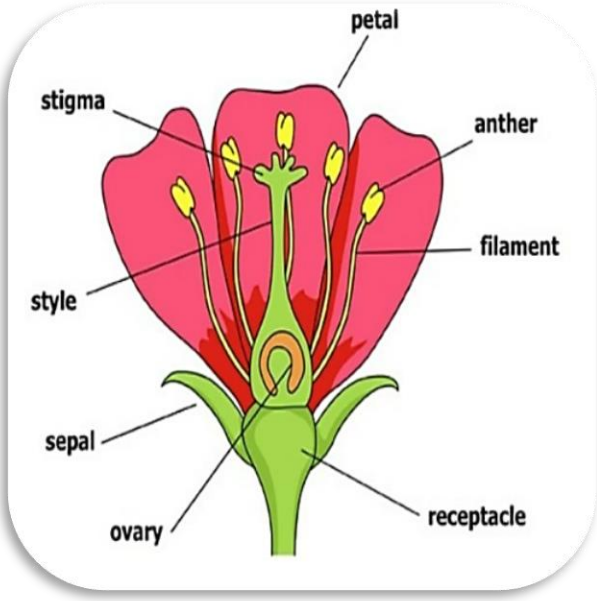
CHAPTER – 2

SEXUAL REPRODUCTION IN FLOWERING PLANTS

Flowers have always been objects of fundamental, social, religious and cultural values, they have always been used as symbols for conveying human feelings like love, affection happiness and grief. But for a botanist flowers are morphological and embryological marvels and site of reproduction.

Structure of a flower: the main parts of a flower as follows:

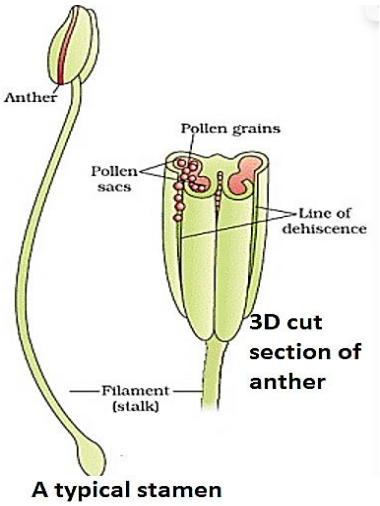
- **Receptacle:** it is the base of a flower to which all flower parts are attached.
- **Sepal:** the outermost circle of a flower that is green and leafy. Together it is known as calyx and they function to protect the flower in bud form.
- **Petals:** the second whorl after sepals, together they are called as corolla. They function to protect the reproductive structures and attract the insects for pollination as they are colourful and scented.
- **Stamen:** it the male reproductive part of the flower. It is made of two parts, the anther and the filament, the anther synthesizes and stores the pollen grains, it is also called as androecium.
- **Pistil: the female reproductive part.** It is differentiated into three parts, the style, stigma and the ovary. Also called as gynoecium



Structure of a flower

Pre-fertilisation: Structure and Events

The development of the floral primordium is influenced by a number of structural and hormonal changes. An inflorescence is created, which bears floral buds before flowering. Male (androecium) and female (gynoecium) gametes are created in flowers as they differentiate and mature.



A typical stamen

Stamen, Microsporangium and Pollen grains

Stamens is a long and a thin stalk called the filament and bilobed anthers. Each lobe has two theca (dithecious).

The **anther** is a four-sided structure with two microsporangia in each lobe.

Development in microsporangia takes place and they become pollen sacs filled with pollen grains.

The epidermis, endothecium, middle layer, and tapetum are the four layers that surround the microsporangium. The outer three wall layers perform the function of protection and help in dehiscence of anther to release the pollen. The tapetum in the innermost layer that nourishes the growing pollen grains.

The sporogenesis tissue: When the anther is young, it has compactly organised homogeneous cells in the centre of each microsporangium called the sporogenesis tissue.

Microsporogenesis: it is the process of formation and differentiation of microspores (pollen grains) from microspore mother cells (MMC) by reductional division.

Sporogenous tissue divides meiotically to create microspore tetrads. The microspore dissociates and develops into pollen grains when the anther matures and dehydrates.

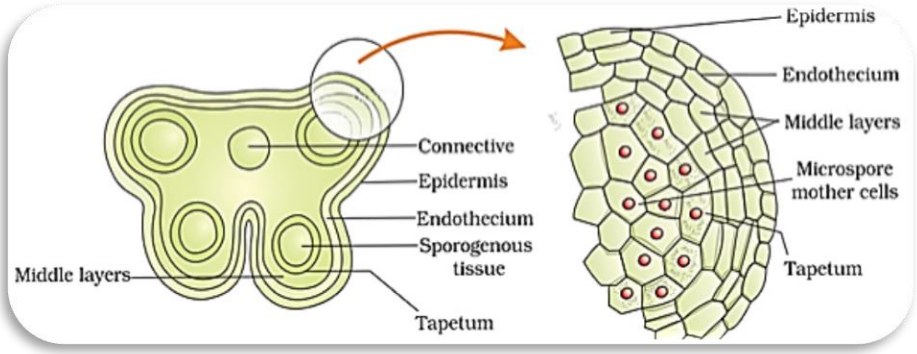


Diagram showing a transverse section of an anther enlarged view of Microsporangium showing the walls

Brush Up Your Knowledge

Q1. What would be the ploidy of the cells of tetrad?
(a) Haploid (b) Diploid
(c) Polyploid (d) Triploid

S1. **(a)**

Q2. The microsporangia develop further and become pollen sacs. In anther these pollen sacs extend.
(a) Transversely
(b) Longitudinally
(c) Obliquely
(d) Sometimes transversally and sometimes longitudinally

S2. **(b)** **The Pollen grain:** it represents the male gametophyte. It is surrounded by two walls:

(i) **Exine:** it is made from sporopollenin, the most resistant biological substance known to man. It is resistant to high temperatures as well as strong acids and alkalis. Sporopollelin cannot be degraded by any enzyme

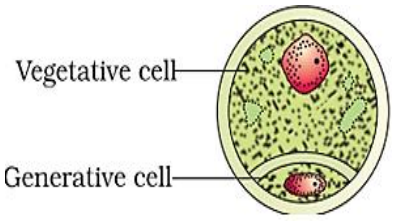
(ii) **Intine:** it is a thin and a continuous layer of cellulose and pectin.
Germ pore helps in formation of the pollen tube during pollen germination via the exine where sporopollenin is absent.

The mature pollen grain: at maturity a pollen contains two cells the

(i) **vegetative cell**: it is bigger and has abundant food reserve, has a large nucleus and is responsible for the development of pollen grain.

(ii) **generative cell:** it is small and is involved in syngamy, it has a dense cytoplasm and a nucleus.

More about pollen grains: Pollen grains from various species, such as *Parthenium*, cause severe allergies and bronchial illnesses in certain people, leading to persistent respiratory problems such as asthma and bronchitis.



A mature pollen grain

Pollen grains are high in nutrients and are used as dietary supplements in the form of pollen tablets. **Pollen grain viability** varies in species. A pollen grain should settle on stigma before this period so that it can germinate. Pollen grains from a variety of species are preserved in liquid nitrogen at a temperature of – 196 degrees in a pollen bank.

