatomy, embryology and phytochemistry .
* Common natural systems were proposed by - John Ray, de Jussiaeu, de Candolle, Bentham and Hooker etc.

D. Phylogenetic System of Classification

* The term phylogeny was given by Lamarck and concept of phylogeny by E. Haeckel.
* Phylogeny is the evolutionary history of the organism. This system is also called **'3D' or vertical system.**
* In this system, plants are classified according to their evolutionary and genetic affinities.
* Organisms belonging to same taxa are believed to have a common ancestor .
* **A.W. Eichler** modified Bentham and Hooker's system of classification by placing gymnosperms in the beginning. He is also called as the pioneer in phylogenetic system of classification.
* Eichler classified plant kingdom into five divisions and arranged them in the order of evolution.
  Thallophyta → Bryophyta → Pteridophyta → Gymnosperm → Angiosperm
* **Adolph Engler and Karl A.E. Prantl,** two german botanists, adopted their system in **"Die naturalichen Pflanzen famhien"** (1887-1915). It was a German work which was later translated in English. The work had 23 volumes.

Merits:

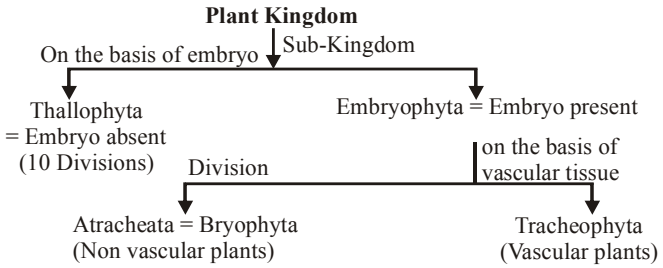
* In this system families are arranged according to increasing complexity of flowers.

Demerits:

* Monocots were considered primitive to dicots.
* According to this system, primitive forms having naked flowers were kept in the beginning.
* The more advanced families have distinct perianth while the highly evolved families have fused perianth.
* Hutchinson, Oswald Tippo, Takhtajan and Cronquist also proposed phylogenetic systems of classification.

Oswald Tippo :

* Proposed the biggest phylogenetic classification of plant kingdom.
* This classification is the complete classification of plant kingdom.
* This is the most acceptable classification for books and study.



BRANCHES OF TAXONOMY

1. Classical Taxonomy:

* In this taxonomy, organisms are classified on the basis of natural affinities.
* These affinities or relationships realise all informations available at the time of collection of plant, *e.g.,* natural systems of classification.

2. Numerical Taxonomy / Phenetics/ Taximetrics/Adansonian Taxonomy:

* In this taxonomy, there is use of numerical methods for the evaluation of similarities and differences between the species.
* Firstly, number and codes are assigned to all the characters. Then, all possible characters are compared by sophisticated calculating machines and computers without giving emphasis on a particular character.
* All characters considered for analysis are given equal importance.
* The organization and analysis of data forms the core of this taxonomy.
* The family tree prepared on the basis of phenetics is called **dendrogram.**

3. Cytotaxonomy/Karyotaxonomy :

* It is based on cytological informations of the cell, chromosome number, structure and behaviour of chromosomes during meiosis.

4. Biochemical (Chemotaxonomy) :

* It is related with the chemical properties of plant, for example, fragrance by the presence of any aromatic compound, presence of specific crystal structures of calcium oxalate (raphides) or calcium carbonate (cystolith).
* The sequencing of DNA and chemical nature of proteins have also been used in this taxonomy.
* Taxonomy is divided into three types by **Turril.**

(i) **Alpha Taxonomy:** It deals with the collection and identification of organism on the basis of gross morphology.

(ii) **Beta Taxonomy :** It deals with the collection and identification of organism on the basis of morphology and all possible evidences from cytology, anatomy, physiology and genetics.

(iii) **Omega Taxonomy :** It is based on microscopic observations and biochemical evidences.

ALGAE

* Algae are chlorophyll containing, simple, thalloid (plant body not differentiated into root, stem and leaf) and autotropic organisms.
* The main characteristics of algae are:

1. Algae are largely aquatic (both fresh water and marine) organisms. They occur in a variety of other habitats: moist stones, soils and wood. Some of them also occur in association with fungi (lichen) and animals (e.g., on sloth bear).

2. The form and size of algae is highly variable. The size ranges from the microscopic unicellular forms like *Chlamydomonas*, to **colonial** forms like *Volvox* and to the **filamentous** forms like *Ulothrix* and *Spirogyra*. A few of the marine forms such as **kelps**, form massive plant bodies.

3. Vascular tissues are absent. Being aquatic, water conduction is not required even in giant forms.

4. The algae reproduce by vegetative, asexual and sexual methods.

5. **Vegetative reproduction** is by fragmentation. Each fragment develops into a thallus.

6. Asexual reproduction is by the production of different types of spores, the most common being the **zoospores**. They are flagellated (motile) and on germination gives rise to new plants.

7. Sex organs are non- jacketed and unicellular. Sexual reproduction takes place through fusion of two gametes. These gametes can be flagellated and similar in size (as in *Ulothrix*) or non-flagellated (non-motile) but similar in size (as in Spirogyra). Such reproduction is called **isogamous**. Fusion of two gametes dissimilar in

size, as in some species of *Udorina* is termed as **anisogamous**. Fusion between one large, non-motile (static) female gamete and a smaller, motile male gamete is termed **oogamous**, e.g., *Volvox, Fucus*.

8. Life cycle is of various types such as haplontic, diplontic or diplohaplontic.

Common names of algae

Spirogyra - Pond silk or pond scum
Chara - Stonewort
Ulva - Sea lettuce
Sargassum - Gulf weed or Sargasso weed
Macrocystis - Gaint Kelp
Thallassiophyllum - Sea fern
Cosmarium & Closterium - Desmids
Batrachospermum - Frog spawn algae
Acetabularia - Umbrella plant
Nostoc - Hair Vegetable
Fucus - Rock weed
Chlorella - Space algae
Hydrodictyon - Web of water beautiful algae
Nereocystic - Sea palm
Laminaria - Sea apron or sea kelp
Pyrrophyta - Fire algae
Volvox - Rolling algae

Types of Algae

* **Kingdom Plantae of Whittaker (1969) includes mainly three types of algae**-red algae, brown algae and green algae.

Table : Types of Algae

Classes	Major pigments	Stored food	Cell wall	Flagellar Number and Position of Insertions	Examples
Chlorophyceae (Green algae)	Chlorophyll a, b	Starch	Cellulose	2-8, equal, apical	*Chlamydomonas, Volvox, Ulothrix, Spirogyra* and *Chara*
Phaeophyceae (Brown algae)	Chlorophyll a, c, fucoxanthin	Mannitol, laminarin	Cellulose and algin	2, unequal, lateral	*Ectocarpus, Dictyota, Laminaria, Sargassum* and *Fucus*
Rhodophyceae (Red algae)	Chlorophyll a, d, phycoerythrin	Floridean starch	Cellulose	Absent	*Polysiphonia, Porphyra Gracilaria* and *Gelidium.*

I. Green Algae -Chlorophyceae

* Majority of the species in this group are fresh water. Some species are marine, *e.g., Acetabularia* (largest plant cell), *Codium, Ulva, Caulerpa.*

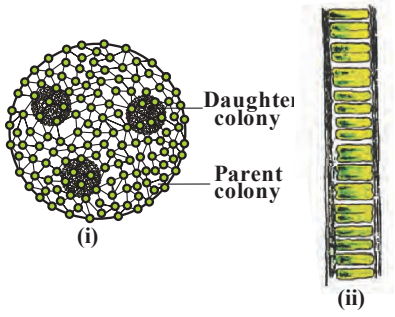


Figure : Green algae : (i) *Volvox* (ii) *Ulothrix*

* Cell wall contains inner cellulose and an outer pectose layer.
* Photosynthetic pigments are similar to those of higher plants-chlorophyll a, chlorophyll b, carotenes and xanthophyills.
* Food reserve is starch. Some algae may store food in the form of oil droplets.
* Chloroplasts generally contain pyrenoids (one or more) for storage of starch. Pyrenoids contain protein besides starch. Chloroplast may have variety of shapes like: Spiral -*Spirogyra,* Star shaped -*Zygnema,* Reticulate -*Oedogonium,* Cup shaped -*Chlamydomonas,* Girdle / Horse shoe shaped -*Ulothrix* and Discoid -*Chlorella.*

* Vegetative reproduction occurs by fragmentation.
* Asexual reproduction takes place by flagellated spores. The common asexual structures are zoospores, aplanospores, hypnospores, akinetes, autospores, etc.
* Sexual reproduction shows considerable variations in the type and formation of sex cells and the methods include isogamy, anisogamy and oogamy.
* Three types of life cycles occur in green algae - haplontic, diplontic and diplohaplontic.
* In haplontic life cycle, the dominant phase is haploid. It is characterised by zygotic meiosis, *e.g., Ulothrix, Spirogyra, Chlamydomonas.* In diplontic life cycle, the dominant phase of the alga is diploid.
* It gives rise to haploid gametes through meiosis (gametic meiosis, *e.g., Caulerpa).* The haplo-diplontic life cycle possesses well developed multicellular haploid and diploid thallus.
* It is characterised by sporic meiosis, *e.g., Ulva, Cladophora.*

Economic importance

* *Codium* and *Ulva* (Sea lettuce) is used as salad or vegetable in European countries after drying and salting.
* *Chlorella pyrenoidosa* (called space alga) is used by exobiologists for food, oxygen and disposal of CO_2 and organic waste in prolonged space flight.
* *Cephaleuros virescence* -It is a parasitic green alga which causes red rust of tea disease.

Based upon habitat green algae may be:

* Cryophyte-e.g., Chlamydomonas nivalis is present in snow.
* Endozoic (inside body of animals) -*e.g., Zoochlorella* present inside Hydra.
* Epizoic (on the surface of animals) -e.g., Characium on crustaceans, Cladophora on molluscan shells.
* Symbiotic -e.g., Trebouxia and Trentepohlia form lichen.
* Parasitic -e.g., Cephaleuros sp. causing red rust of tea and coffee.

II. Brown Algae -Phaeophyceae

* Found primarily in marine habitats.
* The body shows great variation of size and form. It may consist of a branched filamentous structure in lower forms *(e.g., Ectocarpus)* and parenchymatous structure in higher forms *(e.g., Sargassum, Laminaria, Fucus, Macrocystis).* **No unicellular forms are known.**
* Brown algae include the largest algae. The giant brown algae are called **kelps** which may reach a height of 100 m. The largest kelps are *Macrocystis* and *Nereocystis*.

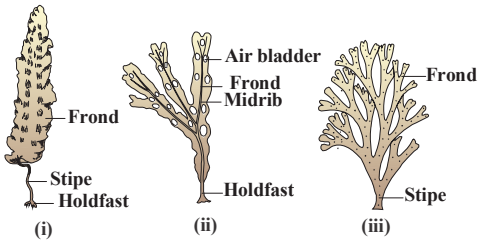


Figure : Brown algae (i) *Laminaria* (ii) *Fucus* (iii) *Dictyota*

* The plant body is often differentiated into holdfast (for attachment), stipe (stalk) and lamina (frond -leaf like photosynthetic organ). A few species of *Sargassum* and *Fucus* are free floating.
* Free floating forms are menace to shipping industry, as they get attached to the bottom of the ships. The large forms often possess **air vesicles** or bladders for providing buoyancy.
* Cell wall contains inner cellulose layer and outer mucilagenous layer, and phycocolloid like **algin** which forms a gelatinous layer.
* Phycocolloids of brown algae are nonsulphated polysaccharides. The common ones are **alginic acid, fucoidin** and **fucin.**
* They are copious in species dwelling in tidal areas. Phycocolloids prevent desiccation during low tide, freezing under low temperature and injury when beaten against rocks.
* The brown colour of algae is due to the presence of large amount of xanthophyll called **fucoxanthin.**

* Photosynthetic pigment is chlorophyll a and c. **laminarin starch** and **mannitol.**
* Cells possess refractile vesicles called **fucosan vesicles.** The vesicles contain a phenolic chemical named **fucosan.** Fucosan is colourless inside water but becomes brown or black on exposure to air.
* Conducting tubes or **trumpet hyphae** to transfer food from lamina to holdfast are present in larger brown algae or kelps.
* Vegetative reproduction occurs through **fragmentation** *(e.g., Sargassum)* , adventitious branches, stolons *(e.g., Dictyota)* etc.
* Asexual reproduction occurs with the help of both motile and non-motile spores. The motile spores or zoospores are pear shaped having **heterokont flagellation** with one smooth whiplash flagellum and other of tinsel type (hairy). These are laterally inserted. Spores in phaeophyceae are produced in different types of sporangia :

(i) **Unilocular sporangia-**In this sporangia, biflagellate zoospores are meiotically produced. These zoospores (n) gives rise to haploid plant or **gametophyte** on germination.

(ii) **Plurilocular or neutral sporangia-**These multicellular sporangia are produced on the diploid plants. Zoospores (2n) are formed by mitosis in large number and on germination gives rise to diploid plants.

* Sexual reproduction varies from **isogamy, anisogamy to oogamy.** In isogamy and anisogamy both gametes are motile with heterokont flagellation. In oogamy, only the male gametes are motile and female gametes are non-motile.
* **Isomorphic alternation of generations** is found in some brown algae, *e.g., Ectocarpus, Dictyota.* Here both the haploid and diploid generations are present and are similar in structure.
* In many brown algae, the diploid generation or phase is dominant. The haploid generation or phase is either microscopic or represented by gametes only *(e.g., Fucus* and *Sargassum).* Heteromorphic alternation of generation is found in *Laminaria.*

Economic importance

* **Iodine:** *Fucus* and *Laminaria* are rich sources of iodine. Potash is abundant in *Macrocystis* and *Nereocystis.*
* **Medicines:** Sodium laminarin sulphate is blood anticoagulant. *Durvillea* has worm expelling properties.
* **Food :** A number of brown algae are used as food in some countries, *e.g., Laminaria* (Kombu), *Macrocystis, Sargassum* and *Alaria* (Sarumen). The edible brown algae are also used as fodder.
* **Alginic acid:** It is phycocolioid which is obtained commercially from a number of brown algae including the giant ones *(e.g., Laminaria, Macrocystis, Nereocystis, Fucus, Sargassum).* Alginic acid and its salts are used in forming emulsions (ice creams, ointments, toothpastes, cosmetics, creams, shampoos, etc.), sizing textiles, flame proof plastics and sound proofing.

III. Red Algae -Rhodophyceae

* They are mostly marine (in warmer areas) occur in both well-lighted regions close to the surface of water and at great depths in oceans where relatively little light penetrates.
* Red algae are autotrophic.
* Motile or flagellate stage is absent throughout the life cycle.
* The plant body varies from **unicellular** *(e.g., Porphyridium)*, **filamentous** *(e.g., Asterocystis)*, **parenchymatous sheets** *(e.g., Porphyra)*, **ribbons** *(e.g., Chondrus)* to graceful **lace-like** sea weeds *(e.g., Gelidium).*
* Cell wall possesses cellulose, pectic compounds and sulphated polysaccharides called **phycocolloids.** The important phycocolloids of rhodophytes are **agar** and **carrageenin.**

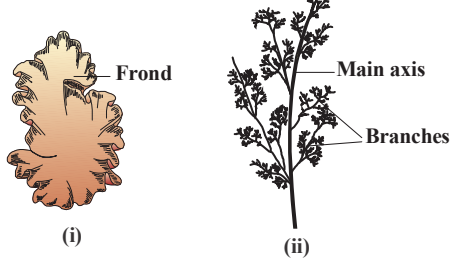
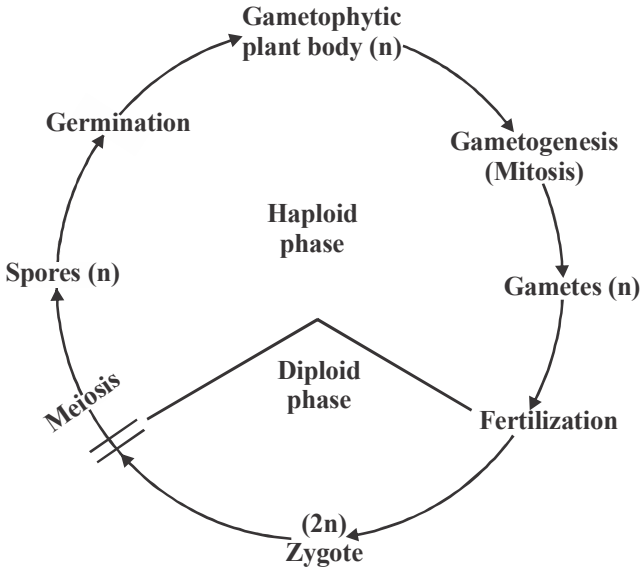


Figure : Red algae :
(i) *Porphyra* (ii) *Polysiphonia*

* The photosynthetic organelles are called **chromatophores.** They have unstacked or single thylakoids.
* Photosynthetic pigments include **chlorophyll** a, d, **carotenoids** and **phycobilins.** Phycobilins are water soluble pigments namely, red coloured **phycoerythrin,** blue coloured **phycocyanin** and **allophycocyanin** (similar pigments also occur in blue green algae).
* Reserve food is **floridean starch** (in constitution, it is very much similar to glycogen). Another soluble sugar fluoridoside (a galactoside of glycerol) is also found.
* The red colour of red algae is due to abundant formation of phycoerythrin. Phycoerythrin is able to absorb blue green wavelengths of light. Being shorter, these wavelengths are able to reach the maximum depth in water. Therefore, **red algae reach the maximum depth in sea** where no other type of photosynthetic organisms grow. However, rhodophytes living in shallower water do not appear reddish due to lesser synthesis of phycoerythrin. They are greenish, violet or purplish *(e.g., Batrac hospermum* is bluish green in colour).
* Vegetative reproduction occurs by fragmentation.
* Asexual reproduction takes place through a variety of non-motile spores -**neutral spores, monospores, tetraspores, carpospores** etc.
* Sexual reproduction is highly advanced and **oogamous.** It is accompanied by complex post fertilization changes. The male sex organ is called **spermatangium or antheridium.** It produces nonflagellate male gamete known as **spermatium.** The female sex organ is flask-shaped and is termed **carpogonium.** Carpogonium possesses an elongated receptive neck like **trichogyne.** Spermatia are carried by water currents to trichogyne tips for affecting fertilization.
* Alternation of haploid and diploid multicellular generations occur in many algae.

