Chapter 3

PLANT KINGDOM

In the previous chapter, we looked at the broad classification of living organisms under the system proposed by Whittaker (1969) wherein he suggested the Five Kingdom classification viz. Monera, Protista, Fungi, Animalia and Plantae. In this chapter, we will deal in detail with further classification within Kingdom Plantae popularly known as the 'plant kingdom'.

We must stress here that our understanding of the plant kingdom has changed over time. Fungi, and members of the Monera and Protista having cell walls have now been excluded from Plantae though earlier classifications placed them in the same kingdom. So, the cyanobacteria that are also referred to as blue green algae are not 'algae' any more. In this chapter, we will describe Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms under Plantae.

Let us also look at classification within angiosperms to understand some of the concerns that influenced the classification systems. The earliest systems of classification 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). Such systems were artificial; they separated the closely related species since they were based on a few characteristics. Also, the artificial systems gave equal weightage to vegetative and sexual characteristics; this is not acceptable since we know that often the vegetative characters are more easily affected by environment. As against this, natural classification systems developed, which were based on natural affinities among the organisms and consider,

1. Assertion (A): Cyanobacteria are no longer classified under algae.
Reason (R): Earlier classification systems grouped all photosynthetic organisms together irrespective of cell structure.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

2. Fill in the Blanks
(i) The five kingdom classification was proposed by _____ in 1969.
(ii) _____ are organisms with cell walls but are no longer considered part of Plantae.
(iii) The _____ classification system was based only on morphological characters.

3. True or False
(a) Blue-green algae are now classified under Kingdom Plantae.
(b) Artificial classification systems gave equal weightage to vegetative and sexual characteristics.
(c) Linnaeus classified plants based on reproductive characters.

4. Which of the following were issues with the artificial system of classification?
1. Based on only a few characters
2. Equal weightage to vegetative and sexual traits
3. Easily affected by environment
4. Separated closely related species
(a) 1, 2 & 4
(b) All 1, 2, 3 & 4
(c)1, 3 & 4
(d) Only 2 & 3

5. Earlier systems placed fungi and members of _____ kingdom under Plantae because of the presence of cell walls.

6. Which of the following statements regarding Linnaeus' system of classification is incorrect?
(a) It used gross morphological traits like colour and habit
(b) It was purely based on genetic relationships
(c) It was considered an artificial system
(d) It did not separate closely related species effectively

7. Answer the following statements as true and False.
1. Gross superficial morphological characters mainly based on vegetative character.
2. Natural classification gave equal weightage to vegetative and sexual characterstics.

8. Select the correct statements:
1. Kingdom Plantae includes only algae and bryophytes
2. Natural classification considers evolutionary relationships
3. Whittaker's system classified organisms into five kingdoms
4. Cyanobacteria are eukaryotic algae
(a) 2 and 3
(b) 1, 2 and 3
(c) Only 3 and 4
(d) All 1, 2, 3 and 4

HOTS

1. Mark the Correct statements

a. vegetative characters are not easily affected by environment.

b. natural classification systems developed, which were based on natural affinities among the organisms and consider only internal featurs

Notes:

not only the external features, but also internal features, like ultra- structure, anatomy, embryology and phytochemistry. Such a classification for flowering plants was given by George Bentham and Joseph Dalton Hooker.

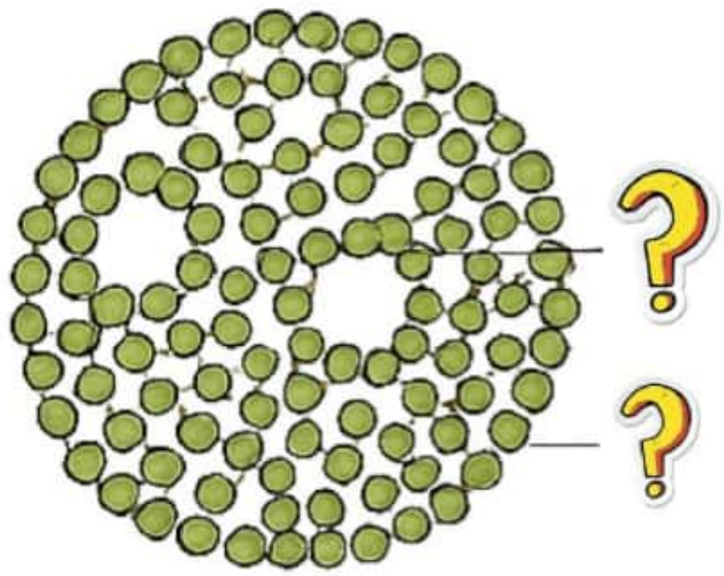
At present phylogenetic classification systems based on evolutionary relationships between the various organisms are acceptable. This assumes that organisms belonging to the same taxa have a common ancestor. We now use information from many other sources too to help resolve difficulties in classification. These become more important when there is no supporting fossil evidence. Numerical Taxonomy which is now easily carried out using computers is based on all observable characteristics. Number and codes are assigned to all the characters and the data are then processed. In this way each character is given equal importance and at the same time hundreds of characters can be considered. Cytotaxonomy, that is based on cytological information like chromosome number, structure, behaviour and chemotaxonomy, that uses the chemical constituents of the plant to resolve confusions, are also used by taxonomists these days.

3.1 ALGAE

Algae are chlorophyll-bearing, simple, thalloid, autotrophic and 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).

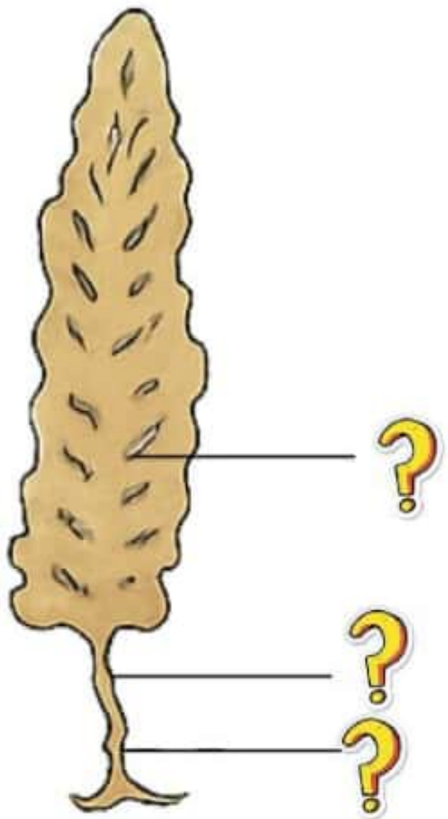
The form and size of algae is highly variable, ranging from colonial forms like Volvox and the filamentous forms like Ulothrix and Spirogyra (Figure 3.1). A few of the marine forms such as kelps, form massive plant bodies.

