chapter - 3

Plant Kingdom

Systems of classification

Artificial system of classification

- It was the earliest system of classification.
  it used only gross superficial morphological characters such as habit, colour, number and shape of leaves etc.
  They were based mainly on vegetative characters or on the androecium structure (system given by Linnaeus).
- They separated the closely related species since they were based on a few characteristics.
  Also, the artificial systems gave equal weightage to vegatative and sexual characteristics, this is not acceptable since we know that often the vegetative characters are more easily affected by environment e.g. Linnaeus classification of plants based on no of androecium

- **Natural system-** it was based on natural affinities among the organisms and consider not only the external features, but also internal features

like ultrastructure, anatomy, like ultra-structure, anatomy, embryology and Photo-chemistry.

e.g. George Bentham and Joseph dalton hooker classification of flowering plant

- **Phylogenetic classification system.**
- it is most acceptable system. it is based on evolutionary relationships between the various organisms
This assumes that organisms belonging to the same taxa have a common ancestor. - Hutchinson

New development in taxonomy

- Carried out using computers based on all observable characteristics. Data processed after assigning number and codes to all the characters

Advantages- each character gets equal importance and a number of characters can be considered

- **cytotaxonomy-** Based on cytological informations
Give importance to chromosome no. Structure and behaviour
- **chemotaxonomy-** Based on chemical constituents of plants

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Plant classification

Body is not differentiated into root, stem, leaves (Thallophyta

Body differentiated into root, stem, leaf

Vascular Tissue is absent (Bryophyta)

Vascular tissue is present (Tracheophyta)

Seeds are absent (Cryptogames) Pteridophyta

Seeds present Phanerogames Spermatophyta

flowers, fruits are absent (Gymnosperms)

flower, fruits are present (Angiosperms

Thallophyta / Algae-

- algae are chlorophyll-bearing, simple thalloid, autotrophic and largely aquatic (both fresh and marine water) organisms.

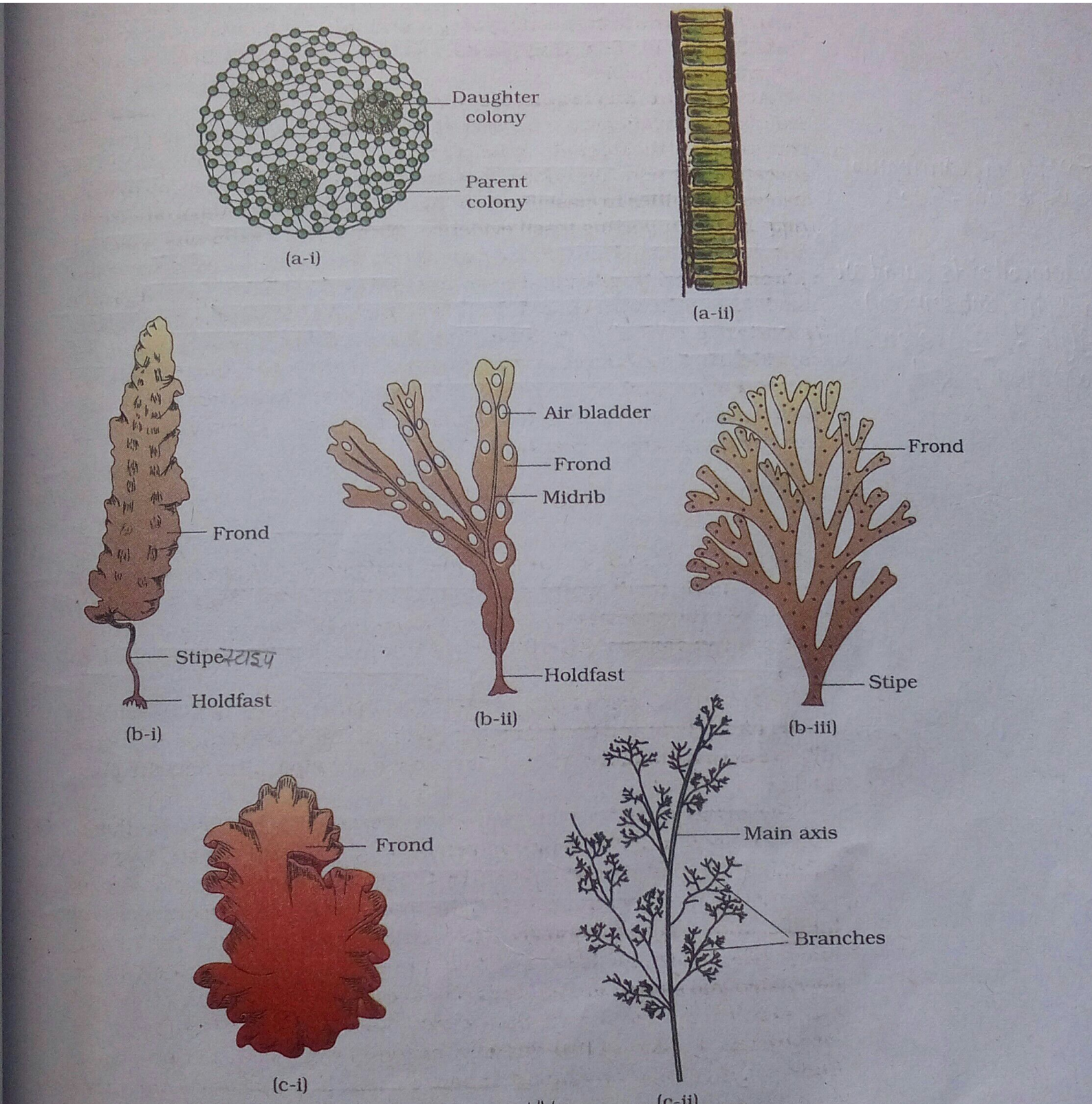

Figure 3.1 Algae : (a) Green algae (i) *Volvox* (ii) *Ulothrix*
(b) Brown algae (i) *Laminaria* (ii) *Fucus* (iii) *Dictyota*
(c) Red algae (i) *Porphyra* (ii) *Polysiphonia*