* **Life cycle in most of the algae**



Economic importance

(i) Phycocolloids:

* A number of phycocolloids are extracted for commercial use. They include agar, carrageenin and funori.
* **Agar** is used in solidifying laboratory culture media for microbes and is added as stabilliser or thickener in the preparation of jellies, puddings, creams, cheese, bakery, etc.
* **Agar is obtained from** *Gelidium* and *Gracilaria.*
* **Carrageenin** is used as a clearing agent in liquors, leather finishing and as emulsifier in chocolates, ice-creams, toothpastes, paints etc. It is extracted from *Chondrus.*
* **Funori** is a glue, used as adhesive and in sizing textiles, paper etc. **It is obtained from** *Gloiopeltis.*

(ii) Food:

* A number of red algae are edible, *e.g., Porphyra* (Laver), *Rhodymenia* (Dulse), *Chondrus* **(Irish** Moss). *Rhodymenia* (also called **sheep's weed)** is also used as fodder. *Porphyra* is cultivated in Japan for commercial exploitation.

* **Batrachospermum** is a fresh water red alga.
* Some red algae have deposits of $CaCO_3$ on their body surface, like **Corallina,** these contribute to coral reef formation.
* **Harveyella** is a parasitic, colourless red algae.

BRYOPHYTA

* Bryophytes are non- vascular terrestrial plants of moist habitats in which a multicellular diploid sporophyte living as a parasite on an independent multicellular haploid gametophyte.
* Bryophytes include the various mosses and liverworts that are found commonly growing in moist shaded areas in the hills.

General characters of Bryophyta

* Bryophytes live in damp, humid and shaded habitats. They may form green carpets or mats on damp soil, rocks, walls, tree trunks during rainy season.
* The dominant phase or plant body is a **free living gametophyte** (n). It is thallus like and may be prostrate or erect.
* **Vascular tissues are absent.**
* True stem, leaf and roots are absent. Instead, rhizoids occur for attachment. The latter may be unicellular *(e.g., Riccia* and *Anthoceros)* or multicellular *(e.g.,* mosses).
* **Vegetative reproduction is quite common** through fragmentation, tubers, gemmae, buds, adventitious branches etc.
* Asexual reproduction by **mitospores is absent.**
* Sex organs are **multicellular and jacketed,** called **antheridium** (male) and **archegonium** (female). The jacket cells are sterile **(Bryophytes are first archegoniates).**
* Antherozoid is twisted and comma shaped with two flagella.
* An external layer of **water is essential** for the swimming of male gametes to reach the archegonia *i.e.,* **zooidogamy.** So these are called **amphibians of plant kingdom.**
* Zygotes do not undergo reduction division immediately. It develops inside archegonia and **divides by mitosis** to produce embryo (so these are considered as **first embryophytes).** The embryo develops further into a sporophyte **which is parasitic over the gametophyte** (may be partial pasasite as in mosses).
* The sporophyte of bryophytes is also called **sporogonium,** it is composed of **three parts** viz, **capsule, seta** and **foot.**
* It produces meiospores or haploid spores inside the capsule part (after meiosis in spore mother cells), while attached to the gametophyte.
* All bryophytes produce only one type of spores **(Homosporous).**
* On germination each spore produces a gametophyte (either directly or through a juvenile filamentous stage called **protonema,** *e.g.,* in mosses).
* Bryophytes show heteromorphic or heterologous alternation of generations in the life cycle *i.e.,* **haplodiplontic life cycle.**

* Term bryophyta was proposed by **Brown. Hedwig** is called father of bryology. **Prof. Shiv Ram Kashyap** is known as **"Father of Indian Bryology"**.
* *Aquatic bryophytes are* ***Riccia fluitans, Ricciocarpus, Fontinalis and Riella.*** *Saprophytic bryophytes* ***are Buxbaumia and Cryptothallus,*** *while* ***Frullania*** *is an epiphytic form.*

Economic importance of Bryophytes

(i) **Prevention of soil erosion:** Bryophytes, especially mosses, form dense mats over the soil and prevent soil erosion against falling rains.

(ii) **Soil formation:** Mosses are an important link in plant succession on rocky areas. They take part in building soil in rock crevices formed by lichens. Growth of *Sphagnum* **(Bog moss)** ultimately fills

ponds and lakes with soil.

(iii) **Water retention** : Dry *Sphagnum* has great water absorbing capacity. This characteristic is employed by gardeners to keep seedlings and cut plants moist during transportation and propagation. *Sphagnum* moss was used in place of absorbent cotton, so is also called **cotton moss.**

(iv) **Peat:** *Sphagnum* often grows in acidic marshes. The older dead parts of moss and other marshy plants got slowly carbonised, compressed and fossilised over thousands of years and have produced a dark spongy mass called **peat.** Peat is dried, compressed and cut to form blocks. The peat blocks are used as fuel. Peat is also a good manure. It overcomes soil alkalinity and increases its water retention as well as aeration.

Classification of Bryophyta

* The bryophytes are divided into liverworts and mosses.

Liverworts

* They have thalloid structure *(e.g., Riccia, Marchantia)* with dorsiventral symmetry. On the ventral side of the thallus they have multicelled scales and unicelled **rhizoids.** Thallus has two distinct zones *i.e.,* assimilatory and storage.
* Leafy members like *Porella* have leaf like tiny appendages in two rows on the stem like structures.
* Asexual reproduction occur by means of fragmentation, or by specialized structure called **gemmae** *(e.g., Marchantia)*. These are '8' shaped, stalked, green and multicellular asexual buds developing in small receptacles (gemma cups) on dorsal surface of thallus. **Each gemma germinates to produce two thalli** in *Marchantia.*
* Antheridia and archegonia are scattered and found embedded in dorsal side of thallus *(e.g., Riccia)* or may be projected from the thallus in form of stalked receptacles called **antheridiophore and archegoniophore** respectively *(e.g., Marchantia).*

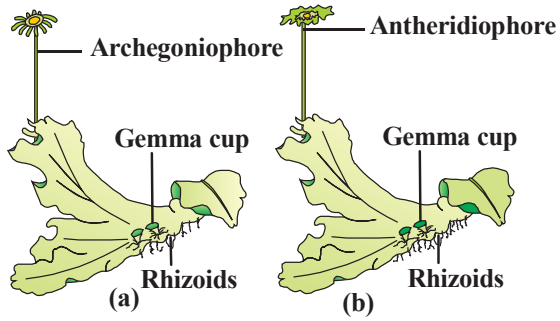


Figure : Bryophytes: A liverwort – *Marchantia* (a) Female thallus (b) Male thallus

* Sporophyte may be represented by capsule only *(e.g. , Riccia)* or differentiated into foot, seta and capsule *(e.g., Marchantia).*
* Capsule may contain spores only *(e.g., Riccia)* or spores and elaters *(e.g., Marchantia).* **Elaters** are diploid, hygroscopic structures with spiral thickenings which help in spore dispersal.
* Sporophyte lacks assimilatory tissue, thus it is a complete parasite over the gametophyte.
* Spores (n) germinate to form the thalloid gametophyte.

Mosses:

* Gametophytic phase consist of two stages -first is **protonema** (juvenile stage) , and second is **gametophore** or leafy stage (mature).
* **Protonema** is filamentous, creeping, green and branched structure developing through spore germination.
* **Gametophore** consist of erect axis bearing spirally arranged leaves and sex organs.
* Rhizoids are multicellular (with oblique septa) and branched.
* Vegetative reproduction occurs by fragmentation and secondary protonema (filament developing from structure other than spore).
* Sex organs develop in the axis of leaves.
* The mosses have an elaborate mechanism of spore dispersal from capsule.
* Mosses may be known by different names : Cord moss *(Funaria),* Maiden hair moss *(Pogonatum),* Peat/Bog moss *(Sphagnum),* Hair cap moss *(Polytrichum).*

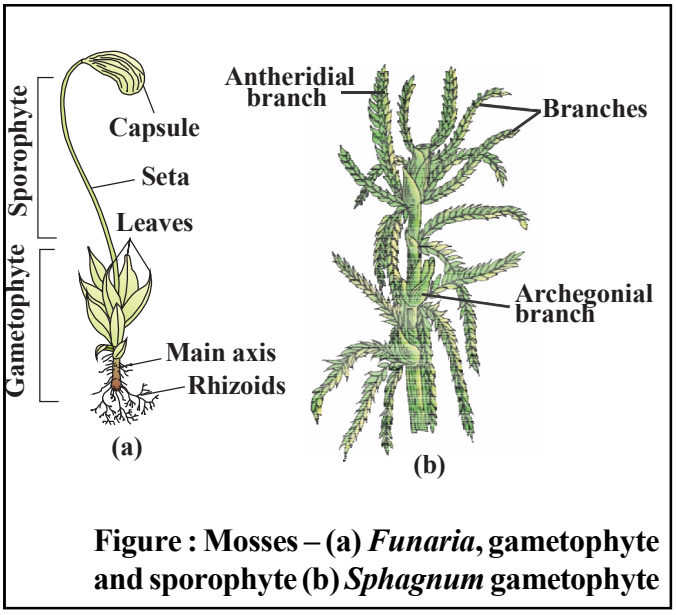
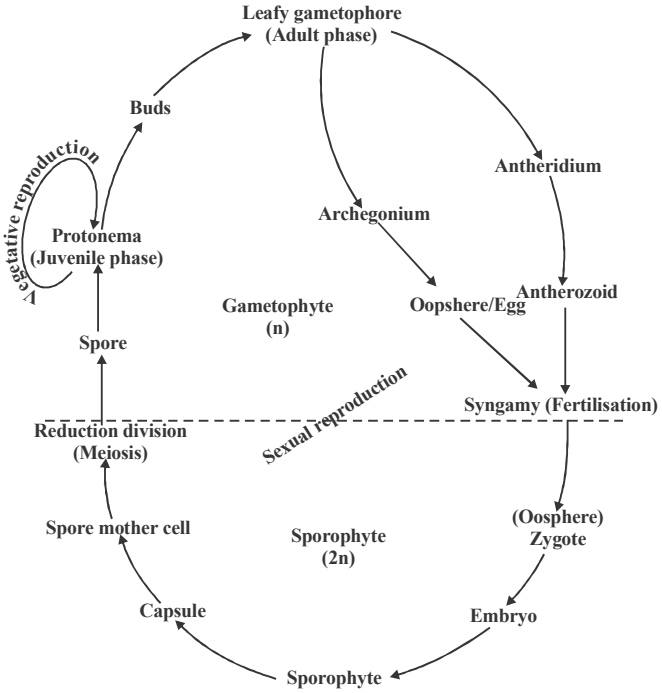


Figure : Mosses – (a) *Funaria*, gametophyte and sporophyte (b) *Sphagnum* gametophyte

Life cycle of Moss

* A typical moss plant like *Funaria* grows in moist, shady places forming dense carpet on soils, rocks, tree trunks etc., during the rainy season.
* The radially symmetric plant body is differentiated into stem or axis, **leaves or phylloids** and rhizoids.
* The rhizoids are multicellular. Moss plants multiply extensively by vegetative means.
* **Graphical representation of life cycle of moss**



Reproduction

1. **Vegetative reproduction:** It occurs by following ways:

(i) **Apospory -** Formation of gametophyte *(i.e.,* the plant body) from sporophyte without meiosis.

(ii) **Protonema buds -** Primary protonema formed as a result of spore germination gives rise to group of cells called buds. These buds when separated give rise to new plants.

2. **Sexual reproduction:** *Funaria* is monoecious and autoecious plant *i.e.,* male and female sex organs are borne on same plant, but on different branches, called as antheridial and archegonial branch respectively.

Antheridium

* Cluster of antheridia (male sex organ) are borne on antheridial branch, surrounded by a large number of closely arranged perigonial leaves.
* An antheridium is a club-shaped structure.
* There is a single layered jacket which encloses mass of sperm mother cell (androcyte) which produces two biflagellate antherozoids(motile male gametes).

Archegonium

* At the apex of archegonial branch, archegonia (female sex organ) intermingled with paraphyses are present, surrounded by a cluster of perichaetial leaves.

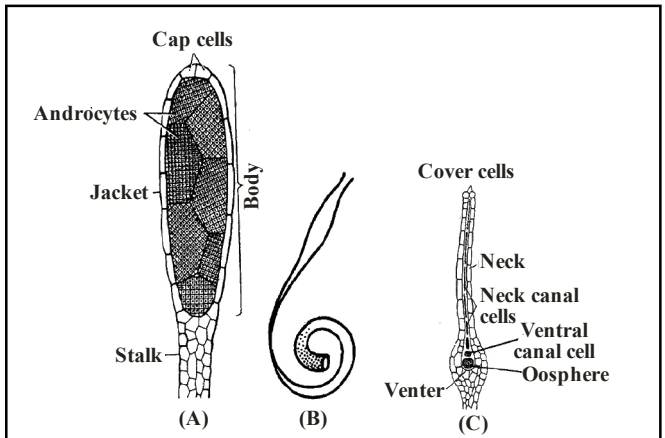


Figure : *Funaria* : (A) An antheridium, (B) One antherozoid,(C) An archegonium

* An archegonium is a flask-shaped structure having a multicellular stalk.

* It has a tubular neck and a swollen basal venter.
* Venter has a two-layered wall which encloses two cells, a venter canal cell and an egg or oosphere. The neck has a single layered wall made of 6-spirally twisted rows of cells.

Development of Sporophyte

* The venter cells form a cover over zygote called **calyptra** (haploid -gametophytic tissue). The diploid oospore develops into a sporophyte. Sporophyte consists of three parts-foot, seta and capsule. Foot is embedded in the tip of gametophytic plant. It takes part in fixation of sporophyte and absorption of water and mineral salts from the gametophyte.
* **Seta** is a narrow stalk which lifts the capsule in the air. The **capsule** is further differentiated into 3 **parts-apophysis, theca** and **operculum.** Apophysis contains assimilatory tissue and stomata (having a single circular guard cell).
* **Theca contains** a central sterile column or **columella, two spore sacs,** air cavity and some assimilatory tissue. Its tip contain two rows of **acellular teeth** called **peristome.** Inside the spore sac, diploid spore mother cells are formed.
* They undergo **meiosis** and produce haploid spores.
* The haploid spores are liberated from the capsule by removal of operculum and **hygroscopic movement of peristomial teeth.**
* Since *Funaria* like mosses have some assimilatory tissue or cells with chloroplast in their sporophyte, unlike liver worts, **sporophyte of mosses are often called as semiparasite over the gametophyte.** Such cells are present in the apophysis, capsule wall and in the spores.
* On germination, each haploid spore produces a filamentous juvenile gametophyte called **protonema.** Protonema has two types of branches, green and nongreen.
* The nongreen branches **(rhizonema)** are subterranean. They function as **rhizoids.** Green branches **(chloronema)** are epiterranean.
* Protonema can multiply vegetatively. It ultimately bears buds on its green branches. The buds grow to form moss plants. The latter, therefore, represent adult gametophyte.

PTERIDOPHYTA

* They are most primitive vascular, flowerless, seedless, spore producing cryptogamic land plants.
* Commonly called **vascular amphibians** "or" **botanical snakes.** These are first successful plants on land.
* Evolutionarily these are first terrestrial plants to possess vascular tissues.
* Term pteridophyta was given by **Haeckel.**
* The pteridophytes are found in cool, damp, shady places though some may flourish well in sandy-soil conditions.
* The Pteridophytes include horsetails and ferns.
* Dominant phase of plant body is a sporophyte.
* Plant body is differentiated into **true stem, leaves and roots.**
* Vascular tissues are present.
* They are of two types, xylem and phloem.
* **In xylem ,** true vessels are absent.
* **In phloem,** companion cells and sieve tubes are absent. Instead, **sieve cells are present.**
* In pteridophytes, the main plant body is a 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 are subtended by leaf-like appendages called **sporophylls**.
* In some cases sporophylls may form distinct compact structures called strobili or cones (Selaginella, Equisetum).
* 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**.
* These gametophytes require cool, damp, shady places to grow. Because of this specific restricted requirement and the need for water for fertilisation, the spread of living pteridophytes is

limited and restricted to narrow geographical regions.

* The gametophytes bear male and female sex organs called **antheridia** and **archegonia**, respectively.
* Water is required for transfer of antherozoids - the male gametes released from the antheridia, to the mouth of archegonium.
* 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.
* In majority of the pteridophytes all the spores are of similar kinds; such plants are called **homosporous**.
* Genera like Selaginella and Salvinia which produce two kinds of spores, macro (large) and micro (small) spores, are known as **heterosporous**.
* 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 take place within the female gametophytes. This event is a precursor to the **seed habit** considered an important step in evolution.
* The pteridophytes are further classified into four classes: Psilopsida (Psilotum); Lycopsida (Selaginella, Lycopodium), Sphenopsida (Equisetum) and Pteropsida (Dryopteris, Pteris, Adiantum).

