Endosperm Development

The endosperms are very vital parts of the fertilized embryo. An endosperm forms the surrounding tissue of the growing embryo. They are the primary storage tissue and their main function is to provide starch and other nutrients to the growing embryo.

Types of Seed

Depending on the utilization of the endosperm, there are two types of seeds :

- Albuminous seed: The endosperms provide nutrition to the developing embryo but remain even during the germination of the seed in this type.
- Exalbuminous seed: This type of seed utilizes the endosperms completely. Thus, these seeds are non-endospermic in nature.

Browse more Topics under Sexual Reproduction In Flowering Plants

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Development of Endosperm

There are three types of Endosperms:

- Nuclear
- Cellular
- Helobial

Image Source: yourarticlelibrary.net

But before understanding these types, we need to understand what gives rise to the endosperm. A phenomenon called as ‘double fertilization‘. Each pollen grain consists of two male gametes. Once they reach the ovary, one of the male gametes fuses with the female gamete and forms the zygote.

The other male gamete fuses with the central cell which is diploid resulting in the formation of a triploid endosperm. Thus, the

endosperm can be polyploid as well in certain cases. But, in gymnosperms, the endosperm is haploid.

Nuclear Endosperms

In this type, the cell divisions are free-nuclear divisions where each cell division is not followed by formation of a cell wall. They may or may not form a cell wall towards later stages. With the cell divisions, the nuclei are pushed towards the periphery of the sac giving rise to a large vacuole in the centre.

This type of endosperm is the most common type and is found in maize, wheat, areca nut and coconut. The endosperm of the coconut gives rise to a large central vacuole that gets eventually filled up with the nutritious coconut water.

Cellular Endosperms

This type is the opposite of the nuclear endosperm. In this type, Cell wall formation follows each cell division. Thus, the endosperm divides into many segments. There might not be coherency in the divisions and they can happen along different planes.

Cellular divisions of the endosperm consequently lead to the formation of the coconut meat. Plants like petunia and Dhatura have this kind of endosperm.

Helobial Endosperms

This is an intermediate form between the other two types. In this type, Cell wall formation follows the first cell division. But the subsequent divisions do not lead to cell wall formation. The first cell division occurs along the transverse plane giving rise to clear micropylar and chalazal ends.

The subsequent division after the first often occurs in the micropylar end. Once the number of division in the micropylar end begin to increase, the chalazal end starts to degenerate or disintegrate.

Solved Example for You

Question: Which of the following options are true about Nuclear Endosperms?

A. Cell wall formation
B. Cell wall formation consequently follows only the first cell division

C. Embryo uses the Endosperms

D. No cell wall formation consequently follows the nuclear divisions

Solution: Option D. No cell wall formation is seen following the nuclear divisions.

Fertilization and Post Fertilization Events

Fertilization is the fusion of the male gamete and female gamete to form a zygote in plants. In flowering plants, the fertilization is consequently termed as double fertilization as the two male nuclei in the pollen grain fuse with the egg and the polar nuclei to form the diploid zygote and the triploid endosperm.

Endosperm

As mentioned earlier, the endosperm is formed by the fusion of the haploid male nucleus with the polar nuclei(diploid) to form the triploid endosperm. The endosperm functions to provide nutrition in the form of starch and in some cases even proteins to the developing embryo.

In some cases, the growing embryo completely uses up the endosperm and the resultant seed is called as ex-albuminous seeds. In other cases, the growing embryo does not completely use up the endosperm and the resultant seed contains the endosperm which is highly nutritious. This kind of a seed is called as albuminous seed. Based on the cell

divisions that the endosperm undergoes, it can be of three types: Nuclear, Cellular and Helobial.

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Embryo

Image Source: moziru

The fusion of one of the male nuclei along with the female gamete in the ovule leads to the formation of the zygote. The zygote undergoes cell divisions to give rise to the embryo. The embryo now develops two distinct ends known as the micropylar end towards the base and the chalazal end being the other end. The dividing embryo forms the seed and the embryo sac.

Post Fertilization changes in a Flower

Once the fertilization occurs, there are many changes that occur in the structure of the flower.

- The ovary consequently becomes the fruit
- The ovule consequently becomes the seed
- The integument of the ovules become the seed coat of the seed
- The sepals of the calyx and the petals of the corolla fall off

Formation of Fruit and Seed

Fruit

Image Source: LeavingBio

Once fertilization has occurred and the seed development begins, the ovary undergoes cell division to begin its transformation into a fruit. The wall of the ovary becomes the wall of the fruit known as the pericarp. The pericarp can be further divided into three layers: Epicarp, Mesocarp, and Endocarp. The pericarp acts as a protective covering for the developing seeds until dispersion occurs.

Fruits are divided into two types based on their development: True Fruit which develop from an ovary, False Fruit which does not develop from an ovary.

