A. Long Answer Questions:
1. Give a brief account of natural vegetative propagation in Angiosperms.
   Ans. Asexual Reproduction (Vegetative propagation) in Angiosperms:
   1. The reproduction which occurs without involving meiosis and fusion of gametes is called asexual reproduction. In Angiosperms it occurs through the parts of vegetative organs like root, stem, leaf or buds of a plant, therefore, it is called vegetative propagation or vegetative reproduction. These vegetative parts which act as propagules have adequate reserve food material and at least a growing point. The Propagule grows to form an independent plant under favorable conditions.
   2. Few Natural Methods of vegetative propagation are given below.
      1) Tuberous roots: In some plants the underground roots store plenty of reserve food and become swollen. Such swollen roots are called tuberous roots. These roots in some plants have adventitious buds on their surface which sprout under favourable conditions to produce ‘Leafy shoots’ (slips) and adventitious roots from the base of shoot. These sprouts may be separated and planted for commercial cultivation. Under natural conditions, ‘slips’ are separated after degeneration of intervening root part. The tuberous roots are adventitious and may be produced singly or in groups or cluster and are called simple tuberous and fasciculated tuberous roots respectively.
         In sweet potato the tuberous roots are produced singly at nodes of a creeping stem. They are irregularly swollen, tapering towards both the ends, dark and blackish-red coloured structures. In Asparagus and Dahlia they are produced in cluster.
      2) Stem Tubers: In Potato plant (Solanum tuberosum), the basal and underground part of stem produce axillary or extra axillary underground branches. The terminal part of such branches becomes swollen due to storage of starchy reserve food. These swollen tips of underground branches of stem are called stem tubers. A stem tuber has many notches on its surface called ‘eyes’. Each ‘eye’ is actually at a node and consists of one or more small axillary buds and reduced scale leaves. After termination of dormancy period, under favorable conditions, one of axillary bud from an ‘eye’ sprouts by suppressing the growth of other buds.
      3) Runner: Runner is a slender, prostrate, sub aerial branch, which creeps horizontally on the soil. It is produced by the plants like Cynodon (doobgrass), Fragaria (strawberry) and Oxalis etc. for vegetative propagation. Runner develops from the lower axillary bud of stem and is thin elongated cylindrical wire like structure with long internodes. It creeps on the ground and becomes rooted at the nodes. Shoots are produced from upper side of nodes. After getting detached from parent, such shoots grow as independent plants. A parent plant produces many such runner which spread in all the directions.
      4) Leaf: In plants like Bryophyllum, Kalanchoe, Begonia etc., vegetative propagation takes place with the help of their leaves. In Bryophyllum, leafis succulent with crenate or notched margin. Adventitious buds called epiphyllous buds (or foliar buds) are produced at the notches at the tip of lateral veins. These buds start sprouting on the leaf to form...
leafy shoot and adventitious roots. When such sprouts fall on the wet soil, they develop into independent plants. In some species of Bryophyllum, the new plants are formed from the parent plant and falls on wet soil. In Begonia, the foliar buds are produced on the surface of leaf.

2. Describe the T.S. of Anther.  
Ans. T.S of anther (bilobed) shows two structures- anther wall and 4 pollen sacs/microsporangia.  
A. Anther wall : A mature anther shows wall consisting of following four layers.  
   1. Epidermis : It is the outermost common wall layer of anther which consist of flattened cells. It is protective in function.  
   2. Endothecium : It is internal to the epidermis, common for the four pollen sacs and consists of single layer of cells. The cells of endothecium shows characteristic fibrous thickening of callose. Cells of endothecium situated in the shallow groove between two microsporangia remain thin walled and represent the line of dehiscence. Fibrous thickening and hygroscopic nature of endothecium cells help in the dehiscence of anther at maturity.  
   3. Middle layers : Internal to endothecium, 1 to 3 layers of parenchyma cells are present surrounding each pollen sac or microsporangium. They are called middle layers. The cells of these layers degenerate at maturity i.e. after the formation of microspores, so that two pollen sacs of each lobe merge to form one chamber in each lobe.  
   4. Tapetum : It is the innermost wall layers surrounding the sporogenous tissue of microsporangium. Cells of tapetum are larger in size, contain dense cytoplasm and one or more diploid nuclei or a polyploidy nucleus. Tapetum provides nutrition to sporogenous tissue and developing microspores. It also contributes in the developing microspores. It also contributes in the formation of sporopollenin, a component of pollen exine.  
B. Microsporangium or pollen sac :  
In an immature anther, inner to the tapetum the microsporangium contain a compact mass of diploid sporogenous tissue. These cells function as microspore mother cells. At maturity, microspore mother cells (2n) undergo meiosis to form four haploid microspores (n). Young microspores are generally present in the form of tetrahedral tetrads. Formation of microspores by the meiosis of diploid microspore mother cells is called Microsporogenesis.  

3. Describe the development of male gametophyte in Angiosperms.  
Ans. Development of male gametophyte :  
Microspore or pollen grain is the initial cell of male gametophyte. The development of male gametophyte is endosporic i.e. occurs within the microspore. It involves one meiotic and only two mitotic divisions. It is completed in two stages at two different places; before pollination in the pollen sac and after pollination on the stigma.  
Before Pollination in the pollen sac :  
   Step 1: Inside pollen sac microspore mother cells undergo meiosis or
**microsporogenesis** to form haploid pollen grains/ microspores.

