Course: Biology–I (6451)
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ASSIGNMENT No. 2

Q.1 Explain the importance of Fungi in food, farming, medicine and ecology.

Fungi are one of the most important microorganisms carrying out essential functions which may not be visible but are crucial in accelerating biological processes. These eukaryotic entities are closely related to the fauna and distantly related to the flora with respect to their characteristics and classification. A few features that set fungi apart from other microbes are :

- Fungi are osmotrophic – can absorb food
- Possess a characteristic hypha at their tips which carry out food exploration
- They possess nucleic cells containing chromosomes
- They are heterotrophs, cannot synthesize their own food.
- Reproduce through spore formation(Mushrooms)

Although we usually think of fungi as food perishing agents, they are economically very beneficial. Fungi are extensively used across industries in various forms and stages of processes.

Economic Importance Of Fungi

Fungi are an important organism in human life. They play an important role in medicine by yielding antibiotics, in agriculture by maintaining soil fertility, are consumed as food, and forms the basis of many industries. Let us have a look at some of the fields where fungi are really important.

Importance in Human Life

Fungi are very important to humans at many levels. They are an important part of the nutrient cycle in the ecosystem. They also act as pesticides.

Biological Insecticides

Fungi are animal pathogens. Thus they help in controlling the population of pests. These fungi do not infect plants and animals. They attack specifically to some insects. The fungus Beauveria bassiana is a pesticide that is being tested to control the spread of emerald ash borer.

Reusing

These microbes along with bacteria bring about recycling of matter by decomposing dead matter of plants and excreta of animals in the soil, hence the reuse enriches the soil to make it fertile. The absence of activities of fungi can have an adverse effect on this on-going process by continuous assembly and piling of debris.

Importance in Medicine

- Metabolites of fungi are of great commercial importance.
- Antibiotics are the substances produced by fungi, useful for the treatment of diseases caused by pathogens. Antibiotics produced by actinomycetes and moulds inhibits the growth of other microbes.

- Apart from curing diseases, antibiotics are also used fed to animals for speedy growth and to improve meat quality. Antibiotics are used to preserve freshly produced meat for longer durations.
- Penicillin is a widely used antibiotic, lethal for the survival of microbes. The reason it is extensively used is since it has no effect on human cells but kills gram-positive bacteria.
- Streptomycin, another antibiotic is of great medicinal value. It is more powerful than Penicillin as it destroys gram-negative entities.
- Yield-soluble antibiotics are used to check the growth of yeasts and bacteria and in treating plant diseases.
- Administration of Griseofulvin results in the absorption by keratinized tissues and are used to treat fungal skin diseases(ringworms).
- Ergot is used in the medicine and the vet industry. It is also used to control bleeding post-child-birth.
- LSD – Lysergic acid, is a derivative of ergot and is used in the field of psychiatry.
- Consuming fungi called Clavatia prevents cancer of the stomach.

Importance in Agriculture

The fungi plant dynamic is essential in productivity of crops. Fungal activity in farmlands contributes to the growth of plants by about 70%.

Fungi are important in the process of humus formation as it brings about the degeneration of the plant and animal matter.

They are successively used in biological control of pests. Plant pests are used as insecticides to control activities of insects. For example – Empausa sepulchralis, Cordyceps melonhae. Use of fungal pesticides can reduce environmental hazards by a great extent.

Fungi are also used in agricultural research. Some species of fungi are used in the detection of certain elements such as Copper and Arsenic in soil and in the production of enzymes. For instance, biological and genetic research on fungi named Neurospora led to the One Gene One Enzyme hypothesis.

The fungi live in a symbiotic relationship with the plant roots known as mycorrhiza. These are essential to enhance the productivity of farmland. 80-90% of trees could not survive without the fungal partner in the root system.

Importance in Food industry

Some fungi are used in food processing while some are directly consumed. For example – Mushrooms, which are rich in proteins and minerals and low in fat.

Fungi constitute the basis in the baking and brewing industry. They bring about fermentation of sugar by an enzyme called zymase producing alcohol which is used to make wine.

Carbon dioxide- a byproduct in the process, is used as dry ice and also in the baking industry to make the dough (rising and lightening of dough).

Saccharomyces cerevisiae is an important ingredient in bread, a staple food of humans for several years. It is also known as the baker's yeast.

Q.2 Give a brief of description of occurrence, features and life of cycle of Riccia.

The genus Riccia has aboutI30 species. Some botanists have reported its 200 species. Many of its species are found in Punjab. Kashmir and Western Himalayas. The species are found scattered from hilly and plains areas. All the species are terrestrial. They grim on **damp** soil or moist rocks.

External Structure

I. External appearance: The adult terrestrial gametophyte is prostrate and rosette-like. It is dichotomously branched. It is deep green dorsoventrally. However, the aquatic species possess light green thallus. It is thin membranous and dichotomously branched. The dichotomous branching of the thallus is quite close to each other. It gives rosette-like appearance.

2. **Notches:** Each branch of thallus has a conspicuous median longitudinal groove. It is present on the dorsal side of each branch of the thallus. A notch is present at the terminal end of each branch. Notch is also present on the dorsal side of each branch of the thallus. The growing pain is present in this notch.
3. **Scales:** The ventral surface of the thallus bears a row of the one-celled scales. The scales are violet coloured and multicellular. They are arranged close to each other towards the apex of the branch. One the other hand, the scales are quite apart from each other assay from the notch. The scales are found in one row towards the apex of the branch. But they are found in two rows in the portion away from the apex. Thus the older parts of the thallus bear two rows of the scales. In Riccia crystallina the scales are either absent **or** rudimentary.
4. **Rhizoids:** The rhizoids are also found on the ventral surface of the thallus. They are unicellular. Rhizoids absorb the nutrients and water from substratum. The rhizoids are of two types. Some are smooth walled and some are with tuberculate walls. The tuberculate rhizoids possess the peg-like infolding peeping. The simple or smooth walled rhizoids have no such infoldings.

Internal structure (anatomy)

Anatomy of Riccia is studied from the vertical sections of the thallus. Internally the thallus is differentiated into two regions.

a) Ventral region: The ventral region of the thallus consists of simple colourless parenchyma. Intercellular spaces are not found in the ventral region. The cells of this region make the storage tissue. They are filled up with starch grains. The ventral region has a single layered epidermis. Epidermis gives rises to several unicellular rhizoids and multicellular scales.

b) Dorsal region: The dorsal region of the thallus consists of the chlorenchymatous cells. These cells have discoidal chloroplasts. These cells are arranged in vertical rows. There are regular air canals in between each two vertical rows. This region is photosynthetic. It prepares carbohydrates. The epidermis of tile dorsal surface of the thallus is discontinuous. It is opened outside at several places by the opening of the air canals. The epidermis is single layered. However, the epidermis is continuous in aquatic species. The exchange of gases takes place through the **air** canals.