Seed

The seed develops from the ovules inside the fruit. As mentioned earlier, the integuments of the ovule from the double-layered seed coat. The seed is made up of one or two cotyledons depending upon the class of plants. As the seed develops, many structural changes occur. The seed takes nourishment from the endosperm for its growth and as the seed nears germination, the water from the seed is lost and the micropyle opens up to allow the stalk to grow from it.

Image Source: getrevising

Solved Example for You

Question: Which is true about the seed?

A. It's a double-walled seed coat

B. It develops from the pollen grain

C. It develops from the ovule

D. Both A and C

Solution: Option D. Options A and C are correct in relation to the seed. Option b is incorrect as the seed doesn't develop from the pollen grain.

Gametogenesis in Plants

Gametogenesis is a biological process by which haploid male and female gametes are formed. This occurs in both plants and animals. In higher plants, there are two stages that are involved- sporogenesis and gametogenesis. Sporogenesis is the formation of spores whereas gametogenesis is the formation of gametes.

Gametogenesis: Formation of Male Gametes

(Image Source: www2.le)

Gametogenesis leading to the formation of male gametes in angiosperms occurs in two stages:

- Microsporogenesis
- Microgametogenesis

The androecium of the plant is made up of the stamen, filament, and anthers. The pollen grains that carry the male gametes are contained in the anthers. The anther is anatomically divided into lobes and the lobes are further divided into chambers called microsporangia.

Pollens present in these microsporangia. The microsporangia are also known as pollen sac. It is said that the pollen sac develops from a parent cell known as the archesporial cell. This archesporial cell divides into outer and inner layers. The inner layer forms the sporogenous tissue or cell that forms the pollen mother cell.

This sporogenous tissue is surrounded by the tapetum layer which provided nourishment to the pollen or microspore mother cell present in the sporogenous tissue. The microspore mother cell is diploid and

divides meiotically to form haploid microspores or pollen. This describes the process of microsporogenesis.

The pollen grain is the haploid cell that is made up of two layers: the outer exine layer which is derived from the tapetum and the inner layer called intine. The exine is present all over the pollen grain except in one small part from where the pollen tube emerges post pollination. This small part is known as the germ pore.

The pollen grain divides into two halves- the small generative nucleus and the larger vegetative nucleus. The generative cell gives rise to two male nuclei whereas the vegetative cell gives rise to the pollen tube. This explains the process of microgametogenesis.

Gametogenesis: Formation of Female Gametes

Image Source: projects.ncsu.edu

Gametogenesis in angiosperms to form the female gametes, like the male gametes, occurs in two stages:

- Megasporogenesis
- Megagametogenesis

The word ‘mega-‘ is used instead of ‘micro-‘ in females because the female gametes are said to be larger in size as compared to the male gametes.

The ovules are present inside the ovary in multiple lobes. A cell in the ovule differentiates into a megaspore mother cell. The megaspore mother cell is diploid. This megaspore mother cell undergoes meiosis to form 4 haploid megaspores. 3 of the 4 megaspores degenerate and only one megaspore is left in each ovule. This process is known as megasporogenesis.

This megaspore nucleus now begins to divide mitotically to form 8 nuclei. 6 of the 8 nuclei migrate to opposing poles (3 each) while two nuclei remain at the center. The nuclei that remain at the center are known as polar nuclei. These polar nuclei fuse to form the secondary nucleus. The megaspore matures into an embryo sac. This entire process is called as megagametogenesis.

Solved Example for You

Q1: Part of the pollen grain not covered by exine is called?

a. Pollen tube
b. Germ pore
c. Pollen nuclei
d. Megaspore

Sol. The correct answer is the option ”b”. The part of the pollen grain wall which is not covered by exine is called the germ pore. The germ pore gives rise to the pollen tube.

Morphology of Flower

Flowers are attractive, colourful and often fragrant structures of flowering plants. They are the primary reproductive organs of the plants. Let's understand more about the flower structure and morphology.

Parts of a Flower

The flower structure is broadly divided into the following parts which are often arranged in a whorled pattern.

Image Source: scienceshorts

Pedicel

This is the stalk of the flower. Plants that have a stalk are known as pedicellate flowers whereas those that do not have a stalk are known as sessile flowers.

Receptacle

This is the base of the flower and lies above the pedicel. It is actually a modified shoot that forms the floral axis and holds the layers of the flower.

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Calyx

This layer actually forms the first layer in the flower structure. They are said to be modified leaves. ‘Calyx’ is the word given for a collection of sepals. The sepals or calyx are often green in colour. Their main function is to protect the flower while it is still in the bud stage.

Corolla

This forms the second whorl of the flower structure. ‘Corolla’ is the term given for a collection of petals. The petals are the colourful parts of the flower to which the pollinators are attracted to. In many flowers, the Corolla is scented to further make the flower attractive. Like the sepals, the petals are also said to be modified leaves.