Some algae also occur in association with fungi (lichen) and animals (sloth bear)

Size and form of algae-

- The microscopic unicellular forms - chlamydomonas.
- colonial forms- Volvox.
  filamentous forms- Ulothrix
- marine and massive plant bodies- Kelps.

Reproduction in Algae-

1. Vegetative Reproduction - by fragmentation, each fragment develops into a thallus.
2. Asexual reproduction - by production of different types of spores like- zoospores. they are flagellated (motile) and on germination gives rise to new plants.
3. Sexual Reproduction - through fusion of two gametes

(i) Isogamous - if gametes are flagellated and similar in size - chlamydomonas.
if gametes are non-flagellated and similar in size - Spirogyra.

(ii) Anisogamous - if gametes are dissimilar in size eg some species of

chlamydomonas.

(iii) Oogamous- fusion between one larger non motile female gamete and a smaller, motile male gamete is termed as oogamous e.g. Volvox, fucus

Economic importance of Algae-

- At least a half of the total carbon dioxide fixation on earth is carried out by algae through photosynthesis
- They are primary producers of energy rich compounds which form the basis of the food cycles of all aquatic animals many species of Porphyra, Laminaria
- Certain marine brown and red algae produce large amounts of hydrocolloids (water holding substances) e.g. algin (brown algae), and carrageen (red algae)
- Agar, one of the commercial products obtained from Gelidium and Gracilaria are used to grow microbes and in preparations of ice-creams and jellies
- chlorella and spirullina are unicellular algae, rich in proteins and are used as food supplements even by space travellers (SCP-single cell protein

The algae are divided into 3 main classes (on the basis of pigment and stored food) chlorophyceae - Phaeophyceae, Rhodophyceae

1. chlorophyceae (Green algae)

- The plant body may be unicellular, colonial or filamentous.
- They are usually grass green due to the dominance of pigments chlorophyll a and b.
  The chloroplast may be discoid, plate like reticulate, cup shaped, spiral or ribbon-shaped in different species.
  most of the members have one or more storage bodies called pyrenoids located in chloroplasts.
- Pyrenoids contain protein besides starch. Some algae may store food in the form of oil droplets.
- Green algae usually have a rigid cell wall made of an inner layer of cellulose and an outer of pectose.

(i) Vegetative reproduction - by fragmentation or by formation of different types of spores.

(ii) Asexual Reproduction - by flagellated zoospores produced in zoosporangia

(iii) The Sexual Reproduction - may be isogamous anisogamous, oogamous.

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e.g. chlamydomonas, Volvox, Ulothrix, Spirogyra, chara.

Phaeophyceae (Brown algae)

- found primarily in marine habitats.
- present in form simple branched filamentous form (ectocarpus) to profusely branched form as represented by Kelps
- They possess chlorophyll a, c, carotenoids and xanthophylls (fucoxanthin) food is stored as complex carbohydrates, which may be in the form on laminarin or mannitol.
- cell wall made up of cellulose and has outer coating of gelatinous substance algin.

The plant body is usually attached to the substratum by holdfast and has a stalk - stipe and leaf like photosynthetic organ - frond

Vegetative reproduction - fragmentation

Asexual - by bifilagellate zoospores that are pear shaped and have two unequal laterally attached filagella.

Sexual - may be isogamous, anisogamous oogamous.

Union of gametes may take place in water or within the oogamous species)

The gametes are hyriform (pear-shaped) and bear two laterally attached flagella e.g- Ectocarpus, Dictyota, Laminaria, Sargassum, Fucus

Rhodophyceae (Red algae)

- Predominance of the red pigment- r-phycoerythrin

majority of red algae are marine with greater concentrations found in the warmer areas.

They occur in both well-lighted regions close to surface of water and also at great depths in oceans where relatively little light penetrates.

- The red thalli of most of the red algae are multicellular.

The food is stored as floridean starch which is very similar to amylopectin and glycogen in structure.

1. Vegetative - fragmentation
2. Asexual - by non-motile spores.
3. Sexual - non motile gametes.

Sexual reproduction is oogamous

e.g. Polysiphonia, Porphyra, Gracilaria Gelidium

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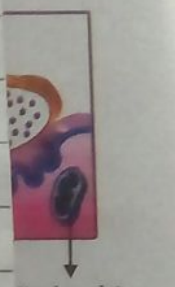
Bryophytes (Amphibians of the plant kingdom)

- Bryophytes include the various mosses and liverworts that are found commonly growing in moist shaded areas in the hills
- Bryophytes are also called amphibians of the plant kingdom because these plants can live in soil but are dependent on water for sexual reproduction.

They play an important role in plant succession on bare rocks/ soil.

