SEXUAL REPRODUCTION IN FLOWERING PLANTS

BASIC CONCEPTS

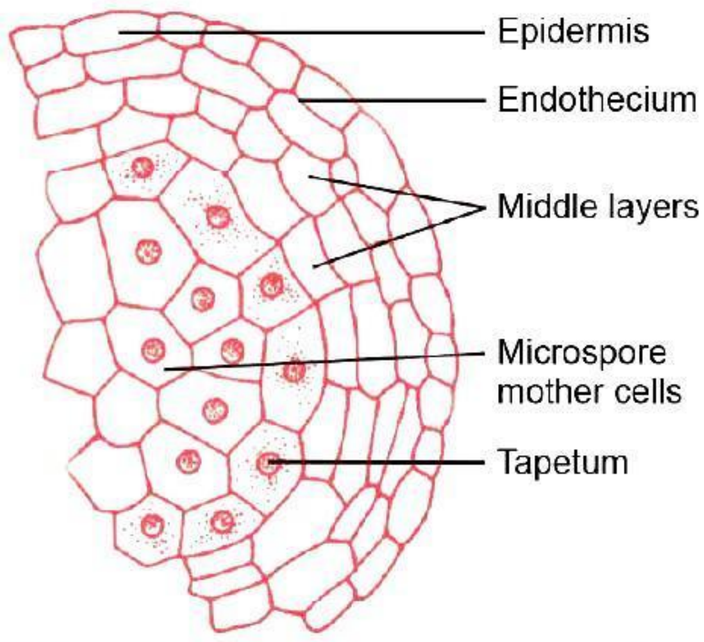
1. A typical microsporangium appears circular and is surrounded by four walls:

(*i*) **Epidermis:** It is the outermost single layer of cell which is protective in nature.

(*ii*) **Endothecium:** It is the second layer with thick cells, help in dehiscence and is protective in nature.

(*iii*) **Middle layer:** It is the third layer composed of 1–3 layers of cells, help in dehiscence and is protective in nature.

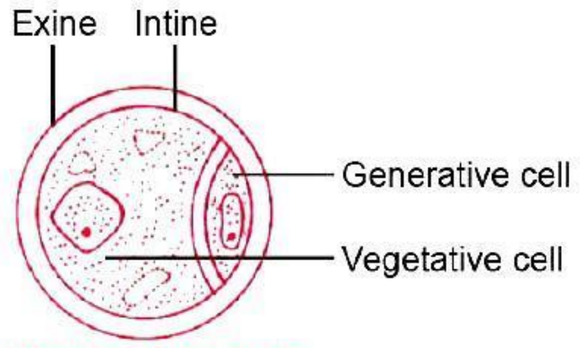
(*iv*) **Tapetum:** It is the fourth and innermost layer of cell with dense cytoplasm and many nuclei. It provides nourishment to the developing pollen grains.



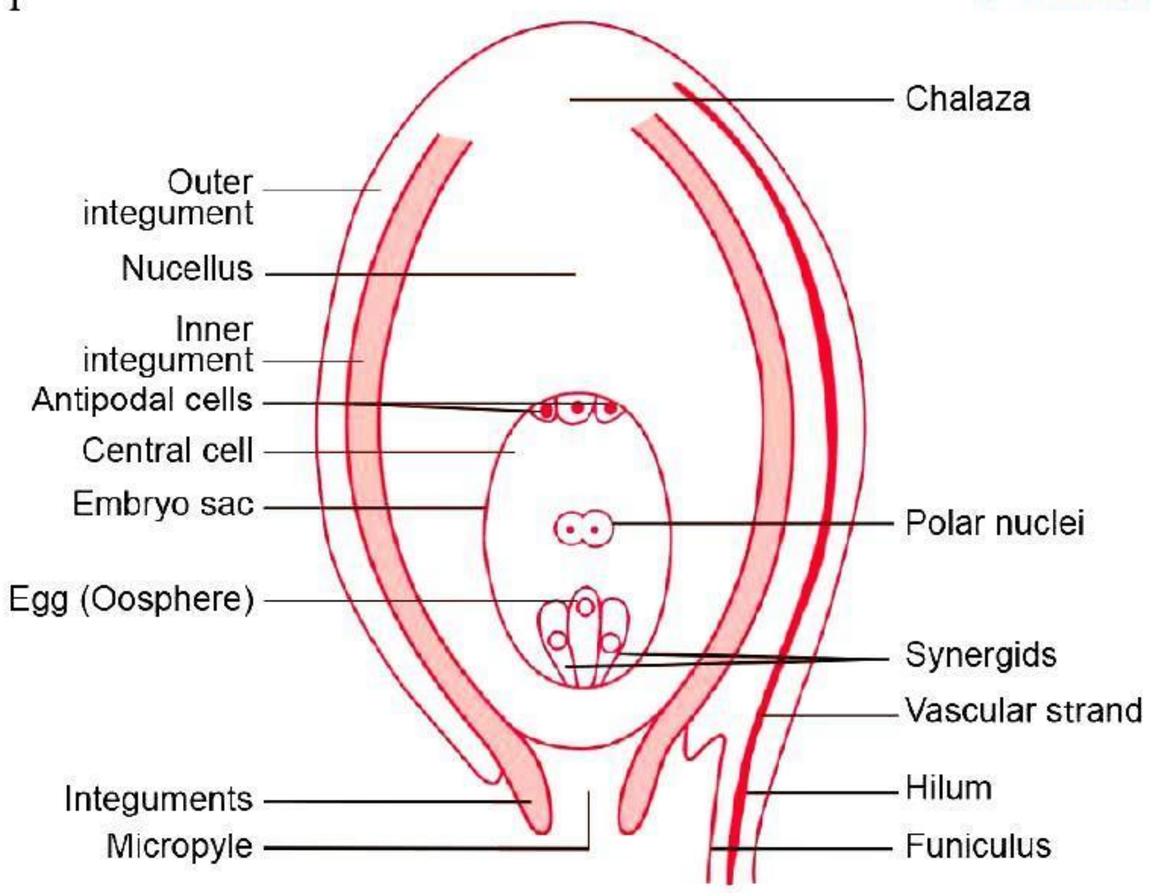
Enlarged view of one microsporangium showing wall layers

2. The process of formation of microspore from a pollen mother cell by meiosis is called **microsporogenesis**. **Pollen mother cell (PMC)** or **microspore mother cell** undergoes meiotic divisions to form cluster of four cells called **microspore tetrad**. On maturity, the anther dehydrates and the microspores separate from each other to form **pollen grains** with two layered wall—outer hard exine and inner intine.

3. The outer wall layer possess **exine**, which is a hard layer made of sporopollenin which is one of the most resistant organic material present in nature. It can withstand high temperature and strong acids and alkalis. Even enzymes cannot degrade sporepollenin and hence pollens are preserved as fossils. The inner thin layer of **intine** is made up of cellulose and pectin.



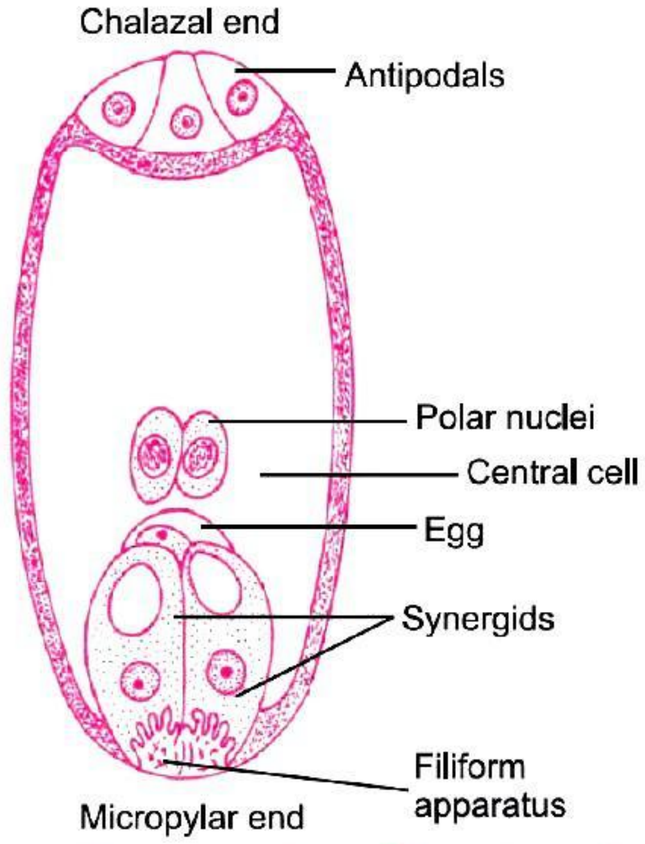
Mature pollen grain (2-celled pollen)



A diagrammatic view of a typical anatropous ovule

4. The process of formation of haploid megaspores from the diploid megaspore mother cell (MMC) is called **megasporogenesis**. MMC first divides transversely into two cells called **dyad**. These two cells again divide transversely, as a result a linear row of four haploid cells is produced which is called **megaspore tetrad** or **linear tetrad**. Out of these four megaspores, only one remains functional while the other three degenerate.
5. The formation of female gametophyte (embryo sac) is called **megagametogenesis**.