The petals are normally arranged in radial symmetry which means the flower can be divided into three equal parts. This type of symmetry is known as actinomorphic symmetry. In other flowers, the petals are arranged bilaterally symmetrical or an irregular pattern and this kind of an arrangement are called zygomorphic symmetry.

The androecium and gynoecium often follow the symmetry seen in the calyx and corolla. The calyx and corolla are collectively called the perianth.

Androecium

The androecium is a term given to the male reproductive system in a flowering plant. It forms the third whorl in a flower. It is made up of one or more stamens. Each stamen is made up of the following parts:

Filament

It is a long slender tube-like structure that holds the anther at the top of it.

Anther

It is the pollen producing part of the plant. It is made up of four chambers or segments known as pollen sacs. The anthers give rise to microspores during their development and each of these microspores forms a pollen grain that carries the male gamete. The nucleus in the pollen grain divided mitotically to form two male nuclei.

The pollen grain has double layered protective coverings. The inner layer is called the intine whereas the outer layer is called the exine.

The pollen grains are released by the anthers and they get pollinated to the same flower(self- pollination) or to a different flower(cross-pollination).

The petals, sepals, and the stamens often show fusion to form tubes: Petals fuse to form a tube and this condition is called gamopetalous. Stamens fuse to form a tube called the staminal tube.

Image Source: Florendica

Gynoecium

It forms the fourth whorl of the flower and is often found towards the centre of the flower. This is the female reproductive part of a flower.

The gynoecium is a term given to a collection of pistils or carpals. It is made up of the following structures:

- Stigma: It is the sticky end of the style which is responsible for catching pollen when they are pollinated.
- Style: It is a thin tube-like structure that holds the stigma and is attached to the ovary at its base.
- Ovary: It is the swollen basal portion of the flower which houses the ovules which contain the female gamete.

Based on the position of the ovary with respect to the other flower whorls, it can be classified into three types:

- Hypogynous (superior ovary): This type of ovary lies above all the whorls of the flower.
- Perigynous (intermediate ovary): This type of ovary is present in between the other flower layers.

- Epigynous (inferior ovary): This type of ovary is present below the other whorls of the flower. It is often surrounded by the receptacle.

Inflorescence

Image Source: worldoffloweringplants.com

So far we have learned about single or solitary flowers. But, in many plants, the flowers exist in a bunch on a branch along the same or different floral axis. These clusters or bunches of flowers are known as an inflorescence. Though the overall structure of the flowers in an

inflorescence remains the same as seen in a solitary flower, the arrangement of these clusters of flowers varies depending on the type of arrangement of the floral axis

Solved Example for You

Question: What is the inner layer of the protective covering of the pollen grain called?

A. Intine

B. Exine

C. Inner integument

D. Tesla

Solution: Option A Intine. The inner layer of the protective coat of the pollen grain is the thin intine whereas the tough outer covering is called the exine.

Outbreeding Devices and Pollen Pistil Interaction

Flowers are beautiful, right? But do you know how they're formed? What is pollination? What is Outbreeding Devices and Pollen Pistil Interaction? Let's find out more about Outbreeding Devices.

Introduction

The transfer of pollen grains from the anther of one flower to the stigma of the same or different flower is called as pollination. Pollination can be of two types:

- Self-Pollination– The transfer of pollen grains from the anther of one plant to the stigma of the same plant.
- Cross- Pollination– The transfer of pollen grains from the anther of one plant to the stigma of a different plant.

Self-pollination is also called as inbreeding whereas cross-pollination is known as outbreeding.

Reasons for Outbreeding

Continued inbreeding or self- fertilization leads to a condition called as inbreeding depression. This condition is characterized by homozygous genes which are not as vital as they need to be leading to unhealthy offsprings.

In self- pollination, since both the male and female gametes share the same genes, there is no genetic variation seen which is necessary for a better, more productive offspring. So, most plants have many mechanisms that they employ to avoid self -pollination and promote cross-pollination.

Outbreeding Devices

Plants have many mechanisms and devices that they employ to promote cross-pollination. Let us look at a few of them in the following segments:

- Unisexuality: In this case, the plant bears either male or female flowers and is not hermaphrodite. It is also called as Dioecism.

- Dichogamy: In this mechanism, the stigma and anther mature at different times. Depending on who matures first, dichogamy can be further divided into two:
    - *Protandry*: In this type, the androecium matures earlier than the gynoecium. Ex: maize plant
    - *Protogyny*: In this type, the gynoecium matures earlier than the androecium.
- Herkogamy: This is a name given to a condition where there is a natural physical barrier that prevents the pollen of the same flower from entering the ovary.
- Self- Sterility: In this condition, there is a gene that recognizes the similar gene and does not allow the pollen grain to germinate. This is due to the self-sterile gene present in the ovule and the grain.

