CHAPTER 9

LONG QUESTIONS

CLASSIFICATION OF PLANTAE

Q.1: What is phylogenetic classification? Give main features of kingdom plantae.

→ Write a note on classification of plantae.

Ans. PHYLOGENETIC SYSTEM OF CLASSIFICATION

Arrangement of organisms on the basis of their mode of origin is called phylogenetic system of classification OR the groups were foreshadowing the natural relationships among living organisms and their mode of origin.

Q. What is phylogenetic system of classification?
(AJK-G1), (SWL-G1)-16

Main Features of Kingdom Plantae

Kingdon plantae mainly includes organisms, which are: eukaryotic, multicellular, non- motile, developing from embryos, having cell wall outer to cell membrane, which is composed of cellulose. There are about 360,000 known species of plants.

CLASSIFICATION OF PLANTAE

Organisms included in plantae can be divided into two broad categories i.e non-vascular (**Bryophyta**) and vascular (**Tracheophyta**) plants. Each category (division) is divided into Sub-divisions, Classes, Sub-classes and other taxonomic ranks.

Division: Bryophyta - (Non-Vascular Plants)		
Sub Division	Hepaticopsida	Liverworts
Sub Division	Musci(Bryopsida)	Mosses
Sub Division	Anthoceropsida	Hornworts
Division: Tracheophyta – (Vascular Plants)		
Sub Division	Psilopsida	Whisk ferns
Sub Division	Lycopsida	Club mosses
Sub Division	Sphenopsida	Horse tails
Sub Division	Pteropsida	Ferns, seed plants
Class	Filicineae	Ferns
Class	Gymnospermae	Naked-seeded plants
Class	Angiospermae	Flowering plants

Table: An outline of classification of Plantae

DIVISION BRYOPHYTA

Q.2: To what does alternation of generations refer in the plants? Define sporophyte and gametophyte. With which stage is an adult animal comparable? How are they reproductively dissimilar?

Ans. DIVISION BRYOPHYTA

The first plants to colonize land were the bryophytes. They are generally thought to have evolved from green algae.

Habitat

The bryophytes are poorly adapted to life on land and are mainly confined to damp shady places.

> Q. Why bryophytes are called amphibious plant? (LHR-G2) (DGK-G1)-15, (SGD-G1) (GUJ-G1)-16

Characteristics

Some of the distinguishing characteristics of bryophytes are:

(i) They are non-vascular, flowerless plants.

(ii) Gametophyte generation is dominant.

(iii) Sporophyte is attached to gametophyte and dependent for food.

(iv) These plants show a regular alternation of heteromorphic (morphologically different) generations.

(v) They are said to be **amphibians of the plant** world because they cannot live away from water. They need water for reproduction

(vi) They are homosporus.

> Q. Write any four character of Bryophyta. (LHR-G1)-14

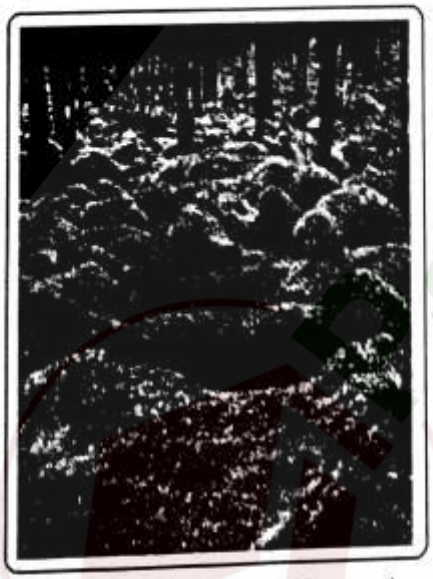

Fig. A moss bug. Lacking rigid supporting tissue, bryophytes are low-profile plants most common in damp habitats

Fig. Mosses often grow at wet places as seen here in a small water fall.

Structure

(i) These plants are devoid of specialized conducting tissues (xylem and phloem) and strengthening tissues. Only the process of diffusion and osmosis helps in the transportation of water and minerals as well as transportation of food and other substances.

(ii) The plant body is with a proper cuticle, without cuticle or has a very thin one.

Life Cycle

Life cycle of bryophytes consists of two generations i.e., these are gametophyte and sporophyte.

1 GAMETOPHYTE

Gamete producing generation is called gametophyte.

Features

(i) It is dominant, independent and free living.

(ii) It is haploid (n).

(iii) It may be **thalloid** (as in many liverworts) or is differentiated into structures resembling to stem, leaves and absorbing and anchoring organs called **rhizoids** (as in mosses and some liverworts).

(iv) **Multicellular male and female sex organs** i.e. antheridia and archegonia respectively, are born on gametophyte either on same or different plants. These sex organs are multicellular and protected by sterile covering of cells.

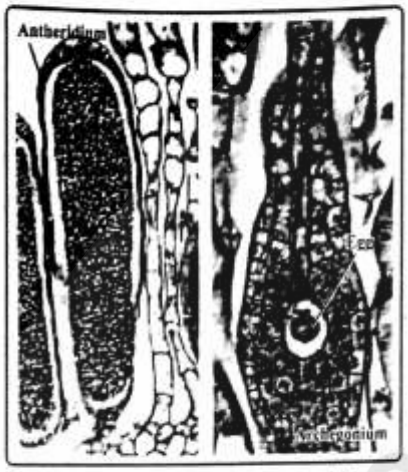

Fig. Sex organs, male (antheridium) female (archegonium) of a bryophytic plant

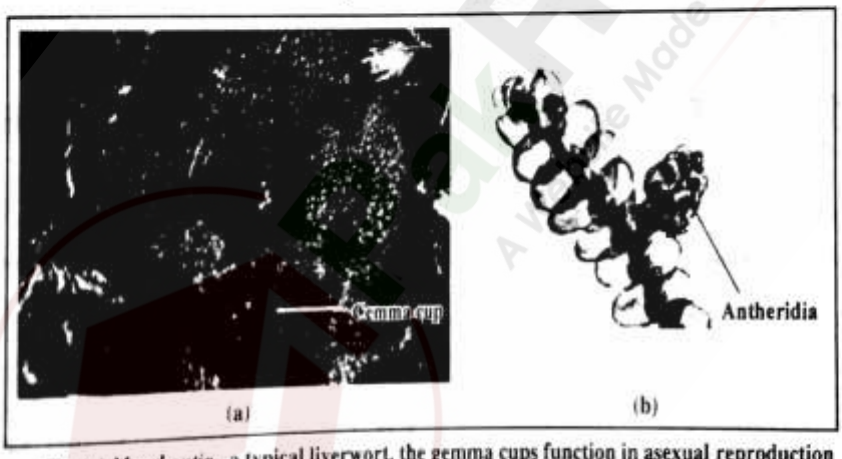

Fig. (a) *Marchantia*, **a typical liverwort, the gemma cups function in asexual reproduction (b)** *Porella*, **a leafy liverwort showing lateral antheridia bearing branch.**

2 SPOROPHYTE

Spore producing generation is called sporophyte.

Features

(i) It is **less conspicuous** generation, partially or totally dependent upon the gametophyte for its nutrition.

(ii) It generally consists of **foot, seta and capsule** (sporangium).

(iii) It is diploid(2n).which produces in sporangia one kind of haploid spore (i.e. it is homosporous) by meiosis.

(vi) The spore germinates and gives rise to gametophyte which is also haploid.

Conversion of Gametophyte into Sporophyte

Haploid gametes are produced by mitosis in sex organs. Male gametes produced within antheridia are called **antherozoids** (also called as sperms or spermatozoa). They are motile and always produced in large number. Female gametes formed within archegonia are termed as **eggs**. A single egg is formed in each archegonium. Fertilization takes place by help of water. Antherozoids (n) are attracted towards archegonia (n) chemotactically. Single antheroziod (n) fuses with an egg (n) thus accomplishing fertilization, which results in the formation of the diploid zygote (2n). The zygote is retained within female sex organ (archegonium) for some time. After resting period the zygote is developed into a diploid embryo by mitotic divisions. The embryo ultimately develops into a sporophyte, which is also diploid.

The entire development of sporophyte thus takes place within the gametophyte plant body. Even when the sporophyte is fully developed it remains attached to gametophyte for nourishment and protection because it cannot manufacture their own food by photosynthesis due to absence of chloroplast. There is an alternation of generation in the life cycle of bryophytes i.e. multicellular diploid gametophtic (gamete producing) generations alternates with the multicellular diplois sporophytic (spore producing) generation. It is very important phenomenon,which provides continous genetic variabilities and selection for the best genetic makeup for survival and adaptation in the changing environments(s).

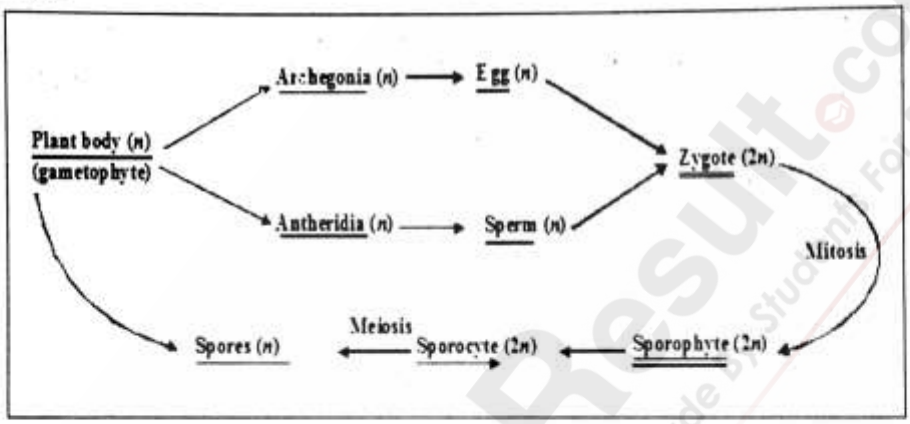

Fig. A generalized life cycle of a Bryophyte showing alternation of generation

ADAPTATIONS TO LAND HABITAT

Q.3: Write a note on adaptations of bryophytes for terrestrial environment?

Ans. In general, bryophytes developed the following adaptive characters for terrestrial environment:

(i) Conservation of Water

Formation of a compact multicellular plant body has helped in conservation of water by reducing cell surface area exposed to dry land conditions. Presence of **cuticle** further reduces loss of water by evaporation.

(ii) Development of photosynthetic tissue

Development of photosynthetic tissue into special chambers for the absorption of carbon dioxide without losing much water and exposure to light.

(iii) Formation of Rhizoids

There is formation of special structures like rhizoids for absorption of water and anchorage.

(iv) Heterogamy

Heterogamy (production of two types of gametes) is evolved, forming non- motile egg containing stored food and motile sperms.

