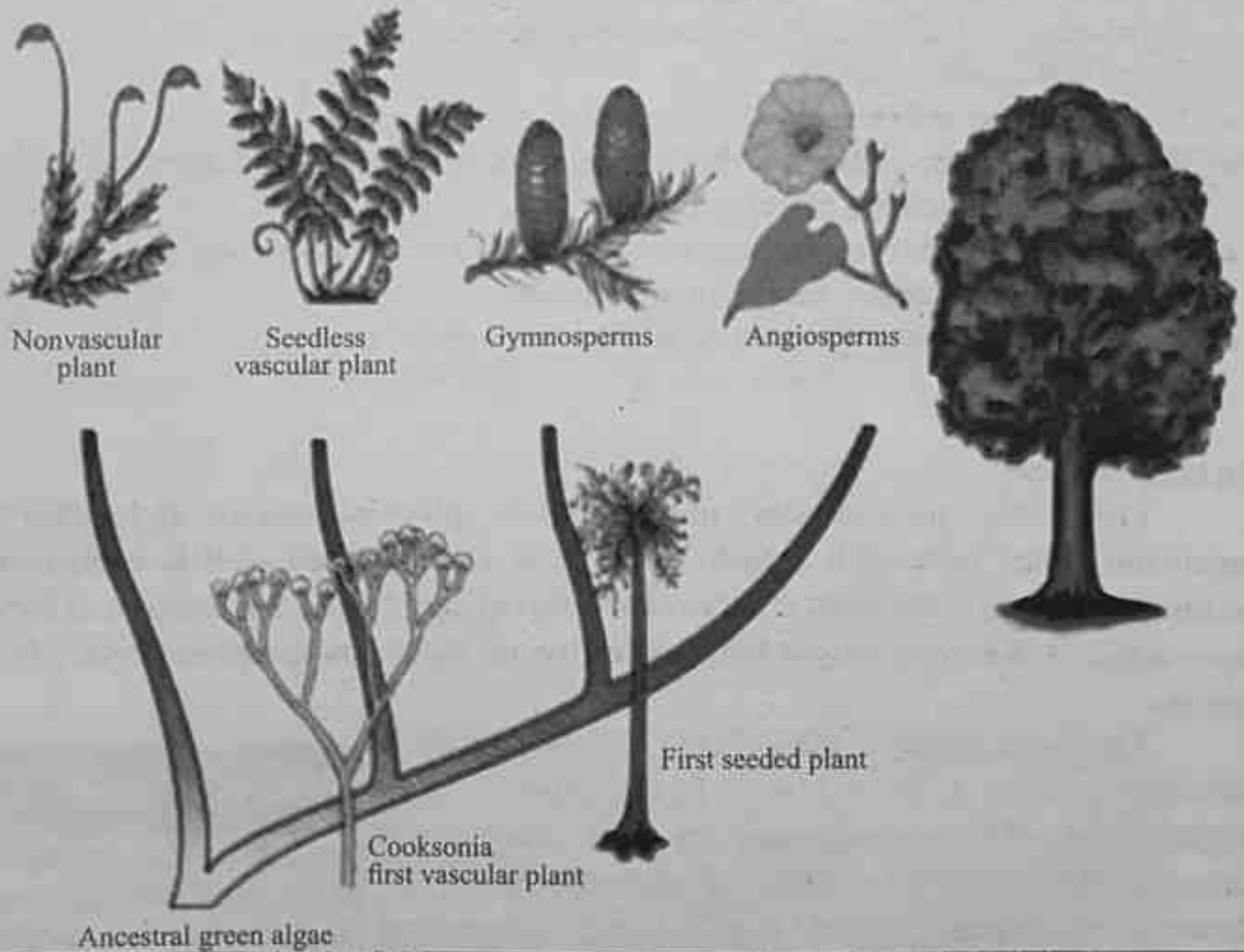
UNIT 8

DIVERSITY AMONG PLANTS

Major Concepts

8.1 The Evolutionary Origin of Plants
8.2 Non-Vascular Plants
8.3 Seedless Vascular Plants
8.4 Seeded Plants



Students Learning Outcomes

On completion of this unit students will be able to:

- Outline the evolutionary origin of plants.
- List the diagnostic features shared by all plants, with emphasis on the alternation of generations.
- Describe the general characteristics of bryophytes.
- Outline the life cycle of a moss.
- Explain the land adaptations of bryophytes.
- List the advantages/uses of bryophytes.
- Describe the general characteristics of vascular plants.
- List the characters of seedless vascular plants with examples of whisk ferns, club mosses, horsetails and ferns.
- Explain the evolution of leaf in vascular plants.
- Outline the life cycle of ferns.
- Describe vascular plants as successful land plants.
- Summarize the importance of seedless vascular plants.
- Describe the evolution of seed.
- Describe the general characteristics and uses of gymnosperms.
- Define angiosperms and explain the difference between monocots and dicots.
- Explain the life cycle of a flowering plant.
- Explain how this life cycle demonstrates an adaptation of angiosperms on land.
- Define inflorescence and describe its major types.
- Describe the significance/benefits of angiosperms for humans.

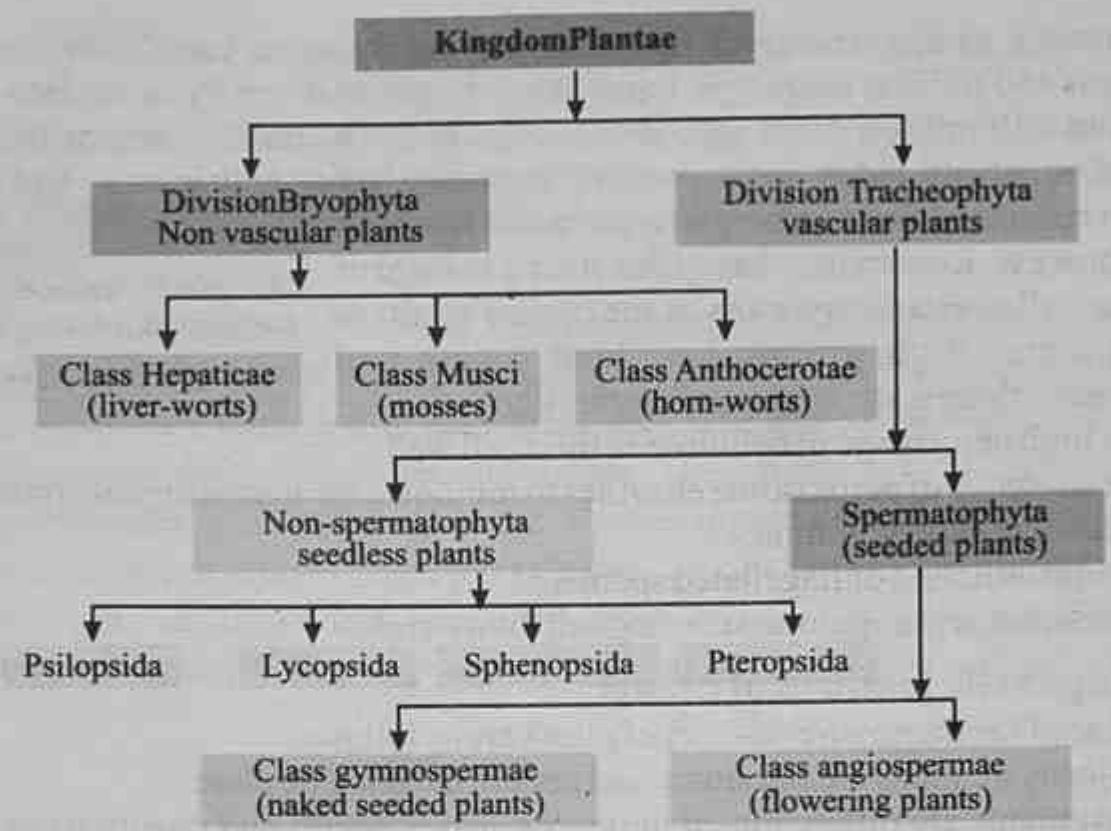
Introduction

Plants are multicellular, predominantly **photosynthetic** and eukaryotic organisms. They have well defined body parts and their **cell wall is composed of cellulose.** They develop from embryo. Their stored carbohydrate is starch and they are non-motile. It is second largest kingdom of living organisms comprises over 3,60,000 species.

The major groups of plants are bryophytes, seedless vascular plants, seeded plants (gymnosperms and angiosperms). The **angiosperms** are very diverse and largest group. Plants live in almost all sorts of habitats. i.e., deserts, mountains, tundra, tropical and subtropical regions as well as in water. The outline of classification of kingdom Plantae is given below.

Do you know?

Plants protect themselves from frost and dehydration stress with the antifreeze proteins, heat shock proteins and sugar.



