CHAPTER : 2

SEXUAL REPRODUCTION IN FLOWERING PLANTS

STUDY-NOTES

Sexual reproduction is the process of development of new organisms with the involvement of two parents leading to the fusion of gametes. Fusion of gametes is known as fertilisation or syngamy. Because of fusion of male and female gametes, sexual reproduction results in offspring that are not identical to parents.

FLOWERS

- It is the main site of reproduction. The reproductive organs or the sporophylls are produced within the flowers.
- The sporophylls are of two types **microsporophyll** (stamen) and **megasporophyll** (carpel).
- Carpel is distinguished as ovary bearing ovule, style and stigma.
- Stamen is distinguished as filament and anther.
- Stamens and carpels are also know as androecium and gynoecium respectively.

The process of sexual reproduction in flowering plants divided into three steps

(i) Pre-fertilisation
(ii) Double fertilisation
(iii) Post-fertilisation

PRE-FERTILISATION EVENTS

(i) Stamen and Pollen grain formation
(ii) Carpel and Embryo sac formation
(iii) Pollination
(iv) Pollen pistil interaction

Stamen and Pollen grain formation

- Stamen is the male reproductive unit of angiosperms. It consists of an anther and a slak called filament. The anther is bilobed and the lobe encloses four pollen sacs or microsporangia. Each pollen sac contains a number of pollen grains. The four pollen sacs lie in four corners of a dithecous anther.
- The anther wall is made up of four layers of cells. An anther wall dehisces by slits to liberate pollen grains.
- During **microsporogenesis**, the parietal cell divides several times to form the anther wall whereas the sporogenous cell undergoes fewer divisions and forms the microspores of pollen mother cells (PMC).
- The process of formation of microspores from a pollen mother cell (PMC) through meiosis is called microsporogenesis. The innermost layer of the cell wall that lies in contact with the PMCs forms the **tapetum**.
- The tapetum is significant in pollen development. It is a tissue present within the anther that provides nourishment to the growing spores.
- The layer below the epidermis forms the endothecium.Wall layers of anther:
  Epidermis – Single layer of cells and protective in function.
  Endothecium – Single layered second wall. Cells have a cellulose thickening with a little pectin and lignin. It helps in anther dehiscence.
  Middle layers – The middle layer degenerates at the time of maturity of the anther.
  Tapetum – an innermost layer of anther wall surrounding the sporogenous tissue. Tapetal cells are nutritive.

Microsporogenesis

- The formation and differentiation of microspores occur during microsporogenesis.

- The PMCs undergo meiosis. Each forms tetrahedral tetrads.
- The microspores are separated from the tetrahedral arrangement. They are then surrounded by a two layered wall.
- The pollen grains are the first cells of the male gametophyte.
- The tapetum gets used up and the anther becomes dry structure. Pollens are liberated by dehiscence of the anther.
- All the four nuclei in a tetrad remain functional to form four microspores.
- Pollen grain is haploid, unicellular body with single nucleus. It has a two-layered wall.
- Outer layer is thick and hard. It is called the exine, which is made of **sporopollenin**. Inner wall is thin and is called the intine. It is made up of **pecto-cellulose**.
- The sporopollenin is resistant to chemical and biological decomposition. This preserves the pollen wall for long periods. It also possess proteins for enzymatic and compatibility reactions.
- Exine is differentiated into inner endexine and outer ektexine.
- Pollen grain contains regions of pores or furrows. In these regions exine is absent. When the areas are circular they are called the germ pores.
- Intine is thin and elastic. It is made up of cellulose and pectin. During pollen germination it is the intine that extends out to form the pollen tube.
- The cytoplasm of the pollen grains is rich in starch and unsaturated oils. They are initially uninucleate and later becomes 2-3 celled.

Development of male gametophyte

- The nucleus increases in size inside the pollen grain. It divides mitotically to produce two unequal daughter cells; a bigger vegetative cell or tube cell and smaller generative cell.
- The generative cell divides mitotically to give rise to the two male gametes.
- Pollination can occur when the pollen grain is two celled (tube + generative) or three-celled (tube + two male gametes).
- The cytoplasm of generative cell does not contain much of stored food material.
- Fat, starch and protein granules are present in the vegetative cell.

Pollen products

- **Pollen food supplements:** Pollen grains contains abundant carbohydrates and unsaturated fat. They are used in the form of tablets and syrups for enhancing vital body functions. Pollen consumption increases performance and used by athletes and given to race horses.
- **Pollen creams:** Pollen grains protect themselves from UV rays. Thus, they are used in creams, emulsions for providing smoothness and protection to skin.

Pollen viability

- The period for which pollen grains remain viable or functional is called pollen viability.
- Pollen grain can be preserved in liquid nitrogen (temp – 196°C) and used as pollen banks.

Pollen allergy

Pollen grains produce severe allergy. They cause hay fever and common respiratory disorders as asthma, bronchitis, etc.