Q. Write a note on adaptation of Bryophytes for life on land. (GUJ-GI-2014: FBD-GI-16)

Q. Describe land adaptation of Bryophytes. (LHR-GI-2014, 16: RWP-14)

Q. Describe adaptations to land habitat in Bryophytes. (AJK-GI-2015)

Q. Discuss the different adaptive characters for terrestrial environment in Bryophytes. (LHR-GI-2016)

Q. Enlist adaptations in bryophytes to land habitat. (LHR-2007)

Q. Describe adaptive characters of bryophytes for terrestrial environment. (BWP-2013)

(v) Protection of Gametes

Gametes are produced and protected by the special multicellular organs called antheridia and archegonia.

(vi) Retention of Embryo in Archegonia

Multicellular embryo, is formed, which is retained and protected inside the female reproductive body during its development.

(vii) Alternation of Generations

Alternation of sore producing generation (sporophyte) with gamete producing generation (gametophyte) enabled the plant to produce and test the best genetic combinations for adapting to the versatile terrestrial conditions.

CLASSIFICATION OF BRYOPHYTES

Q.4: Discuss three subdivisions of bryophytes along with significance of alternation of generations?

Ans. Bryophytes are divided into three subdivisions;

(1) Hepaticopsida (2) Bryopsida (3) Anthoceropsida

1 HEPATICOPSIDA (Liverworts)

Bryophytes belonging to this subdivision are called **Liverworts**. This class includes about **900 species.** Liverworts are the simplest of all bryophytes.

Habitat

They are usually found on moist rocks and on wet soil. Since they live near water therefore chances of drying out are greatly reduced.

Examples

Some common examples of liverworts are *Marchantia* and *Porella*.

Features of Gametophyte

(i) The plant body is gametophyte that is **haploid.**

(ii) It may be **thalloid** i.e. flat or ribbon- like usually dichotomously branched.

(iii) It is attached to soil by means of **rhizoids** e.g. *Marchantia*. Other species tend to grow upright and are falsely leafy i.e. differentiated into false stem and leaves e.g. *Porella*.

(iv) The**sex organs** develop on the upper surface of the thallus near the tips of the branches.

(v) Sometimes, sex organs develop on special branches on gametophyte, called the **antheridiophores** and the **archegoniophores** as in *Marchantia*.

Features of Sporophyte

(i) Sporophyte is **diploid.**

(ii) It is **Dependent** on gametophyte.

2 BRYOPSIDA (MUSCI)

Bryophytes belonging to this class are called **mosses.** They usually grow to form cushions or mats.

Habitat

Like liverworts, most mosses inhabit damp places. In contrast to other bryophytes, they grow equally well in fairly dry places. However, water is essential in the reproduction of mosses.

Examples

Some common examples are***Funaria*** and ***Polytrichum.***

Features

Main generation is gametophyte.

Features of Gametophyte

(i) . **Each adult moss plant, a gametophyte is haploid and always differentiated into structures, which resemble stem and leaves.** Multicellular rhizoids are also present.

(ii) Sexual reproductive organs, **archegonia** and **antheridia**

- Develop on the tips of different branches on the same plant as in *Funaria*
- On different plants as in *Polytrichum*

(iii) The archegonia and antheridia form clusters and are mixed with sterile hairs, forming a structure called **paraphyses.**

Q. What is paraphyses?(MTN-G1)-16

Fig. *Polytrichum*, a hair cup moss plant.

Features of Sporophyte

(i) Formation of diploid sporophyte and haploid spores follow the same sequence of events of alternation of generations as in liverworts.

(ii) Spores of a moss, unlike that of liverworts, develop into an alga like structure, the **protonema.**

(iii) Haploid moss plant (gametophyte) develops from buds on protonema and the life cycle is completed.

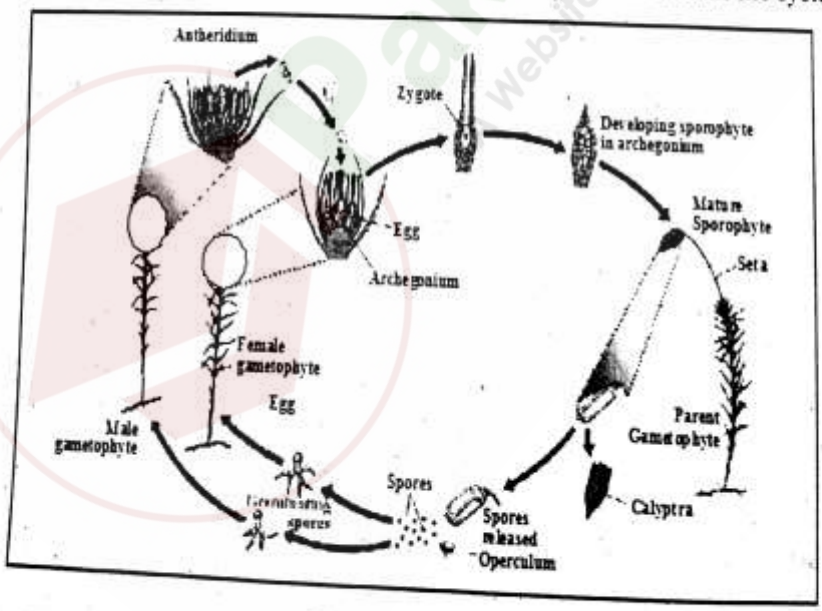

Fig. Moss life cycle

3 ANTHOCEROPSIDA (Horn worts)

Bryophytes belonging to this class are called as **horn worts**. This group is slightly advanced than Bryopsida and Hepaticopsida.

Example

One good example of Anthoceropsida is *Anthoceros*, which is also found in the hilly areas of **Pakistan**.

Features of Gametophyte

(i) Gametophyte is highly **lobed and irregular** in outline.

(ii) Antheridia and archegonia are partially sunken in the gametophytic tissue.

Features of Sporophyte

The Sporophyte exhibit many advanced characters due to which it can survive better on land as compared to other groups.

Q. Explain the advanced characters of subdivision Anthoceropsida.
(SGD-G1-2016), (LHR-G2)-16

(i) Except for a little early stage of development, the sporophyte is not dependent upon gametophyte for nourishment and protection.

(ii) The sporophyte exhibit many advanced characters due to which it can thrive better on land as compared to other groups. It has **Stomata** and **chloroplast** in epidermis and can thus photosynthesize its own food rather than obtaining it from gametophyte.

(iii) It has a waxy **cuticle** to check excessive loss of water (desiccation).

(iv) At the junction of foot and spore producing region, there is a band of **meristematic tissue**. This tissue keeps on adding cells towards the spore- producing region during the formation, maturation and dispersal of spores from the opposite end. Due to fast growth rate of this meristematic tissue the sporophyte keeps on increasing in length for an indefinite period of time.

Due to these characters, the sporophyte continues to survive as such even after the death and decay of the gametophyte.

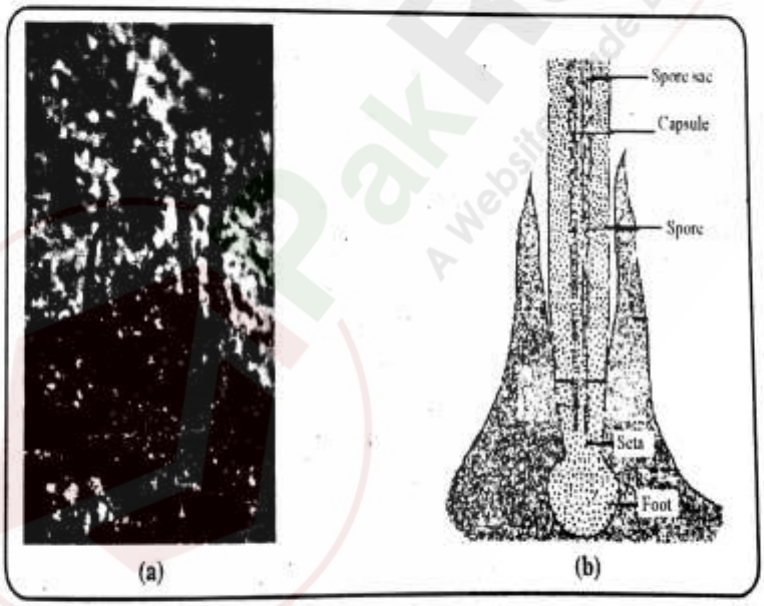

Fig. *Anthoceros*, a hornwort (a) Gametophyte with attached horn-shaped sporophyte (b) V.S. of sporophyte.

ALTERNATION OF GENERATIONS

Process in which one multicellular haploid gametophyte generation alternates with another multicellular, diploid sporophyte generation is called **alternation of generation**. Bryophytes show a regular alternation of heteromorphic (morphologically different) generations.

Conversion of Sporophyte into Gametophyte

In the life history of liverworts, mosses and hornworts there are two distinct multicellular phases or generations. These generations are haploid **gametophyte** and diploid **sporophyte**, which regularly alternate with each other. The gametophyte is the dominant generation because it is more conspicuous. It produces gametes called spermatozoids or antherozoids and eggs, therefore called gamete producing generation. A haploid spermatozoid fuses with a haploid egg to produce diploid **oospore**.

The oospore does not produce the gametophyte directly but produces a totally different plant called sporophyte. The sporophyte in bryophytes is a less conspicuous generation, which is usually differentiated into foot, seta and capsule (also called sporogonium). Spores develop within the capsule by reduction division (meiosis) from spore mother cells. The sporophyte produces spores and is, therefore, called spore producing generation. The spore on germination does not develop into a sporophyte but gives rise to the gametophyte. Thus in the life-history of a bryophytic plant, the two generations, the gametophyte and the sporophyte, regularly alternate with each other. The phenomenon of alternation of gametophyte and sporophyte in the life history of a plant is called **alternation of generations** (Fig).

Q. **Define and explain alternation of generations in bryophytes with its significance.**
(LHR-2007, SGD-GI-14, BWP-GI-15)

Q. **What is alternation of generation? Give its significance.**
(FBD-2013, LHR-GI-2015, MTN-GI-16)

Q. **What is significance of alternation of Generations?**
(MTN-2014GII, 15GI, FBD-GI-15, SWL-GI-16)

Q. **What is alteration of generation? Explain it with special reference to bryophytes.** (MTN-GII-2010)

Q. **Explain alternation of generation with its significance in Bryophyta.**
(SWL-GI-2013)

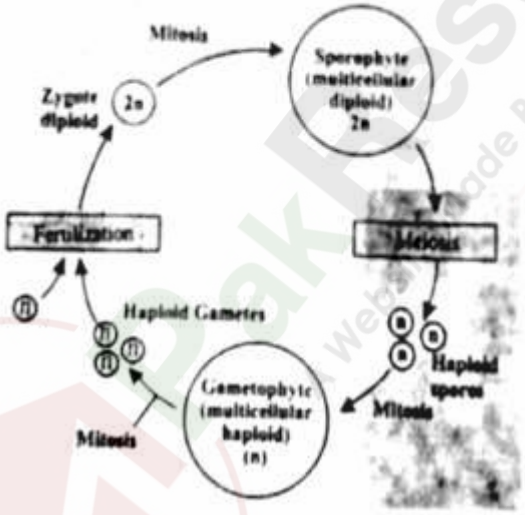

Fig. Graphic representation of the alternation of gametophytic and sporophytic generation

It should be noted that the gametophyte or haploid stage begins with spores and ends at gametes, whereas the sporophyte begins with oospore and ends at spore mother cell.

