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CBSE – XIIth

Biology

Central Board of Secondary Education (CBSE)

Quick Revision Notes + Sample Questions

SIERRA INNOVATIONS

INDEX

01

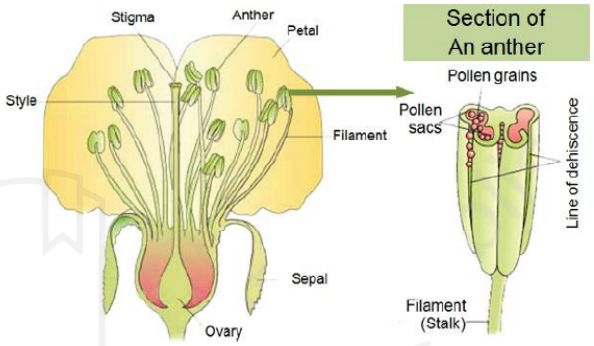
Sexual Reproduction in Flowering Plants

Introduction:

1.1 Flower– A Fascinating Organ of Angiosperms

Flowers are Morophological and embryological structures and are the sites of sexual reproduction. Parts of flower in which units of sexual reproduction envelop are stamen (male) and ovary (female).

KB Stamen is the structural and functional part of androecium.



Ncert Pg.No. 4 A diagrammatic representation of L.S. of a flower (a) A typical stamen,(b) Three-dimensional cut section of an anther

1.2 Pre-Fertilisation: Structures & Events :

- Several hormonal and structural changes result in differentiation & development of the floral primordium.
- Inflorescences bear the floral buds and then the flowers.
- **Androecium** is the male reproductive structure and consists of a whorl of stamens.
- Gynoecium represents female reproductive structure and consists of ovary, style and Stigma.

1.2.1 Structure of a Flower :

A typical flower has Two parts: **Androecium & Gynoecium.**

"A stamen has two parts:

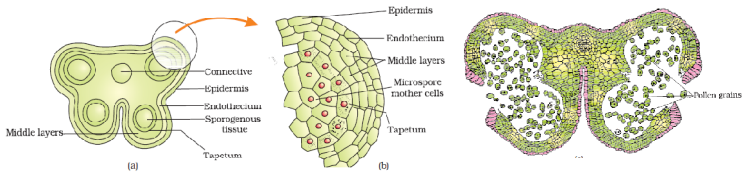
a. **Filament:** Long and slender stalk. Its proximal end is attached to the thalamus or the petal of the flower.

b. **Anther:** Terminal and typically bilobed. Each lobe has Two thecae (dithecous). Often a longitudinal groove runs lengthwise separating the theca.

NCERT Fill-ups

1. Long and slender stalk called the_____.
2. The _____ end of the filament is attached to the thalamus or the petal of the flower.
3. A typical angiosperm anther is _____.

Transverse Section of Anther:



NCERT True-False

4. Several hormonal and structural changes are initiated which lead to the differentiation and further development of the floral primordium. **T/F**
5. The gynoecium represents the male reproductive organ. **T/F**
6. A typical angiosperm anther is bilobed with each lobe having two theca, i.e., they are dithecous. **T/F**

(a) (b) (c)

NCERT Pg. No. 6 (a)Transverse section of a young anther; (b)Enlarged view of one microsporangium showing wall layers; (c) A mature dehisced anther

The proximal end of the filament is attached to the thalamus or the petal of the flower. The number and length of stamens are variable in flowers of different species. Each anther is generally bilobed structure, i.e., it has two anther lobes and each lobe of anther has two theca which are called pollen sacs or pollen chambers therefore they are called Dithecous.

A longitudinal groove runs lengthwise and separates the theca.

- The anther is a four-sided (tetragonal) structure consisting of four Microsporangia located at the corners, two in each lobe.
- The **microsporangia** develop further and become Pollen sacs. They extend longitudinally all through the length of an anther and are packed with pollen grains.

Structure of a Microsporangium

- A typical microsporangium is nearly circular in outline.
- It is surrounded by four wall layers:

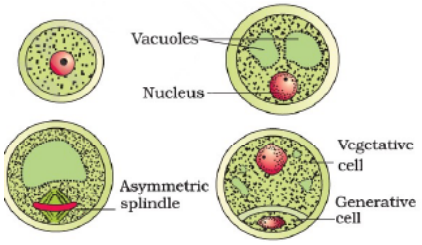
i. Epidermis
ii. Endothecium,
iii. Middle layers
iv. Tapetum (innermost layer).

- The outer three layers give protection and help in dehiscence of anther to release the pollen.
- The tapetum nourishes the developing pollen grains.

  Cells of the tapetum contain dense cytoplasm and generally have more than one nucleus.
- In young anther, each microsporangium has sporogenous tissue at centre.
  It consists of compactly arranged homogenous diploid cells (sporogenous cells).

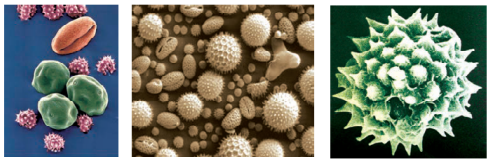
Microsporogenesis :

- As the anther develops, each“sporogenous cell (microspore mother“cell or pollen mother cell) undergoes**“meiotic** divisions to form microspore“tetrads (microspores arranged in a“cluster of four cells).
- Formation of microspores from pollen mother cell (PMC) through meiosis is called microsporogenesis.
- As the anthers mature and dehydrate, the microspores dissociate from each other and develop into pollen grains.
- Each microsporangium contains thousands of pollen grains. They are released with the dehiscence of anther.
- **Pollen grain (male gametophyte):** “Generally spherical. 25-50 Âµm in diameter.
  Cytoplasm is surrounded by a plasma membrane.
  A pollen grain has a two-layered wall: exine and intine.
- **Exine:** Hard outer layer. Made up of sporopollenin (highly resistant organic material). It can withstand high temperature and strong acids and alkali. Enzymes cannot degrade sporopollenin.“Exine has apertures called germ pores where sporopollenin is absent.“Pollen grains are preserved as fossils due to the presence of sporopollenin. Exine exhibits patterns and designs.
- **Intine:** Inner wall. It is a thin and continuous layer made up of cellulose and pectin.
  The cytoplasm of pollen grain is surrounded by a plasma membrane.
  At maturation, pollen grain contains two cells.



***NCERT Pg.No. 7 stages of a microspore maturing into a pollen* grain**

KB Epidermis is the outermost protective layer of anther. It becomes hygroscopic in nature due to presence of fibrous thickening. So it helps in dehiscence of anther.



NCERT Pg.No. 7 Scanning electron micrograhs of a few pollen grains

NCERT Pg. No. 7 Enlarged

NCERT Core

Pollen grains are yellowish and powdery. They are well preserved as fossils because of the presence of sporopollenin.a

NCERT Fill-ups

7. The innermost wall layer is the _____

8. In the centre of each microsporangia a compact arranged tissue is _____

9. The two part of a typical _____ the long and slender stalk called _____ and the terminal generally bilobed structure called _____.

NCERT Core

Sporopollenin can withstand high temperatures and strong acids and alkali. No enzyme that degrades sporopollenin is so far known.

(i) **Vegetative cell:** Bigger and has abundant food reserve; large irregularly shaped nucleus

(ii) **Generative cell:** Small and floats in the Cytoplasm of vegetative cell; spindle shaped with dense cytoplasm and a nucleus.

The viability of pollen grains depend on the prevailing temperature and humidity.

In some cereals such as rice and wheat, pollen grains lose viability within 30. minutes of their

Pollen grains of a large number of species are stored for years in liquid nitrogen (-196 ºC). Such stored pollen can be used as pollen banks, similar to seed banks, in crop breeding programmes.

NCERT Core

In over 60 per cent of angiosperms,pollen grains are shed at 2-celled stage. In the remaining species, the generative cell divides mitotically to give rise to the two male gametes before pollen grains are shed (3-celled stage).

NCERT pg.No. 8 Pollen products

Economic Importance of Pollen Grains:

- These are rich in nutrients. Pollen tablets are used as food supplements. Pollen tablets & syrups increase performance of athletes and race horses.
- They are stored for years in liquid nitrogen (-196^0 C). They can be used as pollen banks in crop breeding programmes.
- Pollen grains of some plants (e.g. Parthenium or carrot grass) are allergic for some people. It leads to chronic respiratory disorders (asthma, bronchitis, etc.).