8.1 The evolutionary origin of plants

The evolution of plants has resulted in widely varying levels of complexity, started from green algae through bryophytes, lycopods and ferns to the complex gymnosperms and angiosperms.

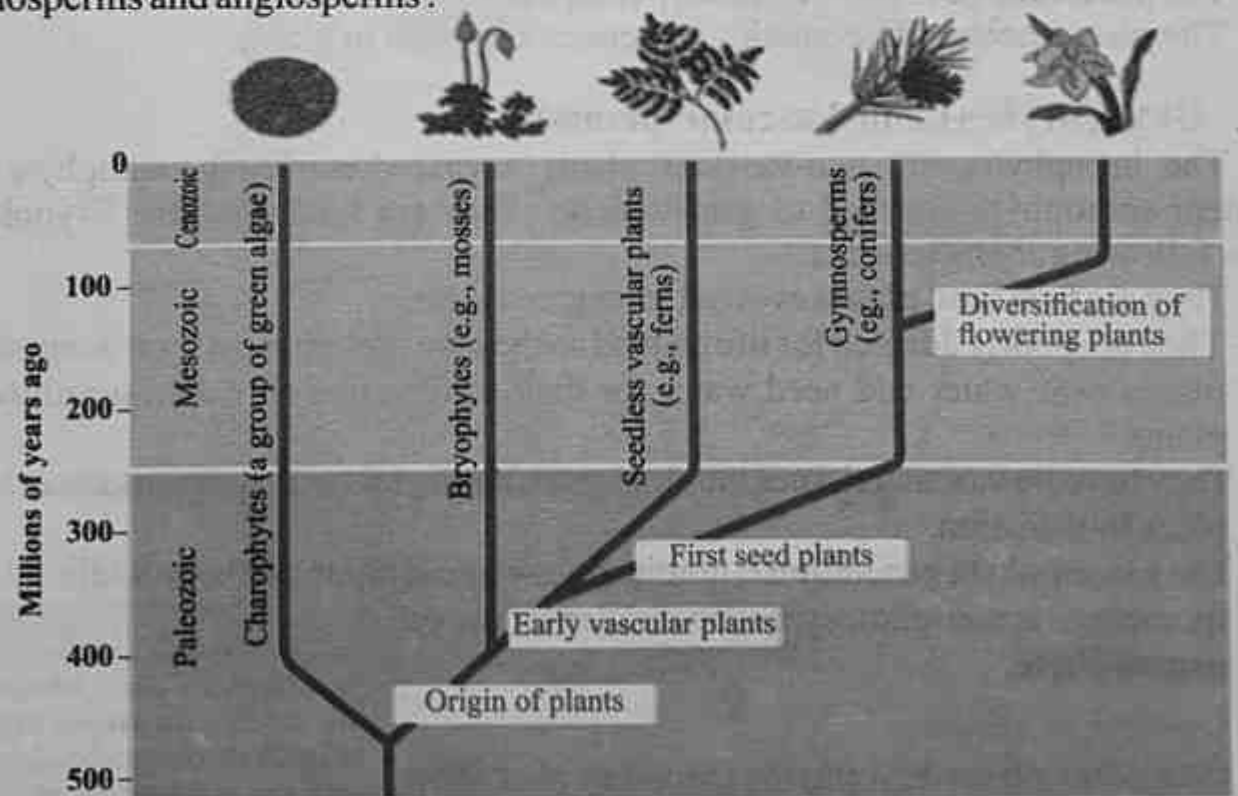


Fig. 8.1 Phylogenetic relationships among the major groups in Kingdom plantae

Evidence of appearance of **first land plants** is traced back in the ordovician period about 450 million years ago. Land plants began to diversify in the late **Silurian** period about 430 million years ago. By the middle of Devonian many of the features recognized in plants today were present, including roots and leaves. Evolutionary innovation continued from carboniferous era and is still an ongoing process. Researchers have identified a lineage of green algae called **charophyceans** as the closest relatives of land plants. Both groups i.e., land plants and charophyceans share some common features like:

Tit bits

The plant science is called botany. (Botany, Gk. botane means pasture or plant.

1. The high percentage of cellulose in their cell wall.
2. The presence of peroxisome enzymes to minimize the loss of organic products as a result of photorespiration.
3. Similar structure of flagellated sperms.
4. Formation of phragmoplast during cell division etc.

8.1.1 Diagnostic features of plants

Some of the diagnostic features of plants are as follows.

- Majority of plants are stationary and remain fixed to one place.
- Most plants are differentiated into roots, leaves, stems and mostly have vascular tissues, (except bryophytes).
- Plants possess chlorophyll hence have the ability of photosynthesis.
- Plants possess cuticle to prevent water loss by transpiration.
- The plant cells have cell wall chiefly composed of cellulose.
- The phenomenon of alternation of generation exists in plants.

8.2 Bryophytes (Non-Vascular plants)

The bryophytes are non-vascular plants having dominant gametophyte and dependent sporophyte attached to gametophyte. They are homosporous. Bryophytes possess following characteristics.

- They are **first land plants** evolved from green algae.
- They are poorly adapted for life on land so they are present mostly on damp shady places near water and need water for their fertilization so called **amphibious** plants.
- They have no vascular tissues thus transport of minerals and food substances takes place by diffusion.
- The gametophyte generation is dominant, green and photosynthetic while sporophyte is non-photosynthetic and dependant on gametophyte.

Tit bits

Bryophytes are important for soil conditioning as bioindicators, pesticides, fuel and as packaging material etc.

8.2.1 Life cycle of Moss

Like other plants bryophytes (Mosses) also show alternation of generation. Alternation of generation is a

phenomenon in which gametophyte and sporophyte generations regularly alternate with each other.

The bryophytes differ from other groups of plants in their life cycle. In bryophytes gametophyte generation is dominant, photosynthetic and independent while sporophyte is dependant and non-photosynthetic.

Gametophyte Generation:

The gamete producing generation is called gametophyte generation. It is haploid generation. The gametes are produced by mitosis. The male and female gametophyte generations are usually separated in case of mosses. The male gametophyte produces sperms while female gametophyte produces eggs. The gamete producing organs (sex organs) are **antheridium** and **archegonium.** The sex organs are intermixed with some multicellular hair-like structures called **paraphyses.** The sperm is motile and needs water for reaching to egg in archegonium. Thus fertilization occurs in archegonium. The egg is large and non-motile, containing large amount of food for nourishment of early stage of embryo.

