CHAPTER › 02

Sexual Reproduction in Flowering Plants

NEET KEY NOTES

- Sexual reproduction occurs in all flowering plants, i.e. angiosperms. It is the process of fusion of haploid gametes, resulting in the production of a diploid zygote. Which ultimately develops into new organism.
- Different types of adaptations are shown in angiosperms by the diversified structures of the inflorescences, flowers and floral parts, to ensure the formation of the end products of sexual reproduction, i.e. the fruits and seeds.

Flower

- It is the modified condensed shoot arising on the axil of small leaf-like structure called **bract** and consists of four whorls or floral appendages, attached on the receptacle.
- Of these, the two lower whorls, i.e. **calyx** and **corolla** are sterile and considered as non-essential/accessory/helping whorls and the two upper whorls, i.e. **androecium** and **gynoecium** are fertile and are considered as essential or reproductive whorls.

Pre-fertilisation: Structures and Events

- Several hormonal and structural changes in plants lead to the differentiation and further development of the floral primordium.
- Inflorescences are formed which bear the floral buds and then the flowers.
- In the flower, the androecium (male reproductive part) and gynoecium (female reproductive part) differentiate and develop to form the male and female gametophyte.

Stamen, Microsporangium and Pollen Grain

The male gametophyte includes the following parts

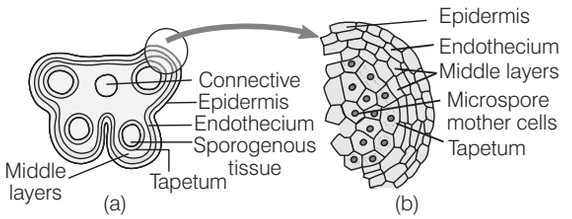
Stamen

- It is the male reproductive unit of angiosperms. It consists of two parts
  - The long and slender stalk called the **filament**.
  - The terminal, generally bilobed structure called the **anther**.
- The proximal end of the filament is attached to the thalamus or the petal (i.e. epipetalous) of the flower. The number and length of the stamens are variable in flowers of different species.
- A typical angiospermic anther is a **bilobed** structure with each lobe having two **theca** (**dithecous**) and are separated by a longitudinal groove running lengthwise.
- In a cross section, the anther is a tetragonal structure consisting of four **microsporangia** located at the corners, two in each lobe. Later, the microsporangia develop and become **pollen sacs,** which are packed with pollen grains.

Structure of Microsporangium

- A typical microsporangium is surrounded by four wall layers, i.e. the **epidermis**, **endothecium**, **middle layers** and the **tapetum**. The outer three wall layers are protective in function and help in dehiscence of anther to release pollen grains.

- **Tapetum** (innermost layer) nourishes the developing microspores or pollen grains and the cells of tapetum possess dense cytoplasm and generally have more than one nucleus.



(a) Transverse section of a young anther (b) Enlarged view of a microsporangium showing four wall layers

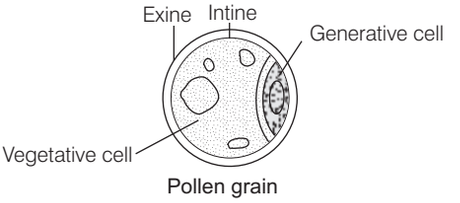
- When the anther is young, a group of compactly arranged homogenous cells called the **sporogenous tissue** occupies the centre of each microsporangium.

Microsporogenesis

- Each cell of the sporogenous tissue is a potential **Pollen Mother Cell** (PMC) or microspore mother cell and can give rise to **microspore tetrad**. This process of formation of microspore from a pollen mother cell through the process of meiosis is called **microsporogenesis**.
- As the anthers mature and dehydrate, the microspores dissociate from one another and form tetrad and develop into pollen grains. Inside each microsporangium, several thousands of **microspores** or **pollen grains** are formed that are released with the dehiscence of anther.
- In general, dehiscence of anther occurs through the rupture of the anther lobe walls, which causes the release of the pollen grains.

Male Gametophyte (Pollen Grain)

- A pollen grain is a partly germinated microspore representing the **male gametophyte**. It is a haploid, uninucleate and minute spore produced in large numbers by meiosis in the microspore mother cell. They vary in their size, shape, colour, design, etc., from species to species.
- Pollen grains are generally spherical measuring about 25-50 micrometre in diameter. It has a two layered wall (also called **sporoderm**), outer hard layer **exine** is made up of **sporopollenin**. It is the most resistant organic material as it can withstand high temperature as well as strong acids and alkali. No known enzyme can degrade it. Thus, pollens are well-preserved as fossils.
- Pollen grains have prominent distal aperture for germination called **germ pore**, where sporopollenin is absent. The inner layer **intine** is thin and chiefly composed of cellulose and pectin.
- Each mature pollen grain in angiosperms has two cells, the **generative cell** and **vegetative cell**.



Pollen grain

- The vegetative cell is larger, has abundant reserve food material and a large nucleus, which is irregular in shape. Whereas, the generative cell is small, spindle-shaped and floats in the cytoplasm of the vegetative cell.
- Pollen grains are generally shed at this **2-celled stage** in over 60% of angiosperms. In the remaining species, the generative cell divides mitotically and gives rise to two male gametes before pollen grains are shed (**3-celled stage**).
- Pollen grains of several plant species may cause severe allergies and bronchial infections leading to asthma, bronchitis, etc., e.g. *Parthenium* or carrot grass came to India as a contaminant with imported wheat, became ubiquitous in occurrence and caused **pollen allergy**.
- Pollen grains are rich in nutrients. In Western countries, large number of pollen products in the form of tablets and syrups are used to increase the performance of athletes and race horses.
- **Viability of pollen** depends on temperature and humidity. It varies from species to species, e.g. 30 minutes in case of wheat, rice and several months as in some members of Solanaceae, Rosaceae, Leguminosae, etc.
- It is possible to store pollen grains for years in liquid nitrogen (–196°C) in pollen banks for later use in plant breeding programmes.

The Pistil, Megasporangium (Ovule) and Embryo Sac

The female gametophyte includes the following parts

Pistil

- The pistil or gynoecium represents the female reproductive part of the flower. It may consist of one pistil or carpel (**monocarpellary**), two carpels (**bicarpellary**), three carpels (**tricarpellary**) or many carpels (**multicarpellary**).
- Pistil may be **syncarpous** (i.e. more than one pistils are fused together) as in *Papaver, Solanum*, etc., or **apocarpous,** i.e. (carpels remain free) as in *Michelia,* rose, etc.
- A typical pistil consists of the hollow basal swollen **ovary**, the elongated **style** and the terminal **stigma** (serves as a landing platform for pollen grains). Inside the ovary, is the **ovarian cavity** (locule) in which placenta is located. **Megasporangium** (ovules) arises from placenta.

Structure of Megasporangium (Ovule)

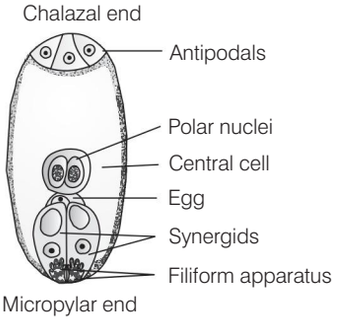
- The ovule is an integumented megasporangium within which meiosis and megaspore formation takes place. It is attached to the placenta by means of a stalk called **funicle**. It develops into a seed after fertilisation. The junction between an ovule and funicle is called **hilum**, which later becomes a scar on the seed.
- Each ovule has one or two protective envelops called **integuments**, which encircle the ovule except at the tip where a small opening called **micropyle** is located.
- The basal part of an ovule just opposite to micropyle is called **chalaza**. Enclosed within the integuments is a mass of cells called **nucellus**, whose cells are rich in reserve food materials. An ovule generally has a single **embryo sac** or **female gametophyte,** developed from a megaspore through reductional division and located within the nucellus.

Megasporogenesis

- The process of formation of megaspores from **Megaspore Mother Cell** or MMC (diploid) is called **megasporogenesis**.
- It occurs inside the nucellus of the developing ovule of angiosperms. The process begins very early when nucellus is not completely surrounded by the integuments.
- The MMC (a large cell containing dense cytoplasm and a prominent nucleus) enlarges in size and divides by meiosis. It first divides transversely into two cells called megaspore dyad.
- These two cells again divide transversely forming a linear row of four haploid cells which is called **megaspore tetrad** or **linear tetrad**.

Female Gametophyte (Embryo Sac)

- In general, the development of embryo sac is **monosporic**, e.g. in *Polygonum*. In this type of development, only one megaspore situated towards chalazal end remains functional, while the remaining three megaspores gradually degenerate and finally disappear.
- Following are the different stages in development of female gametophyte
  - The functional haploid megaspore is the first cell of female gametophyte of angiosperms.
  - Its nucleus undergoes mitotic division to form 2-nuclei that move to opposite poles forming **2-nucleate** embryo sac.
  - The **2-nucleate** embryo sac undergoes two more sequential mitotic divisions giving rise to the **4-nucleate** stage and later **8-nucleate** stage of embryo sac. This stage comprises of a micropylar end and a chalazal end with four nuclei at each end.
  - Six of the eight nuclei are surrounded by cell walls and get organised into cells. The remaining two nuclei, called polar nuclei are situated below the egg apparatus in the large **central cell**.
  - Three cells present towards the micropylar end are grouped together and constitute the egg apparatus, i.e. two **synergids** and one **egg cell**.
  - Three cells of the chalazal end are called the **antipodals**. The large **central cell** is formed by the fusion of 2 **polar nuclei**. Thus, a typical angiospermic **embryo sac** or **female gametophyte** at maturity consists of **eight nuclei** and **seven cells**.



A diagrammatic representation of mature embryo sac

Pollination

The transfer of pollen grains from the anther of the stamen to the receptive stigma of the carpel/pistil is called **pollination**.

Depending upon the source of pollen grains, pollination is of following three types

- **Autogamy** (Self-pollination) It is the kind of pollination achieved within the same flower. The pollens from the anthers of a flower are transferred to the stigma of the same flower, e.g. wheat, rice, pea, etc.
- Plants show following adaptations for autogamy.
  - **Cleistogamous flower**s These are closed flowers and their anthers and stigma lie close to each other, e.g. *Viola* (common pansy), *Mirabilis, Commelina* and *Oxalis*. Almost all the cleistogamous flowers are invariably autogamous as there is no chance of cross-pollination.
  - **Chasmogamous flowers** These are opened flowers with exposed sex organs. On these, pollens from another flower can land on the stigma as well, e.g. *Catharanthus* and *Mirabilis*.
- **Geitonogamy** It is the kind of self-pollination where the pollen grains from the anther of a flower are transferred to the stigma of another flower borne on the same plant, but at different branches. It usually occurs in plants which show monoecious condition, e.g. *Cucurbita.*
- **Xenogamy** (Cross-pollination) It involves the transfer of pollen grains from the anther of one plant to the stigma of another plant. This is the only type of pollination which brings genetically different types of pollen grains to the stigma during pollination, e.g. papaya, maize, etc.

Agents of Pollination

Pollination in plants occurs *via* various abiotic and biotic agents as follows

1. **Abiotic agents** of pollination are wind (anemophily) and water (hydrophily).
   (a) **Wind pollinated** flowers have
   - Light and non-sticky pollen grains.
   - Generally a single ovule in each ovary and numerous flowers packed into an inflorescence, e.g. corn cob.
   - Well-exposed stamens and large feathery stigma to trap air-borne pollen grains.
   - Wind pollination is common in grass, maize, date palm, etc.

   (b) **Water pollination** occurs in mostly monocotyledons (in about 30 genera). Some examples of water pollinated plants are *Hydrilla*, *Vallisneria* and *Zostera*.
   - In majority of aquatic plants, the flowers emerge above the level of water and are pollinated by insects or wind, e.g. water hyacinth and water lily.
   - The female flower reaches the surface of water by the long stalk and pollen grains are released onto the surface of water, e.g. *Vallisneria.*
   - In most of the water pollinated species, pollen grains are protected from wetting by mucilaginous covering.
2. **Biotic agents** of pollination are insects (entomophily), bats (chiropterophily), snails (malacophily), birds (ornithophily) etc.
   - Insect pollinated flowers are generally large, colourful, fragrant and rich in nectar.
   - The pollen grains and stigmatic surface are sticky.
   - The animal pollinated flowers offer certain rewards to the pollinators. Some of them are
     - These offer nectar and (edible) pollen grains.
     - Some species provide safe place for laying eggs, e.g. *Amorphophallus* and *Yucca*.
       A relationship exists between a species of moth and the plant *Yucca,* where both the 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 egg as the seeds start developing.
   - Many insects may consume pollen or the nectar without bringing about pollination. Such floral visitors are referred to as **pollen/nectar robbers**.

Outbreeding Devices

These are developed by bisexual flowers to avoid self-pollination and promote cross-pollination because continuous self-pollination results in poor yield and poor quality of seeds. This phenomenon is called **inbreeding depression**. Such devices are

- Dichogamy (Production of male and female reproductive parts at different times)
- Self-sterility
- Unisexuality
- Chasmogamous flowers
- Protandry (Maturation of male parts prior to female parts)
- Protogyny (Maturation of female parts before male parts)

Note In castor and maize, unisexuality prevents autogamy. In papaya, it prevents both autogamy and geitonogamy.