NCERT Core

Monocarpellary: Gynoecium consist of a single pistil.
Multicarpellary: Gynoecium more than one pistil.

1.2.2 The Pistil, Megasporangium (ovule) and Embryo Sac

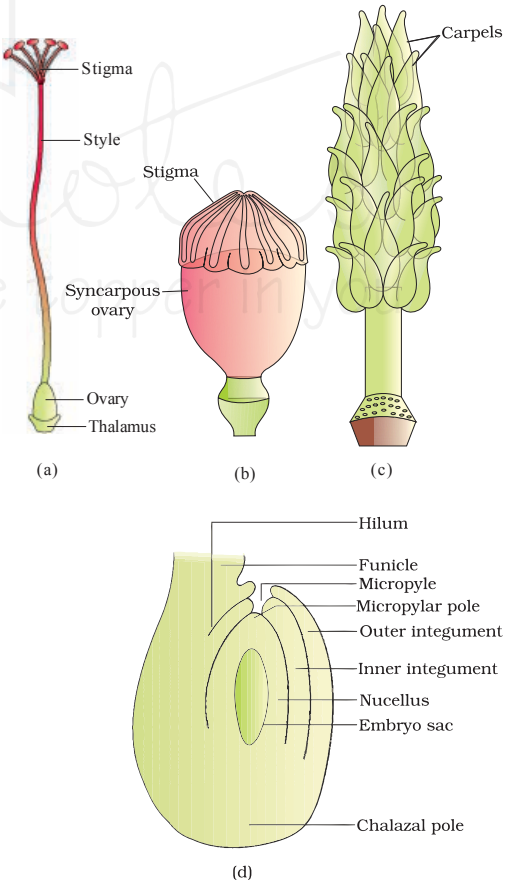
Pistil

Each pistil has three parts:

(i) **Stigma:** It serves as a landing platform for pollen grains.

(ii) **Style:** It is the elongated slender part beneath the stigma.

(iii) **Ovary:** It is the basal bulged part of the pistil. Inside the ovary is the ovarian cavity (locule). The Placenta is located inside the ovarian cavity.



(NCERT Pg. No. 9 (a) A dissected flower of Hibiscus showing pistil (other floral parts have been removed); (b) Multicarpellary, syncarpous pistil of Papaver ; (c) A multicarpellary, apocarpous gynoecium of Michelia; (d) A diagrammatic view of a typical anatropous ovule)

The Ovule or Megasporangium

- Megasporangia or ovules arise from the placenta.
- Each ovule attached to the placenta by means of a stalk called funicle.
- The point of attachment of the funicle with the ovule is called hilum. Hilum represents the junction between ovule and Funicle.

- Each ovule covered by one or two protective envelopes called integuments.
- Integuments encircle the nucellus except at the tip where a small opening called the micropyle is organised.
- Chalaza represents the basal part of the ovule and is located opposite the micropylar end.
- Enclosed within the integuments is a mass of cells called the nucellus.
- Cells of the Nucellus have abundant reserve food materials.
- Located in the nucellus is the embryo sac or female gametophyte.
- An ovule generally has a single embryo sac formed from a megaspore.

Megasporogenesis :

- It is the formation of megaspores from megaspore mother cell (MMC).
- Ovules generally differentiate a single MMC in micropylar region of the nucellus. It is a large cell containing dense cytoplasm and a prominent nucleus.
- MMC undergoes meiosis to produce four megaspores.

Female Gametophyte

- In majority of flowering plants, one megaspore is functional while the other three degenerates.
- The functional megaspore develops into the female gametophyte. The embryo sac formation from a single megaspore is called monosporic development.

Formation of Embryo Sac

- The nucleus of the functional megaspore divides mitotically to form two nuclei which move to the opposite poles, forming the 2-nucleate embryo sac.
- Two more sequential mitotic nuclear divisions result in the formation of the 4-nucleate and later the 8-nucleate stages of the embryo sac.
- These divisions are strictly free nuclear, i.e., nuclear divisions are not followed immediately by cell wall formation.
- After the 8-nucleate stage, cell walls are laid down leading to the organisation of the typical female gametophyte or embryo sac.
- 6 of the 8 nuclei are surrounded by cell walls and organised into cells. Remaining 2 nuclei (polar nuclei) are situated below the egg apparatus in the large central cell.

NCERT Fill-ups

13. Name any plant that caused pollen allergy _____.

14. If a flower has many pistil and they are fused this condition is called as _____.

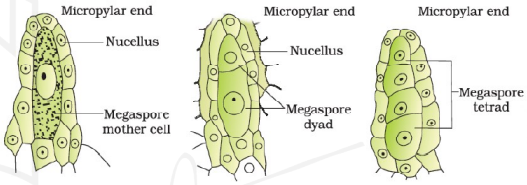
15. What is the process known in which a megaspore is form from the megaspore mother cell? _____

16. Each pistil has three parts _____, _____ and _____.

17. The _____ is elongated slender part beneath the stigma.

18. The basal bulged part of the pistil is the _____.

19. The body of the ovule fuses with _____ in the region called hilum.



NCERT Pg. No. 10 **Parts of the ovule showing a large megaspore mother cell, a dyad and a tetrad of megaspores.**

NCERT True-False

20. Each ovule has one or two protective envelopes called integuments. **T/F**

21. The synergids have special cellular thickenings at the micropylar tip called antipodals. apparatus. **T/F**

22. A typical angiosperm embryo sac at maturity, though 8 nucleate and 7 celled. **T/F**

NCERT Core

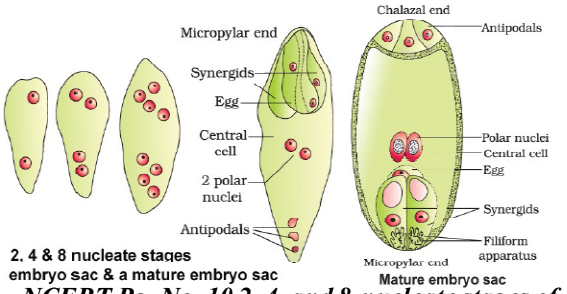
Nucellus , microspore mother cells (MMC), and megaspore mother cells are diploid cells and their ploidy is 2n while the ploidy of female gametophyte is n.

NCERT Core

Filiform Apparatus helps to guide the pollen tubes into the synergid.

Distribution of The Cells within The Embryo Sac

- Three cells are grouped together at the micropylar end and constitute the egg apparatus.
- The egg apparatus consists of two Synergids and one egg cell.
- The synergids have special cellular thickenings at the micropylar tip called filiform apparatus.



- Three cells are at the chalazal end and are called the Antipodals.
- The large central cell has two polar nuclei. Thus, a typical mature angiosperm embryo sac is 8 - nucleate and 7 - celled.

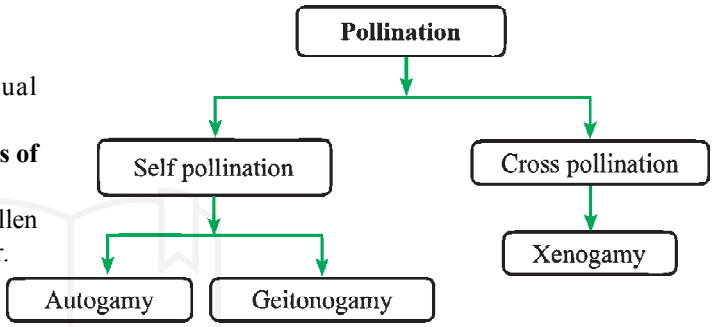
NCERT Pg. No. 10 2, 4, and 8-nucleate stages of embryo sac and a mature embryo sac, A diagrammatic r3epresentation of the mature embryo sac.

1.2.3 Pollination :

- Pollination is defined as the transfer of pollen grains from anther to the stigma of a pistil.
- Pollination is an essential event in the sexual reproduction of seed bearing plants.

Depending on the source of pollen, pollination is of different types:

a. ***Autogamy (self-pollination):*** It is the transfer of pollen grains from the anther to stigma of the same flower.
In a normal flower which opens and exposes the anthers and the stigma, complete autogamy is rather rare.
Autogamy in such flowers requires Synchrony in pollen release and stigma receptivity and also, the anthers and the stigma should lie close to each other so that self-pollination can occur.
Same plant such as Viola (common pansy), Oxalis & Commelina produce two types of flowers:



NCERT Core

Monoecious plants prevent autogamy but not geitonogamy while dioecious plants prevent both autogamy and geitonogamy.