Brush Up Your Understanding

Q1. To some extent viability of pollen grains depends on.
(a) Temperature (b) Humidity
(c) Both (a) and (b) (d) Light

S1. (c)

Q2. Due to which of the following chemical deposition pollen grains are well preserved as fossils.
(a) Pollen kit (b) Callose
(c) Sporopollenin (d) Pecto-cellulose

S2. (c)

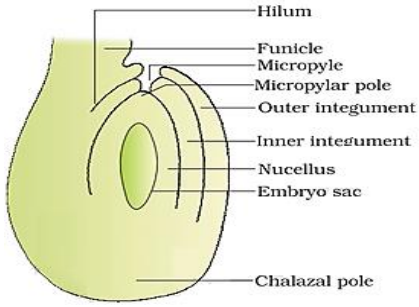
The Pistil, Megasporangium (Ovule), the embryo sac

A gynoecium can have a single pistil (monocarpellary) or several pistils (polycarpellary), which can be united (syncarpous) or free (apocarpous) e.g. multicarpellary and syncarpous pistil is present in *Paver somniferum* and multicarpellary and apocarpous pistils is found in *Michelia.*

Each pistil is made up of three parts: the **stigma, the style, and the ovary**. The ovarian cavity is located within the ovary (locule). The placenta is positioned within the ovarian cavity. Megasporangia (ovules) develop from the placenta.

The ovule/megasporangium: The ovule is a tiny structure that is connected to the placenta. It is characterised by the following:

Funicle: it is a stalk that connects the ovule to the placenta.
Hilum: it is the connection between the ovule and the funicle.
Protective envelops around the ovule is known as **integuments**.
Micropyle: it is a small hole at the apex of the ovule via which the pollen tube enters



A typical anatropous ovule

Chalaza: it is the ovule's basal portion.

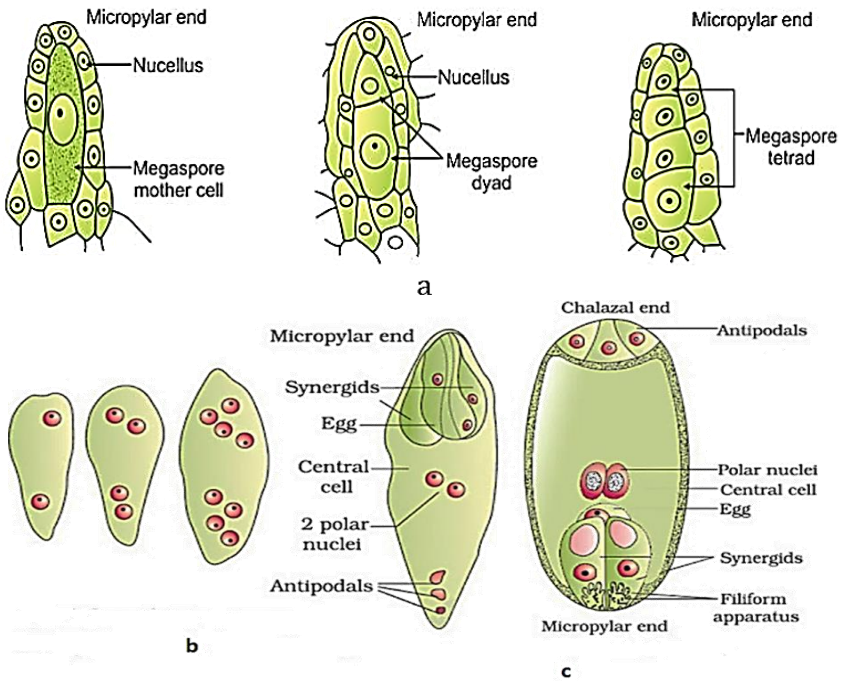
Nucellus (2n): it is a collection of cells surrounded by integuments and has a large food reserve.

Megasporogenesis: it is the process of formation of a megaspore from a megaspore mother cell by meiotic division and occurs within the ovule.
In the nucellus' micropylar region, an ovule develops a single megaspore mother cell (MMC). MMC passes through meiotic division, resulting in the formation of four megaspores.
Three megaspores degenerate in the majority of blooming plants. One megaspore matures into a female gametophyte (embryo sac).

The functional megaspore nucleus splits **mitotically** to create two nuclei that migrate to opposing poles to form a two-nucleate embryo sac. Two further mitotic divisions culminate in an 8-nucleate embryo sac.

Six of the eight nuclei are enclosed by cell wall, with the other two (polar nuclei) located beneath the egg apparatus.

Three cells create the egg apparatus at the micropylar end, and three cells form antipodal cells at the chalazal end. Thus the embryosac is 8-nucleate and 7-celled in maturity.



(a) Parts of an ovule showing a megaspore mother cell, a dyad and a tetrad of megaspores.
(b) 2, 4, and 8 nucleate stages of an embryo sac and a mature embryo sac.
(c) A mature embryo sac.

Brush Up Your Understanding

Q1. Choose the number of diploid structures in the list given below.
Pollen grains, nucellus, perisperm, endosperm, embryo-sac, megaspore
(a) Two (b) Three
(c) Four (d) One

S1. (a)

Q2. Select the odd one out.
(a) Pollen grains (b) Antipodal cells
(c) Synergids (d) Egg cell

S2. (a)

Pollination: transfer of pollen grains from the anther to the stigma is called pollination. It is of the following types:

Autogamy: it is the transfer of pollen grains from the anther to the stigma of the same flower. It is seen in cleistogamous flowers.

Cleistogamous flowers: these flowers do not open at all as there is no probability of cross-pollen landing on the stigma, they are autogamous. Even in the absence of pollinators, cleistogamous flowers yields certain seed-set. *Viola* (common pansy), *Oxalis,* and *Commelina* are a few examples.

Chasmogamous flowers: their anthers and stigma are exposed.

Geitonogamy: Pollen grains are transferred from the anther to the stigma of a separate flower of the same plant. Geitonogamy is cross-pollination with a pollinating agent that is **genetically identical to autogamy** since the pollen grains come from the same plant.
Xenogamy: Pollen grain transfer from anther to stigma of a different plant's flowers on the same species.

Agents of Pollination: includes biotic and abiotic factors. Biotic factors include butterfly, honeybee, insects and abiotic like water and wind.

Wind pollination: it is also called as anemophily, the pollen grains are light in weight, sticky and winged. The anthers are well exposed, stigma is large and feathery and flower has a single ovule arranged in an inflorescence. The flowers of such pollinated plants do not produce nectar and pollen grains are also produced in large quantity. E.g. corn cob, date palm and cotton.

Water pollination: it is also called as hydrophily. The pollen grains in this case is well protected by a mucilaginous covering. The flowers in this case also are devoid of nectar

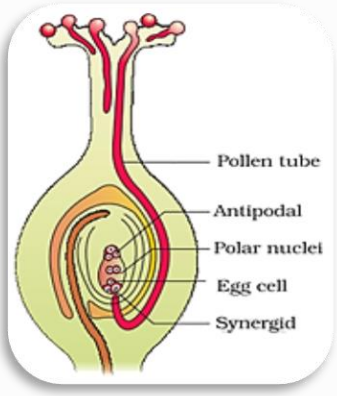
and pollen are produced in large quantity. E.g. *vallisneria, hydrilla and zoestra.*

Insect Pollination: it is also called as entomophily. Flowers in this case are large, colourful and scented and the pollen grains and stigma are sticky. E.g. amorphophalus and yucca.