Pollen-Pistil Interaction

- It consists of all the events from the deposition of pollen on stigma to entry of pollen tube into the ovule.
- It involves **pollen recognition** followed by inhibition of pollen (sexual incompatibility) or promotion of pollen (sexual compatibility).
- Pistil accepts the compatible pollen of the same species and rejects the incompatible pollen either of the same species or of other species.
- After compatible pollination, the pollen grain germinates and produces pollen tube (carries two male gametes) which moves through the style and reaches to the egg, which is known as 'siphonogamy' in angiosperms.

Artificial Hybridisation

- It is the crossing of different species to generate a progeny containing all the desirable characters. These are commercially superior varieties.
- It is used for crop improvement programmes. This process involves
  - **Emasculation** anther removal before dehiscence.
  - **Bagging** covering emasculated flower in a bag to prevent its contamination by unwanted pollen grains.
- After the maturity of the stigma of the bagged flowers, collected pollen grains are dusted over it. The flowers are then rebagged at fruits are allowed to develop.

Double Fertilisation

It occurs after the pollen tube reaches the ovary. It is the characteristic of angiosperms.

- The pollen tube releases two male gametes into the cytoplasm of a synergid.

- One of the male gamete fuses with egg cell (syngamy), which results in the formation of **zygote**.
- The second male gamete fuses with the two polar nuclei to form a triploid **Primary Endosperm Nucleus** (PEN). This is called **triple fusion**.
- Since, two fusions, i.e. syngamy and triple fusion occur in an embryo sac, this is called **double fertilisation**.
- Central cell after the triple fusion called as **Primary Endosperm Cell** (PEC) develops into the **endosperm** and zygote develops into an **embryo**.

Post-fertilisation : Structures and Events

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

Endosperm

- It is a mass of nutritive cell produced as a result of triple fusion through mitotic division.
- On the basis of development, it is of three types
  - **In nuclear type**, which is a common method, the **Primary Endosperm Nucleus** (PEN) undergoes repeated mitotic division without cytokinesis. At this stage, the endosperm is called **free- nuclear endosperm.**
  - **In cellular type**, cell wall formation occurs and the endosperm becomes cellular. The number of free nuclei formed before cellularisation varies greatly, e.g. in coconut the water is free nuclear endosperm and surrounding white kernel is cellular endosperm.
  - **In helobial type** endosperm formation, one half of endosperm is nuclear type and other half is cellular type.

Embryo

- It develops at the micropylar end of the embryo sac where the zygote is situated.
- Embryo formation occurs when certain amount of endosperm is formed, because endosperm provides nutrition for embryo development.
  - Zygote divides by mitosis and forms proembryo.
  - This results in the formation of **globular** and **heart-shaped embryo** that finally becomes **horse shoe-shaped** (mature embryo) having cotyledon.
- Dicot embryo consists of two **cotyledons** and an **embryonal axis** between them
  - The part of embryonal axis above the level of cotyledons is the **epicotyl** which becomes **plumule** (shoot).
  - The part of embryonal axis below the level of cotyledons is the **hypocotyl** which becomes **radicle** or **root tip**.
- Monocot embryo consists of only one cotyledon (called **scutellum** in grass family), e.g. rice, maize plants, etc.
  - Embryonal axis has the radicle on its lower end (hypocotyl), the radicle is covered by an undifferentiated sheath called **coleorhiza.**
  - At the upper end (epicotyl), the embryonal axis has plumule. It is covered by a hollow foliar sheath called **coleoptile.**

Seed

- It is the fertilised ovule formed inside the fruits.
- It consists of seed coat (hardened ovule integuments), cotyledons and an embryonal axis.
- Two types of mature seeds are
  - **Non-albuminous** in which endosperm is completely consumed, e.g. in pea and groundnut.
  - **Albuminous** that retain part of endosperm, e.g. wheat, maize and barley.
- In some seeds, remnants of nucellus are persistant which is called **perisperm**, e.g. black pepper and beet root.
- Micropyle of the ovule remains as the small pore in the seed coat. It facilitates the entry of oxygen and water into seed during germination.
- **Dormancy** In this condition, water content reduces, seed become dry, metabolic activities of embryo slow down and the seed may enter into a state of inactivity called **dormancy**. If conditions are not favourable seed will not germinate and it may germinate, if conditions are favourable.

Fruits

- Ovary develops into fruit and ovule matures into seeds. The wall of ovary becomes wall of fruit, i.e. **pericarp**.
  - In **true fruits**, ovary contributes to fruit formation.
  - **Fruits** may be **fleshy** such as, guava, orange, mango or **dry** such as groundnut, mustard, etc.
  - In **false fruits**, thalamus (swollen end of stems that bear floral parts) also contributes to fruit formation, e.g. apple, cashewnut, etc.
  - **Parthenocarpic fruits** develop without fertilisation and are seedless, e.g. banana.
  - Seedless fruits can be reproduced artificially through the application of growth hormones.

Apomixis and Polyembryony

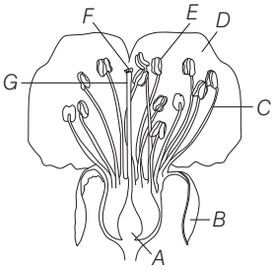
- **Apomixis** is the special mechanism to produce seeds without fertilisation, e.g. grass and is a form of asexual reproduction that mimics sexual reproduction and is useful for the hybrid industry. The modes by which apomictic seeds can be produced are agamospermy, adventive embryony, etc.
- **Polyembryony** is the presence of more than one embryo in a seed. In many *Citrus* and *Mangifera* varieties, some of the nucellar cells surrounding the embryo sac start dividing, protrude into the embryo sac and develop into embryos.

Mastering NCERT

MULTIPLE CHOICE QUESTIONS

TOPIC 1 ~ *Flower and Development of Gametes*

1 Identify *A* to *G* in following figure and answer accordingly.



(a) A–Ovary, B–Filament, C–Sepal, D–Petal, E–Style, F–Stigma, G–Anther

(b) A–Sepal, B–Ovary, C–Petal, D–Filament, E–Anther, F–Stigma, G–Style

(c) A–Ovary, B–Sepal, C–Filament, D–Petal, E–Anther, F–Stigma, G–Style

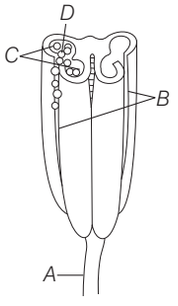
(d) A–Petal, B–Anther, C–Stigma, D–Style, E–Filament, F–Sepal, G–Ovary

2 Find odd one out. ***JIPMER 2019***

(a) Stamen (b) Stigma

(c) Style (d) Ovary

3 Identify *A* to *D* in the following diagram.



(a) A – Filament (stalk) , B – Pollen sac, C – Pollen grain, D – Line of dehiscence

(b) A – Filament (stalk), B – Pollen sac, C – Line of dehiscence, D – Pollen grain

(c) A – Line of dehiscence, B – Filament (stalk) , C – Pollen sac, D – Pollen grains

(d) A – Filament (stalk), B – Line of dehiscence, C – Pollen sac, D – Pollen grains

4 The terminal structure of stamen is called

(a) pollen (b) filament

(c) anther (d) All of these

5 The lengthwise running groove on anther which separate theca is called

(a) rupture line

(b) line of dehiscence

(c) suture of anther

(d) None of the above

6 Number of microsporangia in an angiospermic anther is

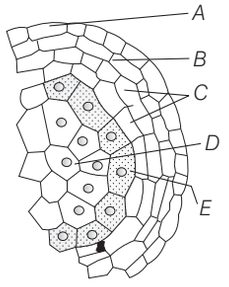
(a) 1 (b) 2 (c) 3 (d) 4

7 Microsporangium develops into

(a) pollens (b) microgametes

(c) megagametes (d) pollen sac

8 Identify *A* to *E* in the following diagram.



(a) A–Tapetum, B–Microspore mother cell, C–Middle layer, D–Endothecium, E–Epidermis

(b) A–Epidermis, B–Middle layer, C–Microspore mother cell, D–Tapetum, E–Endothecium

(c) A–Middle layer, B–Epidermis, C–Tapetum, D–Microspore mother cell, E–Endothecium

(d) A–Epidermis, B–Endothecium, C–Middle layer, D–Microspore mother cell, E–Tapetum

9 The innermost layer of microsporangium is

(a) tapetum (b) endothecium

(c) middle layer (d) epidermis

10 Centre of each microsporangium is occupied by

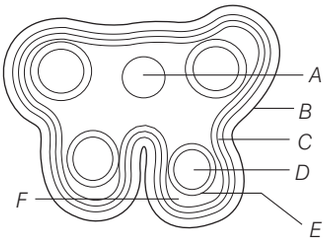
(a) sporogenous tissue

(b) tapetum

(c) central tissue

(d) microspore mother cell

11 Identify *A* to *E* in the following diagram.



(a) A–Epidermis, B–Endodermis, C–Connective, D–Sporogenous tissue, E–Middle layers, F–Tapetum
(b) A–Endodermis, B–Connective, C–Epidermis, D–Tapetum, E–Sporogenous tissue, F–Middle layers
(c) A–Tapetum, B–Middle layers, C–Sporogenous tissue, D–Connective, E–Endodermis, F–Epidermis
(d) A–Connective, B–Epidermis, C–Endothecium, D–Sporogenous tissue, E–Tapetum, F–Middle layers

12 The outermost wall layer of microsporangium in anther is
(a) endothecium (b) tapetum
(c) middle layer (d) epidermis

13 Which of the following perform microsporogenesis?
(a) Microspore mother cell (b) Pollen mother cell
(c) Both (a) and (b) (d) None of these

14 The process of formation of microspores from pollen mother cell through … *A*… is called … *B*... . Microspores are arranged in … *C* … . As the anthers matures and dehydrate, microspores develop into the …*D*… .

Fill in the blanks *A* to *D*.
(a) A–pollen grains, B–microspore tetrad, C–microsporogenesis, D–meiosis
(b) A–microspore tetrad, B–microsporogenesis, C–meiosis, D–pollen grains
(c) A–microsporogenesis, B–microspore tetrad, C–pollen grain, D–meiosis
(d) A–meiosis, B–microsporogenesis, C–microspore tetrad, D–pollen grains

15 Microspore tetrad (pollen grains) is the result of
(a) mitotic cell division (b) meiotic cell division
(c) Both (a) and (b) (d) None of these

16 Dehiscence of anther in mesophytes is caused by
(a) hydration of anthers (b) dehydration of anthers
(c) mechanical injury (d) None of these

17 Pollens have two prominant walls which are …*A*… and …*B*… . Here *A* and *B* refers to
(a) A–intine, B–protein coat
(b) A–exine, B–intine
(c) A–sporopollenin, B–intine
(d) A–sporopollenin, B–exine

18 Intine is made up of
(a) cellulose (b) pectin
(c) Both (a) and (b) (d) protein

19 Exine of pollen is made up of
(a) sporopollenin
(b) sporogenous tissue
(c) spongiform tissue
(d) inorganic material

20 Patterns and designs of exine of pollen grains are the characteristic features of
(a) species of plant (b) genus of plants
(c) order of plants (d) None of these

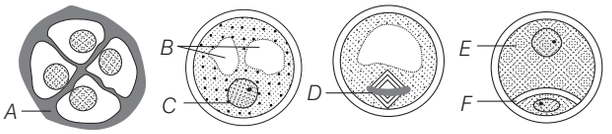
21 Hardest substance in plant kingdom is ***JIPMER 2019***
(a) saple (b) corolla
(c) sporopollenin (d) anther

22 The sporopollenin is non-degradable because
(a) it can withstand strong acids
(b) it is resistant at very high temperature
(c) no enzyme degrade it
(d) All of the above

23 Which of the following has proved helpful in preserving pollen as fossils? ***NEET 2018***
(a) Oil content (b) Cellulosic intine
(c) Pollenkitt (d) Sporopollenin

24 The functions of germ pore is/are
(a) emergence of radicle
(b) absorption of water for seed germination
(c) initiation of pollen tube
(d) All of the above

25 Identify the structures marked *A* to *F* in the given diagram.



(a) A–Asymmetric nucleus, B–Nucleus, C–Generative cell, D–Vegetative cell, E–Pollen, F–Pollen tetrad
(b) A–Pollen tetrad, B–Pollen, C–Generative cell, D–Vegetative cell, E–Asymmetric spindle, F–Nucleus
(c) A–Pollen tetrad, B–Vacuole, C–Nucleus, D–Asymmetric spindle, E–Vegetative cell, F–Generative cell
(d) A–Vacuole, B–Nucleus, C–Pollen tetrad, D–Vegetative cell, E–Asymmetric spindle, F–Generative cell

26 When the pollen grain is mature, it contains two cells, the … *A* … and … *B* ….
(a) A–generative cell, B–spore mother cell
(b) A–vegetative cell, B–spore mother cell
(c) A–spore mother cell, B–male gamete
(d) A–vegetative cell, B–generative cell

27 To achieve 3-celled stage in angiosperms, which cell of the pollen grain divides to form two male gametes ?
(a) Vegetative cell ***NEET 2018***
(b) Generative cell
(c) Microspore mother cell
(d) None of the above

28 60% of the angiosperms shed their pollens at the
(a) 2-celled stage (b) 3-celled stage
(c) 4-celled stage (d) 1-celled stage

29 Male gametophyte in angiosperms produces ***CBSE-AIPMT 2015***
(a) two sperms and a vegetative cell
(b) single sperm and a vegetative cell
(c) single sperm and two vegetative cell
(d) three sperms

30 Pollen tablets are available in the market for ***CBSE-AIPMT 2014***
(a) *in vitro* fertilisation (b) breeding programmes
(c) supplementing food (d) *ex situ* conservation

31 Pollen grains can be stored for several years in liquid nitrogen having temperature of ***NEET 2018***
(a) – 196°C (b) – 80°C (c) – 120°C (d) – 160°C

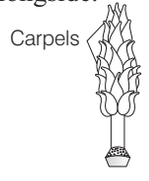
32 In the given diagram of pistil, in which part fertilisation takes place?