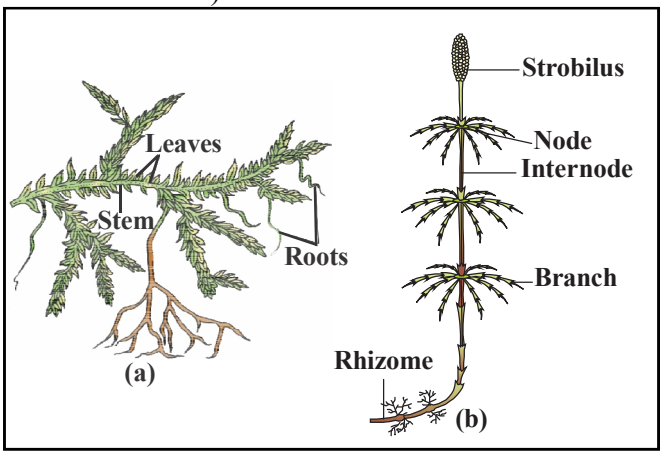
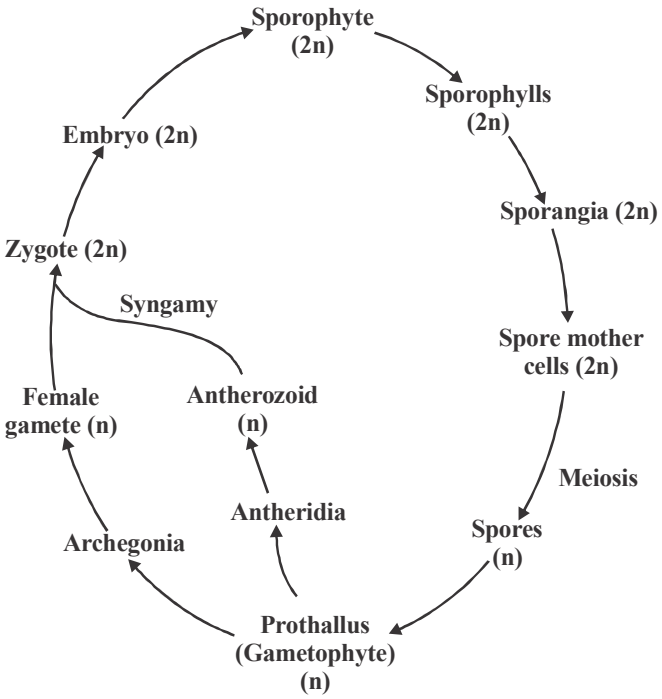


Figure : Pteridophytes : (a) *Selaginella* (b) *Equisetum* (c) *Salvinia*

* **Life cycle of a fern plant**



Economic importance

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

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

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

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

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

GYMNOSPERMS

* The gymnosperms (gymnos : naked, sperma : seeds) are plants in which the ovules are not enclosed by any ovary wall and remain exposed, both before and after fertilisation. The seeds that develop post-fertilisation, are not covered, i.e., are naked.
* Gymnosperms include medium-sized trees or tall trees and shrubs. Ex. *Ginkgo, Pinus, Cycas*

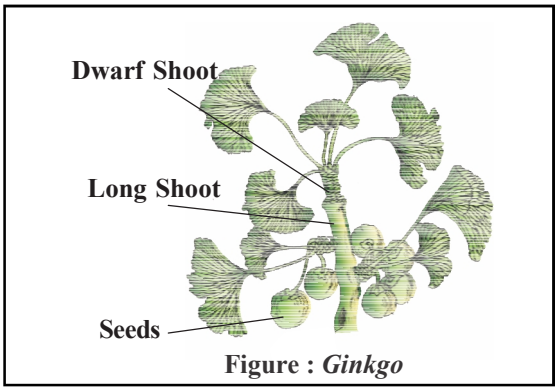


Figure : *Ginkgo*

* One of the gymnosperms, the giant redwood tree Sequoia is one of the tallest tree species.
* The roots are generally tap roots. Roots in some genera have fungal association in the form of **mycorrhiza (Pinus)**, while in some others (Cycas) small specialised roots called coralloid roots are associated with N_2-fixing cyanobacteria.
* The stems are unbranched (Cycas) or branched (Pinus, Cedrus). The leaves may be simple or compound.
* In Cycas the pinnate leaves persist for a few years.
* The leaves in gymnosperms are well-adapted to withstand extremes of temperature, humidity and wind.
* In conifers, the needle-like leaves reduce the surface area. Their thick cuticle and sunken stomata also help to reduce water loss.
* The gymnosperms are heterosporous; they produce haploid microspores and megaspores.
* The two kinds of spores are produced within sporangia that are borne on sporophylls which are arranged spirally along an axis to form lax or compact strobili or **cones.**
* The strobili bearing microsporophylls and **microsporangia** are called microsporangiate or **male strobili**.
* 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 take place within the microsporangia.
* The cones bearing megasporophylls with ovules or **megasporangia** are called macrosporangiate or **female strobili**.
* The male or female cones or strobili may be borne on the same tree (Pinus) or on different trees (Cycas).

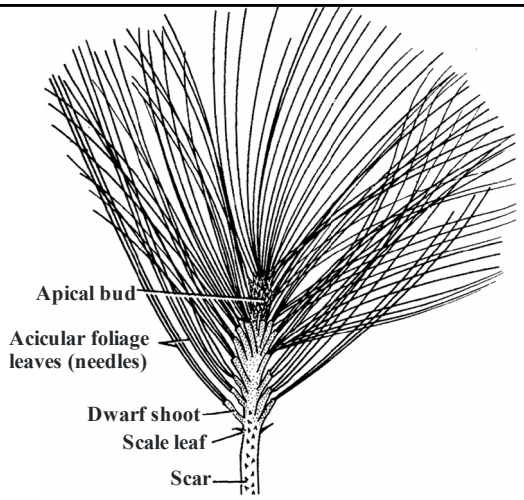


Figure : Pinus

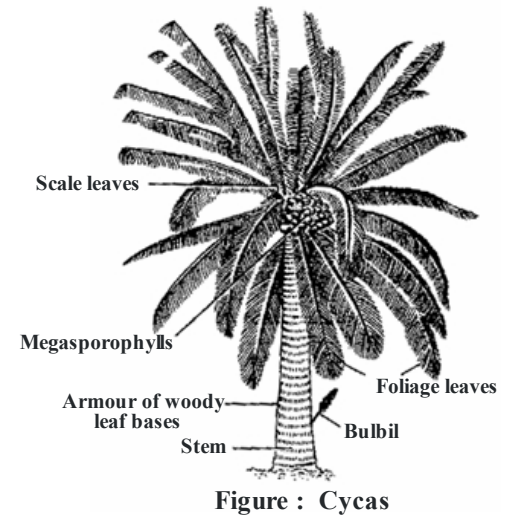
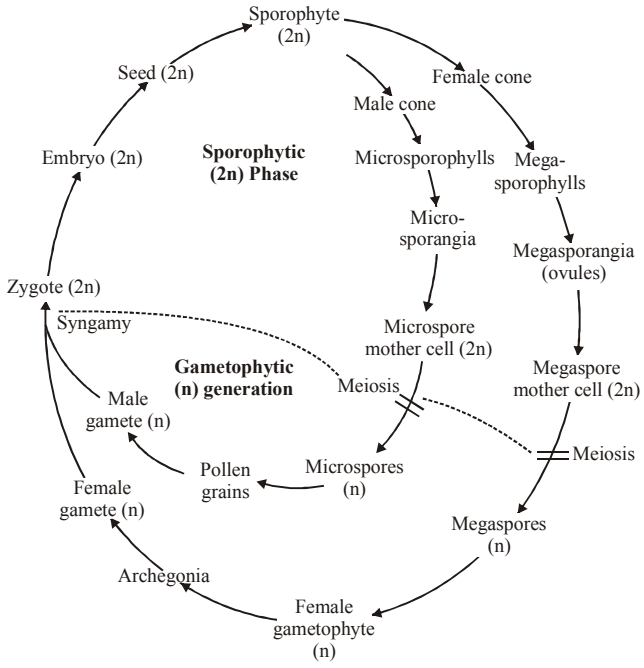


Figure : Cycas

* 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.
* Unlike bryophytes and pteridophytes, in gymnosperms the male and the female gametophytes do not have an independent free-living existence.
* They remain within the sporangia retained on the sporophytes.
* The pollen grain is released from the microsporangium.
* They are carried in air currents and come in contact with the opening of the ovules borne on megasporophylls.
* The pollen tube carrying the male gametes grows towards archegonia in the ovules and discharge their contents near the mouth of the archegonia. Following fertilisation, zygote develops into an embryo and the ovules into seeds. These seeds are not covered.
* **Life cycle of gymnosperm (*Pinus*)**



Types of wood

(i) **Manoxylic :** Soft wood, vascular tissues with medullary rays, commercially less important, *e.g., Cycas*.

(ii) **Pycnoxylic :** Compact wood without or with narrow medullary rays, commercially more important, *e.g., Pinus*.

(iii) **Monoxylic :** With single persistent cambium ring and bundles, *e.g., Pinus*

(iv) **Polyxylic :** With many persistent cambium rings and bundles, *e.g., Cycas*

Economic importance

(i) **Edible Seeds :** Seeds of *Pinus gerardiana* called **chilgoza** are edible.

(ii) **Timber :** Gymnosperms possess soft wood. The same is used in preparation of light furniture, plywood, packing cases, match sticks, railways sleepers, etc, *e.g., Cedrus deodara.*

(iii) **Resin :** Resin is a semifluid secreted by special resin canals. It solidifies on exposure to air. Therefore, it plugs the places of injury. It helps in sealing female cones after pollination. Resin is commercially extracted and distilled to obtain turpentine and resin. Resin is used in water proofing, sealing joints and preparation of writing paper. Turpentine is used as solvent in paints, polishes and wax, *e.g., Pinus*.

(iv) **Ephedrine :** Drug ephedrine is obtained from *Ephedra.* The drug is used in curing respiratory elements including asthma.

(v) **Sago :** A starchy food sago is obtained from stem of *Cycas revoluta* which is thus also called as **sago palm.**

(vi) **Canada balsam :** A mounting agent used in preparation of permanent slides is obtained from *Abies balsamaea.*

(vii) **Cedar wood oil :** Useful in microscopy is obtained from *Juniperus virginiana.*

(viii) **Taxol :** Anticancerous chemical obtained from *Taxus*.

* Smallest gymnosperm = Zamia
  Largest gymnosperm = Sequoia

* The three generations in seed are:
(i) Testa, tegmen and perisperm represent parental sporophyte
(ii) Endosperm represents female gametophyte;
(iii) Plumule, radicle, suspensor and cotyledons (embryo) represent future sporophyte.
* **Polyembryony:** It is the formation of more than one embryo inside a single seed. It was reported by **Leeuwenhoek** in oranges. Simple polyembryony is due to fertilisation of many eggs, *e.g. Pinus* ovule has 2-8 archegonia. Cleavage polyembryony is true polyembryony and very common. It is due to splitting of embryo tissue. Adventive polyembryony is the formation of extra embryos directly from diploid cells (*e.g.,* rosette cells) other than embryonal cells.
* Order Gnetales consists of **Gnetum, Ephedra** and **Welwitschia**. These are nearer to flowering plants in having flower like arrangement of sporophyll and possessing primitive vessels in xylem so wood is called **heteroxylous**. Plants of *Cycadales* and *Coniferales* are commonly called **Cycads** and **Conifers** respectively.
* *Cycas, Ginkgo* and *Metasequoia* are living fossils.
* *Ginkgo biloba* (Pagoda tree or Maiden hair tree) is oldest living fossil and it is connecting link between cycades and conifers.
* Largest ovule (found in *Cycas revoluta*)
* Largest male cone (in *C. circinalis*)
* Largest male gamete (sperm) in *Cycas*
* Largest female gamete (egg) in *Cycas*
* Independent, free living, photosynthetic gametophyte is not found in gymnosperms and angiospersm.

ANGIOSPERMS

* Unlike the gymnosperms where the ovules are naked, in the angiosperms or flowering plants, the pollen grains and ovules are developed in specialised structures called **flowers.**
* In angiosperms, the seeds are enclosed by fruits.
* The angiosperms are an exceptionally large group of plants occurring in wide range of habitats. They range in size from tiny, almost microscopic Wolfia to tall trees of Eucalyptus (over 100 metres).
* They provide us with food, fodder, fuel, medicines and several other commercially important products.
* They are divided into two classes :
The **dicotyledons** and the **monocotyledons**.
* The dicotyledons are characterised by seeds having two cotyledons, reticulate venations in leaves, and tetramerous or pentamerous flowers, i.e. having four or five memerbs in each floral whorls. The monocotyledons on the other hand are characterised by single cotyledonous seeds, parallel venation in leaves, and trimerous flowers having three members in each floral whorls.
* **The male sex organs** in a flower is the stamen. Each stamen consists of a slender filament with an anther at the tip. Within the anthers, the pollen mother cell divide by meiosis to produce microspores which matures into pollen grains.
* **The female sex organs** in a flower is the pistil. Pistil consists of an ovary at its base, a long slender style and stigma. Inside the ovary, ovules are present.
* Generally each ovule has a megaspore mother cell that undergoes meiosis to form four haploid megaspore. Three of them degenerate and one divide to form the embryo sac.

(1) Dicotyledons : They are show following distinguished characteristics.
(i) Tap roots found in the members of this group.
(ii) The leaves in members of these class exihibit reticulate (net like) venation.
(iii) The flowers are tetramerous or pentamerous having four or five members in the various floral whorls, respectively.
(iv) The vascular bundles arranged in a ring, numbering 2–6, open and with cambium.
(v) The seeds of dicotyledons are with two cotyledons as the name indicate.

(2) Monocotyledons : They are show following distinguished characteristics :
(i) Adventitious roots found in the members of this group.
(ii) The leaves are simple with parallel venation.
(iii) The flowers are trimerous having three members in each floral whorl.

(iv) The vascular bundles scattered in the ground tissue, many in number, closed and without cambium.

(v) The seeds of monocotyledons are with one cotyledons as the name indicate. *e.g.,* Cereals, bamboos, sugarcane, palms, banana, lillies and orchids

* The male sex organs in a flower is the **stamen**. Each stamen consists of a slender filament with an anther at the tip.
* The anthers, following meiosis, produce pollen grains. The female sex organs in a flower is the pistil or the carpel.
* Pistil consists of an ovary enclosing one to many ovules.
* Within ovules are present highly reduced female gametophytes termed **embryosacs.**
* 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.
* Pollen grain, after dispersal from the anthers, are carried by wind or various other agencies to the stigma of a pistil. This is termed as pollination.
* 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 (syngamy).
* The other male gamete fuses with the diploid secondary nucleus to produce the triploid primary endosperm nucleus (PEN). Because of the involvement of two fusions, this event is termed as **double fertilisation**, an event unique to angiosperms. The zygote develops into an embryo (with one or two cotyledons) 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.

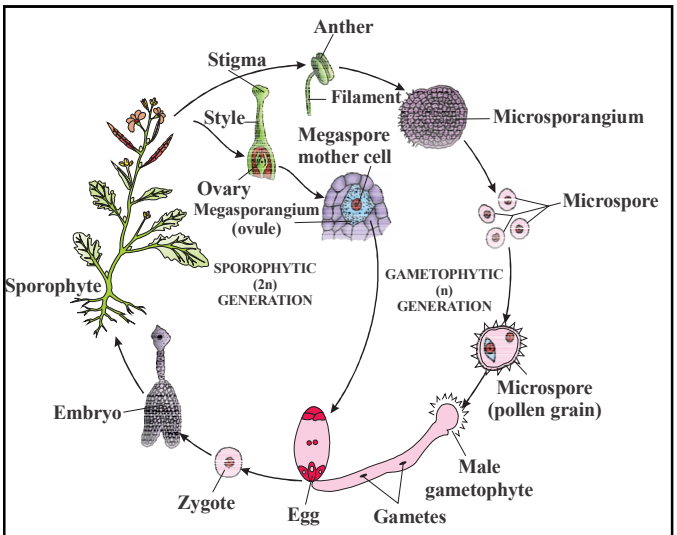


Figure : Life cycle of an Angiosperm showing alternation of generation

* **The smallest** angiosperm is *Wolffia*. The plant body of *Wolffia* consists of tiny flat oval green stem (phylloclade) having a few small roots. The plants are about 1 *mm* in diameter and found free floating in aquatic habitats like ponds, etc.
* **The tallest** angiosperm is *Eucalyptus*. Their trees may attain a height upto 100m or more.
* Depending upon the habit of plants, the angiosperms belong to following categories :

(1) **Herb :** These are small, soft, non-woody plants without persistent parts aboveground. The height of plants usually reaches upto 1 *m*. The plants may be annual (*Brassica*), biennial (Sugar beet) or perennial (*Canna*). The perennial herbs usually possess underground rhizomes which form the new aerial shoots every year. The plants of banana are perennial herbs.

(2) **Shrubs :** These are woody plants of relatively low height (1-4 *m*). They typically branch at or near the base and do not have a main trunk, *e.g.,* Rose. They are mostly perennial.

(3) **Trees :** These are perennial woody plants with one main trunk. The trunk may or may not be branched. These are of the following types :

(i) **Caudex :** The stem is unbranched and usually bears a crown of leaves at the apex. *e.g.,* Date-palm.

(ii) . . . . . The lower part of stem is thicker which gradually tapers above. Branches arise from the main stem in acropetal succession and plant appears conical *e.g., Pinus*.

(iii) **Deliquescent :** The apical bud of the main stem dies after some time and branches and sub-branches spread in different directions. *e.g., Tamarindus, Ficus*.

(4) **Culms :** In these plants, nodes and internodes are extremely clear. Internodes of such plants are usually hollow. These plants are grasses but cannot be considered as herb or shrub or tree. *e.g., Bambusa* (Bans).

Differences between various plant groups having embryo

Features	Bryophyta	Pteridophyta	Gymnosperms	Angiosperms
Dominant phase	Gametophyte	Sporophyte	Sporophyte	Sporophyte
Ploidy of main plant body	Haploid	Diploid	Diploid	Diploid
Differentiation of body	Thallus of foliose structures and rhizoids	Root, stem and leaves	Root, stem and leaves	Root, stem and leaves
Vascular bundles	Absent	Present	Present	Present
Nature of spores	Homospores	Homospores and Heterospores	Heterospores	Heterospores
Seed and its coverings	Seed absent	Seed absent	Seed naked (without covering)	Seed with covering
Flower & fruit	Absent	Absent	Absent	Present

PLANT LIFE CYCLES AND ALTERNATION OF GENERATIONS

* In plants, both haploid and diploid cells can divide by mitosis. This ability leads to the formation of different plant bodies - haploid and diploid.
* The haploid plant body produces gametes by mitosis.
* This plant body represents a gametophyte.
* Following fertilisation the zygote also divides by mitosis to produce a diploid sporophytic plant body.
* Haploid spores are produced by this plant body by meiosis.
* These in turn, divide by mitosis to form a haploid plant body once again. Thus, during the life cycle of any sexually reproducing plant, there is an alternation of generations between gamete producing haploid gametophyte and spore producing diploid sporophyte.
* Different plant groups, as well as individuals representing them, differ in the following patterns:

(i) Sporophytic generation is represented only by the one-celled zygote.

* There are no free-living sporophytes. Meiosis in the zygote results in the formation of haploid spores.
* The haploid spores divide mitotically and form the gametophyte. The dominant, photosynthetic phase in such plants is the free-living gametophyte.
* This kind of life cycle is termed as **haplontic**. Many algae such as Volvox, Spirogyra and some species of Chlamydomomas represent this pattern.

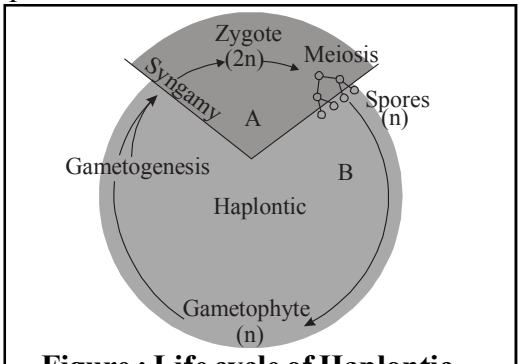


Figure : Life cycle of Haplontic

(ii) On the other extreme, is the type wherein the diploid sporophyte is the dominant, photosynthetic, independent phase of the plant.