- **Structure/ Plant body.**
  - The plant body of bryophytes is more differentiated than that of algae. it is thallus like and prostrate or erect, and attached to the substratum by unicellular or multicellular rhizoids (root like structure)
  - They lack true roots, stem or leaves They may possess root-like, leaf like or stem like structures
- The main plant body of the bryophyte is haploid. it produces gametes, hence it called a gametophyte



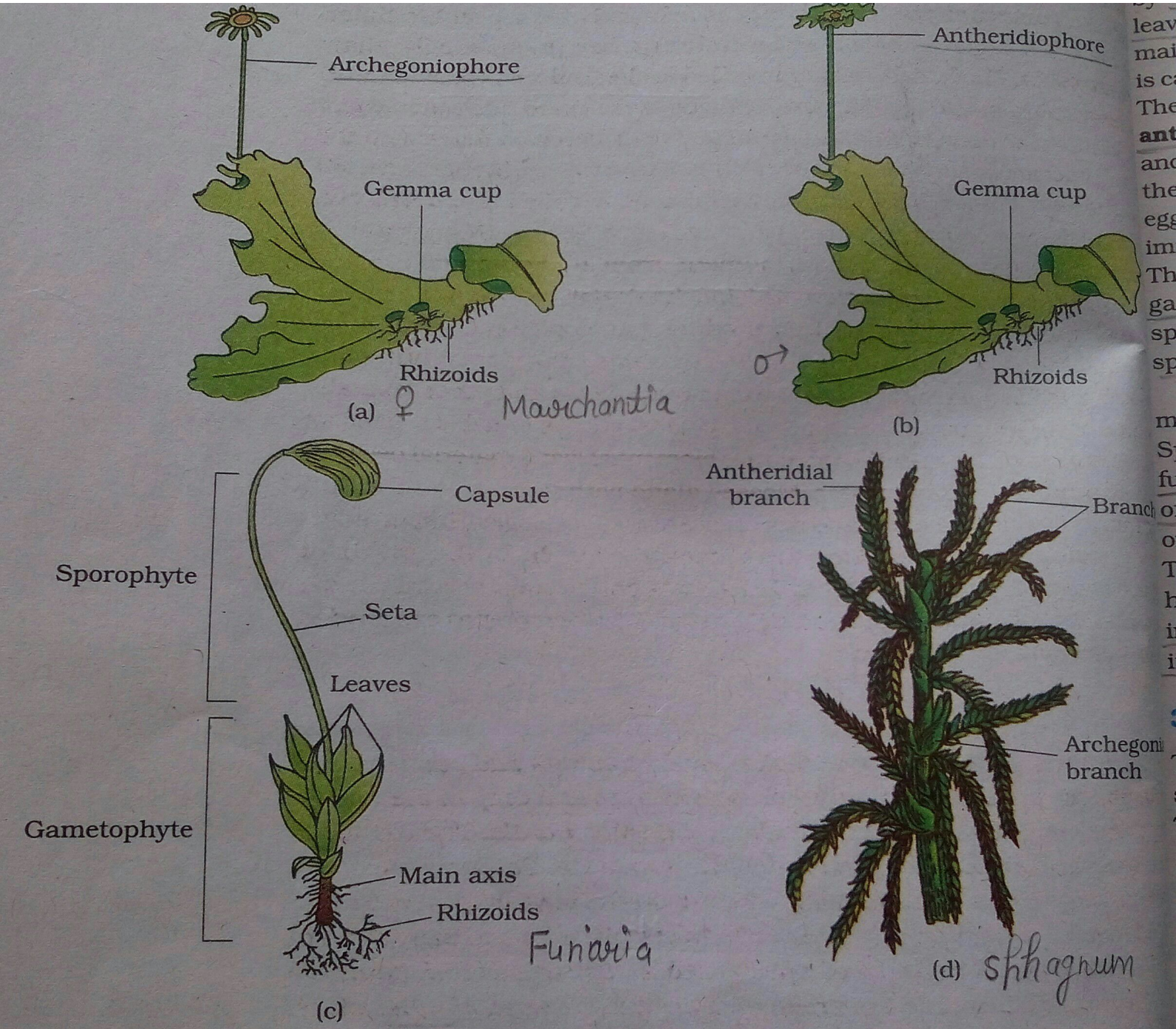


Figure 3.2 Bryophytes: A liverwort – *Marchantia* (a) Female thallus (b) Male thallus Mosses – (c) *Funaria*, gametophyte and sporophyte (d) *Sphagnum* gametophyte

Sex organ- • The sex organs in bryophyte are multicellular.
The male sex organ is called antheridium. they produce bifilagellate antherozoides.
• The female sex organ called archegonium is filask-shaped and produces a single egg.

Fertilization and development-
The antherozoids are released into water where they come in contact with archegonium.
An antherozoid fuses with the egg to produce the zygote.
Zygote do not undergo reduction division immediately. they produce a multicellular body called a "Sporophyte"
• The sporophyte is not free living but attached to the photosynthetic gametophyte and derives nourishment from it. (Sporophyte is parasite or dependent on gametophyte)
Some cells of the sporophyte undergo reduction division (meiosis) to produce haploid spores
These spore germinate to produce gametophyte.

Economic importance-

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

The bryophytes are divided into liverworts and mosses.

1. **Liverworts-** The plant body of liverworts is thalloid.