(a) D (b) C (c) B (d) A

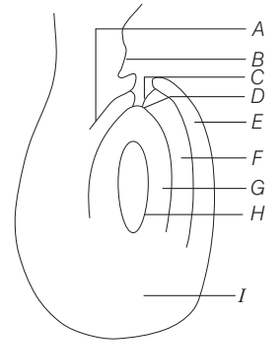
33 Identify the type of pistil in the diagram.

(a) Multicarpellary, apocarpous
(b) Multicarpellary, syncarpous
(c) Multicarpellary, pistillate
(d) Monocarpellary, apocarpous

34 Identify the type of pistil in the diagram alongside.
(a) Monocarpellary, syncarpous
(b) Monocarpellary, apocarpous
(c) Multicarpellary, syncarpous
(d) Multicarpellary, apocarpus



35 Identify *A* to *I* in the given diagram.



(a) A–Chalazal end, B–Embryo sac, C–Nucellus, D–Inner integuments, E–Outer integuments, F–Micropylar pole, G–Micropyle, H–Funicle, I–Hilum
(b) A–Inner integuments, B–Nucellus, C–Embryo sac, D–Chalazal end, E–Hilum, F–Funicle, G–Micropyle, H–Micropylar end, I–Outer integuments
(c) A–Hilum, B–Funicle, C–Micropyle, D–Micropylar pole, E–Outer integuments, F–Inner integuments, G–Nucellus, H–Embryo sac, I–Chalazal pole
(d) A–Micropylar end, B–Micropyle, C–Funicle, D–Hilum, E–Outer integuments, F–Inner integuments, G–Nucellus, H–Embryo sac, I–Chalazal end

36 The stalk which joins ovule and placenta is called
(a) funicle (b) hilum
(c) chalaza (d) micropyle

37 The ovule of an angiosperm is technically equivalent to ***NEET 2016***
(a) megasporangium (b) megasporophyll
(c) megaspore mother cell (d) megaspore

38 An ovule is a
(a) differentiated megasporangium
(b) dedifferentiated megasporangium
(c) integumented megasporangium
(d) redifferentiated megasporangium

39 Chalazal pole is present
(a) opposite to micropyle
(b) at the origin of integuments
(c) opposite to nucellus
(d) near the embryo sac

40 Mass of cells enclosed by integuments is called
(a) nucellus (b) embryo
(c) ova (d) pollen

41 Embryo sac is also called
(a) female gamete (b) synergids
(c) female gametophyte (d) egg of angiosperm

42 Megasporogenesis is
(a) formation of fruits
(b) formation of seeds
(c) formation of megaspores
(d) Both (b) and (c)

43 Megaspore mother cell is found near the region of
(a) micropyle (b) chalaza
(c) nucellus (d) integuments

44 In majority of angiosperms ***NEET 2016***
(a) egg has a filiform apparatus
(b) there are numerous antipodal cells
(c) reduction division occurs in the megaspore mother cells
(d) a small central cell is present in the embryo sac

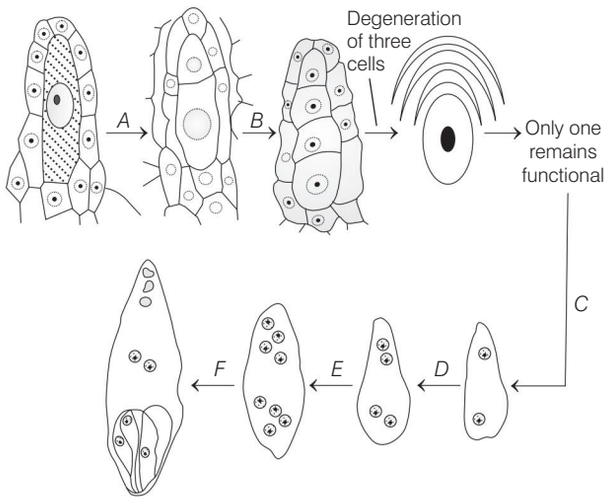
45 In angiosperms, microsporogenesis and megasporogenesis ***CBSE-AIPMT 2015***
(a) occur in anther
(b) form gametes without further divisions
(c) involves meiosis
(d) occur in ovule

46 Functional megaspore in an angiosperm develops into
(a) ovule (b) endosperm ***NEET 2017***
(c) embryo sac (d) embryo

47 Which is the most common type of embryo sac in angiosperms? ***NEET (Odisha) 2019***
(a) Tetrasporic with one mitotic stage of divisions
(b) Monosporic with three sequential mitotic divisions
(c) Monosporic with two sequential mitotic divisions
(d) Bisporic with two sequential mitotic divisions

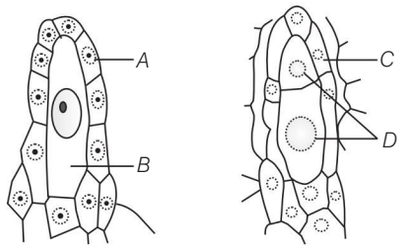
48 Single megasporic development is called
(a) single sporic (b) unisporic
(c) monosporic (d) disporic

49 Identify *A* to *F* in the diagram given below.



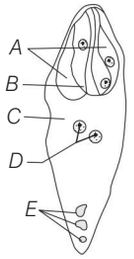
(a) A–Mitosis, B–Meiosis-I, C–Meiosis-II, D–Mitosis, E–Meiosis, F–Meiosis
(b) A–Meiosis-I, B– Meiosis-II, C–Mitosis, D–Mitosis, E–Mitosis, F–Embryo sac
(c) A–Embryo, B–Meiosis-I, C–Meiosis-II, D–Mitosis, E–Mitosis, F–Mitosis
(d) A–Mitosis, B–Mitosis, C–Mitosis, D–Meiosis, E–Meiosis, F–Meiosis

50 Identify the labelling of given diagrams.



(a) A–MMC, B–Megaspore dyad, C–Nucellus, D–Nucleus
(b) A–Nucellus, B–Megaspore dyad, C–Nucellus, D–MMC
(c) A–Nucellus, B–MMC, C–Nucellus, D–Megaspore dyad
(d) A–MMC, B–Nucellus, C–Megaspore dyad, D–Nucleus

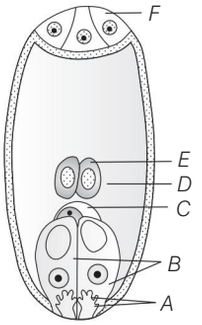
51 Identify *A* to *E* in the diagram given below.



(a) A–Antipodal, B–2 polar nuclei, C–Central cell, D–Egg, E–Synergids
(b) A–Antipodal, B–Central cell, C–2 polar nuclei, D–Egg, E–Synergids
(c) A–2 polar nuclei, B–Central cell, C–Antipodal cell, D–Egg, E–Synergids
(d) A–Synergids, B–Egg, C–Central cell, D–2 polar nuclei, E–Antipodal cell

52 In embryo sac, the number of synergid → egg cell → central cell → antipodal cell follows the order
(a) 1–1–2–3 (b) 2–1–3–2
(c) 2–1–1–3 (d) 3–2–1–2

53 Identify *A* to *F* in the diagram given below.



(a) A–Egg, B–Filiform apparatus, C–Synergid, D–Antipodals, E–Polar nuclei, F–Central cell
(b) A–Egg, B–Synergid, C–Filiform apparatus, D–Antipodals, E–Central cell, F–Polar nuclei
(c) A–Central cell, B–Egg, C–Synergid, D–Antipodals, E–Filiform apparatus, F–Polar nuclei
(d) A–Filiform apparatus, B–Synergid, C–Egg, D–Central cell, E–Polar nuclei, F–Antipodals

54 Filiform apparatus are
(a) special cellular thickenings at antipodal cell
(b) special cellular thickenings at the micropylar end
(c) special cellular thickenings at synergid cells
(d) special cellular thickenings at nuclear end

55 Function of filiform apparatus is to ***CBSE-AIPMT 2014, 08***

(a) recognise the suitable pollen at stigma
(b) stimulate division of generative cell
(c) produce nectar
(d) guide the entry of pollen tube

56 How many nuclei are found in female gametophyte?

(a) 8 (b) 7 (c) 6 (d) 5

57 How many cells are found in female gametophyte?

(a) 6 (b) 8
(c) 7 (d) 5

58 Two nuclei within a single cell is

(a) antipodal cell (b) chalazal cell
(c) central cell (d) synergid cell

59 Egg apparatus consists of

(a) 2 synergids + 2 eggs
(b) 2 synergids + 2 eggs
(c) 2 synergids + 1 egg
(d) 2 synergids + 4 eggs

60 In an embryo sac of anatropous ovule, cells present at chalazal end are called

(a) nucellar cells (b) synergids
(c) antipodal cells (d) None of these

61 In an angiospermic anatropous ovule, the embryo sac contains certain cells at the micropylar end. These are called

(a) synergids (b) antipodal cells
(c) nucellar cells (d) None of these

TOPIC 2 ~ *Pollination*

62 Autogamy stands for

(a) pollination in same flower
(b) pollination between different plants
(c) pollination in two flowers of same plant
(d) division in embryo

63 Cleistogamous flowers are strictly autogamous because they remain

(a) always open
(b) always close
(c) always fragrance
(d) are brighty coloured

64 Identify the type of flower *A* and *B*.

(a) A–Cleistogamous; B–Chasmogamous
(b) A–Homogamous; B–Heterogamous
(c) A–Chasmogamous; B–Cleistogamous
(d) A–Heterogamous; B–Homogamous

65 In chasmogamy pollination takes place in

(a) open flower
(b) closed flower
(c) large flower
(d) geitonogamy flower

66 Advantage of cleistogamy is ***NEET 2013***

(a) higher genetic variability
(b) more vigorous offspring
(c) no dependence on pollinators
(d) vivipary

67 Even in the absence of pollinating agents seed-setting is assured in ***CBSE-AIPMT 2012***

(a) *Commelina* (b) *Zostera*
(c) *Salvia* (d) Fig

68 Geitonogamy involves ***CBSE-AIPMT 2014, 10, 1994***

(a) fertilisation of a flower by the pollen from another flower of the same plant
(b) fertilisation of a flower by the pollen from the same flower
(c) fertilisation of a flower by the pollen from a flower of another plant in the same population
(d) fertilisation of a flower by the pollen from a flower of another plant belonging to a distant population

69 Transfer of pollen grains from the anther to stigma of another flower of different plant is called

(a) geitonogamy (b) xenogamy
(c) chasmogamy (d) cleistogamy

70 The most common abiotic pollinating agency in flowering plant is/ are

(a) water (b) wind
(c) Both (a) and (b) (d) None of these

71 Characteristic of wind pollinated pollens is, they are

(a) non-sticky
(b) light
(c) produced in large number
(d) All of the above

72 The feathery long stigma is found in

(a) rice (b) maize (c) sugarcane (d) None of these

73 Flowers, which have single ovule in the ovary and are packed into inflorescence are usually pollinated by ***NEET 2017***

(a) water (b) bee (c) wind (d) bat

74 Wind pollination is common in ***CBSE-AIPMT 2015, 14***

(a) lilies (b) grasses (c) orchids (d) legumes

75 Pollination in water hyacinth and water lily is brought about by the agency of ***NEET 2016***

(a) water (b) insects or wind
(c) birds (d) bats

76 What type of pollination takes place in *Vallisneria*?
NEET 2019

(a) Pollination occurs in submerged condition by water
(b) Flowers emerge above surface of water and pollination occurs by insects
(c) Flowers emerge above water surface and pollen is carried by wind
(d) Male flowers are carried by water currents to female flowers at the surface of water