- **Chasmogamous flowers:** They are similar to flowers of other species with exposed anthers and stigma.
- **Cleistogamous flowers:** Flowers of some plants remain closed to ensure self pollination. In such flowers the anthers and stigma lie close to each other. When anthers dehisce in the flower buds, pollen grains come in contact with the stigma to effect pollination. They are invariably autogamous as there is no chance of cross-pollen landing on the stigma.

NCERT Fill-ups

23. Depending on the source of pollen, pollination can be divided into _____types.

24. _____is the only type of pollination which during pollination brings genetically different types of pollen grains to the stigma.

NCERT True-False

25. Cleistogamous flowers which are similar to flowers of other species with exposed anthers and stigma. **T/F**

26. Cleistogamous flowers are invariably autogamous as there is no chance of crosspollen landing on the stigma. **T/F**

27. Dioecious condition prevents both autogamy and geitonogamy. **T/F**

28. Continued self-pollination result in outbreeding depression. **T/F**

29. Monoecious plants prevents geitonogamy but not autogamy. **T/F**

b. ***Geitonogamy:***

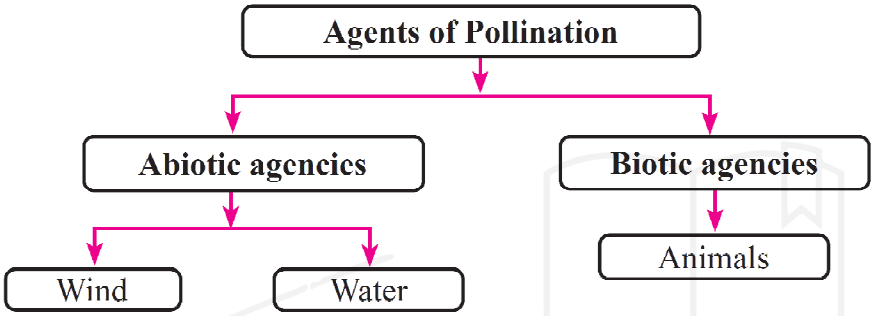
In this type, transfer of pollen grain from anther to the stigma of another flowerof the same plant occurs. Although geitonogamy is functionally cross-pollination involving a pollinating agent, genetically it is similar to autogamy since the pollen grains come from the same plant.

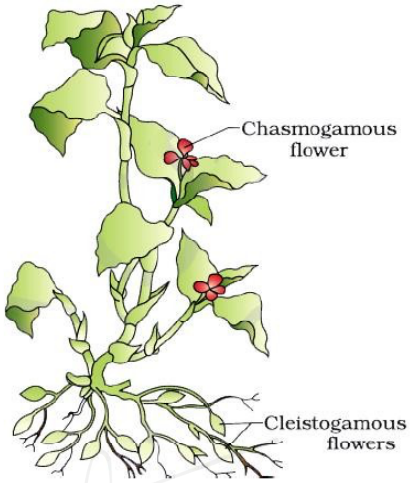
c. ***Xenogamy:*** It is the transfer of pollen grains from anther to the stigma of a different plant. It brings genetically different pollen grains to the stigma.

NCERT Core

Xenogamy is the only type of pollination which during pollination brings genetically different types of pollen grains to the stigma.

Agents of Pollination :





NCERT Pg. No. 12 Cleistogamous flowers

1. Wind pollination

- Pollination by wind is more common amongst abiotic pollinations.
- The pollen grains of wind pollinated plants are light and non-sticky so that they can be transported in wind currents.
- They often possess well-exposed Stamens so that the pollens are easily dispersed into wind currents and large often-feathery stigma to easily trap air-borne pollen grains.
- Wind pollinated flowers often have a single ovule in each ovary and numerous flowers packed into an inflorescence. E.g., tassels in corn cob consist of stigma and style which wave in the wind to trap pollen grains.
- Wind-pollination is quite common in Grasses.

NCERT Core

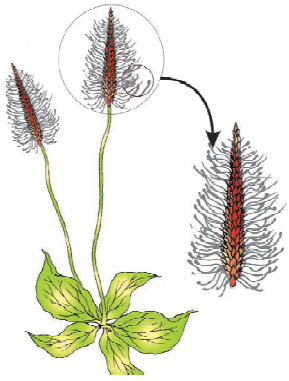
Many insects may consume pollen or the nectar without bringing about pollination. Such floral visitors are referred to as pollen/ nectar robbers.

NCERT Core

Both wind and water pollinated flowers are not very colourful and do not produce nectar because there is no need to attract the pollinating agents.

2. Water pollination

- Pollination by water is limited to about 30 genera, mostly monocotyledons and therefore it is quite rare.
- Vallisneria and Hydrilla are water pollinated plants that grow in fresh water and several marine sea-grasses such as Zostera are also pollinated by water.
- In most of the water-pollinated species, pollen grains are protected from wetting by a mucilaginous covering.
- In a majority of aquatic plants such as water hyacinth and water lily, the flowers emerge above the level of water and are pollinated by insects or wind as in most of the land plants.



NCERT Pg. No. 13

A wind-pollinated plant showing compact inflorecence and wellexposed stamens

3. Pollination by animals :

- Majority of flowering plants use animals as pollinating agents. E.g. Bees, butterflies, flies, beetles, wasps, ants, moths, birds (sunbirds & humming birds) bats, primates (lemurs), arboreal (tree-dwelling) rodents, reptiles (gecko lizard & garden lizard) etc.
- Pollination by insects (Entomophily), particularly bees is more common.
- Often flowers of animal pollinated plants are specifically adapted for a particular species of animal.
  Insect-pollinated flowers are large, colourful, fragrant and rich in nectar.
  Since animals are attracted to flowers by colour and/or fragrance, the flowers pollinated by flies and beetles secrete foul odours to attract pollinating animals.
  When the flowers are small, a number of flowers are clustered into an inflorescence to make them conspicuous.

KB **Bud pollination**
Flowers mature before the opening of the buds to ensure self-pollination. E.g., wheat, rice, pea, etc.

NCERT Fill-ups

30. The _____ has the ability to recognise the pollen, whether it is compatible or incompatible

31. All the events- from pollen deposition on the stigma until pollen tubes enter the ovule-are together referred to as _____ interaction.

32. If the female parent bears flowers, removal of anthers from the flower bud before the anther dehisces using a pair of forceps is necessary. This step is referred to as _____.

NCERT True-False

33. The dialogue between pollen and pistil is mediated by physical components of the pollen interactingwith those of the pistil. T/F

34. It is only in recent years that 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. T/F

Rewards to Pollinators :

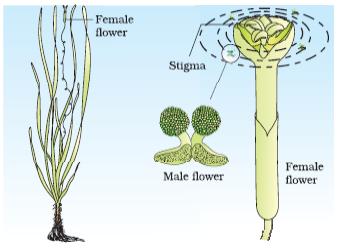
- To sustain animal visits, the flowers have to provide rewards to the animals.
- Nectar and Pollen grains are the usual floral rewards.
- For harvesting the rewards from the flower the animal visitor comes in contact with the anthers and the stigma. The body of the animal gets a coating of pollen grains, which are generally sticky in animal pollinated flowers. When the animal carrying Pollen on its body comes in contact with the stigma, it brings about pollination.
- In some species floral rewards are in providing safe places to lay eggs. For example, the relationship between a species of moth and the plant Yucca. Here, both species cannot complete their life cycles without each other. The moth deposits its eggs in the locule of the ovary and the flower, in turn, gets pollinated by the moth. The larvae of the moth come out of the eggs as the seeds start developing.

NCERT Core

Double fertilisation is an event unique to flowering plants.

NCERT Core

Stages of embryo development
Zygote →Pro-embryo → Globular embryo →Heart shaped embryo→Mature embryo



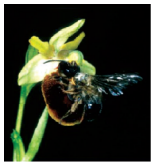
NCERT pg. No. 14 Pollination by water in Vallisneria, Insect pollination

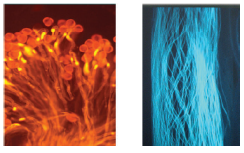
1.2. 4 Outbreeding Devices :

- Continued Self pollination results in inbreeding depression.
- Flowering plants have developed many devices to discourage self pollination and to encourage cross-pollination.