Outbreeding devices: As continuous self-pollination leads to inbreeding depression, several mechanisms prevent self-pollination and stimulate cross pollination. Some the mechanisms are as follows:

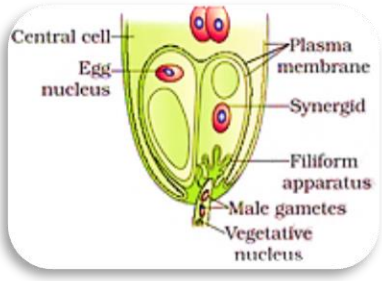
- No synchronisation between pollen release and stigma receptivity.
- Positions of anther and stigma are different.
- Pollen does not germinate on pistil if of any other species.
- Presence of unisexual flowers.

Pollen-pistil interaction: The pistil recognises suitable pollen and initiates post pollination activities that lead to fertilisation. Pollen grain generates pollen tube through germ pores to assist male gamete transfer to the embryo sac.



L.S of a flower showing pollen germination on the stigma of a flower

The pollen has the ability to recognise the correct pollen grains. If pollen is of right type then it leads to fertilisation.



Enlarged view of egg apparatus showing the entry of pollen tube

The pollen after landing on the stigma grows through the tissues and style reaches the ovary.

In plants, the pollen that get shed at the two celled stage, the generative cell divides to give rise to two male gametes during the growth of the pollen tube in the stigma.

In plants in which the pollen are shed at three celled stage, the pollen tube carries the male gametes from the beigning.

Pollen tube enters the ovule through the micropyle, and then enters one of the synergids through the filiform apparatus.

Brush Up Your Understanding

Q1. Pollen tube develops from.
(a) Generative cell (b) Male gametes
(c) Vegetative cell (d) Vegetative nucleus

S1. **(c)**

Q2. When pollen grains of a flower are transferred to stigma of another flower of a different plant, the process is called.
(a) Geitonogamy (b) Xenogamy
(c) Autogamy (d) Homogamy

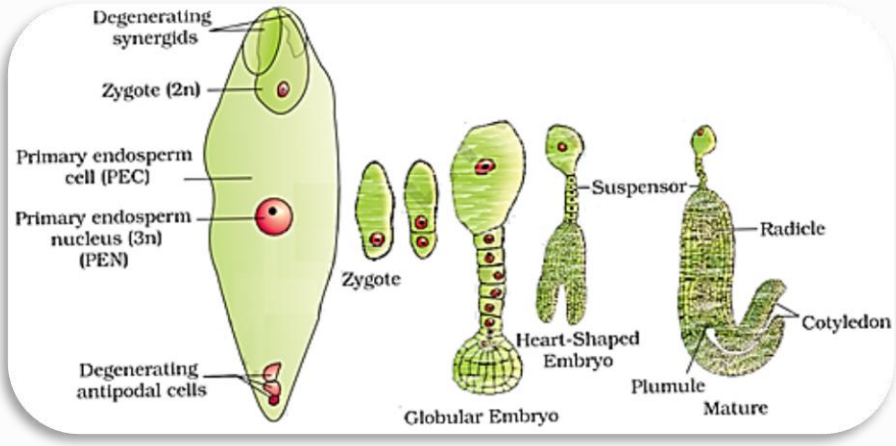
S2. **(b)**
Artificial hybridisation: it is a mode of crop improvement programme, in crossing experiments it is important to make sure that only the desired pollen grains are used for pollination and the stigma is protected from contamination (unwanted pollen grains), this is achieved by:

Emasculation: IF the female parent bears bisexual flowers, removal of anthers from the flower buds before the anther dehisces using a pair of four steps is necessary, this step is called as an emasculation.

Bagging technique: the emasculated flowers have to be covered with a bag of suitable size generally made up of butter paper to prevent contamination of its stigma with unwanted Pollen Grain, this process is called as bagging.

Double Fertilisation: Each pollen grain produces two male gametes after entering one of the synergids. To form a triploid main endosperm nucleus, one male gamete fuses with an egg (syngamy) and another male gamete fuses with two polar nuclei (triple

fusion) (PEN). Because two forms of fusion occur in an embryo sac, the event is known as **double fertilisation**. The PEN becomes the endosperm, and the zygote becomes the embryo.



(a) Fertilised embryo sac showing zygote and primary endosperm nucleus (PEN)
(b) Stages in an embryo development

Brush Up Your Understanding

Q1. The primary endosperm nucleus.
(a) Haploid (b) Diploid
(c) Triploid (d) Tetraploid

S1. (c)

Q2. The main embryo is developed as a result of.
(a) Pollination
(b) Triple fusion
(c) Syngamy
(d) Fusion of two polar nuclei of an embryo sac

S2. (c)

Post-fertilisation structures and events: it includes endosperm and embryo development, maturation of ovule into seed, and the ovary into fruit.

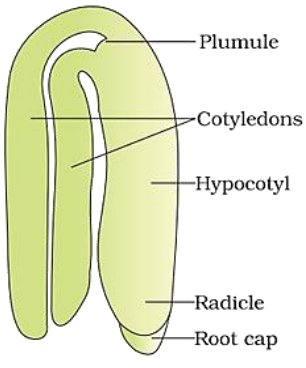
Endosperm: The original endosperm cell multiplies multiple times to generate triploid endosperm tissue with reserve food resources. There are two kinds of endosperm development:

(i) Free nuclear type (common method)
(ii) Cellular type

The endosperm may be totally used before seed maturation (non-albuminous) for example, pea, groundnut or a part of the endosperm may also remain in mature seeds (albuminous. E.g. wheat and castor.

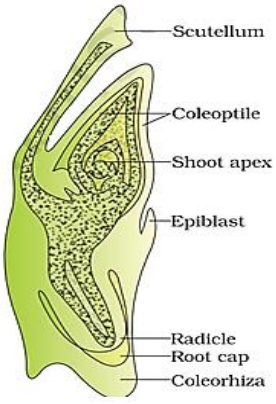
Embryo: the early stages of embryo development is called as **embryogeny**. The zygote gives rise to a pro-embryo, which then develops into the globular, heart-shaped, mature embryo.

Dicot embryo: consists of a embryonal axis and two cotyledons. Epicotyl is the portion above the cotyledons and terminates at the plumule and hypocotyl is the portion below the cotyledons and terminates at the radicle. Root tip is covered by a root cap.



A dicot embryo

Monocot embryo: Have only one cotyledon, that too of the grass family is called **scutellum** and is situated at the lateral side of the embryonal axis. At the lower end, the embryonal axis has the radicle and the root cap that is enclosed by a sheath called **coleorhiza.** The portion above the level of attachment of scutellum is the epicotyl that has a shoot apex and few leaf primordia enclosed in a hollow structure called **coleoptile.**



L.S of embryo of grass

Seed: it is the fertilized and mature ovule develops into seed. It consists of:

cotyledon(s)

embryonal axis

Seed coat- double layered- formed by integuments, **testa** (outer coat) and **tegmen** (inner coat). Seed can be albuminous or ex-albuminous. Other features of a seed are:

Micropyle:- it is a small opening on seed coat that facilitates entry of water and oxygen into seeds (for germination).

Hilum:- it is a scar on seed coat.