Female gametophyte is 7 celled, 8 nucleate as it consist of 7 cells but 8 nuclei (2 nuclei in polar cell).



A diagrammatic representation of the mature embryo sac

6. The transfer of pollen grains from anther and their deposition over stigma of the pistil is termed as **pollination**. Depending upon sources of pollen grains, pollination is of three types.

Pollination

Autogamy
1. The transfer of pollen grains is from anther to stigma of the same flower, *e.g.*, pea, rice, wheat, etc. It is self-pollination.
2. Brings pollen with similar genetic constitution on stigma.

Geitonogamy
1. The transfer of pollen grains is from anther of one flower to the stigma of another flower of same plant, *e.g.*, *Cucurbita*.
2. It is functionally cross-pollination but genetically similar to autogamy.

Xenogamy/Allogamy
1. The transfer of pollen grains is from anther of one flower to the stigma of another flower of different plant, *e.g.*, Papaya, maize.
2. Brings genetically different types of pollen grains to stigma.

7. On reaching synergid, pollen tube releases the two male gametes into cytoplasm of synergid.

One of the male gamete fuses with egg nucleus to form a diploid cell called zygote. This event is called **syngamy**.

Other male gamete fuses with polar nuclei at the centre to produce a triploid **primary endosperm nucleus (PEN)**. This is termed as **triple fusion**.

8. As syngamy and triple fusion take place simultaneously in the embryo sac, it is termed as double fertilisation. The central cell after triple fusion forms **primary endosperm cell (PEC)** which later develops into endosperm. The zygote later develops into an embryo.
9. Endosperm develops first, followed by an embryo. Endosperm develops from PEN. PEN undergoes successive nuclear divisions to give rise to free nuclei and this stage of endosperm development is called **free nuclear endosperm**.

10. Embryo develops from zygote at the micropylar end of embryo sac. The nutrition for development is provided by endosperm. The zygote divides mitotically to form proembryo. The different stages of the developing proembryo are globular and heart-shaped embryo, which finally forms mature embryo.

11. The phenomenon of asexual reproduction that imitates sexual reproduction by formation of seed without fertilisation is called **apomixis** or **agamospermy**.

Ways of development of apomictic seeds:

(*i*) A diploid egg is formed without reduction division and develops into embryo without fertilisation.

(*ii*) Some cells of the nucellus, which are diploid in nature, start dividing and without fertilisation develop into embryo, *e.g.*, citrus fruits and mango.

12. The occurrence of more than one embryo in a seed is called polyembryony, *e.g.*, orange.

Ways of forming polyembryonic seeds:

(*i*) Development of cells like synergids, cells of nucellus, cells of integument, into embryo.

(*ii*) Formation of more than one embryo sac in an ovule.

(*iii*) Formation of more than one egg in an embryo sac.

MULTIPLE CHOICE QUESTIONS

Choose and write the correct option in the following questions.

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

(*a*) coleoptile (*b*) coleorhiza

(*c*) scutellum (*d*) hypocotyl

2. In a typical complete, bisexual and hypogynous flower the arrangement of floral whorls on the thalamus from the outermost to the innermost is *[NCERT Exemplar]*

(*a*) calyx, corolla, androecium and gynoecium

(*b*) calyx, corolla, gynoecium and androecium

(*c*) gynoecium, androecium, corolla and calyx

(*d*) androecium, gynoecium, corolla and calyx

3. A dicotyledonous plant bears flowers but never produces fruits and seeds. The most probable cause for the above situation is *[NCERT Exemplar]*

(*a*) plant is dioecious and bears only pistillate flowers

(*b*) plant is dioecious and bears both pistillate and staminate flowers

(*c*) plant is monoecious

(*d*) plant is dioecious and bears only staminate flowers

4. In angiosperms, male gametes are formed by the division of

(*a*) microspore mother cell (*b*) microspore

(*c*) generative cell (*d*) vegetative cell

5. During microsporogenesis, meiosis occurs in *[NCERT Exemplar]*

(*a*) endothecium (*b*) microspore mother cells

(*c*) microspore tetrads (*d*) pollen grains

6. From among the sets of terms given below, identify those that are associated with the gynoecium. *[NCERT Exemplar]*

(*a*) Stigma, ovule, embryo sac, placenta (*b*) Thalamus, pistil, style, ovule

(*c*) Ovule, ovary, embryo sac, tapetum (*d*) Ovule, stamen, ovary, embryo sac

7. **Starting from the innermost part, the correct sequence of parts in an ovule are** *[NCERT Exemplar]*

(*a*) egg, nucellus, embryo sac, integument (*b*) egg, embryo sac, nucellus, integument
(*c*) embryo sac, nucellus, integument, egg (*d*) egg, integument, embryo sac, nucellus

8. **From the statements given below, choose the option that are true for a typical female gametophyte of a flowering plant.** *[NCERT Exemplar]*

(*i*) It is 8-nucleate and 7-celled at maturity.
(*ii*) It is free-nuclear during the development.
(*iii*) It is situated inside the integument but outside the nucellus.
(*iv*) It has an egg apparatus situated at the chalazal end.

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

9. **Autogamy can occur in a chasmogamous flower if** *[NCERT Exemplar]*

(*a*) pollen matures before maturity of ovule
(*b*) ovules mature before maturity of pollen
(*c*) both pollen and ovules mature simultaneously
(*d*) both anther and stigma are of equal lengths

10. **Dioecy refers to**

(*a*) unisexuality of a flower (*b*) bisexuality of a flower
(*c*) bisexuality of a plant (*d*) unisexuality of a plant

11. **Choose the correct statement from the following.** *[NCERT Exemplar]*

(*a*) Cleistogamous flowers always exhibit autogamy.
(*b*) Chasmogamous flowers always exhibit geitonogamy.
(*c*) Cleistogamous flowers exhibit both autogamy and geitonogamy.
(*d*) Chasmogamous flowers never exhibit autogamy.

12. **Which of the following structures are haploid in nature?**

(*a*) Nucellus and antipodals (*b*) Microspore and antipodals
(*c*) Egg cell and antipodals (*d*) Egg and central cell

13. **Filiform apparatus performs the function of**

(*a*) opening the pollen tube
(*b*) guiding the pollen tube to egg
(*c*) entry of pollen tube into synergids
(*d*) prevents growth of more than one pollen tube

14. **Unisexuality of flowers prevent**

(*a*) geitonogamy (*b*) autogamy
(*c*) xenogamy (*d*) both geitonogamy and xenogamy

15. **A particular species of plant produces light, non-sticky pollen in large numbers and its stigmas are long and feathery. These modifications facilitate pollination by** *[NCERT Exemplar]*

(*a*) insects (*b*) water
(*c*) wind (*d*) animals

16. **From among the situations given below, choose the one that prevents both autogamy and geitonogamy.** *[NCERT Exemplar]*

(*a*) Monoecious plant bearing unisexual flowers
(*b*) Dioecious plant bearing only male or female flowers
(*c*) Monoecious plant with bisexual flowers
(*d*) Dioecious plant with bisexual flowers

17. In a fertilised embryo sac, the haploid, diploid and triploid structures respectively are *[NCERT Exemplar]*

(*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

18. In an embryo sac, the cells that degenerate after fertilisation are *[NCERT Exemplar]*

(*a*) synergids and primary endosperm cell
(*b*) synergids and antipodals
(*c*) antipodals and primary endosperm cell
(*d*) egg and antipodals

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

(*a*) geitonogamy
(*b*) autogamy
(*c*) xenogamy
(*d*) cross-pollination

20. While planning for an artificial hybridisation programme involving dioecious plants, which of the following steps would not be relevant? *[NCERT Exemplar]*

(*a*) Bagging of female flower
(*b*) Dusting of pollen on stigma
(*c*) Emasculation
(*d*) Collection of pollen

21. In angiosperms, a functional megaspore develops into

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

22. Scutellum is

(*a*) grass embryo
(*b*) grass seed
(*c*) grass fruit
(*d*) grass cotyledon

23. In the embryos of a typical dicot and a grass, true homologous structures are *[NCERT Exemplar]*

(*a*) coleorhiza and coleoptile
(*b*) coleoptile and scutellum
(*c*) cotyledons and scutellum
(*d*) hypocotyl and radicle