Apical growth

A row of 3 to 5 cells is present in the notch of each branch. These cells are involved in apical growth of the thallus. Each such cell cuts
off derivatives alternately on its dorsal and ventral faces. Sometimes the segments are cut off from lateral face of the apical cell. These cells form following parts of the plant:

I . The segments of the dorsal surface give rises to dorsal
chlorenchymatous region.

2. [he segments of the ventral face give rise to the region of the ventral surface, rhizoids and scales.
3. The derivatives from the outer daughter cell give rise to the epidermis and the air canals.

Air chamber formation

There are two views about the formation of air chambers:

a) Growth stops in of the tissue of the thallus in surface area at several points. The parts around these points grow vigorously upward. Thus depressions are produced in these points. These depressions become quite deep and narrow. Now these depressions become air chambers.

b) According to the second view, the air chambers develop schizogenously. These develop like intercellular spaces of the higher plants.

Formation of dichotomous branches

I. in the young thallus, divisions stop in one or more cells in the centre of the row of apical cells. Therefore, the original row of apical cells is separated into two sets of initial cells.

2. Each new set of initial cells continuously grows. They develop tissue of the thallus between the two groups of initial cells. Thus the two apical growing regions are further separated from one another.
3. Each of these growing points forms a separate branch. Now each branch possesses its own row of apical cells. This process continues in each of the branches. Thus it new rosette is formed.

REPRODUCTION

Vegetative and sexual reproductions take places in Riccia.

Vegetative reproduction

It takes place by follow ing ways:

a) Death and decay of the older parts of the thallus: Sometimes, a part of the dichotomously branched thallus decays from the posterior end. But the terminal ends of the branches remain unaffected. These branches may grow Separately into new thallus.

b) By cell division or gemma formation: In this case, cell divisions occur in the young rhizoids. It develops into gemmalike structure of the cells. These structures give rise to ilex% plants.

c) By adventitious branches: It occurs in several species of Riccia. In this case, adventitious branches are produced on the ventral surface of the thallus. These branches detach from the thallus and develop into new gametophytes.

d) By thick apices: It occurs in some species like R. hirnalayensis. In this case, the apex of the thallus grows downward into the soil at the end of the growing season. This apex becomes thick. This thick apex survives in the soil. It develops into a new plant in favourable conditions.

e) By tubers: Some species of Riccia develops vegetative structure called tubers. Some branches of the Manus face adverse conditions. The tubers are developed at the apices of these branches. These tubers develop into new plants in favourable conditions.

Sexual reproduction

Majority of the species of Riccia are homothallic (monoecious) like R. glauca. In this case, antheridia and archegonia are borne on the same thallus. Heterothallic (dioecious) species like **R.** himalayensth are also common. In such species, the antheridia and archegonia develop separately on different thalli.

The sex organs are produced in the groove. These grooves are situated on the dorsal surface of the mature gametophyte. These are arranged in acropetal succession. In a homothallic species the alternate groups of antheridia and archegonia are present on the same branches. In heterothallic species, antheridia and archegonia are present in groups. They are present separately in the medial longitudinal grooves of different thalli. Both the antheridia an(- archegonia develop singly on the dorsal surface of the thallus.

Development of antheridium

I. The antheridium develops from a superficial dorsal ceil call the **antheridial initials.** These initials are present at two or th cells back of the special cell.

2. The antheridial initial soon divides. It gives rise to two cells. upper one is called **outer cell** and the lower one the basal The outer cell projects outside the thallus. The basal cell ref embedded in the thallus. It develops into the embedded portion of the stalk of the antheridium. The outer cell develops into the main antheridium.

3. The outer cell further divides by transverse septa. It forms a vertical file of three cells:

• The two upper cells of this vertical file are called **primary antheridial cells.** They produce proper antheridium.

The lowermost cell of the file is called the primary stalk cell. It produces the projecting portion of the stalk.

4. Now, the two primary antheridial cells divide by two successive vertical divisions. These divisions are at right angles. As a result, eight cells are formed. These are arranged in two tiers. Each tier consists of 4 cells.
5. Now each tier of four cells divides periclinally. Thus each tier has 4 jacket initials. These jacket initial encircle the 4 androgonial cells of each tier. In this way, in both tiers, 'eight **primary androgonial cells** are formed. These cells are encircled by **8 jacket sterile initials.**
6. The sterile jacket initials repeatedly divide anticlinally. They give rise to a single layered jacket around the antheridium. The eight primary androgonial cells divide repeatedly. They give rise to a large number of cubical **androgonial cells.**
7. %rther divisions occur in these androgonial cells. As a result, they become smaller and smaller. The last cell generation of the androgonial mother cells becomes **androcyte mother cells.**
8. Each androcyte mother cell divides diagonally. Thus each gives rise to two **androcytes.**

Formation of antherozoid from androcyte

Androcytes are soon metamorphosed into antherozoid The process of metamorphosis is as follows

1. The androcytes are triangular in shape. Each androcyte possesses

a big prominent nucleus. **A blepharoplast** appears in the cell. Blepharoplast is an extra nuclear granule. The granule becomes large in size. It elongates and develops into a cord like body. This body adheres to the plama membrane. Very soon the two flagella arise from the anterior end of the blepharoplast.

Q.3 Give comprehensive details on Selaginalla.

Habit and Habitat of Selaginella:

Selaginella shows considerable variation in size, symmetry and morphology. Mostly they are herbaceous perennials, however, a few are annuals (Selaginella pygmaea).

Majority are dorsiventral, prostrate and creeping on the surface (e.g., Selaginella kraussiana; S. pellidissima; S. chrysocaulis), some are radial and grow erect (e.g., S. rupestris; S. viridangula; S. selaginoides) and few are scandent (e.g., 5. willdenovii; 5. adunca) and climbers (5. alligans).

Most of the species of Selaginella grow on the ground in humid, shady habitats. A few species are xerophytic and grow in arid conditions on exposed rock surfaces (5. pilifera; S. lepidophylla). They have the ability to survive desiccation.