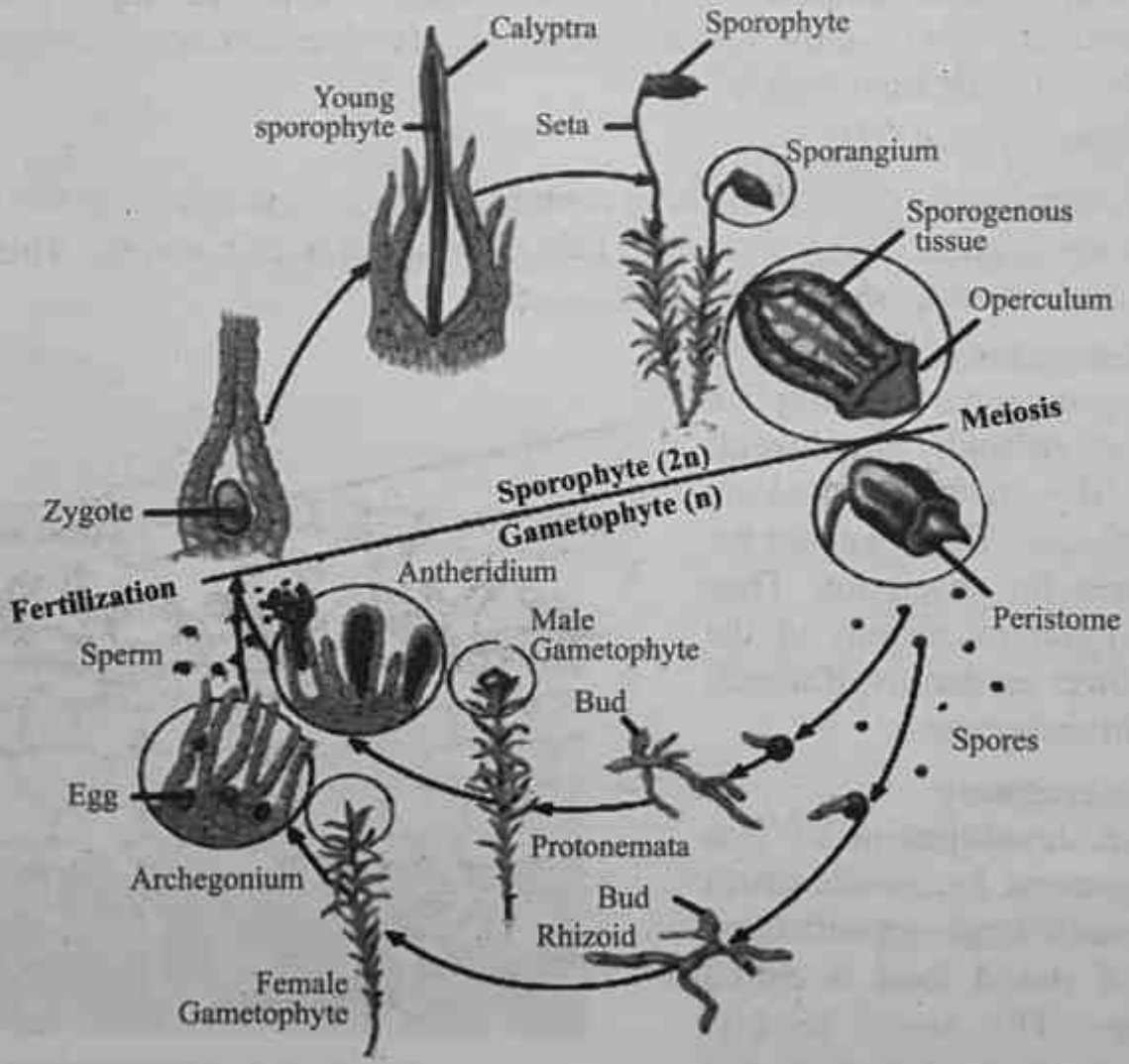


Fig. 8.2 Life Cycle of Moss

Sporophyte Generation:

It produces spores so called sporophyte. The fertilized egg in archegonium develops into sporophyte. The sporophyte remains attached on gametophyte. The sporophyte consists of three parts, i.e., **a foot** which is embedded in the tissue of gametophyte, **a stalk** (seta) and a **capsule** or sporangium.

The sporophyte generation is diploid and spores are produced in sporangium by meiosis. These spores on availability of suitable conditions give rise to gametophytes.

Do you know?

Bryophytes are known as amphibious plants because they need water for their reproduction.

8.2.2 Adaptation of Bryophytes for Life on Land

The bryophytes are called the first invaders of the land among the plants. They show the following adaptations for life on land.

1. Multicellular plant body and conservation of water

A multicellular compact plant body of bryophytes conserves water and reduce surface exposed to dry conditions. Moreover, a layer of cuticle develops to further reduce transpiration of water from surface.

2. Absorption of CO_2

Bryophytes like Marchantia have evolved elaborate structure to absorb CO_2. In epidermis many pores are present which help in diffusion of CO_2 and O_2. This CO_2 is absorbed by the wet surface of photosynthetic cells.

3. Absorption of water

The structures for absorption of water are **rhizoids.** The rhizoids are root-like structures lacking vascular tissues. They increase the surface area for absorption. They are unicellular extensions of the cells of lower epidermis. Rhizoids also help in anchorage.

4. Heterogamy

The development of two types of gametes, i.e., motile sperm and non motile large egg with large amount of stored food is called heterogamy. This stored food is used in early stages of development of embryo.

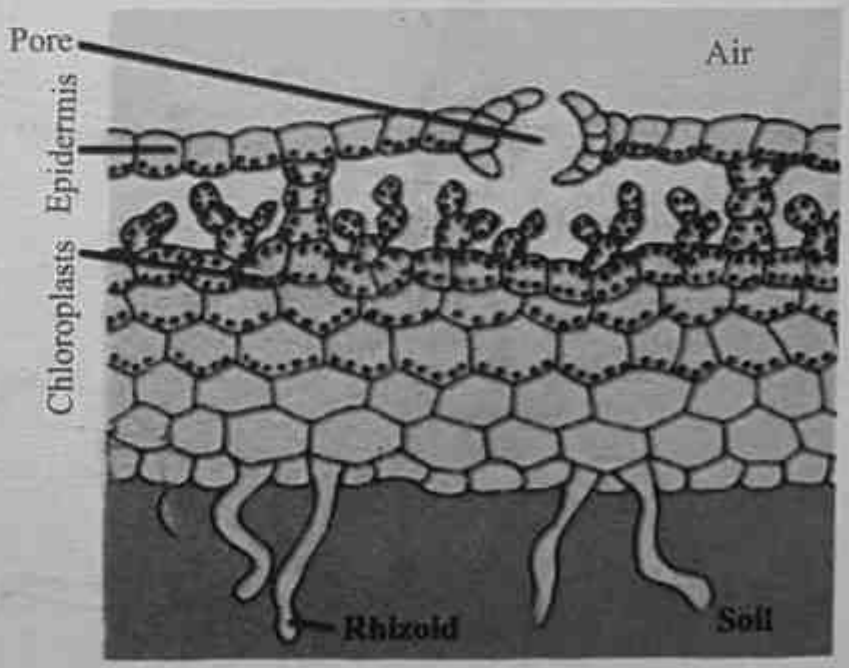


Fig. 8.3 T.S of Marchantia Thallus

5. Protection of Reproductive Cells

The male gametes, (sperms) are produced in antheridium and female gametes (eggs) are produced in archegonium. The sex organs are prevented from drying by leaf-like structures and sterile hairs. Spores are protected by sporangium.

Classification of Bryophytes

Bryophytes are divided into three classes or phylum.
1. Hepaticae (liver-worts).
2. Musci (mosses)
3. Anthocerotae (horn-worts).

6. Embryo formation

The developing zygote is called embryo. In bryophytes embryo remain protected in female sex organ, i.e., archegonium. Thus the embryo is protected from drying and mechanical injury, and it increases the chances of survival.

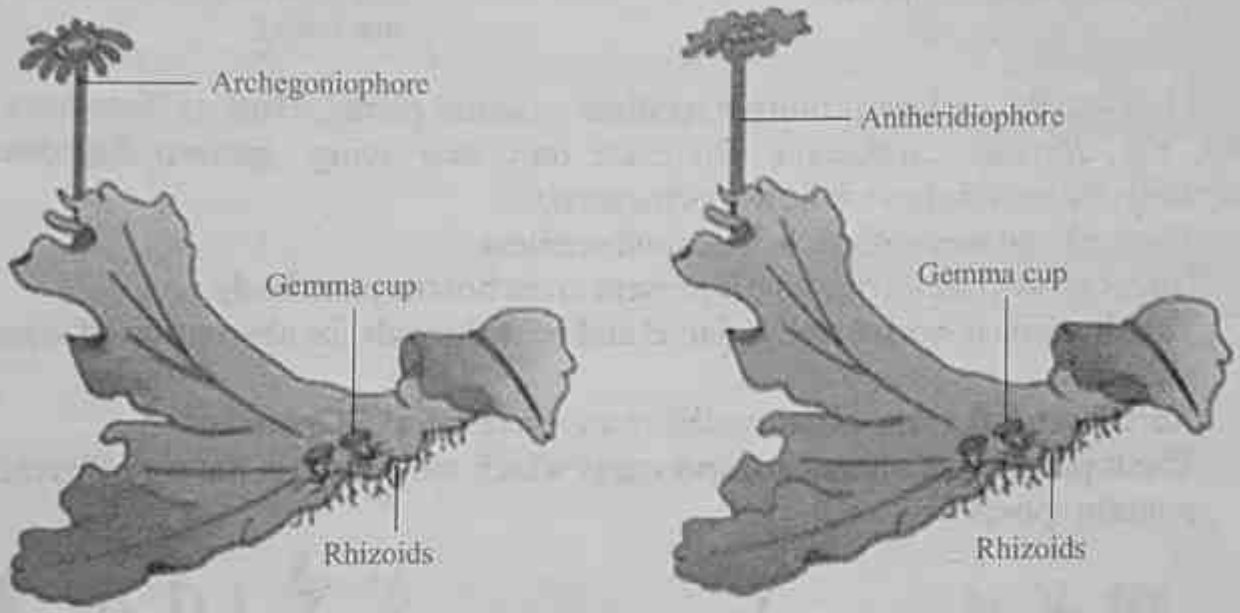


Fig. 8.4 Male and female thallus of Marchantia

7. Alternation of Generation

In all land plants there are two types of generations, i.e. sporophyte and gametophyte which alternate with each other. This phenomenon is called alternation of generation. This ensures the diversity and variation in characters and increases the chances of survival of plants on land.

8.2.3 Importance or Advantages of Bryophytes

Some of the uses of bryophytes are as under.

i) They prevent soil erosion by holding soil in place.
ii) The rocks are broken down into soil by their physical and chemical action.
iii) They increase soil fertility as they decay into soil.
iv) They also provide food for herbivores.
v) They retain soil moisture.
vi) Some bryophytes have medicinal value as well.

8.3 Seedless Vascular Plants

The seedless vascular plants are a sub group of tracheophytes. **The tracheophytes** have vascular tissue, i.e., **xylem** for conduction of water and minerals **phloem** for conduction of organic food. All vascular plants have **tracheids** in their xylem and thus called tracheophytes. They are successful land plants with dominant sporophyte and reduced gametophyte generation. The tracheophytes can be sub divided into following groups.