**Step2:**
1. pollen grain divides by mitosis to from two **unequal cells**. The smaller cell is called generative cell. It has a large nucleus, thin cytoplasm and it lacks reserve food and vacuole, the larger cell is called vegetative or tube cell it has a large vacuole, cytoplasm, nucleus and reserve food. Generative cell lacks a definite cell-wall and is freely suspended in cytoplasm of vegetative cell.
2. In most of the Angiosperms, pollen grains are released at two celled stage after dehiscence of anther. Such 2-celled pollen grain is also called young or partially developed male gametophyte.
3. In some Angiosperms, the generative cell divides by mitosis to form two male gametes and therefore, 3-celled pollen grains are released form anther.

**After pollination on the stigma:**
1. After pollination, 2-celled pollen grain is deposited on stigma surface, comes in contact with sugary stigmatic secretions and absorbs it.
2. Due to this the volume of cytoplasm increases and creates a pressure which acts on the intine. The intine of pollen tube called pollen-tube.
3. The tube nucleus, cytoplasm and generative cell, all migrate into the pollen tube. The pollen tube grows down towards ovule through the style due to chemical stimulus inside ovary.
4. The generative cell divides by mitosis in the pollen tube to form two haploid, non motile male gametes.
5. This germinated pollen grain (**3-celled**) having pollen tube with two male gametes, thin cytoplasm and a degenerating sterile vegetative nucleus represents **mature male gametophyte**. Thus it is highly reduced structure.

4. Describe the structure of a mature anatropous ovule. Add a note on functions of its different parts

**Ans. Structure of Anatropous Ovule:**
1. An **ovule** is the **integumented megasporangium** of the seed bearing plants.
2. An ovule which has a bent axis and downwardly directed opening called micropyle is termed as **anatropous ovule**. It is most common type of ovule in Angiosperms.
3. **Megasporogenesis** i.e. formation of megaspore and development of female gametophyte takes place inside the ovule.

**V.S. of mature ovule shows following structure:** It consists of two main parts, stalk and body.

**Stalk:**
1. Stalk of ovule is called funicle or funiculus. It attaches an ovule with the fertile tissue of ovary called placenta.
2. It has vascular strand and supplies nutrition to the body of ovule. In anatropous ovule, a considerable part of funicle remains attached with the body. This part may even persist in mature seeds and is called raphe.

**Body:**
1. The funicle bears a major swollen part of ovule at its tip called body of the ovule.
2. The stalk/funicle is attached to the basal part of the body of ovule at a point called hilum.

The body of an ovule consists of following parts:

- **Nucellus**: It forms the main central bulk of ovule’s body. The nucellus represents the megasporangium proper of an ovule. It consists of many diploid parenchyma cells.

- **Chalaza**: The basal part of nucleus from where the interuments develop is called chalaza. This end of ovule is called chalazal end.

**Fig. 8.10 V.S. of mature anatropous ovule**

**Integuments**: These are the protective coverings of nucleus, which develop from the chalazal part of nucleus and surround it completely except a small portion at the opposite or terminal end. There are two integuments, outer and inner and therefore, ovule is called bitegmic.

**Micropyle**: The integuments leave a narrow opening at the terminal end of nucellus. It is called micropyle. This end of nucellus is called micropylar end.

**Embryo Sac:**
1. In a mature ovule, nucellus shows the presence of an oval shaped, haploid, structure at micropylar end, this is called embryo sac or female gametophyte. It consists of 7 cells and 8 nuclei.
2. There is a 3-celled egg apparatus at the micropylar end. It consists of central egg cell (oosphere) and two lateral cells called synergids.
3. At the chalazal end, it has two haploid polar nuclei at the centre. These polar nuclei fuse with each other at the later stage (before fertilization) to form diploid secondary.
nucleus. Generally, embryo sac in Angiosperms is **monosporic, endosporic, 7-celled and 8 nucleate. It is called polygonum type.**

**Functions of different parts of Ovule are:**
**Funicle:** It functions for support, projection and conduction.
**Nucellus:** It is the megasporangium of ovule, in which megasporogenesis and development of female gametophyte (embryo sac) takes place.
**Integuments:** They give protection to nucellus and embryo sac. After fertilization, these are converted into seed coats. Outer, thick and resistant is called testa and inner, thin and transport is called tegmen.
**Micropyle:** It forms the passage for the entry of pollen tube in ovule during fertilization. During seed germination it allows the entry of water and radical comes out through it.
**Egg Apparatus:** Egg is the female gamete and after fertilization it gives rise to diploid zygote which develops into an embryo. Synergids play supportive role in fertilization and degenerate after fertilizations. The filiform apparatus of synergids attracts pollen tube during fertilization.

**Polar Nuclei:** Both the polar nuclei fuse with the second male gamete and form primary endosperm nucleus, which develops into a nutritive tissue called endosperm (3n). It nourishes the developing embryo.