Resurrection Plant:

Some xerophytic species (e.g., S. lepidophylla, S. pilifera, 5. bryopteris) rolls up into a compact ball of seemingly dead leaves and stems during dry seasons, but unrolls to carry on normal activities when put in water. Such plants are commonly known as the "resurrection plants" and are often sold as curiosities.

Salient Features of Selaginella:

i. The sporophyte is herbaceous and the shoot is dorsiventral and radial and creeping or erect.

ii. The leaves are small (microphyllous) and a ligule is present at the base of each leaf and sporophyll.

iii. Rhizophore is (a leafless structure where from roots arises) present in some species.

iv. Sporophylls are usually aggregated into strobili at the apices of the branch, hetero- sporous.

v. Heterothallic (dioecious) gametophytic prothalli.

vi. Antherozoids are biciliate.

Structure of Selaginella:

The Sporophyte:

The plant body of Selaginella is differentiated into well developed roots, stem and leaves.

Besides, some species also have rhizophore.

Hieronymus (1902) divided the genus Selaginella into two sub-genera viz., Homoeophyllum and Heterophyllum on the basis of general structure of the plant body.

Stem:

The stem is generally erect and radially constructed in the subgenus Homoeophyllum. The species belonging to the subgenus Heterophyllum are prostrate and dorsiventral. The branching is dichotomous in the member of Homoeophyllum and somewhat lateral in Heterophyllum.

The anatomy of the mature stem is very distinct and is differentiated into an outer epidermis, middle cortex and centrally located stele. The outer cell walls of the epidermis are cutinised. It is devoid of stomata and hairs. In many species there are several layers of thick- walled cells (hypodermis) beneath the epidermis, which merge gradually with thin-walled chlorophyllous cells of the cortex.

The cortex is usually made up of compactly arranged angular parenchymatous cells without intercellular spaces. The most part of the cortex of xerophytic species viz., S. lepidophylla and 5. rupestris, is comprised of thick-walled sclerenchymatous cells.

There is much variation in the vascular cylinder among the different species of Selaginella. The number of stele varies from species to species and sometimes even in the same species. This is due to the dissection of the main stele. Young plants invariably show monostelic configuration.

In most species the creeping stem or prostrate rhizome is protostelic. Species with radial symmetry may have a single, cylindrical proto- stele in the stem (monostelic e.g., S. spinulosa, S. flabellata), whereas dorsiventral species may have two (e.g., distelic e.g., S. kraussiana) or more vascular strands (12-16 steles) (polystelic e.g., S. laevigata) that are either circular or ribbon-shaped.

The number of steles may vary in different parts of the same plant. In S. braunii, the creeping prostrate axis is bistelic, while the erect branches are monostelic. In S. lyalli prostrate branches are bistelic, whereas erect branches are polystelic.

Each stele is surrounded by a single-layered pericycle. The stele is set off from the cortex by a few radially elongated endodermal cells designated as trabeculae. They have the characteristic casparian bands on their radial walls. Thus, the central stele is separated from the cortex by large air spaces.

Regardless of the stelar organisation, the primary xylem is exarch in development and the metaxylem consists primarily of tracheids with scalariform pittings.

The phloem of Selaginella consists of sieve cells and parenchyma. In some species (S. densa, S. rupestris, S. oregana) the xylem possesses true vessels with transverse perforation plates.

Rhizophores:

(Greek rhiza = root; phora = bearer).

In many species of Selaginella, peculiar leafless, prop-like cylindrical, structures, originate from the stem at the point of branching. These grow downwards into the surface and form many adventitious roots at their free ends. They are known as rhizophores.

A T.S. of the rhizophore shows features very much similar to the root, however, with some mild variations. The epidermis is single-layered and highly cutinised. The cortex is extensive and may be differentiated into an inner thin-walled parenchymatous and outer thick-walled sclerenchymatous zone (hypo- dermis).

The stele is protostelic and surrounded by a layer of endodermis. It shows variations in its form and arrangement of protoxylem in different species of Selaginella. In S. martensii, the xylem is monarch and exarch. In S. atroviridis the metaxylem is crescent-shaped and the protoxylem occurs in the form of a few groups on the concave adaxial side. In S. kraussiana, the stele is centroxylic where a single concentric stele with one protoxylem lying in the centre.

Morphological Nature of Rhizophore:

The morphological nature of rhizophore is controversial because of its unusual position and structure. It has been interpretated by various plant scientists as root, stem or an organ sui generis (i.e., an organ, neither a stem nor a root).

I. Similarities with Root:

i. Rhizophores are positively geotropic in nature.

ii. It does not bear leaves.

iii. Monarch xylem like that of root.

iv. Presence of root cap in some species, e.g., S. densa, S. kraussiana, S. martansii, S. wallacei (Webster and Steeves, 1967).

v. Transport of auxin in rhizophore is acropetal which is similar to root (Wochok and Sensex, 1974).

II. Similarities with Stem:

i. Exogenous in origin like stem.

ii. Absence of root caps and root hairs.

iii. Originate due to the activities of meristems which are present between the two branches of the stem. This meristem has been termed as angle meristem which is basically an embryonic shoot (Curick, 1959).

iv. Production of roots endogenously from the tip.

v. Under experimental conditions the rhizophore can be transformed into a leafy short (Foster and Cifford, 1959).

Hence Bower (1908, 1935) and Goebel (1905) suggested that rhizophore is neither a root nor a stem, but an organ sui generis. According to Schoute (1938) it is a specialised stem behaves like root.

However, recent biochemical studies of protein from stem, leaf, root and rhizophore revealed that the polypeptides of the rhizophore more closely resemble those of the stem rather than subterranean roots. The above-mentioned features are not for a typical root, moreover, they produce roots endogenously. Therefore, these outgrowths are called rhizophores (Gr. rhiza = root; phora = bearer).

Root:

The roots of the young sporophyte are ephemeral, but the roots of the mature sporophyte are adventitious in nature and dichotomously branched. Generally they arise at points of branching of the stem from a meristem, termed as angle meristem.

A T.S. of a root shows a very simple arrangement with a centrally located protostele covered by parenchymatous cortex and bounded externally by cuticularised epidermis. In some species, the outer layers of cortex become sclerenchymatous and form hypodermis. The stele consists of a small, exarch and monarch xylem.

Leaf:

The leaves of all species are microphyllous, sessile and simple, attaining a length of a few millimeters. The leaves may be ovate, lanceolate or orbicular in shape with one vein running nearly the entire length of the leaf. All the leaves are of same type and the arrangement is spiral in subgenus Homoeophyllum.