Perisperm: remnants of nucellus that is persistent. Ex: Black pepper

Dormancy: state of inactivity

The ovary wall develops into the fruit wall known as the **pericarp**. Only the ovary contributes to fruit formation in **true fruits**, whereas the thalamus also contributes to fruit formation in **false fruits**.

Apomixis: when seeds are produced without fertilisation. E.g. species of *Asteraceae* and grass. It is a form of asexual reproduction that mimics sexual reproduction.

Ways of development of apomictic seeds:

- the diploid egg cell form without reduction division and develop into the embryo without fertilization
- In many citrus and mango varieties, some of the nucleus cells surrounding the embryo sac start dividing, protruding into the embryo sac and develop into the embryo, this is call ed **polyembryony.**

SUMMARY

The reproductive part of a flowering plant is the flower that consists of androecium and gynoecium. The androecium is the male part of the flower and consists of stamens. Each stamen consists of a filament and an anther. Each anther has two chambers called pollen sacs. Anthers produce these numerous yellowish pollen grains, which contain male gametes. The anther is a four-sided (tetragonal) structure consisting of four microsporangia located at the corners, two in each lobe. A typical microsporangium is generally surrounded by four wall layers the epidermis, endothecium, middle layers and the tapetum. The outer three wall layers perform the function of protection and help in dehiscence of anther to release the pollen. The innermost wall layer is the tapetum. It nourishes the developing pollen grains.

The gynoecium (or pistil) consists of carpels and is the female reproductive part. Each carpel consists of three parts—a basal swollen portion called ovary, a narrow stalk like middle portion called style and a one- to many-lobed flattened disc like sticky structure called stigma at the top of the style. Inside the ovary is the ovarian cavity (locule). The placenta is located inside the ovarian cavity. Arising from the placenta are the megasporangia, commonly called ovules. A typical angiosperm embryo sac, at maturity, though 8-nucleate is 7-celled.

Pollination is the mechanism to achieve this objective. Pollinating agents can be biotic (animals) or abiotic (wind).

Events from landing of pollen grain on the stigma till its entry in the embryo sac (compatible) or the rejection of pollen (incompatible) make constitute the pollen pistil interaction. In case of compatibility, there occurs discharge of the two male gametes inside the embryo sac. Double fertilisation (syngamy and triple fusion) is the characteristic of angiosperms. Syngamy results in formation of zygote that further develops into embryo and primary endosperm cell forms the endosperm.

The developing embryo passes through different stages such as the proembryo, globular and heart-shaped stages before maturation.

After fertilization, ovary develops into fruit and ovules develop into seeds.

A phenomenon called apomixis is found in some angiosperms, particularly in grasses. It results in the formation of seeds without fertilisation.

Some angiosperms produce more than one embryo in their seed. This phenomenon is called polyembryony.

IMPORTANT POINTERS

- Pollen grain is the male gametophyte.
- When the anther is young, a group of compactly arranged homogenous cells called the sporogenous tissue occupies the centre of each microsporangium.
- The process of formation of microspores from a pollen mother cell (PMC) through meiosis is called microsporogenesis.
- Pollen grains are well preserved as fossils because of the presence of sporopollenin.
- In over 60 per cent of angiosperms, pollen grains are shed at this 2-celled stage.
- The process of formation of megaspores from the megaspore mother cell is called megasporogenesis
- The embryo sac represent the female gametophyte that is located in the nucleus.
- There is a characteristic distribution of the cells within the embryo sac. Three cells are grouped together at the micropylar end and constitute the egg apparatus, a typical angiosperm embryo sac, at maturity, though 8-nucleate is 7-celled.
- Removal of anthers from the flower bud before the anther dehisces using a pair of forceps is called emasculation and covering of flowers with a bag of suitable size, is called bagging.
- In the grass family the cotyledon is called scutellum.

MCQ QUESTIONS

Q1. The terminal bilobed structure of a typical stamen of a flower is called as.
(a) Pollen sac (b) Filament
(c) Anther (d) Stalk

Q2. Which of the following is correct about an anther of a typical angiosperm?
(a) It is monothecous (b) It is dithecous
(c) It is trithecous (d) It is tetrathecous

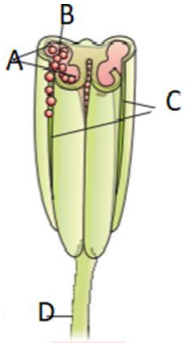
Q3. What is the total number of microsporangia in an anther?
(a) 4 (b) 3
(c) 2 (d) 1

Q4. Which of the following layer of the microsporangium nourishes the developing pollen grains?
(a) Epidermis (b) Tapetum
(c) Middle layer (d) Endothecium

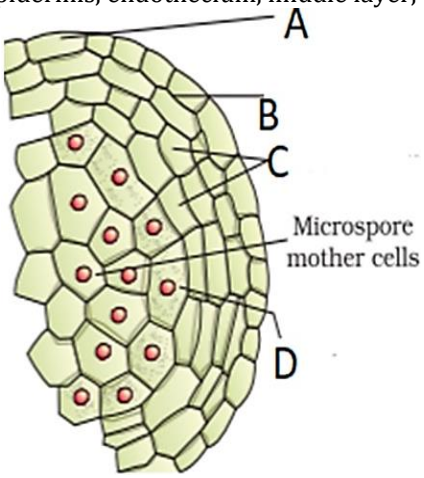
Q5. Which of the following is correct about the sporogenous tissue?
(a) It is a group of compactly arranged homogenous cells present at the centre of the pollen grain
(b) It is a group of compactly arranged homogenous cells present at the centre of the microsporangium
(c) It is a group of compactly arranged homogenous cells present at the center of the anther
(d) It is a group of compactly arranged homogenous cells present at the center of the filament

Q6. What would be the ploidy of the microspore tetrad?
(a) n (b) 2n
(c) 3n (d) 4n

Q7. Look at the diagram and answer A, B, C and D.
(a) Pollen grains, Line of dehiscence, Stalk, Pollen sacs
(b) Stalk, line of dehiscence, pollen grains, pollen sacs
(c) Pollen sacs, pollen grains, line of dehiscence, stalk
(d) Line of dehiscence, stalk, pollen grains, pollen sacs



Q8. Look at the diagram and mark A, B, C and D.
(a) Endothecium, middle layer, epidermis, tapetum
(b) Tapetum, epidermis, endothecium, middle layer
(c) Middle layer, epidermis, tapetum, endothecium
(d) Epidermis, endothecium, middle layer, tapetum



Q9. Microsporogenesis is.
(a) The formation of microspores from pollen mother cells.
(b) The formation of microspores from the tapetum
(c) The formation of microspores from endothecium
(d) All of the above

Q10. Generally, pollen grains are.
(a) Circular, measuring 25-50 micrometer
(b) Spherical, measuring 25-50 micrometer
(c) Rectangular, measuring 25-50 micrometer
(d) Square, measuring 25-50 micrometer

Q11. Which of the following is the most resistant organic material known?
(a) Cellulose (b) Starch
(c) Sporopollenin (d) Sucrose

Q12. The inner wall intine of the following pollen grain is made up of.
(a) Cellulose and hemi-cellulose
(b) Hemi-cellulose and chitin
(c) Chitin and cellulose
(d) Cellulose and pectin

Q13. At which of the following stages, the pollen grains of 60% of the angiosperms are shed?
(a) 1- celled stage
(b) 2-celled stage
(c) 3-celled stage
(d) 4-celled stage