24. The phenomenon observed in some plants wherein parts of the sexual apparatus is used for forming embryos without fertilisation is called *[NCERT Exemplar]*

(*a*) parthenocarpy
(*b*) apomixis
(*c*) vegetative propagation
(*d*) sexual reproduction

25. 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 *[NCERT Exemplar]*

(*a*) haploid
(*b*) diploid
(*c*) a few haploid and a few diploid
(*d*) with varying ploidy

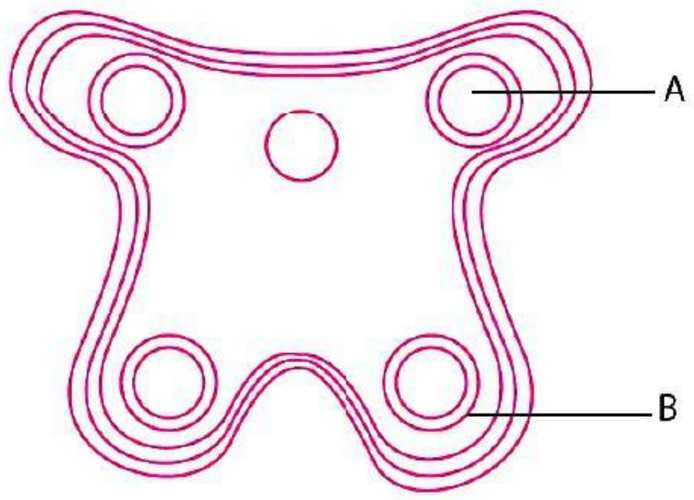
26. Function of germ pore is

(*a*) emergence of radicle
(*b*) absorption
(*c*) growth of pollen tube
(*d*) release of male gamete

27. The function of tapetum in microsporangium is:

(a) In nourishes the developing pollen gains.
(b) It performs the function of protection.
(c) It helps in dehiscence of anther to release pollen grains.
(d) It undergoes meiotic devisions to form microspore tetrads.

28. Identity 'A' and 'B' in the given diagram of a transverse section of a young anther.



(*a*) A—Tapetum B —Sporogenous tissue
(*b*) A—Sporogenous tissue B —Tapetum
(*c*) A—Connective B —Epidermis
(*d*) A—Endothecium B —Tapetum

29. Pollen grain has a prominent two-layered wall and the outer layer is called

(*a*) exine (*b*) intine
(*c*) germ pore (*d*) tapetum

30. _____ is one of the most resistant organic material.

(*a*) Lipoprotein (*b*) Sporopollenin
(*c*) Cellulose (*d*) Hemicellulose

31. 'Pollen grains are well preserved as fossils.' This is so because

(*a*) pollen grains measure about 25–50 micrometers
(*b*) they have two-layered wall
(*c*) both (*a*) and (*b*)
(*d*) sporopollenin is presents in pollens

32. The egg apparatus in the embryo sac consists of

(*a*) two synergids and one egg cell (*b*) one synergid and two egg cells
(*c*) central cell (*d*) only two egg cells

33. Which of the following statements is true for filiform apparatus?

(*a*) It is located at the chalazal end.
(*b*) It is located at the micropylar end.
(*c*) They play an important role in guiding the pollen tubes into the synergid.
(*d*) Both (*b*) and (*c*)

34. Match the terms in column I with the items in column II.

Column I	Column II
(1) Autogamy	(A) Transfer of pollen grains from anther to stigma of the same flower
(2) Geitonogamy	(B) Transfer of pollen grains from anther to stigma of a different plant's flower
(3) Xenogamy	(C) Transfer of pollen grains from the anther to the stigma of another flower of same plant

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

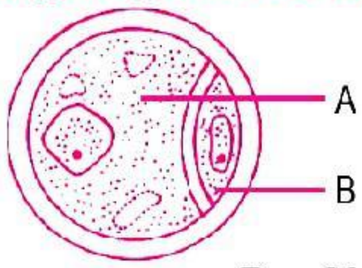
35. Which of the following is not a method to prevent autogamy in plants?

(*a*) Pollen release and stigma receptivity are not synchronised
(*b*) Anther and stigma are placed at different positions
(*c*) Self incompatibility
(*d*) Bisexual flowers

36. Bagging is done in flowers to

(*a*) prevent contamination of stigma with unwanted pollen
(*b*) initiate the process of pollination
(*c*) guide the entry of pollen tube
(*d*) attract the pollinating agents

37. Identify 'A' and 'B' in the following diagram of a mature pollen grain.



(*a*) A—Generative cell B —Vegetative cell
(*b*) A—Vegetative cell B —Generative cell
(*c*) A—Vacuole B —Nucleus
(*d*) A—Nucleus B —Vacuole

38. Formation of microspores from a pollen mother cell through meiosis is called

(*a*) gametogenesis (*b*) pollination
(*c*) megasporogenesis (*d*) microsporogenesis

39. A female plant with the ploidy level as 8*n* is crossed with a male plant with the ploidy level as 4*n* in an experiment. The ploidy of endosperm after double fertilisation would be

(*a*) 10*n* (*b*) 12*n*
(*c*) 8*n* (*d*) 16*n*

40. Flowers which do not open at all are called

(*a*) monocarpellary (*b*) cleistogamous
(*c*) chasmogamous (*d*) syncarpous

41. The number of meiotic divisions which are required to produce 20 seeds are

(*a*) 25 (*b*) 20
(*c*) 10 (*d*) 5

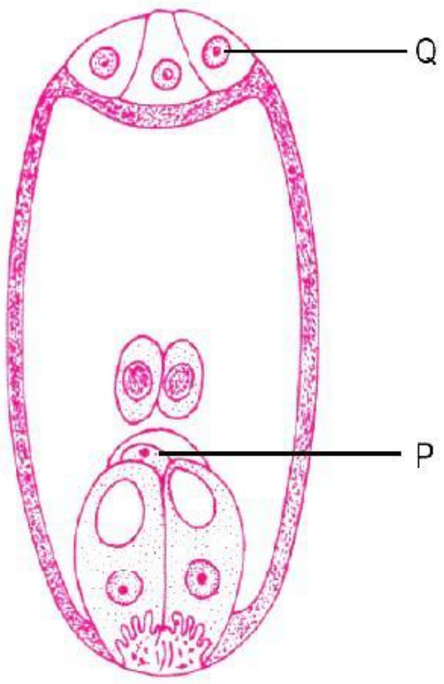
42. A flower pollinated by water is

(*a*) *Vallisneria* (*b*) Water hyacinth
(*c*) Both (*a*) and (*b*) (*d*) *Yucca*

43. After fertilisation, _____ forms the pericap.

(*a*) cotyledons (*b*) ovary wall
(*c*) scutellum (*d*) outer integument

44. Identify the diagram given below and choose the correct option.



(*a*) Ovule; P-Egg; Q-Polar nuclei
(*b*) Embryo sac; P- Egg; Q-Antipodals
(*c*) Anther; P-Endothecium, Q-Connective
(*d*) Stigma; P-Central cell; Q-Antipodals

45. Match the items in column I with the items in column II.

Column I	Column II
(A) Remains of nucellus in a seed	(1) Scutellum
(B) Formation of seed without fertilisation	(2) Perisperm
(C) Cotyledon in the seeds of grasses	(3) Polyembryony
(D) Occurrence of more than one embryo in a seed	(4) Apomixis

(*a*) A—1, B—2, C—3, D—4
(*b*) A—2, B—1, C—4, D—3
(*c*) A—2, B- 4, C—1, D—3
(*d*) A—4, B—3, C—1, D—2

46. Which of the following statements is correct about majority of angiosperms?

(*a*) Egg has five antipodal cells.
(*b*) Reduction division occurs in the megaspore mother cells.
(*c*) A small central cell is present in the embryo sac.
(*d*) Egg has filliform apparatus.