In the sub-genus Heterophyllum, the leaves are of two types; small leaves and large leaves, that are arranged in four rows along the stem. There are two rows of small leaves on the dorsal side of the stem and two rows of larger leaves on the ventral side or in a lateral position.

A small, membranous, tongue-like structure, ligule (latin ligula = a small tongue), is located at the base of each vegetative, leaf and sporophyll. The ligule is found on the ventral (upper) surface of the leaf.

A T.S. of a leaf shows two epidermal layers, mesophyll tissue, stele and stomata. The cells of upper and lower epidermal layers may be similar in most of the species (e.g., 5. rupestris). However, they may be somewhat different in some species (e.g., 5. martensii) where the upper epidermis consists of conical cells, but the cells of the lower epidermis are smaller.

Some species develops bristles or short hair-like structures extending out from the epidermis. The mesophyll consists of loosely arranged spongy parenchyma with intercellular spaces.

The mesophyll tissue may be differentiated into a distinct palisade and spongy parenchyma layers (e.g., S. lyalli, S. concinna) or the entire mesophyll may look like a reticulation lacunate parenchyma cells. A mesophyll cell contains 1-8 cup-shaped chloroplasts with many pyrenoid-like cells.

The stomata are present generally on the abaxial (lower) surface, although in certain species they are present on both the surfaces (amphistomatic). A single vascular bundle composed of central xylem surrounded by phloem is present at the centre. The bundle is bounded by a distinct bundle sheath.

Ligule:

The ligule has a basal cup-shaped sheath with often casparian strips (e.g., S. kraussiana) and an adjacent hemispherical glossopodium (Greek glossa 'tongue' and podiun 'foot') made up of a group of large, vacuolated cells. The remaining cells are more or less cubical in shape. The terminal end of ligule is thin and single-layered. The basal portion of the ligule is somewhat sunken into the tissues of the leaf.

The ligule acts as a water-absorbing structure which keeps the young leaf primordium and sporangium of sporophyll moist during their early development. The ligule in some species, during early development, secretes a mucilagenous substance composed of carbohydrates and proteins that keep the apical meristem moist and prevent them from desiccation (e.g., S. wallacei, S. kraussiana).

Reproduction in Selaginella**:**

The sporophyte of Selaginalla reproduces by vegetative and sexual methods.

i. Vegetative Reproduction:

The vegetative reproduction in Selaginella takes place by tubers (e.g., S. chrysocaulis), bulbils (S. chrysorhizos), dormant buds (S. chrysocaulis) and fragmentation (S. rupestris).

Bulbils and dormant buds are produced in aerial branches, while tubers may be aerial or underground. In favourable condition they germinate to produce new sporophytic plants. In S. rupestris, the trailing branches of the stem develop adventitious branches, that separate from the parent plant and grow into new sporophyte.

ii. Reproduction by Spores:

Numerous haploid spores are produced in the sporangium. The sporangium are located in the sporophylls and the sporophylls are compactly arranged to form cones or strobili.

Strobilus:

All the species of Selaginella forms strobili or cones. Generally strobili occur terminally on side branches, but in some species (e.g., S. patula and S. cuspidata), the apical meristem of the cone may continue meristematic activity producing foliage (vegetative) leaves and, therefore, produces a shoot with sporophylls (sporangium bearing leaves) and foliage leaves in alternate segments along the axis.

Selaginella is heterosporous and, therefore, sporangia are of two types viz., microsporangia and megasporangia. The sporophylls associated with these two types of sporangia are designated as microsporophylls and megasporophylls respectively.

There is variation in distribution of sporangia within the strobili of different species. Strobili either consists entirely of microsporangia or of megasporangia (S. gracilis, S. atroviridis). However, the mixed condition is more common.

The lower portion of a strobilus consists of megasporangia and the upper portion of microsporangia (S. helvetica, S. rupestris, S. selaginoides) or the two types of sporangia may be mixed indiscriminately.

In some species one side of strobilus bears microsporophylls and other side megasporophylls (e.g., S. inaequalifolia, S. oregana). In some species, only one megasporangium is present at the base of each strobilus, while the rest are microsporangia (e.g., S. kraussiana).

Sporangium:

The mature sporangia are stalked with two- layered jacket. The microsporangia are slightly elongated and reddish to bright orange in colour. Megasporangia are larger than microsporangia and are frequently lobed. The megasporangia are whitish-yellow or light orange in colour.

Development of Sporangium:

Initially the development of micro- and megasporangia are similar. The sporangial development is of eusporangiate type i.e., the sporangium develops from a group of initial cells.

The site of sporangial initiation (micro- or mega-sporangium) is in superficial cells of the axis, directly above the sporophyll, or in cells near the base of the sporophyll on the adaxial (upper) side.

Periclinal divisions in these initial cells produce two tier of cells: the outer jacket initials and the inner archesporial initials. A two-layered sporangial jacket is formed by repeated anticlinal and periclinal divisions of the jacket initial. The periclinal division of the archesporial cells produces an outer and inner layer of cells.

The outer layers of cells eventually develop into tapetum; the inner cells, by repeated divisions in various planes, produce sporogenous tissue (spore mother cells). The sporangium at this stage consists of an immature sporangial wall of two layers, a short stalk and a conspicuous tapetal layer enclosing numerous sporogenous tissue. At this stage, microsporangia and megasporangia are indistinguishable.

Further Development of Sporangenous Tissue:

Differentiation of Micro- and Megasporangium:

Further development of sporogenous tissue gives rise to micro and megaspores. In micro- sporangium, about 80-90% of the sporogenous tissue undergoes meiosis and forms tetrads of haploid microspores. The microspores are more or less tetrahedral in shape. They are quite small in size (0.015 to 0.06 mm in diam.). The wall of the spore is divisible into outer thick and ornamented exine and inner thin intine.

In a potential megasporangium, only one spore mother cell becomes functional. The remaining non-functional megaspore mother cells develop large vacuoles and accumulate starch, while functional megaspore mother cell retains a dense cytoplasm which is rich in RNA and lacks starch.

The functional megaspore mother cell undergoes meiosis (reductional division) forming four megaspores. All the nonfunctional mother cells ultimately degenerate.