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



(a-i)

(a-ii)



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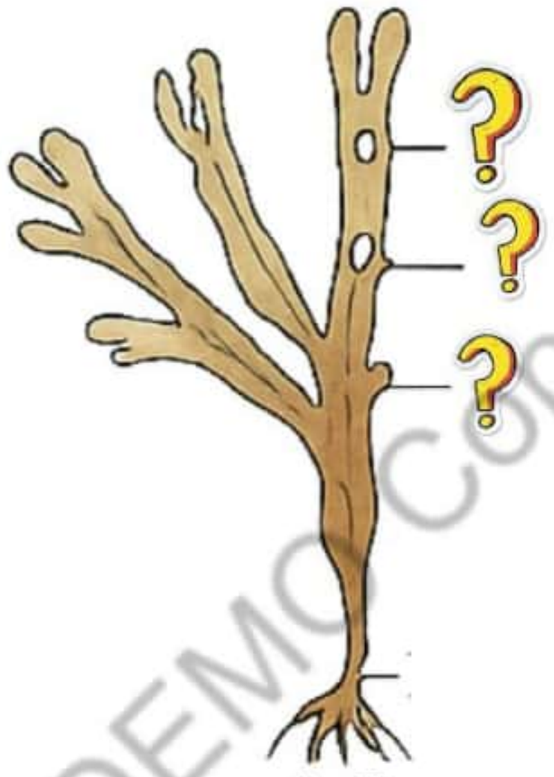

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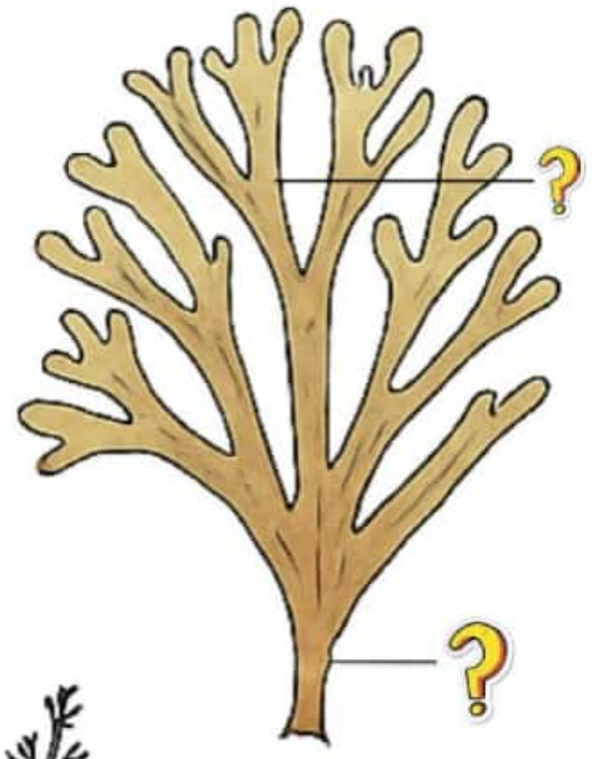

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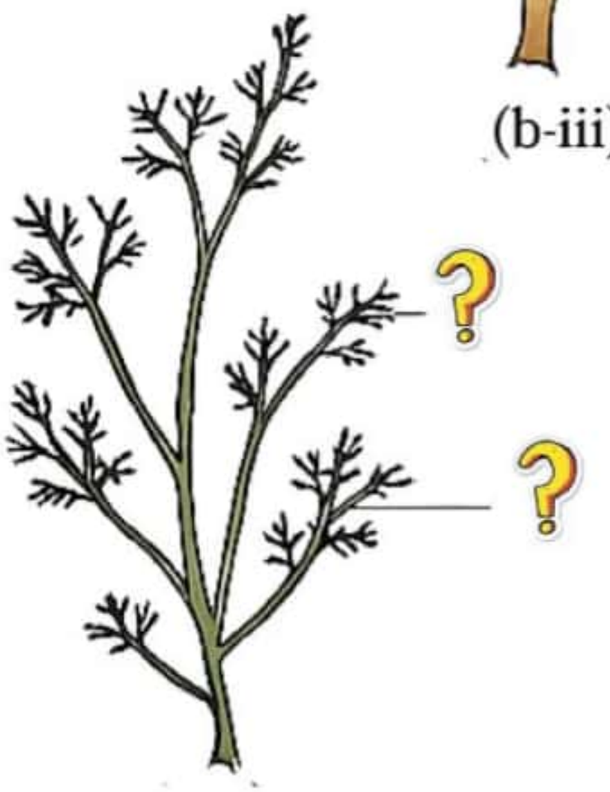


(c-ii)

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	

9. Assertion (A): Numerical taxonomy gives equal weightage to all observable characters.
Reason (R): It is based on evolutionary relationships among organisms.
(a) Both A and R are true, and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

10. Which of the following taxonomic approaches is based primarily on chromosome number and structure?
(a) Cytotaxonomy
(b) Numerical taxonomy
(c) Chemotaxonomy
(d) Phylogenetic taxonomy

11. Which of the following statements are correct regarding numerical taxonomy?
1. It uses fossil evidence to classify organisms.
2. It is carried out using computers.
3. It uses all observable characteristics.
4. Each character is given equal importance.
(a) Only 2 and 3
(b) Only 2, 3 and 4
(c) Only 1 and 4
(d) Only 1, 2, 3

12. _____ classification systems are based on evolutionary relationships and assume a common ancestor for organisms of the same taxa.

13. Which of the following would be most useful for resolving classification issues when fossil evidence is lacking?
(a) Embryology
(b) Phylogenetic taxonomy
(c) Numerical taxonomy
(d) Information from external morphology only

14. True/False
Cytotaxonomy relies on biochemical markers for classification.

15. Assertion (A): Chemotaxonomy helps resolve confusions in nomenclature
Reason (R): It is based on reproductive structures of plants.
(a) Both A and R are true, and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) Both A and R are false

16. Match the column

Column A	Column B
A. Cytotaxonomy	1. Chemical constituents
B.Numerical taxonomy	2. Chromosome behaviour
C. Chemotaxonomy	3.Computer-based characters
D. Phylogenetic system	4. Evolutionary lineage

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

17. The thalloid, simple and autotrophic organisms that occur in aquatic habitats are known as _____.

18. Identify the correct statements:
1. Algae can be colonial or filamentous.
2. Kelps are marine algae forming massive plant bodies.
3. Algae do not show sexual reproduction.
4. Zoospores are non-motile.
(a) 1 and 2 only
(b) 2 and 3 only
(c) 3 and 4 only
(d) All are correct

19. Zoospores are produced during:
(a) Vegetative reproduction
(b) Asexual reproduction
(c) Sexual reproduction
(d) Symbiosis

20. Assertion & Reason
Assertion (A): Fragmentation in algae leads to formation of new plants.
Reason (R): It is a form of asexual reproduction where spores are involved.
(a) Both A and R are true, and R is the correct explanation of A
(b) Both A and R are true, but R is not the correct explanation of A
(c) A is true, but R is false
(d) A is false, but R is true

21. Fusion of two gametes dissimilar in size, as in Eudorina, is called _____.

22. True/False
Oogamous reproduction involves fusion of two motile gametes.

23. Which of the following is an example of isogamy in algae?
(a) Ulothrix
(b) Volvox
(c) Fucus
(d) None

24. Which of the following are methods of reproduction in algae?
1. Fragmentation
2. Zoospore formation
3. Conjugation
4. Gamete fusion
(a) all four
(b) Only 1 and 2
(c) Only 3 and 4
(d) 1, 2 and 4