The thallus is dorsiventral and closely appressed to the substrate.
The leafy membres have tiny leaf like appendages in two rows on the stem like structure.

Asexual Reproduction-by fragmentation of thalli, or by the

formation of specialised structures called gemmae.

Gemmae are green, multicellular, asexual buds, which develop in small receptacles called gemma cup located on the thalli.

The gemmae become detached from the parent body and germinate to form new individuals.

- **Sexual Reproduction** - male and female sex organs are produced either on the same or on different thalli.
- The sporophyte is differentiated into a foot, seta, capsule.

after meiosis, spore are produced within the capsule.

These spores germinate to form free-living gametophytes. e.g. Marchantia.

Mosses - The predominant stage of the life cycle of moss is gametophyte which consists of 2 stages.

- The first stage is the protonema stage, which develops directly from a spore it is a creeping, green, branched and frequently filamentous stage.

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- The second stage is leafy stage, which develops from the secondary protonema as a lateral bud. it has upright, slender axes bearing spirally arranged leaves. They are attached to the soil through multicellular and branched rhizoids. this stages bears the sex organs.

Vegetative Reproduction- fragmentation and budding in the secondary protonema.

Sexual- by the sex organs antheridia and archegonia, which are produced at the apex of leafy shoots.

After fertilization- the zygote develops into a sporophyte, consisting of foot, seta, capsule. the sporophyte in mosses is more elaborate than that in liverworts, the capsule contains spore, which are formed after meiosis. the mosses have an elaborate mechanism of spore dispersal.

e.g. funaria, Polytrichum, sphagnum

- **Pteridophytes-** pteridophytes includes horsetails, ferns.

Evolutionarily, they are the first terrestrial plants to possess vascular tissue- xylem, phloem.

- The pteridophytes are found in cool, damp, shady places though

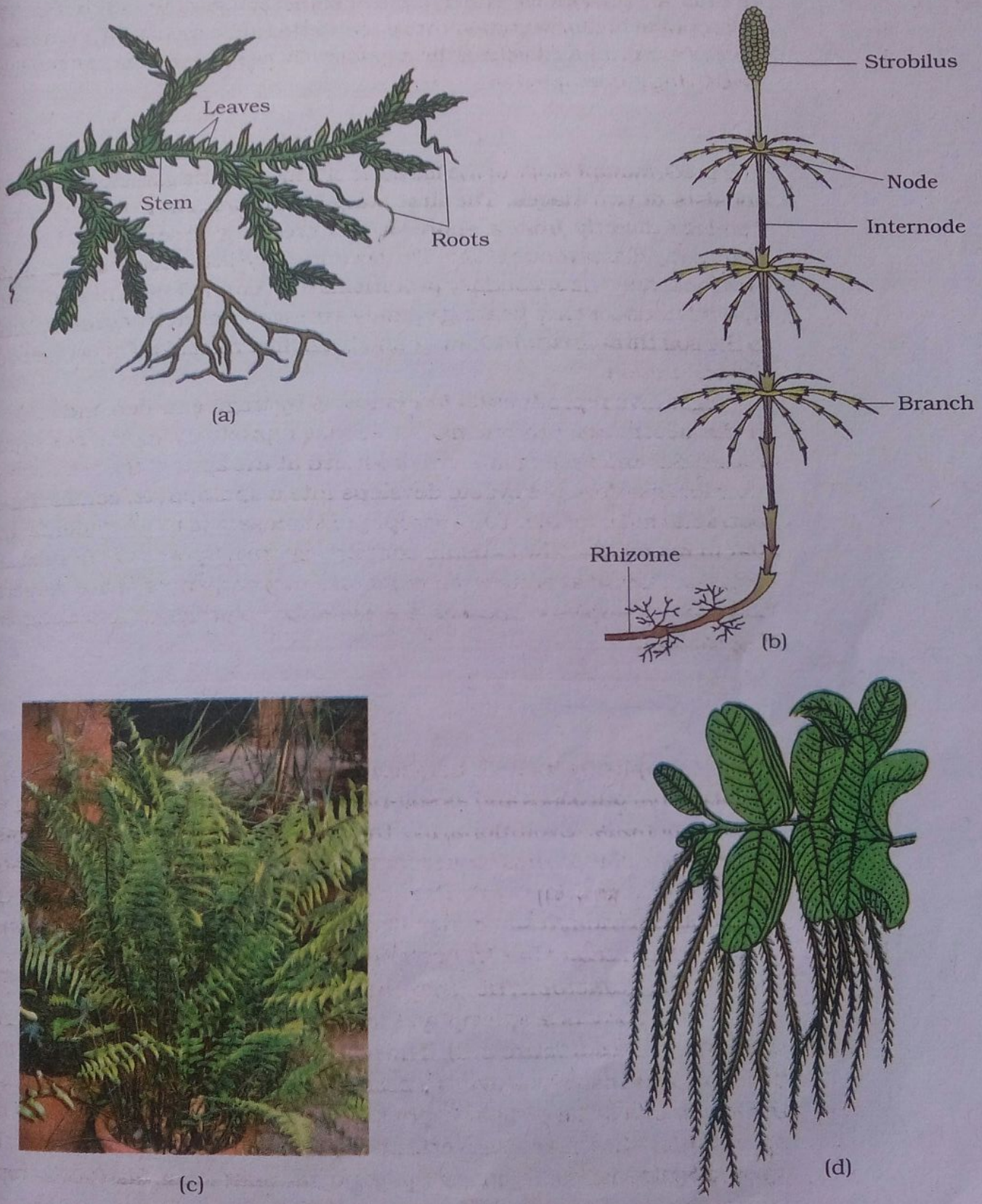

Figure 3.3 Pteridophytes : (a) *Selaginella* (b) *Equisetum* (c) Fern (d) *Salvinia*

some may flourish well in sandy soil conditi

- Structure of plant body -
The main plant body is sporophyte which is differentiated into true root, stem, leaves.
These organs possess well-differentiated vascular tissues.
- The leaves in pteridophyte are small (microphylls) - Selaginella, or large (macrophylls) - 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)