**Antipodals:** These are accessory cells, which degenerate after fertilization.

5. Describe the development of female gametophyte in Angiosperms.
***Ans.*** An ovule is the integumented megasporangium of the seed bearing plants. **Megasporogenesis** i.e. formation of megaspore and **development of female gametophyte** takes place inside the ovule.

**Development of Female gametophyte**

**Step 1. Megasporogenesis**
1. A diploid hypodermal cell at the micropylar end of nucellus gets differentiated to form archesporium directly functions as megaspore mother cell (MMC). The diploid MMC (2n) undergoes **meiosis or megasporogenesis** to form a tetrad of haploid megaspores (n).
2. Megaspores are generally arranged in linear tetrad.
3. Generally the chalazal megaspore remains functional while remaining three degenerate gradually.
4. **Functional (fertile) megaspore** is the **first cell of female gametophyte.** It undergoes **enlargement** and develops into a female gametophyte.

**Step 2.** The haploid nucleus of functional megaspores undergoes **three successive** free-nuclear **mitotic divisions.**

1. First mitotic division results in formation of two nuclei. Both the nuclei undergo two successive divisions. This results in formation of four nuclei at each pole and an 8-nucleated structure is formed. One nucleus from each pole comes to the center and they function as polar nuclei.
2. This is followed by cellular organization to form 3-celled egg apparatus at micropylar end, three antipodals at chalazal end and two polar nuclei remain in the centre.

3. Thus, 8-nucleated, 7-celled female gametophyte is formed within the functional megaspore; therefore the development is called endosporic. Only one megaspore takes part in the formation of embryo sac; therefore it is called monosporic.

6. Enlist the merits and demerits of self and cross pollination.

Ans. Merits of self pollination:
1. Self pollination is nearly a sure method because least chances of failure are there, as no external agents are involved.

2. Self pollination is most economic method for the plant because modification like large and attractive flowers, fragrance and nectar production is not required.

3. Least wastage of pollen grains is there. Improved varieties of plants can be
multiplied by preserving their desired characters.
4. **Genetic stability** (pure lines) can be maintained in the progeny.

**Demerits of Self Pollination:**
1. There is no chance of forming improved varieties like hybrids.
2. Undesirable characters can neither be eliminated nor can the desirable characters be introduced in the offspring.
3. Self pollination, if occurs continuously for many generations then the progeny becomes weaker and susceptible to diseases.
4. Continued self pollination may result in the formation of less number of seeds per fruit, less viability of seeds, less adaptability to climatic variations, etc. it doesn’t favour the variations and **evolution** process.

**Merits of cross pollination:**
1. Cross pollination involves **genetic recombination** and brings **variations**.
2. The undesirable characters can be eliminated and the desirable characters can be introduced in the offspring.
3. Improved varieties like hybrids can be formed are **strong, disease resistant** and better adapted to climatic variations.
4. The offspring show **better vigour** (hybrid vigour) and vitality. It **favours** the process of **evolution**.

**Demerits of cross Pollination :**
1. It depends on the external carries; therefore, failure chances are more (not sure).
2. It is not an economical method because a lot of plant energy is wasted for attraction of carriers.
3. There is **wastage** of pollen grains.
4. Due to genetic recombination, some desirable characters can get eliminated and undesirable ones may get introduced in the offspring.
5. Genetic **purity is not maintained** in the offspring.

7. Explain double fertilization and give its significance.

**Ans.** 1. The process of fusion of male gamete with the female gamete to form the diploid zygote \((2n)\) is known as fertilization”.

2. The fusion of one male gamete with egg and that of another male gamete with secondary nucleus is called double **fertilization**. It is characteristic of angiosperms.

**Steps involved in double fertilization:**
1. After pollination, pollen grain germinates on the stigma to form a pollen tube. Pollen tube grows down towards the ovule in ovary. It carries two non motile male gametes, thin cytoplasm and a degenerating tube nucleus with it. It is **male gametophyte**.
2. Growth of the pollen tube occurs at its tip where most of the cytoplasm is concentrated. On reaching the ovary, a pollen tube mostly enter in an ovule through **micropyle** (porogamy). Sometimes it may enter through integuments (misogamy) or through chalaza (chalazogamy).
3. Irrespective of the place of entry into the ovule, a pollen tube always enters the embryo sac near the egg apparatus. **Filiform apparatus** of synergids attract the pollen tube towards egg-apparatus.
4. The tip of the pollen tube absorbs water from one of the synergids and bursts open to release the **two male gametes**. The tube
nucleus degenerates by this time. The released male gametes bring about double fertilization as follows:

5. **Syngamy or First fertilization**: One of the male gametes fuses with the egg or oosphere to form diploid zygote or oospore. This is called **Syngamy** or First Fertilization.

6. **Triple fusion or second fertilization**: The other male gamete fuses with the diploid secondary nucleus to form the triploid primary endosperm nucleus (PEN). This is called **triple fusion**. Since each of the polar nuclei is sister nucleus of the egg, it is called second fertilization.

7. The fertilization process in which non motile male gametes are transported up to the female gamete through a pollen tube is called **Siphonogamy**.