Carpel and Embryo sac Formation

- The pistil or gynoecium of a flower is the female reproductive unit.
- A carpel or pistil has three parts: stigma, style and ovary.
- **Stigma:** The part that receives pollen grains and serves as landing platform for pollen grains.
- **Style:** The stalk that connects the stigma to the ovary.
- **Ovary:** Swollen region present at the base. Ovary contains one to several ovules.
- Ovule is the **megasporangium** that is surrounded by integuments. On fertilisation, the ovule ripens into a seed. It is oval and whitish.
- The two ends of the ovule are micropylar end and chalazal end.

- **Funicle/funiculus:** Stalk that connects the ovule to the placenta.
- **Hilum:** The point of attachment of funicle to the ovule.
- A raphe (ridge) is formed by the fusion of funiculus with the body of ovule.
- The actual part equivalent to the megasporangium is a parenchymatous tissue called nucellus.

Megasporogenesis

- The process of formation of megaspores from the megaspore mother cell is called megasporogenesis.
- Ovules commonly form a single megaspore mother cell (MMC) in the micropylar region of the nucellus. It is a large cell and contains dense cytoplasm and prominent nucleus.
- The MMC undergoes meiosis to form four megaspores.
- In a majority of flowering plants, only one of the megaspores is functional. The other three degenerate.
- Only functional megaspore develops into female gametophyte (embryosac).

Formation of embryo sac

- The nucleus in the functional megaspore undergoes mitosis to form two nuclei. They move to the opposite poles. Thus, a two nucleate embryo sac is formed.
- Two more sequential mitotic nuclear divisions occur that lead to the formation of four nucleate and then eight nucleate stages of embryo sac.
- These nuclear divisions are not followed immediately by cell wall formation.
- After the eight nucleate stage, cell walls are laid down. This leads to the organisation of the typical female gametophyte or embryo sac.
- Six of eight nuclei are surrounded by cell walls and are organised into cells. The remaining two nuclei are called the polar nuclei. They are located just beneath the egg apparatus in the large central cell.
- Three cells are present together at the micropylar end constitute the egg apparatus. The egg apparatus consists of two synergids and one egg cell. The synergids have special cellular thickenings at the micropylar tip called **filiform apparatus**. They play an important role in guiding the pollen tubes into the synergid.
- Three cells at the chalazal end are called the antipodals.
- Thus, a typical angiosperm embryo sac has seven cells and eight nuclei at mature stage.

Pollination

- Pollination is the process of transfer of pollen grains from the anther and to the stigma of the flower.
- Pollination is of two types; self-pollination and cross pollination.
- Self pollination is the transfer of pollen grains from anthers to the stigma of same flower or a different flower of the same plant. In self-pollination the flowers are genetically similar.
- On the basis of the source of pollen, pollination is of three types: **autogamy, geitonogamy** and **xenogamy.**
  - **(a) Autogamy:** It is the transfer of pollen grains from the anther to the stigma of the same flower. It is favoured due to the following adaptations:
    - (i) **Chasmogamous devices:** When the flowers exposes their mature anther and stigma to the pollinating agents. In Lilac, the stigma lies directly beneath the anthers.
    - (ii) **Cleistogamy:** The flowers remain closed so there is no alternative of self-pollination. **Examples:** *Pisum, Lathyrus, Commelina benghalensis*
    - (iii) **Bud pollination:** Anthers and stigma of bisexual flowers mature before the bud opens. Thus, self-pollination takes place at the time of bud stage itself e.g. pea, wheat etc.
  - **(b) Geitonogamy:** It is transfer of pollen grain from anther of one flower to the stigma of another flower of same plant or genetically similar plants. It is functionally cross pollination but genetically self pollination as pollen grains come from same plant.
  - **(c) Xenogamy :** When pollination takes between two flowers of plants that are genetically and ecologically different.

Agents of Pollination

- **Water pollination (Hydrophily) is of two types**
  (i) Epihydrophily (on surface of water e.g. *Vallisneria*)
  (ii) Hypohydrophily (inside water) e.g. *Zostera*
- **Wind pollination (anemophily)**

  Wind pollination is most common in grasses. Wind pollinated flowers often have single ovule in each ovary and numerous flowers packed into an inflorescence.
- **Entomophily (Insect pollination)**

  Flowers are coloured–Bluish, purplish, violet, yellow that attract bees while reddish flowers attract butterflies and wasps.
- **Ornithophily (Bird pollination)**

  Pollination by birds is common in coral tree, bottle brush and silk cotton tree.
- **Chiropteriphily (Pollination by bats)**

  Chiropteriphilous flower produce abundant pollen grains and secrete more nectar than the ornithophilous flower.

Outbreeding devices

These devices are developed by bisexual flowers to avoid inbreeding depression and promote the cross pollination. It has been observed that sometime self pollination deserves in the poor yield and quality of the seeds.