* The gametophytic phase is represented by the single to few-celled haploid gametophyte.
* This kind of lifecycle is termed as **diplontic**. An alga, Fucus sp., represents this pattern. In addition, all seed bearing plants i.e., gymnosperms and angiosperms, follow this patterns with some variations, wherein, the gametophytic phase is few to multi-celled.

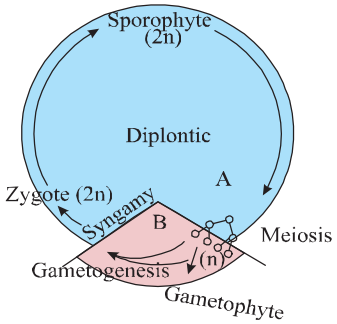


Figure : Life cycle of Diplontic

(iii) Bryophytes and pteridophytes, interestingly, exhibit an intermediate condition (**Haplo-diplontic**); both phases are multicellular and often free-living. However, they differ in their dominant phases.

* A dominant, independent, photosynthetic, thalloid or erect phase is represented by a haploid gametophyte and it alternates with the shortlived multicelluler sporophyte totally or partially dependent on the gametophyte for its anchorage and nutrition.
* All bryophytes represent this pattern. The diploid sporophyte is represented by a dominant, independent, photosynthetic, vascular plant body.

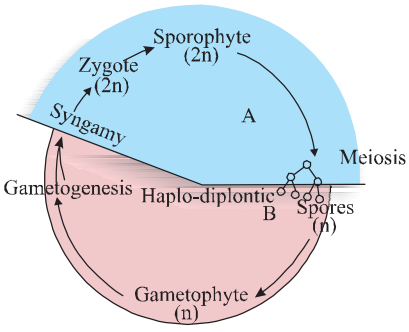


Figure : Life cycle of Haplo-diplontic

* It alternates with multicellular, saprophytic/ autotrophic, independent but short-lived haploid gametophyte. Such a pattern is known as haplo-diplontic life cycle. All pteridophytes exhibit this pattern.
* While most algal genera are haplontic, some of them such as Ectocarpus, Polysiphonia, kelps are haplo-diplontic. Fucus, an alga is diplontic.

CONCEPT REVIEW

* Plant kingdom includes algae, bryophytes, pteridophytes, gymnosperms and angiosperms.
* Algae are chlorophyll-bearing simple, thalloid, autotrophic and largely aquatic organisms.
* Depending on the type of pigment possessed and the type of stored food, algae are classified into three classes, namely Chlorophyceae, Phaeophyceae and Rhodophyceae.
* Algae usually reproduce vegetatively by fragmentation, asexually by formation of different types of spores and sexually by formation of gametes which may show isogamy, anisogamy or oogamy.
* Bryophytes are plants which can live in soil but are dependent on water for sexual reproduction. Their plant body is more differentiated than that of algae. It is thallus-like and prostrate or erect and attached to the substratum by rhizoids. They possess root-like, leaflike and stem-like structures.
* The bryophytes are divided into liverworts, hornworts and mosses.
* The plant body of liverworts is thalloid and dorsiventral whereas mosses have upright, slender axis bearing spirally arranged leaves.
* The main plant body of a bryophyte is gamete-producing and is called a **gametophyte**. It bears the male sex organs called antheridia and female sex organs called **archegonia**. The male and female gametes fuse to form zygote which produces a multicellular body called sporophyte. It produces haploid spores. The spores germinate to form gametophytes.
* In pteridophytes the main plant is a sporophyte which is differentiated into true root, stem and leaves. These organs possess well-differentiated vascular tissues.

* The sporophytes in pteridophytes bear sporangia which produce spores. The spores germinate to form gametophytes which require cool, damp places to grow.
* The gametophytes in pteridophytes bear male and female sex organs called **antheridia** and **archegonia,** respectively.
* Water is required for transfer of male gametes to archegonium in both bryophytes and pteridophytes where zygote is formed after fertilisation. The zygote produces a sporophyte by dividing mitotically.
* The gymnosperms are the plants in which ovules are not enclosed by any ovary wall. After fertilization the seeds remain exposed and therefore these plants are called **naked-seeded plants**.
* The gymnosperms produce microspores and megaspores which are produced in microsporangia and megasporangia borne on the sporophylls.
* The sporophylls-microsporophylls and megasporophylls-are arranged spirally on axis to form male and female cones, respectively.
* The pollen grain germinates and pollen tube releases the male gamete into the ovule, where it fuses with the egg cell in archegonia. Following fertilisation, the zygote develops into embryo and the ovules into seeds.
* In angiosperms, the male sex organs (stamen) and female sex organs (pistil) are born in a flower. Each stamen consists of a filament and an anther. The anther produces pollen grains (male gametophyte) after meiosis. The pistil consists of an ovary enclosing one to many ovules.
* Within the ovule is the female gametophyte or embryo sac which contains the egg cell. The pollen tube enters the embryo-sac where two male gametes are discharged. One male gamete fuses with egg cell (syngamy) and other fuses with diploid secondary nucleus (triple fusion). This phenomenon of two fusions is called **double fertilisation** and is unique to angiosperms.
* The angiosperms are divided into two classes- the dicotyledons and the monocotyledons.
* During the life cycle of any sexually reproducing plant, there is alternation of generations between gamete producing haploid gametophyte and spore producing diploid sporophyte. However, different plant groups as well as individuals may show different patterns of life cycle haplontic, diplontic or intermediate, *i.e.,* haplodiplontic or diplohaplontic.

IMPORTANT POINTS

* Pteridophytes/ferns differ mosses/ bryophytes in possessing well developed vascular system.
* Science of algae is phycology.
* Formation of gametophyte directly from sporophyte is apospory.
* *Ulothrix* is attached unbranched filament.
* Algae showing scalariform conjugation is *Spirogyra*.
* Neck canal cell is absent in the archegonium of Cycas.
* *Pinus* differs from Mango in having ovules not enclosed in ovary.
* Agar is commercially got from red algae.
* Peristome is characteristics of *Funaria*.
* Ribbon-shaped chloroplasts occur in *Spirogyra*.
* *Ginkgo* is a living fossil.
* In gymnosperms, the ovules are naked.
* Cell wall of *Spriogyra* / Green aglae has celluose.
* Cycas resembles angiosperms in having ovules.
* Cycas =
  (i) It has circinate vernation.
  (ii) It does not have well organised female flower.
  (iii) Its roots possess some blue-green algae.
* Fern stomata occur on leaf.
* Stomata do not occur in algae.
* 'Pond silk' is common name of *Spirogyra*.
* Sea Weeds are a source of Iodine.
* Conifers are found in Himalayas.
* *Macrocystis* is a brown alga.
* Moss is a gametophyte which consists of two stages, namely protonema stage and leafy stage.
* Male and female gametophytes are independent and free living in *Sphagnum*.
* *Pinus* belongs to coniferopsida.
* Life cycle of all seed plants is diplobiontic.
* Zoospores are absent in *Spirogyra*.

* Colours of pigments –
  Chlorophyll = Green
  Phycoerythrin = Red
  Fucoxanthin = Brown
* Pteridophytes are called vascular cryptogams as they are non-seeded plants containing xylem and phloem.
* A gymnosperm lacking archegonium is Gnetum.
* Reproductive Structures of Pteridophytes, Gymnosperms and Angiosperms

Angiosperm	Pteridophyte	Gymnosperm
Flower	Cone or strobili, sporophyll	Cone or strobili
Stamens	Microsporophyll	Microsporophyll
Carpel	Megasporophyll	Megaspholophyll
Ovule	Megasporangium	Megasporangium
Anther	Microsporangium	Microsporangium
Pollengrains	Microspore	Microspore
Embryo sac	Megaspore	Megaspore

* Plant life cycle

S.N.	Haplontic	Diplontic	Haplodiplontic
1	Dominating phase haploid (n).	Dominating phase diploid (2n).	Intermediate i.e.haploid & diploid stages equal.
2	only zygote diploid (2n).	Haploid phase only in single cell or few celled gametophyte.	Gametophyte & Sporophyte stages both may be free living.
3	Haploid spores form the main plant body	Zygote forms embryo which forms Sporophyte (main plant body).	eg. Bryophytes & Pteridophyte
4	eg. *Algae viz. Ulothrix, Spirogyra* etc.	eg. Gymnosperms &Angiosperms	

* Homosporous V/s Heterosporous pteridophyte

S.N.	Homosporous pteridophytes	Heterosporous pteridophytes
1	They bear spores that are of the same type.	They bear two kinds of spores – microspores and megaspores.
2	They produce bisexual gametophytes.	They produce unisexual gametophytes.

* Syngamy V/s Triple fusion

S.N.	Syngamy	Triple fusion
1	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.
2	A diploid zygote is formed as a result of syngamy.	A triploid primary endosperm is formed as a result of triple fusion.

* Monocots V/s dicots

Characteristic	Monocot	Dicot
Morphology		
Roots	Fibrous roots	Tap roots
Venation	Generally parallel venation	Generally reticulate venation
Flowers	Trimerous flowers	Pentamerous flowers
Cotyledons in seeds	One	Two
Anatomy		
No. of vascular bundles in stem	Numerous	Generally 2 – 6
Cambium	Absent	Present
Leaves	Isobilateral	Dorsiventral

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.
For Q.1-Q.5
Match the column I with column II.

Q.1

	Column I	Column II
a.	Natural system of classification	i.Benthamand Hooker
b.	Artificial system of classification	ii. Linnaeus
c.	Phylogenetic system of classification	iii. Englarand Prantl

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

Q.2

	Column I	Column II
a.	Algin	i. *Cephaleuros*
b.	Carrageenin	ii. *Gelidium*
c.	Agar	iii. *Chondrus*
d.	Parasitic algae	iv. *Laminaria*

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

Q.3

	Column I	Column II
a.	Isogamous	i. Fusion between male(small) and female gamete (large)
b.	Anisogamous	ii.Both gametes are dissimilar in size
c.	Oogamous	iii. Both gametes are similar in size and non-motile

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

Q.4 Match the following columns.

	Column I	Column II
a.	Polar nuclei+male gamete	i. Double fertilisation
b.	Ovule	ii. Fruits
c.	Ovary	iii. Seed
d.	Syngamy + triple fusion	iv. Endosperm

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

Q.5 Match the following column.

a.	Haplontic life cycle	i. Bryophytes and pteridophytes
b.	Diplontic life cycle	ii. Gymnosperms and angiosperms
c.	Haplo-diplontic life cycle	iii. *Volvox, Spirogyra* and *Chlamydomonas*

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

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.6 to Q.17 :
Choose one word for the given statement from the list.

Chemotaxonomy, Starch, Archegonium, Pyrenoids, Chloroplast, pyrenoid, protein, starch sheath, zoogametes, Stigma; pollen tube, cellulose, numerical taxonomy, pectose, *Rhodomella*

Q.6 Classification on the basis of chemical constituents of plant is known as _____.

Q.7 Green algae store food in form of ___ in specialised structures called ___ located in ____

Q.8 Female reproductive part of bryophytes is called____.

Q.9 In Chlorophyceae each __ has a central __ called 'pyreno-crystal' and a surrounding ____.

Q.10 In class-Chlorophyceae, a sexual reproduction takes place by ____.

Q.11 Green algae usually have a rigid cell wall made of an inner layer of ___ and an outer layer of __.

Q.12. Algae ____ is used to obtain bromine of commercial importance.

Q.13 In angiospermic plant pollen grain reaches to embryo sac after its germination on ____ and through ____.

Q.14 Classification on the basis of all observed characters is known as ____.

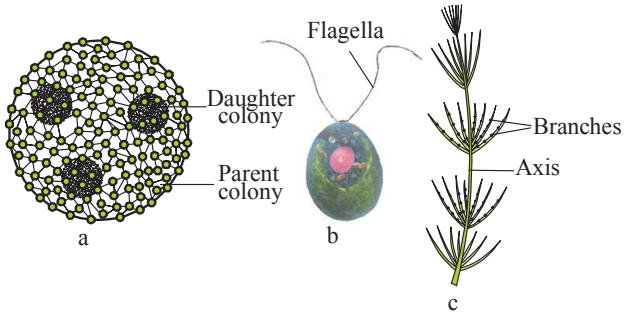
Q.15 Pyrenoids are present in the ___ in most of the green algae.

Q.16 The members of brown algae (class-Phaeophyceae) have gelatinous coating outside the, cellulosic cell wall called _____.

Q.17 In pteridophyte, the sporophytes consist of leaf-like appendages called _____.

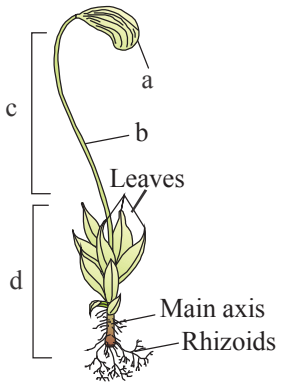
SECTION - 3 (ENHANCE DIAGRAM SKILLS)

Q.18 Identify the given figures of algae and select the correct option.



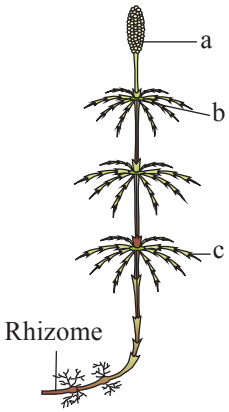
(A) *a-Chlamydomonas, b-Chara, c-Volvox*
(B) *a-Volvox, b-Chlamydomonas, c-Chara*
(C) *a-Chara, b-Laminaria, c-Volvox*
(D) *a-Porphyra, b-Polysiphonia, c-Fucus*

Q.19 a, b, c and d in given figure represents



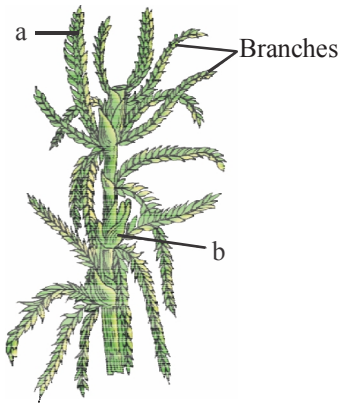
(A) a-Apophysis, b-Capsule, c-Sporophyte, d-Gametophyte
(B) a-Capsule, b-Seta, c-Sporophyte, d-Gametophyte
(C) a-Apophysis, b-Seta, c-Gametophyte, d-Sporophyte
(D) a-Apophysis, b-Capsule, c-Gametophyte, d-Sporophyte

Q.20 Identify a, b and c in the following figure and choose the correct option.



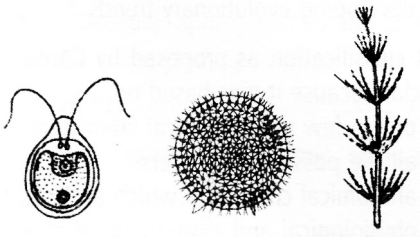
(A) a-Strobilus, b-Node, c-Leaves
(B) a-Strobilus, b-node, c-branch
(C) a-Sporophyll, b-Node, c-Internode
(D) a-Sporophyll, b-Internode, c-Node

Q.21 a and b in given figure represents.



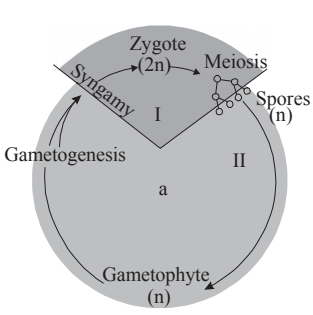
(A) a-Gametophyte branch, b-Sporophyte branch
(B) a-Antheridial branch, b-Archegonial branch
(C) a-Archegonial branch, b-Antheridial branch
(D) a-Sporophyte branch, b-Gametophyte branch

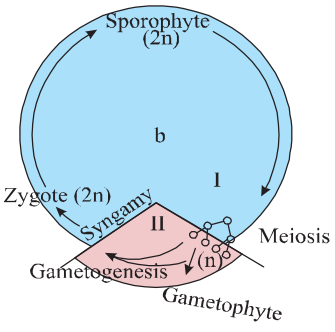
Q.22 The algae shown in figure belong to the class

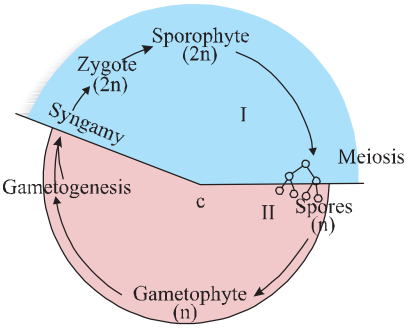


(A) Chlorophyceae (B) Phaeophyceae
(C) Rhodophyceae (D) Cyanophyceae

Q.23 Which of the following correctly represents the type of life cycle patterns from the options given?