THE SIGNIFICANCE OF ALTERNATION OF GENERATIONS

Some of the significantly important points of alternation of generation are as follows.

(i) Source of genetic recombination

During the formation of spores from spore mother cells by meiotic division reshuffling of genes occurs. As a consequence, a great variety of spores with different genetic make-up are produced. These spores in turn produce gametophytes with different genetic combinations. The gametophytes with better genetic make-up will have a better chance for survival in the environment where they occur. On the other hand, the gametophytes with less advantageous characteristics will be eliminated. There is no reshuffling of genes during gametogenesis in the gametophyte as gametes are produced after mitosis.

(ii) Better chances of survival

The oospore developing after fertilization now has a new genetic make-up as compared to the parent. This genetic variation passes to the new sporophyte which on maturity once again produces further genetic recombination which is transferred to the gametophyte. In this natural process the sporophyte thus provide a large amount of genetic variability and nature selects the best genetic combinations. In the long run, this will allow the populations to become increasingly better adapted to their environment.

DIVISION TRACHEOPHYTA

Q.5: Discuss characteristics of division Tracheophyta.

→ Discuss major subdivisions of Tracheophyta (Psilopsida, Lycopsida, Sphenopsida and Prteropsida)

→ Describe evolution of leaf and its importance in vascular plant.

Ans. TRACHAEOPHYTES

Trachaeophytes are called **vascular plants** because of the presence of vascular tissue i.e. **xylem** and **phloem**. These are the successful group of land plants. They are able to adopt the rough land habitat most successfully and amongst them the flowering plants today have dominated land habitat.

Reason of Predominance

The evolution of following complex, vegetative and reproductive characteristics enabled the vascular plants in general and flowering plants specifically to become predominant flora of land:

1) Root, stem and leaves.
2) Vascular systems in stem, roots and leaves.
3) Protected sporangia, leading to the evolution of seed.
4) Pollen tube for safe and water- independent transmission of male gamete to female gamete.
5) Flower and fruit.
6) Heteromorphic alternation of generation.

DIVISIONS OF TRACHEOPHYTES

The tracheophytes are further sub-divided into four sub-divisions i.e.

(1) Psilopsida (2) Lycopsida
(3) Sphenopsida (4) Prteropsida

Q. Name four subdivision of tracheophytes. (RWP-G1)-15

1 PSILOPSIDA (Psilophyta)

Psilopsida is considered to be the earliest group of vascular plants. This group is also called as ***Psilophyta.***

Q. What is ateliers group of vascular plant give example? (RWP-G1)-16

Examples

Most of the representatives of this group have become extinct, for example, ***Rhynia, Horneophyton, psilophyton, Cooksonia***. There are only two living genera *Psilotum* and *Tmesipeteris*.

Q. What is Rhizome? (DGK-G1)-16

Q. Write name of any two extinct vascular plants. (BWP-G1)-15

Features of Sporophyte

(i) Sporophyte is **rootless.**

(ii) Its stem is differentiated into an underground **rhizome** and an aerial part. Both are dichotomously branched.

(iii) The rhizome bears **rhizoids.** Both rhizoid and rhizome perform function of root.

(iv) The **aerial branches** are green, leafless and bear small veinless outgrowth, and carry out photosynthesis.

(v) The reproductive organs of sporophyte are sporangia which develop at the tips of long or short branches, or on lateral sides of branches. Internal structure of stem is simple.

(vi) Vascular tissue is narrow, central and solid without pith, with a broad cortex.

Futures of Gametophyte

(i) The gametophyte is **thalloid, colourless and underground.**

(ii) Its cells contain a fungus, which provides food to the gametophyte and in turn gets protection from it. Such beneficial symbiotic relationship among the two members (fungus and plant) is said to be symbiosis; or **mycorrhizal** association.

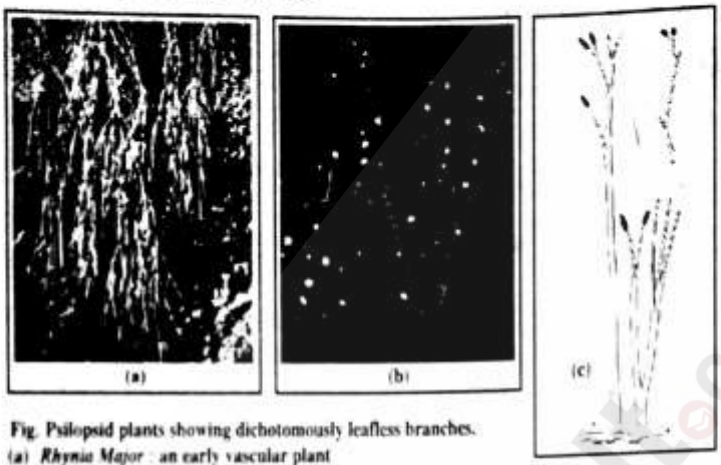

Fig. Psilopsid plants showing dichotomously leafless branches.
(a) *Rhynia Major* : an early vascular plant
(b) The erect branches of another species, showing the brown sporangia.
(c) Reconstruction of *Rhynia*.

EVOLUTION OF LEAF

Leaf is photosynthetic organ of plant.

Plants before Evolution of Leaf

Early vascular land plants did not have true leaves or roots. They were small in size, with dichotomously branched erect smooth aerial parts and equally strong subterranean anchoring and absorbing rhizome.

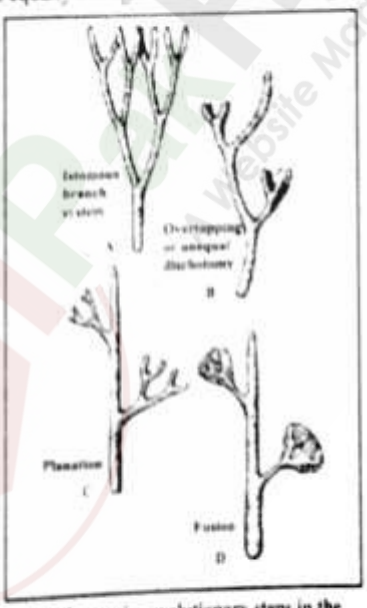

Fig. Successive evolutionary steps in the evolution of leaf.

Example

Cooksonia had the same structural layout i.e. naked stem without leaves.

Types of Leaves

There are two important types of leaves.

(1) Microphylls (2) Megaphylls.

1. Microphyll

"It is a leaf, which is small and has single undivided vein (vascular supply) is called microphyll."

Evolution of Microphyll

Cooksonia like plants started to form leaves as small scale like outgrowths. These outgrowths were not supplied with vascular tissues, therefore they were not regarded as true leaves. **Lycopods** were the first plants that formed the true leaves and roots.

However in lycopods (e.g. *Lycopodium*) the leaves are small in size. Each leaf has single undivided vein* vascular supply).Such a leaf is called microphyll.

2. Megaphyll

"Large leaves having divided veins and veinlets with an expanded leaf blade or **lamina** are known as megaphylls."

Megaphylls are characteristic of ferns and seed plants.

Evolution of Megaphyll

It is suggested that evolution of megaphylls started from a dichotomous branching system in some primitive psilopsids approximately **350 million** years ago.

It is assumed that evolution of a megaphyll included series of successive evolutionary steps. This process of evolution of leaf was very slow and gradual, which completed in more than **15-20 million years.** These steps are as follows.

(i) Overtopping

"It is an unequal development of various branches".

During this step, the dichotomously branched aerial portion of the stem showed unequal branching. Some branches remained short while others grew and expanded at a much faster pace. All these branches grew in different planes.

(ii) Planation

In this step there was arrangement of unequal dichotomies in one plane. This process is thus termed as **planation**.

(iii) Fusion or Webbing

During this step, the space between the overtopped dichotomous branches was occupied by a sheet of parenchyma cells, which connected these branches forming a flat lamina or leaf blade type of structure, having many **dichotomously** branched veins.

During course of evolution, fusion of the vascular strands resulted in net or **reticulate venation** pattern.

Significance of Leaf

Leaves have increased surface area for absorption of light, thus caused increase in process of photosynthesis.

Q. How evolution of leaf took place? **(MTN-GI-2014)**

Q. Describe evolution of leaf. **(BWP-GI-2014: SGD-GI-16)**

Q. Describe in detail evolution of leaf. **(RWP-GI-2015)**

Q. Explain leaf evolution in plants. **(SGD-GII-2015)**

Q. Write main steps of evolution of megaphyll leaf. **(LHR-GII-15)**

Q. What is megaphyll? Describe various steps of evolution of Megaphyll. **(GUJ-GII-2016: MTN-GI-10)**

Q. Describe evolution of leaf and its importance in vascular plants. (LHR-2009)

Q. Write a note on Evolution of leaf. **(SWL-GI-2014)**

Q. Write a short note on "Evolution of Leaf". **(MTN-GI-2012)**

Q. Describe the process of evolution of megaphylis leaf. **(LHR-GI-2014)**

Q. Describe different steps involved in the

2 LYCOPSIDA

Introduction

Lycopsids are not mosses but are called **club mosses or spike mosses** because of their club / spike shaped strobili and small leaves (thought with vascular tissue) resemble mosses.

These are sometimes called **ground pries** because of their slight resemblance to the evergreen plants.

Example

Lycopodium and *Selaginella* are common examples. *Selaginella* resembles seed producing plants (**spermatophytes**) because of its heterosporic condition.

Fig. *Lycopodium:* a club moss. The sporophylls are clustered at the tips of branches into club-shaped structures called strobili.

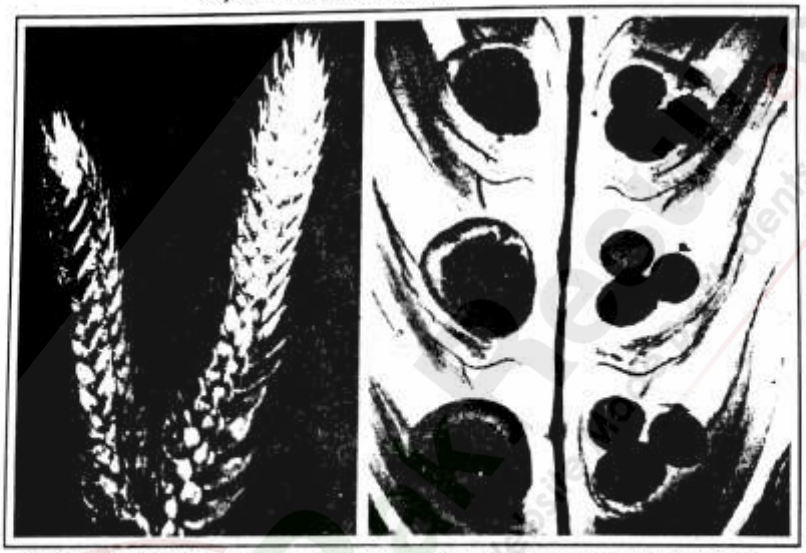

Fig. Strobili of Selaginella : a – two enlarged, compact strobili comprising four rows of sporophylls, b-one-half of a strobilus.