47. Double fertilisation is exhibited by

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

48. A plant that provides safe places to insects for laying eggs as floral reward of pollination is

(*a*) Water lily
(*b*) *Vallisneria*
(*c*) *Amorphophallus*
(*d*) *Viola*

49. Many insects may consume pollen without bringing out pollination. Such floral visitors are referred to as

(*a*) pollen robbers
(*b*) pollen stimulators
(*c*) pollinators
(*d*) pollen inhibitors

50. A dioecious flowering plant prevents both

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

51. The coconut water from tender coconut represents

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

52. Choose the incorrect statement.

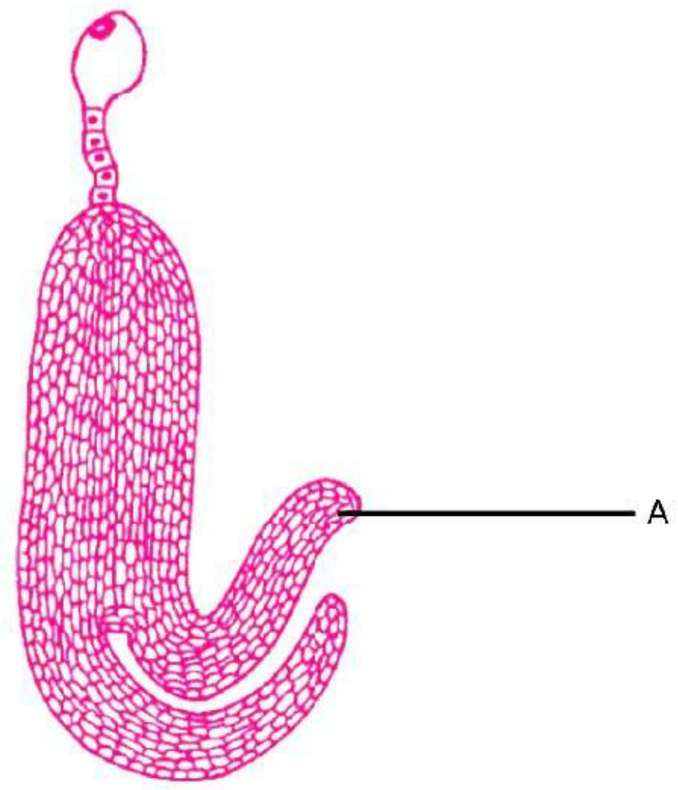
(*a*) The hollow foliar structure that encloses the leaf primordia in a grass embryo is called coleoptile.
(*b*) In apple, the thalamus also contributes to fruit formation and becomes edible.
(*c*) In *Zostera*, the pollen grains are long and ribbon-like and released inside the water.
(*d*) Sepals and petals are concealed in entomophilous flowers.

53. Choose the odd one out.

Vegetative cell, exine, synergids, germ pore

(*a*) Germ pore
(*b*) Synergids
(*c*) Exine
(*d*) Vegetative cell

54. Which of the following option correctly identify 'A' and its function?



(*a*) Suspensor - Protects the radicle
(*b*) Root cap - Gives protection to the plant
(*c*) Cotyledon - Contains reserved food material that are used by embryo
(*d*) Coleoptile - Gives protection to the radicle

55. Female flower of which of the following plants comes to the surface of water to collect pollen grains?

(*a*) *Vallisneria* (*b*) Lotus
(*c*) Water lily (*d*) *Hydrilla*

56. Type of tissue present in the fertilised ovules of an angiosperm plant to supply food and nourishment to developing embryo is

(*a*) tapetum (*b*) sporogenous tissue
(*c*) endosperm (*d*) synergids

57. The meiocyte of rice has 24 chromosomes. The number of chromosomes in its endosperm is

(*a*) 24 (*b*) 12
(*c*) 48 (*d*) 36

58. Normally, one embryo develops in one seed, but when an orange seed is squeezed, many embryos of different shapes and sizes are seen. This is so because

(*a*) orange shows polyembryony (*b*) orange shows sexual reproduction
(*c*) orange shows parthenocarpy (*d*) none of these

59. The common function of nucellus and cotyledons is

(*a*) reproduction (*b*) pollination
(*c*) nourishment (*d*) both (*b*) and (*c*)

60. The chromosome number in gametes (*n*) of maize is 10. So, the number of chromosomes in its endosperm would be

(*a*) 30 (*b*) 10
(*c*) 20 (*d*) 40

61. Fertilisation by a self-incompatible pollen is prevented by

(*a*) inhibiting the germination of the pollen
(*b*) retarding the growth of pollen tube
(*c*) both (*a*) and (*b*)
(*d*) unsynchronized pollen release and stigma receptivity

62. Which of the following statements is incorrect w.r.t. wind-pollinated plants?

(*a*) Pollen grains are light.
(*b*) Pollen grains are non-sticky.
(*c*) They possess well exposed stamens.
(*d*) Pollen grains have mucilaginous covering.

63. Self-pollination means

(*a*) pollen transfer from the same flower
(*b*) pollen transfer from other flower of the same plant
(*c*) both (*a*) and (*b*)
(*d*) pollen transfer from the flower of a different plant

64. Two nuclei that are situated below the egg apparatus in the central cell of female gametophyte are called

(*a*) central nuclei
(*b*) nuclei
(*c*) polar nuclei
(*d*) nucellus

65. A bilobed dithecous anther has 500 microspore mother cells per microsporangium. How many male gametophytes can this anther produce?

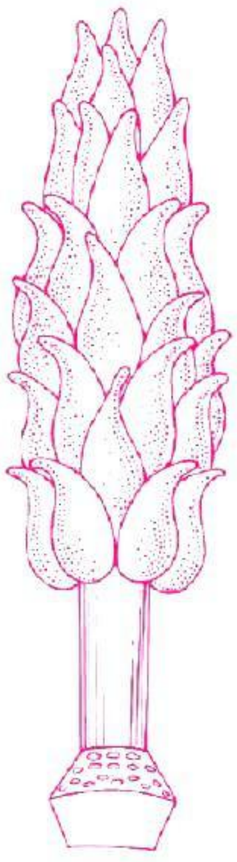
(*a*) 10,000
(*b*) 25,000
(*c*) 20,000
(*d*) 8,000

66. Choose the correct order of stages of development of dicotyledonous embryo.

(*a*) Zygote ⟶ embryo ⟶ globular embryo ⟶ heart shaped embryo
(*b*) Zygote ⟶ globular embryo ⟶ mature embryo
(*c*) Embryo ⟶ proembryo ⟶ mature embryo ⟶ globular embryo
(*d*) Zygote ⟶ proembryo ⟶ globular embryo ⟶ mature embryo

67. Following are the pictures of *Michelia* flower (A) and *Papaver* (B).

Choose the correct option with respect to the difference in the structure of their ovaries.



(*a*) A - Apocarpous ; B - Syncarpous
(*b*) A - Syncarpous; B - Apocarpous
(*c*) A - Syncarpous; B - Multicarpellary
(*d*) A - Monocarpellary; B - Apocapous

68. The transfer of pollens from anther to stigma is called

(*a*) pollination
(*b*) pollen trip
(*c*) sexual journey
(*d*) none of these

69. Cross-pollination is must in

(*a*) monoecious plants
(*b*) dioecious plants
(*c*) bisexual flowers
(*d*) none of these

70. The thick fruit wall is also called

(*a*) theca (*b*) pericarp

(*c*) pomocarp (*d*) none of these

71. The two parts of a typical stamen are

(*a*) anther and filament (*b*) stigma and style

(*c*) thalamus and placenta (*d*) carpel and sepals

72. Proximally, the filament of a flower is attached to

(*a*) anther (*b*) thalamus

(*c*) sepals (*d*) none of these

73. Pollen sacs develop from

(*a*) tapetum (*b*) microsporangia

(*c*) pollen outer wall (*d*) none of these

74. Which of the following plants produce both chasmogamous and cleistogamous flowers?

(*a*) *Viola* (*b*) *Oxalis*

(*c*) *Commelinaa* (*d*) All of these

75. A group of compactly arranged homogenous cells, occupying the centre of each microsporangium when the anther is young is the

(*a*) tapetal layer of cells (*b*) epithelial cells

(*c*) sporogenous tissue (*d*) endothelium tissue

76. Which of the following divide to give rise to microspores?

(*a*) Microspore mother cell (*b*) Tapetal cells

(*c*) Epithelial cells (*d*) Sporogenous tissue

77. Pollen grains represent

(*a*) male gamete (*b*) male gametophyte

(*c*) male reproductive organ (*d*) none of these

78. The microspores are generally formed in a cluster of

(*a*) 4 (*b*) 1

(*c*) 2 (*d*) 8

79. The enzyme that can degrade sporopollenin is

(*a*) carbonic anhydrase (b) acid hydrolase

(*c*) alkaline hydrolase (*d*) none of these

80. Sporopollenin is found in

(*a*) pollen exine (*b*) pollen intine

(*c*) pollen interior (*d*) none of these

81. The regions of pollen exine where sporopollenin is absent is called

(*a*) dehiscence point (*b*) naked region

(*c*) germ pore (*d*) none of these

82. Intine is composed of

(*a*) pectocellulose (*b*) lipoproteins

(*c*) sporopollenin (*d*) glycoproteins

83. In majority, matured angiospermic pollen grain is

(*a*) 3-celled (*b*) 2-celled

(*c*) 4-celled (*d*) 1-celled

84. Which of the following statements is true?

(*a*) Generative cell is larger than vegetative cell.