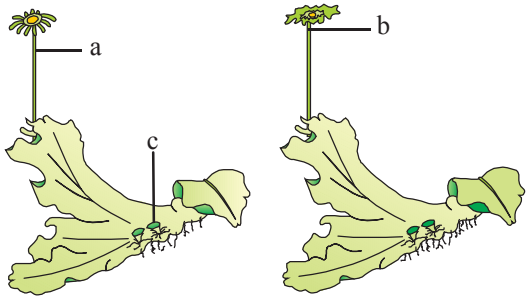






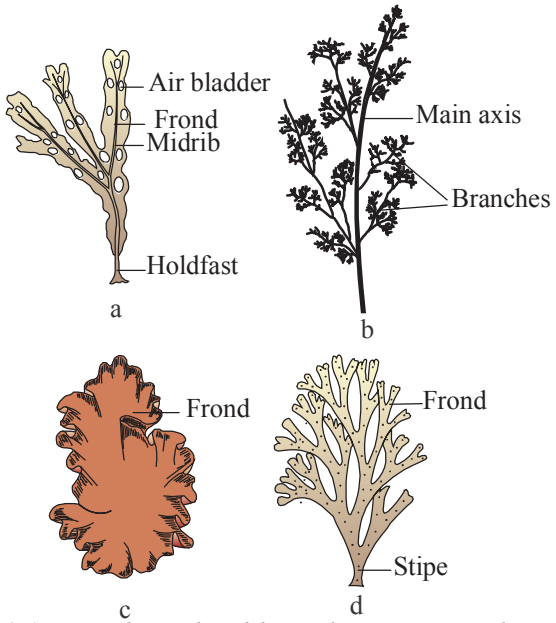
(A) a-Haplontic, b-Diplontic, c-Haplo-diplontic
(B) a-Diplontic, b-Haplontic, c-Haplo-diplontic
(C) a-Haplo-diplontic, b-Diplontic, c-Haplontic
(D) a-Diplontic, b-Haplo-diplontic, c-Haplontic

Q.24 Observe the diagrams given below and choose the correct option out of a to c, in which all the three items a, b and c are rightly identified



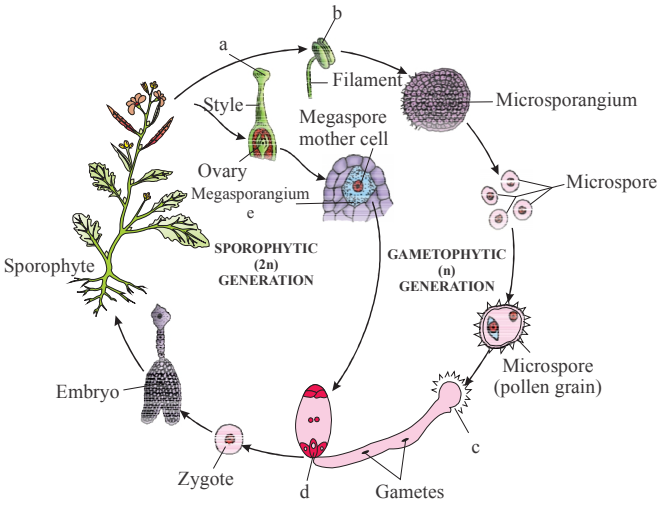
(A) a-Antheridiophore, b-Archegoniophore, c-Endospore
(B) a-Archegoniophore, b-Antheridiophore, c-Gemma cup
(C) a-Antheridiophore, b-Archegoniophore, c-Gemma cup
(D) a-Archegoniophore, b-Antheridiophore, c-Seta cup

Q.25 Identify the given figures of algae and select the correct option.



(A) *a-Volvox, b-Chlamydomonas, c-Chara, d-Porphyra*
(B) *a-Fucus, b:Polysiphonia, c-Porphyra, d-Dictyota*
(C) *a-Fucus, b-Dictyota, c-Porphyra, d-Polysiphonia*
(D) *a-Dictyota, b-Porphyra, c-Fucus, d-Polysiphonia*

Q.26 The diagram represents the life cycle of angiosperm. Choose the correct combination of labelling.



(A) a-Anther, b-Stigma, c-egg, d-Male gametophyte, e-Ovule
(B) a-Ovule, b-Stigma, c-Male gametophyte, d-Anther, e-Egg
(C) a-Male gametophyte, b-Stigma, c-Anther, d-Egg, e-Ovule
(D) a-Stigma, b-Anther, c-Male gametophyte, d-Egg, e-Ovule

SECTION - 4 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : SYSTEMS OF CLASSIFICATION

Q.27 Kingdom-Plantae includes
(A) algae, bryophytes and pteridophytes
(B) algae, bryophytes, pteridophytes, gymnosperms and angiosperms
(C) algae, fungi, pteridophytes, gymnosperms and angiosperms
(D) algae, pteridophytes, gymnosperms and angiosperms.

Q.28 Classification done on the basis of cytological information, chromosome structure and their behaviour, is known as
(A) molecular classification
(B) cytotaxonomy
(C) chemotaxonomy
(D) karyotaxonomy

Q.29 Subkingdom Cryptogamia in classification system given by Linnaeus includes
(A) Thallophyta, Bryophyta and Gymnosperms
(B) Thallophyta, Bryophyta and Pteridophyta
(C) Pteridophyta, Gymnosperms and Angiosperms
(D) Gymnosperms and Angiosperms.

Q.30 Phylogenetic system of classification was given by
(A) Engler and Prantl (B) Aristotle
(C) Linnaeus (D) Bentham & Hooker

Q.31 Which of the following type of taxonomy deals with the collection and identification of organism on the basis of gross morphology?
(A) Alpha taxonomy (B) Beta taxonomy
(C) Omega taxonomy (D) Karyotaxonomy

Q.32 Natural system of classification was developed by
(A) Linnaeus
(B) Engler and Prantl
(C) Bentham and Hooker
(D) Aristotle

Q.33 Select the incorrect pair.
(A) Numerical taxonomy - All observable characteristics
(B) Cytotaxonomy - Cytological information
(C) Chemotaxonomy - Chromosome number and structure
(D) Cladistic taxonomy - Origin from a common ancestor

Q.34 Artificial system of classification was given by
(A) Aristotle (B) Linnaeus
(C) Theophrastus (D) Haeckel

Q.35 Find odd one out w.r.t. natural classification systems
(A) Bentham and Hooker's system
(B) de Candolle system
(C) John Ray's system
(D) Eichler's system

Q.36 Phylogenetic system of classification is based upon
(A) evolutionary relationship of organism
(B) cytological information
(C) structural embryology
(D) All of the above

PART - 2 : ALGAE

Q.37 The members of algae reproduce by
(A) vegetative method (B) asexual method
(C) sexual method (D) All of these

Q.38 Floridean starch is reserve food in
(A) Phaeophceae (B) Chlorophyceae
(C) Rhodophyceae (D) Cyanophyceae

Q.39 Coenobium is the name given to the colony of
(A) *Chlamydomonas* (B) *Fritschiella*
(C) *Volvox* (D) *Vaucheria*

Q.40 The members of Phaeophyceae are commonly called
(A) green algae (B) blue algae
(C) brown algae (D) golden algae

Q.41 Read the given statements about algae and select the correct option.
(i) Plant body is thalloid.
(ii) Largely aquatic.
(iii) Reproduction by vegetative, asexual & sexual methods.
(iv) Chlamydomonas, Volvox, Ulothrix are the multicellular algae.
(A) Statements (i) and (ii) are true
(B) Statements (ii) and (iii) are true
(C) Statements (i), (ii) and (iii) are true
(D) All statements are true

Q.42 *Ectocarpus, Dictyota, Laminaria, Sargassum* and *Fucus* belongs to the class –
(A) Phaeophyceae (B) Rhodophyceae
(C) Chlorophyceae (D) Cynophyceae

Q.43 All given algal members possess unicelled sex organs, *except*
(A) *Chara* (B) *Ulothrix*
(C) *Spirogyra* (D) *Chlamydomonas*

Q.44 ___ and ___ are unicellular algae, rich in proteins, which are used as food supplements even by space travellers.
(A) *Chlorella*, *Spirulina*
(B) *Gelidium*, *Gracilaria*
(C) *Porphyra*, *Spirogyra*
(D) *Laminaria*, *Spirogyra*

Q.45 Which of the following type(s) of sexual reproduction is/are present in algae?
(A) Isogamy (B) Anisogamy
(C) Oogamy (D) All of these

Q.46 Agar-agar is obtained from –
(A) *Chlorella* (B) *Spirogyra*
(C) *Ulothrix* (D) *Gelidium*

Q.47 *Chlamydomonas, Volvox, Ulothrix, Chara* are the examples of
(A) class-Chlorophyceae (green algae)
(B) class-Phaeophyceae (brown algae)
(C) class-Rhodophyceae (red algae)
(D) class-Cyanophyceae (blue-green

Q.48 Chloroplast is star shaped in
(A) *Oedogonium* (B) *Zygnema*
(C) *Chlorella* (D) *Ulothrix*

Q.49 In algae, sexual reproduction takes place through the fusion of two
(A) spores (B) fragments
(C) gametes (D) zoospores

Q.50 Rhodophytes are commonly called as
(A) blue-green algae (B) red algae
(C) brown algae (D) green algae

Q.51 Anteriorly placed, equal, 2-8, flagella are characteristic to –
(A) Blue green algae (B) Green algae
(C) Brown algae (D) Red algae

Q.52 Isogamy is found in
(A) *Spirogyra* (B) *Chlamydomonas*
(C) Both (A) and (B) (D) *Fucus*

Q.53 Algae are –
(A) chlorophyll bearing autotroph
(B) simple and thalloid
(C) Both (A) and (B)
(D) heterotroph

Q.54 In brown algae, brown colour is due to presence of –
(A) carotenoids (B) fucoxanthin
(C) phycoerythrin (D) chlorophyll

Q.55 The members of Chlorophyceae are commonly called –
(A) red algae (B) brown algae
(C) green algae (D) blue-green algae

Q.56 Choose the correct statement –
(A) Most algal genera are haplontic.
(B) *Ectocarpus*, *Polysiphonia*, kelps are haplo-diplontic.
(C) *Fucus*, an alga is diplontic.
(D) All of these

Q.57 In brown algae asexual reproduction takes place by –
(A) aplanospores (apple-shaped and non-motile)
(B) biflagellate gametes (pear-shaped and have two unequal flagella)
(C) endospores (round and have one flagella)
(D) multiflagellate gametes and are sickle-shaped

Q.58 Which set of characters is specific to red algae?
(A) Phycobilins, Chlorophyll a and c
(B) Chlorophyll a and d, Floridean starch
(C) Flagella absent, Mannitol
(D) Fucoxanthin, Floridean starch

Q.59 Which of the following is an important source of edible protein?
(A) *Spirogyra* (B) *Chlorella*
(C) *Spirullina* (D) Both (B) and (C)

Q.60 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) & pectose (outer layer)
(D) chitin (inner layer) and pectose (outer layer)

Q.61 Thin walled, non-motile, asexual, endogenous spores in some algal members are called
(A) Zoospores (B) Aplanospores
(C) Hypnospores (D) Cyst

Q.62 In algae the flagellate (motile) spore is called
(A) aplanospore (B) endospore
(C) zoospore (D) akinetes

Q.63 Choose the correct statement –
(A) *Chlamydomonas* : Anisogamous
(B) *Volvox* : Oogamous
(C) *Fucus* : Oogamous
(D) All of these

Q.64 Select the incorrect statement regarding reproduction in Rhodophyceae.
(A) Asexual reproduction occurs by non-motile spores.
(B) Sexual reproduction occurs by motile gametes.
(C) Sexual reproduction is oogamous.
(D) Complex post-fertilization developmental events occur.

Q.65 Oogamous type of fusion is found in
(A) *Volvox* and *Fucus* (B) *Chlamydomonas*
(C) *Spirogyra* (D) All of these

Q.66 Find odd one out w.r.t. fresh water algae
(A) *Batrachospermum* (B) *Spirogyra*
(C) *Volvox* (D) *Chondrus*

Q.67 In brown algae, food is stored in the form of
(A) mannitol (B) laminarian starch
(C) Both (A) and (B) (D) algin

Q.68 Algae include unicellular forms like _____, filamentous like ____ and colonial forms like ___.
(A) *Chlamydomonas, Volvox, Ulothrix*
(B) *Ulothrix, Volvox, Chlamydomonas*
(C) *Volvox, Ulothrix, Chlamydomonas*
(D) *Chlamydomonas, Ulothrix, Volvox*

Q.69 A protein rich blue-green alga is
(A) *Chlorella* (B) *Spirulina*
(C) *Spirogyra* (D) *Ulothrix*

Q.70 Pyrenoids are made up of –
(A) core of starch surrounded by sheath of protein.
(B) core of protein surrounded by fatty sheath.
(C) protein aceous centre and starchy sheath.
(D) core of nucleic acid surrounded by protein sheath.

Q.71 Plant body is differentiated in hold fast, stipe and frond in
(A) *Ulva* (B) *Laminaria*
(C) *Oedogonium* (D) *Acetabularia*

Q.72 Anisogamous means both gametes are
(A) similar in size and non-motile
(B) dissimilar in size
(C) similar in size and motile
(D) dissimilar in size and non-motile

Q.73 Usually plant body of brown algae is differentiated into –
(A) holdfast and frond
(B) stipe and holdfast
(C) frond and stipe
(D) holdfast, stipe & frond

Q.74 Select an incorrect match
(A) *Porphyra* -Edible red algae
(B) *Gracilaria* -Agar
(C) *Alaria* -Sarumen
(D) *Cephaleuros* -Iodine

Q.75 The "seaweeds" that form the under water forest are –
(A) kelps (B) Laminaria
(C) Macrocystis (D) all of these

Q.76 Which type of chloroplasts are present in the members of class-Chlorophyceae?
(A) Discoid and plate-like
(B) Reticulate and cup-shaped
(C) Spiral or ribbon-shaped
(D) All of the above

Q.77 In *Ulothrix*, sexual reproduction is by
(A) isogamy (B) anisogamy
(C) oogamy (D) conjugation

Q.78 In algae, vegetative reproduction mainly takes place by –
(A) budding (B) akinetes
(C) fragmentation (D) heterocyst

PART - 3 : BRYOPHYTES

Q.79 Bryophytes include
(A) liverworts and mosses
(B) lycopods and mosses
(C) lycopods and liverworts
(D) liverworts and *Volvox*

Q.80 Mosses are attached to substratum by
(A) roots (B) capsule
(C) rhizoids (D) main axis

Q.81 Which of the following plant group lack true roots, stem and leaves?
(A) Angiosperms (B) Gymnosperms
(C) Pteridophytes (D) Bryophytes

Q.82 Thallus of which bryophyte resembles algae in structure?
(A) *Porella* (B) *Riccia*
(C) *Anthoceros* (D) *Marchantia*

Q.83 In liverworts asexual reproduction takes place by
(A) gemmae and fragmentation of thalli
(B) fragmentation and zoospores
(C) gemmae formation and spores formation
(D) isogamy and anisogamy

Q.84 Bryophytes are also called 'amphibians of the plant kingdom' because
(A) water is essential for reproduction
(B) they are occur in only water
(C) these plants can live in soil but are dependent on water for sexual reproduction
(D) water is essential for spore formation

Q.85 In the life cycle of mosses, the gametophyte has two stages (a and b). These stages can be called
(A) a - Protonema; b - Leafy stage
(B) a - Protonema; b - Sporogonium
(C) a - Sporophyte; b - Gametophyte
(D) a - Zygote; b - Spore mother cell

Q.86 Gemmae are multicellular green structures for vegetative propagation. These are found inside gemma cups in
(A) *Riccia* capsule (B) *Marchantia* thallus
(C) *Funaria* protonema (D) Fern prothallus

Q.87 In mosses, vegetative reproduction takes place by –
(A) fragmentation and budding in the secondary protonema.
(B) gemmae formation and endospore formation
(C) gemmae and tubers formation
(D) protonema

Q.88 All given members are monoecious, *except*
(A) *Marchantia* (B) *Funaria*
(C) *Anthoceros* (D) *Sphagnum*

Q.89 The plant body of bryophytes is
(A) more differentiated than that of algae
(B) equally differentiated to that of algae
(C) less differentiated than that of algae
(D) is not differentiated at all

Q.90 The spores in the moss plant are formed in –
(A) foot (B) seta
(C) capsule (D) Both (B) and (C)

Q.91 Gemmae are –
(A) Unicelled structures
(B) Multicelled asexual buds
(C) Diploid sporophytic structures
(D) Haploid sexual structures

Q.92 Asexual reproduction in liverworts takes place by –
(A) fragmentation of thalli and gemmae formation
(B) gemmae formation and diploid spore formation
(C) spores formation and isogamy
(D) fragmentation and zoospore formation.

Q.93 In Bryophyta, the adult plant body is
(A) sporophyte (B) epiphyte
(C) sporophyll (D) gametophyte

Q.94 Resemblances between algae and bryophytes include
(A) presence of root-like, stem-like and leaf-like structures
(B) thallus-like plant body, lack of vascular tissue, autotrophic nutrition
(C) thallus-like plant body, presence of vascular tissue, autotrophic nutrition.
(D) presence of roots, heterotrophic nutrition.

Q.95 The gametophyte of moss is
(A) seta (B) capsule
(C) zygote (D) protonema

Q.96 The plant having capacity of absorbing water used to replace cotton and used as a fuel is –
(A) *Marchantia* (B) *Riccia*
(C) *Sphagnum* (D) *Funaria*

Q.97 Select incorrect statement w.r.t. characters of true moss
(A) Multicelled branched rhizoids
(B) Presence of scales
(C) Presence of protonema
(D) Erect leafy axis as mature gametophyte

Q.98 Mossess occur in moist place because –
(A) they cannot grow on land
(B) their gamete fuses in water
(C) they lack vascular tissue
(D) they lack root and stomata

Q.99 Which of the following is not a moss?
(A) *Polytrichum* (B) *Sphagnum*
(C) *Funaria* (D) *Riccia*

Q.100 *Funaria, Polytrichum* and *Sphagnum* are the examples of
(A) liverworts (B) fems
(C) mosses (D) pteridophytes

PART - 4 : PTERIDOPHYTES

Q.101 Horse tails and ferns belongs to
(A) gymnosperms (B) bryophytes
(C) mosses (D) pteridophytes

Q.102 Antheridium of *Dryopteris* has _____celled jacket and about ____sperm mother cells.
(A) 3, 16 (B) 2, 32
(C) 2, 16 (D) 3, 32

Q.103 When a plant produces two kind of spores, the condition is known as
(A) homospory (B) heterospory
(C) apospory (D) sporogenesis

Q.104 Pteridophytes are also called
(A) Vascular amphibians of plant kingdom
(B) First tracheophytes
(C) Botanical snakes
(D) All of these

Q.105 In pteridophytes spore germinate to give rise to
(A) thalloid gametophytes called prothallus
(B) thalloid sporophytes called prothallus
(C) thalloid sporocarp
(D) thalloid, photosynthesis sporophyte

Q.106 In pteridophytes, prothallus produces –
(A) sporangia
(B) antheridia and archegonia
(C) vascular tissues
(D) root, stem and leaf.