Features of Sporophyte

The plants of Lycopsida have sporophytes differentiated into roots, stem and true leaves.

(i) The **leaves** are small and single veined also called microphylls. The arrangement of leaves is spiral or opposite.

(ii) The **sporangia** develop singly on the upper side of the sporophylls, which may or may not be arranged to form strobili. The saprophyte may have sporangia of one kind as in *Lycopodium* or of two kinds i.e. microsporangia and megasporangia as in *Selaginella.*

(iii) In some Lycopsids such as *Lycopodium,* leaves and sporophylls are without a **ligule** (small outgrowth). In others, the ligule is present on the upper side of the sporophylls, near their base as in *Selaginella.* On the basis of type of spores produced in sporophyte they are thus referred as being '**homosporous**' or '**heterosporous**', respectively. This condition is called homospory and heterospory respectively. *Selaginella* resembles seed producing plants (spermatophytes) because of its heterosporic condition and some other characters.

Features of Gametophyte

Gametophyte of Lycopsida is mainly **underground.**

3 SPHENOPSIDA

Plants present in this group are called as **Horsetails.**

Q. Why Sphenopsida are called arturophytes.
(AJK-G1)-15, (FBD-G1)
(MTN-G1)-16

Example

Most common example is *Equisetum.*

Features of Sporophyte

(i) Sporophyte is differentiated into stem, roots and leaves.

(ii) Main **stem** is not smooth, it has large number of ridges and furrows.

(iii) **Leaves** may be expanded or scale- like and are always arranged in whorls.

(iv) Plants belonging to this group are also called **arthrophytes** because the whole plant body is composed of large number of joints. They represent nodes. Each node has whorl of branches.

(v) The **sporangia** are born on structures called sporangiophores, aggregated to form cones. Each sporangiophore has a slender stalk and an expanded disc at its free end. The sporangia appear on the underside of the disc.

Features of Gametophyte

Gametophyte is **thalloid** and grows upon clayey soil and on mud.

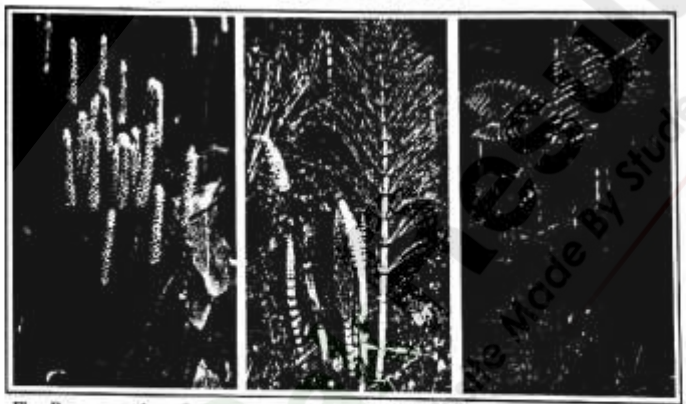

Fig. Representative of three of the subdivisions of vascular plants in all of the living representatives are seedless. (a) club moss lycopodium (b) A horsetail, equisetum (c) A tree fern.

4 PTEROPSIDA

Pteropsida is divided into three classes;

(i) Filicineae (ii) Gymnospermae (iii) Angiospermae

Class Filicineae

Introduction

Plants present in this group are commonly called **ferns.**

Q. What are fronds? OR
What are circinatevernation.
(BWP-G1)-16 (GUJ-G1)(LHR-G2)-17

Features

(i) They are **worldwide** in distribution and are especially abundant in tropics.

(ii) They are mostly **shade and moisture loving plants**. Few are able to live under dry conditions. They grow on hills and in plains.

(iii) Some are **epiphytic** and grow on the bark of tress.

(iv) They vary greatly in **size.**

(v) They contain seedless plants with **foliar sporangia** (sporangia attached to fronds), such leaves are called fronds. When the frond is immature and young, it is coiled, this pattern of development is called **circinate vernation.**

Examples

Important ferns are *Dryopteris*, *Pteridium*, *Adiantum* and *Pteris* etc.

***Adiantum* (Maiden-hairfern)**

Introduction

It is one of the most common examples of fern, belonging to class Filicineae.

> **Q. Give common name of adiantum. (LHR-G1)-15 (SGD-G1)-14, (DGK-G2)-16**

Habitat

It usually grows along moist walls, water courses and drains.

Structure

(i) It is small **herb** consisting of stem, roots and leaves.

(ii) **Stem** is short, thick, underground, usually unbranched, horizontally growing **rhizome**.

(iii) Rhizome is protected by brownish scales called ramenta and covered by persistent leaf basis.

(iv) Fibrous**adventitions roots** arise from the lower side of the rhizome.

(v) Large, pinnately compound leaves or frondsarise from the upper side of rhizome. Young leaves (fiddle heads) show circinate vernation.

(vi) The**Stipe** (stalk) and rachis of leaf are black, smooth, and shiny (hence called maiden hair fern).

(vii) The **leaflets** (pinnae and pinnules- leaflets of second order) show dichotomous venation.

(viii) **Sori** (groups of sporangia) are born on the underside of reflexed lobes of the margins of leaflets and are protected by bent margins of the leaflets, forming false indusium.

> **Q. Write down the life cycle of *Adiantum*. (FBD-GI-2014, 15)**
>
> **Q. Describe gametophyte stage in the life history of *Adiantum*. (GUJ-GII-2016)**
>
> **Q. Write a note on life cycle of *Adiantum* with the help of diagram. (MTN-GI-2013)**
>
> **Q. Discuss in detail the life cycle of *Adiantum* and also sketch it. (LHR-2009)**

Life Cycle.

Life Cycle of *Adiantum* shows heteromorphic alternation of generation, in which:

- Sporophyte being dominant.
- Gametophyte small and reduced but separate and independent.

Structural features of Sporophyte

Different structural features are as following.

(i) The diploid sporophyte produces number of sori (singular-sorus). They are green but when ripe they become dark brown.

(ii) Each sorus consists of a number of sporangia covered by false indusium. The leaves bearing sporangia are called sporophylls.

(iii) Each sporangium is slightly flattened, biconvex body (capsule) born on a multicellular stalk. The capsular wall consists of a single layer of flat, thin walled cells. The edge of the capsule is made of two parts i.e. the annulus and the stomium. The **annulus** occupies three fourth of the edge and remaining one fourth is the stomium. Annular cells have their radial and inner walls thickened. The stomial cells are thin walled.

Sporophyte into Gametophyte

Inside the sporangia, haploid spores are produced by reduction division (meiosis) of diploid spore mother cells.

The annulus of the sporangium contracts in dry weather, the stomial cells being thin- walled rupture and spores are dispersed by wind.

When a spore falls on a moist soil, it germinates at a suitable temperature and produces a haploid gametophyte or prothallus.

Structural Features of Gametophyte

Different structural features are as follows:

Q. What is prothallus?(FBD-G1)-14

(i) The **prothallus (gametophyte)** is an autotrophic, small, flat, heart-shaped structure.

(ii) At anterior end of the prothallus is a notch in which lies the growing point. Its size is about 8mm at is longest diameter.

(iii) It is horizontally placed on the soil and has unicellular rhizoidson its lower surface towards the posterior end. The rhizoids fix the prothallus to the soil and absorb nutrients for it.

(iv) It is composed of rounded thin walled cells. The margin of the prothallus is one-cell thick but the middle part is many- celled thick and is cushion-like.

(v) The prothallus is **monoecious** i.e. male and female sex organs appear on the underside of the same prothallus. In the mature prothallus, archegonia occur near the notch and the antheridia are scattered among the rhizoids.

(vi) The **archegonium** consists of a venter and a neck. The venter contains the egg or oosphere and is embedded in the cushion of the thallus.

Gametophyte into Sporophyte

Each antheridium produces numerous spermatozoids which are spirally coiled and multiciliated. They reach the archegonuim by swimming in water. Fertilization occurs and an oospore is formed. The oospore forms the sporophyte. Young sporophyte is first attached to the gametophyte but later becomes independent.

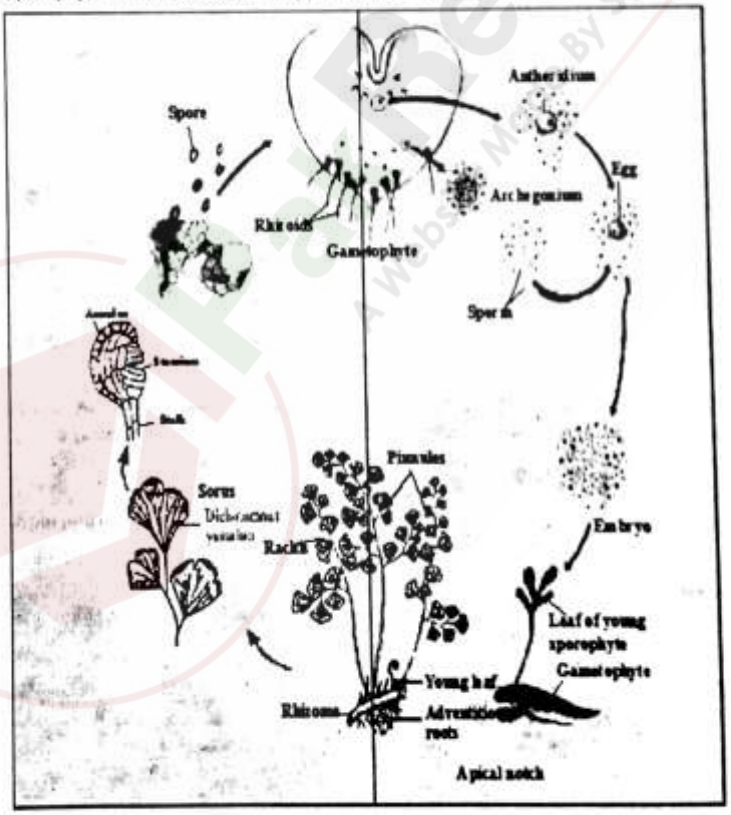

Fig. Life history of Adiantum

EVOLUTION OF SEED HABIT

Q.6: What is a seed? Why is the seed a crucial adaptation to terrestrial life?

➔ Discuss evolution of seed and it significance.

➔ What two classes comprise the angiosperms? How do the two classes structurally differ from one another? Which class derived from the other? Explain.

Ans.

Seed plants (spermatophytes) predominate over non-seeded vascular plants. One of the most significant events in the history of land plants was the development of seed habit. It was an important change in the reproductive system of the vascular plants, which occurred approximately **390 million years age.** First complete seed appeared approximately **365 million years ago** during late Devonian times.