**Significance of Double Fertilization**

1. It involves the **use of both the male gametes** produced by a pollen grain. This avoids the chances of polyembryony and increases the chances of survival of future plant.

2. It consists of two fusions and results in formation of two products. First fertilization restores diploidy in the life cycle. Diploid zygote develops into **embryo** which subsequently develops into a **new plant**.

3. Second fertilization product, triploid PEN (Primary Endosperm Nucleus) develops to form a nutritive tissue called **endosperm** for developing embryo.

4. As the development of embryo and endosperm takes place close to each other, proper nutrition of embryo is ensured.

5. Development of embryo and endosperm takes place simultaneously; therefore, unnecessary wastage of endosperm is avoided.

6. The **triploid endosperm** gives better nutrition to the developing embryo; therefore, seeds are **more viable** in Angiosperms.

7. Triploid endosperm is the characteristic feature of only Angiosperms.

8. **Describe the development of embryo in Angiosperms.**

**Ans. Development of Embryo:**

1. First fertilization of double fertilization results in the formation of zygote. Diploid **zygote** develops into **embryo**.

2. Second fertilization product, triploid PEN (Primary Endosperm Nucleus) develops to form a nutritive tissue called **endosperm** for developing embryo.

3. The zygote forms a wall around it and is converted into oospore.

4. The oospore divides transversely to form a large basal cell (or suspensor cell) towards the micropyle and a small apical cell (or embryonal cell) towards the interior of embryo sac.

5. From 2 celled stage, until the formation of organs the embryo is commonly called proembryo.
6. The basal cell divides transversely to form a row of cells called suspensor. The suspensor pushes the developing embryo deeper in the endosperm for its proper nutrition.
7. The apical cell of the 2-celled pro-embryo undergoes a transverse and two vertical divisions at right angles to each other to form an octant stage.
8. The eight cells of octant pro-embryo undergo many divisions to form a spherical mass of cells called globular embryo.

9. Gradually this mass becomes heart-shaped and then horse-shoe shaped.
10. Finally it gets differentiated to form an embryonal axis with plumule, radicle and two cotyledons in dicots and a single cotyledon in monocots.

9. Describe the development of endosperm in Angiosperms.

Ans. Development of endosperm:
1. Endosperm is the nutritive tissue for the nourishment of developing embryo. In Angiosperms, the product of second fertilization or triple fusion is Primary Endosperm Nucleus (PEN). It develops into endosperm. The endosperm is post fertilization product and is commonly a triploid tissue.
2. In some cases, endosperm is totally consumed during embryo development so that the mature seeds do not possess endosperm and such seeds are called non endospermic or ex-albuminous seeds. e.g. pea, bean, gram, ground nut, etc.
3. In other Angiosperms, the endosperm persists in the mature seeds and it continues to support the growth of embryo during seed germination. Such seeds are called endospermic or albuminous seeds. e.g. castor, sunflower, coconut and cereals like maize, wheat, etc.
4. Depending upon the mode of development, three types of endosperm are recognized. These are as follows:
5. **Nuclear Endosperm:** In this type, the primary endosperm nucleus undergoes free nuclear divisions or karyokinesis (i.e. nuclear-divisions are not followed by cytokinesis). This result in formation of large number of triploid nuclei freely suspended in common cytoplasm of central cell. Later on wall formation occurs around these nuclei in a centripetal manner to form cellular mass. It is the most common type of endosperm.

6. **Cellular Endosperm:** In this type, the primary endosperm nucleus undergoes nuclear divisions which are followed by cytokinesis. Therefore, endosperm development occurs in cellular form right from the beginning. It is less common and seen mostly in dicots.

7. **Helobial Endosperm:** In this type, first division of primary endosperm nucleus is followed by wall formation. As a result, the central cell is divided into a large micropylar and a small chalazal chamber. In both, further development of endosperm occurs as nuclear type. Thus it is an intermediate type which is common in Helobiae series of monocots, hence the name.

9. **In post fertilization changes, describe the formation of fruit and seed. Add a note on significance of fruit and seed.**

**Ans. Formation of fruits and seeds:**

1. Simultaneously with the development of embryo and endosperm, **ovary** enlarges in size. Sepals, petals, stamens, style and stigma fall off and ovary changes into **fruit**. Ovary wall changes into **pericarp** (fruit wall) which may or may not be differentiated into epicarp, mesocarp and endocarp, pericarp is initially green in colour and on ripening becomes orange, red, purple, yellow etc.

2. Each ovule in the ovary also enlarges in size. **Outer integument** becomes thick and hard outer seed coat, called **testa** and the **inner integument** changes into thin, inner seed coat, called **tegmen**. Thus small, soft and succulent ovule becomes dry and **hard seed** after fertilization.

**Significance of seeds and fruits:**

1. The seeds are the most **efficient propagules** produced by the plants. The distribution and dominance of Angioperms on the earth (conquest of land by Angiosperms) is due to the seeds. success of seeds as propagule is due to many characteristics of seeds as follows.

2. **Dormancy** – It is temporary suspension of growth. One of the factors which control dormany is presence of certain growth inhibitors in the seeds which prevent germination. During this period, seeds are dispersed at different places. (Zygote produced by Cryptogams, germinates immediately).