- Life cycle - The sporangia produce spore by meiosis in spore mother cell.
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 place to grow. Because of this specific restricted requirement and the need for water for fertilization

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the spread of living pteridophytes is limited and restricted to narrow geographical regions.

Sexual Reproduction- The gametophytes bear male and female sex organs called antheridia or archegonia, respectively. Water required for transfer of antherozoids (the male gametes) to the mouth of archegonium. Fusion of male gamete with egg present in archegonium result in formation of zygote.

Zygote produces multicellular well differentiated sporophyte.

- The four classes are- Psilopsida (Psilotum), Lycopsida (Selaginella) Sphenopsida (equisetum) and Pteropsida (Pteris).

Two types of sporophytes in pteridophytes-

- **homosporous-** All spores are of similar kinds. e.g. In majority of the pteridophytes
- **heterosporous-** two types of spores are produced small, male microspores, and large female megaspore e.g **Selaginella.**

- 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

Economic Use-

- used for medicinal purposes and as soil binders.
- They are also frequently grown as ornamentals.

Gymnosperms- plant in which ovules are not enclosed by any ovary wall and remain exposed both before and after fertilization.

The seeds that develop post-fertilization are not covered (naked)

- Plant body.

Gymnosperms include medium sized trees or tall trees and shrubs. one of the gymnosperms, the giant redwood tree Sequoia is one of the tallest tree species

Root- are generally tap roots

- Root in Pinus have fungal association in the form of mycorrhiza
- In cycas small specialized roots called coralloid roots are associated with N_2 - fixing cyanobacteria

Stem- are unbranched (cycas) branched (Pinus Cedrus)

- **Leaves** - 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 tem. humidity, wind. in conifers, the needle like leaves reduce the surface area. their thick cuticle and sunken stomata also help to reduce water loss.
- Gymnosperms are heterosporous produced haploid microspores and mega spores.
- male cone has microsporophylls which bear microsporangia having microspores which develop into reduced gametophyte called **pollengrain**.
- Female cone has megasporophylls which bear megasporangia having megaspores which are enclosed within the megasporangium (Nucellus).

one megaspore develops into female gametophyte bearing two or more archegonia.

pollen grains carried in air currents reach ovules, form pollen tube which reach archegonia and release male gametes which fertilise egg cell and form zygote which produce(develop)

into seeds, which are not covered.

- **Angiosperms-**

Angiosperms called "flowering plants" and have seeds enclosed in fruits.

Divided into 2 classes.

1. **Dicotyledons-** have to cotyledons.
2. **Monocotyledons-** have one cotyledons.

Smallest angiosperm- **Wolfia**

Large tree- Eucalyptus cover 100meters

- Stamen has filament and anther.

anther bear pollen grains. pollen grains have two male gametes.

Pistil has stigma, style and ovary.

ovary has ovule in which female gametophyte (embryo sac) develops.

- embryo sac has 7 cells and 8 nuclei, one egg cell 2 synergids, 3 antipodals and two polar nuclei which fuse to form secondary nucleus

pollen grains is carried by wind, water, insects and other agents reaches to stigma and produces pollen tube which enters embryo sac.

Double fertilization- one male gamete fuses with egg cell **(Syngamy)** to form zygote which develops into embryo

(a) (b)

Figure 3.5 Angiosperms : (a) A dicotyledon (b) A monocotyledon

other male gamete fuses with secondary nucleus (triple fusion) which forms triploid Primary endosperm nucleus. (PEN). PEN develops into endosperm which nourishes the developing embryo.

ovules develop into "seeds" and ovaries into "fruits".

Life cycle and alternation of generations.

- Plants completete their life cycle in two phase - a diploid sporophyte phase and the haploid gametophyte phase. these two phase follow each other rigidly. this phenomenon is called alternation of generation.

Life cycle of different plant group individuals can be of following patterns.

1. **Haplontic life cycle** - In this, sporophytic generation is represented only by the one-celled zygote and 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.

e.g. Volvex, Spirogyra and some species of chlamydomonas (most of the algae)

2. **Diplontic lifecycle**- In this diploid sporophyte is the dominant, photosynthetic, independent phase of the plant. the gametophytic phase is represented by the single to few celled haploid gametophyte.
e.g. all seed bearing plant i.e. gymnosperms and angiosperms, some algae like fucus.

3. **Haplo-diplontic/Intermediate lifecycle**
In this both gametophytic and sporophytic phase are multicellular and often free living.
e.g. bryophytes, (dominant Phase- gametophyte) and Pteridophytes (dominant Phase- Sporophyte) Some algae like Ectocarpus, Polysiphonia.