(*b*) Vegetative cell is larger than generative cell.

(*c*) Both have same size.

(*d*) Size of both cells are variable.

85. A large, irregularly shaped nucleus is found in

(*a*) vegetative cell (*b*) generative cell

(*c*) both (*a*) and (*b*) (*d*) none of these

86. Generative cell is_____ shaped.

(*a*) circular (*b*) oval

(*c*) spindle (*d*) rectangular

87. Which of following is correct about *Parthenium*?

(*a*) It was imported along with contaminated wheat.

(*b*) It is ubiquitous.

(*c*) It causes pollen allergy.

(*d*) All of these

88. Pollen grains of wheat and rice lose viability after

(*a*) sexual years (*b*) 30 minutes

(*c*) few seconds (*d*) few months

89. Pollens grains are kept viable by preserving in

(*a*) liquid H_2 (*b*) liquid O_2

(*c*) liquid N_2 (*d*) liquid air

90. More than one and fused pistil is termed as

(*a*) multicarpellary, apocarpous (*b*) megacarpellary, syncarpous

(*c*) multicarpellary syncarpous (*d*) megacarpellary, apocarpous

91. The ovarian cavity is called as

(*a*) locule (*b*) theca

(*c*) carpous (*d*) none of these

92. Which of the following serves as a landing platform for pollens ?

(*a*) Anther (*b*) Stigma

(*c*) Placenta (*d*) Style

93. The basal bulged part of the pistil is called

(*a*) ovary (*b*) placenta

(*c*) thalamus (*d*) stigma

94. The ovule is attached to the placenta by means of

(*a*) hilum (*b*) raphae

(*c*) funicle (*d*) chalaza

95. Which of the following is the junctional region between ovule and funicle ?

(*a*) Raphae (*b*) Placenta

(*c*) Chalaza (*d*) Hilum

96. Ovules are otherwise called

(*a*) megagametophyte (*b*) megaspore

(*c*) megasporangia (*d*) none of these

97. The tissue enclosed within the walls of megasporangium is called

(*a*) integumental tissue (*b*) sporogenous tissue
(*c*) nucellus (*d*) none of these

98. Generally from which region of nucellus, does the megaspore mother cell arise?

(*a*) Chalazal end (*b*) Micropylar end
(*c*) Either (*a*) or (*b*) (*d*) None of these

99. The development of the embryo sac from a single megaspore is called

(*a*) unisporic development (*b*) monosporic development
(*c*) monomegasporic development (*d*) none of these

100. The organisation of the typical embryo sac begins at

(*a*) 8-nucleate stage (*b*) 8-celled stage
(*c*) 4-celled stage (*d*) none of these

101. The cell in the centre of the matured embryo sac is called

(*a*) polar nuclei (*b*) central cell
(*c*) central nuclei (*d*) all of these

102. The cells of the chalazal end of the embryo sac are called

(*a*) antipodals (*b*) synergids
(*c*) polar nuclei (*d*) none of these

103. The mechanism in plants that helps in meeting of their reproductive units is called

(*a*) copulation (*b*) fertilisation
(*c*) pollination (*d*) ejaculation

104. Synchrony in pollen release and stigma receptivity is must in

(*a*) herkogamy (*b*) heterogamy
(*c*) xenogamy (*d*) autogamy

105. In flowering plants, archesporium gives rise to

(*a*) wall of sporangium (*b*) wall and sporogenous tissue
(*c*) tapetum and sporogenous (*d*) tapetum and endothecium

106. Gietonogamy involves

(*a*) one flower only (*b*) one plant only
(*c*) two plants (*d*) all of these

107. Light and non-sticky pollens support

(*a*) entomophily (*b*) chiropterophily
(*c*) malacophily (*d*) anemophily

108. Water lily shows

(*a*) malacophily (*b*) entomophily
(*c*) hydrophily (*d*) anemophily

109. Grasses show

(*a*) wind pollination (*b*) insect pollination
(*c*) water pollination (*d*) none of these

110. Pollen grains are protected by a mucilaginous covering in

(*a*) anemophily (*b*) zoophily
(*c*) hydrophily (*d*) all of these

111. Large, colourful and nectarious flowers are adaptations for

(*a*) anemophily (*b*) entomophily
(*c*) zoophily (*d*) hydrophily

112. Artificial removal of _____ is called emasculation in case of plants.

(*a*) placenta (*b*) stigma

(*c*) anthers (*d*) style

113. Which of the following is true?

(*a*) Triple fusion = Double fertilisation + Syngamy

(*b*) Double fertilisation = Triple fusion + Syngamy

(*c*) Both (*a*) and (*b*)

(*d*) None of these

114. The embryo of the plant is

(*a*) globular, heart shaped (*b*) bean shaped

(*c*) amoeboid (*d*) none of these

115. Pea and groundnut are

(*a*) albuminous (*b*) non-albuminous

(*c*) both (*a*) and (*b*) (*d*) none of these

116. Apple and strawberry are

(*a*) false fruits (*b*) true fruits

(*c*) parthenocarpic fruits (*d*) none of these

117. Oldest viable seed is of

(*a*) *Amorphophallus* (*b*) *Phoenix*

(*c*) *Lupinus* (*d*) Mulberry

118. Fruits produced without the phenomenon of fertilisation is

(*a*) false fruits (*b*) pseudo fruits

(*c*) both (*a*) and (*b*) (*d*) parthenocarpic fruits

119. The radicle in dicots is protected by a protective covering called

(*a*) coleorrhiza (*b*) coleoptile

(*c*) both (*a*) and (*b*) (*d*) none of these

120. Fusion between male gamete and secondary nucleus gives

(*a*) endosperm (*b*) zygote

(*c*) primary endosperm nucleus (*d*) none of these

121. The typical matured embryo sac of a flowering plant is

(*a*) 7 celled, 8 nucleated (*b*) 8 celled, 7 nucleated

(*c*) 7 celled, 7 nucleated (*d*) 8 celled, 8 nucleated

122. Coconut has

(*a*) nuclear endosperm (*b*) cellular endosperm

(*c*) both (*a*) and (*b*) (*d*) none of these

123. Which of the following statements is true about vegetative cell in a pollen?

(*a*) Vegetative cell is smaller than generative cell.

(*b*) It has abundant food reserve.

(*c*) It is spindle shaped.

(*d*) It has a small circular nucleus.

124. After triple fusion, the central cell becomes the

(*a*) central endosperm cell (*b*) zygote

(*c*) primary endosperm cell (*d*) embryo

125. How many megaspores are functional after megasporogenesis?

(*a*) Four (*b*) Three

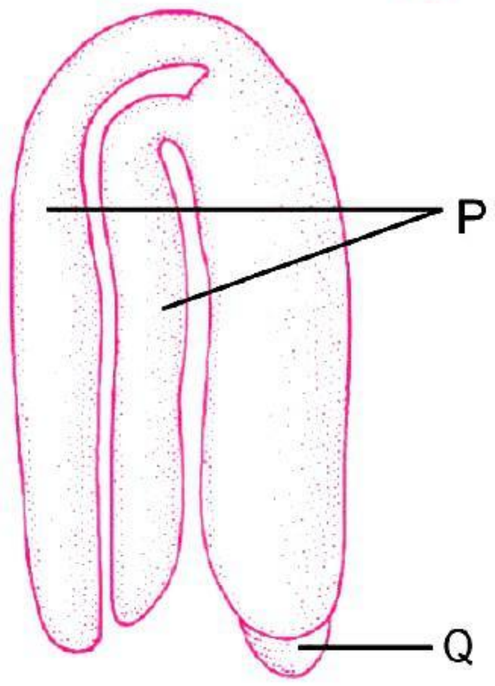
(*c*) One (*d*) Two

126. To produce 20,000 pollen grains, how many microspore mother cells will be required?

(*a*) 10,000 (*b*) 15,0000

(*c*) 20,000 (*d*) 5000

127. Identity (P) and (Q) in the following diagram of a typical dicot embryo.



(*a*) P—Cotyledons Q—Root cap (*b*) P—Hypocotyl Q—Root cap

(*c*) P—Cotyledon Q—Plumule (*d*) P—Plumule Q—Radicle

128. 'Corn cobs have long tassels'. This is because

(*a*) they can easily trap the air-borne pollen grains

(*b*) they are useful in protecting the pollen grains from wetting

(*c*) they can easily attract insects

(*d*) it helps them to reach the surface of water which helps them to get pollinated by insects