25. Match the following

Column A	Column B
A. Green algae	1. Porphyra
B. Brown algae	2. Fucus
C. Red algae.	3. Volvox
D. Brown algae.	4. Laminaria

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

Notes:

Algae are useful to man in a variety of ways. At least a half of the total carbon dioxide fixation on earth is carried out by algae through photosynthesis. Being photosynthetic, they increase the level of dissolved oxygen in their immediate environment. They are of paramount importance as primary producers of energy-rich compounds which form the basis of the food cycles of all aquatic animals. Many species of Porphyra, Laminaria and Sargassum are among the 70 species of marine algae used as food. **Certain marine brown and red algae produce large amounts of hydrocolloids (water holding substances), e.g., algin (brown algae) and carrageen (red algae) which are used commercially**. 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, a unicellular alga rich in proteins, is used as food supplement even by space travellers**. The algae are divided into three main classes: Chlorophyceae, Phaeophyceae and Rhodophyceae.

3.1.1 Chlorophyceae

The members of chlorophyceae are commonly called 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 pigments are localised in definite chloroplasts. The chloroplasts 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 the chloroplasts. Pyrenoids contain protein besides starch. Some algae may store food in the form of oil droplets. Green algae usually have a rigid cell wall made of an inner layer of cellulose and an outer layer of pectose.

Vegetative reproduction usually takes place by fragmentation. Asexual reproduction is by flagellated zoospores produced in zoosporangia. **The sexual reproduction shows considerable variation in the type and formation of sex cells and it may be isogamous, anisogamous or oogamous. Some commonly found green algae are: Chlamydomonas, Volvox, Ulothrix, Spirogyra and Chara (Figure 3.1a).**

3.1.2 Phaeophyceae

The members of phaeophyceae or brown algae are found primarily in marine habitats. They show great variation in size and form. They range from simple branched, filamentous forms (Ectocarpus) to profusely branched forms as represented by kelps, which may reach a height of 100 metres. **They possess chlorophyll *a*, *c*, carotenoids and xanthophylls**. They vary in colour from olive green to various shades of brown depending upon the amount of the xanthophyll pigment, fucoxanthin present in

26. At least _____ of the total carbon dioxide fixation on Earth is carried out by algae.

27. Assertion (A): Algae contribute significantly to the oxygen levels in aquatic environments.
Reason (R): They are photosynthetic and increase dissolved oxygen through photosynthesis.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) A is false, R is true

28. Which of the following groups of algae is used as food in many parts of the world?
(a) Ulothrix, Volvox, Chara
(b) Porphyra, Laminaria, Sargassum
(c) Ectocarpus, Fucus, Dictyota
(d) Chlorella, Spirogyra, Chara

29. Hydrocolloids such as _____ (from brown algae) and _____ (from red algae) are used commercially.

30. Which alga is used as a protein-rich food supplement by astronauts?
(a) Ulothrix
(b) Chlamydomonas
(c) Chlorella
(d) Porphyra

31. True / False
Agar is extracted from green algae and used in jelly production.

32. _____ and _____ are commercial red algae sources of agar.

33. In Chlorophyceae, chloroplasts may be _____, _____, or _____ shaped.
Answer: discoid; cup-shaped; ribbon-shaped

34. Assertion (A): Pyrenoids in green algae help in photosynthesis.
Reason (R): Pyrenoids store proteins and starch within the chloroplast.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) A is false, R is true

35. True / False
Green algal cell wall has an inner layer of cellulose and an outer layer of pectose.

36. In Chlorophyceae, vegetative reproduction typically occurs through:
(a) Zoospores
(b) Budding
(c) Fragmentation
(d) Isogamy

37. Asexual reproduction in green algae occurs via flagellated _____ produced in _____.

38. Brown algae are primarily found in _____ habitats.
(a) Freshwater
(b) Brackish water
(c) Terrestrial
(d) Marine

39. The brown colour in members of Phaeophyceae is due to:
(a) Chlorophyll a and b
(b) Phycobilins
(c) Fucoxanthin
(d) Phycoerythrin

40. Some brown algae, such as kelps, may reach up to 100 metres in height. (True\False)

them. **Food is stored as complex carbohydrates, which may be in the form of laminarin or mannitol. The vegetative cells have a cellulosic wall usually covered on the outside by a gelatinous coating of algin.** The protoplast contains, in addition to plastids, a centrally located vacuole and nucleus. The plant body is usually attached to the substratum by a **holdfast,** and has a stalk, the **stipe** and leaf like photosynthetic organ – the **frond.** Vegetative reproduction takes place by fragmentation. **Asexual reproduction in most brown algae is by biflagellate zoospores that are pear-shaped and have two unequal laterally attached flagella.**

Sexual reproduction may be isogamous, anisogamous or oogamous. Union of gametes may take place in water or within the oogonium (oogamous species). The gametes are pyriform (pear-shaped) and bear two laterally attached flagella. **The common forms are *Ectocarpus, Dictyota, Laminaria, Sargassum* and *Fucus*** (Figure 3.1b).

3.1.3 Rhodophyceae

The members of rhodophyceae are commonly called red algae because of the predominance of the red pigment, r-phycoerythrin in their body. Majority of the red algae are marine with greater concentrations found in the warmer areas. They occur in both well-lighted regions close to the surface of water and also at great depths in oceans where relatively little light penetrates.

The red thalli of most of the red algae are multicellular. Some of them have complex body organisation. **The food is stored as floridean starch which is very similar to amylopectin and glycogen in structure.**

The red algae usually reproduce vegetatively by fragmentation. They reproduce asexually by non-motile spores and sexually by non-motile

TABLE 3.1 Divisions of Algae and their Main Characteristics

Classes	Common Name	Major Pigments	Stored Food	Cell Wall	Flagellar Number and Position of Insertions	Habitat
Chlorophyceae	Green algae	Chlorophyll ***a, b***	Starch	Cellulose	2-8, equal, apical	Fresh water, brackish water, salt water
Phaeophyceae	Brown algae	Chlorophyll ***a, c,*** fucoxanthin	Mannitol, laminarin	Cellulose and algin	2, unequal, lateral	Fresh water (rare), brackish water, salt water
Rhodophyceae	Red algae	Chlorophyll ***a, d,*** phycoerythrin	Floridean starch	Cellulose, pectin and poly sulphate esters	Absent	Fresh water (some), brackish water, salt water (most)

41. Assertion (A): Brown algae vary in colour from olive green to brown.
Reason (R): This variation is due to the presence of fucoxanthin, a xanthophyll pigment.
(a) Both A and R are true, and R explains A
(b) Both A and R are true, but R is not the correct explanation
(c) A is true, R is false
(d) A is false, R is true