Various devices are: Self sterility, Unisexuality, Dichogamy, Protogyny, Protandry and Chasmogamous flower

Pollen Pistil interaction

Pistil has the ability to recognise the correct pollen. It accepts right type of pollen to promote post pollination events that leads to fertilisation. All the events that from pollen deposition on the stigma until pollen tube enter the ovule are together referred to as pollen-pistil interaction.

Double Fertilisation

- One out of the two male gametes, moves towards the egg cell and fuses with the nucleus resulting in the formation of zygote. This fusion is called **syngamy**.
- The other male gamete moves towards two polar nuclei in the centre and fuses with them to produce triploid primary endosperm. The fusion is called **triple fusion**.
- As two types of fusion, syngamy and triple fusion occurs within the embryo sac, the phenomenon is called double fertilisation.

Post fertilisation: Structure and Events

Events of endosperm and embryo development, maturation of ovule to seed and ovary to fruit are post fertilisation events.

Endosperms

Endosperm is a nutritive tissue formed from vegetative fertilisation. Endosperm is meant for nourishing the embryo. It is triploid.

Functions of endosperms

- In plants with albuminous seeds the nutrients in the endosperm help in early seedling growth.
- Endosperm provides nutrition to developing embryo.
- Liquid endosperm of coconut contains auxins, cytokinins and GA and induces cytokinesis when added to basic nutrient medium.

Embyrogeny (embryo formation)

- It is the development of mature embryo from zygote or oospore.
- Development of embryo occurs on inner side because of presence of suspensor. Thus, embryo development is endoscopic.

- The part of embryonal axis above the level of cotyledons is called epicotyl. It ends with the stem tip called the plumule. The plumule gives rise to the future shoot.
- The part below the level of cotyledons is called hypocotyl. It terminates in the root tip called radicle. The radicle gives rise to the future root. The root tip is covered with root cap.

Formation of seed and fruit

- **Fruit:** Ripened ovary or fertilised ovary is called fruit. Wall of the ovary forms fleshy or dry fruit wall called pericarp.
- Fleshy fruit or pericarp has three layers – epicarp, mesocarp and endocarp.
- Ripened ovules are known as seeds.
- Integuments of ovule forms seed coat. Outer integuments form testa and tegmen develops from inner integuments.

Depending upon the presence or absence of endosperm the seeds are classified as follows:

(a) **Non-endospermic or ex-albuminous:** Food stored in endosperm is completely used up by developing embryo. **Examples:** gram, pea, bean, orchid.

(b) **Endospermic or albuminous:** Endosperm grows vigorously and is not used up completely by the developing embryo. In this case the cotyledons are thin. **Examples:** wheat, barley, castor, poppy.

Seed viability

- It is the period of time for which the seeds retain the ability to germinate.
- Seed viability is determined genetically as well as environmentally.
- Environmental conditions which can alter viability are humidity and temperature.
- Genetically, seed viability ranges from a few days to 2–5 years.

Other modes of Reproduction

Apomixis: It is the formation of new individuals by asexual methods which mimic sexual reproduction including seed formation but do not involve fusion of gametes or sex cells e.g. mango, orange, *opuntia*, onion.

Parthenogenesis: It is the development of a new individual from a single gamete without fusion with another gamete.

Apogamy: It is the formation of sporophyte or embryo directly from cells of gametophyte. **Examples:** Citrus, groundnut, onion, *Opuntia*, *Mangifera*.

Parthenocarpy: It is the process of formation of fruit without an event of fertilisation. Parthenocarpic fruits are seedless e.g. apple, pear, banana, pineapple, etc.

Fruits that have seeds with an asexual embryo or pseudoseeds are also parthenocarpic fruit.

Importance of parthenocarpic fruits

- They do not contain seeds which have to be removed before eating fruits.
- Fruits can be developed inside the green houses where pollinators are not available.
- Quicker food processing.

QUESTION BANK

MULTIPLE CHOICE QUESTIONS

1. The product of sexual reproduction result in

(a) new genetic combination cause variation
(b) large biomass
(c) longer viability of seeds
(d) prolonged dormancy

2. **Animal vectors are required for pollination in**
   (a) rose (b) mulberry (c) cucumber (d) maize

3. **The functional megaspore in an angiosperm develops itself into a/an**
   (a) placenta (b) embryo sac (c) embryo (d) seed

4. **Male gametophyte of angiosperms is shed at**
   (a) four celled pollen grain (b) three celled pollen grain
   (c) microspore mother cell (d) anther

5. **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

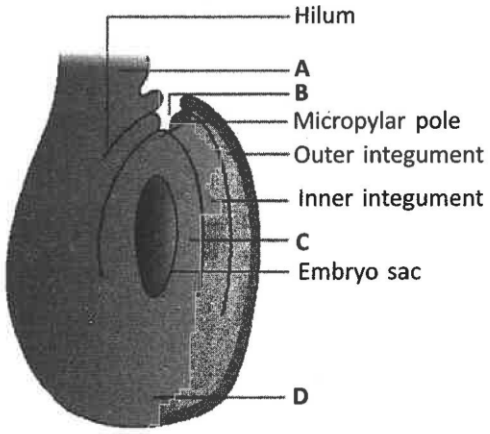
6. **The phenomena of formation of gametophyte directly from sporophyte without inclusion of meiosis is**
   (a) apospory (b) apogamy (c) parthenogenesis (d) amphimixis