Q14. The viability of pollen grains depends on.
(a) Temperature
(b) Humidity
(c) Both (a) and (b)
(d) None of the above

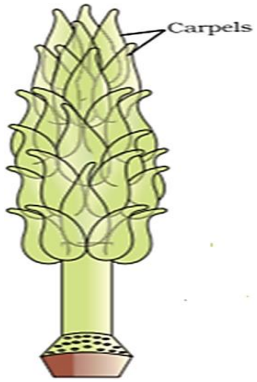
Q15. Which of the following is correct about the pollen grains of cereals?
(a) They have a viability of months
(b) They lose viability within 30 minutes of their release
(c) They have viability of one year
(d) None of the above

Q16. The condition, when the pistils are fused together in a gynoecium is called.
(a) Apocarpous (b) Syncarpous
(c) Both (a) and (b) (d) None of the above

Q17. Which of the following part of the pistil serves as the landing platform for the pollen grains?
(a) Style
(b) Stigma
(c) Ovary
(d) All of the above

Q18. Ovarian cavity is also called.
(a) Placenta (b) Locule
(c) Style (d) Filament

Q19. Look at the figure and identify the type of gynoecium.
(a) Multicarpellary, Syncarpous gynoecium
(b) Monocarpellary, Syncarpous gynoecium
(c) Multicarpellary, Apocarpous gynoecium
(d) Monocarpellary, Apocarpous gynoecium



Q20. Which of the following part attaches an ovule of an angiosperm to the placenta?
(a) Hilum (b) Funicle
(c) Micropyle (d) None of the above

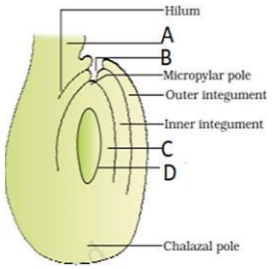
Q21. At which of the following place of the ovule, the integuments are absent?
(a) Chalaza (b) Hilum
(c) Micropyle (d) Funicle

Q22. The female gametophyte is located in the.
(a) Nucellus (b) Chalaza
(c) Micropyle (d) None of the above

Q23. Where does the differentiation of the ovule into a megaspore mother cell takes place?
(a) Chalazal region of the nucellus
(b) Micropylar region of the nucellus
(c) Hilum region of the nucellus
(d) Funicle region of the nucellus

Q24. The structure of a bilobed anther consists of.
(a) 2 thecae, 2 sporangia
(b) 4 thecae, 4 sporangia
(c) 2 thecae, 4 sporangia
(d) 4 thecae, 2 sporangia

Q25. Look at the picture of a typical anatropous ovule and mark A, B, C and D.
(a) A- Funicle, B-Micropyle, C-Nucellus, D- Embryo sac
(b) A- Micropyle, B-Funicle, C-Embryo sac, D- Nucellus
(c) A- Embryo sac, B-Nucellus, C-Micropyle, D- Funicle
(d) A- Nucellus, B-Embryo sac, C-Funicle, D- Micropyle



Q26. Which of the following constitutes the egg apparatus?
(a) Three cells at the chalazal end
(b) Three cells at the micropylar end
(c) Both (a) and (b)
(d) None of the above

Q27. Which of the following cells forms the filiform apparatus?
(a) Egg cell (b) Synergids
(c) Central cell (d) All of the above

Q28. Antipodal cells are present at the.
(a) Micropylar end. (b) Chalazal end
(c) Hilum (d) None of the above

Q29. A typical angiosperm embryo sac at maturity is.
(a) 7-celled 8-nucleated
(b) 8-celled 7-nucleated
(c) 6-celled 8-nucleated
(d) 8-celled 6-nucleated

Q30. Which of the following plants produce chasmogamous flowers?
(a) Sunflower (b) Beans
(c) Pea (d) All of the above

Q31. Plants bearing cleistogamous flowers invariably show.
(a) Xenogamy (b) Autogamy
(c) Syngamy (d) Geitonogamy

Q32. Which of the following is genetically similar to autogamy?
(a) Geitonogamy (b) Xenogamy
(c) Chasmogamy (d) All of the above

Q33. which of the following is a biotic agent for pollination?
(a) Wind (b) Water
(c) Animals (d) All of the above

Q34. What characteristics should pollen grains possess to get wind pollinated?
(a) They should be light in weight
(b) They should be non-sticky
(c) Stamens should be well exposed so that pollen grains get easily dispersed in air.
(d) All of the above

Q35. In which of the following plants, wind pollination takes place?
(a) Grass (b) Corn
(c) Both (a) and (b) (d) None of the above

Q36. Water is a regular mode of transport for male gametes in which of the following group of plants?
(a) Algae
(b) Bryophytes
(c) Pteridophytes
(d) All of the above

Q37. Which of the following are water pollinated plants?
(a) Vallisneria *(b) Hydrilla*
(c) Zoestra *(d)* All of the above

Q38. Among the biotic pollinating agents particularly insects, which of the following are the most dominant pollinators?
(a) Moths (b) Butterflies
(c) Bees (d) Flies

Q39. What are the characteristics of flowers that get insect pollinated?
(a) They are large
(b) They are colourful
(c) They are fragrant and rich in nectar
(d) All of the above

Q40. What are pollen/nectar robbers?
(a) The animals that consume pollen or the nectar without bringing about any pollination
(b) The birds that consume pollen or the nectar without bringing about any pollination
(c) The insects that consume pollen or the nectar without bringing about any pollination
(d) The humans that consume pollen or the nectar without bringing about any pollination

Q41. Continuous self-pollination leads to.
(a) Reduction in pollen grains
(b) In-breeding depression
(c) Reduced pollination
(d) All of the above

Q42. Which of the following devices prevent autogamy in plants?
(a) Positioning of anther and stigma at different positions
(b) Unisexual flowers
(c) Self-incompatibility
(d) All

Q43. How would a plant prevent fertilisation if a wrong pollen has landed on the stigma of a flower?
(a) The pollen will die
(b) The pistil prevents pollen germination on the stigma
(c) The pistil prevents pollen tube growth in the style
(d) Both (a) and (b)

Q44. Pollen and pistil interaction in a flower is.
(a) A mechanical phenomenon
(b) A chemical phenomenon
(c) Both (a) and (b)
(d) None of the above

Q45. What is the function of the filiform apparatus present at the micropylar end of the synergids?

(a) It guides the entry of the pollen grain

(b) It guides the entry of the pollen tube

(c) It guides the entry of the chemicals

(d) None of the above

Q46. What is emasculation?

(a) It is the technique of removal of pistil from a bisexual flower to prevent self-pollination

(b) It is the technique of removal of anthers from a bisexual flower to prevent self-pollination

(c) It is the technique of removal of pollen grains from a bisexual flower to prevent self-pollination

(d) All of the above

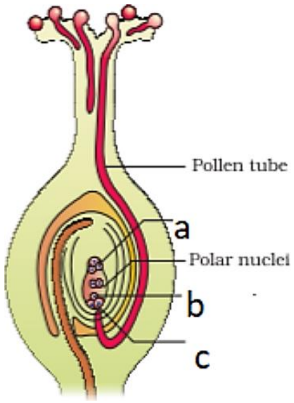
Q47. Look at the longitudinal section of a flower showing the growth of pollen tube. Study the picture carefully and answer a, b and c.