These are as follows:

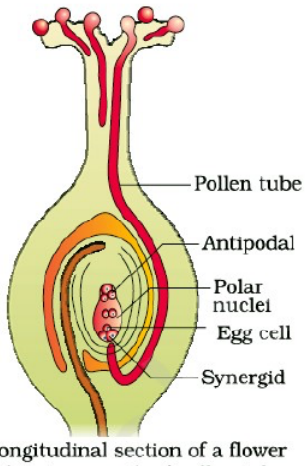
- ***Unsynchronized pollen grain:*** In some species, pollen release and stigma receptivity is not synchronised.
  Either the pollen is released before the stigma becomes receptive or stigma becomes receptive much before the release of pollen. This prevents Autogamy.
- In some species, the anther and stigma are placed at different positions so that the pollen cannot come in contact with the stigma of the same flower.
  This also prevents autogamy.





NCERT Pg. No. 16 Pollen grains germinating on the stigma; (b) Pollen tubes growing through the style

- ***Self-incompatibility:*** In some species, a genetic mechanism called self-incompatibility prevents self-pollen (from the same flower or other flowers of the same plant) from fertilising the ovules by inhibiting pollen germination or pollen tube growth in the pistil.
- ***Unisexuality:*** The production of unisexual flowers also prevents self-pollination. When both male and female flowers are present on the same plant, this is called monoecious condition such as castor and maize. In several species such as papaya, male and female flowers are present on different plant that is each plants is either male or female, this condition is called Dioecious.

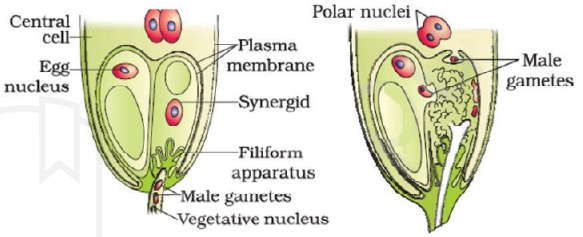


Longitudinal section of a flower showing growth of pollen tube

NCERT Pg.No. 16 L.S. of pistil showing path of pollen tube growth

Pollen-pistil Interaction :

- Pollen-pistil interaction is a dynamic process involving Pollen recognition followed by promotion or inhibition of the pollen.
- All the events, from pollen deposition on the stigma until pollen tubes enter the ovule, are together referred to as Pollen-pistil interaction.
- All pollinations do not lead to successful fertilisation because sometimes pollen of the wrong type, either from other species or from the same plant (if it is self-incompatible), land on the stigma.
- The pistil has the ability to recognize the pollen, whether it is of the right type (compatible) or of the wrong type (incompatible).
- If it is of the right type, the pistil accepts the pollen and promotes post-pollination events that lead to fertilisation. ***(NCERT Pg.No. 16 enlarged view of an egg apparatus showing entry of pollen tube into a synergid,Discharge of male gametes into a synergid and the movements of the sperms, one into the egg and the other into the central cell)***



a) Entry of tube into a synergid (b) Discharge of male gametes into a synergid, then to egg & central cell

- If the pollen is of the wrong type, the pistil rejects the pollen by preventing pollen germination on the stigma or the pollen tube growth in the style.
- If pollination is compatible, the pollen grain germinates on the stigma to produce a pollen tube through one of the germ pores.
- The contents of the pollen grain move into the pollen tube. Pollen tube grows through the tissues of the stigma and style and reaches the ovary.
- In some plants, pollen grains are shed at two-celled condition (a vegetative cell and a generative cell). In such plants, the generative cell divides and forms the Two male gametes during the growth of the pollen tube in the stigma.
- In plants which shed pollen in the three-celled condition, pollen tubes carry the two male gametes from the beginning. Pollen tube, after reaching the ovary, enters the ovule through the micropyle and then enters one of the synergids through the Filiform apparatus.

NCERT Fill-ups

35. The male gamete fuses with two polar nuclei located in the central cell produce a triploid _____.

36. The formation of PEN involves fusion of 3 haploid nuclei, which is termed as _____.

37. The central cell after triple fusion becomes _____ and develops into _____.

NCERT True-False

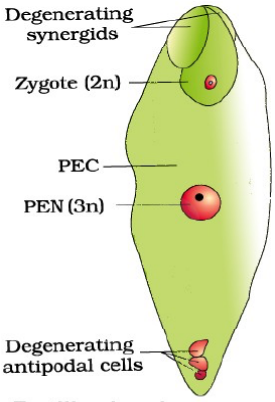
38. The other male gamete moves towards the two polar nuclei located in the central cell and fuses with them to produce a triploid primary endosperm nucleus (PEN). **T/F**

39. Double fertilisation is an event unique to flowering plants. **T/F**

40. The primary endosperm cell divides repeatedly and forms a haploid endosperm tissue. **T/F**

Artificial Hybridisation :

- It is one of the major approaches of crop improvement programme.
- Only the desired pollen grains are used for pollination and the stigma is protected from contamination (from unwanted pollen).
  This is achieved by two techniques:
- **Emasculation:** Removal of anther from the flower bud before its dehiscence by using a pair of forceps.
- **Bagging:** Emasculated flowers covered by a bag made up of butter to prevent contamination of stigma with unwanted pollen. This process is called bagging. When the stigma of bagged flower attains receptivity, mature pollen grains are dusted on the stigma, and the flowers are rebagged, and fruits allowed to develop.
- If the female parent produces Unisexual flowers, there is no need for emasculation. The female flower buds are bagged before the flowers open. When the stigma becomes receptive, pollination is carried out using the desired pollen and the flower rebagged.



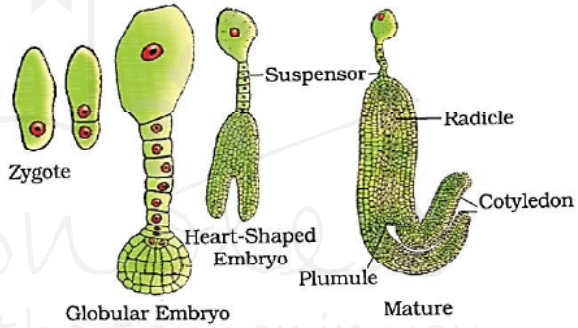
Fertilized embryo sac

NCERT Pg. No. 18

1.3 Double Fertilisation:

Showing zygote and Primary Endosperm Nucleus (PEN).

- After entering the synergid, the pollen tube releases two male gametes into the cytoplasm of the synergid. **One male gamete moves towards the egg cell and fuses with its nucleus (syngamy) to form zygote (diploid).**
- The other male gamete moves towards the two polar nuclei located in the central cell and fuses with them to produce a triploid primary endosperm nucleus (PEN). As it involves fusion of 3 haploid nuclei, it is called **triple fusion.**
- Since two types of fusions (syngamy & triple fusion) take place in an embryo sac, it is called double fertilisation.
- It is an event unique to flowering plants.



Stages in embryo development in a dicot

NCERT Pg. No. 18

- The Central cell after triple fusion becomes the primary endosperm cell (PEC) and develops into the endosperm while the zygote develops into an embryo.
- The pollen tube releases two male gamete into the cytoplasm of synergid.

1.4 Post-Fertilisation: Structures & Events :

- Events of endosperm and embryo development, maturation of ovule into seed and ovary into fruit, are collectively termed as post-fertilisation events.

1.4.1 Endosperm :

- Development of endosperm takes place before the embryo development.
- Primary endosperm cell divides repeatedly to form a triploid endosperm.
- Cells of endosperm tissue are filled with reserve food material and are used for the nutrition of the developing embryo.
- PEN undergoes successive Nuclear division to give rise to free nuclei. This called free-nuclear endosperm.
- Subsequently cell wall formation takes place and become cellular endosperm.
- The coconut water is free nuclear endosperm (made up of thousands of nuclei) and the surrounding white Kernel is the cellular endosperm.

- In pea, groundnut and beans, endosperm may either be completely consumed by the developing embryo before seed maturation.
- In castor and coconut, endosperm may persist in the mature seed and be used up during seed germination.