3. **Viability** – It is the functional ability of seeds to germinate after considerable...
dormancy period. Germination can be delayed till the onset of favourable conditions.

4. **Reserve food** – Fully developed embryo is nourished by food stored in either endosperm or cotyledons during germination of seed and a seedling is produced.

5. **Protective coat** – Testa, the outer, hard seed coat, gives protection against the mechanical shocks, fluctuations in temperature and dry conditions. Animals eat fruits and either throw away seeds or if are consumed, they are not digested due to the hard seed coat and are removed through excreta.

6. **Dispersal** – Some seeds produce various structures like wings, pappus calyx (persistent and hairy), hooks or sticky substances, and seeds are actively or passively transported to distant places.

7. **Edible fruits** – Many fruits are consumed by different organisms and seeds are thrown.

8. **Dry fruits** split open at maturity and thus helps in seed dispersal. Thus development of fruits and seeds play significant role in the spread of the species.

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B. **Short Answer Questions:**

A. **Anemophily:**
   
   **Ans.**
   
   1. The transfer of pollen grains through wind is described as anemophily. The wind pollinated plants are called anemophilous plants.

   2. Anemophily is considered as the most *primitive* type of pollination and mostly the plants produce unisexual flowers.

   3. Anemophilous flowers are small, inconspicuous without bright colours, nectar and fragrance. Petals are green or highly reduced.

   4. When flowers are unisexual, the male flowers are more numerous than female and are situated at a higher level. Stamens are with long filaments, versatile and exposed anthers. Pollen grains are produced in extremely large numbers to compensate their wastage. These are small, smooth walled, pale yellow in colour and light weighted.

   5. Long style bears *large feathery or hairy stigma* to trap pollen grains. E.g. Grasses, Maize, Jowar, Sugarcane, etc.

B. **Hydrophily:**
   
   **Ans.:**
   
   1. The transfer of pollen grains through the agency of water is Hydrophily.

   2. Hydrophilous plants are that their flowers are mostly unisexual, small and inconspicuous.

   3. They are without fragrance, bright colour and nectar. Pollen grains and other floral parts are unwettable i.e. coated with mucilage.

   4. Specific gravity of pollen grains is controlled by the formation of one or more starch grains in the pollen grain. Stigma is long and sticky.

   5. Hydrophily is of two types; Hypohydrophily and Epihydrophily.

   6. **Hypohydrophily:** Pollination with the help of water takes place below the water
surface in the hydrophytes bearing submerged female flowers. E.g. *Zostera* and *Ceratophyllum*

7. **Epihydrophily**: When pollination occurs on the surface of water, it is called epihydrophily. It is a more common type of hydrophily. E.g. *Vallisneria*

C. **Ornithophily**

**Ans.** 1. When the pollination takes place through the birds, then it is called ornithophily.

2. Ornithophilous plants show large flowers with thick and fleshy floral parts. Corolla is tubular or funnel shaped.

3. Flowers with bright colored corolla like orange, red, yellow, blue which help in attracting the birds.

4. Flowers lack fragrance because birds have poor sense of smell. Flowers produce large amount of sugary nectar, which is used as a drink by the birds.

5. Pollen grains are sticky. E.g. *Callistemon* (Bottle brush), *Bignonia*, *Butea* and *Bombax* (Silk Cotton).

6. The common pollinating birds are; sunbirds, humming birds, crow, bulbul,

D. **Entomophily**

1. Pollination through the agency of insects is called entomophily. Common insects which act as carriers in entomophily are moths, butterflies, beetles, flies, bees etc.

2. Bees are most common agents and nearly 75-80% of total insect pollination is achieved with the help of bees.

3. Entomophilous flowers are large and attractive, when small; flowers are produced in compact group or inflorescence e.g. Sunflower.

4. Flowers have attractive bright colours, pleasant fragrance and nectar.

5. In some plants, additional modifications are made for attraction of insects e.g., Corona in passion flower, petaloid bracts in *Bougainvillea* etc.

6. The pollen grains have spiny of rough exine. Stigma is sticky. E.g. Jasmine, Rose, Cestrum, Salvia, Bougainvillea.

7. Few plants develop special mechanism to favour this process e.g. Salvia has developed lever mechanism.

E. **Chiropterophily**

**Ans.**

1. Pollination which takes place with the help of bats is called chiropterophily.

2. In these plants flowers are large, stout enough so that bats can hold on to the flowers

3. Chiropterophilous plants are nocturnal and open their flowers during night time. Flowers emit rotten fruits like fermenting fruity odor.

4. Flowers produce copious nectar. Flowers have large number of stamens to produce a considerably large quantity of pollen grains. E.g. *Anthocephallus* (Kadamb), *Kigellia piñata*, *Adansonia* (Baobab tree), *Bauhinia*.

F. **Dichogamy**

**Ans.**

1. Most of the Angiosperms produce bisexual flowers. Cross pollination is preferred by majority of flowering plants and they develop out breeding devices.
2. In many plants, self-pollination is avoided as stamens and carpels do not mature simultaneously. This is called dichogamy.