(Image Source: exxamm)

- Heterostyly: In some plants like the oxalis, the stigma and the anthers are placed at different levels. This prevents the pollen from reaching the stigma and pollinating it.
- Pollen prepotency: In this mechanism, the pollen of a different flower germinates faster than of the same flower thus preventing autogamy.

Pollen-Pistil interaction

(Image Source: learncbse)

Pollination described above is just the beginning or rather the first step of pollen-pistil interaction. The pistil is the female reproductive part of a flowering plant comprising of the ovary, style, and stigma. The pollen-pistil interaction begins with pollination, followed by pollen adhesion to the stigma. After it adheres, it imbibes water and gets hydrated which initiates pollen tube germination.

This pollen tube penetrates through the stigma and the tube grows through the style and reaches the ovary. Once it reaches the ovary, the tube penetrates it and reaches the micropyle of the ovule and enters into the embryo sac. Here, the two male nuclei fuse with the

megaspore and the vegetative nucleus to form the diploid zygote and the triploid endosperm respectively. This fusion of the male and female gametes is known as fertilization.

Solved Example for You

Q1: Which is the word given for describing the condition where the stigma and stamens are at different levels to avoid self- pollination?

a. Heterostyly
b. Herkogamy
c. Dichogamy
d. Prepotency

Sol. The correct answer is the option ”a”. The condition where the stamens and the stigma are placed at different levels to avoid inbreeding is called as heterostyly.

Parthenocarpy and Apomixis

Plants produce fruits and seeds following pollination and fertilization. But, there are other ways fruits and seeds are produced. Parthenocarpy is the formation or development of fruit without fertilization. Apomixis, on the other hand, is the formation of seeds without fertilization. Let us understand more about each of the phenomenon.

Parthenocarpy

Image Source: qsstudy.com

As mentioned above, parthenocarpy is a phenomenon by which fruits are developed without the process of fertilization. The difference between the fruits developed naturally and through parthenocarpy is

that the fruits formed through parthenocarpy are seedless. They are known as seedless or virgin fruits.

Parthenocarpy is a form of asexual reproduction seen in flowering plants. It is found naturally in plants like banana and can also be induced artificially using growth regulators. Parthenocarpy is being increasingly used to produce seedless fruit varieties today because of the high quality and consistency in the yield.

In parthenocarpy, the ovary is stimulated even without pollination and thus fruit development begins without fertilization. This is common in plants that have no ovary or plants that have lost their ability to reproduce sexually due to a mutation.

Seedless Watermelon (Image source: differencebetween)

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Apomixis

While parthenocarpy is the formation of fruit without fertilization, apomixis is the formation of seeds without fertilization. In a natural flow of biological processes, pollination is the first step in the formation of a fruit and seed. The subsequent steps include cell divisions and fertilization.

But, in this case, there is no meiotic division and fertilization of the gametes to form a zygote. The entire process is cut short and seed formation occurs by the way of apomixis. It can be of two types:

- *Sporophytic* – In this type, apomixis occurs from the diploid sporophyte
- *Gametophytic* – In this type, apomixis occurs from the haploid gametophyte

Since apomixis involves the formation of seeds without syngamy, all the seeds are genetically similar. Therefore, it can be used in vegetative propagation.

Learn more about Seeds and Fruits here in detail.

Similarities and Differences

We have understood about parthenocarpy and apomixis individually, but let us understand the similarities and difference between the two.

Similarities

- In both apomixis and parthenocarpy, there is no fertilization involved. So, both produce offsprings similar to parents. In both cases, there is no chance of diversity in genes.
- Since both the types of phenomenon do not involve fertilization, they are both used as asexual means or vegetative propagation methods. Though both methods are asexual, they still use the sexual organs of the plant- the ovary and the ovules.

Differences

- Both apomixis and parthenocarpy are asexual modes of reproduction, apomixis is the formation of seeds whereas parthenocarpy is the formation of fruits without fertilization.

- Apomixis produces genetically identical mother cells whereas parthenocarpy produces genetically identical offsprings.
- Apomixis is seen in angiosperms and gymnosperms but parthenocarpy is seen in plants and animals. Parthenocarpy in animals is called as parthenogenesis. Learn more about Endosperm Development here.

Solved Example for You

Q1: Which of the following fruits undergo parthenocarpy naturally?

a. Apple
b. Mango
c. Banana
d. Plums

Sol. The correct answer is the option ”c”. Fruits like Banana, fig, pineapple, grapes, and oranges show parthenocarpy naturally as well. Today, in order to get seedless varieties of fruits, they are being sprayed with hormones to simulate parthenocarpy and give rise to seedless fruits.