77 Pollen grain of water pollinated plants are coated by covering to prevent it from wetting

(a) mucilage (b) cuticle
(c) exine (d) intine

78 Wind pollinated and water pollinated flowers

(a) are colourful
(b) are non-colourful
(c) are small in size
(d) produce nectar

79 Pollenkitt is present in ***JIPMER 2018***

(a) anemophily
(b) entomophily
(c) malacophily
(d) zoophily

80 Attractants and rewards are required for ***NEET 2017***

(a) anemophily
(b) entomophily
(c) hydrophily
(d) cleistogamy

81 Which one of the following plants shows a very close relationship with a species of moth, where none of the two can complete its life cycle without the other?
NEET 2018

(a) Banana (b) *Yucca*
(c) *Hydrilla* (d) *Viola*

82 Continued self-pollination results in

(a) inbreeding depression
(b) out breeding depression
(c) hybrid vigour
(d) better result in offspring

83 Device to discourage self-pollination or increase cross-pollination is

(a) pollen release and stigma receptivity are not synchronised
(b) anther and stigma placed at different position
(c) same height of stamen and stigma
(d) Both (a) and (b)

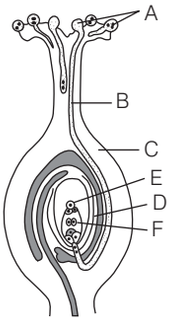
84 A dioecious flowering plant prevents both ***NEET 2017***

(a) autogamy and xenogamy
(b) autogamy and geitonogamy
(c) geitonogamy and xenogamy
(d) cleistogamy and xenogamy

85 In which of the following, both autogamy and geitonogamy are prevented?
NEET (Odisha) 2019, CBSE-AIPMT 2012

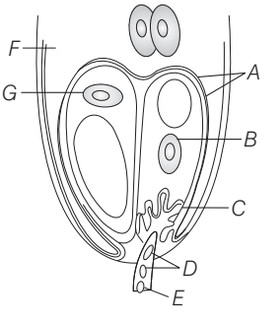
(a) Wheat (b) Papaya (c) Castor (d) Maize

86 Identify *A* to *F* in the given diagram.



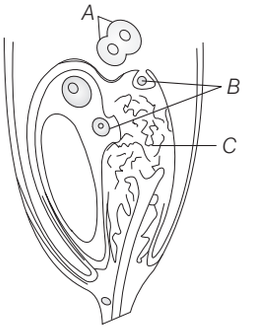
(a) A–Pollen tube, B–Ovary, C–Ovule, D–Antipodal cell, E–Pollen grain, F–Polar nuclei
(b) A–Polar nuclei, B–Antipodal cell, C–Ovule, D–Ovary, E–Pollen tube, F–Pollen grain
(c) A–Pollen grain, B–Pollen tube, C–Ovary, D–Ovule, E–Antipodal cell, F– Polar nuclei
(d) A–Antipodal cell, B–Ovule, C–Ovary, D–Polar nuclei, E–Pollen grain, F–Pollen tube

87 Diagram showing entry of pollen tube to the embryo sac. Identify *A* to *G* in the diagram.



(a) A–Synergid, B–Filiform apparatus, C–Male gamete, D–Plasma membrane, E–Central cell, F–Egg nucleus, G–Vegetative nucleus
(b) A–Filiform apparatus, B–Central cell, C–Egg nucleus, D–Vegetative nucleus, E–Male gamete, F–Synergid, G–Plasma membrane
(c) A–Plasma membrane, B–Synergid, C–Filiform apparatus, D–Male gametes, E–Vegetative nucleus, F–Central cell, G–Egg nucleus
(d) A–Central cell, B–Egg nucleus, C–Vegetative nucleus, D–Male gametes, E–Synergid, F–Plasma membrane, G-Filiform apparatus

88 Diagram showing discharge of gametes in the egg apparatus. Identify *A*, *B* and *C*.



(a) A–Polar nuclei, B–Female gametes, C–Synergid cell
(b) A–Male gametes, B–Synergid cell, C–Polar nuclei
(c) A–Synergid cell, B–Male gametes, C–Polar nuclei
(d) A–Polar nuclei, B–Male gametes, C–Synergid cell

89 Generally pollen tube enters through
(a) micropylar region
(b) antipodal region
(c) chalazal end
(d) nuclear region

90 The ability of the pistil to recognise the pollen followed by its acceptance or rejection is the result of a continuous dialogue between pollen grain and the pistil.
Which of the following chemicals mainly takes part in this interaction.
(a) Nucleotides (b) Proteins
(c) Minerals (d) Lipid or Inulin

91 The process of removal of anther from the flower bud before it dehisces is called as ***AIIMS 2019***
(a) emasculation (b) bagging
(c) embryo rescue (d) budding

92 For artificial hybridisation experiment in bisexual flower, which of the sequence is correct?
(a) Bagging → Emasculation → Cross-pollination → Rebagging
(b) Emasculation→ Bagging → Cross-pollination → Rebagging
(c) Cross-pollination → Bagging → Emasculation → Rebagging
(d) Self-pollination → Bagging → Emasculation → Rebagging

TOPIC 3 ~ *Double Fertilisation and Development of Endosperm*

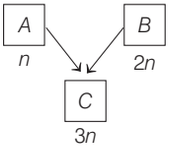
93 Double fertilisation is ***NEET 2018***
(a) fusion of two male gametes with one egg
(b) fusion of one male gamete with two polar nuclei
(c) fusion of two male gametes of pollen tube with two different eggs
(d) syngamy and triple fusion

94 Double fertilisation is exhibited by ***NEET 2017***
(a) gymnosperms (b) algae
(c) fungi (d) angiosperms

95 I. Antipodal cell II. Egg cell
III. Synergid cell IV. Polar nuclei
V. Male gamete VI. Nucellar cell
VII. Central cell
Out of the seven names given above, find out haploid cells.
(a) I, II, IV and V (b) II, IV, VI and VII
(c) I, II, III and V (d) II, IV, III and I

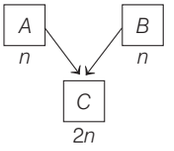
96 What is the fate of the male gametes discharged in the synergid? ***NEET 2019***
(a) All fuse with the egg
(b) One fuses with the egg, other(s) fuse(s) with synergid nucleus
(c) One fuses with the egg and other fuses with central cell nuclei
(d) One fuses with the egg other(s) degenerate(s) in the synergid

97 Find out *A, B* and *C* in the flowchart given below.



(a) A–Female gamete, B–Male gamete, C–Endosperm
(b) A–Endosperm, B–Female gamete, C–Male gamete
(c) A–Male gamete, B–Polar nuclei, C–Endosperm
(d) A–Female gamete, B–Endosperm, C–Male gamete

98 Find out *A, B* and *C* in the flowchart given below.



(a) A–Embryo, B–Male gamete, C–Female gamete
(b) A–Male gamete, B–Female gamete, C–Embryo
(c) A–Female gamete, B–Embryo, C–Male gamete
(d) A–Male gamete, B–Embryo, C–Female gamete

99 How many number of nuclei are involved in fertilisation?
(a) 1 (b) 1 + 1 (c) 2 + 1 (d) None of these

100 The total number of nuclei involved in triple fusion is/are
(a) 2 (b) 3 (c) 4 (d) 1

101 Syngamy and triple fusion is called …*A*… . The central cell becomes …*B*… develop into …*C*… and zygote develops into …*D*… .
A, B, C and *D* in the above statements are
(a) A–fusion, B–haploid, C–diploid cell, D–embryo
(b) A–double fertilisation, B–PEC, C–endosperm, D–embryo
(c) A–embryo, B–endosperm, C–PEC, D–diploid cell
(d) A–PEC, B–endosperm, C–syngamy, D–fertilisation

102 If stem has $2n = 10$ number of chromosomes then find out
A – number of chromosome in endosperm.
B – number of chromosome in egg cell.
C – number of chromosome in polar nuclei, respectively.
(a) 15, 15, 20 (b) 10, 15, 20
(c) 15, 5, 10 (d) 10, 5, 15

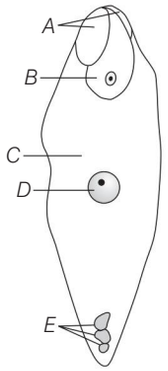
103 If endosperm has 36 number of chromosomes then find out the chromosome number of male and female gamete.
(a) 18, 18 (b) 17, 18 (c) 20, 20 (d) 12, 12

104 PEC (Primary Endosperm Cell) is formed
(a) after triple fusion (b) before triple fusion
(c) at the time of syngamy (d) always persisted

105 In an angiosperm, male plant is diploid and female plant is tetraploid then endosperm will be
(a) haploid (b) triploid
(c) tetraploid (d) pentaploid

106 In angiosperm, pollen tube librates their male gametes into the
(a) central cell (b) antipodal cell
(c) egg cell (d) synergids

107 In the given fertilised embryo sac, identify *A* to *E*.



(a) A–Degenerating antipodal cell, B–Primary endosperm nucleus, C–Primary endosperm cell, D–Synergid cell, E–Zygote
(b) A–Synergid cell, B–Antipodal cell, C–Zygote, D–Endosperm cell, E–Chalazal cell
(c) A–Degenerating synergids, B–Zygote, C–Primary endosperm cell, D–Primary endosperm nucleus, E–Degenerating antipodal cell
(d) A–Zygote, B–Synergid, C–Primary endosperm cell, D–Primary endosperm nucleus, E–Degenerating antipodal cell

108 Out of the following choose the post-fertilisation event(s).
(a) Endospermogenesis (b) Embryogenesis
(c) Both (a) and (b) (d) Megasporogenesis

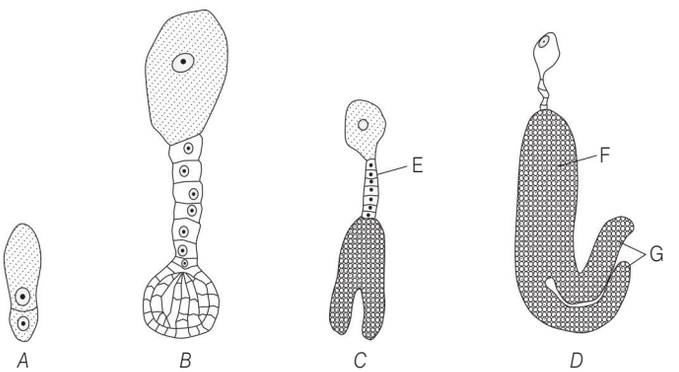
109 The morphological nature of the edible part of coconut is ***NEET 2017***
(a) perisperm (b) cotyledon
(c) endosperm (d) pericarp

110 Coconut water from a tender coconut is ***CBSE-AIPMT 2015***
(a) immature embryo
(b) free-nuclear endosperm
(c) innermost layers of the seed coat
(d) degenerated nucellus

111 Endosperm is consumed by developing embryo in the seed of
(a) pea (b) maize
(c) coconut (d) castor

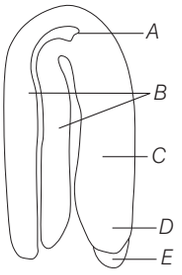
TOPIC 4~ *Embryo, Seed and Fruit Formation*

112 Identify the different stages in embryogenesis in the given diagram *A, B, C*, *D*, *E*, *F* and *G*.



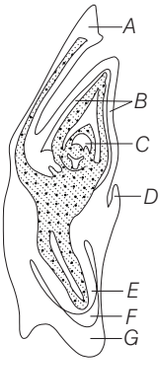
(a) A–2-celled stage, B–Heart-shaped embryo, C–Globular embryo, D–Mature embryo, E–Radicle, F–Suspensor, G–Cotyledon
(b) A–2-celled stage, B–Mature embryo, C–Heart-shaped embryo, D–Globular embryo, E–Cotyledon, F–Radicle, G–Suspensor
(c) A–2-celled stage, B–Globular embryo, C–Heart-shaped embryo, D–Mature embryo, E–Suspensor, F–Radicle, G–Cotyledon
(d) A–Mature embryo, B–Heart-shaped embryo, C–Globular embryo, D–2-celled stage, E–Suspensor, F–Cotyledon, G–Radicle

113 Identify the *A* to *E* in the following diagram of typical dicot embryo.



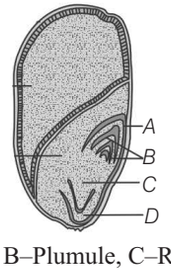
(a) A–Cotyledons, B–Hypocotyl, C–Plumule, D–Root cap, E–Radicle
(b) A–Radicle, B–Root cap, C–Plumule, D–Hypocotyl, E–Cotyledons
(c) A–Hypocotyl, B–Cotyledons, C–Plumule, D–Radicle, E–Root cap
(d) A–Plumule, B–Cotyledons, C–Hypocotyl, D–Radicle, E–Root cap

114 In figure given below, find out the type of seed and identify coleoptile, coleorhiza and epiblast.



(a) Monocots–*A*, *B* and *C*
(b) Dicots–*F*, *A* and *C*
(c) Monocots–*B*, *G* and *D*
(d) Dicots–*D*, *E* and *A*