(i) Sub division Psilopsida
(ii) Sub division Lycopsida
(iii) Sub division Sphenopsida
(iv) Sub division Pteropsida

Critical Thinking

Bryophytes do not have true roots and leaves. Guess how do they absorb water and nutrients?

8.3.1 Sub division Psilopsida: (whisk ferns)

They are the earliest primitive seedless vascular plants. Most of them have been extinct, e.g., *Rhynia, Cooksonia.* There are only two living *genera Psilotum and Tmesipteris*. Psilopsida have following characters.

- These plants are rootless, leafless and seedless.
- Under ground stem, rhizome is present to anchor the plant body.
- The rhizome is horizontally placed and bear rhizoids for absorption of water and minerals.
- Aerial stem is green, photosynthetic and having forked branches.
- The reproductive organs are sporangia which are borne on the tip of branch and contain spores.

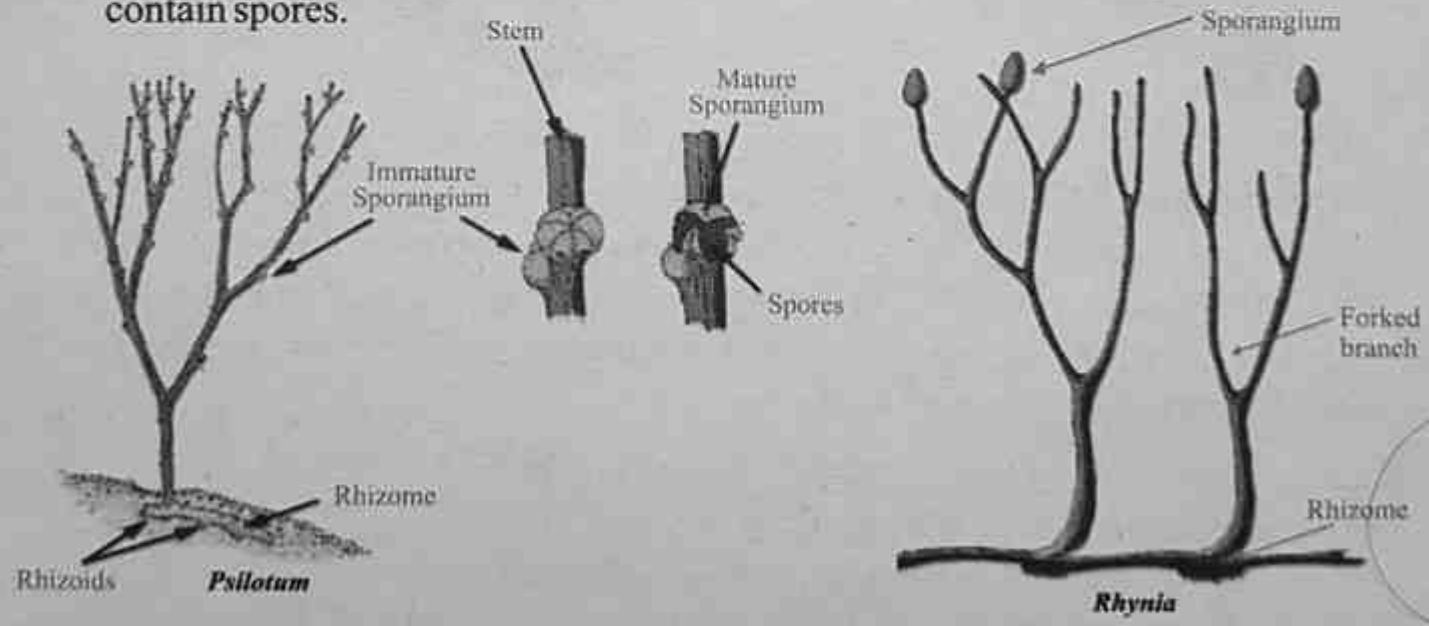


Fig. 8.5 Primitive Vascular Plants

8.3.2 Lycopsida (Club mosses)

It includes plants like *Lycopodium* and *Selaginella.* These plants are also called club mosses or spike mosses due to their club/spike shaped cones or ***strobilli*** and small

moss like leaves. These plants have following characteristics.

- The plant body is sporophyte which is differentiated into roots, stems and leaves. Their leaves are called microphylls.
- Leaves may be spirally arranged or opposite.
- Sporangia develop singly on upper side of leaf such leaf is called sporophyll.
- Sporophylls may be grouped together to form cone or strobilus.
- These plants may be homosporous (*Lycopodium*) or heterosporus (*Selaginella*).
- Gametophyte of lycopsida is underground and has fungal association called mycorrhiza.

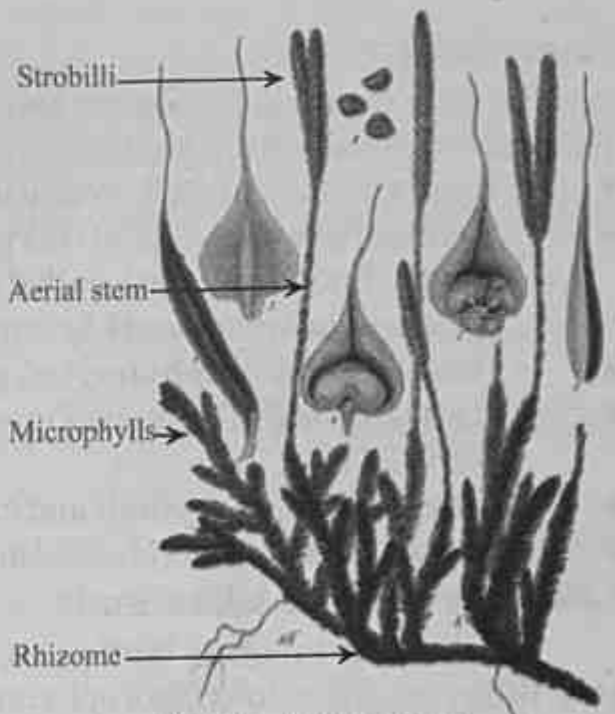


Fig. 8.6 Lycopodium

Do you know?

Lycopodium herb has been used in the traditional Austrian medicine internally as tea or externally to treat, skin, liver, bile, kidney and urinary tract infections.

8.3.3 Sphenopsida (Horsetail)

The plants of this group are called **arthrophytes** because whole plant consists of large number of joints. These plants are found in humus and wet places round the world. There is only one surviving genus *Equisetum*. They have following characteristics.

- The plant body is sporophyte differentiated into root, stem and leaves.
- Leaves may be broad or scale-like and are always arranged in whorls.
- Main stem is jointed and have ridges and furrows. From each node there is given out whorls of branches.
- The sporangia develop on sporangiophore. The sporangiophores group together to form cones.
- The gametophyte is thalloid and grows on clay soil or mud.

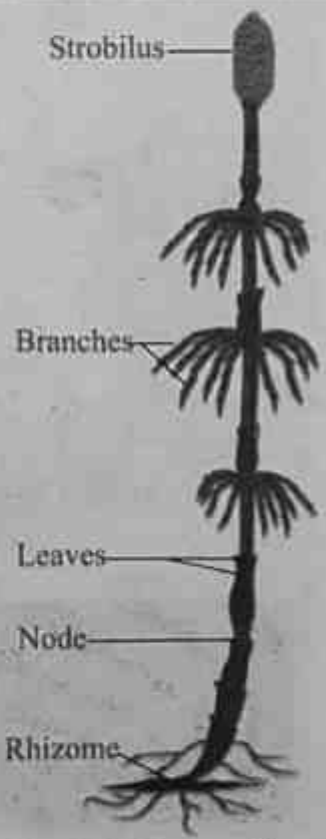


Fig. 8.7 Horsetail

8.3.4 Pteropsida

The Pteropsida is a heterogenous group of seedless vascular plants which consist of sub group or class Filicinae. These are found in moist and warm tropical areas.

Class Filicinae:

This class includes ferns which are the largest group of seedless vascular plants. These plants possess following important characteristics.

- These plants are usually found in moist and shady places.
- An important character of this group is that sporangia are attached on underside of leaves. Such leaves are called **fronds.** The immature or young frond has coiled pattern of development like watch spring and it is called **circinate Vernation**.
- Some ferns are **epiphytes**, i.e., grow on the bark of trees.
- Plant body is differentiated into leaves, stems and roots. Plants range in size from 1cm –24 m.
- Leaves are megaphyllous and may grow upto 5 meters (in a tree fern).
- Sex organs are antheridia and archegonia, for example: *Adiantum, Pteris* etc.

Life cycle of Fern (Adiantum):

Adiantum involves both asexual and sexual reproduction, i.e., morphologically two different generations (sporophyte and gametophyte) exist.