1.4.2 Embryo :

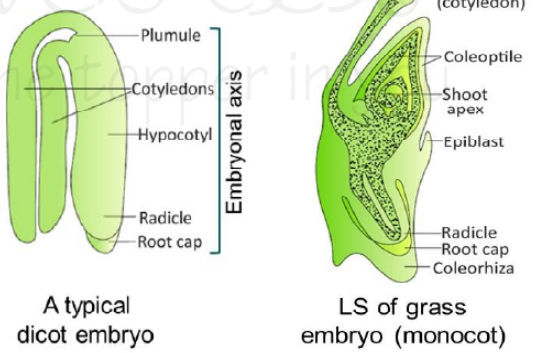
- Embryo develops at the Micropylar end of the embryo sac where the zygote is situated.
- Most zygotes divide only after certain amount of endosperm is formed. This is an adaptation to provide assured nutrition to the developing embryo.
- The dicot and monocot seeds differ greatly but the early stages of embryo development (embryogeny) are similar.

Monocot Embryovs. Dicot Embryo :

Dicot embryo

- A typical dicotyledonous embryo consists of an embryonal axis and two cotyledons.
- Embryonal axis above the cotyledon is the epicotyl.
- Terminal part of the epicotyls is the plumule or stem tip.
- The cylindrical portion axis below the cotyledon is the hypocotyl.
- The terminal part of the hypocotyl is called the radicle (root tip). The root tip is covered by the root cap.

- Monocot embryo possesses only one cotyledon.
- In grass family, the cotyledon is called Scutellum.
- Scutellum is situated towards one side (lateral) of the embryonal axis.
- At the lower end, the embryonal axis has radicle and the root cap enclosed in an undifferentiated sheath called coleorhiza.
- The portion of the Embryonal axis above level of attachment of scutellum is called epicotyl.
- Epicotyl has the shoot apex or plumule enclosed by hollow foliar structure called Embryonal axis. (***NCERT Pg.No. 19 A typical dicot embryo; L.S. of an embryo of grass***)



A typical dicot embryo — LS of grass embryo (monocot)

1.4.3. Seed

- Seed is the final product of the sexual reproduction in angiosperms.
- Seed consists of seed coat, Cotyledon and an embryonal axis. In a maize seed, scutellum is considered as cotyledon because it absorbs food materials and supplies them to the embryo.

NCERT Fill-ups

46. The portion of embryonal axis above the level of cotyledons is the _____, which terminates with the _____ or stem tip.
47. In the grass family, the cotyledon is called____ that is situated towards one side of the embryonal axis.
48. Epicotyl has a shoot apex and a few leaf primordia enclosed in a hollow foliar structure called _____.
49. In some seeds such as black pepper and beet, the residual persistent nucellus is _____.
50. The wall of the ovary develops into the wall of fruit called _____.

NCERT Fill-ups

41. Endosperm is a _____ tissue.
42. Ovary is a _____ ovule.
43. Endosperm is completely consumed by the developing embryo in _____ and _____.
44. The coconut water from tender coconut is _____ endosperm and the surrounding white kernel is_____ endosperm.
45. Embryo develops at the _____ end of the embryo sac where zygote is situated.

NCERT True-False

51. Mature seeds may be non-albuminous or exalbuminous. T/F
52. The general metabolic activity of the embryo fastens. T/F
53. The embryo may enter a state of activity called dormancy, or if favourable conditions are available (adequate moisture, oxygen and suitable temperature),they germinate. T/F

- The cotyledons of the embryo are simple structures, generally thick and swollen due to storage of food reserves.
- Remnants of nucellus in the matured seed is called perisperm. E.g., black peeper, beet.
- The wall of the ovary develops into the wall of fruit called pericarp.
- Integuments of ovules harden as tough protective seed coats. The micropyle remains as a Small pore in the seed coat. This facilitates entry of oxygen and water into the seed during germination.

NCERT Core

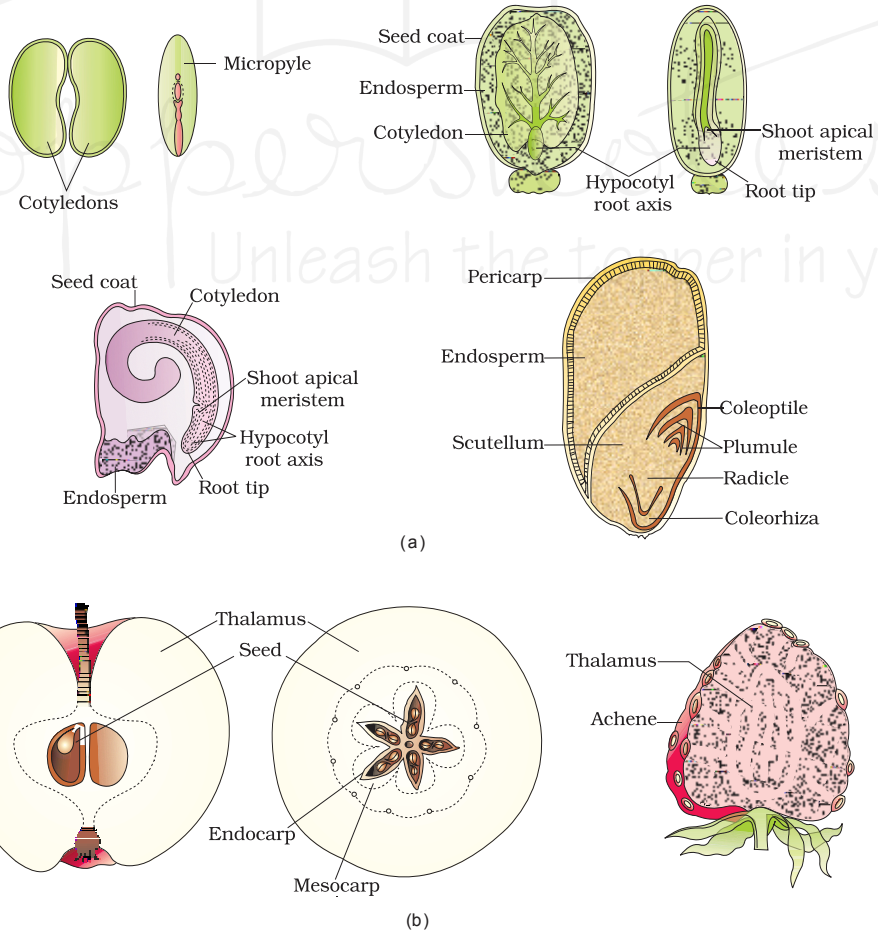
A recent record of 2000 years old viable seed is of the date palm, Phoenix dactylifera discovered during the archeological excavation at King Herod's palace near the Dead sea.

NCERT Core

Fruits of some plants contain very large number of seeds. E.g., Orchid fruits, fruit of some parasitic species such as Orobanche and Striga.

- The general metabolic activity of the embryo slows down. The embryo may enter a state of inactivity called Dormancy , or if favourable ocnditions are available (adequate moisture, oxygen and suittable temperature), they germinate.
- As the seed matures, its water content is reduced and seeds become relatively dry (10-15percent moisture by mass)
- As ovules mature into seeds, the ovary develops into a fruit, i.e., the transformation of ovules into seeds and ovary into fruit proceeds simultaneously.

Non-albuminous or ex-albuminous seeds	Albuminous seeds
• Non-albuminous seeds have no Residual endospermas it is completely consumed during embryo development. •E.g., pea, groundnut, sunflower.	•Albuminous seeds retain a part of endosperm as it is not completely used up during embryo development. • E.g., wheat, maize, barley, castor



NCERT Pg. No. 21 (a) Structure of some seeds. (b) False fruits of apple and strawberry

Types of Fruits

(i) ***Fleshy fruits:*** Pericarp is soft or fleshy at maturity. E.g., guava, orange, mango, etc.

(ii) ***Dry fruits:*** Pericarp is hard at maturity. E.g., groundnut, mustard, etc.

(iii) ***True fruits:*** If the fruit is developed only from the ovary, it is called true fruit.

(iv) ***False fruits:*** If the fruit is developed from the part other than ovary, E.g., from thalamus, contributes to fruit formation. Such fruits are called false fruits. E.g., apple, strawberry, cashew, etc.

(v) ***Parthenocarpic fruit :*** If a fruit is develops without fertilisation, it is called parthenocarpic fruit, e.g., Banana. Parthenocarpy may be induced by the application of hormones, as in tomato.