42. In brown algae, food is stored as complex carbohydrates in the form of _____ or _____.

43. Which part of brown algal body performs photosynthesis?
(a) Holdfast
(b) Stipe
(c) Frond
(d) Rhizoid

44. Brown algae attach to substrate by a _____ and may have a stalk called a _____.

45(A) Asexual reproduction in most brown algae occurs by biflagellate zoospores. (True / False)

(B) Zoospores of brown algae are:
(a) Uniflagellate and apical
(b) Biflagellate, laterally attached and equal
(c) Multinucleate, non-motile Biflagellate
(d), pear-shaped, and unequal

46. Assertion (A): Sexual reproduction in brown algae can be oogamous.
Reason (R): Gametes are pyriform and non-motile.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) A is false, R is true

47. What gives red algae their characteristic coloration?
(a) Fucoxanthin
(b) R-phycoerythrin
(c) Chlorophyll c
(d) Mannitol

48. In red algae, food is stored as _____, which resembles _____ and _____ in structure.

49. Vegetative reproduction in Rhodophyceae occurs by:
(a) Zoospores
(b) Conjugation
(c) Fragmentation
(d) Isogamy

50. Both gametes and spores in red algae are non-motile. (True / False)

51. The red algae thalli are mostly _____ and may have _____ body organisation.

52. Red algae predominantly occur in which type of habitat?
(a) Soil
(b) Freshwater in cold regions
(c)Polluted freshwater
(d) Marine in warm areas

53. Which statements are true for Rhodophyceae?
1. Pigments include chlorophyll a and d
2. No flagellated stages in life cycle
3. Reproduction includes motile spores
4. Mostly marine, some freshwater

(a) 1 and 4 only
(b) All except 3
(c) 1 and 3 only
(d) All are true

54. (True or False) Majority of the red algae are marine with greater concentrations found in the colder areas.

gametes. Sexual reproduction is oogamous and accompanied by complex post fertilisation developments. **The common members are: Polysiphonia, Porphyra (Figure 3.1c), Gracilaria and Gelidium.**

3.2 BRYOPHYTES

Bryophytes include the various mosses and liverworts that are found commonly growing in moist shaded areas in the hills (Figure 3.2).

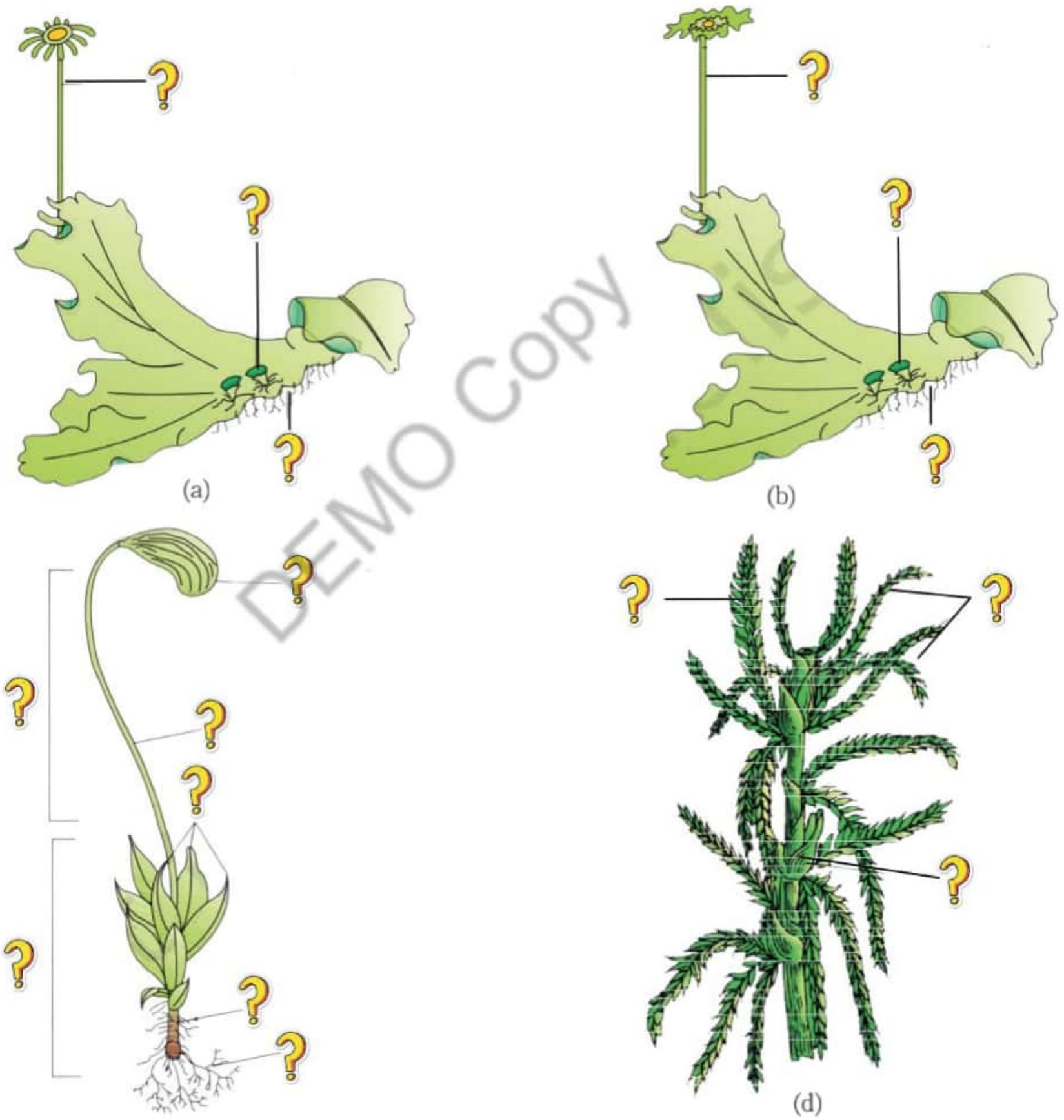


Figure 3.2. Bryophytes: A liverwort – Marchantia (a) Female thallus (b) Male thallus Mosses – (c) Funaria, gametophyte and sporophyte (d) Sphagnum gametophyte

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 usually occur in damp, humid and shaded localities. They play an important role in plant succession on bare rocks/soil.

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.** 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 is called a *gametophyte*.** The sex organs in bryophytes are multicellular. The male sex organ is called *antheridium*. They produce biflagellate *antherozoids*. **The female sex organ called *archegonium* is flask-shaped and produces a single egg. The antherozoids are released into water where they come in contact with archegonium. An antherozoid fuses with the egg to produce the zygote.** Zygotes do not undergo reduction division immediately. **They produce a multicellular body called a *sporophyte*.** The sporophyte is not free-living but attached to the photosynthetic gametophyte and derives nourishment from it. Some cells of **the sporophyte undergo reduction division (meiosis) to produce haploid spores. These spores germinate to produce gametophyte.**

Bryophytes in general are of little economic importance but 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 as packing material for trans-shipment of living material because of their capacity to hold water. 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*.

3.2.1 Liverworts

The liverworts grow usually in moist, shady habitats such as banks of streams, marshy ground, damp soil, bark of trees and deep in the woods. **The plant body of a liverwort is thalloid, e.g., Marchantia.** The thallus is dorsiventral and closely appressed to the substrate. The leafy members have tiny leaf-like appendages in two rows on the stem-like structures.