Sporophyte: The plant body is diploid sporophyte bearing groups of sporangia or **sori** on underside of margins of leaflets. Mature sori become black. The leaves bearing sporangia are called **sporophylls.** The sporangium is flattened, biconvex capsule born on the multicellular stalk. These capsules contain spores. Each spore is a simple cell consisting of cytoplasm and nucleus surrounded by two layers of cell wall. When the spores fall on suitable soil, it is germinated into a haploid gametophyte called **prothallus.**

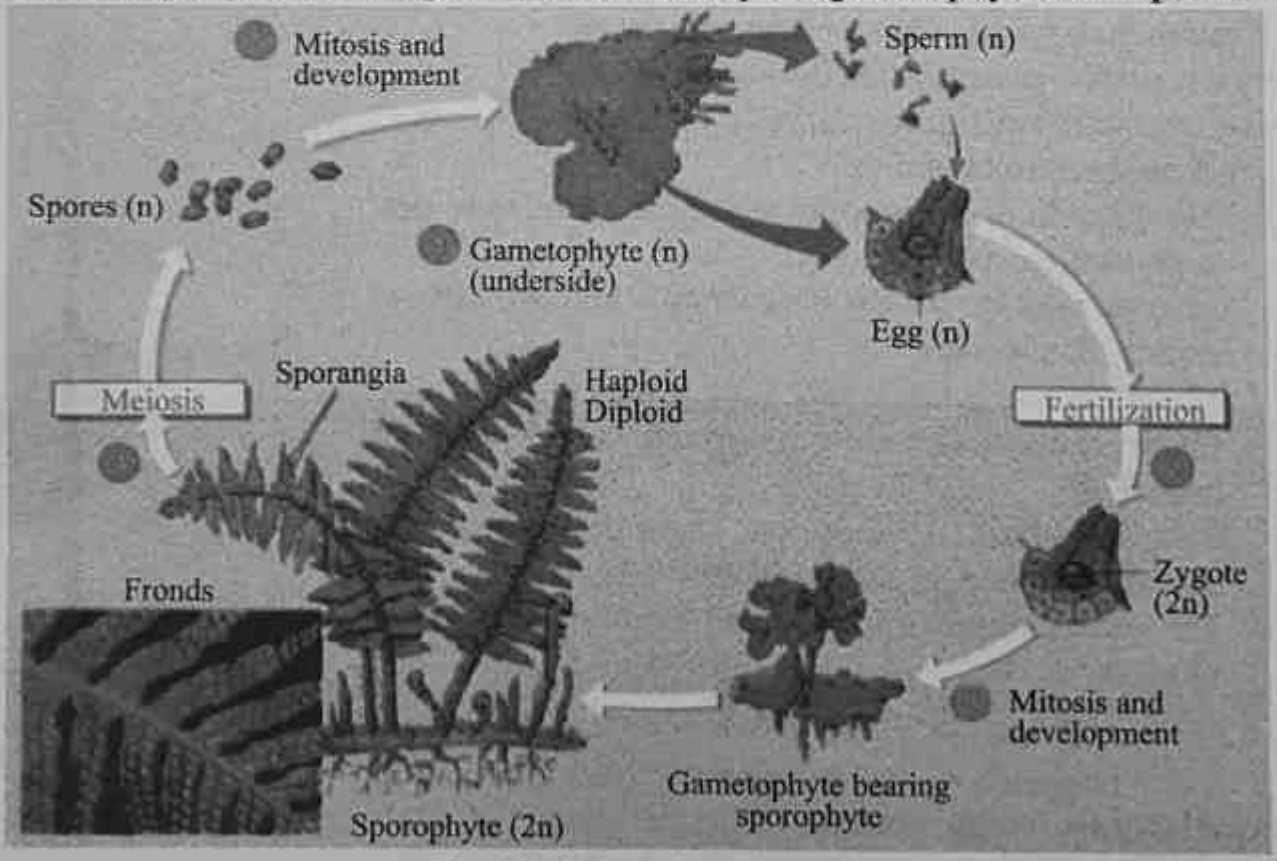


Fig. 8.8 Life cycle Adiantum

Gametophyte: The gametophyte generation is called prothallus which is a heart shaped structure and underground. From it's posterior, under surface rhizoids are given out which fix the prothallus and absorb water. The prothallus is **monoecious**, i.e., both male and female sex organs develop on the same prothallus.

Antheridium: It is male sex organ in which large number of coiled multiciliated spermatozoids are produced.

Archegonium: These are flask shaped having broader part **ventre** and elongated part **neck**. Ventre contains egg or oospore.

Fertilization: The spermatozoids (sperms) reach the neck of archegonium by water pass through neck and unite with egg to form zygote or oospore.

Formation of sporophyte: The diploid zygote divides by mitosis to form the embryo and develops into sporophyte which is attached to gametophyte but later on becomes independent.

8.3.5 Evolution of Leaf

Lycopsida were the first group of plants that formed true leaves. There are two types of leaves.

1. **Microphylls:** These are small single veined leaves found in lycopods.
2. **Megaphylls:** These leaves have large blade or lamina, with large number of parallel or divided veins. These leaves are found in ferns and spermatophytes.

Evolution of one veined leaf (Microphyll):

There is no fossil record showing the evolution of one veined leaf. However, two hypothesis have been proposed to explain the evolution of one veined leaf.

a. Outgrowth hypothesis
b. Reduction hypothesis

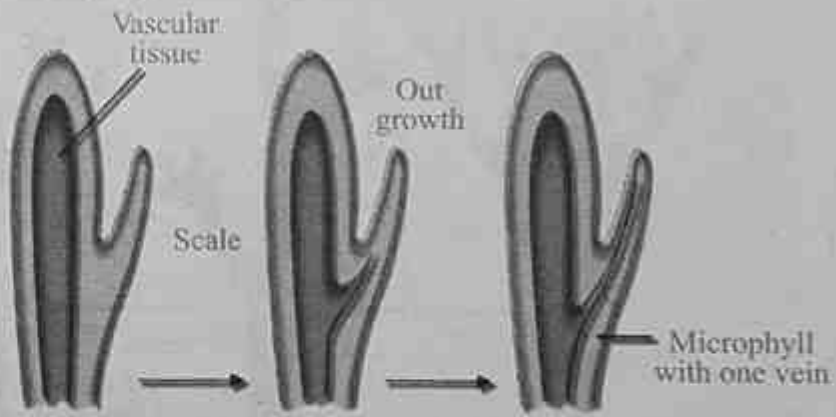


Fig. 8.9 Outgrowth Hypothesis

Out growth hypothesis:

This hypothesis states that one veined leaf originated as a result of outgrowth from the naked branches of primitive vascular plants. Due to increase in size of these outgrowth vascular tissues were needed for transport of food and water. Thus vascular

Tit bits

Evolution of leaf was a slow process and it took about 15–20 million years.

bundles extended to these outgrowths which gave rise to one veined leaf.

Reduction hypothesis:

This hypothesis states that one veined leaf originated as a result of reduction in size and flattening of leafless branches.

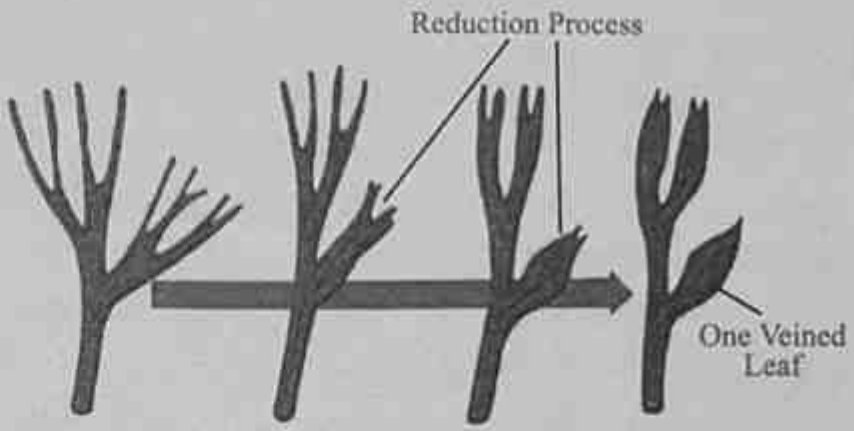


Fig. 8.10 Reduction Process of One Vein Leaf

Evolution of many veined leaf:

The evolution of many veined (Megaphylls) leaf took place in following steps.

a. **Overtopping:** It is unequal development of various branches. In primitive Rhynia and fern like plants the aerial portions of stem showed unequal branching, i.e., some branches were small while others were long.

b. **Plannation and flattening:** The unequal branches become arranged in one plane and became flat called plannation.

c. **Fusion or webbing:** The space between overtopped branches were filled by photosynthetic tissues that connected these branches. Thus a flat leaf **blade** was formed which superficially resembles to the webbed foot of duck and thus many veined leaf evolved.