7. **Meiosis in plants takes place in**
   (a) gemmule (b) megaspore (c) meiocyte (d) zoospores

8. **The seed coat is not thin, but membranous in**
   (a) groundnut (b) gram (c) maize (d) coconut

9. **Perisperm differs from endosperm in**
   (a) being a diploid tissue
   (b) its formation by fusion of secondary nucleus with several sperms
   (c) being a haploid tissue
   (d) having no reserve food

10. **Identify D in the given diagram.**



   (a) Chalaza (b) Nucellus (c) Synergids (d) Polar cells

11. **Flowers which have single ovule in the ovary and packed into inflorescence are usually pollinated by**
   (a) bat (b) wind (c) butterfly (d) water

12. **A dioecious flowering plant prevents both**
   (a) autogamy and geitonogamy (b) geitonogamy and xenogamy
   (c) cleistogamy and xenogamy (d) autogamy and xenogamy

13. **Adventive embryony in *Citrus* is due to**
   (a) nucellus (b) integuments (c) zygotic embryo (d) fertilised egg

14. In grasses what happens in the microspore mother cell for the formation of mature pollen grains?

(a) One meiotic and two mitotic divisions
(b) One meiotic and one mitotic divisions
(c) One meiotic division
(d) One mitotic division

15. Anemophily type of pollination is found in

(a) rose (b) bottle brush (c) *Vallisneria* (d) coconut

16. Endosperm is formed during the double fertilisation by

(a) two polar nuclei and one male gamete
(b) one polar nuclei and one male gamete
(c) ovum and male gamete
(d) two polar nuclei and two male gametes

17. Double fertilisation is observed in

(a) algae (b) fungi (c) angiosperms (d) gymnosperms

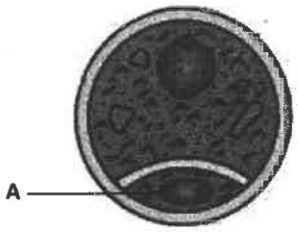
18. In majority of angiosperms, the basic phenomena observed is

(a) a small central cell is present in that embryo sac
(b) there are numerous antipodal cells
(c) reduction division occurs in the megaspore mother cells
(d) egg has a filiform apparatus

19. Pollination in water hyacinth and water lily is brought about by the agency

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

20. The structure A in the given diagram signifies



(a) nucleus (b) generative cell (c) endocarp (d) vegetative cell

21. The coconut water from tender coconut represents

(a) mesocarp
(b) free nuclear endosperm
(c) endocarp
(d) free nuclear pro-embryo

22. Which one of the following statements is not correct?

(a) Pollen grains of many species cause severe allergies.
(b) Stored pollen in liquid nitrogen can be used in the crop breeding programmes.
(c) Tapetum helps in the dehiscence of anther.
(d) Exine of pollen grains is made up of sporopollenin.

23. Seed formation without fertilisation in flowering plants involves the process of

(a) hybridisation (b) apomixis (c) sporulation (d) budding

24. If there are 4 cells in anthers, what will be the number of pollen grains?

(a) 16 (b) 12 (c) 8 (d) 4

25. The anthesis is defined as the phenomena of

(a) development of anthers
(b) opening of flower bud
(c) stigma receptors
(d) all of these

26. In an angiosperm, how many microspore mother cells are required to produce 100 pollen grains?

(a) 85 (b) 100 (c) 25 (d) 50

27. Double fertilisation is characteristic of

(a) angiosperms (b) Algae (c) gymnosperms (d) bryophytes

28. Ovule is straight with funiculus, embryo sac, chalaza and micropyle lying on one straight line. It is

(a) orthotropous (b) anatropous (c) campylotropous (d) amphitropous

29. Proximal end of the filament of stamen is attached to the

(a) placenta (b) thalamus or petal (c) carpel (d) connective

30. Filiform apparatus is characteristic feature of

(a) aleurone cell (b) synergids

(c) generative cell (d) nucellar embryo

31. Which one of the following statements is wrong?

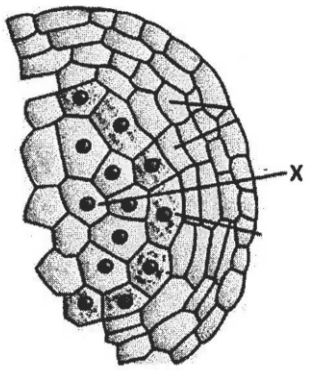
(a) When pollen is shed at two celled stage, double fertilisation does not take place.

(b) Vegetative cell is larger than generative cell.

(c) Pollen grains in some plants remain viable for months.