3. In some plants, pollen grains are released much before stigma becomes receptive, this is protandry e.g. sunflower, and in some plants, stigma becomes receptive first, this is protogyny e.g. Michelia.

G. Egg Apparatus
   Ans. 1. There is a 3-celled egg apparatus at the micropylar end of the embryo sac. It consists of central egg cell (oosphere) and two lateral cells called synergids.
   2. Egg is the female gamete and after fertilization, it gives rise to diploid zygote which develops into an embryo. Synergids play supportive role in fertilization and degenerate after fertilizations. The filiform apparatus of synergids attracts pollen tube during fertilization.

H. Endosperm
   Ans.
   1. Second fertilization product, triploid PEN (Primary Endosperm Nucleus) develops to form a nutritive tissue called endosperm for developing embryo.
   2. As the development of embryo and endosperm takes place close to each other, proper nutrition of embryo is ensured.
   3. The triploid endosperm gives better nutrition to the developing embryo; therefore, seeds are more viable in Angiosperms.
   4. Triploid endosperm is the characteristic feature of only Angiosperms.
   5. There are two types of seeds- endospermic and non-endospermic seeds.

I. Triple fusion
   Ans.
   1. Triple fusion or second fertilization: During double fertilization, the other male gamete fuses with the diploid secondary nucleus to form the triploid primary endosperm nucleus (PEN). This is called triple fusion. Since each of the polar nuclei is sister nucleus of the egg, it is called second fertilization.
   2. The PEN develops to form a nutritive tissue called endosperm for developing embryo.
   3. The triploid endosperm gives better nutrition to the developing embryo; therefore, seeds are more viable in Angiosperms.

2. Describe the structure of pollen grain.
   Ans. Structure of Pollen Grain:
   1. Each pollen grain (microspore) is unicellular, uninucleate, spherical or oval haploid structure.
   2. It is with a double layered wall called sporoderm. The outer layer of pollen wall is thick, highly resistant and is called exine.
   3. The exine may be spiny (as in insect pollinated plants) or smooth (in wind pollinated plants).
   4. Exine is mainly composed of a complex substance called sporopollenin which provides resistance to a pollen grain from physical and biological decomposition.
   5. Exine is interrupted at one or more places, which look like small pores called germ pores. Pollen grains are mostly uniporate (single germ pore) in monocots and triporate (three germ pores) in dicots.
   6. The inner layer of sporoderm is called intine, it is composed of cellulose and...
pectin. It encloses protoplasm with single haploid nucleus.

7. Draw the figure of pollen grain.

3. Give significance of double fertilization.
   Ans. Significance of Double Fertilization
   1. It involves the use of both the male gametes produced by a pollen grain. This avoids the chances of polyembryony and increases the chances of survival of future plant.
   2. It consists of two fusions and results in formation of two products. First fertilization restores diploidy in the life cycle. Diploid zygote develops into embryo which subsequently develops into new plant.
   3. Second fertilization product, triploid PEN (Primary Endosperm Nucleus) develops to form a nutritive tissue called endosperm for developing embryo.
   4. As the development of embryo and endosperm takes place close to each other, proper nutrition of embryo is ensured.
   5. Development of embryo and endosperm takes place simultaneously; therefore, unnecessary wastage of endosperm is avoided.
   6. The triploid endosperm gives better nutrition to the developing embryo; therefore, seeds are more viable in Angiosperms.
   7. Triploid endosperm is the characteristic feature of only Angiosperms.

4. Enlist the advantages of vegetative propagation.
   Ans. advantages of vegetative propagation.
   1. It is easy and cheaper method of multiplication of plants.
   2. The plants like banana, pineapple, grapes do not form viable seeds under natural conditions, thus they can be propagated by this method only.
   3. It forms genetically similar plants; it is useful to multiply improved variety with same characters for several generations.
   4. It helps in production of clones of economically useful and rare plants.
   5. The yield can be increased by grafting method.
   6. It is useful for rapid propagation of plants which produce seeds with long dormancy period.

5. Explain how commercial cultivation of sweet potato and potato crop is done.
   Ans. 1. Sweet potato is a tuberous root with adventitious buds on it. So for commercial cultivation it is cut into pieces each at least with one bud and are grown separately.
   2. Potato is a stem tuber with many notches or eyes on its surface. Each eye consists of one or many axillary buds. So for commercial cultivation it is cut into pieces each at least with one eye and are grown separately.

6. Distinguish between Sexual and Asexual reproduction.

<table>
<thead>
<tr>
<th>Asexual reproduction</th>
<th>Sexual reproduction</th>
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<tbody>
<tr>
<td>1. It is uniparental</td>
<td>1. It is biparental.</td>
</tr>
<tr>
<td>2. It is called Apomixis</td>
<td>2. It is called Amphimixis</td>
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<tr>
<td>3. It does not involve meiosis.</td>
<td>3. It does always involve meiosis.</td>
</tr>
</tbody>
</table>
4. Offsprings have same characters as that of parent. Offsprings are clones.