Pollination

Pollination is the transfer of pollen grains from the anther of one flower to the stigma of the same or another flower. It is said to be the first process of sexual fertilization in flowering plants. Pollen grains contain the male gamete and are present in the anthers of the flower.

Types of Pollination

Pollination can be of two types:

- Self- Pollination
- Cross-Pollination

Let us understand more about each type of pollination a little in detail.

Self- Pollination

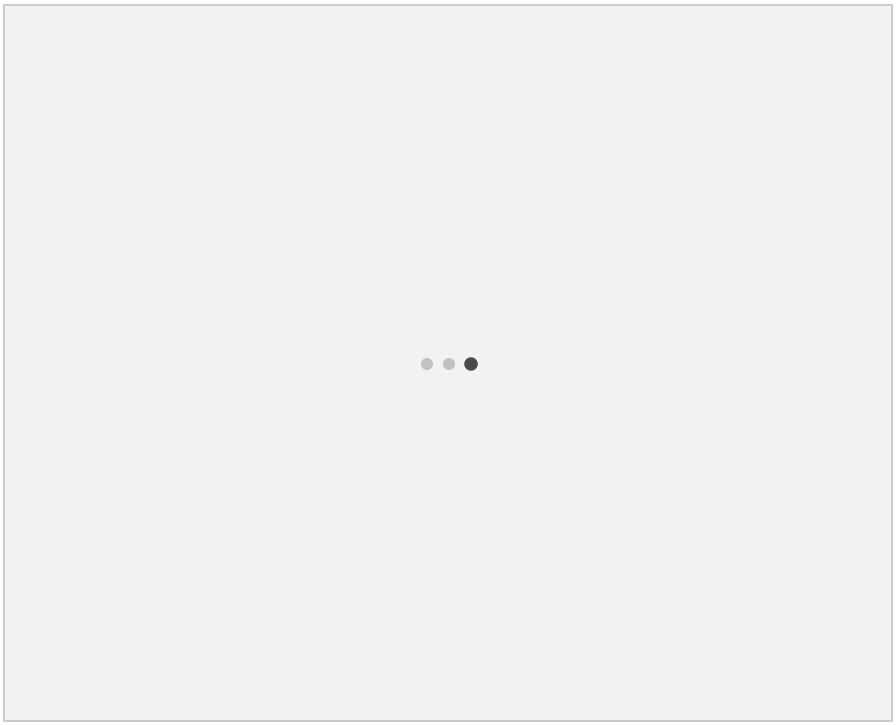

Image Source: newtonsapple

When the pollen is transferred from the anthers of a flower to the stigma of the same flower, it is called as self- pollination. This form of pollination is common in hermaphrodite or dioecious plants which contain both male and female sexual parts on the same flower.

In self-pollinating plants, there is less dependence on the external factors to cause pollination. These plants depend on wind or other smaller insects that visit the flower regularly. In self- pollinating flowers, the anthers, and stigma are of similar lengths to facilitate the

transfer of pollen. Self – pollination can be further divided into two types:

- *Autogamy*– In this type of self-pollination, the pollen is transferred from the anthers of one flower to the stigma of the same flower.
- *Geitonogamy*– In this type of self- pollination, the anthers are transferred from the anthers of one flower to the stigma of another flower but on the same plant.

Advantages of self – pollination

- In self- pollination, there is no diversity in the genes and therefore the purity of the race is maintained.
- The plants do not depend on external factors for pollination and even smaller quantities of pollen grains produce have a good success rate in getting pollinated.
- Self- pollination ensures that recessive characters are eliminated.

Disadvantages of self- pollination

- Since there is no mixing up of genes, there are no new characters or features that are introduced into the lineage of the offsprings.
- Self- pollination is said to reduce the vigor and vitality of the race as there are no new features introduced.
- Without new characters introduced, the resultant offsprings' immunity to diseases reduces.

Cross-Pollination

In this type of pollination, the pollen is transferred from the anthers of one flower to the stigma of another flower. In this case, the two flowers are genetically different from each other. Cross-pollination is always dependant on another agent to cause the transfer of pollen. The agents of pollination include birds, animals, water, wind, and insects. Based on the agent of pollination, cross-pollination can be of different types:

- Hydrophilous Flowers-These flowers are pollinated by water means. The flowers are often very small and inconspicuous to other agents. They do not have any fragrance or too much color on their petals. The pollen is adapted to be able to float in water.

Image Source: drgpbiology

- Zoophilous flowers– In this type of pollination, the pollinating agents are animals like human beings, bats, birds etc. The zoophilous flowers have pollen that is designed to stick on to the body of the animal so that they can be easily carried from one flower to another.
- Anemophilous flowers– These flowers are pollinated by the agency of wind. These flowers, like zoophilous flowers, are small and inconspicuous. Another important feature of flowers that are wind pollinated is that they are very light so that they are easily carried by the wind. The pollen grains are very light, non-sticky and sometimes winged.
- Entomophilic flowers– These flowers are pollinated by insects. These flowers are often attractive to look at with bright petals and are fragrant to attract the insect visitors to them. They often have broad stigmas or anthers to allow the insect to perch on it. Many of the insect-pollinated flowers also secrete nectar which attracts bees, butterflies or other similar insects to the flowers.