(d) Intine is made up of cellulose and pectin.

32. The part X in the diagram is known as



(a) epidermis (b) Microspore mother cell

(c) endothecium (d) tapetum

33. Filiform apparatus is a characteristic feature of that can be seen with

(a) suspensor (b) egg (c) synergid (d) zygote

34. Nucellar polyembryony is reported in species of

(a) Citrus (b) *Gossypium* (c) *Triticum* (d) *Brassica*

35. Which one of the following pollination is autogamous in nature?

(a) Chasmogamy (b) Xenogamy (c) Geitonogamy (d) Cleistogamy

36. In angiosperms, microsporogenesis and megasporogenesis both

(a) involve meiosis (b) occur in ovule

(c) occur in stamen (d) form gametes without further divisions

37. Flowers are unisexual in

(a) china rose (b) onion (c) pea (d) cucumber

38. 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

39. Which one of the following fruits is parthenocarpic among the following option?

(a) Papaya (b) Banana (c) Brinjal (d) Apple

40. Male gametophyte in angiosperms produces

(a) single sperm and two vegetative cells
(b) three sperms
(c) two sperms and a vegetative cell
(d) single sperm and a vegetative cell

41. Which of the following are the important floral rewards to the animal pollinators?

(a) Floral fragrance and calcium crystals
(b) Protein pellicle and stigmatic exudates
(c) Large size of flower
(d) Nectar and pollen grains

42. Which one of the following may require pollinators, but is genetically similar to autogamy?

(a) Apogamy (b) Cleistogamy (c) Geitonogamy (d) Xenogamy

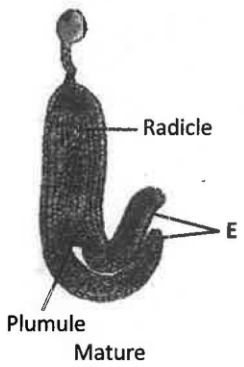
43. A plant produces light and non-sticky pollen grains and possesses well exposed stamens. The possible means of pollination is this plant is

(a) Insect (b) Wind (c) Water (d) Bat

44. Geitonogamy involves

(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.

45. The given diagram is showing the image of a mature embryo. Identify the part denoted as E.



(a) zygote (b) seeds (c) cotyledons (d) synergids

46. Many pollen tablets are available in the market for

(a) in vitro fertilisation (b) breeding programmes (c) supplementing food (d) ex-situ conservation

47. Epihydrophily is seen in

(a) Water lily (b) *Zostera* (c) *Vallisneria* (d) Water hyacinth

48. Seed coat is not thin and membranous in

(a) groundnut (b) gram (c) maize (d) coconut

49. Perisperm is observed to be different from endosperm in

(a) being a diploid tissue
(b) its formation by fusion of secondary nucleus with several sperms
(c) being a haploid tissue
(d) having no reserve food

50. One major advantage of cleistogamy is

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

51. Megasporangium is equivalent to

(a) nucellus (b) ovule (c) embryo sac (d) fruit

52. Identify the true statement.

(a) Endothecium produces the microspores.
(b) Tapetum nourishes the developing pollen.
(c) Hard outer layer of pollen is called intine.
(d) Sporogenous tissue is haploid.

53. Albuminous seeds store their reserve food mainly in

(a) endosperm (b) cotyledons (c) hypocotyl (d) perisperm

54. Megaspores are produced from the megaspore mother cells after

(a) mitotic division
(b) formation of thick wall
(c) differentiation
(d) meiotic division

55. Which one of the following statements is true?

(a) Cleistogamous flowers are always autogamous.
(b) Xenogamy occurs only by wind pollination.
(c) Chasmogamous flowers do not open at all.
(d) Geitonogamy involves the pollen and stigma of flowers of different plants.

56. Which of the following statements is correct?

(a) Sporopollenin can be easily degraded by enzymes.
(b) Sporopollenin is made up of fat component.
(c) Sporopollenin can withstand high temperatures as well as strong acids and alkalis.
(d) Sporopollenin can withstand high temperatures but not strong acids.

57. Which one of the following is correctly matched?

(a) Onion–Bulb
(b) Ginger–Sucker
(c) *Chlamydomonas*–Conidia
(d) Yeast–Zoospores

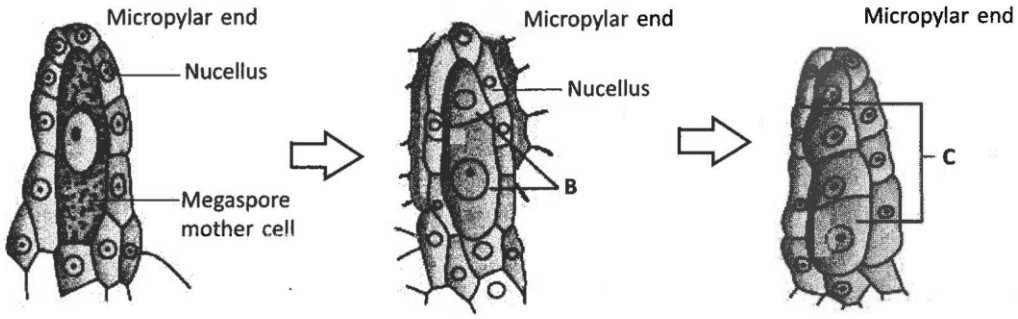
58. An organic substance that can withstand environmental extremes and cannot be degraded by any enzyme