NCERT Fill-ups

54. In mango the _____ is the edible part.
55. The term used for fruits which are develop without fertilisation is _____.
56. In a few species like apple, cashew, etc, the _____ contributes to fruit formation. Such fruits are called false fruits.
57. The oldest viable seed is that of Lupinus arcticus excavated from _____.

KB

An aggregate fruit develops from a single flower, with multicarpellary, apocarpous, superior ovaries and each of them develops into simple fruitlets.

NCERT True-False

58. Parthenocarpic fruits have seeds. T/F
59. The hard seed coat provides protection to the mature embryo. T/F

Advantages of Seeds to Angiosperms

- Since reproductive processes such as pollination and fertilisation are independent of water, seed formation is more dependable.
- Seeds have better adaptive strategies for dispersal to new habitats and help the species own.
- Dehydration and dormancy of mature seeds are crucial for storage of seeds which can be used as food throughout the year and also to raise crop in the next season.
- The hard seed coat provides protection to the young embryo.
- Being products of sexual reproduction, they generate new genetic combinations leading to variations.
- The oldest viable seed of a lupine, Lupinus arcticus excavated from Arctic tundra.
  The seed germinated and flowered after an estimated record of 10,000 years of dormacy.

NCERT Fill-ups

60. A seed have more than one embryo this condition is called as _____
61. Apomixis is common in _____ and _____.
62. Apomicts have several advantages in____ and ___.
63. In species such as ____ and _____, each ovule contains many embryos.
64. _____ is a form of asexual reproduction that mimics sexual reproduction.

Parthenocarpy

- In some species, fruit develop without fertilisation. Such fruits are called parthenocarpic fruits and the process is called parthenocarpy. E.g., banana
- Parthenocarpy can be induced by application of growth hormones (auxin, gibberellin). Such fruits are seedless.

1.5 Apomixis and Polyembryony

- Apomixis is a type of Asexual reproduction which mimics the sexual reproduction.
- In this method, seeds are produced without fertilisation.
- Apomixis is very common in Asteraceae and grasses.
- Hybrid plants are developed by apomixis to maintain the genetic identity.
- Apomicts have several advantages in horticulture and agriculture.

NCERT True-False

65. There are several ways of development of apomictic seeds. T/F
66. In some species, the haploid egg cell is formed without reduction division and develops into the embryo without fertilisation. T/F
67. Hybrid seeds need not to be produced every year. T/F

- In some species each ovule contains many embryos, seed having more than one embryo is termed as polyembryony.

Ways of Development of Apomictic Seeds

- In some species, diploid egg cell is formed without meiosis and develops into seed without fertilisation.
- In citrus and mango, the nucellar cells surrounding the embryo sac starts dividing, protrude into the Embryo sac and develop into embryo.

Sample Questions CBSE

1.2 Pre-fertilisation : Structures and Events

Stamen, Microsporangium and Pollen grain

MCQ

1. The structure of bilobed anther consists of

(a) 2 thecae, 2 sporangia

(b) 4 thecae, 4 sporangia

(c) 4 thecae, 2 sporangia

(d) 2 thecae, 4 sporangia.

(Term-I, 2021-22) R

2. Pollen grains are well preserved as fossils because of presence of

(a) sporopollenin (b) cellulose

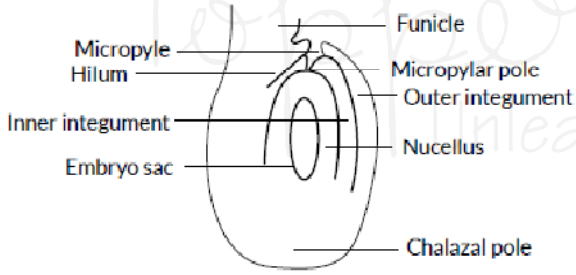
(c) lignocelluloses (d) pectocellulose.

(Term-I, 2021-22) R

Pistil, Megasporangium and Embryo sac

MCQ

3. In the figure of anatropous ovule given below, choose the correct option for the characteristic distribution of cells within the typical embryo sac.



	Number of cells atchalazal end	Number of cells at micropylar end	Number of nuclei left incentral cell
(a)	3	2	3
(b)	3	3	2
(c)	2	3	3
(d)	2	2	4

(Term-I, 2021-22) R

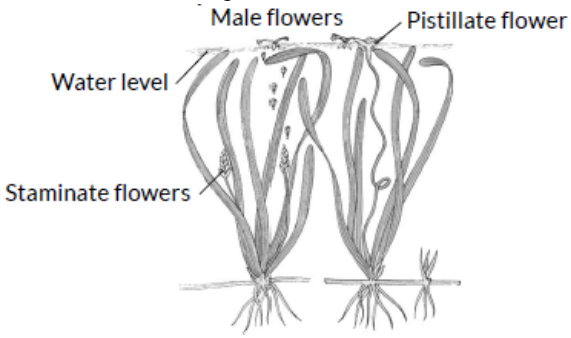
LA (5 marks)

4. Trace the development of a megaspore mother cell to the formation of mature embryo sac in a flowering plant. **(2022-23) U**

Pollination

MCQ

5. In the dioecious aquatic plant shown, identify the characteristics of the male flowers that reach the female flowers for pollination.



	Size of the flower	Colour of flower	Characteristic feature of pollen grain
(a)	small	brightly coloured	light weight and non-sticky
(b)	large	colourless	large and sticky
(c)	small	white	small, covered with mucilage
(d)	large	colourless	non sticky

(Term-I, 2021-22) Ap

6. A botanist studying Viola (common pansy) noticed that one of the two flower types withered and developed no further due to some unfavorable condition, but the other flower type on the same plant survived and it resulted in an assured seed set.

Which of the following will be correct?

(a) The flower type which survived is cleistogamous and it always exhibits autogamy.

(b) The flower type which survived is chasmogamous and it always exhibits geitonogamy.

(c) The flower type which survived is cleistogamous and it exhibits both autogamy and geitonogamy.

(d) The flower type which survived is chasmogamous and it never exhibits autogamy.

(Term-I, 2021-22) Ap

VSA (1 mark)

7. How does pollination take place in water hyacinth and water lily?

(2020-21) R

SA II (3 marks)

8. State the agent(s) which helps in pollinating the following plants. Explain the adaptations in these plants to ensure pollination :

(a) Corn

(b) Water hyacinth

(c) Vallisneria

(2022-23) An

1.3 Double Fertilisation

MCQ

9. In a fertilised ovule, n, 2n and 3n conditions occur respectively in

(a) antipodal, zygote and endosperm

(b) zygote, nucellus and endosperm

(c) endosperm, nucellus and zygote

(d) antipodals, synergids and integuments.

(Term-I, 2021-22) R

1.4 Post-fertilisation : Structures and Events

Endosperm

MCQ

10. The coconut water from tender coconut is

(a) cellular endosperm

(b) free nuclear endosperm

(c) both cellular and nuclear endosperm

(d) free nuclear embryo.

(Term-I, 2021-22) R

VSA (1 mark)

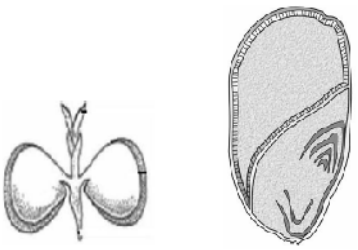
11. Why does endosperm development precede embryo development?

(2020-21) U

Embryo

MCQ

12. Which of the following statements are true related to seed X and Y?



Seed X Seed Y

(i) Seed X is dicot and endospermic or albuminous.

(ii) Seed X is dicot and non-endospermic or nonalbuminous.

(iii) Seed Y is monocot and endospermic or albuminous.

(iv) Seed Y is monocot and non-endospermic or non-albuminous.

Choose the correct option with the respect to the nature of the seed.

(a) (i), (iii) (b) (ii), (iii)

(c) (i), (iv) (d) (ii), (iv)

(Term-I, 2021-22) Ap

13. The thalamus contributes to the fruit formation in

(a) banana (b) orange

(c) strawberry (d) guava.

(Term-I, 2021-22) R

VSA (1 mark)

14. How many meiotic divisions are required to produce 76 seeds in a guava fruit? **(2020-21) Ev**

1.5 Apomixis and Polyembryony

MCQ

15. **Assertion (A) :** Apomictic embryos are genetically identical to the parent plant.

Reason (R) : Apomixis is the production of seeds without fertilisation.

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).