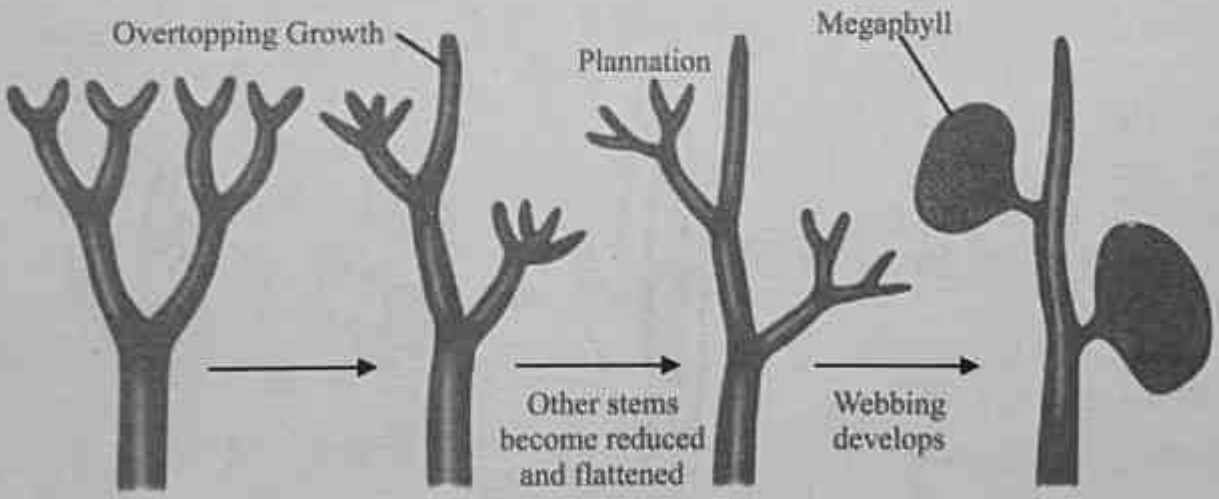


Fig. 8.11 Evolutaion of many veined leaf

8.4 Evolution of seed

Seed forming plants are called spermatophytes among vascular plants seeded plants are more successful land plants.

The development of seed habit occurred approximately 390 million years ago but complete seed forming plants appeared in late Devonian period about 365 million years ago. Seed can be defined as fertilized ovule, integumented in indehiscent

megasporangium. Integument is a specialized protective covering around megasporangium.

Following steps were involved in the evolution of seed:

1. Evolution of heterospory.
2. Retention and germination of megaspore within megasporangium.
3. Development of integument, a protective layer around megasporangium.
4. Reduction to a single functional megaspore per megasporangium.
5. Development of embryo sac within megasporangium.
6. Modification of distal end for megasporangium to capture pollen.

Spermatophyta (Seeded plants):

There are two groups of seeded plants, gymnosperms and angiosperms.

8.4.1 Gymnosperms: (Latin, Gymno: naked, Greek, Sperma: seed)

These plants produce naked seeds, i.e. seed is not enclosed in fruit. It is wide spread group of plants and consists of one third of world forests. The gymnosperms are woody plants either shrubs, trees or rarely vines (in some gnetophytes). They differ from

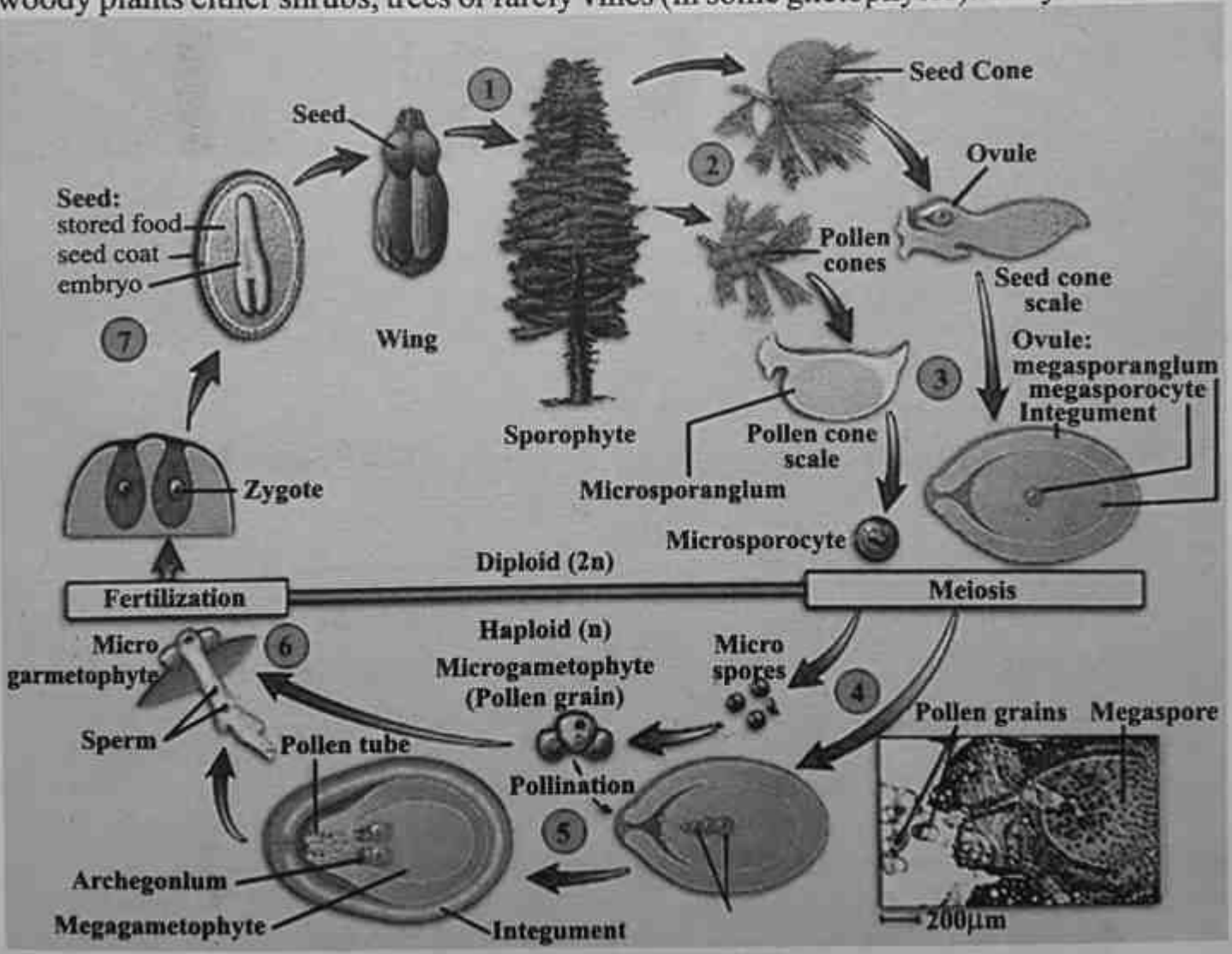
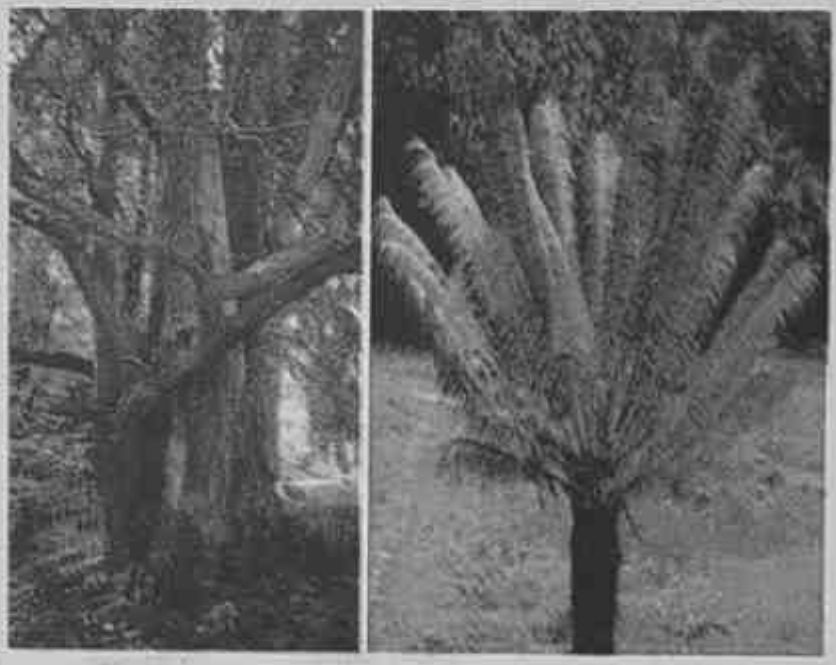


Fig. 8.12 Life cycle of *Pinus*

flowering plants in that the seeds are not enclosed in an ovary but are exposed within any of the variety of structure, the most familiar being cones. The plants show heteromorphic alternation of generation with independent dominant sporophyte and dependent reduced gametophyte. The female gametophyte is retained in the ovule permanently. The microspore develops on microsporophyll and megaspores develop on megasporophyll. There are two types of leaves, i.e. **foliage and scale.** The leaves are evergreen and exhibit xerophytic features like thick and tough cuticle, sunken stomata etc. The xylem consists of tracheids and xylem parenchyma. **Polyembryony** is common but usually single embryo gets mature.