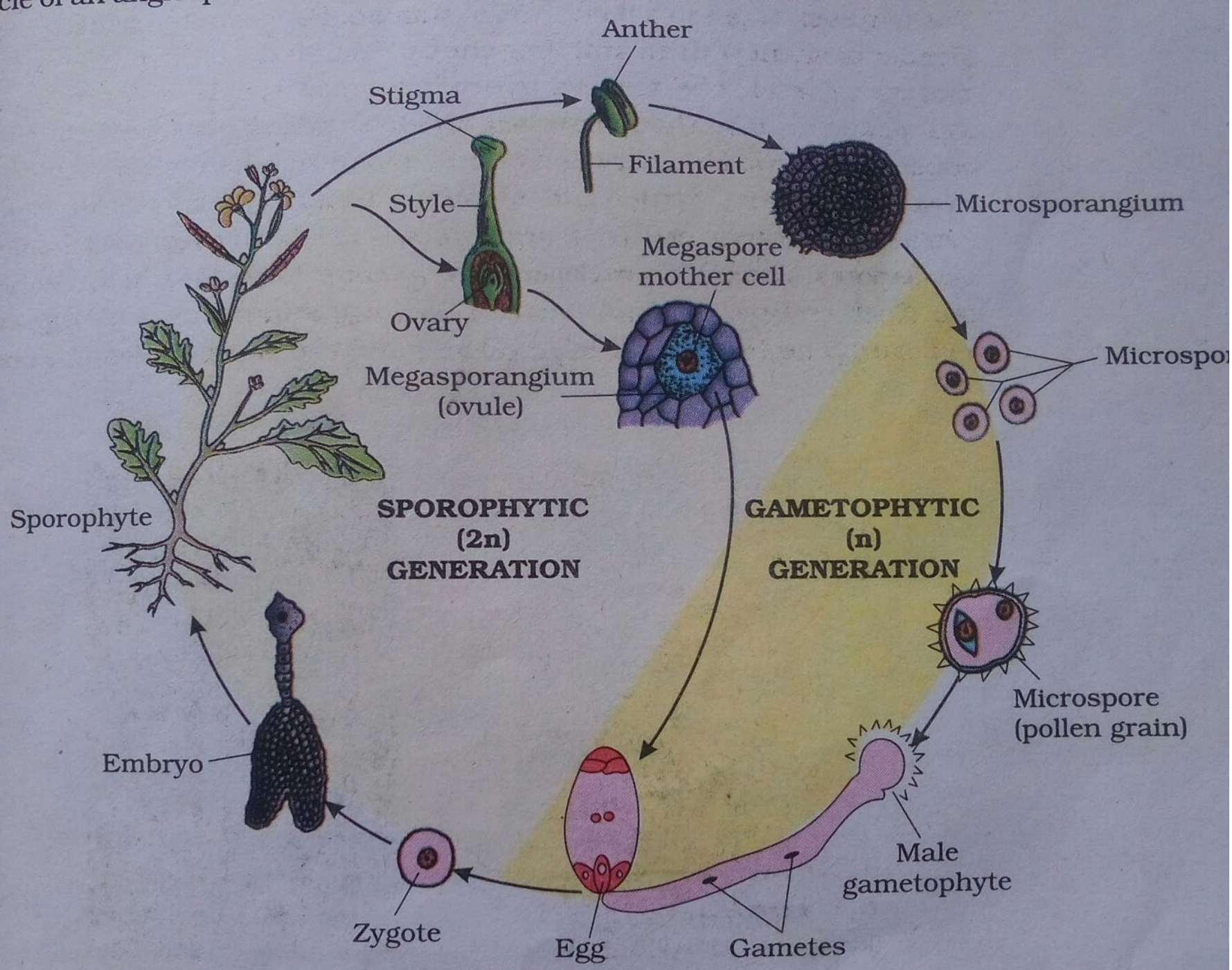
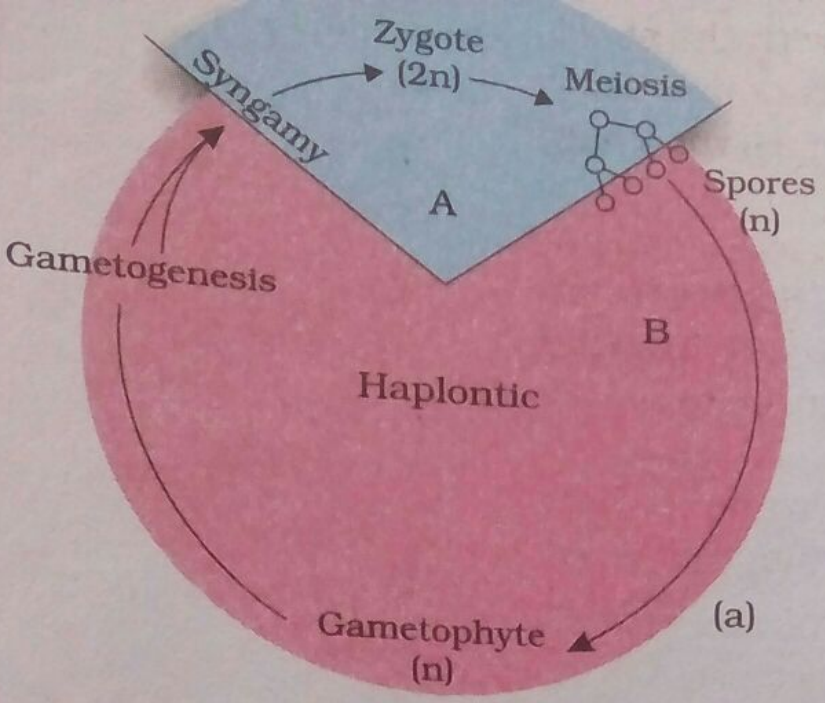