(a) a- Egg cell, b-antipodal cell, c-synergids

(b) a- antipodal cell, b-egg cell, c-synergids

(c) a- synergids, b-antipodal cell, c- egg cell

(d) a- egg cell, b-antipodal cell, c- synergids



Q48. Syngamy is completed after the fusion of.

(a) Male gamete fuses with nucleus of the egg cell

(b) Male gamete fuses with the antipodal cells

(c) Male gamete fuses with polar nuclei

(d) All of the above

Q49. Syngamy results in the formation of.

(a) Embryo

(b) Diploid cell

(c) Zygote

(d) Both (b) and (c)

Q50. What is the ploidy of PEN?

(a) Haploid (b) Diploid

(c) Triploid (d) Tetraploid

ASSERTION AND REASON

Direction: in the following questions, a statement of assertion (A) is followed by a statement of reason (R). Choose the correct option among a, b, c and d.

Q1. **Assertion (A):** Artificial hybridisation is one of the major approaches of crop improvement programme.
Reason (R): In such crossing experiments any of the pollen grains are used for pollination.

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

(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)

(c) Assertion (A) is true but reason(R) is false

(d) Assertion (A) is false but reason(R) is true

Q2. **Assertion (A):** During double fertilisation, after entering one of the synergids, the pollen tube releases the two male gametes into the cytoplasm of the synergid.
Reason (R): One of the male gametes moves towards the egg cell and fuses with its nucleus thus completing the syngamy.

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

(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)

(c) Assertion (A) is true but reason(R) is false

(d) Assertion (A) is false but reason(R) is true

Q3. **Assertion (A):** In plants, the nucellus is the embryo sac or female gametophyte.
Reason (R): In plants, an ovule generally have multiple embryo sacs formed from a megaspore.

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

(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)

(c) Assertion (A) is true but reason(R) is false

(d) Assertion (A) is false but reason(R) is true

Q4. **Assertion (A):** Autogamy is the transfer of seeds within the same flower.
Reason (R): Autogamy in such fruits requires synchrony in pollen release and stigma receptivity.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

TRUE AND FALSE

Q1. A mature pollen grain contains two cells, the vegetative cell and the generative cell.

Q2. The style serves as the landing platform for the pollen grain in a flower.

Q3. In majority of flowering plants, all the megaspores are functional.

Q4. The cylindrical portion below the level of cotyledons is called the hypocotyl that terminates at its lower end in the radicle or the root tip.

PRACTICE QUESTIONS

Q1. The fusion of the two polar nuclei with one of the male gamete is called as.
(a) Double fertilisation (b) Triple fusion
(c) Both (a) and (b) (d) None of the above

Q2. Which of the following statement for a flower is wrong?
(a) They are morphological and embryological marvels in an angiosperms
(b) They are sites of sexual reproduction
(c) They are objects of aesthetic, ornamental, social, religious and cultural value
(d) Calyx and gynoecium are essential whorls

Q3. Pick the odd one out with respect to wall layers of microsporangium in flowering plants.
(a) Endothecium (b) Tapetum
(c) Hilum (d) Middle layers

Q4. The prominent pollen grain apertures called germ pores are present on the.
(a) Vegetative cell (b) Intine
(c) Exine (d) Generative cell

Q5. Which of the following weed has become a major cause of pollen allergy in India?
(a) Pistia *(b) Mirabilis*
(c) Parthenium *(d)* All of the above

Q6. Pick the odd one out with respect to pollen grains.
(a) Pollen grains are rich in nutrients
(b) Its consumption increases the performance of athletes and race horses
(c) It can be stored for years in liquid nitrogen
(d) They possess non-sticky covering called pollen kit.

Q7. Which of the following is incorrect about generative cell?
(a) It floats in the cytoplasm of the vegetative cell
(b) It has abundant food reserve
(c) It is spindle shaped
(d) It has dense cytoplasm and a nucleus

Q8. A mature male gametophyte is.
(a) One celled
(b) Two celled
(c) One celled and two nucleate
(d) Three celled

Q9. In entomophily, flowers are.
(a) Dull coloured
(b) Necterless
(c) With sticky pollen grains
(d) Small in size and solitary

Q10. In flowering plants, the generative cell of the pollen grain divides mitotically to give rise to the.
(a) 2 male gametes (b) 3 male gametes
(c) 1 male gamete (d) 4 male gametes

Q11. Entry of pollen tube into the embryo sac is under which guidance?
(a) Chemotropic (b) Chemotactic
(c) Phototropic (d) Thigmotripic

Q12. Choose the number of diploid structures in the list given below.
Pollen grains, nucellus, perisperm, endosperm, embryo-sac, megaspore
(a) Two (b) Three
(c) Four (d) One

Q13. Select the odd one out.
(a) Pollen grains (b) Antipodal cells
(c) Synergids (d) Egg cell

Q14. Endosperm may persist in mature seed in.
(a) Pea (b) Castor
(c) Groundnut (d) Bean

Q15. Embryo develops at which end of embryo-sac?
(a) Micropylar end (b) Chalazal end
(c) Funiculus (d) Outside the ovary

Q16. An event unique to flowering plants is.
(a) True fertilisation (b) Double fertilisation
(c) Embryogenesis (d) Pollination

Q17. Main function of endothecium (in anther) is.
(a) Mechanical (b) Nutritive
(c) Dehiscence (d) Storage

Q18. How many pollen sacs are present in a mature anther?
(a) 4 (b) 1
(c) 3 (d) 2

Q19. That haploid cell which divides by mitosis to form embryo sac is.
(a) Megaspore mother cell
(b) Microspore mother cell
(c) Functional megaspore
(d) Non-functional megaspore

Q20. Which structure of the ovule is diploid?
(a) Nucellus (b) Integuments
(c) Sec. nucleus (d) All of the above

Q21. In flowering plants, the main embryo is develops as a result of.
(a) Pollination
(b) Triple fusion
(c) Syngamy
(d) Fusion of two polar nuclei of an embryo sac

Q22. Which of the following is correct about scutellum ?
(a) It is a single cotyledon in monocots
(b) It is radical sheath in monocot
(c) It is plumule covering in monocots
(d) It is cotyledon in dicots

Q23. Select the incorrect option with respect to endospermic seeds.
(a) Wheat (b) Pea
(c) Castor (d) Coconut

Q24. Which of the following produces false fruit?
(a) Apple (b) Strawberry
(c) Cashewnut (d) All of the above

Q25. Which of the following facilitates the entry of oxygen and water into the seed during germination?
(a) Testa (b) Tegmen
(c) Micropyle (d) Seed coat

Q26. Choose the correct option with respect to the function of germ pore.
(a) It allows the growth of the pollen tube
(b) It allows water absorbtion in the seed
(c) It helps in dehiscence of pollen grain

Q27. The thin and continuous wall layer of pellen is.
(a) Exine (b) Intine
(c) Germ pore (d) Endothecium

Q28. What is the number of embryo sac in an ovule?
(a) 1 (b) 2
(c) 3 (d) 4

Q29. What is the role of triple fusion in angiosperms?
(a) To produce cotyledons
(b) To produce PEN
(c) To produce endocarp
(d) To produce seed

Q30. The type of pollination which brings genetically different types of pollen on the stigma is.
(a) Autogamy
(b) Xenogamy
(c) Geitonogamy
(d) Cleistogamy

ASSERTION AND REASON

Direction: in the following questions, a statement of assertion (A) is followed by a statement of reason (R). Choose the correct option among a, b, c and d.