All the four megaspores develop from a megaspore mother cell may not be functional. Sometimes one (S. sulcata) or two (S. rupestris) megaspores are functional. Sometimes more than one megaspore mother cell in a megasporangium becomes functional resulting into 8, 12 or even more megaspores in a single megasporangium.

The resulting megaspores soon develop a thick-layered cell wall. The outer layer is thick and ornamented with spines or ridges known as exine (exospore). The inner layer is thin and termed as intine (endospore). In some species a third layer (mesospore) forms between exine and intine. The megaspores are much larger (diam. 1.5 to 5 mm) than the microspores.

Gametophyte:

The haploid spores germinate to form the endosporic gametophytes. The development of microspores and megaspores generally starts while they are still inside their respective sporangia. Therefore, the spores are shed at multicellular stage.

Male Gametophyte:

The microspore germinates to form the male gametophyte. The first unequal division (1-1) in a microspore results in the formation of a small lenticular prothallial cell (vegetative cell) and a large antheridial initial. The prothallial cell does not divide further. The antheridial initial divides (2-2) vertically forming two primary antheridial cells.

The upper two cells divide anticlinally (3-3) by means of a curved transverse wall forming four antheridial cells and the lower two cells do not divide constituting the first jacket cells of the antheridium. The antheridial cells nearer to the prothallial cell divide (4-4) periclinally by means of a curving vertical wall to form two small distal cells (2nd jacket cells) and two large inner cells (androgonial cells).

The other two antheridial cells divide (5-5) anticlinally to form two distal cells (3rd jacket cells and two proximal cells which again divide periclinally (6-6) by means of a curving vertical wall to form two outer (4th jacket) cells and two inner antrogonial cells.

Thus, at this stage, the male gametophyte has 13 cells (1 prothallial cell, 8 jacket cells and 4 androgonial cells) and male gametophyte is shed at this 13- celled stage.

After shedding, the four primary androgonial cells undergo several divisions forming 128 or 256 androcytes. Each androcyte gets metamorphosed into a biflagellate sperm (antherozoid) which on disintegration of the jacket cells and rupture of the spore wall along the triradiate ridge are liberated (as free-swimming sperm/antherozoid).

The antherozoids (sperms) are free-swimming type, very narrow and about 15-50 pm in diameter at about the middle of the sperm/antherozoid. Each flagellum is about 30 pm in length. The sperms of Selaginella are the smallest among vascular plants.

Since the whole process of development of male gametophyte takes place inside the microspore wall, the development is endosporic (where gametophyte develops inside the spore wall) and the gametophyte is an extremely reduced structure.

Female Gametophyte:

Like the male gametophyte, the megagametophyte (female gametophyte) development of Selaginella begins while the megaspores are still inside the megasporangium.

A conspicuous vacuole develops within the cytoplasm of the megaspore at a very early stage. Thus, the megaspore nucleus undergoes repeated nuclear divisions without cell wall formation (free nuclear division). As a result a thin layer of multinucleate cytoplasm is developed around the large vacuole.

The formation of cell walls around each nucleus starts initially at the apical end beneath the triradiate ridge and an apical patch of cells, two to three layered thick, is formed. In some species of Selaginella, the cell wall formation continues until the megagametophyte is entirely cellular.

In some species, e.g., S. kraussiana, the apical patch of cells is separated from the rest of the gametophyte by conspicuous arching diaphragm (wall). Ultimately the vacuole is obliterated by the formation of cells. The stage at which the megaspore is shed from the megasporangium varies from species to species.

In majority of the species, the final stages of female gametophyte development, and fertilisation and germination of young sporophyll take place while the megaspore with its enclosed megagametophyte rests on the substratum. The female gametophyte increases in size and exerts pressure on the megaspore wall.

This results in the splitting open the megaspore wall along the triradiate ridge. Tufts of rhizoids may develop from the exposed gametophytic tissue which play an important role in absorption of water and nutrients, also in anchorage.

However, in S. rupestris, the megaspores are not shed (retention of megaspore in megasporangium) and the development of female gametophyte and fertilisation take place in situ and the young sporophyte can be seen developing on the parent plant.

Development of Archegonium:

Archegonia originate in the apical region of the female gametophyte. Each archegonium develops from a single superficial cell (archegonial initial) which divides periclinally to form a primary cover cell and a central cell.

The primary cover cell follows two vertical divisions at right angle to each other to form four neck initials which again divide transversely to form eight neck cells, arranged in two tiers. The central cell divides periclinally to form an outer primary neck canal cell and an inner primary venter cell.

The primary neck cell does not divide further so that a neck canal cell is formed, while the primary venter cell divides transversely into a ventral canal cell and an egg. Thus, a single archegonium consists of eight neck cells arranged in two rows of four cells each, one neck canal cell, one ventral canal cell and an egg.

The venter, along with the inner tier of neck, lies embedded in the gametophytic tissue, while the terminal neck cells extend above the surface of the gametophytic tissue.

Fertilisation:

In majority of the species, fertilisation takes place after the megasporangium gets settled on the substratum, but in some cases (e.g., 5. rupestris), fertilisation occurs while the female gametophyte is still within the sporangium. Biflagellate sperms (haploid) are liberated, then they swim to the archegonia through a thin film of water and fertilise the egg (haploid) to form diploid zygote.

The Embryo (The New Sporophyte):

After fertilisation, the diploid sporophytic generation (i.e. zygote) is established. The first division of the zygote is generally transverse. The upper cell (epibasal) develops into one- or several-celled suspensor (that are toward the archegonial neck) and the lower cell (hypobasal) to the embryonic cell. The embryo is endoscopic (embryonic cell directed toward the base of the archegonium) in nature.

The embryonic cell divides by two vertical walls at right angles to each other resulting into a four-celled embryo. A short apical cell with three cutting faces is formed because of oblique divisions in one of the embryonic cells. At this stage, the embryo proper undergoes a 90-degree turn to its left.

The first pair of leaves are developed laterally on two sides of the shoot apex. Eventually a foot is formed on the lower side of the embryonic tissue and the primary root is developed between the suspensor and foot. The young sporophyte emerges from the gametophytic tissue through continued growth of the shoot and root.

How far Selaginella approaches seed habit?

Selaginella exhibits a significant approach towards seed habit because of the following notable features:

(i) It is a heterosporous pteridophyte.

(ii) In some species of Selaginella, viz., S. rupestris and S. monospora, the megaspore number is reduced to one.

(iii) In S. rupestris, the megaspore is retained within the megasporangium and the development of female gametophyte and subsequent fertilisation takes place in situ and even the young sporophyte can be seen developing on the parent plant.