(a) cuticle (b) sporopollenin (c) lignin (d) cellulose

59. Both, autogamy and geitonogamy are prevented in

(a) papaya (b) cucumber (c) castor (d) maize

60. What type of cell division is shown in this diagram?



(a) Equational division (b) Amitosis (c) Mitosis (d) Meiosis

61. The "eyes" of the potato tuber are

(a) root buds (b) flower buds (c) shoot buds (d) axillary buds

62. Transfer of pollen grains from the anther to the stigma of another flower of the same plant is called

(a) xenogamy (b) geitonogamy (c) karyogamy (d) autogamy

63. Wind pollinated flowers are

(a) small, brightly coloured, producing large number of pollen grains
(b) small, producing large number of dry pollen grains
(c) large producing abundant nectar and pollen
(d) small, producing nectar and dry pollen

64. The polyembryony commonly occurs in

(a) tomato (b) potato (c) lemon (d) turmeric

65. When pollen of a flower is transferred to the stigma of same flower of the same plant, the pollination is referred to as

(a) autogamy (b) geitonogamy (c) xenogamy (d) allogamy

66. Embryo sac represents

(a) megaspore (b) megagametophyte (c) megasporophyll (d) megagamete

67. Number of meiotic divisions required to produce 200/400 seeds of pea would be

(a) 200/400 (b) 400/800 (c) 300/600 (d) 250/500

68. Vegetative propagation in *Pistia* occurs by

(a) stolon (b) offset (c) runner (d) sucker

69. Which one of the following pairs of plant structures has a haploid number of chromosomes?

(a) Nucellus and antipodal cells (b) Egg nucleus and secondary nucleus

(c) Megaspore mother cell and antipodal cells (d) Egg cell and antipodal cells

70. What does the filiform apparatus do at the entrance into the ovule?

(a) It brings about opening of the pollen tube.

(b) It guides pollen tube from a synergid to egg.

(c) It helps in the entry of pollen tube into a synergid.

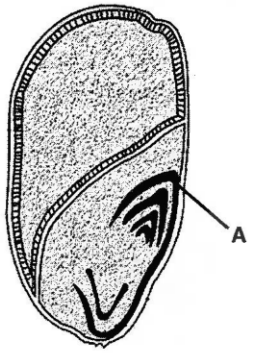
(d) It prevents entry of more than one pollen tube into the embryo sac.

71. Unisexuality of flowers prevents which of the phenomena?

(a) Geitonogamy, but not xenogamy (b) Autogamy and geitonogamy

(c) Autogamy, but not geitonogamy (d) Both geitonogamy and xenogamy.

72. The given diagram is the LS of maize. Observe the diagram and identify the label A.



(a) Pericarp (b) Scutellum (c) Coleorhiza (d) Coleoptile

73. Male gametes in angiosperms are formed by the division of

(a) generative cell (b) vegetative cell

(c) microspore mother cell (d) microspore

74. Two plants can be conclusively said to belong to the same species if they

(a) have more than 90 percent similar genes

(b) look similar and possess identical secondary metabolites

(c) have reproductive isolation

(d) can reproduce freely with each other and form seeds

75. Which one of the following is surrounded by a callose wall?

(a) Male gamete (b) Egg

(c) Pollen grain (d) Microspore mother cell

76. The parthenocarpic tomato fruits can be grown by

(a) treating the plants with phenylmercuric acetate

(b) removing androecium of flowers before pollen grains are released

(c) treating the plants with low concentrations of gibberellic acid and auxins

(d) raising the plants from vernalized seeds

77. In a cereal grain the single cotyledon of embryo is represented by

(a) coleoptile (b) coleorhiza (c) scutellum (d) prophyll

78. The arrangement of the nuclei in a normal embryo sac in the dicot plants is

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

79. 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

80. Through which cell of the embryo sac, does the pollen tube enter the embryo sac?

(a) Egg cell (b) Synergid (c) Antipodals (d) Central cell

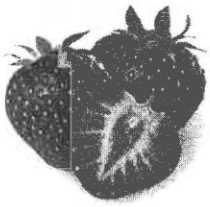
81. In pollination the attractants and rewards are required for