Asexual reproduction in liverworts takes place by fragmentation of thalli, or by the formation of specialised structures called *gemmae* (sing. gemma). Gemmae are green, multicellular, asexual buds, which develop in small receptacles called gemma cups located on the thalli. The gemmae become detached from the parent body and germinate to form new individuals. During sexual reproduction, male and female sex

55. Assertion (A): Red algae such as Gelidium exhibit oogamous reproduction.
Reason (R): Their reproductive cycle has complex post-fertilisation changes.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) A is false, R is true

56. Bryophytes are called the _____ of the plant kingdom because they depend on water for sexual reproduction.

57. Which of the following is *not* a function performed by bryophytes?
(a) Soil erosion prevention
(b) Fuel production
(c) ecological succession
(d) Mycorrhizal association

58. Assertion (A): The main plant body of a bryophyte is diploid.
Reason (R): It produces gametes and is therefore called a sporophyte.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) Both A and R are false

59. Bryophytes attach to substratum using unicellular or multicellular _____.

60. True / False
Bryophytes possess true roots, stems, and leaves.

61. Which statement is *true* about sex organs in bryophytes?
(a) Male organ is flask-shaped
(b) Female organ is called antheridium
(c) Archegonium produces a single egg
(d) Antherozoids are non-motile

62. In bryophytes, the zygote develops into:
(a) Another gametophyte directly
(b) Free-living sporophyte
(c) Multicellular sporophyte attached to gametophyte
(d) Diploid rhizoid

63. Spores in bryophytes are formed by _____ in some cells of the _____.

64. The sporophyte of a bryophyte is autotrophic and independent. True / False

65. Which moss is used commercially for packaging due to its water-holding capacity?
(a) Marchantia
(b) Polytrichum
(c) Sphagnum
(d) Funaria

66. Which role do mosses play in preventing soil erosion?
(a) Absorbing nutrients from soil
(b) Decomposing other organisms
(c) Forming dense mats that buffer rain impact
(d) Fixing atmospheric nitrogen

67. The liverwort plant body is _____ and closely appressed to the substrate.

68. In Marchantia, leaves are arranged in spiral phyllotaxy on the stem. True / False

69. What is the function of gemmae in liverworts like Marchantia?
(a) Form archegonia
(b) Anchor to substrate
(c) Asexual reproduction
(d) Produce motile gametes

70. Gemmae in liverworts are located in specialised receptacles called _____.

organs are produced either on the same or on different thalli. The sporophyte is differentiated into a foot, seta and capsule. After meiosis, spores are produced within the capsule. These spores germinate to form free-living gametophytes.

3.2.2 Mosses

The predominant stage of the life cycle of a moss **is the gametophyte which consists of two stages. The first stage is the *protonema* stage, which develops directly from a spore.** It is a creeping, green, branched and frequently filamentous stage. 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.

Vegetative reproduction in mosses is by fragmentation and budding in the secondary protonema. In sexual reproduction, the sex organs antheridia and archegonia are produced at the apex of the leafy shoots. After fertilisation, the zygote develops into a sporophyte, consisting of a foot, seta and capsule. **The sporophyte in mosses is more elaborate than that in liverworts.** The capsule contains spores. **Spores are formed after meiosis.** The mosses have an elaborate mechanism of spore dispersal. **Common examples of mosses are Funaria, Polytrichum and Sphagnum** (Figure 3.2).

3.3 Pteridophytes

The Pteridophytes include horsetails and ferns. Pteridophytes are used for medicinal purposes and as soil-binders. They are also frequently grown as ornamentals. Evolutionarily, they are the first terrestrial plants to possess vascular tissues – xylem and phloem. You shall study more about these tissues in Chapter 6. The pteridophytes are found in cool, damp, shady places though some may flourish well in sandy-soil conditions.

You may recall that in bryophytes the dominant phase in the life cycle is the gametophytic plant body. However, in pteridophytes, the main plant body is a sporophyte which is differentiated into true root, stem and leaves (Figure 3.3). 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,**

71. (A) The moss gametophyte develops in two stages: a _____ stage and a _____ stage.

(B) Which structure in moss develops directly from the spore?
(a) Leafy gametophyte
(b) Sporophyte
(c) Secondary protonema
(d) Primary protonema

72. Assertion (A): The leafy stage in moss is a result of budding from secondary protonema.
Reason (R): It bears sex organs and is anchored by rhizoids.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) A is false, R is true

73. The sex organs in mosses—_____ and _____—are borne at the apex of leafy shoots.

74. The moss sporophyte consists of:
(a) Capsule only
(b) Foot and capsule
(c) Foot, seta, and capsule
(d) Rhizoid and capsule

75. The sporophyte in moss is more complex than that of liverworts. (True / False)

76. Vegetative reproduction in mosses occurs by:
(a) Budding in gametes
(b) Spore dispersal
(c) Fragmentation and budding in secondary protonema
(d) Fusion of rhizoids

77. Spores in mosses are formed in the capsule after _____.

78 . Assertion (A): Mosses like Funaria and Polytrichum show spore dispersal mechanisms.
Reason (R): Their spores are formed via mitosis inside the capsule.
(a) Both A and R are true and R is the correct explanation of A
(b) A is true, R is false
(c) A is false, R is true
(d) Both A and R are false

79. Which of the following plants is not a moss?
(a) Sphagnum
(b) Polytrichum
(c) Selaginella
(d) Funaria

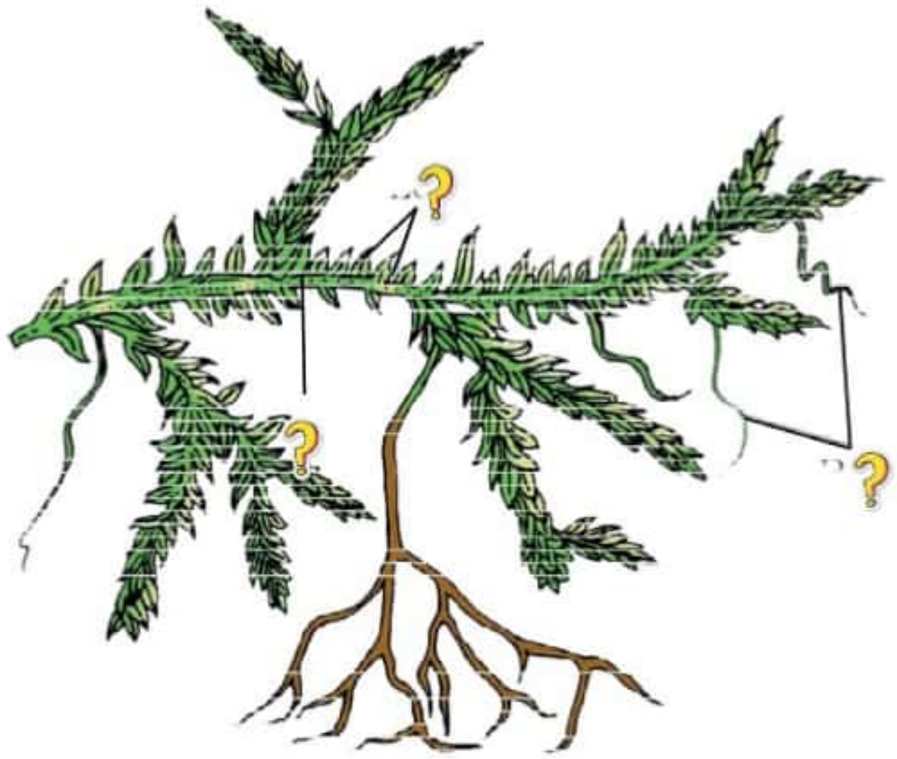
80. Pteridophytes include vascular cryptogams like _____ and _____.