115 Identify the parts labelled as *A* to *D* in structure of seed given below.



(a) A–Coleoptile, B–Plumule, C–Radicle, D–Coleorhiza
(b) A–Plumule, B–Coleoptile, C–Coleorhiza, D–Radicle
(c) A–Coleorhiza, B–Radicle, C–Plumule, D–Coleoptile
(d) A–Radicle, B–Plumule, C–Coleoptile, D–Coleorhiza

116 A typical dicotyledonous embryo consist of an …*A*… axis and …*B*… cotyledons.
The portion of embryonal axis above the level of cotyledons is …*C*… which terminates with the …*D*… or stem tip.
A, B, C and *D* in the above statement are
(a) A–plumule, B–epicotyl, C–cotyledons, D–embryonal
(b) A–embryonal, B–two, C–epicotyl, D–plumule
(c) A–embryonal, B–epicotyl, C–cotyledons, D–plumule
(d) A–embryonal, B–plumule, C–cotyledons, D–epicotyl

117 The cylindrical portion below the cotyledons is …*A*… that terminates to …*B*… and its tip is called …*C*… . *A, B* and *C* here refers to
(a) A–radicle, B–hypocotyl, C–root cap
(b) A–root cap, B–radicle, C–hypocotyl
(c) A–hypocotyl, B–root cap, C–radicle
(d) A–hypocotyl, B–radicle, C–root cap

118 The wheat grain has an embryo with one large, shield-shaped cotyledon known as ***CBSE-AIPMT 2015***
(a) epiblast (b) coleorhiza
(c) scutellum (d) caleoptile

119 Number of seeds are equal to the
(a) number of ovules (b) number of ovaries
(c) Both (a) and (b) (d) None of these

120 Persistent nucellus in the seed is known as ***NEET 2019***
(a) perisperm (b) hilum (c) tegmen (d) chalaza

121 Which is most crucial for seed storage?
(a) Dehydration and dormancy
(b) Endosperm and water
(c) Least amount of development
(d) Endosperm in large quantity

122 True fruit is directly derived from
(a) stem (b) root
(c) ovary (d) None of these

123 False fruit is a fruit in which
(a) only ovary take part in fruit development
(b) only embryo take part in fruit development
(c) only chalazal cells take part in fruit development
(d) ovary and other floral part are included in fruit development

124 Thalamus contributes in the fruit formation in
(a) apple (b) strawberry
(c) cashewnut (d) All of these

125 The world's oldest viable seed, excavated from Arctic Tundra is of
(a) lupine (b) *Ficus* (c) date palm (d) *Phoenix*

126 Viability of date palm (*Phoenix dactylifera*) seed is
(a) 2000 yrs (b) 1000 yrs
(c) 500 yrs (d) 100 yrs

TOPIC 5 ~ *Apomixis and Polyembryony*

127 Seed formation without fertilisation in flowering plants involves the process of ***NEET 2016***
(a) budding (b) somatic hybridisation
(c) apomixis (d) sporulation

128 Type of cell division takes place in apomixis is
(a) reductional (b) meiosis
(c) Both (a) and (b) (d) mitosis

129 Ovules contain many embryo in
(a) *Citrus* (b) apple
(c) mango (d) Both (a) and (c)

130 Occurrence of more than one embryo is called
(a) polyembryony (b) embryony
(c) parthenogenesis (d) fertilisation

131 Vegetative/Asexual reproduction and apomixis are common to each other in
(a) type of cell division
(b) clone nature of offspring
(c) Both (a) and (b)
(d) only in dicot plant

132 Nucellar polyembryony is reported in
(a) *Gossypium* (b) *Triticum*
(c) *Brassica* (d) *Citrus*

133 Apomictic embryos in *Citrus* arise from
(a) synergids
(b) maternal sporophytic tissue in ovule
(c) antipodal cell
(d) haploid egg

NEET
SPECIAL TYPES QUESTIONS

I. Assertion and Reason

■ **Direction** (Q. No. 134-148) *In each of the following questions, a statement of Assertion (A) is given followed by corresponding statement of Reason (R). Of the statements, mark the correct answer as*
(a) If both A and R are true and R is correct explanation of A
(b) If both A and R are true, but R is not the correct explanation of A
(c) If A is true, but R is false
(d) If A is false, but R is true

134 **Assertion** (A) Gynoecium consists of pistil.
Reason (R) It represents the male reproductive part in flowering plants.

135 **Assertion** (A) Meiosis is the cell division which occurs in the sexually reproducing organisms.
Reason (R) Meiotic cell division results into two cells having exactly same genetic makeup.

136 **Assertion** (A) Flowers are the structures related to sexual reproduction in flowering plants.
Reason (R) Various embryological processes of plants occur in a flower.

137 **Assertion** (A) Megaspore mother cell undergoes meiosis to produce four megaspores.
Reason (R) Megaspore mother cell and megaspore both are haploid.

138 **Assertion** (A) Pollen grain of angiosperm is considered as the male gametophyte.
Reason (R) Pollen grain contains stigma, style and ovary.

139 **Assertion** (A) Geitonogamy is genetically similar to autogamy.
Reason (R) In geitonogamy, pollen grains come from the same plant.

140 **Assertion** (A) Cleistogamous flowers produce assured seed set in the absence of pollinators.
Reason (R) Cleistogamous flowers do not open at all.

141 **Assertion** (A) Removal of anthers is first step in artificial hybridisation.
Reason (R) It prevents contamination of anthers.

142 **Assertion** (A) Endosperm development preceds embryo development.
Reason (R) It assures nutrition to the developing embryo.

143 **Assertion** (A) Non-albuminous seeds have no residual endosperm.
Reason (R) The endosperm is completely consumed during embryo development.

144 **Assertion** (A) Mango is a false fruit.
Reason (R) The thalamus also contributes to fruit formation in false fruits.

145 **Assertion** (A) Some fruits are seedless or contain non-viable seeds.
Reason (R) They are produced without fertilisation.

146 **Assertion** (A) In apomixis, plants of new genetic variations are not produced.
Reason (R) In apomixis, reductional division takes place.

147 **Assertion** Parthenocarpy involves the formation of seedless fruits. ***AIIMS 2019***
Reason Apomixis occurs without fertilisation.

148 **Assertion** In apomixis, the plants of new genetic sequence are produced. ***AIIMS 2019***
Reason In apomixis, two organisms of same genetic sequence meet.

II. Statement Based Questions

149 Read the following statements and choose the correct ones.
I. Non-essential floral organs in a flower are sepals and petals.
II. Stamens represent microsporophylls.
III. A dithecious anther consists of four microsporangia two in each lobe.
IV. The anther wall has middle layer lieing between endothecium and tapetum.
(a) I and II (b) II and III
(c) III and IV (d) I, II, III and IV

150 Which one of the following statement is correct? ***NEET 2013***
(a) Hard outer layer of pollen is called intine
(b) Sporogenous tissue is haploid
(c) Endothecium produces the microspores
(d) Tapetum nourishes the developing pollen

151 Self-incompatibility is a device for
I. ensuring cross-pollination.
II. preventing self-fertilisation.
III. ensuring self-fertilisation.
IV. genetic control for self-fertilisation.
Choose the correct statements from those given above.
(a) I, II and III (b) I, II, III and IV
(c) I, III and IV (d) I, II and IV

152 Which of the following statement(s) is/are correct?
I. The stigma serves as a landing platform for pollen grains.
II. Ovarian cavity is also known as ovarian locule and is present inside the ovary.
III. Placenta is located inside the ovarian cavity.
IV. The ovule is attached to the placenta by funicle.
(a) I, II and III (b) I, II and IV
(c) I and III (d) I, II, III and IV

153 Read the following statements.
I. Generative cell is bigger and contains abundant food reserve.
II. Vegetative cell is small and floats in the cytoplasm of the generative cell.
III. In angiosperms various stages of reductional divisions can be studied in young anthers.
IV. Hilum represents the junctions between ovule and funicle.
Choose the option with correct set of statements.
(a) I and II (b) I and III
(c) II and IV (d) III and IV

154 Read the following statements and choose the correct statements.
I. Heterostyly as a contrivance for cross-pollination is found in *Primula vulgaris*.
II. Cleistogamous flower is present in *Commelina*.
III. Tallest flower are of *Amorphophallus*.
IV. In monoecious condition, both male and female flowers are borne on same plant, an example of such plant is *Cucurbita*.
(a) I and II
(b) II and III
(c) III and IV
(d) I, II, III and IV

155 Read the following statements and choose the correct ones.
I. Mature ovules in which micropyle comes to lie close to the funiculus the ovule is anatropous.
II. When micropyle, chalaza and hilum lie in a straight line the ovule is said to be orthotropous.
III. Megasporangium along with its protective integument is called ovule.
(a) I and II (b) II and III
(c) I and III (d) I, II and III

156 Consider the following statements.
I. Pollination by bats is known as chiropterophily.
II. Pollination by ants is known as ornithophily.
(a) Both statements I and II are true
(b) Statements I is true, but II is false
(c) Statements I is false, but II is true
(d) Both statements I and II are false

157 Which one of the following statement is incorrect about pollination?
(a) Anemophily is by wind and occurs in grasses and date palm
(b) Hydrophily is by water and occurs in *Zostera*, *Vallisneria* and *Ceratophyllum*
(c) Entomophily is by insects and occurs in rose, jasmine, *Salvia*, etc.
(d) Ornithophily is by birds and occurs in *Adansonia*

158 Which of the following statement(s) is/are correct about *Parthenium* (carrot grass)?

(a) *Parthenium* came into India as a contaminant with imported wheat
(b) It has became ubiquitous in occurrence
(c) It causes pollen allergy
(d) All of the above

159 Choose the incorrect statement from the following.

(a) Long ribbon-like pollen grains are seen in some aquatic plants
(b) In some insect species, the floral reward for pollination is the safe place to lay eggs in the flower
(c) Insect robbers consume pollens or nectar without bringing about pollination
(d) Majority of the flowering plants produce homosexual flowers

160 Refer to the given characteristics of some flowers :

I. Flowers are small. They are often packed in inflorescence.
II. Flowers are colourless, nectarless and odourless
III. Well exposed stamens.
IV. Pollen grains produced in large number, light and non-sticky.
V. Flowers often have a single ovule in each ovary.
VI. Stigma-large, often feathery.

The above features are the characteristics of

(a) Self-pollination
(b) Anemophily (pollination by wind)
(c) Ornithophily (pollination by birds)
(d) Entomophily (pollination by insects)

161 The events in pollen-pistil interaction are given below.

I. Pollen grain germinates to form pollen tube.
II. Pollen tube enters the ovule through micropyle.
III. Pollen grain reaches the stigma.
IV. Pollen tube grows through the tissues of stigma and style and reaches the ovary.

The sequential order of their occurrence is

(a) III → I → IV → II
(b) II → IV → III → I
(c) III → IV → II → I
(d) II → III → I → IV

162 Which of the following statement is correct?

(a) Pollination gives the guarantee of the promotion of post-pollination events that lead to fertilisation
(b) The events 'from pollen deposition on stigma until pollen tubes enter the ovule' are together referred to as pollen-pistil interaction
(c) Pollen-pistil interaction is a dynamic process involving pollen recognition followed by only promotion (not rejection) of the pollen
(d) Pistil has no ability to recognise the pollen, whether right or wrong type

163 Study the following and find correct statement(s).

I. Pollination by water is quite rare in flowering plants and is limited to about 50 genera, mostly monocotyledons.
II. Water is a regular mode of transport for the male gametes among higher plant groups.
III. Distribution of bryophytes and pteridophytes are limited because of the need of water for transport of male gametes and fertilisation.

(a) Only I (b) II and III
(c) Only III (d) Only II

164 Read the following statements.

I. Double fertilisation was discovered by Nawaschin in *Lilium* and *Fritillaria*.
II. The total number of nuclei involved in double fertilisation is five.
III. The central cell of embryo sac, as a result of triple fusion becomes primary endosperm cell (PEC).
IV. Synergids are haploid.

Choose the correct set of statements.

(a) I, II and III
(b) II and IV
(c) I, III and IV
(d) I, II, III and IV

165 Find out the correct statement(s).

I. Most common endosperm is of nuclear type.
II. Coconut water is male gametophyte.
III. Coconut has both free-nuclear and cellular type of endosperm.

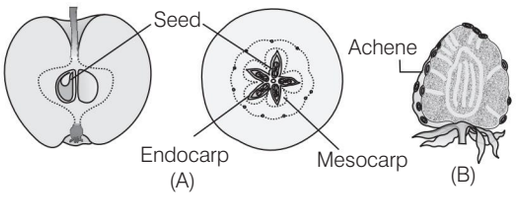
(a) I, II and III (b) I and III
(c) II and III (d) I and II

166 Find out the correct statement(s).

I. Endosperm formation is the prior event than embryo formation.
II. Angiospermic and gymnospermic endosperm are $3n$ and n, respectively.
III. Endospermic seeds are found in castor, barley and coconut.
IV. In albuminous seed, food is stored in endosperm and in non-albuminous seeds, it is strored in cotyledons.