The important genera of gymnosperms are:

1. Cycas (Cycad)
2. Pinus (pines)
3. Picea (hemlock)
4. Cedrus (deodar)
5. Ginkgo
6. Ephedra



Ginkgo Cycad

Fig. 8.13 Gymnosperms

Activity

Search the pictures of gymnosperms like Ephedra, Cedrus(deodar) and Picea(hemlock) from internet sources.

Table 8.1 Differences between male and female cones

Female cone	Male cone
• It is woody.	• It is herbaceous.
• It is large in size.	• It is small in size.
• It grows singly.	• It grows in groups.
• Borne on higher branches.	• Borne in lower branches.
• It is long lasting.	• It is short lived.

Importance of Gymnosperms:

The gymnosperms are used by man for following purposes.

- Their seeds may be used as food, e.g. pine, chilghoza.
- To obtain drugs, e.g., ephedrine which is obtained from *Ephedra.*
- Wood is used for making paper, construction, packing etc.
- Grown as ornamental plants like cycads.

Many commercial products, e.g., resins, turpentine's, tar and many oils, soap, varnish, nail polish, gum, perfumes etc., are obtained from gymnosperms.

8.4.2 Angiosperms (Greek: Angio means enclosed, sperm means seed)

All flowering plants belong to angiosperms. Like gymnosperms, angiosperms are seed producing plants. It is most diverse group of plants. They are distinguished from gymnosperms by characteristics including, flower, endosperm within seeds, and production of fruits that contain seeds. It is believed that angiosperms diverged from gymnosperms in Triassic period about 245 million years ago. There are 3,60,000 known species of plants out of these 2,35,000 species are angiosperms. All angiosperms are divided into two sub classes, i.e. monocot and dicot.

Life cycle of the flowering plants (Angiosperms):

Like other plant groups, angiosperms also show alternation of generation, i.e. both sporophyte and gametophyte generations are present which alternate with each other.

Sporophyte generation:

The adult flowering plant is diploid sporophyte consisting of root, stem, leaves and flowers. **Flower** is the reproductive part and is modified shoot. Each flower consists of pedicel, thalamus and floral leaves, i.e. sepals, petals, stamens and carpel. The **thalamus** is a modified stem while floral leaves are essential parts of flower. The sepals and petals are not essential for reproduction, however, sepals and petals are protective parts of flower and also attract insects for pollination. **Stamen** is the male reproductive part of flower and consisting of long filament having bilobed anther at its tip. In anther haploid microspores are produced by meiosis inside the pollen sacs. **Carpel** is a female reproductive part of flower. The basal broader part of the carpel is ovary, elongated part is style and terminal broad part of carpel is stigma. Inside ovary one or more ovules are present which are covered by integument. The embryo sac is surrounded by a tissue called nucellus.

Pollination:

The transfer of pollen grains from anther of stamen to the stigma of carpel is called pollination. The pollination may takes place either by insects, wind or water.

Gametophyte Generation:

The gametophyte generation is inconspicuous and haploid (n). There are separate male and female gametophytes.

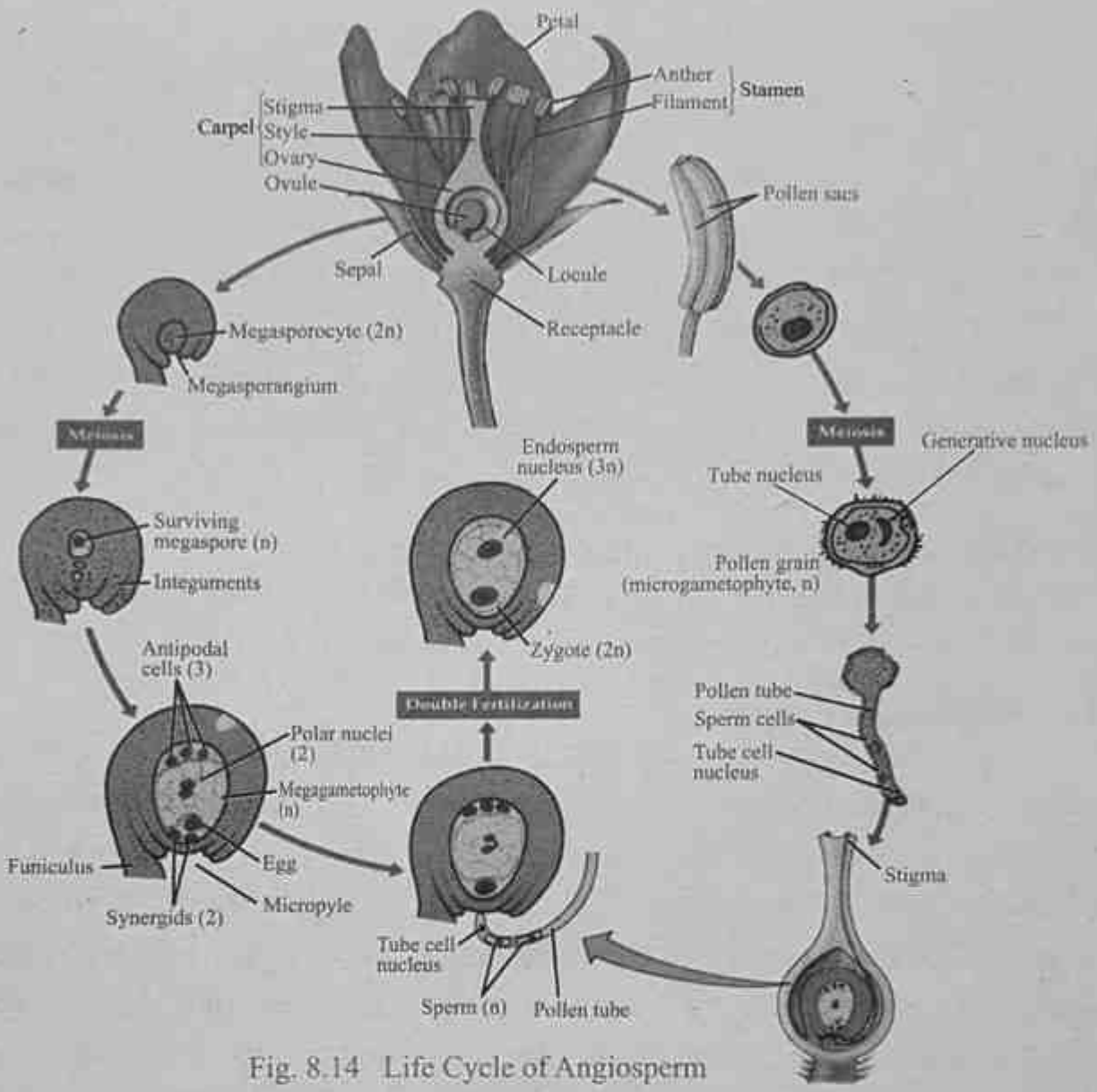


Fig. 8.14 Life Cycle of Angiosperm

Male gametophyte: After pollination, the pollen grain is transferred to stigma. Here it germinates to form pollen tube. The nucleus of the pollen grain divides by mitosis into two nuclei, one generative and other tube nucleus. The generative nucleus again divides into two sperm nuclei. The part of pollen tube with tube nucleus and two sperm nuclei is called male gametophyte.

Female gametophyte: Inside the ovule a single functional megaspore divides by mitosis to form female gametophyte or embryo sac. Embryo sac contains eight cells out of which one cell is egg or oospore.

Double fertilization: The pollen tube brings two sperms into ovule. One sperm fuses with egg to form zygote, while other sperm fuses with diploid nucleus to form endosperm. So it is called double fertilization which is unique characteristic of angiosperms.

Significance of double fertilization:

It is an important evolutionary advancement. The stored food is made after

fertilization. This stored food is utilized at the time of germination.

Seed and fruit formation:

After formation of endosperm and embryo the ovule increases in size to form seed. Its integument becomes hard and dry to form seed coat or testa and tegmen. The wall of the embryo grows rapidly around the seed and matures to form fruits.

8.4.3 Inflorescence

An inflorescence is a group of flowers arranged on a stem that is composed of a main branch or a complicated arrangement of branches on stem. There are three main types of inflorescence.