Q.107 The main plant body in pteridophyte is
(A) sporophyte (2n) which is differentiated into root, stem and leaf
(B) sporophyte having no root, stem and leaf
(C) gametophyte (n) which is differentiated into root, stem and leaf
(D) gametophyte having no root, stem and leaf

Q.108 Which of the following plant group is considered as first terrestrial plants to possess vascular tissues xylem and phloem?
(A) Bryophytes (B) Pteridophytes
(C) Gymnosperm (D) Angiosperm

Q.109 Which of the following pteridophytes is heterosporous in nature?
(A) *Selaginella* and *Salvinia*
(B) *Adiantum* and *Equisetum*
(C) *Psilotum* and *Lycopodium*
(D) *Adiantum* and *Psilotum*

Q.110 Select a set of heterosporous genera
(A) *Marsilea, Azolla*
(B) *Salvinia, Pteridium*
(C) *Adiantum, Azolla*
(D) *Pteris, Lycopodium*

Q.111 Which of the following can be regarded as seedless vascular plants?
(A) Angiosperms (B) Gymnosperms
(C) Bryophytes (D) Pteridophytes

Q.112 Which of the following is an aquatic fern?
(A) *Adiantum* (B) *Dryopteris*
(C) *Salvinia* (D) *Equisetum*

Q.113 Seed habit is linked to
(A) homospory (B) heterospory
(C) parthenocary (D) parthenogenesis

Q.114 Prothallus of the fern produces –
(A) spores (B) gametes
(C) Both (A) and (B) (D) cones

Q.115 True ferns are associated with all, *except*
(A) Circinate ptyxis
(B) Presence of ramenta
(C) Presence of frond
(D) Biflagellated male gametes

Q.116 Pteridophytes are also known as
(A) cryptogams (B) vascular cryptogams
(C) amphibious plants (D) phanerogams

Q.117 In homosporous pteridophyte, gametophyte is
(A) vascular
(B) monoecious
(C) dioecious
(D) may be monocious or dicecious

PART - 5 : GYMNOSPERMS

Q.118 Which is the tallest gymnospermic tree species?
(A) *Pinus* (B) *Cycas*
(C) *Ginkgo* (D) Red wood tree *Sequoia*

Q.119 In gymnosperms, the nucellus is protected by envelops & this composite structure is –
(A) ovule (B) ovary
(C) anther (D) strobili

Q.120 "Organ sui generis" is also called
(A) Rhizoid (B) Rhizomorph
(C) Rhizophore (D) Rhizine

Q.121 Seed plants are all
(A) heterosporous (B) dioecious
(C) monoecious (D) homosporous

Q.122 Gymnosperms are characterised by
(A) multiflagellate sperms (B) naked seeds
(C) winged seeds (D) seeds inside fruits

Q.123 Which of the following gymnospermic coralloid roots are associated with N_2 - fixing cyanobacteria?
(A) *Pinus* (B) *Cycas*
(C) *Cedrus* (D) *Ginkgo*

Q.124 Mycorrhizal roots of __ are associated with some fungal symbionts.
(A) *Pinus* (B) *Cedrus*
(C) *Cycas* (D) *Ginkgo*

Q.125 Megasporophyll is the term used in gymnosperm to denote
(A) carpel (B) leaves
(C) female cone (D) stamens

Q.126 In gymnosperms ovules are borne on
(A) microsporophyll (B) megasporophyll
(C) macrosporophyll (D) Both (A) and (C)

Q.127 Consider the given features
a. Resurrection habit
b. Meroblastic embryo development
c. Endosporic and diploid female gametophyte
d. Precocious germination of spores
Find correct w.r.t. *Selaginella*
(A) a, b, c (B) a, c, d
(C) a, c (D) a, b, d

Q.128 In gymnosperms the development of pollen grains take place with in the
(A) megasporangia (B) microsporangia
(C) male gametophyte (D) female gametophyte

Q.129 In gymnosperms, the ovule is naked because
(A) ovary wall is absent
(B) integuments are absent
(C) perianth is absent
(D) nucellus is absent

Q.130 In *Pinus,* male cone bears a large number of
(A) ligules (B) anthers
(C) microsporophylls (D) megasporophylls

Q.131 Endosperm in gymnosperms is
(A) n (B) 2n
(C) 3n (D) 4n

Q.132 Select the mismatched pair.
(A) *Cycas* - Living fossil
(B) *Thuja* - Agar production
(C) *Pinus* - Resin, turpentine production
(D) *Araucaria* - Ornamental plant

Q.133 In gymnosperms, pollination takes place by
(A) water (B) air
(C) Insects (D) animals

Q.134 In gymnosperm the roots are generally
(A) respiratory root (B) prop root
(C) tap root (D) adventitious root

Q.135 Mark the odd one (w.r.t. *Ginkgo biloba)*
(A) Presence of naked seeds
(B) Absence of flowers
(C) Presence of heterospory
(D) Absence of long shoot

Q.136 Choose the correct statement –
(A) The gymnosperms are heterosporous.
(B) The strobili bearing microsporophylls and microsporangia are called male strobili.
(C) The cones bearing megasporophylls with ovules are called female strobili.
(D) All of these

Q.137 Gymnosperms produce neither flower nor fruit because they do not possess
(A) embryo (B) ovary
(C) ovule (D) seed

Q.138 Which structures are haploid in gymnosperms?
(A) Pollen grain, megaspore, embryo
(B) Pollen grain, megaspore, endosperm
(C) Megaspore, leaf, root
(D) Leaf, root, integument

Q.139 In gymnosperms one of the megaspores develops into multicellular structure called multicellular ..... that bears two or more archegonia.
(A) male gametophyte (B) female gamete
(C) female gametophyte (D) male gamete

Q.140 Microsporangia in gymnosperm are produced
(A) on the middle portion of microsporophyll
(B) on the lowerside of microsporophyll
(C) on the middle portion of megasporophyll
(D) at the extreme tip of microsporophyll

Q.141 How many ovules are present on each megasporophyll of *Pinus?*
(A) One (B) Two
(C) Four (D) Eight or more

Q.142 Which one is not the feature of *Cycas?*
(A) Unbranched stem
(B) Pinnate leaves
(C) The male or female cones may be borne on the different tree
(D) Archegonia is absent

Q.143 Transfusion tissue is found in the leaves of
(A) Gymnosperms (B) Ferns
(C) Monocots (D) Dicots

Q.144 In gymnosperms the reduced gametophyte is called
(A) endospore (B) pollen grain
(C) ovule (D) aplanospore

PART - 6 : ANGIOSPERMS

Q.145 Smallest flowering plant is
(A) *Ginkgo* (B) *Wolffia*
(C) tulip (D) sweet bay

Q.146 Haplontic life cycle generally occurs in
(A) most algae (B) bryophytes
(C) pteridophytes (D) gymnosperms

Q.147 Double fertilisation involves
(A) syngamy and triple fusion
(B) double fertilisation
(C) development of antipodal cell
(D) development of synergids

Q.148 Carpel consists of –
(A) style and stigma
(B) style, stigma and pistil
(C) style, anther and pistil
(D) anther, style and stigma

Q.149 In flowering plants, meiosis occurs at the time of
(A) formation of buds
(B) germination of seed
(C) formation of root primordia
(D) formation of pollen grains

.

Q.150 *Spirogyra, Volvox* and *Chlamydomonas* shows
(A) haplontic life cycle
(B) diplontic life cycle
(C) haplo-diplontic life cycle
(D) diplobiontic life cycle

Q.151 Female gametophyte in angiosperms is called
(A) Endosperm (B) Carpel
(C) Ovule (D) Embryo sac

Q.152 Select the mismatched pair.
(A) Smallest angiosperm – *Rafflesia*
(B) Tallest angiosperm – *Eucalyptus regnans*
(C) Marine angiosperms – *Zostera, Thalassia*
(D) Angiosperm with smallest seed – *Orchid*

Q.153 Stamen consits of
(A) filament and anther (B) style and stigma
(C) filament and pistil (D) anther and pistil

Q.154 Tallest flowering tree is
(A) *Pinus* (B) *Cedrus*
(C) *Sequoia* (D) *Eucalyptus*

Q.155 Find odd one out w.r.t. haplontic life cycle
(A) *Ectocarpus* (B) *Ulothrix*
(C) *Spirogyra* (D) *Chlamydomonas*

Q.156 Which kind of life-cycle pattern is exhibited by seed-bearing plants?
(A) Haplontic (B) Diplontic
(C) Haplo-diplontic (D) All of these

Q.157 Angiosperms are also called
(A) seed less plants (B) fruit less plants
(C) flowering plants (D) All of these

Q.158 In angiosperms after fertilisation the ovules develop into
(A) fruit (B) seed coats
(C) seed (D) integuments

Q.159 In angiosperm endosperm is
(A) haploid (B) diploid
(C) triploid (D) None of the above

Q.160 In angiosperms after fertilisation the ovaries develop into
(A) fruit (B) seed coats
(C) seed (D) integument

Q.161 Anther produces
(A) pollen grains (B) spores
(C) gametes (D) egg cell

Q.162 Select correct w.r.t. diplohaplontic life cycle
(A) Found in *Polysiphonia* and *Gnetum*.
(B) Both gametophyte and sporophyte phases are present.
(C) Common in green algae.
(D) Gametic meiosis occurs.

Q.163 In haplontic life cycle, the dominant generation is
(A) sporophyte (B) gametophyte
(C) Both (A) and (B) (D) None of the above

Q.164 Double fertilisation occurs among
(A) algae (B) bryophytes
(C) angiosperms (D) gymnosperms

Q.165 Haplo-diplontic life cycle is followed by
(A) bryophytes and pteridophytes
(B) algae and bryophytes
(C) angiosperm and gymnosperm
(D) bryophytes and gymnosperm

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 Consider the following statements.
I. In red algae vegetative reproduction takes place by fragmentation.
II. In red algae the food is stored as floridean starch, which is very similar to amylopectin and glycogen in structure.
III. Cell wall of red algae consists of chitin.
Which of the statements given above are correct?
(A) I and II (B) I and III
(C) II and III (D) All of these

Q.2 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

Q.3 Mosses (along with lichen) are of great ecological importance because
(A) they colonise on barren rocks and decompose rock
(B) its contribution to prevent soil erosion
(C) its contribution in ecological succession
(D) All of the above

Q.4 Oogamous means
(A) fusion between female and male gametes. Both are similar in size.
(B) fusion between one large female gamete and a smaller non-motile male gamete.
(C) fusion between one large female gamete and a smaller motile male gamete.
(D) fusion between one smaller female gamete and a large motile male gamete.

Q.5 Which of the following is incorrect with respect to angiosperms?
(A) Endosperm – Triploid
(B) Megaspore – Diploid
(C) Pollen grain – Haploid
(D) Synergid – Haploid

Q.6 In case of heterosporous pteridophyte the gametophyte is
(A) always dioecious
(B) monoecious
(C) may be monoecious or dioecious
(D) vascular

Q.7 Which of the following does not belong to class-Phaeophyceae (brown algae)?
(A) *Ectocarpus* and *Dictyota*
(B) *Laminaria* and *Sargassum*
(C) *Fucus* and *Dictyota*
(D) *Polysiphonia* and *Gelidium*

Q.8 The moss plant is
(A) sometimes gametophyte and sometimes sporophyte
(B) predominantly gametophyte with sporophyte attached to it
(C) gametophyte
(D) sporophyte

Q.9 In gymnosperm dominant phase is
(A) sporophyte (B) gametophyte
(C) haploid (D) diploid

Q.10 *Kelp* (branched form) and *Sargassam* (filamentous form) belongs to
(A) green algae (B) brown algae
(C) red algae (D) blue-green algae

Q.11 The characteristic features of bryophytes are
I. main plant body is gametophytic.
II. main plant body is sporophytic.
III. requirement of water for fertilisation.
Which of the statements given above are correct?
(A) I and II (B) I and III
(C) II and III (D) I, II and III

Q.12 Which of the following group of marine algae are used as food?
(A) *Chlamydomonas, Volvox* and *Gracilaria*
(B) *Porphyra, Laminaria* and *Sargassum*
(C) *Laminaria* and *Gracilaria*
(D) *Porphyra* and *Chlamydomonas*

Q.13 Which of the following plants produces seeds but not flowers?
(A) Maize (B) Mint
(C) Peepal (D) *Pinus*

Q.14 Mannitol is the stored food in –
(A) *Chara* (B) *Porphyra*
(C) *Fucus* (D) *Gracilaria*

Q.15 In which of the following group would you place a plant, which produce seeds but lacks fruits?
(A) Fungi (B) Pteridophytes
(C) Bryophytes (D) Gymnosperms

Q.16 Which of the following liverworts have thalloid plant body?
(A) *Marchantia* (B) *Funaria*
(C) *Sphagnum* (D) *Pogonatum*

Q.17 In the 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

Q.18 Cycas are
(A) homosporous and dioecious
(B) homosporous and monoecious
(C) heterosporous and dioecious
(D) heterosporous and monoecious

Q.19 Eight nucleated female gametophyte is found in
(A) bryophytes (B) gymnosperms
(C) angiosperms (D) pteridophytes

Q.20 *Chlamydomonas* shows
(A) isogamy (B) anisogamy
(C) Both (A) and (B) (D) oogamy

Q.21 Which of the following pigments gives brown and golden algae their color?
(A) Phycobilins (B) Fucoxanthin
(C) Chlorophylls (D) Carotenoids

Q.22 In majority of the Pteridophytes all the spores are of similar kind such plants are called –
(A) Homosporous (B) Heterosporous
(C) Prothallus (D) Protanema

Q.23 Chlorophyll a, chlorophyll b, and carotenoids are found
(A) green algae, red algae, and land plants
(B) green algae, euglenoids, and land plants
(C) brown algae, green algae, and golden algae
(D) brown algae, diatoms, and golden algae

Q.24 Which is the dominant phase of Pteridophytes –
(A) Gametophyte (B) Sporophyte
(C) Spores (D) Gametes

Q.25 Phycoerythrin is present in
(A) *Polysiphonia* (B) *Laminaria*
(C) *Kelps* (D) *Chlamydomonas*

Q.26 Which protists have photosynthetic pigments similar to those of the cyanobacteria?
(A) golden algae (B) diatoms
(C) euglenoids (D) red algae

Q.27 Gemmae are asexual buds, which originate from small receptacles called gemma cups. These are found in
(A) *Funaria* (B) *Marehantia*
(C) *Fern* (D) *Sphagnum*

Q.28 Land plants are thought to have evolved from
(A) green algae (B) fungi
(C) bryophytes (D) mosses

Q.29 Which of the following does not have true roots?
(A) Conifers (B) Ferns
(C) Flowering plants (D) Mosses

Q.30 Stored food in Phaeophyceae is –
(A) Laminarin or manitol (B) Starch
(C) Cellulose (D) Algin

Q.31 Seed plants lack which of the following structures?
(A) ovules surrounded by integuments.
(B) microspores and megaspores.
(C) vascular tissues
(D) a large, nutritionally independent gametophyte.

Q.32 Gymnosperms include –
(A) Medium sized trees (B) Tall tree
(C) Shrubs (D) All the above

Q.33 In Gymnosperm which is not found –
(A) Antheridia (B) Archegonia
(C) Both (D) None of these

Q.34 A strobilusis –
(A) on a diploid plant (B) on a haploid plant
(C) on a vascular plant (D) all of the above

Q.35 Conifers, cycads, ginkgo, & gnetophytes are collectively called –
(A) fern allies (B) gymnosperms
(C) angiosperms (D) dicots

Q.36 The main plant body of bryophyte is –
(A) Haploid (B) Diploid
(C) Haplo-diploid (D) Diplo-haploid

Q.37 Most conifers are ___, having male and female reproductive parts at different locations on the same plant.
(A) incomplete (B) imperfect
(C) monoecious (D) dioecious

Q.38 Vegetative reproduction in mosses is by –
(A) Fragementation (B) Budding
(C) Both (A) & (B) (D) By spore

Q.39 *Marchantia* is the example of –
(A) Mosses (B) Liver worts
(C) Sphenopsida (D) Lycopsida

Q.40 'Chilgoza' a gymnospermic seed that is eaten as dry fruit is produced by –
(A) *Pinus roxburghii* (B) *Pinus gerardiana*
(C) *Ginkgo biloba* (D) *Cedrus deodara*

Q.41 The spore cases on a fern are
(A) usually on the fronds
(B) formed by the haploid generation
(C) called sporangia
(D) often arranged in a sorus

Q.42 Motile sperm cells are found as vestiges in these two gymnosperm groups
(A) monocots, dicots
(B) gnetophytes, conifers
(C) gnetophytes, flowering plants
(D) cycads, ginkgo

Q.43 This class of flowering plants includes the palms, grasses, and orchids.
(A) dicots (B) gnetophytes
(C) cycads (D) monocots

Q.44 Algae reproduce by –
(A) Asexual (B) Sexual
(C) Vegetative (D) All the above

Q.45 Major Pigments in Phaeophycae –
(A) Chlorophyll a (B) Chlorophyll c
(C) Fucoxanthin (D) All the above

Q.46 The plant body of liverworts is –
(A) Sporophyte (B) Thalloid
(C) With roots (D) Xerophytic

Q.47 In Mosses creeping, green, branched and frequently filamentous stage is called –
(A) Protonema (B) Rhizome
(C) Rhizophore (D) All of these

Q.48 Gymnospermic plants are –
(A) Homosporous (B) Heterosporous
(C) Both (D) Without spores

Q.49 The nucellus is protected by envelopes and the composite structure is called –
(A) Megaspore (B) Microspore
(C) Ovule (D) Cone

Q.50 In cycas specialised roots are associated with N_2 fixing cyanobacteria, called –
(A) Tap root (B) Coralloid root
(C) Adventitious root (D) All the above

Q.51 In Gymnosperms, the seeds are naked because they lack-
(A) Integuments (B) Pericarp
(C) Nucellus (D) Parienth

Q.52 The role of double fertilization in angiosperms is to produce-
(A) Endosperm (B) Integuments
(C) Cotyledons (D) Endocarp

Q.53 If there are 4 cells in anther, what will be the number of pollen grains –
(A) 8 (B) 4
(C) 16 (D) 12

Q.54 During monsoon ground becomes slippery because of
(A) Green algae (B) Blue-green algae
(C) Mosses (D) Liverworts

Q.55 Which blue-green alga remain in symbiotic association with Anthoceros –
(A) Azolla (B) Spirochaete
(C) Spirulina (D) Nostoc

Q.56 Alga associated with Cycas root is –
(A) Anabaena (B) Chara
(C) Chlorella (D) Cladophora

Q.57 Endosperm in Gymnosperm is formed –
(A) At the time of fertilization
(B) Before fertilization
(C) After fertilization
(D) Along with the development of embryo

Q.58 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.