4. There are always Variations between parents and offsprings and among the offsprings.

7. Sketch and label
   a. T.S. of anther   b. Pollen grain   c. Embryo sac

8. Enlist floral adaptations of Anemophily.
   Ans. floral adaptations of Anemophily:
   1. Anemophilous plants make certain adaptations in their flowers to favour this process. These are called floral adaptations for anemophily.
   2. Anemophilous flowers are small, inconspicuous without bright colours, nectar and fragrance. Petals are green or highly reduced.
   3. When flowers are unisexual, the male flowers are more numerous than female and are situated at a higher level. Stamens are with long filaments, versatile and exposed anthers. Pollen grains are produced in extremely large numbers to compensate their wastage. These are small, smooth walled, pale yellow in colour and light weighted.
   4. Long style bears large feathery or hairy stigma to trap pollen grains. E.g. Grasses, Maize, Jowar, Sugarcane, etc.

   Ans. floral adaptations of Entomophily:
   1. Entomophilous plants make certain adaptations in their flowers to favour this flowers to favour this process. These are called floral adaptations for entomophily.
   2. Entomophilous flowers are large and attractive, when small; flowers are produced in compact group or inflorescence e.g. Sunflower.
   3. Flowers have attractive bright colours, pleasant fragrance and nectar.
   4. In some plants, additional modifications are made for attraction of insects for e.g.. Corona in passion flower, petaloid bracts in Bougainvilea etc.
   5. The pollen grains have spiny of rough exine. Stigma is sticky. E.g. Jasmine, Rose, Cestrum, Salvia, Bougainvillea.
   6. Few plants develop special mechanism to favour this process e.g. Salvia has developed lever mechanism.

10. Describe autogamy and allogamy. Or different types of pollinations.
    Ans. Types of Pollination:
    1. Self Pollination or Autogamy
       Transfer of pollen grains from anther to the stigma of same flower or a different flower produced on the same plant, is called self pollination. Self pollination may occur by three ways.
       1. Autogamy: It is the transfer of pollen grains from anther to the stigma of same flower. It occurs in bisexual flowers only. e.g. Pea.
       2. Geitonogamy: It is the transfer of pollen grains from anther to the stigma of another flower produced on the same plant e.g. Cucurbits.
3. Plants showing vegetative reproduction:
When the pollen grains are transferred from anther of a flower produced on one plant to the stigma of another flower produced on another plant having similar genetic make-up, then this is also considered as self pollination. This is possible in plants showing vegetative reproduction.

2. Cross Pollination or Allogamy: it is the transfer of pollen grains from anther of a flower to the stigma of another flower produced on a different plant having dissimilar genetic makeup. There are two types of cross pollination; Xenogamy and Hybridization.

Xenogamy: The transfer of pollen grains from anther of a flower to the stigma of another flower produced on a different plant belonging to the same species is called Xenogamy. E.g. Papaya

Hybridization: The transfer of pollen grains from anther of a flower to the stigma of another flower produced on a different plant belonging to a different variety / subspecies /species is called hybridization. For e.g. pollination between two species/varieties of cotton

Ans. In pollination process, the non-motile pollen grains are required to be transferred from anther to the stigma of flower. For this purpose plants have to depend upon certain external carriers. Such carriers are described as agencies of pollination or pollinating agents. Various agencies of pollination are broadly classified in two major categories.

Abiotic agents: These are the nonliving or physical factors like wind or water which help in transfer of pollen grains from anther to the stigma of flower.

Biotic agents: These are the living organisms like insects, birds, bats etc. which help in transfer of pollen grains.

12. Describe hypohydrophily.
Ans. 1. The transfer of pollen grains through the agency of water is Hydrophily.

2. Hypohydrophily: Pollination with the help of water takes place below the water surface in the hydrophytes bearing submerged female flowers.

3. Such plants produce needle like pollen grains which lack the exine. They bear same specific gravity as that of water; therefore, they float below the water surface.

4. Such pollen grains when come in contact with stigma, they coil around it and germinate. E.g. Zostera and Ceratophyllum

12. Describe Epihydrophily
Ans. 1. Epihydrophily: When pollination occurs on the surface of water, it is called epihydrophily. It is a more common type of hydrophily.

2. Vallisneria is a dioecious plant i.e. male and female flowers are submerged and produced on separate plants.

3. At the time of maturity the male flowers are detached from the male
inflorescence and begin to float on water surface.

4. The female flowers have a coiled, long pedicel, which undergoes uncoiling at the time of maturity. They now reach the water surface.

5. The male flowers surround the female flower and undergo anthesis (formation of pollen grains at maturity) due to which pollen grains are deposited on the stigma of female flower and cross pollination is achieved.


Ans. 1. Pollination through the agency of insects is called entomophily. Entomophilous plants develop floral adaptations to achieve it.

2. Few plants develop special mechanism to favour this process e.g. Salvia has developed lever mechanism.

3. In Salvia, flower is bisexual and protandrous. The two stamens of flower have long bifurcated (divaricate) connective.

4. Upper branch of connective bears fertile anther lobe while the lower has sterile anther lobe.

5. An insect when enters in the flower, it pushes the lower sterile lobe as a result the upper fertile anther lobe bends down.

6. It comes in contact with back side of insect body and pollen grains are dusted there.

7. The same insect when visits another flower with matured Gynoecium, the pollen grains are picked up by the receptive stigma Such mechanism is called lever – mechanism.