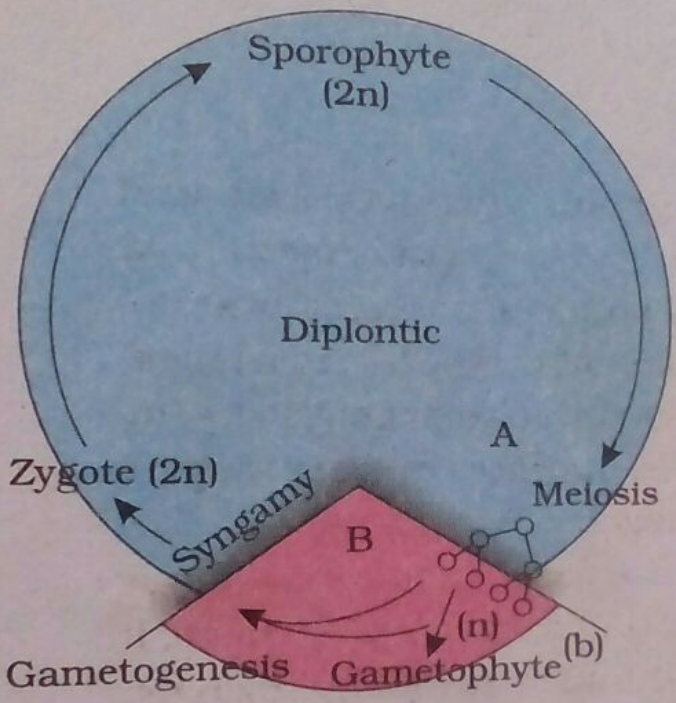
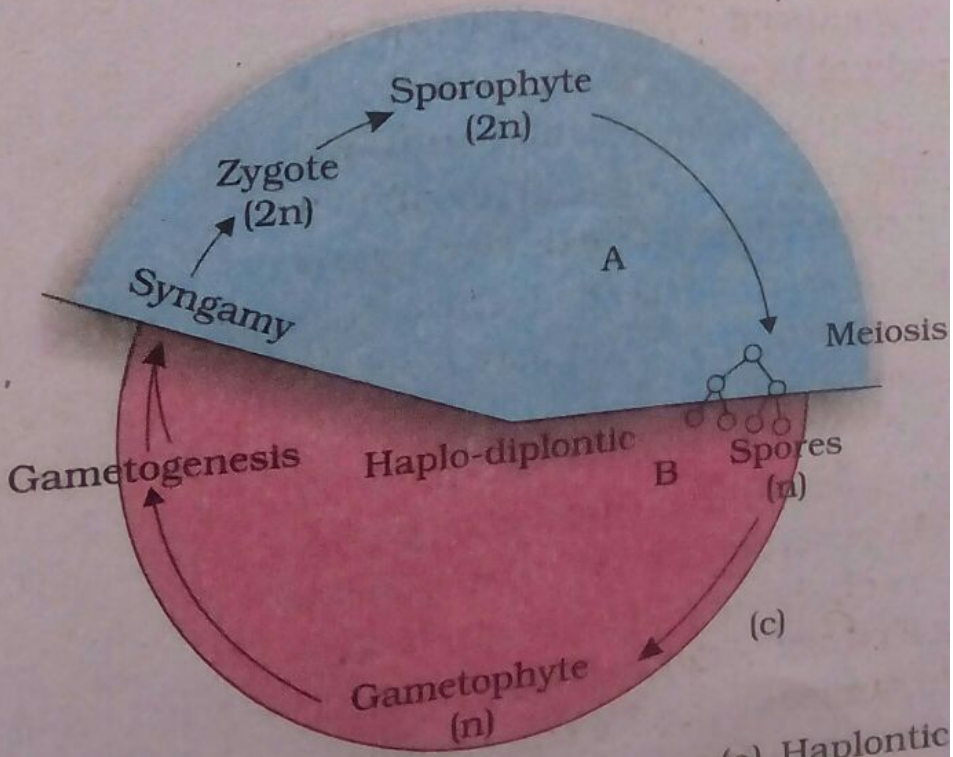