- Technically a seed may be defined as a **fertilized ovule.**
- An **ovule** is an integumented indehiscent megasporangium.
- **Integuments** are specialized protective coverings around megasporangium, which vary in number.

Q. Define Seed and ovule.
(GUJ-G1)-(SGD-G1)-16, (MTN-G2)-17

All seed producing plants are called spermatophytes. Various steps involved in the evolution of seed habit are as following.

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

1 Evolution of heterospory

- Primitive vascular land plants produced one kind of spores, a condition called **homospory.** All groups of land plants up to pteridophytes are homosporous.
- During early phase of evolution some plant groups started producing two different types of spores, the smaller ones called microspores and the larger ones called megaspores. This condition is called heterospory.
- The **microspores** produced inside microsporangia germinated to form male gametophyte or the **microgametophyte.**
- **Megaspores** germinated to form female gametophyte or **megagametophyte.**

Q. Discuss at least four steps leading to the evolution seed habit.
(SWL-GI-2014: DGK-GI-16)

Q Describe at least four steps to the evolution of seed habit. (DGK-GII-2015)

Q. Enlist the steps involved in evolution of seed. Describe any two in detail.
(GUJ-2014GI, 15GII)

Q. Give the list of various steps involved in the evolution of seed Habit? Discuss any two. (GUJ-GI-2013, 16)

Q. Describe the important steps involved in the evolution of seed habits.
(DGK-GII-2016)

Q. Discuss evolution of seed and its significance. (LHR-2010)

Q. Describe the Evolution of Seed.
(MTN-GII-2011)

2 Retention and germination of megaspore within the megasporangium

- During the usual reproductive cycle in the heterosporous vascular land plants, the megaspores are used to be shed and dispersed soon after their formation in order to germinate into female gametophyte.
- In some plants (e.g. *Selaginella*) the megaspore was not allowed to escape from megasporangium immediately after its formation.
- In others the megaspore is permanently retained within the megasporangium. Here, within the confined wall of megasporangium, the megaspore germinated to form egg containing female gametophyte.

3 Development of protective layers around megasporangium

Some branch like structures of sporophyte surrounding the megasporangium fused around the megasporangium to form protective envelope or **integument**. The megasporangium tightly locked by integuments became totally indehiscent. This important change led to the evolution and formation of ovule, which is nothing but an integumented indehiscent megasporangium. In this way more protection was accorded to the egg-containing apparatus in terrestrial environment.

4 Reduction to a single functional megaspore per sporangium

Each megaspore mother cell within a megasporangium used to produce four functional megaspores.

- If these megaspores germinate to produce four viable female gametophytes. There was a competition for space and food among the four gametophytes.
- Soon the early vascular plants adopted a new strategy i.e. only one megaspore was selected for the further development into a healthy female gametophyte while the remaining three were aborted.

5 Development of an embryo sac within the sporangium

The single healthy megaspore retained with the megasporangium germinates to form an egg containing female gametophyte called an embryo sac.

6 Modification of distal end of megasporangium for pollen capture

When most of the structural and functional changes leading to the development of seed habit were completed, another important modification took place in the megasporangium, which was now integumented, indehiscent and permanently attached to the sporophyte. The distal end of the megasporangium became modified for capturing pollen (microspore containing male gametophyte).

Pollen after being trapped in the distal cavity of the megasporangium produces pollen tube, which carry male gametes deep into the embryo sac to fertilize the egg, forming a zygote, which forms an embryo. The megasporangium (ovule) after fertilization is transformed into a seed, the integuments becoming the seed coats. The seed offers maximum degree of protection to a developing embryo under the unfavorable terrestrial environment. The development and evolution of seed habit was a great success and a giant leap, which ultimately enabled plants to colonize land permanently.

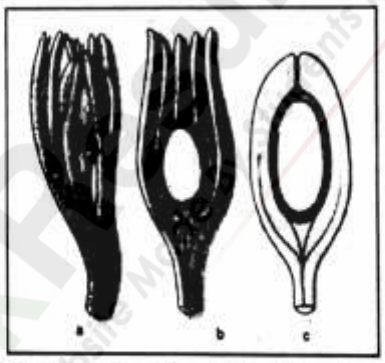

Fig. Steps in seed evolution. Fossil evidence for step b suggests hypothetical step a. step c shows integument seed of a modern plant.

Q.6: Discuss class Gymnospermae with example of *Pinus*.

➔ Write a note on life cycle of *Pinus*.

Ans. CLASS GYMNOSPERMAE

Q. What are gymnospermae?
(SGD-G1)-15, (LHR-G2)-16

Introduction

'**Gymno**' means '**naked**' and '**spermae**' mean '**seed**'.

Thus the term gymnospermae means '**naked – seeded plants**'.

Characteristics

(i) Gymnosperms are **one of the successful groups** of seed plants, which are worldwide in distribution.

(ii) They constitute about **one-third** of the world's forests.

(iii) The gymnosperms are **heterosporous plants**, which produce seeds but no fruits. The two kinds of spores are microspores and megaspores, which develop on microsporophylls and megasporophylls respectively.

(iv) The**ovules** in these plants are usually borne on the exposed surfaces of the fertile leaves (megasporophylls). These ovules, unlike those of angiosperms are not enclosed but naked on the surface of fertile leaves.

(v) Like Filicinae, they show **regular heteromorphic alternation of generations.** They have independent, dominant sporophyte but less conspicuous, dependent gamertophyte. The female gametophyte is permanently retained within the ovule.

(vi) The megasporophylls bearing ovules are not folded and joined at the margins to form an ovary.

Classification of Gymnosperms

The important genera of gymnosperms are;

- *Cycas* (Sago- palm)
- *Pinus* (pines)
- *Taxus* (Yew)
- *Picea* (Hemlock)
- *Cedrus* (Deodar)
- Ginkgo etc.

PINUS-LIFE CYCLE

Introduction

Pinus is a **conifer,** which belongs to class gymnospermae. Conifers are heterosporous.

Life cycle

In the life cycle of *Pinus*, the dominant diploid sporophyte generation alternates with inconspicuous haploid gametophyte generation. The main plant body is sporophyte which produces spores after reduction division of spore mother cell in sporangia microspores and megaspores are produced in microsporangia and megasporangia respectively. Sporangia (i.e. micro and megasporangia) are produced on respective cones.

Steps of life cycle with characteristic features

(i) Formation of Cones

Male and female cones are produced on same plant.

- **Male cones** are small in size and produced in clusters on an axis.
- **Female cones** are large and conspicuous.

(ii) Formation of Megagametophyte

The megasporangium is located on female cone. Each female cone is composed of large number of spirally arranged scale leaves (megasporophylls), which are woody in texture.

At the base of each scale two ovules are present. An ovule is actually a megasporangium which is protected by an integument.

Each megasporangium has a single diploid megaspore mother cell. The megaspore mother cell divides meiotically to produce four haploid megaspores.

The functional megaspore (n) undergoes mitosis to produce female gametophyte or an embryo sac. The embryo sac contains one to several archegonia. The archegonia contain the female gamete or an egg.

(iii) Formation of Microgametophyte

Pollen are formed in microsporangia, which are present on microsporophylls. The microspore germinates within its own wall to form a small inconspicuous male gametophyte (microgametophyte) by meiosis.

Such a microspore of seed plants that contains the microgametophyte or male gametophyte including the gametes is called a **pollen grain** (Plural= pollen).

(iv) Pollination

Pollen grain in *Pinus* has two wings attached to its lateral sides. Pollen are produced in great number and are transported by wind. Due to wings, pollen can float in air for a longer period of time and can travel long distance. Due to wings, pollen can float in air for a longer period of time and can travel long distances. The gymnosperms have successfully evolved this totally new mechanism of transfer of male gamete to the female gametophyte through wind which has made them independent of water for this purpose. This is an important improvement and evolutionary adaptation to survive in the harsh dry terrestrial (land) environment.

During pollination the pollen land directly on the ovules.

(v) Fertilization

Only few pollen are able to germinate to form pollen tubes through which male gametes are transferred to the embryo sac for fertilization. More than one egg can be fertilized to form several zygotes, but one zygote usually survives to form a single embryo.

(vi) Germination of New Sporophyte Plant

After fertilization the ovule becomes the seed. The seeds now contain an embryo along with some stored food material. The seed upon germination gives rise to a new sporophyte plant.

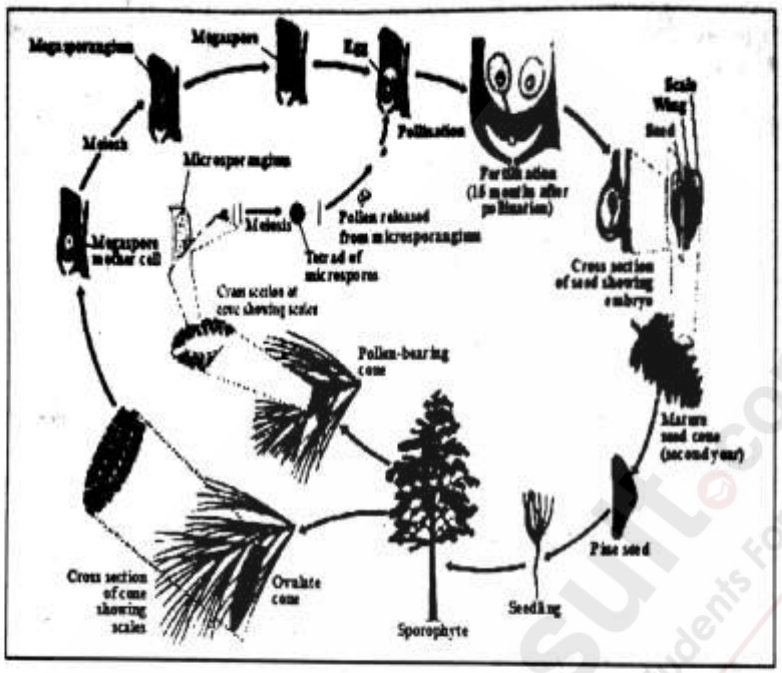

Fig. Life Cycle of Pinus

Q.7: What two classes comprise the angiosperms? How do the two classes structurally differ from one another? Which class derived from the other? Explain.

Ans. CLASS ANGIOSPERMAE

Introduction

'Angio' means **'close'** and **'sperm'** means **'seed'.** The term 'angiosperms' literally means **'enclosed seeded plants'**

> **Q. Describe the life cycle of an angiospermic plant(*pinus*) and sketch it (DGK-GI-2015)**
>
> **Q. Differentiate between Monocots and Dicots. (BWP-GI-2016)**
>
> **Q. Write any four differences between Monocot and Dicot. (AJK-GI-2016)**

Features

(i) Angiosperms make up **235,000** of the 360,000 known species of plants.

(ii) They are' **heterosporous'** autotrophic plants.

(iii) They are **most abundant and highly evolved** of all the plants on the earth.

(iv) They produce **flowers, fruits and seeds.**

(v) In these plants, fertile leaves bearing ovules are folded and joined at the margins to form **ovaries.** The ovary after fertilization is changed into a fruit, containing seeds.