129. Which of the following is true for typical bilobed angiospermic anther ?

(*a*) 2 theca, 2 sporangia (*b*) 4 theca, 4 sporangia

(*c*) 4 theca, 2 sporangia (*d*) 2 theca, 4 sporangia

130. In which of the following, self pollination is must?

(*a*) Cleistogamous condition (*b*) Chasmogamous condition

(*c*) Heterostyly (*d*) Both (*b*) and (*c*)

Answers

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

89. (*c*)	**90.** (*c*)	**91.** (*a*)	**92.** (*b*)	**93.** (*a*)	**94.** (*c*)	**95.** (*d*)	**96.** (*d*)
97. (*b*)	**98.** (*b*)	**99.** (*b*)	**100.** (*a*)	**101.** (*b*)	**102.** (*a*)	**103.** (*c*)	**104.** (*d*)
105. (*b*)	**106.** (*b*)	**107.** (*d*)	**108.** (*d*)	**109.** (*a*)	**110.** (*c*)	**111.** (*b*)	**112.** (*c*)
113. (*b*)	**114.** (*a*)	**115.** (*b*)	**116.** (*a*)	**117.** (*a*)	**118.** (*d*)	**119.** (*b*)	**120.** (*c*)
121. (*a*)	**122.** (*c*)	**123.** (*b*)	**124.** (*c*)	**125.** (*a*)	**126.** (*d*)	**127.** (*a*)	**128.** (*a*)
129. (*d*)	**130.** (*b*)						

CASE-BASED QUESTIONS

Attempt any 4 sub-parts from each question. Each question carries 1 mark.

1. Read the following and answer the questions given below:

DOUBLE FERTILISATION

Following compatible pollination, the pollen grain germinates on the stigma to produce a pollen tube which grows through the tissues of stigma and style and reaches to ovary. If the pollen grain was shed at 2-celled stage, the generative cell divides and forms the two male gametes during the growth of pollen tube. In plants which shed pollen grains in 3-celled condition, pollen tube carries the two male gametes from the beginning. The pollen tube enters into ovule and penetrates into the embryo sac. Within embryo sac, the pollen tube enters into one of the synergids through the filiform apparatus. Now the pollen tube releases two male gametes into the space developed by degeneration of peneterated synergid. One of the male gamete moves towards the egg cell and fuses with its nucleus thus completing syngamy resulting into the formation of diploid zygote. The other male gamete moves towards the two polar nuclei located in the central cell and fuses with them to produce a triploid primary endosperm nucleus (PEN). As this involves the fusion of three haploid nuclei, it is termed as triple fusion. Since two types of fusion – syngamy and triple fusion, takes place in an embryo sac, this phenomenon is termed as double fertilisation, an event unique to flowering plants. After fusion, the central cell become primary endosperm cell (PEC) and develops into endosperm while the zygote develops into an embryo.

(*i*) Why angiospermic plants produce endosperm while the other plants do not?

(*a*) Angiosperms lack source of nutrition for the embryo.
(*b*) Female gametophyte of angiosperms is the smallest.
(*c*) Triple fusion takes place in angiosperms.
(*d*) None of these

(*ii*) Filiform apparatus performs the function of

(*a*) opening the pollen tube
(*b*) guiding the pollen tube to egg
(*c*) entry of pollen tube into synergids
(*d*) preventing growth of multiple pollen tubes

(*iii*) Double fertilisation refers to

(*a*) fusion of male gametes twice within an embryo sac
(*b*) syngamy as well as triple fusion
(*c*) fusion of one male gamete with the two polar nuclei
(*d*) both (*a*) and (*b*)

(*iv*) Pollen tube enters into embryo sac through

(*a*) micropylar end (*b*) chalazal end
(*c*) integument (*d*) all of these

(v) The growing pollen tube which reaches to ovule consist of

(*a*) two male gametes and one tube nucleus

(*b*) one male gamete and two vegetative nuclei

(*c*) one male gamete and one tube nucleus

(*d*) two male gametes, one vegetative nucleus and one tube nucleus

Answers

1. (*i*) (*c*) Triple fusion takes place in angiosperms
   (*ii*) (*b*) Guiding pollen tube to egg
   (*iii*) (*d*) Both (*a*) and (*b*)
   (*iv*) (*a*) Micropylar end
   (*v*) (*a*) Two male gametes and one tube nucleus.

2. Read the following and answer the questions given below:

SEEDS

In angiosperms, the seed is the final product of sexual reproduction. It is often described as fertilised ovule. As seeds develop, the ovary develops into fruits, hence seeds remain enclosed within fruit. A seed typically consists of seed coat, cotyledon and an embryo axis. The cotyledons are simple structure generally thick and swollen due to storage of food reserves. Mature seeds may be albuminous or non-albuminous. Non-albuminous seeds have no residual endosperm as it is completely consumed during embryonic development (*e.g.*, pea, groundnut). Albuminous seeds retain a part of endosperm as it is not completely used up during embryonic development (*e.g.*, wheat, maize, barley, castor, sunflower). Occasionally in some seeds such as black pepper and beet, remnants of nucellus are also persistent. This residual, persistent nucellus is perisperm.

(i) Which of the following seeds possess perisperm?

(*a*) Pea (*b*) Groundnut

(*c*) Wheat (*d*) Beet

(ii) Which of the following plant seeds are non-albuminous?

(*a*) Beet (*b*) Wheat

(*c*) Groundnut (*d*) Castor

(iii) Cotyledons of a seed perform a function of

(*a*) protection to the axis (*b*) development of axis

(*c*) storage of food reserve (*d*) storage of water

(iv) Percentage of moisture in a dry seed is

(*a*) zero (*b*) 10–15

(*c*) 20–30 (*d*) 50

(v) The perispermic seed possess

(*a*) endosperm (*b*) persistent nucellus

(*c*) dead cells (*d*) embryo

Answers

2. (*i*) (*d*) Beet (*ii*) (*c*) Groundnut
   (*iii*) (*c*) Storage of food reserve (*iv*) (*b*) 10–15
   (*v*) (*b*) Persistent nucellus

3. Read the following and answer the questions given below:

HYDROPHILY

Hydrophily is the mode of pollination taking place with the agency of water. In hydrophilous plants, flowers are small and inconspicuous, with perianth and other floral parts being unwettable. These flower lack nectar glands and also lack any odour. Pollen grains are elongated, ribbon like, light and unwettable due to presence of mucilage cover. Stigma is long, sticky but unwettable. Hydrophily occurs in about 30 genera which are mostly monocotyledonous, *e.g.*, *Vallisneria*, *Zostera*, *Ceratophyllum*, etc. In many aquatic plants with emergent flowers, pollination occurs by wind or insects, *e.g.*, Lotus, Water lily, Water Hyacinth. Hydrophily is of two types—epihydrophily and hypohydrophily. Epihydrophily takes place on water surface. *Zostera* and Ceratophyllum are hypohydrophilous while *Vallisneria* is epihydrophilous. In case of hypohydrophilous condition, the pollen grains have same specific gravity as that of water.

(*i*) Which of the following characters of pollen grain is not present in hydrophilous plants?

(*a*) Pollen grains are ribbon like.
(*b*) Pollen grains are light and unwettable.
(*c*) Pollen grains possess mucilaginous covering.
(d) Pollen grains possess pollenkit.

(*ii*) In which of the following plants, epihydrophily takes place?

(*a*) *Zostera* (*b*) *Vallisneria*
(*c*) *Hydrilla* (*d*) Lotus

(*iii*) Which of the following aquatic plants lack hydrophily?

(*a*) *Vallisneria* (*b*) *Zostera*
(*c*) Lotus (*d*) *Ceratophyllum*

(*iv*) Which of the following hydrophilous plants is marine in nature?

(*a*) *Vallisneria* (*b*) *Ceratophylum*
(*c*) *Hydrilla* (*d*) *Zostera*

(*v*) Which of the following characters are not present in water pollinated flowers?

(*a*) Inconspicuous (*b*) Odourless
(*c*) Without nectories (*d*) Brightly coloured

Answers

3. (*i*) (*d*) Pollen grains possess pollenkit. (*ii*) (*b*) *Vallisneria*
(*iii*) (*c*) Lotus (*iv*) (*d*) *Zostera*
(*v*) (*d*) Brightly coloured

4. Read the following and answer the questions given below:

AUTOGAMY

Autogamy is the type of pollination achieved within the same flower. It is the transfer of pollen grains from anther to stigma of the same flower. In a normal flower which opens and exposes the anthers and stigma, complete autogamy is rather rare. Autogamy in such flowers requires synchrony in pollen release and stigma receptivity, and also, the anthers and the stigma should lie close to each other so that self pollination can occur. Some plants such as *Viola*, *Oxalis* and *Commelina* produces two types of flowers—chasmogamous, the flowers that open at maturity with exposed anthers and stigma, and cleistogamous flowers which do not open at all. In such flowers, the anther and stigma lie close to each other. When anther dehisces the pollen grains come in contact with the stigma to effect pollination. Thus, cleistogamous flowers are invariably autogamous as there is no chance of cross-pollen landing on the stigma. Cleistogamous flowers produce assured seed-set even in the absence of pollinators.