The pollen grains in these flowers are often spiny or have extensions that help them to stick on to the body of the insects.

Image Source: brainkart

- Ornithophilous flowers– These flowers are pollinated by birds. Very few flowers and birds show this form of pollination.

Advantages of cross-pollination

- Cross-pollination is beneficial to the race of the plant as it introduces new genes into the lineage as a result of the fertilization between genetically different gametes
- Cross-pollination improves the resistance of the offsprings to diseases and changes in the environment.
- The seeds produced as a result of cross-pollination are good in vigor and vitality.
- If there are any recessive characters in the lineage, they are eliminated as a result of genetic recombination.
- It is the only way unisexual plants can reproduce.

Disadvantages of cross-pollination

- There is a high wastage of pollen grains that need to be produced to ensure fertilization occurs.
- There are high chances that the good qualities may get eliminated and unwanted characteristics may get added due to recombination of the genes.

Solved Example for You

Q1: What is pollination caused by birds called?

a. Entomophily
b. Ornithophily
c. Anemophily
d. Zoophily

Sol. The correct answer is the option ”b”. Ornithophily is the pollination caused by birds.

Seeds and Fruits

The seeds and fruits are the results of fertilization or sexual reproduction in plants. The ovary in angiosperms develops into the fruit whereas the ovules become the seeds enclosed within the fruit. Seeds are found both in gymnosperms and angiosperms. Let us individually learn about seeds and fruits.

Fruits

One of the many healthy things available in the world today is fruits. They are mostly sweet to taste, are filled with nutrients and some of them are like tomatoes are also eaten as vegetables. The fruit is broadly divided into the pericarp which is the various covering layers of the fruit and the seed or seeds which are present inside it. The pericarp of a fruit can be further divided into:

Image Source: en.wikipedia.org

- *Exocarp*– It is the outermost layer which is formed from the outer layer or the epidermis
- *Mesocarp*– Is the second or the middle layer which is often juicy and varies in thickness in different fruits
- *Endocarp*– It is the innermost layer and also is different in different kinds of fruits

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Development of a Fruit

As mentioned earlier, once pollination and fertilization occur, the zygote is formed and the ovary begins to differentiate into the fruit. The outer wall of the ovary begins to differentiate into the pericarp whereas the seed develops within the fruit itself.

Types of Fruits

Fruits can be classified in many ways.

- True and False Fruits
- Simple, Aggregate, and Multiple Fruits
- Simple fruits are further classified as fleshy and dry fruits depending on their appearance

True and False Fruits

Image Source: slideplayer

- True Fruits- True fruits are those that are formed solely from the ovary with ovules inside it. No other flower parts form a part of this type of fruit.
- False Fruits-False fruits are formed from the ripened ovary along with some other flower parts like the base or receptacle, the perianth etc.

Simple, Aggregate, Multiple and Accessory Fruits

Simple Fruits

These fruits are formed from a single pistil only. They are further divided into Fleshy and Dry fruits based on the nature of their pericarp and its layers.

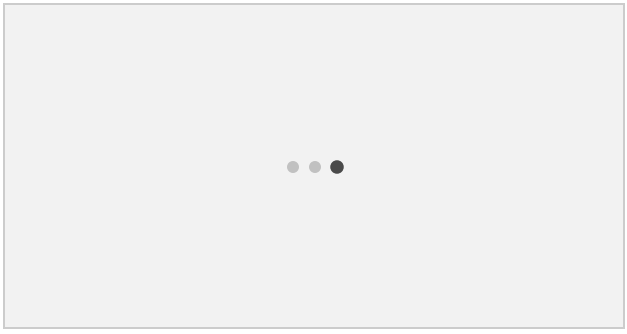


Image Source: wizznotes

I. Fleshy Fruits

Fleshy fruits, as the name mentions, have a fleshy and juicy pericarp. They are further of many different types:

- Drupe- In this type of fleshy simple fruit, the exocarp is thin, the mesocarp is thick and juicy while the endocarp is stony. Examples of such fruits are mango, plum, and coconut.

- Berry- In this type of fleshy fruits, the endocarp is absent and the seeds are scattered in the mesocarp. Examples are grapes, banana, tomato.
- Pome- Is a false fruit as the thalamus forms a part of the fruit. Examples of this type of fruit are apples, pears.

II. Dry fruits

Dry fruits do not have juicy or thick pericarps and are of two types.