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

82. The embryo of an angiosperm is developed from

(a) zygote (b) endosperm (c) megaspore mother cell (d) megaspore

83. The edible part of the given fruit is



(a) mesocarp (b) placenta (c) thalamus (d) entire fruit

84. Plants with ovaries having only one or a few ovules, are generally pollinated by

(a) bees (b) butterflies (c) birds (d) wind

85. An aggregate fruit is defined as the one which get develops from

(a) multicarpellary syncarpous gynoecium (b) multicarpellary apocarpus gynoecium

(c) complete inflorescence (d) multicarpellary superior ovary

86. What is the function of germ pore among the given below statements?

(a) Emergence of radicle (b) Absorption of water for seed germination

(c) Initiation of pollen tube (d) Release of male gametes

87. Which one of the following is resistant to enzymatic action?

(a) Pollen exine (b) Leaf cuticle (c) Cork (d) Wood fibre

88. Wind pollination is very common phenomenon in

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

89. In angiosperms, the functional megaspore develops into

(a) embryo sac (b) ovule (c) endosperm (d) pollen sac

90. What is common feature between vegetative reproduction and apomixis?

(a) Both occur round the year (b) Both bypass the flowering phase

(c) Both are applicable to only dicot plants (d) Both produce progeny identical to the parent

91. Apomictic embryos in citrus fruits arises from

(a) synergids (b) maternal sporophytic tissue in ovule
(c) antipodal cells (d) haploid cell

92. An ovule which becomes curved so that the nucellus and embryo sac lie at right angles to the funicle is

(a) hemitropous (b) campylotropous (c) anatropous (d) orthotropous

93. 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

94. Below the egg apparatus, two polar nuclei are found in

(a) central cell (b) antipodal cells (c) funicle cell (d) synergid cell

95. Eight nucleated embryo sac is

(a) only monosporic (b) only bisporic (c) only tetrasporic (d) trisporic

96. The endosperm of gymnosperms is

(a) diploid (b) polyploid (c) triploid (d) haploid

97. The embryo in sunflower has

(a) two cotyledons (b) many cotyledons (c) no cotyledon (d) one cotyledon

98. The role of double fertilisation in angiosperms is to produce

(a) cotyledons (b) endocarp (c) endosperm (d) integuments

99. 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

100. Non-albuminous seed is produced in

(a) maize (b) castor (c) wheat (d) pea

INPUT-TEXT BASED QUESTIONS

Read the following paragraphs and answer the following questions.

I. A typical angiosperm anther is bilobed with each lobe having two theca, i.e., they are dithecous. Often a longitudinal groove runs lengthwise separating the theca. The bilobed nature of an anther is very distinct in the transverse section of the anther. The anther is a four-sided (tetragonal) structure consisting of four microsporangia located at the corners, two in each lobe. The microsporangia develop further and become pollen sacs.They extend longitudinally all through the length of an anther and are packed with pollen grains.

1. Which of the following has true angiospermic anther? Choose the correct option.

(i) *Hibiscus* (ii) Mushroom (iii) Sunflower (iv) Fern

(a) (i) and (iv) (b) (ii) and (iv) (c) (i) and (ii) (d) (i) and (iii)

2. A typical angiosperm anther is

(a) Unilobed and dithecous (b) Bilobed and dithecous
(c) Bilobed and tetrathecous (d) Tetralobed and octathecous

3. Microsporangim is generally surrounded by four wall layers. What is the correct sequence of those layers?

(a) Endothecium, epidermis, middle layers and the tapetum
(b) Endothecium, middle layers, epidermis and the tapetum
(c) Epidermis, endothecium, middle layers and the tapetum
(d) Tapetum, endothecium, middle layers and the epidermis

4. The anther consists of
   (a) 8 microsporangia (b) 4 microsporangia
   (c) 2 microsporangia (d) 1 microsporangium
5. Which of the following is considered as male gametophyte?
   (i) *Microspore mother cells* (ii) Microspores
   (iii) Pollen grains (iv) Tapetum
   (a) (i) and (iv) (b) (ii) and (iv) (c) (i) and (ii) (d) (ii) and (iii)

II. The nucleus of the functional megaspore divides mitotically to form two nuclei which move to the opposite poles, forming the 2-nucleate embryo sac. Two more sequential mitotic nuclear divisions result in the formation of the 4-nucleate and later the 8-nucleate stages of the embryo sac. It is of interest to note that these mitotic divisions are strictly free nuclear, that is, nuclear divisions are not followed immediately by cell wall formation. After the 8-nucleate stage, cell walls are laid down leading to the organisation of the typical female gametophyte.