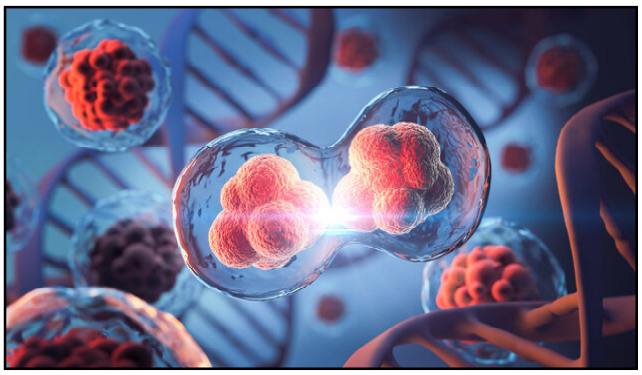
(b) Both (A) and (R) are true and (R) is not the correct explanation of (A).

(c) (A) is true but (R) is false.

(d) (A) is false but (R) is true. **(2022-23) R**

02

Human Reproduction

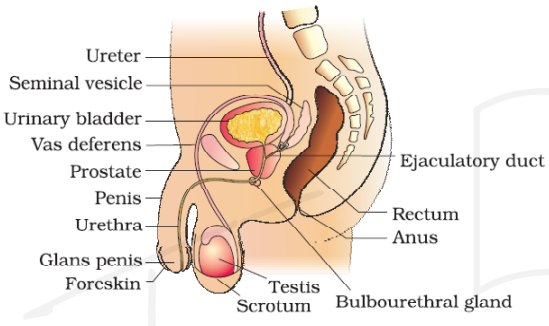


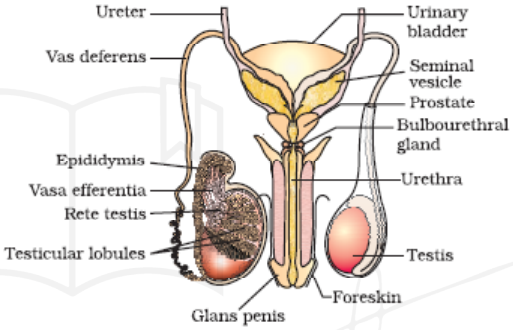
Introduction :

- Reproduction is the production of young once by and organism. Humans are Sexually reproducing and viviparous.

2.1 *Male Reproductive System :*

- The male reproductive system is located in the pelvis region.
- It consists of paired testes, Accessory ducts, Accessory glands & external genitalia (penis).





NCERT Pg. No. 27 (a) Diagrammatic sectional view of male pelvis showing reproductive system.
(b) Diagrammatic view of male reproductive system (part of testis is open to show inner details).

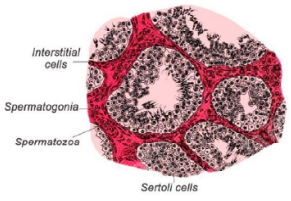
a. Paired testes

- Primary sex organs that produce sperms & testosterone.
- Testes are formed within the abdomen. Soon after the birth or at the 8th month of pregnancy they descent into the scrotal sac (scrotum) through inguinal canal.
- The low temperature (2-2.5^0 C less than the body temperature) of scrotum helps for proper functioning of testes and for spermatogenesis.
- Each testis is oval shaped. Length 4-5 cm, width: 2-3 cm.
- Each testis has about 250 testicular lobules.
- Each lobule contains 1-3 coiled seminiferous tubules.

NCERT Fill-ups

The removal of which part labeled in the diagram would most directly affect the temperature regulation of sperms? ____(1)____.
Based on the diagram, the number of tubes that combine to form the Rete testis corresponds to the number of ____(2)____.
The structure labeled →eVas deferens→f is a continuation of ____(3)____.

- Seminiferous tubule is lined internally with spermatogonia (male germ cells) & Sertoli cells (supporting cells).
- Sertoli cells give shape and nourishment to developing spermatogonia.
- The regions outside the seminiferous tubules (interstitial spaces) contain small blood vessels, interstitial cells (Leydig cells) and immunologically competent cells.
- Leydig cells secrete testicular hormones (androgens).



NCERT Pg.No. 28 Diagrammatic sectional view of seminiferous tubule

b. Accessory ducts (Duct system)

- Include rete testis, vasa efferentia, epididymis & vas deferens. They conduct sperms from testis as follows:
- Seminiferous tubules→ rete testis (irregular cavities) → vasa efferentia (series of fine tubules) → epididymis (stores sperms temporarily) → vas deferens → join with duct of seminal vesicle to form ejaculatory duct → urethra → urethral meatus.

NCERT Core

Ejaculatory ducts store and transport the sperms from the testis to the outside through urethra.

c. Accessory glands

- Include a prostate gland, a pair of seminal vesicles and a pair of Cowper' glands (bulbo-urethral glands).
- Their collective secretion (seminal plasma) is rich in fructose, Ca and enzymes.
- Seminal plasma + sperms → semen.
- Functions of seminal plasma:
- Helps for transporting sperms.
- Supplies nutrients to sperms.
- Provides alkalinity to counteract the acidity of uterus.
- Secretions of Cowper' glands lubricate the penis.
- Secretions of epididymis, vas deferens, seminal vesicle & prostate help for maturation and motility of sperms.

d. Penis (external genitalia)

- It is a copulatory organ made of erectile spongy tissue.
- When spongy tissue is filled with blood, the penis erects. It facilitates insemination.
- The cone-shaped tip of the penis is called glans penis. It is covered by prepuce (foreskin).

NCERT Core

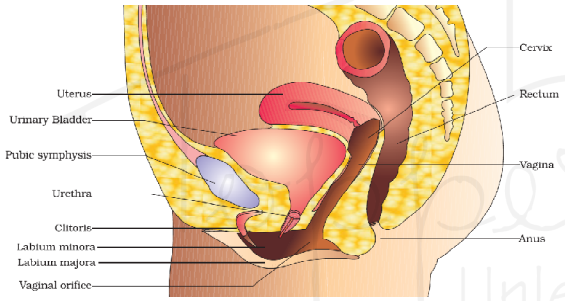
The secretions of the bulbourethral gland help in the lubrication of the penis.

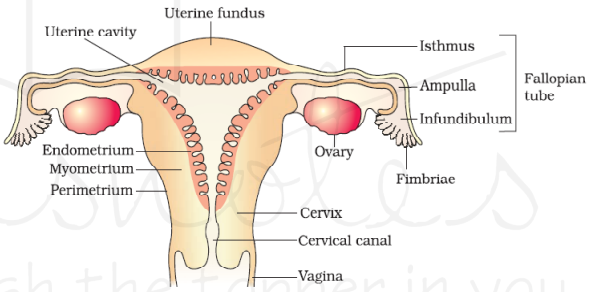
NCERT Fill-ups

4. Scrotum helps in maintaining the low temperature of the testes about _____ which maintains the temperature of testes _____ than the normal body temperature necessary for process known as _____.
5. The male reproductive system is located in the _____ region in humans.
6. The testes are situated outside the male abdominal cavity within a pouch called _____.
7. In testes, _____ cells provide nutrition to the germ cells.
8. The enlarged end of penis called _____ is covered by a loose fold of skin called _____.

2.2 Female Reproductive System :

It includes Ovaries, Accessory ducts & External genitalia.





NCERT Pg. No. 29 (a) Diagrammatic sectional view of female pelvis showing reproductive system. (b) Diagrammatic sectional view of the female reproductive system

a. Paired ovaries

- Primary sex organs which produce ova (female gamete) & steroid ovarian hormones (estrogen & progesterone).
- Each ovary is 2-4 cm in length.
- They are located on both side of the lower abdomen and connected to the pelvic wall and uterus by ligaments.
- Each ovary is covered by a thin epithelium which encloses the ovarian stroma.
- The stroma has outer cortex and inner medulla.
- Ovary contains groups of cells (Ovarian follicles). Each follicle carries a centrally placed ovum.

b. Accessory ducts (Duct system)

Include 2 oviducts (Fallopian tubes), a uterus & vagina.

Oviducts: Each oviduct (10-12 cm long) has 3 parts:

NCERT Core

The endometrium undergoes cyclical changes during menstrual cycle while the myometrium exhibits strong contraction during delivery of the baby.