Q1. **Assertion (A):** When the anthers mature and dehydrate, the microspores dissociate from each other and develop into pollen grains.
Reason (R): The pollen grains represent the female gametophyte.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q2. **Assertion (A):** Pollen grains are generally spherical measuring about 25-50 micrometers in diameter.
Reason (R): pollen grains are well preserved as fossils because of the presence of cellulose and pectin.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q3. **Assertion (A):** An ovule generally has a single embryo sac formed from a megaspore.
Reason (R): In a majority of flowering plants, only single megaspore is functional and the other three degenerate
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

Q4. **Assertion (A):** A typical angiosperm embryo sac, at maturity, is 8-nucleate is 7-celled.
Reason (R): Flowering plants have evolved an amazing array of adaptations to achieve pollination.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A)
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A)
(c) Assertion (A) is true but reason(R) is false
(d) Assertion (A) is false but reason(R) is true

MCQ SOLUTIONS

S1. **(c)** a stamen consists of two parts, a long slender stalk called the filament and the terminal generally bilobed structure that

S2. **(**b) A typical angiosperm anther is bilobed with each lobe having two thecae, it is dithecous, often a longitudinal groove runs lengthwise separating the theca.

S3. **(a)** the bilobed nature of an anther is very distinct in the transverse section of the anther. The anther is a four-sided structure consisting of four microsporangia that are located at the corners, two in each lobe.

S4. **(b)** a typical microsporangium is surrounded by four wall layers that is the epidermis, endothecium, middle layer and the tapetum, the outer three wall layers perform the function of protection and help in the dehiscence of anther to release the pollen grains, the innermost wall layer is the tapetum that nourishes the developing pollen grains.

S5. **(b)** sporogenous tissue is a group of cells that differentiate into pollen mother cell, each microspore mother cell undergoes meiosis and give rise to haploid microspores.

S6. **(a)** microspore tetrad is 4-nucleated. When meiosis 1 occurs in a microspore mother cell, it produces two diploid cells, after meiosis 2 the number of cells become 4 and the ploidy reduces to 'n', that is haploid.

S7. **(c)** A stamen consists of two parts, filament and a bilobed structure called the anther. The proximal end of the filament is attached to the thalamus or the petal of the flower.

S8. **(d)** The picture is an enlarged view of a microsporangium showing wall layers.

S9. **(a)** Microsporogenesis is the process of formation of microspores from PMC via meiosis.

S10. **(b)** pollen grains are of variety of architecture-sizes, shapes, colours and designs.

S11. **(c)** sporopollenin is the most resistant organic material known, no enzyme that degrades sporopollenin is so far known, it forms the hard outer layer called the exine of the pollen grain.

S12. **(d)** Pollen Grain is surrounded by two layers, the outer layer is known as exine and the inner layer is called intine which is thin and continuous layer made up of cellulose and pectin.

S13. **(b)** in about 60% angiosperms, pollen grains are shed at this 2-celled (vegetative and generative) stage.

S14. **(c)** The viability of pollen grains is important so as to bring about fertilization. The period of viability is different in different species.

S15. **(b)** Pollen grains of every plant species have different viability.

S16. **(b)** The gynoecium is the female reproductive part of the flower. When a gynoecium has more than one pistil, and they get fused then the condition is syncarpous.

S17. **(b)** It is the stigma, where the pollen grains are deposited by the agents of pollination, water, wind, air or insects.

S18. **(b)** The basal bulged part of a pistil is called the ovary. Inside the ovary is the ovarian cavity also called as the locule.

S19. **(c)** When a gynoecium has more than one pistil and they are free then condition is apocarpous.

S20. **(b)** Funicle is a stalk like structure, that attaches ovule to the placenta.

S21. **(c)** the integument encircles the nucleus except at the tip where a small opening called the micropyle is organised.

S22. (a) nucellus is the mass of cells that is enclosed within the integument, the cells of the nucellus have abundant reserve food material, inside this nucellus is situated the embryo sac or the female gametophyte.

S23. (b) The process of formation of megaspores from the megaspore mother cell is called megasporogenesis.

S24. (c) a typical angiosperm anther is bilobed, each anther is four-sided structure consisting of four microsporangia located at the corners, two in each lobe.

S25. (a) The diagram is of a typical anatropous ovule, showing all the parts.

S26. (b) In the embryo, cells at the micropylar end constitutes the egg apparatus which in turn consists of two synergids and one egg cell.

S27. (b) filiform apparatus plays an important role in guiding the pollen tubes into the synergids.

S28. (b) the cells present at the chalazal end are called antipodals cell and they are three in number.

S29. (a) at maturity a typical angiosperm embryo sac has 8 nuclei and 7-cells.

S30. (d) chasmogamous flowers are cross pollinated and have the advantage of sexual reproduction between two different parent resulting in sexual recombination and genetically distinct seeds.

S31. (b) the flowers that do not open at all during their lifetime are called cleistogamous flowers, in such flowers the anther and stigma like close to each other, when the anthers dehiscence in the flower buds, pollen grains come in contact with stigma to affect pollination. Thus, cleistogamous flowers are invariably autogamous as there is no chance of cross pollen landing on the stigma.

S32. (a) Geitonogamy is the transfer of pollen grains from the anther to the stigma of another flower of same plant, though it is cross pollination involving a pollinating agent, it is genetically similar to autogamy since the pollen grains come from the same plant.

S33. (c) plants use abiotic and biotic agents to achieve pollination, most of the plants used biotic agents like animals for pollination.

S34. (d) pollination by wind is more common among abiotic pollination, despite of having the above characteristics in pollen grains, the stigma of such flowers is often feathery so that they can easily trap the air borne pollen grains.

S35. (c) wind pollination is common in grasses, also if we see the cobs of the corns their tassels are nothing but the stigma and style which wave in the wind so as to trap the pollen grains.

S36. (d) pollination by water is quite rare in flowering plants and is generally limited to about 30 genera and mostly the monocotyledons.

S37. (d) *Vallisneria and hydrilla* grow in freshwater and zoestra is a sea grass grows in marine water are all water pollinated plants.

S38. (c) most of the flowering plants use a range of animals as pollinating agents, among the biotic pollinators particularly the insects, bees are the most dominant biotic pollinators.

S39. (d) large colourful flowers, rich in nectar attract the insects as nectar serves food from them and in turn they carry the pollen grains of those flowers for pollination.

S40. (c) the insects that consume pollen grains and the nectar of the flowers without bringing about any pollination, such floral visitors are called nectar robbers.

S41. (b) continuous self-pollination in plants can lead to inbreeding depression, to discourage this flowering plants have developed many devices like in some plants, pollen release and stigma receptivity are not synchronised.

S42. (d) plants have developed many mechanisms to prevent autogamy.

S43. (d) pollination does not guarantee the transfer of the right type of pollen. Sometime, pollen of wrong type also lands on the stigma, in such a case the pistil has the ability to recognise the pollen, whether it is compatible or incompatible, if it is incompatible the pistil rejects the pollen.