Figure 3.6 Life cycle of an angiosperm







cycle patterns : (a) Haplontic
Haplo-diplontic

EXERCISES

1. What is the basis of classification of algae?
2. When and where does reduction division take place in the life cycle of a liverwort, a moss, a fern, a gymnosperm and an angiosperm?
3. Name three groups of plants that bear archegonia. Briefly describe the life cycle of any one of them.
4. Mention the ploidy of the following: protonemal cell of a moss; primary endosperm nucleus in dicot, leaf cell of a moss; prothallus cell of a ferm; gemma cell in *Marchantia*; meristem cell of monocot, ovum of a liverwort, and zygote of a fern.
5. Write a note on economic importance of algae and gymnosperms.
6. Both gymnosperms and angiosperms bear seeds, then why are they classified separately?
7. What is heterospory? Briefly comment on its significance. Give two examples.

8. Explain briefly the following terms with suitable examples:-
   (i) protonema
   (ii) antheridium
   (iii) archegonium
   (iv) diplontic
   (v) sporophyll
   (vi) isogamy

9. Differentiate between the following:-
   (i) red algae and brown algae
   (ii) liverworts and moss
   (iii) homosporous and heterosporous pteridophyte
   (iv) syngamy and triple fusion

10. How would you distinguish monocots from dicots?

11. Match the following (column I with column II)

Column I	**Column II**
(a) *Chlamydomonas*	(i) Moss
(b) *Cycas*	(ii) Pteridophyte
(c) *Selaginella*	(iii) Algae
(d) *Sphagnum*	(iv) Gymnosperm

12. Describe the important characteristics of gymnosperms.

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Qus/Ans.

(1) The presence of absence of pigments in the main basis of classification of algae.

1. **Chlorophyceae** - chlorophyll a and b are present in them and impart green colour, chlorophyceae are also called "blue green algae"
2. **Phaeophyceae** - chlorophyll a and c and fuxoxanthin are present. fucoxanthin impart brown colour. Phaeophyceae also called "brown algae"
3. **Rhodophyceae** - chlorophyll a and d and phycoerythrin are present. Phycoerythrin are present and imparts red colour. Rhodophyceae are also called "Red algae.

(2) In liverwort, moss, fern, the sahrophytic plant produces haploid spores after meiosis while in gynosperm and angiosperms meiosis take place in antheridium and ovary for the formation of pollen grains and ovules.

(3) Bryophytes, pteridophytes and Gymnosperms bear distinct archegonia.

(4) Protonemal cell of a moss - haploid
primary endosperms nucleus in a dicot. (7)
Triploid
Leaf cell of moss - Haploid
Prothallus of fern - Haploid
Gemma cell in Marchantia - Haploid
Meristem cell of monocot - Diploid
ovum of liverwort - Haploid
Zygote of fern - Diploid

(5) Economic importance of gymnosperms:
gymnosperms are widely used as ornamental 8.
many conifers such as pine, cedar, are sources of the soft wood used in construction and packing. medicinal use. An anticancer drug Taxol is obtained from Taxus. many species of Ephedra produce ephedrine, which can be used in the treatment of asthma and bronchitis. The seeds of pinus gerardinana are edible. Resins are used commercially for manufacturing sealing waxes and water proof paints, a type of resin known as turpentine is obtained from various species of pinus.

(6) The seeds of gymnosperms are naked while that of angiosperms are covered by a membrane therefore, they are

classified separately.

(7) Heterospory is a phenomenon in which two kinds of spores are borne by the same plant. these spores differ in size, the smaller one are called microspor. and bigger ones are called megaspores produce female gametophyte. thus it is considered as a crucial step in evolution as it is a forecursor to the seed habit. this ultimately let to seed development in gymnosperms and angiosperms.

8. (i) Protonema- it is the first stage in the lifecycle of a moss, developing directly from spore. It consist of creeping, green, branched and often filamentous structures

(ii) Antheridium- it is male sex organ present in bryophytes and pteridophytes and is surrounded by a jacket of sterile cells it enclose the sperm mother cells, which give rise to male gametes.

(iii) Archegonium- It is female sex organ present in bryophytes, pteridophytes and gymnosper. In bryophytes and pteridoph it generally has swollen venter and a tubular neck and contains the female gamete called the egg.

(v) Sporophyll- In pteridophytes, the sporophytic plant body bears sporangia. these sporangia are subtended by leaf like appendages known as Sporophyll. In gymnosperms, microsporophylls and mega-sporophylls are found. these bear microspore and megaspore respectively.

(vi) Isogamy- It is a type of sexual reproduction involving the fusion of morphologically-similar gametes. this means that the gametes are of the same size, but perform different function. this type of reproduct is commonly observed in Spirogyra.

9. (ii) Red algae.	Brown
• Red algae grouped under class Rhodophyceae	• Phaeophyceae
• They contain floridean Starch as stored food	• mannitor or laminarin as Stored food
• They contain the Photo-synthetic pigments chlorophylls a and d and phycoerythrin	• chlorophyll a and c and fucoxanthin
• cell wall composed of cellulose, pectin. phycocolloides	• cellulose and algin

•	flagella absent	present
2.	**Liverwort**	**Moss**
	1. They have unicellular rhizoids	multicellular rhizoids
	• Scales are present	absent.
	• They are generally thalloid, with dichotomous branching	They are foliage, with lateral branching
	• Gamma cups present	Gamma cups absent
	• Sporophytes has Very little photosynthetic tissue	Sporophyte has abundant photosynthetic tissue
3.	**Homosporous**	**Heterosporus**
	1. They bear spores that are of same type.	two kinds of spore
	2. They produce bisexual gametophyte.	unisexual gametophyte
	4. **Syngamy**	**Triple fusion**
•	It is the process of fusion of male gamete with egg in an angiosperms.	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.

(11.) a. (i) Algae b. (ii) Gymnosperm
c. (iii) Pteridophyte d. (iv) Moss.

(10.)

Characteristic	Monocot	dicot
Morphology		
Root	Fibrous root	Tap
Venation	Parallel	Reticulate
Flowers	Trimerous	Pentamerous
cotyledons in seeds	one	two.
Anatomy	(Scattered)	
1. No. of vascular bundles in stem	1. Numerous 2. Absent	Arranged in ring present
2 Cambium		
3. Leaves.	3. Isobilateral	dorsiventral