LIFE CYCLE OF AN ANGIOSPERMIC PLANT

Angiospermic plants show **heteromorphic alternation of generations.**

Feature

(i) The adult plant is **diploid sporophyte** mostly differentiated into roots, stem and leaves.

(ii) At maturity, sporophyte plant produces flowers.

(iii) A **flower** is a modified shoot, which consists of a pedicel, thalamus (torus) and floral leaves (Sepals, petals, stamens and carpels). Thalamus and floral leaves, especially the stamens and carpals, are so modified, that they do not even look like stem and leaves respectively.

The sepals and petals are non- essential or non- reproductive parts. Sepals protect the inner parts while petals attract insects for pollination. When the pollination is over, the sepals usually and the petals always fall off.

Stamens and carpel's are the essential or reproductive parts of the flower. The stamen consists of a filament and an anther. It is male reproductive part of flower. The anther contains microspore mother cells which produce haploid microspores through meiosis. Each microspore germinates to produce male gametophyte. Such microspores containing male gametophyte are called pollen.

Q. What are essential and non essential parts of plant flowers? (GUJ-G1)-14, (GUJ-G2)-15, (BWP-G1)-16

The carpal consists of a basal broader part, the ovary, the style and the terminal part of the style, the stigma. Carpal is female reproductive part of flower.

Q. Define ovule. (DGK-G1)-16

Life cycle

Different steps occurring through life cycle of angiosperms are as follows.****

(i) Formation of Megagametophyte

The ovary contains ovule, which consists of an integument (covering) and a tissue, the nucellus present inside. Inside ovule, a megaspore cell is present, which on meiosis produces four haploid megaspores (n). One remaining functional megaspore divides by mitosis to form eight cells. Two groups of three cells each, move towards opposite poles. Remaining two central cells join to form diploid fusion nucleus.

Out of three cells present near micropyle, one is egg, (central). This seven celled structure (containing egg and fusion nucleus) is called female gametophyte (megagametophyte).

Megaspore mother cell ⇒ Four Megaspores ⇒ Functional Megaspore ⇒ Egg + Diploid Fusion Nucleus.

(ii) Formation of Pollen Grain

Inside pollen sac, several microspores are produced by meiosis. Each microspore consists of two nuclei, generative and tube nucleus. At this stage of development, the pollen grain is called male gametophyte.

(iii) Pollination

During pollination, pollen grain is transferred from anther of stamen to stigma of carpal.

(iv) Formation of Microgametophyte

After pollination, pollen grain transferred to stigma and germinates to form pollen tube.

The generative nucleus of the microspore divides by mitosis to form two male gametes and the tube nucleus. At this stage of development, the pollen grain is called male gametophyte.

(v) Double Fertilization

The pollen tube grows through the style, enters the ovule and then reaches the female gametophyte. Here it discharges the male gametes (sperms).

- One of the sperms (male gamete) (n) fuses with egg (n) to from zygote (2n) also called oospore, which develops into an embryo.
- Other sperm (n) fuses with diploid fusion nucleus (2n) endosperm nucleus (3n), which develops into a multicellular nutritive tissue, the endosperm.

Q. What is double fertilization?
Q. Give its importance and also for storage of food. (RWP-G1) (MTN-G1)-15, (LHR-G1) (SGD-G)-15, (DGK-G2)-16, (LHR-G1)(RWP-G1)-17

Double fertilization is a special process found in Angiosperms. In this two male gametes fuses with two cells simultaneously. A male gamete (n) fuses with egg (n) to form a diploid zygote (2n) which develops later into an embryo and second male gamete (n) fuses with another female cell called fusion nucleus (2n) resulting into a triploid (3n) endosperm cell, which develops into food storing endosperm tissue. It is an important evolutionary advancement in which food storage in fertilized ovule is made only on fertilization i.e. formation of zygote. This actually helps the plant to economize its food resources.

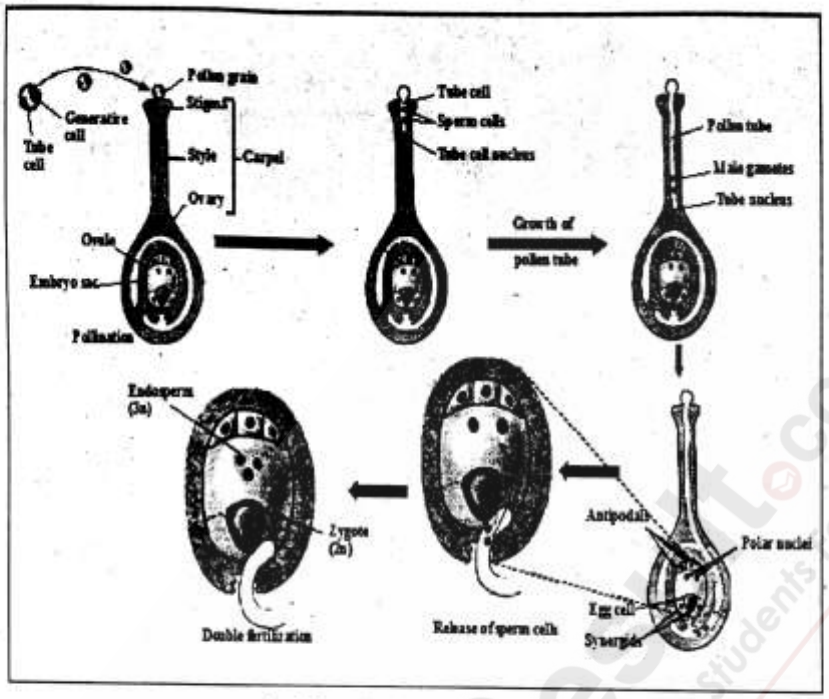

Fig. Life cycle of Angiospermic plants

(vi) Seed formation

After double fertilization, the integuments of the ovule form testa and tegmen and ovary wall develops into the fruit.

(vii) Germination of New sporophyte plant.

Seeds usually undergo a period of rest and then under suitable condition, germinate and produce a seedling, which gradually changes into a sporophyte.

Thus an alternation of dominant sporophytes generation (2n) occurs with in conspicuous gametophyte generation (n).

CLASSIFICATION OF ANGIOSPERMS

The class of angiosperms is divided into two sub-classes:

(1) Monocotyledonae

The plants included in the Monocotyledonaeare called **Monocotyledonous** or **Monocots.**

(2) Dicotyledonae

The plants included in the Dicotyledonae are called Dicotyledonous or **Dicots.**

DIFFERENCE BETWEEN MONOCOT AND DICOT

DIFFERENCE	MONOCOT	DICOT
Number of Cotyledons in seeds	One cotyledon	Two cotyledons
Number of sepals and petals	3 or multiple of 3	4 or 5 or multiple of 4 and 5
Arrangement of vascular bundle in stem	Bundles scattered	Bundles in a ring
Pattern of veins	Parallel veins	Net veins
Presence or absence of wood	All herbaceous	Both herbaceous and woody
Examples.	Wheat, rice, maize	Gram pea

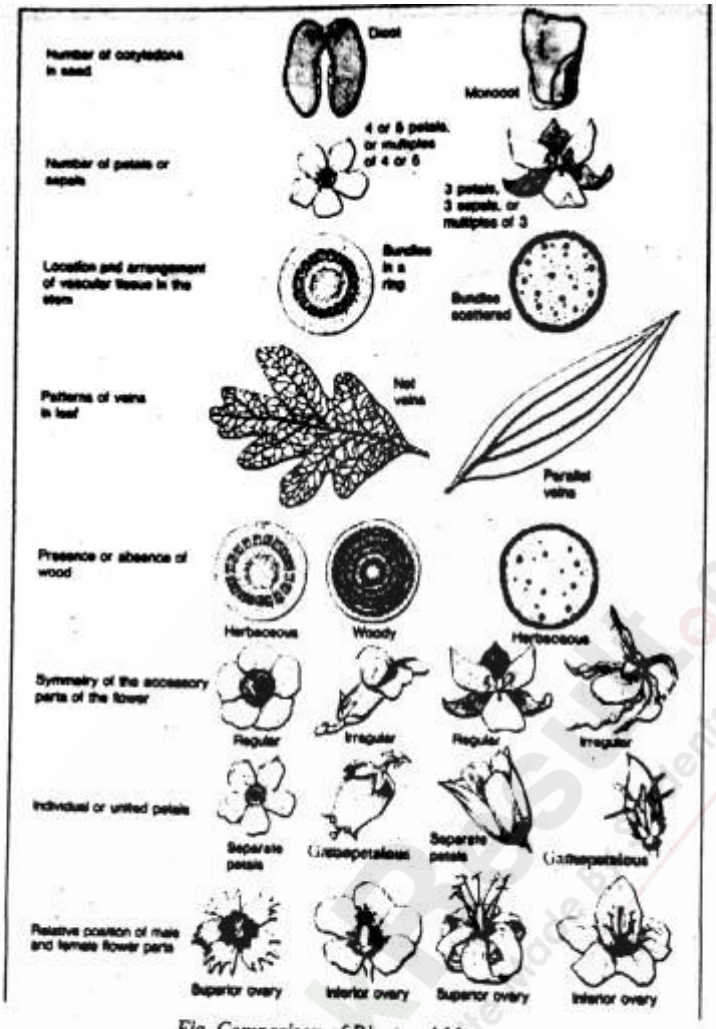

Fig. Comparison of Dicot and Monocot

ANGIOSPERMIC FAMILIES

Some angiospermic families are described below:

1. Rosaceae (Rose family).
2. Solanaceae (Potato family).
3. Fabaceae (Pea family).
4. Caeselpiniaceae (*Cassia* family).
5. Mimosaceae (*Acacia* family).
6. Poaceae (Grass family).

Q. Write a short note on "Family Fabaceae". (MTN-GII-2012)

Q. Explain the floral parts of family. Solanaceae, Rosaceae, Fabaceae, Caesalpiniaceae, Mimosaceae and Poaceae. (LHR-2008)

Q. Describe vegetative and floral characters of Rose Family (Rosaceae). (LHR-GI-2011)

ROSACEAE

- It is also called **rose family**
- This family contains nearly **100 genera** and **2000 species** and is distributed over most of the earth.
- **In Pakistan,** 29 genera and about 213 species are reported.

Q. Give two examples of Family rosaceae. (AJK-G1)-16

Familiar plants

Pyrus (pear), *Rosa* (rose), *Malus* (apple), *Fragaria* (strawberry) etc.

Vegetative Characters

(i) **Habit:** Plants are trees, shrubs and herbs.

(ii) **Stem** of Shrubby plants usually have spines.

(iii) **Leaves** are alternate, rarely opposite, simple or compound, with paired stipules, which are sometimes attached to the petiole. Spines may also occur on the rachis.