(a) I and IV (b) II and III
(c) I and III (d) I, II, III and IV

167 Observe the following diagrams.

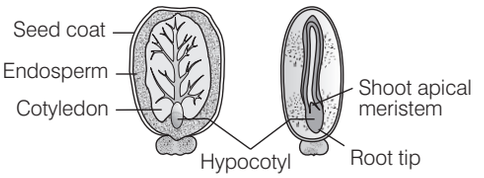


A. Fruit of apple B. Fruit of strawberry

Select correct statement regarding the above fruits.

(a) Both are parthenocarpic fruits which develops without fertilisation
(b) Both are true fruits which develops only from the ovary
(c) Both are false fruits in which thalamus also contributes to fruit formation
(d) A is false fruit and B is true fruit

168 The given diagram is related to castor seeds. Select the incorrect statement regarding the labelled parts.



(a) Seed coat protect the seed from physical, temperature or water damage
(b) Endosperm provides nourishment to the developing embryo
(c) Castor seed has single cotyledon, i.e. monocotyledonous and is albuminous
(d) Hypocotyl terminates at its lower end in the root tip

III. Matching Type Questions

169 Match the following columns.

	Column I		Column II
A.	Outer integuments	1.	Testa
B.	Inner integuments	2.	Tegmen
C.	Ovary	3.	Fruit
D.	Ovules	4.	Seed

Codes

	A	B	C	D		A	B	C	D
(a)	1	3	2	4	(b)	3	4	1	2
(c)	1	2	3	4	(d)	4	3	2	1

170 Match the following columns.

	Column I (Ovary)		Column II (Pistil)
A.	Monocarpellary	1.	Free pistil
B.	Multicarpellary	2.	Fused pistil
C.	Syncarpous	3.	Many pistil
D.	Apocarpous	4.	Single pistil

Codes

	A	B	C	D
(a)	1	2	3	4
(b)	4	3	2	1
(c)	3	4	2	1
(d)	4	3	1	2

171 Match the following columns.

	Column I		Column II
A.	Antipodal	1.	$3n$
B.	Central cell	2.	$2n$
C.	MMC	3.	$(n + n)$
D.	Endosperm	4.	n

Codes

	A	B	C	D		A	B	C	D
(a)	4	3	1	2	(b)	3	2	1	4
(c)	4	3	2	1	(d)	3	4	1	2

172 Match the following columns.

	Column I (Seeds / Fruits)		Column II (Examples)
A.	Endospermic seed	1.	Wheat
B.	Non-endospermic seed	2.	Mango
C.	True fruit	3.	Cashew
D.	False fruit	4.	Pea

Codes

	A	B	C	D		A	B	C	D
(a)	4	2	3	1	(b)	1	4	2	3
(c)	1	3	2	4	(d)	4	3	2	1

173 Match the following columns.

	Column I (Agents of pollination)		Column II (Technical term)
A.	Wind	1.	Anemophily
B.	Water	2.	Hydrophily
C.	Insects	3.	Entomophily
D.	Birds	4.	Ornithophily

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	3	4	(b)	1	3	2	4
(c)	4	2	3	1	(d)	2	3	4	1

174 Match the following columns.

	Column I (Parts of seed)		Column II (Features)
A.	Cotyledon	1.	Portion below the cotyledon
B.	Epicotyl	2.	Portion above the cotyledon
C.	Plumule	3.	Stem tip
D.	Hypocotyl	4.	Leaf of embryo

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	3	4	(b)	1	3	2	4
(c)	4	2	3	1	(d)	1	2	4	3

175 Match the following columns.

	Column I (Other modes of reproduction)		Column II (Examples)
A.	Parthenocarpy	1.	Grasses
B.	Apomixis	2.	Citrus
C.	Polyembryony	3.	Banana

Codes

	A	B	C		A	B	C
(a)	1	2	3	(b)	2	1	3
(c)	3	2	1	(d)	3	1	2

176 Match the following columns.

	Column I		Column II
A.	Viability of pollen grains	1.	Genetically different pollen grains
B.	Autogamy	2.	Prevailing temperature and humidity
C.	Pollen allergy	3.	Genetically similar pollen grains
D.	Xenogamy	4.	Carrot grass

Codes

	A	B	C	D
(a)	2	3	4	1
(b)	1	2	3	4
(c)	3	2	4	1
(d)	4	3	2	1

177 Match the following columns.

	Column I		Column II
A.	Ovary	1.	Groundnut, mustard
B.	Ovule	2.	Guava, orange, mango
C.	Wall of fruit	3.	Pericarp
D.	Fleshy fruits	4.	Seed
E.	Dry fruits	5.	Fruit

Codes

	A	B	C	D	E
(a)	5	4	3	2	1
(b)	1	2	3	4	5
(c)	1	3	2	4	5
(d)	5	4	1	2	3

NCERT & NCERT Exemplar

MULTIPLE CHOICE QUESTIONS

NCERT

178 What is the correct sequence of development of microsporogenesis?
(a) Pollen grain → Sporogenous tissue → Microspore tetrad → PMC → Male gametes
(b) Sporogenous tissue → Microspore tetrad → PMC → Male gametes
(c) Pollen grain → Male gametes → PMC → Microspore tetrad – Sporogenous tissue
(d) Sporogenous tissue → PMC → Microspore tetrad → Pollen grain → Male gametes

179 Strategies to prevent self-pollination are
(a) dioecy (b) self-incompatibility
(c) Both (a) and (b) (d) None of these

180 The portion of embryonal axis above the level of cotyledons is
(a) epicotyl (b) hypocotyl (c) plumule (d) radicle

181 Perisperm is
(a) residual nucellus (b) residual endosperm
(c) covering of fruit (d) None of these

182 Name the part of gynoecium that determines the compatible nature of pollen grain.
(a) Pistil (b) Ovary
(c) Ovum (d) Ovule

183 Which type of pollination occurs in self-incompatible plant?
(a) Self-pollination (b) Cross-pollination
(c) Water pollination (d) Wind pollination

NCERT Exemplar

184 In a typical complete, bisexual and hypogynous flower the arrangement of floral whorls on the thalamus from the outermost to the innermost is
(a) calyx, corolla, androecium and gynoecium
(b) calyx, corolla, gynoecium and androecium
(c) gynoecium, androecium, corolla and calyx
(d) androecium, gynoecium, corolla and calyx

185 Among the terms listed below, those that are not technically correct names for a floral whorl are
I. androecium II. carpel
III. corolla IV. sepal
(a) I and IV (b) III and IV
(c) II and IV (d) I and II

186 Embryo sac is to ovule as ..... is to an anther.
(a) stamen
(b) filament
(c) pollen grain
(d) androecium

187 A dicotyledonous plant bears flowers, but never produces fruits and seeds. The most probable cause for the above situation is
(a) plant is dioecious and bears only pistillate flowers
(b) plant is dioecious and bears both pistillate and staminate flowers
(c) plant is monoecious
(d) plant is dioecious and bears only staminate flowers

188 During microsporogenesis, meiosis occurs in
(a) endothecium
(b) microspore mother cells
(c) microspore tetrads
(d) pollen grains

189 From among the sets of terms given below, identify those that are associated with the gynoecium.
(a) Stigma, ovule, embryo sac, placenta
(b) Thalamus, pistil, style, ovule
(c) Ovule, ovary, embryo sac, tapetum
(d) Ovule, stamen, ovary, embryo sac

190 Starting from the innermost part, the correct sequence of parts in an ovule are
(a) egg, nucellus, embryo sac, integument
(b) egg, embryo sac, nucellus, integument
(c) embryo sac, nucellus, integument, egg
(d) egg, integument, embryo sac, nucellus

191 From the statements given below choose the option that are true for a typical female gametophyte.
I. It is 8-nucleate and 7-celled at maturity.
II. It is free-nuclear during the development.
III. It is situated inside the integument, but outside the nucellus.
IV. It has an egg apparatus situated at the chalazal end.
(a) I and IV (b) II and III
(c) I and II (d) II and IV

192 Autogamy can occur in a chasmogamous flower if
(a) pollen matures before maturity of ovule
(b) ovules mature before maturity of pollen
(c) Both pollen and ovules mature simultaneously
(d) Both anther and stigma are of equal lengths

193 Choose the correct statement from the following.
(a) Cleistogamous flowers always exhibit autogamy
(b) Chasmogamous flowers always exhibit geitonogamy
(c) Cleistogamous flowers exhibit both autogamy and geitonogamy
(d) Chasmogamous flowers never exhibit autogamy

194 From among the situations given below, choose the one that prevents both autogamy and geitonogamy.
(a) Monoecious plant bearing unisexual flowers
(b) Dioecious plant bearing only male or female flowers
(c) Monoecious plant with bisexual flowers
(d) Dioecious plant with bisexual flowers

195 In an embryo sac, the cells that degenerate after fertilisation are
(a) synergids and primary endosperm cell
(b) synergids and antipodals
(c) antipodals and primary endosperm cell
(d) egg and antipodals

196 While planning for an artificial hybridisation programme involving dioecious plants, which of the following steps would not be relevant?
(a) Bagging of female flower
(b) Dusting of pollen on stigma
(c) Emasculation
(d) Collection of pollen

197 In the embryos of a typical dicot and a grass, true homologous structures are
(a) coleorhiza and coleoptile (b) coleoptile and scutellum
(c) cotyledons and scutellum (d) hypocotyl and radicle

198 The phenomenon observed in some plants where in parts of the sexual apparatus is used for forming embryos without fertilisation is called
(a) parthenocarpy (b) apomixis
(c) vegetative propagation (d) sexual reproduction

199 In a flower, if the megaspore mother cell forms megaspores without undergoing meiosis and if one of the megaspores develops into an embryo sac, its nuclei would be
(a) haploid
(b) diploid
(c) a few haploid and a few diploid
(d) with varying ploidy

200 The phenomenon wherein, the ovary develops into a fruit without fertilisation is called
(a) parthenocarpy (b) apomixis
(c) asexual reproduction (d) sexual reproduction

201 In a fertilised embryo sac, the haploid, diploid and triploid structures are
(a) synergid, zygote and primary endosperm nucleus
(b) synergid, antipodal and polar nuclei
(c) antipodal, synergid and primary endosperm nucleus
(d) synergid, polar nuclei and zygote

202 The outermost and innermost wall layers of microsporangium in an anther are respectively.
(a) Endothecium and tapetum
(b) Epidermis and endodermis
(c) Epidermis and middle layer
(d) Epidermis and tapetum

203 A particular species of plant produces light, non-sticky pollen in large numbers and its stigmas are long and feathery. These modifications facilitate pollination by
(a) insects (b) water (c) wind (d) animals

Answers

› Mastering NCERT with MCQs

1 (c)	2 (a)	3 (d)	4 (c)	5 (b)	6 (d)	7 (d)	8 (d)	9 (a)	10 (a)	11 (d)	12 (d)	13 (c)	14 (d)	15 (b)
16 (b)	17 (b)	18 (c)	19 (a)	20 (a)	21 (c)	22 (d)	23 (d)	24 (c)	25 (c)	26 (d)	27 (b)	28 (a)	29 (a)	30 (c)
31 (a)	32 (b)	33 (b)	34 (d)	35 (c)	36 (a)	37 (a)	38 (c)	39 (a)	40 (a)	41 (c)	42 (c)	43 (a)	44 (c)	45 (c)
46 (c)	47 (b)	48 (c)	49 (b)	50 (c)	51 (d)	52 (c)	53 (d)	54 (c)	55 (d)	56 (a)	57 (c)	58 (c)	59 (c)	60 (c)
61 (a)	62 (a)	63 (b)	64 (c)	65 (a)	66 (c)	67 (a)	68 (a)	69 (b)	70 (b)	71 (d)	72 (b)	73 (c)	74 (b)	75 (b)
76 (d)	77 (a)	78 (b)	79 (b)	80 (b)	81 (b)	82 (a)	83 (d)	84 (b)	85 (b)	86 (c)	87 (c)	88 (d)	89 (a)	90 (b)
91 (a)	92 (b)	93 (d)	94 (d)	95 (c)	96 (c)	97 (c)	98 (b)	99 (b)	100 (b)	101 (b)	102 (c)	103 (d)	104 (a)	105 (d)
106 (d)	107 (c)	108 (c)	109 (c)	110 (b)	111 (a)	112 (c)	113 (d)	114 (c)	115 (a)	116 (b)	117 (d)	118 (c)	119 (a)	120 (a)
121 (a)	122 (c)	123 (d)	124 (d)	125 (a)	126 (a)	127 (c)	128 (d)	129 (d)	130 (a)	131 (c)	132 (d)	133 (b)		

› NEET Special Types Questions

134 (c)	135 (c)	136 (a)	137 (c)	138 (c)	139 (a)	140 (a)	141 (c)	142 (a)	143 (a)	144 (d)	145 (a)	146 (c)	147 (b)	148 (d)
149 (d)	150 (d)	151 (d)	152 (d)	153 (d)	154 (d)	155 (d)	156 (b)	157 (d)	158 (d)	159 (d)	160 (b)	161 (a)	162 (b)	163 (c)
164 (d)	165 (b)	166 (d)	167 (c)	168 (c)	169 (c)	170 (b)	171 (c)	172 (b)	173 (a)	174 (c)	175 (d)	176 (a)	177 (a)	

› NCERT & NCERT Exemplar Questions

178 (d)	179 (c)	180 (a)	181 (a)	182 (a)	183 (b)	184 (a)	185 (c)	186 (c)	187 (d)	188 (b)	189 (a)	190 (b)	191 (c)	192 (c)
193 (a)	194 (b)	195 (b)	196 (c)	197 (c)	198 (b)	199 (b)	200 (a)	201 (a)	202 (d)	203 (c)				

Answers & Explanations

2 (*a*) Stamen is the odd one out among the other options. Stamen represents the male reproductive part of a flower, whereas stigma, style and ovary, are the parts of a carpel or pistil which represents the female reproductive part of a flower.