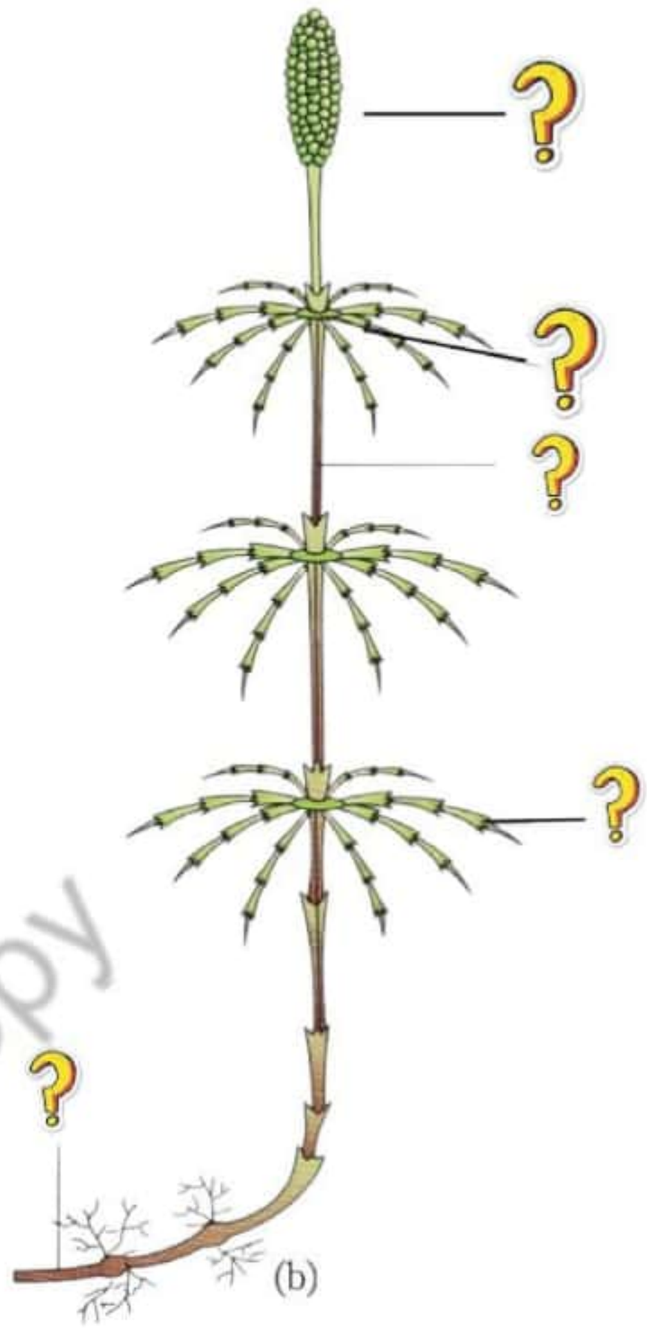
81. Pteridophytes are evolutionarily important because they are the first terrestrial plants to possess:
(a) Seeds (b) True flowers
(c) Vascular tissues (d) Cotyledons

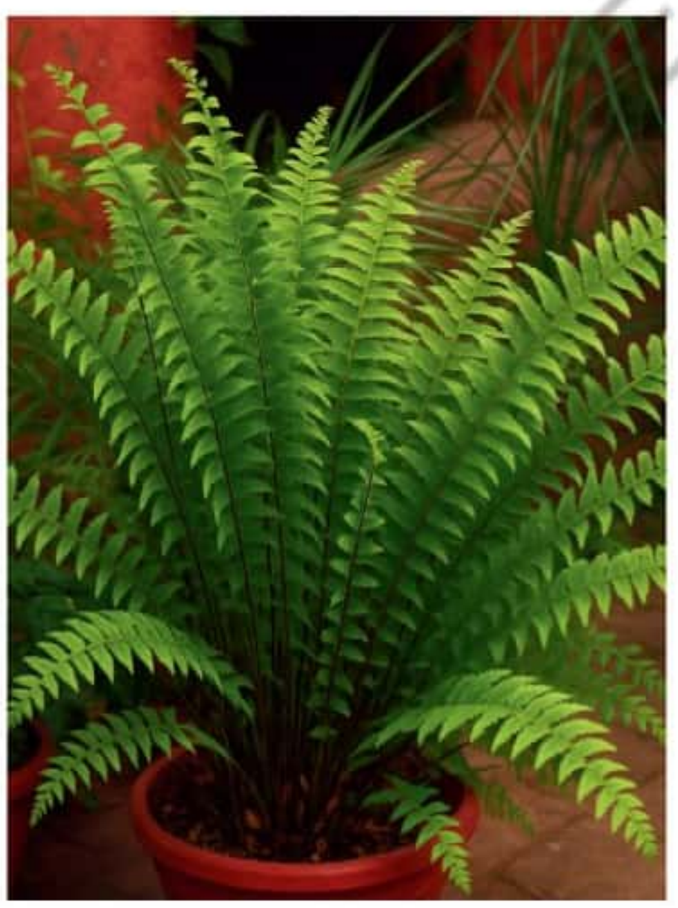
82. Assertion (A): Pteridophytes are found only in dry, arid habitats.
Reason (R): They lack vascular tissues and grow only in rock crevices.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is false, R is true
(d) Both A and R are false

83. Leaves in pteridophytes may be small called _____ (e.g. Selaginella) or large called _____ (e.g. ferns).

84. Which of the following pteridophytes has strobili (cones)?
(a) Ferns (b) Funaria
(c) Selaginella (d) Polytrichum







(c)

(d)

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

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).