Q. Write a short note on "Family Fabaceae". (MTN-GII-2012)

Q. Explain the floral parts of family. Solanaceae, Rosaceae, Fabaceae, Caesalpiniaceae, Mimosaceae and Poaceae. (LHR-2008)

Q. Describe vegetative and floral characters of Rose Family (Rosaceae). (LHR-GI-2011)

FLORAL CHARACTERS

(i) **Inflorescence** is variable, solitary or may be racemose or cymose cluster.

(ii) **Flowers are** mostly bisexual, actinomorphic, often perigynous to some degree, usually showy and scented.

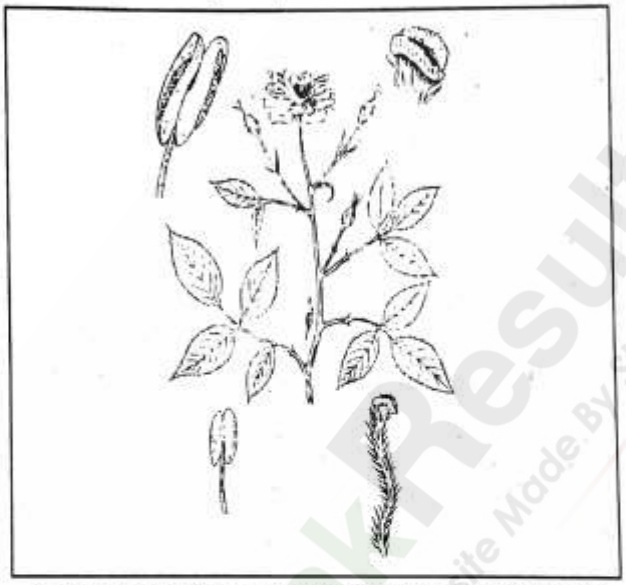

Fig. Rosaceae : A-twig; B-young stamen; B1-enlarged open anther, showing pollen grains in it; C-style hairy and stigma bilabiate; C1-enlarged bilabiate stigma.

(iii) **Calyx** consists of 5 sepals rarely 4 which are united at the base.

(iv) **Corolla**consists of 5 petals or numerous in multiple of 5, which are free, rosaceous, large and showy.

(v) **Androecium** consists of numerous stamens, sometimes only 5 or 10.

(vi) **Gynoecium**is of 1 to numerous separate carpals or variously united, ovary generally superior, sometimes inferior.

(vii) **Placentation** is basal, when the carpal is one or apocarpous, but axile when the carpals are many and syncarpous (fused).

Economic importance

Economic importance of this family is great in providing the pleasure and welfare to mankind. The members of this family are important in temperate regions for fruit and ornamentals. Perhaps they rank third in commercial importance in the temperate zone among the families of flowering plants.

Some economically important points are as follows.

(i) Production of Fruits

Important fruits are Apple, Pear, Peach, Almond, Apricot, Strawberry etc.

(ii) Use as Ornamentals

A large number of plants are ornamental and are grown in gardens for their beautiful and scented flowers. The most widely cultivated genus for decorative purpose is *Rosa* (rose).

Roses which have been grown in gardens since ancient times are now numbered in thousands. Many other genera are also grown for their beautiful flowers in the parks and gardens

(iii) **Use as wood and walking sticks**

The branches of *Crataegus* provide excellent walking sticks and wood. The wood of *Pyrus pastia* is used for making tobacco pipes.

(iv) **Production of different substances**

- In Asian countries, the petals of common rose usually called gulabs are used in making gulkand.
- These petals are also used in extraction of an essential oil (rose oil) used as perfume.
- When distilled with water, the petals of rose give rose- water or Ark-e-Gulab, which is used for curing eye disease and for many other purposes.

SOLANACEAE

- It is also called **potato family, night shade due to double green colour.**
- It is family of about **90 genera** and **2000 species** of tropical and temperate distribution
- **In Pakistan,** 14 genera and about 52 species are reported (Nasir, 1985).

Familiar Plants

Solanum tuberosum(**Potato**)*Nicotiana tobacum*(**Tobacco**), *Lycopersicum esculentum* (**Tomato**) and *Capsicum frutescens* (**Red pepper**).

Vegetative Characters

(i) **Habit:** Plants including in this family are herbs, shrubs, sometimes trees or vines.

(ii) **Stem** is hairy or prickly.

(iii) **Leaves** are alternate or rarely becoming opposite in the floral region. They are simple, petiolate, rarely sessile.

Floral Characters

(i) **Inflorescence** is typically axillary cyme or combination of cymes, sometimes helicoids or axillary umbellate cymes.

(ii) **Flowers** are mostly bisexual, usually actinomorphic or weakly zygomorphic, hypogynous, usually pentamerous.

(iii) **Calyx** consists of 5 united sepals, which are usually persistent.

(iv) **Corolla**consists of 5 united petals which are rotate to tubular.

(v) **Androecium** consists of 5 free stamens but inserted on corolla tube (epipetalours). Rarely stamens 4 and didynamous (arranged in two whorls of 2 each).

(vi) **Gynoecium**is a compound pistil of 2 united carpals. Ovary is obliquely placed, superior, bilocular or imperfectly 4- locular by false septum.

(vii) **Placentation** is axile.

Fig. Solanaceae: Solanum nigrum, A-twig, B-Flower, C-fruit,D-seed

Economic Importance

Members of the family Solanaceae provide drugs and food, some are weedy, some are poisonous and others are handsome ornamentals.

(i) Use as Food

- The most important plant in the family is *Solanum tuberosum* (Potato-white or Irish potato). In Ireland, people are completely dependent on Potatoes.
- *Lycopersicum esculentum* (Tomato), the favourite home garden vegetable, was once believed to be poisonous.
- The fruits of *Capsicum annum* and *Capsicum frutescens* are rich in vitamin C and A and are used as condiment.
- *Physalis* (Ground- cherry) produces an edible fruit enclosed in a bladder like persistent calyx, the husk, giving the name husk tomato.
- Other important food plants are *Solanum melangena*(**egg plant or brinjal**).

(ii) Production of Tobacco

Nicotiana tobacum, the leaves of which are dried and made into tobacco, which is used in making cigarettes.

(iii) Use in Medicines

Many members of these family yield powerful alkaloids e.g. *Atropa belladonna*, *Datura* which are rich in atropine and daturine respectively are used medicinally.

(iv) Use as Ornamentals

Many plants are cultivated in the gardens for their beautiful flowers, these include *petuniaNicotiana*. *Cestrum* and *Solanum* etc.

FABACEAE

- It is also called **Pea family or Papilionaceae.**
- It is family of about **400 genera** and **900 species.**
- Members of this family occur all over the world, but particularly in the warm temperate regions.
- **In Pakistan** about 82 genera and about 587 species have been reported.

Familiar plants

Lathyrus odoratus(**Sweet pea**), *Arachis hypogea*(**Peanut**),*Cicer arietinum*(**Chick pea**) and *Dalbergia sisso*(**Shisham**).

Q. Write biological name of Shisham and Pea. (GUJ-G1)-16

Vegetative Characters

(i) **Habit:** Plantsare herbs, shrubs and trees.

(ii) **Stem** is herbaceous or woody or climber by tendrils (wiry, coiled thread-like structures).

(iii) **Leaves** are compound or rarely simple, sometimes partially or completely modified into tendrils, alternate, stipulate. Stipules are mostly leafy.

Floral Characters

(i) **Inflorescence** is racemose or solitary axillary.

(ii) **Flowers** are bisexual, zygomorphic, bracteate, pedicellate, perigynous, pentamerous and papilionaceous.

(iii) **Calyx** consists of 5 sepals ,more or less united in a tube ,mostly hairy.

(iv) **Corolla** consists of 5 petals, papilionaceous, usually clawed, dissimilar.

- The upper posterior petal is large and conspicuous and is called **Standard or vexillum.**
- 2 lateral ones are free called **wings.**
- 2 anterior inner most that fuse to form a boat-shaped structure called **keel or carina**

(v) **Androecium** consists of 10 stamens, mostly diadelphous (united by their filaments in two groups),9 fused to form a sheath round the pistil,while 10th posterior is free.

(vi) **Gynoecium**consists of 1 carpal with 1 locule; ovary is superior, style is long and slightly bent at is bar.

(vii) **Placentation (mono carpellary)** is marginal.

(viii) **Fruit** is usually a legume or pod, showing a great variety of form in various species.

Fig. Fabaceae (Papilionaceae): Sesbania sesbar: A-twig; B-flower, B1 standard verillium, C-fruit a legume, D-carpel

Economic Importance

The family is of considerable importance as a source of high protein food, oils and forage as well as ornamentals and other uses. Some economically important points are as following;

(i) Use as Food

Pulses belonging to this family are used as food. Some important and common species of pulse yielding plants are Gram, Pea, and Kidney bean. These pulses are rich in protein contents.

(ii) Forage for animals

Medicago sativa(**Alfafa**) is one of the world's best forage crop for horses. *Vicia*, *Melilotus* and *Trifolium* are also cultivated as main fodder crops.

(iii) Timber plants

Many trees of this family provide excellent timber for building, furniture and fuel. Main timber plants are *Buttea*, *Dalbergia* etc.

(iv) Production of different substances

- Seeds of *Arachis hypogea*(**Peanut**) are edible and are also used for extraction of peanut oil, which after hydrogenation is used as vegetable oil.
- Indigo dyes are obtained from *Indigofera tinctoria* and yellow dyes from flowers of *Butea monosperma*.
- The red and white seed of *Abrus precatorious* are used by jewelers as weights called ratti.

(v) Production of Medicines

Many plants of this family are important for medicines. These include

- *Glycyrrhiza glabra* for cough and cold.
- *Clitoria ternatea* is used against snake bite.

(vi) Ornamental plants

Some important ornamental plants include *Lathyrus*, *Lupinus*, *Clitoria*, *Butea* etc.

CAESALPINIACEAE

Introduction

- It is also called ***Cassia* family.**
- This family includes about **152 genea and 2300 species.**
- **In Pakistan** the family is represented by 16 genera and about 60 species.

Familiar Plants

Tamarindus indica, *Cassia fistula*(**Amaltas**), *Bauhinia veriagata*(**Kachnar**), etc.

Vegetative Characters

(i) Habit: Plantsare mostly trees and shrubs; some are woody climbers, rarely herbs.

(ii) **Stem is erect, woody,** herbaceous or climbing.

(iii) **Leaves** are compound, pinnate very rarely simple stipulate.

Floral Characters

(i) **Inforescence** is axillary or terminal raceme or panicle or spikes, rarely cymose, showy.

(ii) **Flowers** are bisexual, zygomorphic, rarely actinomorphic and perigynous.

(iii) **Calyx** consists of 5 sepals, free or connate at base, often colored.

(iv) **Corolla**consists of mostly 5 petals, which are free.

(v) **Androecium** consists of 10 stamens or fewer, rarely numerous, free or variously united.

(vi) **Gynoecium**consists of a simple pistil (1-carpal). Ovary is superior, unilocular, **stigma is simple.**

(vii) **Placentation** is marginal.

(viii) **Fruit** is legume.