(iv) Therefore, it becomes evident that the heterosporous vascular cryptogam, Selaginella, has considerably advanced towards seed habit in some species but its approach to the true seed is not complete due to the following reasons:

(a) The megasporangium wall is dehiscent and is not covered with the protective integuments,

(b) The retention of the megaspore permanently within the megasporangium has not become established,

(c) The absence of complete histological fusion between the megasporangium wall and the megaspore,

(d) The direct access of sperms to the egg,

(e) There is lack of resting period after the development of embryo.

Q.4 Write comprehensive note on life cycle of Cycus.

Cycas is the most prominent genus of the Eastern Hemisphere.

C. circinalis, C. pectinata, C. rumphii, and C. beddomeii are found wild in India. C. revoluta (native of Japan) is the most common cultivated species in Indian gardens. C. siamensis (found in Burma) is sometimes cultivated.

The **Sporophyte of Cycas:**

The vegetative body of the sporophyte externally resembles a palm tree. The stem is typically un-branched, short, thick, cylindrical and more or less columnar, covered by an armour of persistent leaf- bases, and bearing a crown of leaves. Leaves are pinnate, tough, leathery, large (sometimes up to 3 metres in length), spirally arranged round the free-growing apex of the stem, and show circinate ptyxis characteristic of ferns.

Each leaflet has only one midrib without branches. The primary root elongates as a strong tap root with scanty branches, but numerous secondary roots are present. These secondary roots, near the surface of the ground, branch profusely and dichotomously forming coralloid masses, known as root tubercles.

A cross-section of the stem shows a large pith, a comparatively thin vascular cylinder with conjoint, collateral, open and endarch bundles, and a very thick cortex showing numerous leaf-traces (girdles), limited externally by an epidermis. Numerous canals filled with mucilage also occur in the cortex and in the pith, and these are connected with one another through leaf-gaps forming a network.

The primary cambium is short-lived, and a succession of secondary cambiums is formed in the cortex producing concentric series of vascular cylinders. The first cortical cambium produces a prominent secondary vascular cylinder, the second cambium produces much narrower ones with widely separated vascular bundles, and as this process is continued the constructive power of the successive cambium layers is greatly reduced, which ultimately form isolated patches of smaller vascular bundles here and there at the periphery. These secondary cortical bundles are concentric.

The root is usually tetrarch and the secondary growth begins early but in an irregular fashion. In a cross-section of the petiole, numerous collateral and open vascular bundles are found to be present in a convoluted arc.

The xylem of each bundle lies on the upper face with phloem below, and the former is composed of an endarch protoxylem with both centripetal and centrifugal masses of xylem, which are apparently secondary in origin.

A cross-section of the leaf shows strongly cutinized epidermis on both sides of it and with deeply sunken stomata only on the under-surface. Below the upper epidermis there is a hypodermis, consisting of a few layers of thick-walled cells, and this tissue gives a tough and leathery texture to the leaf.

The mesophyll tissue is differentiated into an upper palisade and a lower spongy parenchyma, full of chloroplasts, and these two tissues are separated by colourless, elongated cells forming the transfusion tissue, which runs parallel to the leaf-surface. The vascular bundle is usually mesarch.

Cycas is strictly dioecious and heterosporous, the micro-and megasporophylls being borne on different plants. In this case, the microsporophylls only are in compact strobili, while the megasporophylls are arranged spirally like the ordinary crown of foliage leaves around the terminal vegetative bud of the shoot-axis. The staminate strobiIi are apparently terminal in position but in reality lateral, being situated close to the growing apex.

Staminate (or Male) Strobilus:

It consists of a central axis on which numerous microsporophylls are arranged in acropetal succession forming a compact, elongated and ovoid structure, often attaining a length of 50 cm. or more. One or more strobili may grow simultaneously about the growing point.

The terminal and basal microsporophylls are sterile, while the remaining ones bear 700 or more microsporangia or pollen sacs on their abaxial (lower) surface in two, more or less distinct patches, separated by a sterile median line.

The microsporangia occur in definite groups of 5, 4, 3, sometimes 2, forming sori. Each microsporophyll, which is not leafy in nature, is narrow below, and broadened above into a more or less sterile expanded portion.

The sporangium is eusporangiate in development, and consists of a wall of several layers of cells surrounding an inner large mass of sporogenous tissue, from the surface of which a comparatively scanty tapetum is developed. From each spore mother cell, by reduction division, four microspores or pollen grains are produced.

Ovulate or Female Strobilus:

The megasporophylls do not form compact strobili, as in the case of microsporophylls, but are spirally and loosely arranged like ordinary crown of foliage leaves around the terminal vegetative bud of the shoot-axis. The megasporophylls, in some cases bear considerable resemblance to foliage leaves (e.g., C. revoluta, C. circinalis, etc.), are devoid of chlorophyll, and covered with short brownish hairs.

Several ovules or megasporangia, sometimes only two (C. siamensis), are borne on the margins of the megasporophyll. In a species of Cycas (C. circinalis) the ovules are the largest, measuring about 6 x 4 cm., and in some cases they are densely hairy (C. revoluta).

The ovule consists of a nucellus surrounded by a single massive integument which develops a testa of three layers; an outer fleshy, a middle stony, and an inner fleshy layer. The outer fleshy layer, in a ripe seed, becomes characteristically coloured, and the inner fleshy one usually becomes thin and membraneous.

The nucellus is fused with the thick integument for most part of its length, except at the apical region, where it forms a beak-like structure, called the nucellar beak, which projects into the micropyle. Within the nucellar beak develops a conspicuous chamber, called the pollen chamber, in which the pollen grains are collected.

The vascular supply of the ovule is divided into two sets, the outer set enters the outer fleshy layer, and the inner set traverses the inner fleshy layer just within the stony coat, and continues beyond the free portion of the nucellus.

Deep within the tissue of the nucellus a spore mother cell soon becomes differentiated which by reduction division, forms a linear tetraid of four megaspores or embryo-sacs, of which the innermost one is functional, while the others disorganize.

The Gametophytes of Cycas::

1. Male Gametophyte:

The microspore, the first cell of the male gametophyte, has two coats:

i. The exine and

ii. The intine.

It germinates while still within the microsporangium; its nucleus divides and two unequal cells are formed, a small persistent prothallial cell or vegetative cell, and a large cell, the antheridial initial.