- Dehiscent dry fruits

These fruits burst on their own to release the seeds. They are of many types:

- Follicle- These fruits are formed from a single carpel and dehisce along one suture or margin only. Ex: Calotropis
- Legume- These fruits are formed from a single carpel and dehisce along both sutures. Ex: legumes, beans

- Capsule- Is formed from multiple carpels. It has many pores or chambers in it and it dehisces by splitting into many parts to release seeds. Example: Lady’s Finger
- Siliqua-It is formed by two carpels and dehisces from the base upwards with the seeds attached to the base itself. Example: mustard

Image Source: Toppr.com

- Indehiscent dry fruits

These fruits do not dehisce or burst to release the seeds. They are of many types:

- Achene: Is single-seeded and the seed coat is separate from the fruit coat or pericarp. Example: Magnolia
- Caryopsis: Is similar to the achene except that the seed coat and the fruit coat are united or fused. Example: Maize
- Samara: One-seeded fruit with wings. Example: Hiptage, Ash
- Nut: One-seeded fruit with a stony pericarp. It may contain husk on its wall as well. Example: Oak, Chestnut
- Cypsela: Is formed from a bicarpellary inferior pistil. It is also one-seeded. Example: Sunflower

Image Source: ficcio

Aggregate Fruits

These fruits are developed from an aggregate or cluster of multiple separate pistils that are borne on a single flower. This aggregate or group of fruits that are developed from a single flower are known as an etaerio. Example: Raspberry.

Multiple Fruits

When an entire inflorescence develops into a single fruit, it is called a multiple fruits. Example: Pineapple, figs, mulberry, jackfruit.

Seeds

Once fertilization occurs, the mature ovule begins to differentiate into a seed. A seed contains many parts, namely:

(Image Source: societynatureo.blogspot)

- Seed Coat– is formed from the integuments of the ovule. The seed coat contains a hilum which is a scar that represents the spot where the ovule was attached to the ovarian wall. The seed coat is present all over the seed except for a small pore called as the micropyle which the where the new plant will germinate on finding a favorable environment.
- The cotyledons-Monocots contain a single cotyledon whereas the dicots contain two cotyledons.The two cotyledons act as appendages and help in absorption of food from the endosperm.
- Endosperm– It is a triploid tissue that is formed by the fusion of one of the male nuclei(haploid) and the vegetative

nuclei(diploid). The endosperm functions to provide nutrition to the developing embryo.Learn more about the Endosperm development here.

- Seeds can be classified as endospermic and non-endospermic seeds. Those seeds that utilize the endosperm during the embryo development completely are called as non-endospermic seeds. Those seeds which do not completely utilize the endosperm during the growth of the embryo, are called as endospermic seeds.
- Embryo– is made up of a central axis that contains two ends- the root apex and the radicle, and the shoot apex and the hypocotyl. The radicle gives rise to the primitive root whereas the hypocotyl gives rise to the primitive shoot.

Solved Example for You

Q1: Which of the following fruits have a missing endocarp and the seeds are found scattered in the mesocarp?

a. Berry
b. Drupe

c. Pome

d. Caryopsis

Sol. The correct answer is the option ”a”. Examples of this type of fruits are grapes, banana, tomato.

Sexual Reproduction

Don’t beautiful and colourful flowers on plants and trees always please us? Did you know the flowers are the sexual organs of the body and help it to reproduce sexually? Plants can be unisexual and bisexual depending on the parts they contain. Let us understand these parts for plant reproduction in this section.

Parts of a Flower in Plant Reproduction

A bisexual flower typically contains the male and female parts in it. There are other supporting structures as well apart from the reproductive parts for sexual reproduction.

(Source: Instructables)

There are four main layers of the parts of a flower:

- Calyx
- Corolla
- Androecium
- Gynoecium

Calyx

It is a collection of sepals. The sepals are the green coloured small florets that are considered the first layers of the flower from the base. In some cases, the sepals have colour. They are called petaloid. Their main function is to protect the flower while it is still in the bud stage.

Corolla

This layer is a collection of petals. It is the second layer of the flower, superior to the calyx layer. The petals are the colourful part of a flower that helps to attract insects and birds to the flower to facilitate pollination.