Fig. Caesalpiniaceae: Cassia senna; A-twig,B-flower, C-fruit

Economic importance

The family is of great importance. Some plants are ornamental, some have medicinal importance, a few have food and other values.

(i) **Use as Medicine**

- The leaves of *Cassia alata* are used to cure ring worm and skin diseases.
- *Cassia senna* and *Cassia obovata* are cultivated for the leaves, which yield the drug Senna, which is the base for a laxative.
- Oil extracted from the seeds of *Cynometera cauliflora* is applied externally for skin diseases.

(ii) **Ornamental Plants**

Common ornamental plants are *Bauhinia variegate*(**Kachnar**), *Cassia fistula*(**Amaltas**), *Parkinsonia*, etc.

(iii) **Use as food.**

- The leaves and flower buds of *Bauhinia variegate* are used as vegetables.
- The acidic fruit of *Tamarindus indica* are edible and are rich in tartaric acid.

(iv) **Production of different substances**

- The bark of *Bauhinia* and *Tamarindus indica* is used in tanning.
- The heartwood of *Haematoxylon* (Longwood) yields the dye Haematoxylin.

MIMOSACEAE

Introduction

- It is also called **Mimosa or Acacia family.**
- It is a family of about **56genera** and **2800 species.**
- **In Pakistan,** it is represented by 11 genera and 49 species, of these only 4 genera and 18 species are native and rest are introduced.

Familiar Plants

Acacia nilotica, Albizzia lebbek **(Shireen)** *Mimosa pudica*(**Touch me not**), *Prosopis glandulosa Prosopis cineraria.*

Vegetative Characters

(i) **Habit**: Mostly plants are trees or shrubs, rarely climbers or herbs. Most of them are xerophytes.

(ii) **Stem** is mostly woody.

(iii) **Leaves** are pinnate by compound, alternate and stipulate, stipules modified into thorns.

Floral Characters

(i) **Inflorescence** is spike- like or head or umbel, rarely racemose or globose umbels.

(ii) **Flowers** are bisexual, actinomorphic, hypogynous to slightly perigynous and bracteate.

(iii) **Calyx** usually consists of 5 sepals which are generally fused, toothed or lobed.

(iv) **Corolla** consists of 5 petals, which are free or fused and lobed.

(v) **Androecium** consists of 5 to numerous stamens, which are free or adnate to the base of corolla

(vi) **Gynoecium** consists of a simple pistil of 1 carpal, ovary unilocular, superior ovules are many, placentation marginal.

(vii) **Fruit** is legume, dehiscent or indehiscent.

Fig. Mimosaceae : *Prosopsis cineraria;* A-twig, B-infloresence; C-flower; -D-fruits

Economic importance

(i) **Production of Wood.**

Many trees of this family including species of *Acacia*, *Albizzia* and *Xylia* provide commercially important wood, which is used for construction purpose or for furniture or as a fuel. The wood of *Albizzia lebbek* is used in cabinet word and railway carriage.

(ii) **Production of different substance**

- Arabic gum is obtained from *Acacia nilotica* and *A. senegal.*
- **Katha**, a dye is obtained from *Acacia catechu.*
- The tender leaves of *Acacia nilotica* are used as blood purifier.

(iii) **Ornamental plants**

- Some common garden plants grown for their beautiful flowers are *Mimosa pudica* and *Acacia melanoxylon*.
- A few species of *Prosopis* are planted in the arid zones for breaking the wind pressure.

POACEAE

Introduction

- It is also called as **Gramineae or grass family**
- It is distributed throughout the world wherever vascular plants can survive.
- It includes about **600 genera** and **10,000 species.**
- **In Pakistan,** it is represented by 158 genera and 492 species.

The traditional family name Gramineae takes its name from the Latin Grammar, which was used as a generic name for certain grasses, is permitted by the International Code of Binomial Nomenclature,which also provides for the use of Poaceae, based upon the type genus *Poa* Linn.

Familiar plants

Triticum vulgare **(Wheat)***Zea mays* **(Corn)**, *Avena sativa* **(Oats)** *Oryza sativa***(Rice)**, *Bambusa***(Bamboo)**, *Saccharum officinarum***(Sugar cane)** etc.

Vegetative Characters

(i) **Habit:** Plantsare annual or perennial, herbs.

(ii) **Stem** is jointed; usually hollow at the internodes, closed at nodes.

Q. Write the biological name of wheat and rice. (SGD-G2)-15

(iii) **Leaves** are solitary at the nodes, sometimes crowded at the base of the stem, alternate, exstipulate, ligulate, mostly sessile, leaf- base mostly sheathing, simple.

Floral Characters

(i) **Inflorescence** is mostly compound, composed of units called spikelet's

- These are variously arranged (indense clusters as in wheat, compound spike or loosely on branched axis-panicle as in oats.
- Each **spikelet** consists of **bracts.**
- These bracts are arranged along a slender axis called **Rachilla.**
- There are two lower bracts called **glumes,** which are empty. The succeeding **lemmas** enclosing a flower and opposed by a hyaline scale called **palea.**
- The whole (lemma, palea and flower) is termed as **floret.**
- The glumes or lemmas often bear one or more stiff bristles called **awns.**
- This basic pattern of spikelet structure is consistent throughout the family. Spikelets of grasses vary widely in different genera, particularly as number of fertile florets in each and deposition of sexes with them

(ii) **Flower** is usually bisexual, sometimes unisexual, small and inconspicuous, sessile, bracteate, incomplete, zygomorphic, hypogynous.

(iii) **Perianth** is absent or represented by 2, rarely 3 minute hyaline or fleshy scales called lodicules.

(iv) **Androecium** consists of 1 to 6 stamens, usually 3 with delicate filaments

(v) **Gynoecium** consists of a compound pistil of 3 united carpels, anther versatile, though only one is functional free, stigmas usually large and feathery.

(vi) **Fruits** are grains or caryopsis (a dry, indehiscent fruit, in which fruit wall (pericarp) is completed fused with seed coat).

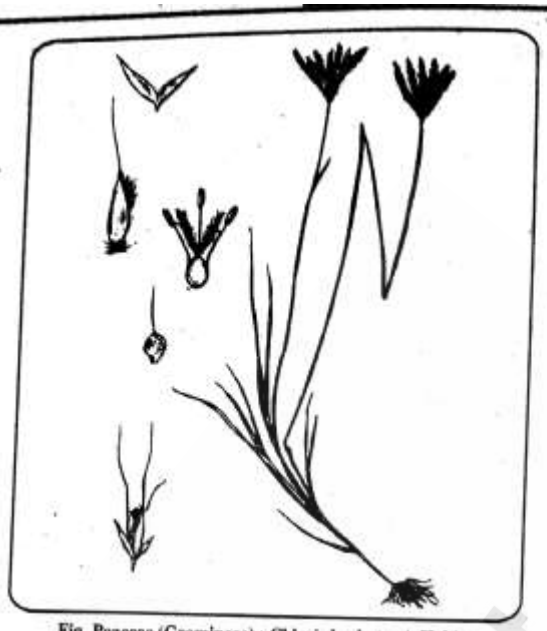

Fig. Poaceae (Gramineae) : Chloris barbata; A-Habit; B-spikelet; C-gulumes; D-fertile lamma, E-flower; F-fruit;

Economic Important

Economically family Poaceae has greater importance than any other family of flowering plants. It has great economic importance to both man and animals.

i) **Use as food**

- Cereals and millets, which constitute the chief food stuff of mankind, belongs to this family.
- Plants providing food for man includes: *Triticum aestivum* **(Wheat)**, *Avena sativa***(Oats)**, *Zea mays***(Corn)**, *Oryza sativa***(Rice)**, *Hordeum vuglare***(Barley)**, *Secale cereal***(Rye)***Penisetum typhoideum*, *Sorghum vulgare* etc.

ii) Sugar is obtained from the juice of *Saccharum officinarum* (Sugar cane).**Use as fodder**

- Most of the fodder crops, which are equally important to domestic animals, belong to this family.

The dried stem and leaves of the cereal crop are used as fodder for the cattle.

iii) **Use as fodder**

- Most of the fodder crops, which are equally important to domestic animals, belong to this family.
- The dried stem and leaves of the cereal crop are used as fodder for the cattle.

iv) **Production of different substances**

- Certain grass yield aromatic oils e.g. *Cymbopogon citratus* (lemon grass), which yield lemon grass oil.
- It is used in perfumes and soap industry and for making infusions. Some species of grasses are used in making papers.
- Ethyl alcohol and many other kind of beverages are also prepared from cereals e.g. whisky from rye, barley, corn and rum molasses, from sugar cane.
- Fibers obtained from leaves of *Saccharum munja*, which is used in making ropes.

v) **Use of Bamboo**

- *Bambusa* (bamboo)are used as building material for the thatching huts, making boats, carts, pipes etc. and the split stem are woven into mats, baskets, fans, hats, course umbrella.
- Leaves are also given to horses as a cure of cough and cold etc.

vi) **Ornamental plants**

- Many grasses are used in the lawns e.g. *Agrostis, Poa, Festuca* etc. and have ornamental significance.

Q.8: In what way do the flowering plants differ from the rest of the seed plants? What is the stigma? Is fertilization in angiosperms direct or indirect? From what tissue does angiosperm fruit develop?

Ans. The flowering plants differ from all other seed plants differ in many respects. In fact all seed plants which are also known as spermatophytes are divided into two group *i.e.*, the flowering and the non-flowering respectively called angiosperm and gymnosperm. Following are some of main differences between flowering plants and the other seed plants:

	Flowering Plants (Angiosperms)	Other Seed Plants (Gymnosperm)
1.	Ovule is enclosed in the ovary	Ovules are naked
2.	Fruit formation	No fruit formation
3.	Flower is one of most distinct tissue	Flower is absent
4.	In the xylem tissue vessel are present	In the xylem tissue vessels are absent in most gymnosperms
5.	Double fertilization take place	Double fertilization is absent
6.	Endosperm is triploid (3n)	Endosperm is monoploid (n)
7.	Wood is hard in woody angiosperm	Wood is soft in woody gymnosperms

Stigma

- Carpel is the female part of flower and it has three parts stigma, style and ovary.
- Stigma is the upper most part of carpal and it receives the pollen from anther.

Fertilization

- In Gymnosperms the fertilization is direct as the pollen grain direct lands on the ovules and one sperm nucleus directly fuses with one egg cell.
- In Angiosperms, the fertilization is indirect as the pollen land on the stigma which is much away from the ovule.
- The pollen produces pollen like which grows and goes inside the ovule where it produced three nuclei *i.e.*, a tube and two sperm nuclei.
- Out of these three nuclei only one fuses with the ovum. In this way the pollination and fertilization in angiosperm is indirect.

Fruit Formation

- Fruit is characteristic feature of angiosperm. Soon after fertilization the zygote begins to develop into an embryo.
- At the same time ovule begins to mature as seed and wall of ovary begins to develop into fruit.
- In other words the fruit is formed from the ovary part of the flower.