3.4 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 (Figure 3.4). **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 - fixing cyanobacteria.**

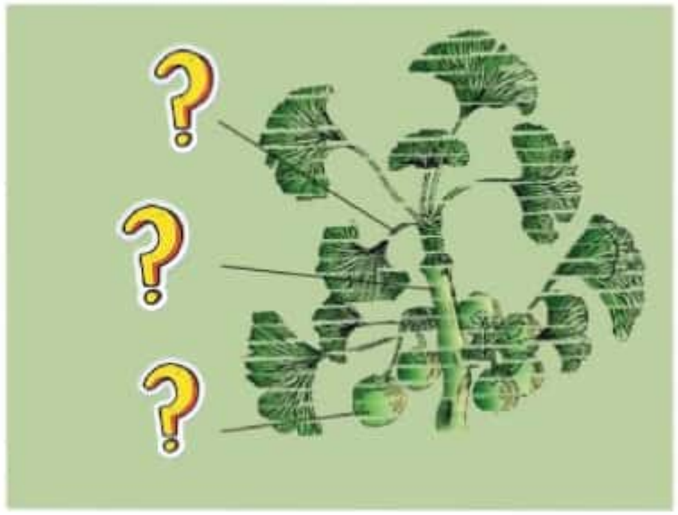
The stems are unbranched (Cycas) or branched (Pinus, Cedrus). The leaves may be simple or compound. In **Cycas the pinnate leaves persist for a few years.** The leaves in gymnosperms are well-adapted to withstand extremes of temperature, humidity and wind. **In conifers, the needle-like leaves reduce 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*).** However, in *cycas* male cones and megasporophylls are borne on different trees. 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 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.

(a)

(b)



(c)

Figure 3.4 Gymnosperms: (a) ***Cycas*** (b) ***Pinus*** (c) ***Ginkgo***

85. In Figure 3.3, which structure is common in Selaginella and Equisetum?
(a) Rhizome
(b) Strobilus
(c) Frond
(d) Node

86. True / False
The internode and node are clearly visible in the Equisetum.

87. The photosynthetic thalloid gametophyte of pteridophytes is called the _____.

88. Assertion(A): Water is essential for fertilisation in pteridophytes.
Reason (R): Male gametes (antherozoids) require water to reach archegonia.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) A is false, R is true

89. In pteridophytes, the fusion of male and female gametes occurs inside the _____.

90. True / False
The sporophyte of pteridophytes is haploid and dependent on the gametophyte.

91. Which of the following plants is heterosporous?
(a) Lycopodium
(b) Selaginella
(c) Equisetum
(d) Psilotum

92. True / False
In pteridophytes, zygotes develop into embryos outside the gametophyte.

93. match the following

Column A	**Column B**
A. Homosporous	1.Heterosporous
B. Heterosporous	2. Micro and megaspore
C. Selaginella	3. One type of spore
D. Lycopodium	4. Homosporous

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

94.Which of the following features of pteridophytes is considered a precursor to seed habit?
(a) Strobilus formation
(b) Heterospory with female gametophyte retained on parent
(c) Rhizoid-based anchorage
(d) Sporophyll clustering

95. match the following

Column A (Class)	**Column B** (Example)
A. Psilopsida.	1. Selaginella
B. Lycopsida.	2.Psilotum
C. Sphenopsida	3. Equisetum
D. Pteropsida	4. Adiantum

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

96. In gymnosperms, ovules remain _____ both before and after fertilisation.

HOTS :

2. True\False
Like bryophytes and pteridophytes, in gymnosperms, the male and the female gametophytes also have an independent free-living existence as these gymnosperms have evolved from bryophytes and pteridophytes only.

97. True / False
Gymnosperm seeds are covered by fruit walls post fertilisation.

98. Which of the following trees is considered one of the tallest living species?
(a) Pinus
(b) Ginkgo
(c) Sequoia
(d) Cycas

99. Assertion (A): Pinus has fungal associations in roots.
Reason (R): These associations form coralloid roots for nitrogen fixation.
(a) Both A and R are true and R is the correct explanation of A
(b) A is true, R is false
(c) A is false, R is true
(d) Both A and R are false

100. In Cycas, the roots are called _____ and are associated with _____ bacteria.

101. Needle-like leaves with sunken stomata are a feature of:
(a) Cycas
(b) Pinus
(c) Lycopodium
(d) Adiantum

102. Gymnosperms are _____; they produce microspores and megaspores.

103. What is the reduced male gametophyte in gymnosperms called?
(a) Antheridium
(b) Microsporophyll
(c) Pollen grain
(d) Sperm

104. The megaspore mother cell undergoes _____ to produce four megaspores.

105. Assertion (A): In gymnosperms, male and female gametophytes are free-living.
Reason (R): Pollen grains and ovules are produced outside the sporophyte body.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) Both A and R are false

106. The microsporangiate strobili in gymnosperms bear _____ and _____.

107. Pollen grains in gymnosperms develop within the megasporangia. (True / False)

108. Assertion (A): The male and female strobili of gymnosperms may be on the same or different plants.
Reason (R): Pinus is monoecious, while Cycas is dioecious.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) A is false, R is true

109. In Cycas, male cones and megasporophylls are borne on _____ trees.

110. The megaspore mother cell in gymnosperms is formed by differentiation in the:
(a) Integument
(b) Archegonium
(c) Nucellus
(d) Ovary wall

111. True / False
The multicellular female gametophyte in gymnosperms is enclosed within the megasporangium.

3.5 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 in fruits.** The angiosperms are an exceptionally large group of plants occurring in wide range of habitats. **They range in size from the smallest Wolffia to tall trees of Eucalyptus (over 100 metres).** They provide us with food, fodder, fuel, medicines and several other commercially important products. They are divided into two classes : the *dicotyledons* and the *monocotyledons* (Figure 3.5).

(a) (b)

Figure 3.5. Angiosperms : (a) _____ (b) _____

SUMMARY

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 possesed and the type of stored food, algae are classfied 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, leaf-like and stem-

112. The megaspore mother cell undergoes _____ to produce four megaspores in angiosperms.

113. Match the Following –

Column A	Column B
A. Megaspore.	1. Male gametophyte (Pollen grain)
B. Microspore	2. Female gametophyte
C. Pollen tube	3. Contains megaspore mother cell
D. Nucellus.	4. Carries male gametes

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

114. The pollen tube grows towards the _____ in the ovule and discharges male gametes.

115. Assertion(A): Seeds in gymnosperms are enclosed in fruits.
Reason (R): Ovules are protected by ovary walls during fertilisation.
(a) Both A and R are true and R is the correct explanation of A
(b) A is true, R is false
(c) A is false, R is true
(d) Both A and R are false

116. In angiosperms, the pollen grains and ovules are developed in:
(a) Cones
(b) Leaves
(c) Flowers
(d) Rhizoids

117. Unlike gymnosperms, where ovules are naked, angiosperms develop ovules in _____.

118. Assertion (A): Seeds in angiosperms are exposed at maturity.
Reason (R): Angiosperm ovules are not enclosed by any tissue.
(a) Both A and R are true and R is the correct explanation of A
(b) A is true, R is false
(c) A is false, R is true
(d) Both A and R are false

119. Which of the following correctly describes the seeds of angiosperms?
(a) Naked seeds
(b) Enclosed in fruits
(c) Present in cones
(d) Free-floating

120. Which group has the widest distribution among the plant kingdom?
(a) Algae
(b) Gymnosperms
(c) Pteridophytes
(d) Angiosperms

121. True / False
The smallest known flowering plant is Wolffia.

122. Which angiosperm can grow over 100 metres in height?
(a) Salvinia
(b) Eucalyptus
(c) Cycas
(d) Adiantum

123. Assertion (A): Angiosperms are ecologically and economically significant.
Reason (R): They provide food, medicine, and raw materials across habitats.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) A is false, R is true

like structures. **The bryophytes are divided into liverworts and mosses.** The plant body of liverworts is thalloid and dorsiventral whereas mosses have upright, slender axes 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 produced fuse to form zygote which produces a multicellular body called a 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 bear sporangia which produce spores. The spores germinate to form gametophytes which require cool, damp places to grow. The gametophytes bear male and female sex organs called antheridia and archegonia, respectively. Water is required for transfer of male gametes to archegonium where zygote is formed after fertilisation. The zygote produces a sporophyte.