Androecium

It is the third layer of the flower superior to the Corolla. This is a term given to the male parts for sexual reproduction of a plant. The androecium is made up of a collection of stamens. Each stamen has the following parts:

- Anther- It is present at the tip of the filament. It is internally lobed. Pollen grains are inside the Anther Lobe.
- Filament- It is a thin stalk-like structure that holds the anther

Gynoecium

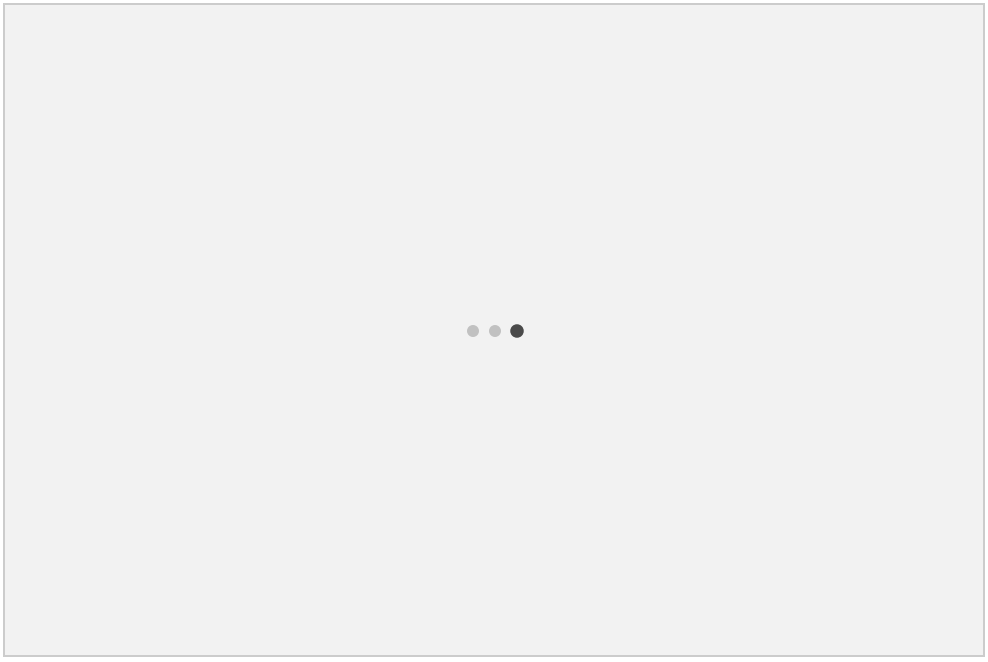
A Gynoecium is a collection of carpels. It is the fourth layer of a flower. It has three parts:

- Stigma- It is a small and sticky landing structure. The pollen grain from the same or different flower stick to it. This structure acts as a landing for the insects or birds that act as pollinating agents.
- Style- It is a thin stalk-like structure that holds the stigma.

- Ovary- It is the base of the style and contains the ovules which contain the female gametes.

Pollination and Fertilization in Plant Reproduction

The transfer of pollen grains from the anther of one flower to the stigma of the same or another flower is known as pollination. It can be caused by insects, birds, wind, water and animals including man. These are together called as pollinating agents.



(Source: googlegalaxyscience)

Types of Pollination

- Self-Pollination: Self-Pollination is when the pollen of one flower transfers to the stigma of the same flower. Many flowers that are hermaphrodite see this kind of pollination. However, there are many advantages and disadvantages of this type of pollination. Many flowers have various mechanisms to prevent self-pollination or promote cross-pollination.
- Cross-Pollination: Cross-Pollination is when the pollen of one flower transfers to the stigma of another flower. This type of pollination helps brings about genetic variation in the species and allow the plant to withstand changes in the environment better. Once the pollen has landed on the stigma of a flower, the pollen tube develops to transfer the pollen to the ovules which contain the female gamete.

Microsporogenesis results in the formation of Male Gametes and Megasporogenesis results in the formation of Female Gametes.

Microsporogenesis

- The anthers contain the pollen mother cell (2n-diploid) that undergoes meiosis to form microspores.
- Tetrad is the result of the microspore mother cell diving and the formation of 4 microspores.
- The Anther releases the microspores/pollen grains when it is mature.

Megasporogenesis

Megasporangium are the Ovules. They are in the ovary and contain the female gametes. Megasporogenesis is the formation of megaspores from the megaspore mother cell (diploid). The resultant of the meiosis fo the megaspore mother cell is 4 haploid megaspores. Of the four cells that form, only one is functional while the other degenerate.

Double Fertilization happens in angiosperms. This is because the male gamete that enters the ovule has two nuclei. One of the male gametes fuses with the female gamete to form a diploid zygote whereas the other one forms a triploid endosperm by fusing with the diploid polar nuclei. The zygote divides to form the future plant whereas the endosperm provides nutrition to the developing embryo.

(Source: jagranjosh)

Events after Fertilization in Plant Reproduction

After fertilization, the ovary becomes the fruit and the ovules become the seeds. The other structures like the calyx, corolla and the remaining parts of the androecium and gynoecium degenerate or fall off.

Solved Examples for You

Question: Which of the following is a triploid structure?

A. Microspore

B. Megaspore

C. Polar Nuclei

D. Endosperm

Solution: Endosperm. The male gamete that enters the ovule has two nuclei. One of the nuclei fuses with haploid male gamete to form a diploid zygote. The second male nucleus fuses with the diploid polar nuclei to form the triploid endosperm.