(*i*) Chasmogamous flowers are the characteristic of

(*a*) *Commelina* (*b*) Pea

(*c*) *Viola* (*d*) All of these

(*ii*) Which of the following statement(s) is true regarding chasmogamous flowers?

(*a*) They are usually self pollinated. (*b*) They have more chances of cross pollination.

(*c*) They are mostly autogamous. (*d*) They are mostly geitonogamous.

(*iii*) Cleistogamous flowers do not ensure

(*a*) assured seed set (*b*) no wastage of materials

(*c*) variations (*d*) pollens

(*iv*) Which of the following statement(s) is correct regarding autogamous flowers?

(*a*) They may be considered as cleistogamous flowers.

(*b*) They may be considered as geitonogamous flowers.

(*c*) Plants are dioecious.

(*d*) Plants are monoecious.

(*v*) Which of the following is possible in cleistogamous flowers?

(*a*) Autogamy (*b*) Geitonogamy

(*c*) Xenogamy (*d*) Cross-pollination

Answers

4. (*i*) (*d*) All of these

(*ii*) (*b*) Chasmogamous flowers are open flowers with exposed stamens and stigma which facilitate cross pollination.

(*iii*) (*c*) Variations are not introduced in the progeny.

(*iv*) (*a*) Autogamous flowers may be considered as cleistogamous flowers.

(*v*) (*a*) Autogamy

ASSERTION-REASON QUESTIONS

In the following questions a statement of assertion followed by a statement of reason is given. Choose the correct answer out of the following choices.

(a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

(b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

(c) Assertion is correct statement but reason is wrong statement.

(d) Assertion is wrong statement but reason is correct statement.

1. **Assertion** : The endosperm of angiosperms is generally triploid ($3n$).
   Reason : It develops from primary endosperm nucleus formed by fusion of haploid male gamete and diploid secondary nucleus.
2. **Assertion** : Dictogamy refers to maturation of male and female sex organs at different times.
   Reason : This is a safeguard against cross-fertilisation.
3. **Assertion** : Megaspore mother cell undergoes meiosis to produce four megaspores.
   Reason : Megaspore mother cell and megaspores are both haploid.

4. **Assertion** : Entomophilous plants produce less pollen when compared to anemophilous plants.
   Reason : The wastage of pollen is reduced to the minimum in entomophilous plants because of the directional pollination.
5. **Assertion** : The structure of a typical microsporangium in angiosperms consists of four wall layers—epidermis, endothecium, middle layers and tapetum.
   Reason : The function of outer three wall layers is protection and also help in dehiscence of anther to release pollen.
6. **Assertion** : A pollen grain can withstand harsh conditions.
   Reason : The exine of pollen grains is made up of sporopollenin which is resistant to high temperatures, strong acids or alkali as well as enzymatic degradation.
7. **Assertion** : In plants, apomixis is a type of asexual reproduction that mimics sexual reproduction.
   Reason : In apomixis seeds are produced without the fusion of gametes.
8. **Assertion** : In coconut, the water represents the free nuclear endosperm and the white kernel represents the cellular endosperm.
   Reason : PEN undergoes a number of free nuclear divisions which are followed by wall formation.
9. **Assertion** : In monosporic type of embryo development, megaspore is situated towards the micropylar end and remains functional.
   Reason : In monosporic development the embryo sac develops from a single functional megaspore.
10. **Assertion** : Microspore is the first cell of male gametophyte.
    Reason : It is diploid in nature.

Answers

1. (*a*) **2.** (*c*) **3.** (*c*) **4.** (*b*) **5.** (*b*) **6.** (*a*) **7.** (*a*) **8.** (*c*)
9. (*d*) **10.** (*c*)

HINTS/EXPLANATIONS OF SELECTED MCQs

28. (*b*) Microsporangium is circular and is generally surrounded by wall layers namely, epidermis, endothecium, 2 or 3 middle layers and tapetum. The middle layers and the innermost layer (tapetum), nourishes the developing pollen grains. When the anther is young, a group of compactly arranged homogenous cells called sporogenous tissues occupies the centre of each microsporangium. This tissue gives rise to pollen mother cells. Each pollen mother cell undergoes meiosis to form four pollen grains.

31. (*d*) Exine is the hard-outer layer of pollen grains, made up of sporopollenin. It is one of the most resistant organic material as it can withstand high temperature, strong acids and alkali. It cannot be degraded by enzymes. That is why, pollen grains are well-preserved as fossils.

33. (*d*) A filiform apparatus made of cellular thickening of synergids at the micropylar end, plays an important role in guiding the pollen tubes into the synergid.

34. (*a*) Pollination is the transfer of pollen grains from anther to the stigma of a pistil. It is of three types based on the source of pollen namely, autogamy, geitonogamy and xenogamy. Autogamy is the transfer of pollen grains from anther to the stigma of the same flower, geitonogamy is the transfer of pollen grains from anther to the stigma of another flower of same plant and xenogamy is the transfer of pollen grains from anther to the stigma of s different plant's flower.

35. (*b*) The flowers which contain both male and female reproductive organs are known as full or bisexual flowers. They will self-pollinate themselves. **Examples:** Tulip, Sunflower and Lily.

All other options represent the outbreeding devices which promote cross pollination.

36. (*b*) During artificial hybridisation, emasculated flowers are covered with a suitable bag made up of butter paper to prevent contamination of its stigma with unwanted pollen and this process is called bagging.

39. (*b*) The fusion of nucleus of haploid (n) male gamete with the diploid ($2n$) secondary nucleus of female gamete leads to the formation of triploid ($3n$) endosperm cell. It is also called triple fusion. Endosperm helps in embryo nourishment.

Female = '$8n$' number of chromosomes

Male = '$4n$' number of chromosomes

Female gamete or ploidy of egg = $4n$

Male gamete or ploidy of sperm = $2n$

During zygote formation, male and female gametes fusion takes place, $4n + 2n = 6n$

For endosperm formation, 2 polar nuclei + 1 male gamete = $8n + 2n = 10n$.

So, the correct option is '$10n$'.

40. (*b*) Plants like *Viola, Oxalis* and *Commelina* produce two types of flowers namely, chasmogamous and cleistogamous. Cleistogamous flowers do not open at all. Anther and stigma of these flowers lie close to each other to effect self -pollination and there is no chance of cross pollination in such flowers.

41. (*b*) To produce 20 seeds, 20 male gametes must be fused with 20 female gametes. To find the correct number, we have to consider meiotic divisions required for both the male and the female gamete formation.

1 female gamete is formed by 1 meiotic division. Remaining three cells degenerate to provide nutrition to the female gamete (egg cell). So, for 20 seeds, 20 female gametes have to be formed. So, there will be 20 meiotic divisions in case of female gamete formation.

Now, 1 meiotic division is required to produce 4 male gametes. So, in order to make 20 male gametes, there will be 5 meiotic divisions. In total there would be 20 + 5 = 25 meiotic divisions are required to produce 20 seeds.

42. (*a*) Flowers of water hyacinth are pollinated by insects and flowers of Yucca are pollinated by moth, so both of these are entomophilous flowers while *Vallisneria* is hydrophilous flower.

44. (*b*) The given diagram represents the typical embryo sac (female gametophyte) of flowering plants, which is eight nucleate but seven-celled. In the given diagram, P is denoting the egg and Q is denoting the antipodals of embryo sac.

45. (*c*) Apomixis means the production of seeds without fertilisation and occurrence of more than one embryo in a seed is called as polyembryony.

In some seeds like black pepper, beet etc., the remnant of nucellus is also present. It is called perisperm.

In the grass family, the cotyledon is called scutellum which is situated lateral to the embryonal axis.

46. (*b*) Megaspore mother cell of megasporangium undergoes meiosis and forms megaspore tetrad, out of which, one megaspore is functional. Central cell of embryo sac is the large cell consisting of two polar nuclei. Synergids, the flanking cells of the egg cell, have finger-like projections of the wall in their cytoplasm, the filiform apparatus. An embryo sac has three antipodal cells which provide nutrition to the developing embryo.

47. (*b*) Double fertilisation process is the characteristic of flowering plants in which one sperm cell of a pollen grain fertilises an egg cell while second one fuses with two polar nuclei to produce a triploid endosperm.

50. (*a*) In dioecious plants like papaya, the male and female flowers are present on different plants, preventing both autogamy and geitonogamy.