14. What are out breeding devices?

Ans. Out breeding Devices:

1. Most of the Angiosperms produce bisexual flowers. Cross pollination is preferred by majority of flowering plants and they develop out breeding devices specially to avoid self pollination.

2. In many plants self pollination is avoided as stamens and carpels do not mature simultaneously. This is called dichogamy.

3. In some plants, pollen grains are released much before stigma becomes receptive, this is protandry e.g. sunflower and in some plants, stigma becomes receptive first, this is protogyny e.g. Michelia.

4. The third device to avoid self pollination is genetic mechanism and it is called self-incompatibility or self sterility, e.g. Orchids. Pollen germination on the stigma of the same flower is inhibited.

5. The fourth device is to produce unisexual flowers, i.e. unisexuality. In some plants like Castor, male and female flowers are produced on the same plant and such plants are called monoecious. In such plants autogamy is prevented but not geitonogamy.

6. In dioecious plants like Papaya, male and female flowers are produced on different plants. This condition prevents autogamy as well as geitonogamy.

15. Describe pollen pistil interactions.

Ans. Pollen – Pistil Interaction:

1. All the events from deposition of pollen grain on the stigma to the entry of pollen tube in the ovule are referred to as pollen-pistil interaction. It is very dynamic process involving pollen recognition followed by promotion or inhibition of pollen germination.
2. Cross pollination by any agent is always by chance. It does not guarantee the transfer of the right type of pollen i.e. compatible pollen of the same species as the stigma. Quite often, the wrong type of pollen i.e. either from other species or from the same plant but it is self-incompatible, lands on the stigma. The pistil has the ability to recognize the pollen. If it is right type, the pistil accepts it and promotes post-pollination events that lead to fertilization. If it is wrong type, the pistil rejects it by preventing germination of pollen on the stigma or growth of pollen tube in the style.

3. Thus, only right type, compatible pollen, germinates on stigma and a pollen tube comes out through one of the germ pores and passes through the tissues of stigma and then style.

4. After reaching the ovary, pollen tube enters the ovule through the micropyle and then enters one of the synergids through the filiform apparatus and bursts to release male gametes. All these events are part of pollen-pistil interaction.

5. The ability of pistil to recognize the pollen is due to certain chemical components present in the pollen grain which interact with those of the pistil.

6. Recently, botanists have been able to identify some of the pollen and pistil components and the interactions leading to the recognition, followed by acceptance or rejection. The knowledge gained in this area would certainly help the plant breeders in manipulating pollen-pistil interaction, even in incompatible pollinations, to get desired hybrids.

Ans. Parthenocarpy:
1. Mostly, the fruits are formed after fertilization, but there are some species in which fruits develop without fertilization.
2. This is called parthenocarpy and such fruits are called parthenocarpic fruits, e.g. Banana.
3. Parthenocarpic fruits are without seeds and hence are preferred by consumers.
4. Parthenocarpy can be induced through application of growth hormones like gibberellins, e.g. seedless grapes.

17. Describe Apomictic seeds:
Ans. 1. Seeds are the products of fertilization. In some species of family Asteraceae and some grasses seeds are produced without fertilization. This is called apomixes and such seeds are called apomictic seeds.
2. Apomixis is a form of asexual reproduction that mimics sexual reproduction.
3. In some species, diploid egg cell is formed without reduction division (meiosis) and it develops into an embryo without fertilization and thus apomictic seeds can be formed.

1. Other way to form apomictic seeds is polyembryony. In many Citrus varieties, some of the nucellar cells near the embryo sac start dividing, protrude into the embryo sac and develop into the embryos. Ovule in such species contain many embryos, this is called polyembryony.
2. Active research is going on to make hybrids which will produce apomictic seeds, so that there will be no segregation of characters in the progeny. Farmers can keep on using such apomictic hybrid seeds year after year and need not buy hybrid seeds every year.

17. Describe Micropropagation:
Ans: Micropropagation: To produce large number of plant propagules, tissue culture technique is used and many shoot apices can be produced which are called micropropagules. These micropropagules are used to produce large number of genetically identical plants i.e. clones within short time period. This is called Micropropagation.

19. Explain the terms scion and stock and mention advantages of grafting.
Ans: 1. Grafting is the technique of joining together the parts of two different plants in such a way that they unite and continue their growth as one plant.
2. In Grafting the plant rooted in the soil and on which the part of other plant is inserted, is known as stock while the other which is inserted on stock is called scion (graft).
3. Advantage of grafting process is that some desired character of stock like disease resistance, vigour, etc can be transferred to the scion.

19. What are endospermic and Non-endospermic seeds? Give one example of each.
Ans. After fertilization, PEN forms endosperm which provides nutrition to developing embryo. Whether the endosperm is totally consumed by embryo or not, there are two types of seeds.
1. Endospermic or albuminous seeds: in these seeds endosperm is present. Castor, sunflower, coconut, cereals like maize, wheat, etc. 
2. Non endospermic or ex-albuminous seeds: these seeds do not contain endosperm at maturity. Eg. Pea, bean. In such seeds cotyledons are fleshy.