Q.59 The endosperm of Gymnosperm is-
(A) Haploid (B) Diploid
(C) Triploid (D) Tetraploid

Q.60 The longest neck of archegonia is found in which of the Gymnosperm –
(A) Gnetum (B) Ephedra
(C) Welwestchia (D) Pinus

Q.61 Polycotyledonary habit is found in –
(A) Monocot (B) Dicot
(C) Fems (D) Gymnosperm

Q.62 In which of the following, fertilization is possible without water –
(A) Algae (B) Bryophytes
(C) Pteridophytes (D) Gymnosperm

Q.63 In Gymnosperms, the vascular strand is made up of –
(A) Conjoint vascular bundles
(B) Open vascular bundles
(C) Collateral vascular bundles
(D) All of the above

Q.64 Sporophyte is dependent on gametophyte in
(A) Bryophytes (B) Gymnosperms
(C) Angiosperms (D) Pteridophytes

Q.65 Among the following which one are non-vascular plants
(A) Pteridophytes (B) Bryophytes
(C) Angiosperms (D) Gymnosperms

Q.66 Bryophytes are different from fungi in having
(A) Land habit
(B) Sterile jacket layers
(C) Multiflagellate gametes
(D) Gametophytic plant body

Q.67 Funaria may be differentiated from Pinus by the character
(A) No fruits are produced
(B) No seeds are produced
(C) Antheridia and archegonia
(D) Presence of sporophyte

Q.68 The only positive evidence of aquatic ancestry of bryophytes is –
(A) Their green colour
(B) Thread-like protonema
(C) Ciliated sperms
(D) Some forms are still aquatic

Q.69 Fern plant is a –
(A) Haploid gametophyte
(B) Diploid gametophyte
(C) Diploid sporophyte
(D) Haploid sporophyte

Q.70 A plant having vascular supply, producing spores but lacking seeds is a –
(A) Bryophyte (B) Pteridophyte
(C) Gymnosperm (D) Angiosperm

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 Match the following columns.

	Column I	Column II
a.	*Ulothrix*	i. Kelp
b.	*Volvox*	ii. Filamentous
c.	*Chlamydomonas*	iii. Colonial form
d.	Some giant marine form	iv. Unicellular

Codes

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

Q.2 Microsporangia of *Cycas* occur over microsporophyll

(A) laterally (B) abaxially
(C) adaxially (D) marginally

Q.3 Consider the following statements regarding the major pigments and stored food in the different groups of algae and select the correct options–

I. In Chlorophyceae, the stored food material is starch and the major pigments are chlorophyll-a and d.
II. In Phaeophyceae, laminarin is the stored food and major pigments are chlorophyll-a and *b*.
III. In Rhodophyceae, floridean starch is the stored food and major pigments are chlorophyll-a, *d* and phycoerythrin.

(A) I is correct, but II and III are incorrect
(B) I and II are correct, but III is incorrect
(C) I and III are correct, but II is incorrect
(D) III is correct, but I and II are incorrect

Q.4 Primary endosymbiosis is where a nonphotosynthetic eukaryotic cell engulfs a ____ that becomes a permanent resident and transforms into a plastid, as in red-green algae and land plants.

(A) nonphotosynthetic prokaryotic cell.
(B) photosynthetic prokaryotic cell
(C) nonphotosynthetic eukaryotic cell
(D) photosynthetic eukaryotic cell

Q.5 Asexual reproduction in Brown Algae is by –

(A) Biflagellated zoospore
(B) Single flagellated zoospore
(C) Aplanospore
(D) None of these

Q.6 Secondary endosymbiosis is where a nonphotosynthetic eukaryotic cell engulfs a ____ that becomes a permanent resident and transforms into a plastid in *Euglena*.

(A) nonphotosynthetic prokaryotic cell
(B) photosynthetic prokaryotic cell
(C) nonphotosynthetic eukaryotic cell
(D) photosynthetic eukaryotic cell

Q.7 Many factors contributed to the adaptive success of angiosperms, including __

(i) more efficient transport of water and nutrients embryos.
(ii) enhanced nutrition & physical protection of embryos.
(iii) enhanced dispersal of seeds.
(iv) requirement of water for sperm to fertilize egg.

Choose the correct option –

(A) (i), (ii), (iv) (B) (i), (iii), (iv)
(C) (ii), (iii), (iv) (D) (i), (ii), (iii)

Q.8 A pine tree has

(i) sporophylls.
(ii) megasporangia on female cones.
(iii) two sizes of spores in separate cones.
(iv) separate male and female parts on the same tree.

Choose the correct option –

(A) (i), (ii), (iv) (B) (i), (ii), (iii), (iv)
(C) (i), (iii) (D) (i), (ii), (iii)

Q.9 In gymnosperms, the pollen grain develops from

(i) the gametophyte generation
(ii) microspore cells
(iii) the male gametophyte
(iv) meiosis of cells in microsporangium

Choose the correct option –

(A) (i), (ii) (B) (i), (iii)
(C) (ii), (iv) (D) (i), (iv)

Q.10 Generally red Algae do not form –

(A) Zoospore (B) Non - motile spore
(C) Non- motile gamete (D) None of these

Q.11 A strobilus is –
(i) on a diploid plant (ii) on a vascular plant
(iii) found on horsetails (iv) on a haploid plant
Choose the correct option –
(A) (i), (ii), (iv) (B) (i), (ii), (iii), (iv)
(C) (i), (iii) (D) (i), (ii), (iii)

Q.12 The sporophyte generation of a plant
(i) is haploid.
(ii) is diploid.
(iii) produces haploid spores by meiosis.
(iv) produces haploid spores by mitosis.
Choose the correct option –
(A) (i), (ii) (B) (i), (iii)
(C) (ii), (iii) (D) (i), (iv)

Q.13 The leaves of Pteridophyta are –
(A) Microphylls (B) Macrophylls
(C) Both (A) & (B) (D) None of these

Q.14 The spore case on ferns is –
(i) formed by the haploid generation
(ii) usually on fronds
(iii) called sporangia
(iv) often arranged in a sorus
Choose the correct option –
(A) (i), (ii), (iv) (B) (ii), (iii), (iv)
(C) (i), (iii) (D) (i), (ii), (iii)

Q.15 The gametophyte generation of a plant
(i) is haploid.
(ii) is diploid.
(iii) produces haploid spores.
(iv) produces haploid gametes by mitosis.
Choose the correct option –
(A) (i), (ii) (B) (i), (iii)
(C) (ii), (iv) (D) (i), (iv)

Q.16 In Pteridophytes, sporophylls may form distinct compact structure, called –
(A) Strobili or cones (B) Microphyll
(C) Macrophyll (D) Tropophyll

Q.17 Spores grow –
(i) into gametophyte plants.
(ii) into sporophyte plants.
(iii) into a haploid plant.
(iv) to form a plant body by mitosis.
Choose the correct option –
(A) (i), (ii), (iv) (B) (i), (iii), (iv)
(C) (ii), (iii), (iv) (D) (i), (ii), (iii)

Note (Q.18-Q.23) :
(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) Statement-1 is False, Statement-2 is False

Q.18 **Statment 1 :** *Spirogyra* shows anisogamy.
Statement 2 : Gametes are identified on the basis of their motility.

Q.19 **Statement 1 :** *Chlorella* could be utilised to keep the air in space vehicles.
Statement 2: The space travellers feed on *Chlorella* soup.

Q.20 **Statement 1 :** Bryophytes possess archegonium as a female sex organ.
Statement 2: Algae also possess the archegonium.

Q.21 **Statement 1 :** Sporogonium of *Riccia* is totally dependent on the gametophyte.
Statement 2 : Sporogonium of *Marchantia* is partly dependent on the gametophyte.

Q.22 **Statement 1 :** Sporophytes of pteridophyta are dominant individual.
Statement 2: They do not show the formation of true root.

Q.23 **Statement 1 :** Gymnosperms seeds are naked.
Statement 2 : They lack ovary wall.

Q.24 At least a half of the total CO_2 fixation on earth is carried out through photosynthesis by
(A) angiosperms (B) gymnosperms
(C) algae (D) bryophytes.

Q.25 *Batrachospermum* is a
(A) red algae of sea (B) brown algae
(C) blue algae (D) red algae of freshwater

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

Choose one correct response for each question.

Q.1 Isogamous condition with non-flagallated gametes is found in – **[NEET 2013]**
(A) *Fucus* (B) *Chlamydomonas*
(C) *Spirogyra* (D) *Volvox*

Q.2 Monoecious plant of *Chara* shows occurrence of: **[NEET 2013]**
(A) upper oogonium and lower antheridium on the same plant.
(B) antheridiophore and archegoniophore on the same plant.
(C) stamen and carpel on the same plant.
(D) upper antheridium and lower oogonium on the same plant.

Q.3 Select the wrong statement : **[NEET 2013]**
(A) *Chlamydomonas* exhibits both isogamy and anisogamy and *Fucus* shows oogamy.
(B) Isogemetes are similar in structure, function and behaviour.
(C) Anisogametes differ either in structure, function or behaviour.
(D) In Oomycetes female gamete is smaller and motile, while male gamete is larger and non-motile.

Q.4 Read the following statements (a – e) and answer the question which follows them. **[NEET 2013]**
(a) In liverworts, mosses and ferns gametophytes are free living.
(b) Gymnosperms and some ferns are heterosporous.
(c) Sexual reproduction in Fucus , Volvox and Allbugo is oogamous.
(d) The sporophyte in liverworts is more elaborate than that in mosses.
(e) Both, Pinus and Marchantia are dioecious.
How many of the above statements are correct?
(A) Four (B) One
(C) Two (D) Three

Q.5 Which one of the following is wrong about *Chara*? **[AIPMT 2014]**
(A) Upper oogonium & lower round antheridium
(B) Globule and nucule present on the same plant
(C) Upper antheridium and lower oogonium
(D) Globule is male reproductive structure

Q.6 Which of the following is responsible for peat formation? **[AIPMT 2014]**
(A) *Marchantia* (B) *Riccia*
(C) *Funaria* (D) *Sphagnum*

Q.7 In which of the following gametophyte is not independent free living ? **[AIPMT 2015]**
(A) *Marchantia* (B) *Pteris*
(C) *Pinus* (D) *Funaria*

Q.8 Read the following five statements (a to e) and select the option with all correct statements: **[AIPMT 2015]**
(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)

Q.9 Male gametes are flagellated in: **[AIPMT 2015]**
(A) *Anabaena* (B) *Ectocarpus*
(C) *Spirogyra* (D) *Polysiphonia*

Q.10 Which one of the following statements is wrong? **[AIPMT 2015]**
(A) Agar-agar is obtained from Gelidium and Gracilaria.
(B) Chlarella and Spirulina are used as space food.
(C) Mannitol is stored food in Rhodophyceae.
(D) Algin and carragen are products of algae.

Q.11 Select the correct statement **[NEET 2016 PHASE 1]**

(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.

Q.12 In bryophytes and pteridophytes, transport of male gametes requires **[NEET 2016 PHASE 1]**

(A) Wind (B) Insects
(C) Birds (D) Water

Q.13 Which one of the following statements is wrong? **[NEET 2016 PHASE 2]**

(A) Algae increase the level of dissolved oxygen in the immediate environment.
(B) Algin is obtained from red algae, and carrageenan from brown algae.
(C) Agar-agar is obtained from *Gelidium* and *Gracilaria*
(D) *Laminaria* and *Sargassum* are used as food.

Q.14 Select the mismatch : **[NEET 2017]**

(A) *Pinus* – Dioecious
(B) *Cycas* – Dioecious
(C) Salvinia – Heterosporous
(D) Equisetum – Homosporous

Q.15 An example of colonial alga is **[NEET 2017]**

(A) Chlorella (B) Volvox
(C) Ulothrix (D) Spirogyra

Q.16 Zygotic meiosis is characterstic of – **[NEET 2017]**

(A) *Marchantia* (B) *Fucus*
(C) *Funaria* (D) *Chlamydomonas*

Q.17 Life cycle of *Ectocarpus* and *Fucus* respectively are **[NEET 2017]**

(A) Haplontic, Diplontic
(B) Diplontic, Haplodiplontic
(C) Haplodiplontic, Diplontic
(D) Haplodiplontic, Haplontic

Q.18 Select the mismatch : **[NEET 2017]**

(A) *Frankia* - *Alnus*
(B) *Rhodospirillum* - *Mycorrhiza*
(C) *Anabaena* - *Nitrogen fixer*
(D) *Rhizobium* - *Alfalfa*

Q.19 Double fertilization is exhibited by : **[NEET 2017]**

(A) Gymnosperms (B) Algae
(C) Fungi (D) Angiosperms

Q.20 Which 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*

Q.21 Winged pollen grains are present in **[NEET 2018]**

(A) Mango (B) *Cycas*
(C) Mustard (D) *Pinus*

Q.22 Which one is wrongly matched? **[NEET 2018]**

(A) Gemma cups – *Marchantia*
(B) Biflagellate zoospores – Brown algae
(C) Uniflagellate gametes – *Polysiphonia*
(D) Unicellular organism – *Chlorella*

Q.23 From evolutionary point of view, retention of the female gametophyte with developing young embryo on the parent sporophyte for some time, is first observed in **[NEET 2019]**

(A) Liverworts (B) Mosses
(C) Pteridophytes (D) Gymnosperms

Q.24 Pinus seed cannot germinate and established without fungal association. This is because :

(A) its embryo is immature. **[NEET 2019]**
(B) it has obligate association with mycorrhizae.
(C) it has very hard seed coat.
(D) its seeds contain inhibitors that present germination.

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (D) **(2)** (D) **(3)** (A) **(4)** (B)
(5) (D) **(6)** Chemotaxonomy
(7) Starch, pyrenoids, Chloroplast
(8) Archegonium
(9) Pyrenoid, Protein, Starch sheath
(10) Zoogametes **(11)** Cellulose, Pectose
(12) *Rhodomella* **(13)** Stigma; pollen tube
(14) Numerical taxonomy **(15)** Chloroplast
(16) Algin **(17)** Sporophylls

EXERCISE - 1 [SECTION-3 & 4]

Q	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
A	B	B	B	B	A	A	B	B	D	B	B	B	A	A	C	C	B	D	A	D	C	C	C	C	A
Q	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67
A	A	A	D	D	A	B	C	B	B	C	C	B	C	D	B	B	D	C	B	C	D	B	A	D	C
Q	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92
A	D	B	C	B	B	D	D	D	D	A	C	A	C	D	C	A	C	A	B	A	A	A	C	B	A
Q	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117
A	D	B	D	C	B	B	D	C	D	D	B	D	A	B	A	B	A	A	D	C	B	B	D	B	B
Q	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142
A	D	A	C	A	B	B	A	A	B	D	B	A	C	A	B	B	C	D	D	B	B	C	D	B	D
Q	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165		
A	A	B	B	A	A	A	D	A	D	A	A	D	A	B	C	C	C	A	A	B	B	C	A		

EXERCISE - 2

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	A	A	D	C	B	A	D	B	A	B	B	B	D	C	D	A	C	C	C	C	B	A	B	B	A
Q	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A	D	B	A	D	A	D	D	A	D	B	A	C	C	B	B	B	D	D	D	D	B	A	B	C	B
Q	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70					
A	B	A	C	B	D	A	B	D	A	B	D	D	D	A	B	B	B	C	C	A					

EXERCISE - 3

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	D	B	D	B	A	D	D	B	C	A	D	C	C	B	D	A	B	B	B	C	B	C	A	C	D

EXERCISE - 4

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A	C	A	D	D	C	D	C	B	B	C	C	D	B	A	B	D	C	B	D	C	D	C	C	B

SOLUTIONS

EXERCISE-1

(1) (D) **(2)** (D) **(3)** (A) **(4)** (B)
(5) (D) **(6)** Chemotaxonomy
(7) Starch, pyrenoids, Chloroplast
(8) Archegonium
(9) Pyrenoid, Protein, Starch sheath
(10) Zoogametes **(11)** Cellulose, Pectose
(12) *Rhodomella* **(13)** Stigma; pollen tube
(14) Numerical taxonomy **(15)** Chloroplast
(16) Algin **(17)** Sporophylls
(18) (B) **(19)** (B)
(20) (B) **(21)** (B)
(22) **(A).** The algae shown in figure are *Chlamydomonas*, *Volvox* and *Chara* respectively, belonging to class *Chlorophyceae*.
(23) (A) **(24)** (B) **(25)** (B) **(26)** (D)
(27) (B) **(28)** (B) **(29)** (B) **(30)** (A)
(31) (A) **(32)** (C) **(33)** (C) **(34)** (B)
(35) (D) **(36)** (A) **(37)** (D) **(38)** (C)
(39) (C) **(40)** (C) **(41)** (C) **(42)** (A)
(43) (A) **(44)** (A) **(45)** (D) **(46)** (D)
(47) (A) **(48)** (B) **(49)** (C) **(50)** (B)
(51) (B) **(52)** (C) **(53)** (C) **(54)** (B)
(55) (C) **(56)** (D) **(57)** (B) **(58)** (B)
(59) (D) **(60)** (C) **(61)** (B) **(62)** (C)
(63) (D) **(64)** (B) **(65)** (A) **(66)** (D)
(67) (C) **(68)** (D) **(69)** (B) **(70)** (C)
(71) (B) **(72)** (B) **(73)** (D) **(74)** (D)
(75) (D)
(76) **(D).** In class-Chlorophyceae, the cells possess one or more chloroplasts. The shape of chloroplasts may be
Cup-shaped : *Chlamydomonas*
Girdle-shaped : *Ulothrix*
Spiral : *Spirogyra*
Star-shaped : *Zygnema*
Reticulate : *Chlamydomonas reticulata*
Partial reticulate : *Oedogonium*
Partial band-shaped : *Hydrodictyon*
Disc-shaped : *Chara*
(77) **(A).** Isogamous type of sexual reproduction is found in Ulothrix and in majority, the plants are heterothallic. The gametes are found in large number, i.e. 32 to 64 in each gametangium.
(78) (C) **(79)** (A) **(80)** (C) **(81)** (D)
(82) (C) **(83)** (A)
(84) **(C).** Bryophytes are dependent on water for reproduction, because sperms must swim to the archegonia. They are partly adapted to the land, because the gametes develop in protective structures, *i.e.,* antheridia and archegonia. So, bryophytes are also called 'amphibians of the plant kingdom.'
(85) **(A).** The predominant stage of the life cycle of a moss is the gametophyte, which consists of two stages. The first stage is protonema stage, which develops directly from a spore. The second stage is the leafy stage which develops from the secondary protonema as a lateral bud. They consist of upright slender axes bearing spirally arranged leaves. They are attached to the soil through multicellular and branched rhizoids. This stage bears the sex organs.
(86) **(B).** In *Marchantia*, the plant body consists of a dorsiventrally flattened, prostrate and dichotomously branched thallus. The thalli are conspicuous, apex of each thallus is notched. Along the mid-rib are present characteristic, prominent goblet or cup-shaped structures, the gemma cups, with smooth, dentate or frilled margins. These cups enclose asexual reproductive bodies called gemma.
(87) (A) **(88)** (A) **(89)** (A)
(90) **(C).** The capsule bears spores. Spores are formed after meiosis.
(91) (B) **(92)** (A) **(93)** (D) **(94)** (B)
(95) **(D).** Protonema is the juvenile stage of moss. It results from the germinating rneiospore. When fully grown, it consists of a slender green, branching system of filaments called the protonema.
(96) **(C).** Species of *Sphagnum,* a moss provide peat that have long been used as fuel, and because of their capacity to hold water, used

as packing material for trans-shipment of living material.