51. (*b*) The tender coconut water is a free-nuclear endosperm which is made up of thousands of nuclei and the surrounding white kernel is the cellular endosperm.

52. (*d*) Insect-pollinated flowers are generally large, colourful, fragrant and rich in nectar.

53. (*b*) All other terms except synergids are related to pollen grains while synergids cells are located in the female gametophyte.

54. (*c*) The given figure represents a stage of embryo development in a dicot plant and label "A" in the given figure denotes the cotyledon. It is the store house of reserve food material.

55. (*a*) In *Vallisneria,* the female flowers reach the surface of water by the long stalk and the male flowers or pollen grains are released on to the surface of water. These male flowers or pollen grains are carried by water currents and reach the female flowers.

56. (*c*) The endosperm is a tissue produced inside the seeds of most of the flowering plants following fertilisation. It is triploid in most species and it surrounds the embryo to provide it nutrition.

57. (*d*) A meiocyte is a type of cell that differentiates into a gamete through the process of meiosis. Through meiosis, the diploid meiocyte divides into four genetically different haploid gametes. If the number of chromosomes in meiocyte is 24 then each haploid gamete will contain 12 chromosomes. Therefore, the number of chromosomes in its endosperm will be 36 ($3n$) because the endosperm in angiosperms is triploid ($3n$) as it is formed by the fusion of two polar nuclei and one gamete.

58. (*a*) In orange seed, embryo originate by adventive embryony where an embryo develops directly from a diploid cell other than egg like that of nucellus and integument, *e.g., Citrus, Opuntia.* It gives rise to a condition called polyembryony or the phenomenon of having more than one embryo.

59. (*c*) The common functions that cotyledons and nucellus perform is nourishment as cotyledons nourish embryo and nucellus nourishes embryo sac.

60. (*a*) If a haploid gamete (n) contains 10 chromosomes. The number of chromosomes in its endosperm will be ($n \times 3$) *i.e.*, $10 \times 3 = 30$ because the endosperm in angiosperms is triploid ($3n$) as it is formed by the fusion of two polar nuclei and one gamete.

61. (*d*) Self-incompatibility is a mechanism that prevents pollen from one flower from fertilising other flowers of the same plant. In self-incompatible plants, when a pollen grain lands on a style expressing the same allele, pollen tube growth is stopped or retarded and there is no delivery of sperm to the ovary.

62. (*b*) The mucilaginous covering is present in pollen grains of water-pollinated species to offers them protection from water.

65. (*d*) Each microsporangium has 500 microspore mother cells which form 2000 microspores by meiosis (500×4).

In an anther, there are four microsporangia. So, the total number of microspores will be $4 \times 2000 = 8000$.

As each microspore forms one male gametophyte, 8000 male gametophytes can be produced by this anther.

66. (*d*) In dicots, embryo formation starts after a certain amount of endosperm is formed. Zygote divides by mitosis to form a proembryo. Later on, formation of globular and heart-shaped embryo occurs, which finally becomes horse shoe-shaped and forms a mature embryo.

69. (*a*) In dioecious plants like papaya, the male and female flowers are present on different plants, that is why cross-pollination is must in such plants.

73. (*d*) The microsporangia, which are usually bilobed, are pollen sacs in which the microspores develop into pollen grains.

74. (*d*) Plants like *Viola, Oxalis* and *Commelina* produce two types of flowers namely, chasmogamous and cleistogamous. Cleistogamous flowers do not open at all.

75. (*c*) When the anther is young, a group of compactly arranged homogenous cells called sporogenous tissues occupies the centre of each microsporangium. This tissue gives rise to pollen mother cells. Each pollen mother cell undergoes meiosis to form four pollen grains.

76. (*a*) A sporogenous tissue contain the diploid microspore mother cells. These spore mother cells present in the sporogenous tissue divide meiotically to form the haploid microspores that arrange themselves in a tetrad fashion.

79. (*d*) Exine is the hard-outer layer of pollen grains, made up of sporopollenin. It is one of the most resistant organic material as it can withstand high temperature, strong acids, alkali and it cannot be degraded by enzymes.

81. (*c*) One or more thin areas present in the exine of pollen grains are known as germ pores. 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. There are usually three germ pores in dicots (tricolpate) and one in monocots (monocolpate).

83. (*b*) A pollen grain is partly germinated microspore representing the male gametophyte. It divides by unequal mitotic division and forms two cells. Thus, each mature pollen grain in angiosperms have a generative cell and a vegetative cell. In about 60% of angiosperms, pollen grains are shed at this 2-celled stage.

84. (*b*) A matured pollen grain contains two cells namely, vegetative and generative cell. The vegetative cell is the bigger cell having abundant food reserve and a large irregularly shaped nucleus while generative cell is smaller, spindle shaped and it floats in the cytoplasm of the vegetative cell.

85. (*b*) A matured pollen grain contains two cells namely, vegetative and generative cell. The vegetative cell is the bigger cell having abundant food reserve and a large irregularly shaped nucleus while generative cell is smaller, spindle shaped and it floats in the cytoplasm of the vegetative cell.

87. (*d*) *Parthenium hysterophorus* is an aggressive ubiquitous annual herbaceous weed with no economic importance. This weed produces as much as 3,000 million pollen grains per square meter during the flowering season. They may cause allergic type reactions like asthma, skin rashes, puffy eyes, peeling skin, eczema, running nose, swelling and itching of mouth and nose, etc.

89. (*c*) Pollen grains can be stored for several years in liquid nitrogen at a temperature of –196°C and this is known as cryopreservation.

92. (*b*) Stigma is the upper most part of female reproductive part and serves as the landing platform for the pollen grains. Stigma shows chemotropic movement because of the presence of sugary substance.

95. (*d*) The ovule is a small structure attached to the placenta by means of a stalk called funicle. The body of the ovule fuses with funicle in the region called hilum. Thus, hilum represents the junction between ovule and funicle.

96. (*d*) Ovule is equivalent to megasporangium. Ovule is also called integumented megasporangium. It is present inside the ovary that is attached to placenta. It has a single embryo sac that is formed from a megaspore through reduction division.

97. (*b*) Within the walls of an ovule, there is a mass of cells called nucellus which contain reserve food materials. Inside the nucellus, it is the embryo sac, which is also called female gametophyte.

99. (*b*) When the female gametophyte (embryo sac) develops from a single megaspore, it is called monosporic development.

101. (*b*) The matured embryo sac consists of four cell types; the egg cell and the two synergids at the micropylar end, the antipodals at the chalazal end and the central cell containing the two polar nuclei and a large central vacuole.

103. (*c*) Pollination helps in meeting of reproductive units of plants that are male gamete and female gamete.

104. (*d*) Autogamy is possible only when anther and stigma are close together and there is synchrony in pollen release and stigma receptivity. As in case of cleistogamy, the flowers remain closed so that anthers and stigmas are never exposed. The flowers undergo only self-pollination. No external pollinating agency is required.

105. (*b*) Archesporium is a cell or cell structure in a sporophyte from which spores may later develop during the alternate generation. Archesporium cell divides into the primary parietal cell which later forms the anther wall and primary sporogenous cells which form the microspore mother cell.

106. (*b*) Geitonogamy is the type of pollination where the flower is pollinated by another flower of the same plant.

107. (*d*) The pollen grains of anemophilous flowers are light and non-sticky so that they can be transported via wind currents.

108. (*d*) Water lily is aquatic plant yet show entomophily as it has waxy, bowl -shaped flower to float on water. Secondly, its coloured flowers attract insects. Therefore, in spite of being an aquatic plant, its pollination is entomophilous. It grows on the surface of water.

109. (*a*) All grasses are wind pollinated. Grasses are angiosperms or flowering plants. They do not have all the flowering structures or the flowering structures that grasses have are smaller than flowering plants that draw insect pollinators.

110. (*c*) The mucilaginous covering is present in pollen grains of water-pollinated species to offer them protection from water.

112. (*c*) Emasculation is the process of removing anthers from bisexual flowers without affecting the female reproductive part (pistil). It is performed by plant breeders in bisexual flowers to obtain the desired variety of a plant by crossing a particular plant with the desired pollen grain.

113. (*b*) The process of double fertilisation occurs in angiosperms. Here, one of the 2 male gametes fuses with the egg nucleus and forms a diploid zygote (in a process called syngamy). The other male gamete pushes further into the embryo sac and fuses with the secondary nucleus and gives rise to a triploid nucleus called the primary endosperm nucleus (in a process called triple fusion).

114. (*a*) In dicots, embryo formation starts after a certain amount of endosperm is formed. Zygote divides by mitosis to form a proembryo. Later on, formation of globular and heart-shaped embryo occurs, which finally becomes horse shoe-shaped and forms a mature embryo.