The gymnosperms are the plants in which ovules are not enclosed by any ovary wall. After fertilisation 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.

The angiosperms are divided into two classes – the dicotyledons and the monocotyledons.

EXERCISES

1. What is the basis of classification of algae? When and where does reduction
2. 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. Both
6. 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

10. 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

11. Describe the important characteristics of gymnosperms.

124. In liverworts, the plant body is _____ and _____.

125. Which of the following plant groups has upright slender axes with spirally arranged leaves?
(a) Algae
(b) Liverworts
(c) Mosses
(d) Gymnosperms

126. True / False
In bryophytes, the main plant body is a diploid sporophyte.

127. Assertion (A): Bryophyte gametophytes bear antheridia and archegonia.
Reason (R): Antheridia produce eggs and archegonia produce sperm.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) A is false, R is true

128. Fusion of gametes in bryophytes forms a _____, which gives rise to a _____ that produces spores.

129. In pteridophytes, the main plant body is:
(a) Gametophyte
(b) Rhizoid
(c) Sporophyte
(d) Prothallus

130. What is required for male gamete transfer in pteridophytes?
(a) Insects
(b) Water
(c) Wind
(d) Light

131. After fertilisation in pteridophytes, the zygote develops into a _____.

132. True / False
Gymnosperms produce seeds that are enclosed within a fruit wall.

133. In gymnosperms, megasporangia are borne on:
(a) Microsporophylls
(b) Ovary wall
(c) Megasporophylls
(d) Prothalli

134. Male and female sporophylls in gymnosperms are arranged spirally on axis to form _____ and _____ respectively.

135. Assertion (A): Pollen tubes release male gametes into ovule in gymnosperms.
Reason (R): Fertilisation occurs inside archegonia.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not the correct explanation of A
(c) A is true, R is false
(d) Both A and R are false

136. True / False
In gymnosperms, the ovule becomes the fruit after fertilisation.

137. Angiosperms are divided into two classes: _____ and _____.

Notes:

CRUX OF NCERT

Q. A team of evolutionary botanists discovers a plant species in a transitional ecosystem between an aquatic marsh and a dry upland forest. Across seasons, the plant exhibits different structural and reproductive traits:

- During rainy months, it forms a dominant green thalloid body anchored via rhizoids. It produces multicellular sex organs with jacket layers, requires water for fertilisation, and shows a zygote attached to the gametophyte.
- In the post-monsoon phase, a vascular structure develops bearing spirally arranged microphylls and sporophylls in cone-like strobili.
- Reproductive structures shift to forming two types of spores. Fertilisation occurs via pollen tubes, resulting in exposed seeds lacking fruit.
- Microscopic studies of the plant across stages reveal:
- — Thalloid body with parenchyma and simple tissues
- — Sporophyte with tracheid-based xylem, sieve cells, sclerenchyma, and no companion cells
- — Green pigmentation from chlorophyll a, b, and brownish fucoxanthin
- Vegetative reproduction via fragmentation occurs in aquatic phases. Alternation of generations is clearly evident, though dominance changes with season and maturity.

Based on this, which of the following interpretations is most appropriate?
1. The plant exhibits characteristics from all five groups: Chlorophyceae, Phaeophyceae, Bryophyta, Pteridophyta, and Gymnosperms.
2. It follows a haplodiplontic life cycle, but shows a shift from gametophyte dominance to sporophyte dominance, mirroring terrestrial evolution.
3. Despite seed production, it cannot be strictly classified under Gymnosperms due to its functional dependence on a bryophyte-like gametophyte stage.
4. Presence of microphylls, heterospory, and exposed ovules reflects a combination of traits typically found in pteridophytes and gymnosperms.
5. The occurrence of fucoxanthin in a land plant is expected due to convergent evolution in pigment pathways.

Choose the most appropriate option:
(a) 1, 2, 3 and 4 are correct
(b) 1, 2, and 5 are correct
(c) 2, 3 and 4 only
(d) All 1 to 5 are correct

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

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

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

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

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

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

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

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

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

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

1. a
2. (i)Whittaker,(ii)fungi, (iii)Artificial
3. FTF
4. b
5. Monera and Protista
6. b
7. (1)True , (2) False
8. a
9. c
10. a
11. b
12. Phylogenetic
13. b
14. False
15. d
16. a
17. Algae
18. a
19. b
20. c
21. Anisogamous
22. False
23. a
24. a
25. d
26. Half
27. a
28. b
29. Algin ,carrageen
30. c
31. False
32. Gelidium, gracilaria
33. Discoid ,Cup shape , Ribbon shape
34. b
35. True
36. c
37. Zoospore ,zoosporangia
38. d
39. c
40. True
41. a
42. Laminarian ,mannitol
43. c
44. Holdfast ,stipe
45. (A) True, (B) d
46. c
47. b
48. Florideanstarch ,amylopectin, glycogen.
49. c
50. True
51. Multicellular ,complex
52. d
53. b
54. False
55. b
56. Amphibians
57. d
58. d
59. Rhizoids
60. False
61. c
62. c
63. Meiosis ,sporophyte
64. False
65. c
66. c
67. Thalloid
68. False
69. c
70. Gemma cups
71. (A) Protonema,leafy (B) d
72. b
73. Antheridia ,archegonia
74. c
75. True
76. c
77. Meiosis
78. b
79. c
80. Horsetails ,ferns
81. c
82. d
83. Microphyll,macrophylls
84. c
85. b
86. True
87. Prothallus
88. a
89. Archegonium
90. False
91. b
92. False
93. a
94. b
95. d
96. Exposed
97. False
98. c
99. b
100. Coralloid root ,Nitrogen fixing
101. b
102. Heterosporous
103. c
104. Meiosis
105. d
106. Microsporophylls ,Microsporangia
107. False
108. b
109. Different
110. c
111. True
112. Meiosis
113. b
114. Archegonia
115. d
116. c
117. Flowers
118. d
119. b
120. d
121. True
122. b
123. a
124. Thalloid ,dorsiventral
125. c
126. False

127. c
128. Zygote,sporophyte
129. c
130. b
131. Sporophyte
132. False
133. c
134. Male cone ,female cones
135. a
136. False
137.Dicotyledon,
monocotyledon

CRUX - a

HOTS -

1.both a and b are incorrect

2. false

NCERT EXEMPLAR

1. c
2. c
3. c
4. d
5. c
6. d
7. b
8. c
9. a
10.d