4 (*c*) The terminal structure of stamen is called anther, which contains pollen grains (male gametophyte). Pollen grains are haploid in nature.

5 (*b*) The dehiscence (release of pollen grain) of anther occurs through the line of dehiscence which is the running groove on anther longitudinally. It separates the theca of anther.

6 (*d*) A typical angiosperm anther is bilobed with each lobe having two theca. The anther is a four-sided (tetragonal) structure consisting of four microsporangia located at the corner with two in each theca.

7 (*d*) Microsporangium develops further and becomes pollen sac. It is like a sac in which pollen develops. It is called pollen sac at the time of maturity.

10 (*a*) Sporogenous tissue occupies the centre of each microsporangium. Each cell of this tissue is a potential pollen mother cell and can give rise to microspore tetrad.

12 (*d*) Microsporangium is surrounded by four wall layers. The outermost layer is epidermis which is followed by endothecium, the middle layer and the innermost layer called tapetum. The three outer layers of microsporangium perform the function of protection and help in dehiscence of anther to release pollen.

13 (*c*) Microspore mother cell and pollen mother cell are the same terms and form male gametes (pollens) by the process called microsporogenesis.

16 (*b*) As the anthers of angiospermic mesophytic plants mature and dehydrate, the line of dehiscence ruptures releasing the microspores in atmosphere. These microspores dissociate from each other and develop into pollen grains.

18 (*c*) The inner layer of pollen grain is called intine. It is a continuous and thin layer made up of cellulose and pectin.

21 (*c*) Sporopollenin is the hardest substance in plant kingdom. It is the major constituent of outer layer, exine of pollen grains and is non-degradable.

23 (*d*) Sporopollenin enables in preservation of pollen as fossils. Since, sporopollenin cannot be degraded by any enzyme. It is not affected by high temperature, strong acid or strong alkali. Thus, it keeps pollen grains well-preserved as fossils.

24 (*c*) The germ pores are apertures in the exine layer of a pollen grain which help in the initiation of pollen tube and the release of the male gametes during fertilisation. There are usually three germ pores in dicots (tricolpate) and one in monocots (monocolpate).

26 (*d*) When a pollen grain is mature it contains two cells, a vegetative cell and generative cell. The vegetative cell is bigger, has abundant food reserve and a large irregularly shaped nucleus. The generative cell is small

and floats in the cytoplasm of the vegetative cell. It is spindle-shaped with dense cytoplasm and a nucleus.

27 (*b*) The generative cell of a pollen grain divides to form two male gametes in order to achieve the 3-celled stage in angiospermic plants.

28 (*a*) 60% of angiosperms shed their pollens at 2-celled stage and in rest 40%, the pollens are shed at 3-celled stage.

30 (*c*) Pollen grains are rich in nutrients. These are available in the market in the form of tablets and are used as food supplements to improve health. Pollen consumption has been claimed to enhance the performance of athletes and race horses.

31 (*a*) Pollen grains can be stored for several years in liquid nitrogen having a temperature of –196°C (cryopreservation). Pollen grains can be later used in plant breeding programmes.

32 (*b*) The part labelled as C shows ovary. It is the site of fertilisation, the process in which the fusion of male and female gametes takes place. Fertilisation occurs in the ovary of a pistil.

33 (*b*) The diagram represents the multicarpellary, syncarpous pistil of *Papaver*. The gynoecium of this plant consists of more than one pistil, showing multicarpellary condition. These pistils are fused together and hence are called syncarpous.

34 (*d*) The diagram shows the multicarpellary apocarpous pistil of *Michelia*. The gynoecium of this ovary consists of more than one pistil (multicarpellary) which are free (apocarpous).

37 (*a*) Ovule of an angiosperm is equivalent to the megasporangium which consists of 2 synergids, 1 egg, 3 antipodal cells and a secondary nucleus.

38 (*c*) An ovule is an integumented megasporangium found in angiosperms, which develops into seeds after fertilisation.

39 (*a*) Chalazal pole is present just opposite to the micropylar end and represents the basal part of the ovule.

40 (*a*) Integuments enclose a mass of cells called the nucellus. Cells of the nucellus have abundant reserve food materials.

41 (*c*) Embryo sac is also called the female gametophyte. In flowering plants, it is formed by the division of the haploid megaspore nucleus and acts as the site of fertilisation and development of the embryo.

43 (*a*) Megaspore Mother Cell (MMC) is found in the micropylar region of the nucellus. It is a large cell containing dense cytoplasm and prominent nucleus.

44 (*c*) In most of the angiosperms, the megaspore mother cell ($2n$) divides meiotically (reductional division) to produce 4 cells.

Out of these, three degenerate and the remaining one forms the functional megaspore. This further divides mitotically and forms embryo sac.

45 (*c*) Microsporogenesis and megasporogenesis are the processes involving the formation of male gamete and female gamete, respectively by meiotic cell division in flowering plants.

46 (*c*) In angiosperms, functional megaspore develops into an embryo sac. The functional megaspore is the first cell of the female gametophyte.

47 (*b*) The most common type of female gametophyte (embryo sac) in angiosperms is the monosporic embryo sac in which the embryo sac develops from a single functional megaspore (n), while the other three megasproes degenerate. The functional megaspore undergoes three sequential mitotic divisions and gives rise to the 8-nucleate and 7-celled mature embryo sac.

52 (*c*) The functional megaspore develops into the embryo sac containing 2 synergids, l egg cell, 1 central cell and 3 antipodal cells. Thus, option (c) gives the correct number of different cells in an embryo sac.

55 (*d*) The function of filiform apparatus is to guide the entry of pollen tube into the synergids and release of sperm cells.

56 (*a*) A typical angiospermic embryo sac at maturity has 8-nuclei. Six out of the eight nuclei are surrounded by cell walls and organised into cells (egg apparatus and antipodal cells) and the remaining two nuclei, called polar nuclei, are situated below the egg apparatus in the large central cell.

57 (*c*) Female gametophyte is 7-celled structure. Out of these, three cells are grouped together at the micropylar end and constitute of two synergids and one egg cell, three antipodal cells are at the chalazal end and the large central cell.

63 (*b*) Cleistogamous flowers are strictly autogamous because they always remain close for ensuring self-pollination. In these flowers, there is no chance of cross-pollination.

66 (*c*) Cleistogamous flowers are not dependent on pollinators. These are bisexual flowers which never open, i.e. always remain closed. In such flowers, the anthers and stigma lie very close to each other. When anthers dehisce in the flower buds, pollen grains come in contact with the stigma of the same flower, i.e. autogamy occurs. So, these flowers produce assured seed set, even in the absence of pollinators.

67 (*a*) *Commelina* has flowers which does not open at all, i.e. cleistogamous flowers. So, even in the absence of pollinating agent, assured seed setting takes place in *Commelina*.

68 (*a*) Geitonogamy is a type of self-pollination. In other words, geitonogamy is the transfer of pollen grains from the anther of one flower to the stigma of another flower of either the same or a genetically similar plant.

69 (*b*) Xenogamy is also called cross-pollination. In this, transfer of pollen grains takes place between the anther and the stigma of different plants of same species.

71 (*d*) Wind pollinated pollens are non-sticky and light so that they can go far away in wind currents. These are produced in large numbers, because there is a lot of wastage of pollens.

72 (*b*) Maize (corn cob) stigma are feathery and long, which wave in the air to trap pollen grains.

73 (*c*) The flowers with packed inflorescence and single ovary are wind pollinated. These flowers produce pollen grains in large numbers and such pollen grains are light weighted sometimes winged, e.g. cereals and grasses.

75 (*b*) Insect or Wind act as pollinating agents in the majority of aquatic plants such as water hyacinth and water lily. In these plants, the flowers emerge above the level of water and are pollinated by insects or wind as in most of the land plants.

76 (*d*) *Vallisneria* is a water pollinated plant. In *Vallisneria*, the female flowers reach the surface of water by the long stalk and the male flowers or pollen grains are released on to the surface of water. These are carried passively by water currents to the female flowers at the surface of water.

78 (*b*) Wind pollinated and water pollinated flowers are non-colourful. As these do not need any biotic agency for pollination, there is no need for fragrance, nectar and colourfulness.

79 (*b*) Pollenkitt is present in entomophily. It is a yellow, sticky, viscous and oily layer that covers exine of some insect pollinated pollen grains. Its major function is to make the pollen to stick to the bugs. Thus, it helps in pollination.

80 (*b*) Attractants and rewards are required for entomophily (insect pollination). Flowers are colourful and produce a specific odour to attract the insects for effective pollination. To sustain animal visits, flowers also provide nectar and pollen grains as rewards to them.

81 (*b*) Out of the given options, only *Yucca gloriosa* has developed an obligate symbiotic relationship with the moth, *Pronuba yuccasella*. The moth cannot complete its life cycle without the association with *Yucca* flowers. 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.

82 (*a*) Continued self-pollination results in inbreeding depression. Due to the continuous breeding of related species the productivity of the progeny species is reduced which leads to inbreeding depression.

83 (*d*) Both option (a) and (b) are correct as
Flowering plants have developed many devices to discourage self-pollination. In some species, pollen release and stigma receptivity is non-synchronised, i.e. either the pollen is released before the stigma becomes receptive or stigma becomes receptive much before the release of pollen.

In other 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.

Both these devices prevent autogamy (self-pollination) and increases cross-pollination.

84 (*b*) Dioecious flowering plants prevent the occurrence both autogamy and geitonogamy in them. In dioecious condition, flowers occur on different plants, i.e. male and female flowers are present on different plants.

Hence, it does not favour autogamy and geitonogamy because autogamy takes place in bisexual flowers and geitonogamy takes place between different flowers of the same plant.

85 (*b*) Autogamy and geitonogamy both are prevented in the papaya plant. This is because in papaya, male and female flowers are present on different plants that is each plant is either male or female (dioecy).

91 (*a*) The process of removal of anther from flower bud before it dehisces is called as emasculation. When an emasculated flower is covered with a bag of suitable size to prevent contamination of its stigma with unwanted pollen it is called bagging. These methods are a part of artificial hybridisation technique used in plants.

93 (*d*) Double fertilisation is the fusion of two male gametes to two different cells of the same female gametophyte.

It consists of the following two events

- **Syngamy** is the fusion of the egg nucleus with one male gamete.
- **Triple fusion** is the fusion of second male gamete and polar nuclei of central cell.

95 (*c*) Out of the given structures, antipodal cell, egg cell, synergid cell and male gamete are haploid. Thus, option (c) is correct. The ploidy of the remaining structures mentioned is diploid.

96 (*c*) Out of the male gametes discharged in the synergid, one fuses with the egg and other fuses with central cell nuclei. The fusion between male gamete and egg is called syngamy or true fertilisation which forms zygote ($2n$). The fusion between male gamete and central cell nuclei is called triple fusion and it results in the formation of a triploid primary endosperm nucleus ($3n$).

100 (*b*) Two polar nuclei and one nuclei of the remaining male gamete (total 3 nuclei) are involved in the triple fusion of double fertilisation.

102 (*c*) Option (c) is correct. If stem has $2n = 10$ number of chromosomes, then

$$\text{Endosperm} = 3n = 5 \times 3 = 15 \text{ chromosomes.}$$
$$\text{Egg cell} = 1n = 1 \times 5 = 5 \text{ chromosomes.}$$
$$\text{Polar nuclei} = 2n = 2 \times 5 = 10 \text{ chromosomes.}$$

103 (*d*) Option (d) is correct. The ploidy of endosperm is $3n$.
Now, Chromosome given = 36

$$\text{Haploid number} = \frac{36}{3} = 12$$

Chromosomes of male and female gametes are haploid, so answer is 12 and 12, respectively.

104 (*a*) After triple fusion, i.e. the fusion of male gametes and polar nuclei, the central cell of female gametophyte becomes the Primary Endosperm Cell (PEC).

105 (*d*) Option (d) is correct. If a male plant is diploid ($2n$) it will produce haploid male gamete (n).

If a female plant is tetraploid ($4n$) it will produce tetraploid polar nuclei ($4n$).

Endosperm is formed by fusion of male gamete with polar nuclei, i.e. fusion of tetraploid polar nuclei and haploid male gamete will give pentaploid ($5n$) endosperm.