S44. (b) the interaction between the pollen grain and the pistil is mediated by some chemical components of the pollen that interacts with the pistil, it is only in recent years that botanist has been able to identify some of the pollen and pistil components and the interactions leading to the recognition followed by acceptance or rejection.

S45. (b) as the pollen tube reaches the ovary, it enters the ovule through the micropyle and then enters one of the synergids through the filiform apparatus, recent studies have shown that filiform apparatus present at the micropylar part of the synergid guides the entry of the pollen tube.

S46. (b) if a female parent bears bisexual flowers then removal of anthers from the flower bud before the anther dehisces using a pair of forceps is done, this is called emasculation. It is an important technique in artificial hybridisation experiments in which only desired pollen grains are used for pollination and stigma is protected from contamination.

S47. (b) the diagram is of a longitudinal section of a flower, that is showing the growth of a pollen tube and the placement of cells and nuclei.

S48. (a) after entering one of the synergids, the pollen tube releases the two male gametes in the cytoplasm of the synergid, one of the male gamete move towards the egg cell and fuses with its nucleus thus completing syngamy.

S49. (d) the fusion of the male gamete with the nucleus of the egg cell give rise to a diploid cell that is the zygote.

S50. (c) the second male gamete fuses with the two polar nuclei located in the centre of the cell and produces a triploid primary endosperm nucleus (PEN).

ASSERTION AND REASON

S1. (c) Artificial hybridisation is one of the major approaches of crop improvement programme. In such crossing experiments it is important to make sure that only the desired pollen grains are used for pollination and the stigma is protected from contamination (from unwanted pollen). This is achieved by emasculation and bagging techniques.

S2. (a) After entering one of the synergids, the pollen tube releases the two male gametes into the cytoplasm of the synergid. One of the male gametes moves towards the egg cell and fuses with its nucleus thus completing the syngamy. This results in the formation of a diploid cell, the zygote.

S3. (c) In plants, enclosed within the integuments is a mass of cells called the nucellus. Cells of the nucellus have abundant reserve food materials. Located in the nucellus is the embryo sac or female gametophyte. An ovule generally has a single embryo sac formed from a megaspore.

S4. (d) In autogamy pollination is achieved within the same flower. Transfer of pollen grains from the anther to the stigma of the same flower. In a normal flower which opens and exposes the anthers and the stigma, complete autogamy is rather rare. Autogamy in such flowers requires synchrony in pollen release and stigma receptivity.

TRUE AND FALSE

S1. (True)

S2. (False) The stigma serves as the landing platform for the pollen grain in a flower.

S3. (False) In majority of flowering plants, only one megaspore is functional while the other three degenerate.

S4. (True)

SOLUTIONS (PRACTICE QUESTIONS)

S1. (b) as the fusion of three haploid nuclei takes place, two polar nuclei and one male gamete, it is termed as triple fusion.

S2. (d) Androecium and gynoecium are essential whorls

S3. (c) Hilum is the point of attachment of the ovule and the funicle.

S4. (c) The prominent apertures called germ pores are present in the exine at the place where the sporopollelin is absent.

S5. (c) *Parthenium* or carrot grass that came to India as a contaminant with imported wheat has now become ubiquitous in occurrence and causes pollen allergy.

S6. (d) Pollenkitt is a coating of yellow sticky material that is present around insect-pollinated pollen plant of pollen grains. It is an oily layer which provides the pollen with stickiness and a specific odour and helps with insect pollination.

S7. (b) it is the vegetative cell that is bigger and has abundant food reserve and a large irregularly shaped nucleus.

S8. (d) Mature male gametophyte in angiosperms is a three-celled structure i.e., the 3-celled germinated pollen grain. The terminal poistion is occupied by cytoplasm and nucleus of tube cell and two male gametes remain in back side of tube nucleus.

S9. (c) The plants that are pollinated by insects are colourfull, fragment and with sticky pollen grains.

S10. (a) In 40% of the angiosperms, the generative cell divides mitotically to give rise to two male gametes before pollen grains are shed.

S11. (a) The entry of pollen tube in the embryo sac is an example of chemotropism.

S12. (a) The ploidy of nucleus, MMC are diploid

S13. (a) antipodal cells, synergids and egg cell are part of female gametophyte and pollen grain is a male gametophyte.

S14. (b) there are some plants where the endosperm is not entirely consumed by growing embryos. They have the presence of stored food. This means the endosperm remains persistent. Such plants are called endospermic seeds or albuminous seeds. All the cereals have persistent endosperm. Examples of such plants are- Rice, Mustard, Wheat, Maize, castor.

S15. (a) After the fertilization of primary pollen nucleus and egg towards the micropylar end develops zygote which further develops into the embryo.

S16. (b) Double fertilization is a chief trait of flowering plants. In the phenomena, one female gamete unites with two male gametes. One of the male gametes fertilizes the egg resulting in the formation of a zygote and the other unites with 2 polar nuclei for the formation of an endosperm.

S17. (c) Besides protection of the contents of pollen sac, endothecium ensures dehiscence of anther at maturity.

S18. (d) Two pollen sacs (theca) are present in each lobe of a typical anther, the pollen sacs are elongated cavities in which pollen grains are produced.

S19. (c) Functional haploid megaspores are generated after meiotic division. Only one megaspore divides mitotically to generate an embryo sac while other 3 degenerate.

S20. (d) Nucellus, integuments and the secondary nucellus are diploid.

S21. (c) In double fertilisation out of the two male gametes one fuses with egg or oosphere to perform generative fertilisation. Generative fertilisation is also called syngamy or true fertilisation. It gives rise to a diploid zygote or oospore.

S22. (a) Embryos of monocotyledons possess only one cotyledon. In the grass family the cotyledon is called scutellum that is situated towards one side (lateral) of the embryonal axis.

S23. (b) Pea is a non-endopsermic seed in which the endosperm is completely consumed by the developing embryo.

S24. (d) Fruit that develops from other floral parts and thalamus along with the development of ovary wall is called false fruit.

S25. (c) The micropyle remains as a small pore in the seed coat. This facilitates the entry of oxygen and water into the seed during germination.

S26. (a) The germ pores are apertures in the exine layer of the pollen grain where the sporopollenin is absent. The germ pore helps in the formation of the pollen tube and the release of the male gametes during fertilisation.

S27. (b) The inner wall of the pollen grain is called the intine. It is a thin and continuous layer made up of cellulose and pectin.

S28. (a) the number of embryo sac in an ovule is one.

S29. (b) The central cell after triple fusion becomes the primary endosperm cell (PEC) and develops into the endosperm while the zygote develops into an embryo.

S30. (c) Xenogamy is the cross pollination between the flowers of different plants. It produces hererozygosity because two genetically different parents are involved.

ASSERTION AND REASONING

S1. (c) When the anthers mature and dehydrate, the microspores dissociate from each other and develop into pollen grains, the pollen grains represent the male gametophyte.

S2. (c) Pollen grains are generally spherical measuring about 25-50 micrometers in diameter. Pollen grains are well preserved due to sporopollelin.

S3. (a) An ovule generally has a single embryo sac formed from a megaspore and in a majority of flowering plants, only single megaspore is functional and the other three degenerate.

S4. (b) A typical angiosperm embryo sac, at maturity, is 8-nucleate is 7-celled. Flowering plants have evolved an amazing array of adaptations to achieve pollination. Many biotic and abiotic agents are involved in pollination