(97) (B)

(98) **(B).** The reproduction in mosses takes place in water, thus they occur in moist places.

(99) **(D).** *Riccia* is a liverwort (Hepaticae), which grows predominantly in wet terrestrial habitats and are free floating or submerged aquatic.

(100) **(C).** *Funaria, Polytrichum* and *Sphagnum* are the examples of mosses.

(101) **(D).** Pteridophytes are called vascular cryptogams, also known as seedless vascular plants. They produce spores rather than seeds. These include horse tails and ferns.

(102) (D) **(103)** (B) **(104)** (D)

(105) **(A).** Haploid spore germinates to form a prothallus (gametophyte), which is monoecious, *i.e.,* has both santheridia (♂) and archegonia (♀).

(106) **(B).** The gametophytes bear male and female sex organs called antheridia and archegonia, respectively.

(107) **(A).** The main plant body in pteridophytes is sporophyte (2n) which is differentiated into root (2n), stem and leaf.

(108) **(B).** Pteridophytes are considered as first terrestrial plants to possess vascular tissues xylem and phloem. All the vegetative parts possess vascular tissues *(i.e.,* xylem and phloem) organised in definite groups.

(109) **(A).** Genera like *Selaginella* and *Salvinia,* which produce two kinds of spores, macro (large) and micro (small) spores are known as heterosporous.

(110) (A)

(111) **(D).** Pteridophytes are called vascular cryptogams also known as seedless vascular plants. They produce spores rather than seeds.

(112) **(C).** *Salvinia* is an aquatic fern with both annual (e.g., *S. nutans*) and perennial species (e.g., *S. molesta*). The plant body consists of a floating stem bearing two rows of large green hairy leaves on the upper surface and highly branched leaf roots on the lower surface.

(113) **(B).** Some of the bryophytes produce smaller spores called microspores and larger one called megaspore. This nature is called heterospory. In angiosperms, there is only one functional megaspore. The male and female gametes fuse to form zygote, which eventually develops into embryo. The embryo forms the seed.

(114) **(B).** Prothallus is a small, flattened, multicellular structure that represents the independent gametophytic generation of a fern. The prothalli bear antheridia (male sex organs) and archegonia (female sex organs), which produce male & female gametes respectively.

(115) (D)

(116) **(B).** Pteridophytes are called vascular cryptogams because among cryptogams the vascular strands are present only in pteridophyte. All the vegetative parts possess vascular tissues *(i.e.,* xylem and phloem).

(117) **(B).** The spores are homosporous and germinate to produce independent cushion-like monoecious gametophyte.

(118) **(D).** The gaint *Sequoia* is the world's most massive tree and arguable the largest living organism on earth.

(119) **(A).** In gymnosperms, the nucellus is protected by envelopes and this composite structure is called ovule. Each ovule is actually the female spore-producing organ surrounded by a protective envelope called integuments.

(120) (C)

(121) **(A).** Heterospory is the condition of producing two types of spores, i.e. megaspores & microspores. Heterospory occurs in all seed bearing plants i.e. gymnosperms and angiosperms.

(122) **(B).** Gymnosperms lack ovary thus, fruits are absent. They possess naked seeds due to presence of naked ovules.

(123) **(B).** Coralloid root is developed in *Cycas*. It contain an algal zone in the cortex. This algal zone contains blue-green algae like *Nostoc, Anabaena,* which grow in symbiotic association with corolloid root.

(124) **(A).** A mycorrhiza is a symbiotic association of a fungus with a root system. The mycorrhizal roots of Pinus occur near the soil surface. They are devoid of root hair and root cap. The fungus commonly associated with mycorhizic roots of Pinus is Boletus elegans.

(125) (A) **(126)** (B)

(127) (D) **(128)** (B)

(129) **(A).** After fertilisation the ovary develops into fruit ovule forms seeds and ovary wall forms the fruit wall (pericarp). But gymnosperms have naked seeds because in gymnosperms, ovary (pericarp) is absent.

(130) **(C).** In *Pinus,* each male cone consists of an elongated axis, bearing a number of spirally arranged microsporophylls. On the underside of which two microsporangia develop and get filled with microspores (pollen grains).

(131) (A)

(132) **(B).** *Thuja plicata* possesses the wood which is known for possessing certain antibiotics. It is resistant to weathers and is widely used for commercial purposes. It also provides an essential oil which is used in perfumery. Agar is obtained from cell wall of *Gelidium* and *Gracilaria*.

(133) **(B).** In gymnosperm pollen grain is released from microsporangium and carried with the help of air current. It comes in contact with opening of ovule.

(134) **(C).** In gymnosperms the primary root commonly grows to become a thick central root, the tap root, which may or may not have thick lateral roots (branches).

(135) (D) **(136)** (D) **(137)** (B)

(138) **(B).** In gymnosperms, the pollen grains and the megaspores are haploid and develop as a result of meiosis in the respective mother cells. The functional megaspore forms the embryo sac. The endosperm is formed prior to fertilization, hence is haploid.

(139) **(C).** In gymnosperms, megaspores develops into multicellular structure called multicellular female gametophyte that bears two or more archegonia or female sex organs.

(140) **(D).** Microsporangia are produced at the extreme tip of microsporophyll. Microsporangia is a sporangium that produces spores that give rise to male gametophyte.

(141) (B)

(142) **(D).** The stems are unbranched in *Cycas* or branched in *Pinus* and *Cedrus*. In *Cycas*, leaves reduced and usually once pinnate circinate. The male or female cones or strobili may be borne on the same tree *(Pinus)* or on different trees (*Cycas*). In Cycas the archegonia are embedded in the female gametophytes and open into the archegonial chamber.

(143) (A) **(144)** (B)

(145) (B) **(146)** (A)

(147) **(A).** Double fertilisation is the fusion of one male gamete with female gamete (syngamy) and other male gamete with diploid secondary nucleus (triple fusion), *i.e.,* double fertilisation = syngamy + triple fusion.

(148) (A) **(149)** (D)

(150) (A) **(151)** (D)

(152) **(A).** Smallest angiosperm is *Wolffia microscopici*, while *Rafflesia arnoldii* is the parasitic plant with world's largest flower.

(153) (A)

(154) **(D).** The tallest flowering plant in the world is swamp gum *(Eucalyptus regnans)* found in Australia's Southern Island state Tasmania. They grow upwards upto 100-101 meters tall and are 405 cm in diameter.

(155) (A)

(156) **(B).** In diplontic life cycle, the dominant free living phase is the diploid (2n). Sporophyte is photosynthetic. The gametophytic phase is represented by single to few-celled haploid gametophyte e.g., all seed-bearing plants i.e., gymnosperms and angiosperms.

(157) **(C).** Division/phylum A-angiospermae is sometimes called division-Anthophyta *(anthe*-flower; *phyto*-plant*)* because the common name for this group is the 'flowering plants'.

(158) **(C).** After fertilisation ovules develop into seeds and ovaries develop into fruit.

(159) **(C).** The primary endosperm nucleus is triploid (3n) as it is the product of triple fusion.

(160) (A) **(161)** (A) **(162)** (B)

(163) **(B).** In haplontic life cycle gametophyte is dominant and sporophyte is single celled zygote. Haplonts are

(i) Most fungi.

(ii) Some green algae, *e.g., Chlamydomonas.*

(iii) Many Protozoa, *e.g., Plasmodium.*

(164) **(C).**

(165) **(A).** Haplo-diplontic life cycle is followed by bryophytes and pteridophytes. In this case sporophytic as well as gametophytic phase is multicellular.

EXERCISE-2

(1) (A) **(2)** (A) **(3)** (D)

(4) **(C).** Fusion of a large non-motile egg or ovum with a smaller motile sperm (except in Rhodophyceae). The gametes differ morphologically as well as physiologically and are called oogametes. The fusion of gametes is called oogamy, *e.g., Chlamydomonas, Fucus, Chara* and *Volvox*.

(5) **(B).** Megaspores are haploid.

(6) **(A).** Heterosporous pteridophytes like *Selaginella* and *Marsilea* always produce dioecious gametophyte because microspore will form male gametophyte and megaspore will form female gametophyte.

(7) **(D).** *Polysiphonia* and *Gelidium* belongs to class-Rhodophyceae.

(8) **(B).** The haploid gametophyte is dominant, long lived, green and independent whereas the diploid sporophyte is short lived and dependent upon the gametophyte.

(9) **(A).** In gymnosperms the dominant phase is sporophyte. Gymnosperms are heterosporous produced haploid megaspore and microspores, which are produced within sporangia born on sporophyll. These spore bearing plants are called sporophytes.

(10) **(B).**

(11) **(B).** In bryophytes, the haploid gametophyte is dominant, long lived, green and independent whereas the diploid sporophyte is short lived and dependent upon the gametophyte. Water is essential for reproduction. The sex organs are multicellular and jacketed with sterile jacket.

(12) **(B).**

(13) **(D).** *Pinus* is gymnospermic plant. Ovules of *Pinus* are uncovered, which lie on the megasporophyll, hence this plant does not have flowers. However it produces seeds (from ovule after fertilisation) like other three plants mentioned, all of the other three are angiosperms.

(14) **(C).** *Fucus* belongs to class-Phaeophyceae, in which reserve food is found in form of laminarin, mannitol and oil.

(15) **(D).** Gymnosperms lack ovary thus, fruits are absent. They possess naked seeds due to presence of naked ovules.

(16) **(A).** The vegetative plant body of *Marchantia* is a dorsiventral lobed thallus. It is dichotomously branched. The upper surface is smooth whereas the lower surface bears a large number of unicellular rhizoids, which penetrate into the soil.

(17) **(C).** In the angiosperm ovule, central cell of the embryo sac prior to the triple fusion, contains two haploid polar nuclei. Triple fusion in angiosperm is the fusion of second sperm with two polar nuclei or the diploid secondary nucleus, which results in the formation of a triploid primary endosperm nucleus.

(18) **(C).** *Cycas* are heterosporous and in additions, produce highly specialised complex reproductive and dispersal structure called seeds. *Cycas* is also a dioecious plant. Dioecious plants are unisexual, having male and female reproductive organs on different individual (plants).

(19) **(C).** *Polygonum* type of embryo sac is the most common in angiosperms. It is 7-celled and 8-nucieate.The nuclei are arranged in such a way that three organised at micropylar end form egg apparatus (one egg and two

synergids), two nuclei migrate to centre and form polar nuclei in a single central cell and three nuclei at chalazal pole organised into antipodal cells.

(20) (C) **(21)** (B)
(22) (A) **(23)** (B) **(24)** (B)
(25) **(A).** *Polysiphonia* is the example of class-Rhodophyceae. It is red algae.
The characteristic red colour of algae is due to presence of excess amount of r-phycoerythrin.
(26) (D)
(27) **(B).** Asexual reproduction in *Marchentia* occurs by the formation of gemmae. The gemmae are multicellular green and biconvex lens shaped bodies produced in gemma cups. They detach from gemma cup and germinate to produce new plants.

(28) (A) **(29)** (D) **(30)** (A) **(31)** (D)
(32) (D) **(33)** (A) **(34)** (D) **(35)** (B)
(36) (A) **(37)** (C) **(38)** (C) **(39)** (B)
(40) (B) **(41)** (B) **(42)** (D) **(43)** (D)
(44) (D) **(45)** (D) **(46)** (B) **(47)** (A)
(48) (B) **(49)** (C) **(50)** (B) **(51)** (B)
(52) (A) **(53)** (C) **(54)** (B) **(55)** (D)
(56) (A) **(57)** (B) **(58)** (D) **(59)** (A)
(60) (B) **(61)** (D) **(62)** (D) **(63)** (D)
(64) (A) **(65)** (B) **(66)** (B) **(67)** (B)
(68) (C) **(69)** (C) **(70)** (A)

EXERCISE-3

(1) **(D).**
(2) **(B).** Each microsporophyll has two microsporangia on the abaxial surface.
In microsporangium, microspores are developed.
(3) **(D).**

Group	Major Pigment	Reserve Food
Chlorophyceae	Chlorophyll-a, *b*	Starch
Phaeophyceae	Chlorophyll-a, c	Laminarin and mannitol
Rhodophyceae	Chlorophyll-a,*d*	Floridean starch

(4) **(B).** Primary endosymbiosis is where a nonphotosynthetic eukaryotic cell engulfs a photosynthetic prokaryotic cell that becomes a permanent resident and transforms into a plastid, as in red-green algae and land plants.

(5) (A) **(6)** (D) **(7)** (D) **(8)** (B)
(9) (C) **(10)** (A) **(11)** (D) **(12)** (C)
(13) (C) **(14)** (B) **(15)** (D) **(16)** (A)
(17) (B)
(18) **(B).** In *Spirogyra*, the fusing gametes are morphologically alike but dissimilar in their behaviour. One of the fusing pairs may be more active than the other. The gametes of *Spirogyra* are distinguishable by their degree of motility. This different in behavior is the first step towards anisogamy. It is called physiological anisogamy.
(19) **(B).** *Chlorella* could be utilised to keep the air in space vehicles pure and supply food in space stations and prolonged space flight trips. The space travellers could feed on *Chlorella* soup. It is nourishing but not appetizing food.
(20) **(C).** The female sex organ of the bryophytes is a remarkable structure. It appears for the first time in the liverworts and mosses and continues in the pteridophytes. Archegonium is absent in thallophytes (algae and fungi). Sex organs in them are male gametes and female gamete.
(21) **(B).** Sporogonium of *Riccia* completely lacks chloroplasts. Therefore, it is dependent upon the gametophyte for food, water and minerals. However in *Marchantia*, with differentiation of the young sporophyte into foot, seta and capsule, the immature cells of the seta, capsule wall, elaters and even those of the foot develop chlorophyll. They are autotrophic to a considerable extent. It may be partly dependent upon the parent plant (gametophyte) for its food supply. For the supply of water and minerals in solutions it is entirely dependent upon the parent plant.
(22) **(C).** In the pteridophytes, the sporophyte gains physiological independence and develops into the dominant, typically photosynthetic phase of the life cycle. It is organized into stem, leaves and roots. For the first time in

the sporophyte of the pteridophytes true roots develops. Psilophyta (a pteridophyte division) lack true roots.

(23) **(A).** The gymnosperms have their ovules freely exposed before and after fertilization. They are not enclosed by any ovary wall. The seeds formed by them lack seed coat. Hence due to absence of every wall and seed coat their seeds are nacked.

(24) **(C).** Nearly 50% of total carbon dioxide fixation or photosynthesis of world is carried out by algae. Photosynthesis by algae releases oxygen in the immediate aquatic environment. It is essential for respiration of aquatic life. Algae are primary producers of food in large bodies of fresh, brackish and sea water.

(25) **(D).** *Batrachospermum* is a freshwater filamentous red alga, commonly called frog sprawn alga.

EXERCISE-4

(1) **(C).** *Volvox* & *fucus* are example of oogamous and chlamydomonas contain isogamous flagellated gametes.

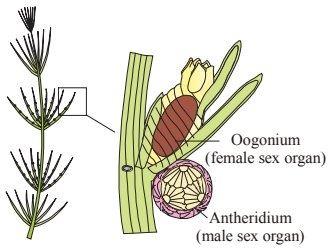
(2) **(A).** *Chara* is monoecious green algae.

(3) **(D).** In oomycetes female gamete is large & non motile while mole gamete is small & motile.

(4) **(D).** a, b & c statements are right. In statement d, the sporophyte of mosses is more eleborate then liverworts & in statement (e) pinus is monoecious & marchantia is dioecious.

(5) **(C).** Nucule/oogonium/upper sex organ

Globule/antheridium/lower sex organ



(6) **(D).** Species of *Sphagnum*, a moss provides peat that have long been used as fuel.

(7) **(C).** Marchantia & Funaria have dominant phase gametophyte. While pteris has independent gametophyte and sporophyte. But Pinus is gymnosperm in which free living gametophyte is absent.

(8) **(B).** a - Mosses & lichen are pioneers on rocks

b - *Selaginells* is heterosporous

c-Coralloid roots of cycas has cyanobacteria - Anabena cycadae.

d & e are correct.

(9) **(B).** *Anabaena* - non flagellatedmale gamete

Spirogyra - Aplanogamy

Polysiphomia - Nonmotile spermatia

Ectocarpus - Pear shaped motile male gametes.

(10) **(C).** Mannitol is store food in phaeophyceae.

(11) **(C).** *Sequoia* is one of the tallest tree species, known as red wood tree.

(12) **(D).** In several simple plants like algae, bryophytes and pteridophytes, water is the medium through which male gamete transfer takes place.

(13) **(B).** Algin is obtained from brown algae, and carrageenin from red algae.

(14) **(A).** *Pinus* is monoecious plant having both male and female cones on same plant.

(15) **(B).** Volvox is motile colonial fresh water alga with definite number of vegetative cells.

(16) **(D).** *Chlamydomonas* has haplontic life cycle hence showing zygotic meiosis or initial meiosis.

(17) **(C).** *Ectocarpus* has haplodiplontic life cycle and *Fucus* has diplontic life cycle.

(18) **(B).** Rhodospirillum is anaerobic, free living nitrogen fixer. Mycorrhiza is a symbiotic relationship between fungi and roots of higher plants.

(19) **(D).** Double fertilization is a characteristic feature exhibited by angiosperms. It involves syngamy and triple fusion.

(20) **(C).** Gymnosperms have naked ovule.

Called phanerogams without womb/ovary.

(21) **(D).** In *Pinus*, winged pollen grains are present. It is extended outer exine on two lateral sides to form the wings of pollen. It is the characteristic feature, only in *Pinus*.

Pollen grains of Mustard, *Cycas* & Mango are not winged shaped.

(22) **(C).** *Polysiphonia* is a genus of red algae, where asexual spores and gametes are non-motile or non-flagellated. Other options (A, B & D) are correctly matched.

(23) **(C).** In Pteridophyte, megaspore is retained for some times in female gametophyte, however the permanent retention is required for seed formation in Gymnosperms. That's why Pteridophytes exhibit precursor to seed habit only.

(24) **(B).** Fungus associated with roots of *Pinus* increases minerals & water absorption for the plant by increasing surface area and in turn fungus gets food from plant. Therefore, mycorrhizal association is obligatory for *Pinus* seed germination.