The larger cell in its turn, divides again into two unequal cells, one, a small cell closely in contact with the prothallial cell, is the generative cell, and the other larger cell is the tube cell. It is at this three-celled condition the microspores or pollen grains are discharged from the microsporangium, and are disseminated by wind. It has been accepted that Cycas is wind-pollinated.

The three-celled microspores are carried by the wind to the ovules of the neighbouring female plants. They are caught by a mucilagenous secretion from the micropyle and as the fluid dries up, they are sucked into the pollen chamber. The tube cell elongates and penetrates the tissue of the nucellus forming the pollen tube, and the tube nucleus passes into it. The pollen tube often branches, and always functions as an absorptive organ.

The generative cell then divides into a stalk cell and a body cell. The former is functionless, but the latter again undergoes division producing two spermatozoid mother cells, in each of which a large spirally coiled, multiflagellate spermatozoid is produced. These spermatozoids are remarkably large, larger than any known in other plants and animals, and are easily visible to the naked eye.

2. Female Gametophyte:

The megaspore is the first cell of the female gametophyte. It germinates within the mega-sporangium (or ovule), and is never shed, but is retained within it.

The development of the gametophyte can be broadly divided into five stages:

a. The megaspore enlarges, its nucleus divides freely forming a variable number of free nuclei distributed in its general mass of cytoplasm;

b. Due to the development of a large central vacuole, all the nuclei are pushed at the periphery of the megaspore;

c. Free nuclear division continues;

d. A peripheral tissue is gradually developed by the formation of cell walls separating the free nuclei;

e. This process is continued, and the tissue grows centripetally until it fills up the cavity of the megaspore.

This gametophytic tissue, which is developed before fertilization, is known as the endosperm, which, at maturity, contains abundant starch grains.

It consists of two regions:

(a) A region of large cells near the base performing nutritive function, and

(b) A region of small cells near the micropylar region.

Within the latter region develops a variable number of archegonia (2-8 in C. revoluta). Any superficial cell of the gametophyte may become an archegonium initial, which divides periclinally into an outer primary neck cell, and an inner central cell.

The primary neck cell divides vertically to form two neck cells, while the central cell enlarges remarkably and gradually becomes surrounded by a special jacket of nutritive cells, known as the archegonial jacket. The nucleus of the central cell finally divides to form a ventral nucleus, and an egg nucleus, and there is no wall in between the two.

The absence of such a wall is regarded as an advanced character. Around the latter an oosphere is gradually differentiated. The ventral nucleus soon disorganizes. The oosphere and its nucleus have been described as the largest among plants, and can be detected by the unaided eye.

During the development of the archegonia at the micropylar surface of the gametophyte, its neighbouring cells continue to grow upwards, so that the archegonia are left in a shallow depression, known as the archegonial chamber.

After penetrating the nucellus the pollen tube bursts, when the spermatozoids are set free in the archegoniaI chamber. The spermatozoids then make their way into the archegonium, and one of them fertilizes the oosphere. The fertilized oosphere surrounds itself by a wall, and forms an oospore.

The New Sporophyte of Cycas:

After fertilization the oospore enlarges, its nucleus by free cell formation produces as many as 256 or probably more (C. revoluta) nuclei, distributed through the cytoplasm of the oospore. A large central vacuole soon appears (C. circinalis), followed by the formation of a peripheral tissue.

This tissue is the pro-embryo. In Zamia the pro-embryo is formed only at the lower end of the developing oospore. The cells below the tip-cells of this pro-embryo elongate remarkably, and ultimately form a long, coiled, flexuous and massive filamentous structure, called the suspensor, which forces the tip-cells out of the archegonium into the nutritive gametophytic tissue (endosperm).

From the tip-cells a dicotyledonous embryo is produced. The embryo and the endosperm remain within the three-layered testa, and the ovule is gradually transformed into a seed. The seed, on germination, gives rise to a new seedling sporophyte, and the mode of germination is hypogeal.

Fossil Cycads:

The Cycadales first appeared in Upper Triassic and are the only group out of all the Cycadopsida that has survived until the present-day. Among the living plant they are extremely ancient and retained primitive features both in their morphology and life cycle.

The fossil cycads are mostly included in the order Nilssoniales by the following Cycas:

Leaves- Nilssonia.

Seed-bearing organs- Beania.

Pollen-bearing organs- Androstrobus.

Nilssonia is a common form that have large frond, and the lamina is often cut into segments of various sizes and shapes. The common Indian species are N. princeps, N. morrisiana, N. medlicottiana, etc.

The leaves are with strong midribs, undivided lamina forked or simple veins pass to the margins at right angles to the midrib or slightly upwardly bent.

Haplocheilic type of stoma typical of the fossil Nilssoniales shows its resemblances with Cycadales. Hence the leaves of Nilssoniales represent the foliage of fossil member of Cycadales.

The pistillate fructification of fossil Cycads is Beania from the Jurassic of Yorkshire. Each of the peltate sporophylls bears two ovules, sporophylls are arranged spirally in a loose cone, and the structure of the ovule shows close resemblance with that of Cycas.

The male cone referred to Androstrobus, belonged to the same plant as Beania, because they are associated together in the rocks, and the pollen grains inside the micropyle of Beania are same as obtained from the male cones of Androstrobus.

Fern-Characters in Cycas:

1. The sporophyte of Cycas has a columnar and an unbranched stem covered over with persistent leaf-bases and bearing a crown of large pinnate compound leaves towards the apex, as in tree ferns.
2. Rachis and leaflets enrolled from the apex in a circinnate manner.
3. Megasporophylls are leaf-like as is indicated by their arrangement on the stem, where they take the place of foliage leaves; by their approach to pinnate character, especially in Cycas revoluta, and by their developing chlorophyll, as in C. circinalis. In ferns also the sporophylls are either leaves or resemble them very much.
4. In the arrangement of microsporangia in sori on the under-surface of the microsporophylls, presence of indusial hairs beneath the sori, structure and eusporangiate development of the microsporangia and their dehiscence and their large output of microspores, Cycas resembles Marattiaceae.
5. Motile and flagellate sperms.
6. Xylem has no vessels and phloem is without companion cells. Sieve plates are present on the longitudinal walls of the sieve tubes and sometimes even concentric bundles are found in the leaf, cone-axis and stalks of sporophylls. The entire cortical bundled of the stem are concentric. All these are fern characters. Further, like them in ferns, pith and cortex are large.
7. Presence of leaf gaps in the cortex.