1. Egg apparatus in a female gametophyte constitute the following structures. Choose the correct option.
   (i) Egg cell (ii) Synergids (iii) Antipodals (iv) Embryo sac
   (a) (i) and (iv) (b) (ii) and (iv) (c) (i) and (ii) (d) (i) and (iii)
2. The female gametophyte is otherwise known as
   (a) Egg apparatus (b) Megaspore mother cell
   (c) Embryo sac (d) Megaspore
3. How many nuclei are surrounded by cell walls and organised into cells in a female gametophyte?
   (a) 2 out of 4 cells (b) 2 out of 8 cells
   (c) 6 out of 8 cells (d) 1 out of 8 cells
4. A typical angiosperm embryo sac, at maturity is
   (a) 7-nucleate and 7-celled (b) 7-nucleate and 8-celled
   (c) 8-nucleate and 7-celled (d) 8-nucleate and 8-celled
5. Which of the following is/are true regarding the female gametophyte?
   (i) The number of egg cell in micropylar end is 2.
   (ii) The polar nuclei situated below the egg apparatus is called central cell.
   (iii) The polar nuclei situated below the egg apparatus is called antipodals.
   (iv) The mitotic divisions are strictly free nuclear in formation of typical female gametophyte.
   (a) (i) and (iv) (b) (ii) and (iv) (c) (i) and (ii) (d) (ii) and (iii)

ANSWERS

1. (a)	**2.** (c)	**3.** (b)	**4.** (b)	**5.** (b)	**6.** (a)	**7.** (c)	**8.** (d)	**9.** (a)	**10.** (a)
11. (b)	**12.** (a)	**13.** (a)	**14.** (b)	**15.** (d)	**16.** (a)	**17.** (c)	**18.** (c)	**19.** (b)	**20.** (b)
21. (b)	**22.** (c)	**23.** (b)	**24.** (a)	**25.** (b)	**26.** (c)	**27.** (a)	**28.** (a)	**29.** (b)	**30.** (b)
31. (a)	**32.** (b)	**33.** (c)	**34.** (a)	**35.** (d)	**36.** (a)	**37.** (d)	**38.** (a)	**39.** (b)	**40.** (c)
41. (d)	**42.** (c)	**43.** (b)	**44.** (a)	**45.** (c)	**46.** (c)	**47.** (c)	**48.** (d)	**49.** (a)	**50.** (a)
51. (b)	**52.** (b)	**53.** (a)	**54.** (d)	**55.** (a)	**56.** (c)	**57.** (a)	**58.** (b)	**59.** (a)	**60.** (d)
61. (d)	**62.** (b)	**63.** (b)	**64.** (c)	**65.** (a)	**66.** (b)	**67.** (d)	**68.** (b)	**69.** (d)	**70.** (b)
71. (c)	**72.** (d)	**73.** (a)	**74.** (d)	**75.** (d)	**76.** (c)	**77.** (c)	**78.** (c)	**79.** (b)	**80.** (b)
81. (a)	**82.** (a)	**83.** (d)	**84.** (d)	**85.** (b)	**86.** (c)	**87.** (a)	**88.** (c)	**89.** (a)	**90.** (d)
91. (b)	**92.** (a)	**93.** (c)	**94.** (a)	**95.** (a)	**96.** (d)	**97.** (a)	**98.** (c)	**99.** (b)	**100.** (d)

EXPLANATION

4. In angiosperms, pollen grains are generally shed from the anther at 2-celled stage, i.e. one generative cell and one vegetative cell. In few cases the generative cell divides prior to the dehiscence of anther and shed at 3-celled stage, i.e. one vegetative cell and two male gametes.

6. **Apospory:** Formation of gametophyte directly from sporophyte without meiosis and spore formation

21. In coconut the primary endosperm nucleus (PEN) first undergoes a number of free nuclear divisions without wall formation to form a large number of free nuclei (free nuclear endosperm) and the surrounding kernel is known as cellular endosperm.

24. One pollen mother cell gives rise to microspore tetrad in the process of microsporogenesis, means four pollens from each mother cell i.e. $4 \times 4 = 16$.

34. Nucellar polyembryony is the process in which the nucellar cells surrounding the embryo starts dividing and protrude into the embryo sac and develop into the embryos.

38. In embryo sac the synergids are pair of haploid cells, at the micropylar end. Zygote which is a diploid structure undergoes divisions to form an embryo. The antipodal and polar nuclei are haploid in nature. Primary endosperm nucleus formed with the fusion of one male gamete is triploid in nature.

64. Polyembryony is defined as a condition in which two or more embryos develop from a single fertilised egg. It is the common phenomenon in most of the plant species. Examples: citrus fruits and *Opuntia*.

75. Callose is a kind of plant polysaccharide that plays an important role in different stages of development of plants. It is also present in cell wall of some plant cells. Callose synthase is an enzyme that synthesises callose. It is located on plasma membrane.

78. The 3 nuclei at micropylar end constitute egg apparatus and the 3 nuclei at chalazal end constitute antipodals. The 2 nuclei are present at the centre as the polar nuclei. So it is 3 + 2 + 3 arrangement.

86. The germ pores are present in the exine layer of the pollen grain and lack the sporopollenin. The germ pore helps in the formation of the pollen tube and the release of the male gametes during fertilisation.

Input-Text Based Answers					
I.	**1.** (d)	**2.** (c)	**3.** (c)	**4.** (b)	**5.** (d)
II.	**1.** (c)	**2.** (c)	**3.** (c)	**4.** (c)	**5.** (b)