1. Racemose
2. Cymose
3. Compound

Racemose Inflorescence:

In this type of inflorescence, the main axis does not end in a flower but it continues to grow and flowers arise laterally.

Cymose inflorescence:

The determinate simple inflorescence is generally called cymose. In cymose the primary axis terminates in a flower but the growth continues through the lateral buds. These buds give rise to lateral branches which bear flowers. The outer flowers are younger and upper flowers are older.

Compound inflorescence:

In this type of inflorescence, the main axis branches once or twice repeatedly in racemose or cymose manner and these repeated branches bear flowers. The oldest flower are at the tip while the younger ones are away from it e.g., amaltas, wheat, rice etc.

Critical thinking

What are unisexual and bisexual flowers? Why are the stamens and carpels called the reproductive parts of flowers?

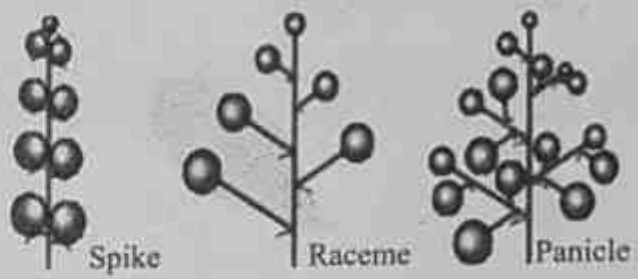


Fig. 8.15 Racemose

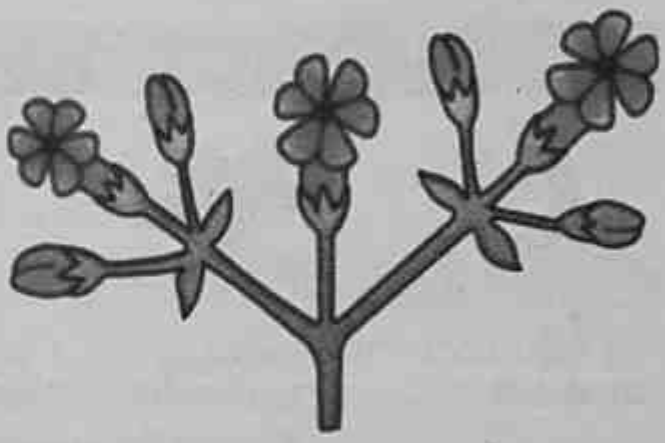


Fig. 8.16 Cymose

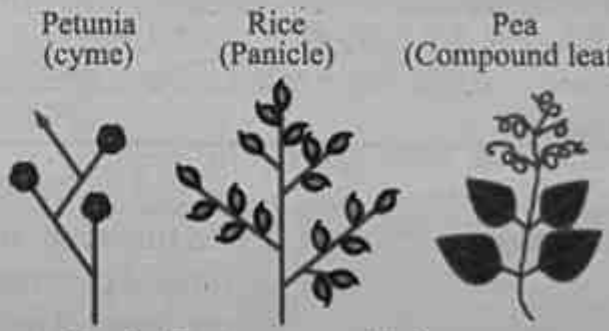


Fig. 8.17 Compound inflorescence

Tit bits

Angiospermae consists of 416 families 13164 genera and 2,95,383 known species.

Table 8.2 Differences Between Monocot and Dicot.

Dicot	Monocot
1. Embryo has two cotyledons.	1. Embryo has one cotyledon.
2. Petals in multiple of 4 or 5.	2. Petals in multiple of three.
3. Leaf venation is reticulate, i.e. veins form network in lamina.	3. Leaf venation run parallel in the lamina.
4. Secondary growth often present.	4. Secondary growth absent.
5. Tap root system is found in them.	5. Fibrous root system is found in them.
6. Examples: peas, beans, roses, lilies, mints, tomatoes etc.	6. Examples: corn, wheat, rice, banana, bamboo, sugar cane, onion, grasses etc.

Fig. 8.18 Comparison between monocot and dicot plants

Do you know?

The earth has more than 80,000 species of edible plants. 90% of human food comes from just 30 plants. 70,000 plant species are utilized for medicine. Only 1% of rain forest plants have been studied.

Table 8.3 Comparison of Major Plant Groups

Bryophytes	Fertilization occurs in water, haploid generation is dominant, diploid generation is reduced, cuticle, stomata present in some. They are found in moist habitats.
Pteridophytes	Fertilization occurs in water, diploid generation is dominant in them.
Spermatomhyta **(a) Gymnosperms** **(b) Angiosperms**	Seed is present, fertilization mostly does not need Water. Vascular plants with naked seeds, no fruit or flower. Vascular plants with flowers and protected seeds.

Significance of angiosperms to humans: Angiosperms virtually provide all plant based food, i.e., Wheat, rice, sugar cane, maize, barley, rye, oats, etc. They provide a significant amount of livestock feed, provide all important vegetables like potato, tomato, peppers, cabbage, carrot, raddish, turnip, mustard. Great deal of fleshy fruits like cherries, mangoes, oranges, apples, water melon, peach, apricot, grapes, pears, plums and host of others. They are source of oils, like soybean, sunflower, mustard, coconut and olive. They are good source of dry fruits like almond, walnut, pistachio. Flowering plants also provide economic resources in the form of wood, paper, fiber (cotton, flex and hemp), medicines (digitalis, camphor) ornamental landscaping plants and many other uses.

Do you know?

A sunflower looks like one large flower, but each head is composed of hundreds of tiny flowers called florets, which ripen to become the seeds.

In one year, the average tree gives off enough oxygen to allow four people to breathe for a year.

SUMMARY

- The kingdom Plantae contains land plants, which manufacture their own food through photosynthesis and retain a multicellular embryo within the female gametangium. All plants have an alternation of generations.
- Plant kingdom includes bryophytes, pteridophytes, gymnosperms and angiosperms.
- Bryophytes are plants which can live in soil but are dependent on water for sexual reproduction. They possess root-like, leaf-like and stem-like structures.
- The bryophytes are divided into liverworts and mosses.
- 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.
- 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 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.
- In angiosperms, the male sex organs (stamen) and female sex organs (pistil) are borne in a flower.

- 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.

EXERCISE

Section I: Objective Questions

Multiple Choice Questions

A. Choose the best correct answer.

1. Which of the following is the amphibian of the plant kingdom?
   (a) Pteridophytes (b) Bryophytes
   (c) Gymnosperms (d) Angiosperms
2. Liverworts are closely related to
   (a) Algae (b) Fungi
   (c) Lichens (d) Mosses
3. The only positive evidence of aquatic ancestry of bryophytes is
   (a) Thread like protonema (b) Green colour
   (c) Some forms are still aquatic (d) Ciliated sperms
4. If the chromosome number in the leaf of Funaria is 20, what will be the chromosome number in the spores
   (a) 20 (b) 40
   (c) 10 (d) 5
5. Most primitive living vascular plants are
   (a) Brown algae (b) Sphagnum
   (c) Ferns (d) Cycads
6. A fern differs from moss in having
   (a) An independent gametophyte (b) An independent sporophyte
   (c) Presence of archegonia (d) Swimming antherozoids
7. Spore baring leaf is called
   (a) Sorus (b) Indusium
   (c) Ramentum (d) Sporophyll
8. Circinate vernation is found in
   (a) Cycas (b) Fern
   (c) Both a and b (d) None of these

9. Megasporophyll is the term used in gymnosperm to denote
   (a) Carpels (b) Stamens
   (c) Leaves (d) Female cone
10. In which of the following feature angiosperm resemble gymnosperm.
   (a) Presence of ovules (b) Presence of vessels
   (c) Nature of endosperm (d) Mode of fertilization

A. Fill in the blanks.

1. The gametophytes of bryophytes possess_____ number of chrmosomes.
2. The highly developed plants group is_____.
3. Liver worts are placed in the class_____.
4. The female sex organs of amphibious plants are called_____.
5. Double Fertilization is the unique characteristics of _____.
6. Xylem tissues of angiosperms contain xylem vessels and also_____.
7. Adiantum belongs to group_____.
8. Gametophyte generation is dominant in_____ plants.

Section II : Short Questions.

1. What are sporangia and what do they do?
2. Define antheridia and archegonia and also write their functions.
3. Define alternation of generation.
4. Define sporangium, sporophyte and gametophyte.
5. Briefly discuss the economic and ecological value of the gymnosperms.
6. What changes have taken place to the gametophyte generations in seed plants?
7. How would you distinguish between following?
   monocots and dicots, microphyllous and megaphyllous leaves, xylem and phloem, male gametophyte and female gametophyte.

Section III: Extensive Questions.

1. Explain life cycle of Moss.
2. How Sphenopsida differ from Lycopsida? Discuss.
3. Explain evolution of both one vein and many vein leaves.
4. Describe life cycle of fern.
5. Explain life cycle of angiosperm.
6. What is inflorescence? Explain its types.
7. Explain land adaptation of bryophytes.