All these characters lead one to believe that Cycas might have evolved from the ferns.

Q.5 Describe in details economic importance of Angiosperms.

An angiosperm is a plant that produces flowers. The angiosperms, also identified as the flowering plants, belong to one of the vital groups of plants having seeds. The word angiosperm has been derived from a couple of Greek words where angeion stands for "vessel" and sperma means "seed".

Angiosperms belong to one of the most diverse and largest extant groups of plants found in the universe. There are approximately 453 families of angiosperms that contain around 260,000 living species classified in them. Moreover, around 80 percent of all known green plants living on the earth are represented by angiosperms (Manjunatha et al., 2019). It is very well elaborated that the vascular seed plants in which an egg is fertilized and developed into a seed in an enclosed hollow ovary are angiosperms.

The seed of angiosperms, unlike gymnosperms, such as conifers and cycads, are found in the flower. In gymnosperms, the seeds are borne exposed to the bodies and surfaces of the reproductive parts for example cones. Furthermore, both male and female organs can easily be found in the flowers of angiosperms.

The angiosperms occupy nearly every habitat located on the earth except the environments that bear extreme climatic conditions such as uppermost mountain ranges, the deepest blue oceans, and the regions that are present and surrounding the poles. They can be found as epiphytes (living on various other plants), floating on the surfaces of surface waters, rooted in freshwater and marine habitats, and terrestrial plants that vary in dimensions.

Angiosperms can be seen as tiny herbs, parasitic plants, vines, and gigantic trees and they range in small millimeters as tiny floating plants to large trees that are over 100 meters tall. It is worth mentioning here that, massive diversity can be found in the chemistry, reproductive cycles, morphology, anatomy, and sizes of the angiosperms as compared to the other members and species in the Plant Kingdom.

S. No.	**Name of Flowering Plant**	**Family**	**Species**
1.	Orchidaceae	Orchid Family	25,000
2.	Asteraceae or Compositae	Daisy Family	20,000
3.	Fabaceae or Leguminosae	Pea Family	17,000
4.	Poaceae or Gramineae	Grass Family	9,000

5.	Rubiaceae	Madder Family	7,000
6.	Euphorbiaceae	Spurge Family	5,000
7.	Malvaceae	Mallow Family	4,300
8.	Cyperaceae	Sedge Family	4,000
9.	Araceae	Aroid Family	3,700

With reference to the definition and background of the angiosperm plants elaborated above, many scientists describe them as "flowering" plants and classified them into a single phylum: the Anthophyta. Their floral anatomical parts include pollens, stamens, and/or carpels.

The sperm of the flowering plants are pollen grains that are produced by stamens. The pollen grains contain the male gametes that may react with the female gametes (ova) in the ovaries of the plants. These gametes enable angiosperms to reproduce sexually. (Note: apart from sexual reproduction, angiosperms may also carry out certain forms of asexual reproduction, e.g. vegetative propagation and apomixis.)

The pollen grains in the angiosperms are smaller in size than the pollen found in the gymnosperms, hence the reduced size aids the process of fertilization by reaching the female eggs in less time. It is often seen that some families of the angiosperms reproduce without being fertilized or in other scenarios, by using their own pollen they can fertilize themselves. Hence, the stamens play a very crucial role in the fertilization cycle of flowering plants.

The flowers after stamens and pollens are the next very important part of the anatomy of the angiosperms and they are referred to as the structure where both male and female reproductive parts of the angiosperms can be found. The flowers are designed in such a way that they may attract insects and other mammals for the cross-pollination process. It can be seen in various plants that the flowers are colorful and have pleasant smells.

The ovaries, behind the flowers of the plants, are enclosed in the carpels. The ovaries in the angiosperms can receive the pollen and can start the process of producing seeds, flowers, and fruits more swiftly as compared to gymnosperms. If the whole process of the development of the plant can be observed carefully, it can be concluded that the fruit is developed from the flower after pollination and this is the prime responsibility of the carpels.

The angiosperms, despite their diversity, are united by shared and derived features collectively known as **synapomorphies**. Some of the vital angiosperms characteristics are that the ovules are present in the carpels, which is a structure that is made up of ovary and the ovules are enclosed in it and the process of pollination occurs here. Secondly, a cycle of double fertilization occurs which leads to the formation of endosperm and there are three stamens that have a couple of pollen sacs. Finally, the angiosperms have phloem tissues that are mainly composed of sieve tubes and companion cells. Hence it can be concluded that the extent of angiosperms occurred from various origins instead of one.

Economic Importance of Angiosperms

Another economical advantage of angiosperms is that they provide various pharmaceuticals. Apart from some of the antibiotics that are manufactured vary in compositions, almost all of the medicines are either derived and extracted directly from the angiosperms or if synthesized, their major components are found in angiosperms. The list of medicines includes vitamins, aspirin, narcotics, and quinine. There are certain angiosperms that are extremely toxic to livings have proved to be very effective in the treatment of cancer, leukemia, and several heart problems. Quinine is used to treat malaria, vincristine is used to treat leukemia, curare for muscle relaxants in open-heart surgeries, and diosgenin is used as a precursor in oral contraceptives. The contribution of angiosperm in maintaining our habitat is extremely vital. The variety of food resources and oxygen supply in our habitat is strongly dependent on the versatility of angiosperms found. A significant loss in the number of angiosperms will have a huge impact on the survival of our habitat.

Angiosperms and Gymnosperms

The angiosperms and gymnosperms are both types of plants but they differ from each other in many ways. The angiosperms are the flowering plants such as fruits, grains, and vegetables whereas all kinds of pines, fir, cedar, juniper, cypress that indeed are all non-flowering plants come in gymnosperms. The angiosperms accumulate to form flowered while cones are produced via accumulation of gymnosperms whereas the angiosperms are mostly bisexual and occasionally unisexual and the latter are generally unisexual and rarely bisexual. The structural differences between both of them include the presence of sepals, petals, stigma, and styles in the flowering plants. Moreover, in angiosperms the ovules are produced on the stalk and archegonia is absent where in gymnosperms the ovules are sensible and the distinct archegonia are present. The major difference again in both of them is the presence of the various numbers of cotyledons. Lastly, both kinds of plants have their domestic uses. The angiosperms are the primary source of hardwoods worldwide and are economically vital as the source of pharmaceuticals, timbers, ornaments, and fiber production while the softwoods are supplied by gymnosperms such as pine fir and thus, they are used to produce paper, lumber, and plywood.