NCERT True-False

9. Leydig cells synthesise and secrete testicular hormones called androgens and other immunologically incompetent cells are also present. **T/F**
10. The epididymis leads to vas deferens that descends to the abdomen and loops over the urinary bladder. **T/F**
11. Secretions of accessory glands constitute the seminal plasma which is rich in glucose, calcium and certain enzymes. **T/F**

- Infundibulum: Funnel-shaped opening provided with many finger-like fimbriae. It helps to collect the ovum.
- Ampulla: Wider part.
- Isthmus: Narrow part. It joins the uterus."The ciliated epithelium lined the lumen of the oviduct drives the ovum towards the uterus.
- **Uterus (womb):** It is inverted pear shaped. It is supported by ligaments attached to the pelvic wall."Uterus has 3 parts- Upper fundus, middle body and terminal cervix. Cervix opens to vagina."Cervical canal and vagina forms birth canal."The uterine wall has 3 layers:
- Perimetrium: External thin membrane.
- Myometrium: Middle thick layer of smooth muscle.
- Endometrium: Inner glandular and vascular layer.
- **Vagina:** It opens to the exterior between urethra & anus. The lumen of vagina is lined by a glycogen-rich mucous membrane consisting of sensitive papillae & Bartholin's glands. Bartholinâ€™s glands secrete mucus that lubricates the penis during sexual act.

c. External genitalia (vulva or pudendum)

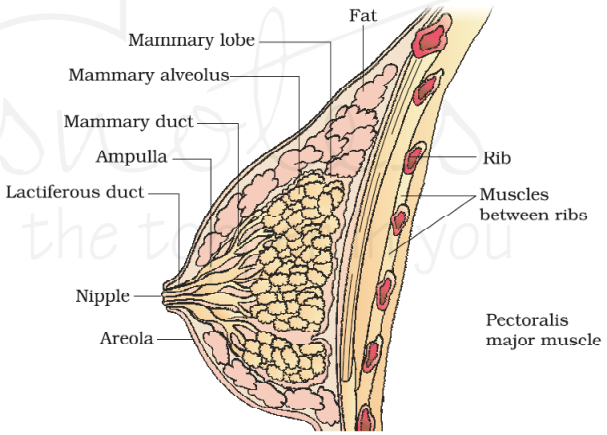
- Consist of Mons pubis, labia majora, labia minora, hymen & clitoris.
- Mons pubis: A cushion of fatty tissue covered by pubic hair.
- Labia majora: Large, fleshy, fatty and hairy outer folds. Surrounds vaginal opening.
- Labia minora: Small, thin and hairless inner folds.
- Hymen (Maiden head): A membrane which partially cover the vaginal opening. It is often torn during the first coitus. It may also be broken by a sudden fall or jolt, insertion of a vaginal tampon; active participation in some sports items etc. In some women, hymen persists after coitus. So the hymen is not a reliable indicator of virginity or sexual experience.
- Clitoris: A highly sensitive organ lying just in front of the urethral opening

NCERT Fill-ups

12. Ovaries are the _____ female sex organs.
13. The ovarian stroma is divided into two zones–a peripheral _____ and an inner _____.
14. The shape of the uterus is like _____.
15. The cavity of the cervix is called _____, which along with _____ forms the birth canal.

NCERT True-False

16. The oviducts, uterus and vagina constitute the female accessory ducts. T/F
17. Several mammary ducts join to form a narrower mammary ampulla which is connected to a lactiferous duct through which milk is sucked out. T/F
18. The infundibulum leads to narrow part of oviduct called ampulla. T/F



NCERT Pg.No. 30 A diagrammatic sectional view of Mammary gland

Mammary glands (breasts) :

- A pair of mammary glands contains glandular tissue & fat.
- Glandular tissue of each breast has 15-20 mammary lobes containing clusters of cells (mammary alveoli).
- Cells of alveoli secrete milk. It is stored in lumen of alveoli.
- The alveoli open into mammary tubules.
- The tubules of each lobe join to form a mammary duct.
- Several mammary ducts join to form a wider mammary ampulla which is connected to lactiferous duct through which milk is sucked out.

NCERT Core

Spermatogenesis, initiated at puberty in the testes, involves spermatogonia transforming into mature sperm cells.

2.3 Gametogenesis :

- It is the formation of gametes in the gonads.
- It is 2 types: Spermatogenesis and Oogenesis.

1. *Spermatogenesis :*

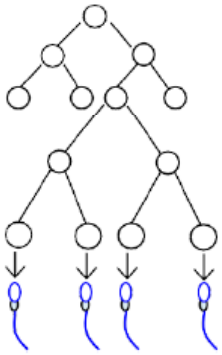
It is the process of formation of sperms (spermatozoa) in seminiferous tubules of testis. It has 2 stages:

a. **Formation of spermatids:** In this, Sperm mother cells (Spermatogonia or male germ cells) produce spermatids.
b. Spermiogenesis: Spermatids transform into sperm.

NCERT Core

The functions of male sex accessory ducts and glands are maintained by the testicular hormones (androgens).

Schematic representation of spermatogenesis:

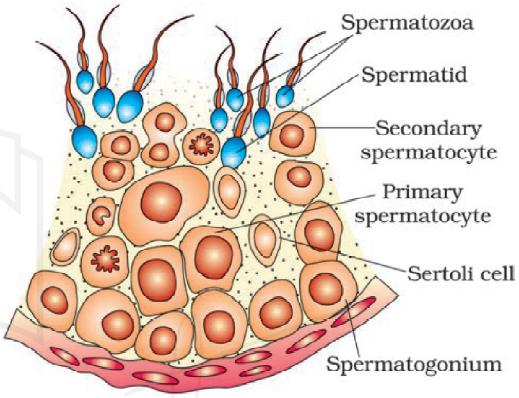


Spermatogonia -2n (46 chromosomes) ↓ Mitosis differentiation Primary spermatocytes (2n) ↓" 1st meiotic division"Sec. spermatocytes -n (23) ↓" 2nd meiotic division Spermatids (n) ↓" DifferentiationSpermatozoa (n)

- 4 spermatids are formed from each primary spermatocyte.
- After spermiogenesis, sperm heads are embedded in Sertoli cells to get nourishment. Then they are released to lumen of seminiferous tubules. It is called spermiation.

Role of Hormones in Spermatogenesis :

- Hypothalamus releases Gonadotropin releasing hormone **(GnRH).**
- GnRH stimulates the anterior pituitary gland to secrete 2 gonadotropins such as Luteinizing hormone (LH) and follicle stimulating hormone (FSH).
- LH acts on the Leydig cells and stimulates secretion of androgens. Androgens stimulate the spermatogenesis.
- FSH acts on the Sertoli cells and stimulates secretion of some factors for the spermiogenesis.



NCERT Pg. No. 31 Diagrammatic sectional view of a seminiferous tubule

Structure of Spermatozoa (Sperm):

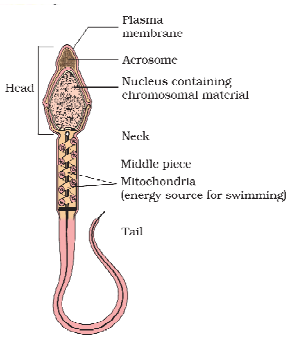
- A mature sperm is about 60 (0.06 mm) long.
- A plasma membrane envelops"the whole body of sperm.
- A sperm has 3 regions:

a. **Head:** Oval shaped."Formed of nucleus and"acrosome. Acrosome is"formed from Golgi"complex. It contains lytic"enzymes. Behind the head"is a neck.
b. **Middle piece:** Composed of axial filament surrounded by mitochondria & cytoplasm. Mitochondria produce energy for the sperm motility.
c. **Tail:** Consists of a central axial filament. The sperm moves in fluid medium and female genital tract by the undulating movement of the tail.

- Man ejaculates 200-300 million sperms during a coitus.
- For normal fertility, at least 60% sperms must have normal shape and size. 40% of them must show vigorous motility.

NCERT Fill-ups

19. Spermatogenesis starts at the age of _____ due to significant increase in the secretion of _____.
20. A spermatogonia is a _____ cell containing _____ chromosomes.
21. The seminal plasma along with the sperms constitute _____.



KB Acrosome is a vessicl-like double membranous structure which has hydrolytic enzymes. These are combinedly known as spermlysin. These enzymes help in the penetration of egg.

NCERT Pg. No. 32 Structure of a sperm