106 (*d*) Pollen tube liberates both male gametes in synergids, out of which one male gamete fuses with egg cell and other with the polar nuclei.

108 (*c*) Endospermogenesis and embryogenesis are the post-fertilisation event under which formation of endosperm and embryo take place. Whereas, megasporogenesis is the formation of megaspores and is a pre-fertilisation event.

111 (*a*) Endosperm is consumed by the developing embryo in seeds of pea plant. Endosperm may either be completely consumed by the developing embryo in plants like pea, groundnut, beans before seed maturation or it may persist in mature seed in plants like castor, maize and coconut and be used up during seed germination.

118 (*c*) In wheat or maize (family–Poaceae), the scutellum is thought to be a large, shield-shaped cotyledon or seed leaf, which is situated towards one side (lateral) of the embryonal axis.

120 (*a*) Persistent nucellus in the seed is known as perisperm. The albuminous seeds usually retain a part of endosperm as it is not completely used up during embryo development. But in some seeds, remnants of nucellus are also persistent. This residual persistens nucellus is called perisperm, e.g. in black pepper and beet root.

121 (*a*) Dehydration and dormancy are most crucial for seed storage. In dehydration, there is less amount of water due to which the seed enzymes cannot work and hence, there will be no germination. Dormancy is the time period in which seed cannot grow due to inactive state of embryo or lacking of other necessary condition for growing.

124 (*d*) Thalamus contributes to fruit formation in apple, strawberry and cashewnut. In such plant species where the thalamus contributes to fruit formation, the fruits are called false fruits. But in most of the plants, the fruit develops from the ovary (true fruits) and other floral part degenerates and fall off.

125 (*a*) The oldest viable seed is that of a lupine, *Lupinus arcticus* excavated from Arctic Tundra. The seed germinated and flowered after an estimated record of 10,000 years of dormancy.

127 (*c*) Apomixis is a special mechanism found in flowering plants to produce seeds without meiosis and fertilisation. It is a type of asexual reproduction which mimics sexual reproduction and is commonly found in species of Asteraceae and grasses.

129 (*d*) In varieties of both *Citrus* and mango ovules contain many embryos. In these varieties some of the nucellar cell surrounding the embryo sac starts dividing, protrude into the embryo sac and develop into many embryos.

130 (*a*) Occurrence of more than one embryo is called polyembryony. It is generally observed in *Citrus* varieties. Orange and lemon are common examples of polyembryony.

131 (*c*) Option (c) is correct as

In asexual/vegetative and apomictic reproduction, mitotic cell divison takes place, due to which the resultant progeny are identical to the parents and to each other (clone nature of offspring).

132 (*d*) Nucellar polyembryony is a form of seed production that occurs in *Citrus* varieties. During the development of seeds in plants that possess this genetic trait, the nucellar tissue which surrounds the megagmetophyte can produce additional embryos (polyembryony) which are genetically identical to the parent plant. These nucellar seedling are clones of the parent.

133 (*b*) Synergids, antipodal cell, haploid egg do not take part in seed or apomictic seed formation because they are haploid and can only take part in sexual reproduction. Only maternal sporophytic tissue in ovule takes part in seed formation in apomictic embryogenesis as it is diploid.

134 (*c*) Assertion is true, but Reason is false and can be corrected as

The gynoecium represents the female reproductive part of the flower and consists of pistil.

135 (*c*) Assertion is true, but Reason is false and can be corrected as

In meiosis, the resultant cells do not have exactly same genetic makeup due to the process of crossing over.

136 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

The structures related to sexual reproduction in flowering plants are flowers. This is because embryological processes during sexual reproduction occur in ovary, which is a part of a flower.

137 (*c*) Assertion is true, but Reason is false and can be corrected as

Megaspore mother cell is diploid and megaspore is haploid.

138 (*c*) Assertion is true, but Reason is false and can be corrected as

Pollen grain does not contain the stigma, style and ovary. These are parts of the female reproductive structure of flower, gynoecium.

139 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Geitonogamy is functionally cross-pollination involving a pollinating agent, but genetically it is similar to autogamy. This is because the pollen grains come from different flowers of the same plant.

140 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Cleistogamous flowers do not open at all. This ensures fertilisation and consequently leads to the production of assured of seed-set even in the absence of pollinators.

141 (*c*) Assertion is true, but Reason is false and it can be corrected as

Removal of anthers (emasculation) is done in artificial hybridisation as it prevents contamination of the pistil (female reproductive structure).

142 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Endosperm is source of nutrition for the developing embryo, thus the development of endosperm takes place before the process of embryogenesis.

143 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

In non-albuminous seeds, the endosperm is fully consumed by the developing embryo and thus, no residue is left in such seeds.

144 (*d*) Assertion is false, but Reason is true. Assertion can be corrected as

Mango is a true fruit, which develops only from the ovary.

145 (*a*) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Parthenocarpic fruits are either seedless or contain non-viable seeds. This is because such fruits are formed without fertilisation.

146 (*c*) Assertion is true, but Reason is false and can be corrected as

Apomixis is the type of asexual reproduction in which seeds are produced without meiosis (reductional division) and syngamy.

147 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion. The correct explanation is as follows

Parthenocarpy involves the formation of seedless fruits, because the fruit formation from parthenocarpy does not involve pollination and fertilisation and hence, fruits develop without seed formation.

Apomixis is a mechanism that mimics sexual reproduction and produces seeds without the union of male and female gametes. The diploid egg cell is formed without meiotic division and develops into embryo without fertilisation, e.g. members of Asteraceae and grasses.

148 (*d*) Assertion is false, but Reason is true. Assertion can be corrected as

In apomixis, sexual reproduction is completely replaced by asexual reproduction. In this process, no new genetic sequence is formed as the progeny is genetically identical to the parent.

150 (*d*) The statement in option (d) is correct. Rest of the statements are incorrect and can be corrected as

- The inner wall of pollen grain is called intine.
- Sporogenous tissue is diploid and undergoes meiotic division to form microspore tetrads.
- Endothecium is the wall around the microsporangium, which provides protection and helps in the dehiscence of anther to release the pollen.

151 (*d*) Statements I, II and IV are correct. Statement III is incorrect and can be corrected as

Self-incompatibility is a device which ensures cross-pollination, prevents self-fertilisation and keeps genetic control for self-fertilisation.

153 (*d*) Statements III and IV are correct. Statements I and II are incorrect and can be corrected as

- In a mature pollen grain vegetative cell is bigger and has abundant food reserve and a large irregular shaped nucleus.
- The generative cell is small and floats in the cytoplasm of vegetative cell. It is spindle-shaped with dense cytoplasm and nucleus.

156 (*b*) Statement I is true, but statement II is false. The false statement can be corrected as

Pollination by ants is called myrmecophily.

157 (*d*) The statement in option (d) is incorrect and can be corrected as

- Ornithophily is pollination by birds and occurs in *Butea, Bignonia*, etc.
- In *Adansonia*, chiropterophily occurs (i.e. pollination by bats).

Rest of the statements are correct.

159 (*d*) The statement in option (d) is incorrect and can be corrected as

Majority of the flowering plants produce bisexual flowers.

Rest of the statements are correct.

162 (*b*) The statement in option (b) is correct.

Rest of the statements are incorrect and can be corrected as

- Pollination does not give the guarantee of the promotion of post-pollination events that lead to fertilisation.
- Pollen-pistil interaction is a dynamic process involving pollen recognition followed by promotion or inhibition of the pollen.
- The pistil has the ability to recognise the pollen, whether it is of the right type (compatible) or of the wrong type (in compatible).

163 (*c*) Statement III is correct. Statements I and II are incorrect and can be corrected as

- Pollination by water is quite rare in flowering plants and is limited to about 30 genera, mostly monocotyledons.
- Water is a regular mode of transport for the male gametes among lower plant groups such as algae and bryophytes.

165 (*b*) Statements I and III are correct, but statement II is incorrect and can be corrected as

The coconut water from tender coconut represents free-nuclear endosperm not male gametophyte and the surrounding white kernel is the cellular endosperm.

167 (*c*) The statement in option (c) is correct. Rest of the statements are incorrect and can be corrected as

The fruit of apple (A) and fruit of strawberry (B), are false fruits, in which thalamus also contributes to fruit formation alongside ovary. These fruits are not parthenocarpic because parthenocarpic fruits are seedless and are formed without fertilisation.

168 (*c*) The statement in option (c) is incorrect and can be corrected as

Castor seed is dicotyledonous, i.e. with two cotyledons and is albuminous, i.e. having residual endosperm.

Rest of the statements are correct.

178 (*d*) The correct sequence is given in option (d).

During microsporogenesis, the sporogenous tissue initially forms Pollen Mother Cell (PMC). Then this pollen mother cell undergoes meiotic division to form microspore tetrad. The microspores further develop into pollen grains, which contain the male gametes.

179 (*c*) Dioecy and self-incompatibility are the methods to prevent self-pollination in plants. In dioecy, male and female flowers are borne on separate plants. So, that cross-pollination is promoted.

In self- incompatibility, pollens are prevented to fertilise the ovules of same flower by inhibiting pollen germination on the pistil.

180 (*a*) A typical dicotyledonous embryo consists of an embryonal axis and two cotyledons. The portion of embryonal axis above the level of cotyledon is the epicotyl and below the level of cotyledon is hypocotyl.

181 (*a*) In some plants/seeds, such as black pepper remains of nucellus are also persistent, this is called as perisperm.

182 (*a*) The pistil is the part of gynoecium which has the ability to recognise the pollen. Thus, determine the compatible nature of pollen grain.

184 (*a*) In a typical complete, bisexual and hypogynous flower, the arrangement of floral whorls on the thalamus from the outermost to the innermost is

Calyx is the whorl of sepals is the outermost.

Corolla is the whorl of petals inside the calyx.

Androecium is the whorl of stamens inside the corolla.

Gynoecium is the whorl of pistils in the centre of the flower forming the innermost whorl.

185 (*c*) Sepal and carpel are technically incorrect names for a whorl. This is because sepals collectively form a whorl called as calyx, while the carpel is technically known as gynoecium.

186 (*c*) The pollen grains represent the male gametophyte. As the anther matures and dehydrates, the microspore dissociates from each other and develop into pollen grains. So, embryo sac is to ovule as pollen grains is to an anther.

187 (*d*) In dioecious plants, the unisexual flower is either staminate, i.e. bearing stamens only or is pistillate bearing only pistil or carpel. For the production of fruits and seeds fertilisation must take place, which is possible only in the presence of both male and female flowers. So, in this situation plant is dioecious and bears only staminate flowers.

188 (*b*) During microsporogenesis, meiosis occurs in Microspore Mother Cell (MMC) and four haploid microspores (microspore tetrad) are formed.

189 (*a*) Gynoecium is the female reproductive part of a flower and is also called pistil. Each pistil has three parts, i.e. stigma, style and ovary. Inside the ovarian cavity, the placenta is located. Arising from placenta is the ovule. The functional megaspore undergoing the meiotic division develops into embryo sac. Thus, option (a) is correct.

190 (*b*) Starting from the inner to the outer side of ovule, the ovule bears egg cell, embryo sac, nucellus, and integument.

191 (*c*) Statements I and II are correct. Statements III and IV are incorrect and can be corrected as

- Female gametophyte is present inside the nucellus.
- Egg apparatus is situated at the micropylar end.

192 (*c*) Autogamy is self-pollination. In chasmogamous flower, anthers and stigma are exposed. For autogamy in such a flower to take place, pollen and ovule should mature simultaneously and anther and stigma should lie close to each other.

193 (*a*) The statement in option (a) is correct as Cleistogamous flowers (that do not open at all) always exhibit autogamy.

Rest of the statements are incorrect and can be corrected as

Chasmogamous flowers (with exposed anther and stigma) can exhibit autogamy, geitonogamy or xenogamy.

194 (*b*) Dioecious plants (bearing only male or female flowers) prevent both autogamy and geitonogamy.

195 (*b*) In a fertilised embryo sac, antipodals and synergids gradually degenerate after the formation of zygote.

196 (*c*) If the female parent produces unisexual (dioecious) flowers, there is no need for emasculation. Because in a dioecious flower only single reproductive structure is present thus chances of self-pollination are not there.

197 (*c*) In the embryos of a typical dicot and a grass (monocot), true homologous structures are cotyledons and scutellum. This is because in the monocots such as the grass family a single cotyledon is present which is called scutellum.

199 (*b*) Option (b) is correct.

Megaspore mother cell is diploid ($2n$). lf it forms megaspores without meiosis, the megaspores will be diploid ($2n$) too. If this diploid megaspore develops into embryo sac, its nuclei would also be diploid.

202 (*d*) A typical microsporangium is generally surrounded by four-wall layers, i.e. the epidermis (outermost protective layer), then endothecium, then middle fibrous layers and the tapetum (innermost nutritive layer).

203 (*c*) Wind pollination requires light and non-sticky pollen grains so that, they can be transported with wind currents and its stigma are long and feathery to easily trap airborne pollen grains.