Sexual Reproduction in Flowering Plants

Previous Years' CBSE Board Questions

1.2 Pre-fertilisation: Structures and Events

Stamen, Microsporangium and Pollen grain

MCQ

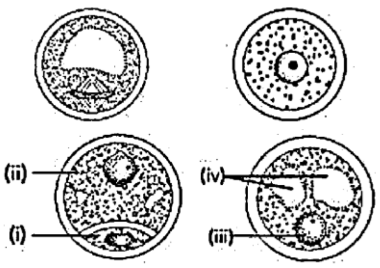
1. A group of compactly arranged homogenous mass of cells occupying the centre of a typical microsporangium in an anther is ___________.

(a) sporogenous tissue (b) pollen sacs

(c) microspore tetrads (d) spores.

(Term-1, 2021-22)

2. The figures of the developmental stage of a microspore into a mature pollen grain are given below. Choose the option showing the correct labellings for (i), (ii), (iii) and (iv).



	(i)	(ii)	(iii)	(iv)
(a)	Generative cell	Vegetative cell	Male gametes	Vacuoles
(b)	Vegetative cell	Generative cell	Vacuoles	Male gametes
(c)	Generative cell	Vegetative cell	Nucleus	Vacuoles
(d)	Vegetative cell	Generative cell	Vacuoles	Nucleus

(Term-1, 2021-22)

VSA (1 mark)

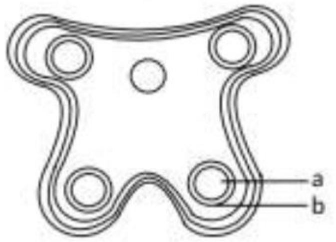
3. Give an example of a plant which came into India as a contaminant and is a cause of pollen allergy. **(AI 2014)**

SA I (2 marks)

4. (a) Explain the process of the development of a male gametophyte in an angiosperm.

(b) Why is it called a male gametophyte?
(2023)

5. In the T.S. of a mature anther given below, identify "a" and "b" and mention their functions.



(AI 2019)

6. A pollen grain in angiosperm at the time of dehiscence from an anther could be 2-celled or 3-celled. Explain. How are the cells placed within the pollen grain when shed at a 2-celled stage?

(Al 2017)

7. Name the organic materials exine and intine of an angiosperm pollen grain are made up of. Explain the role of exine.
(Delhi 2014)

8. Draw a diagram of a matured microspore of an angiosperm. Label its cellular components only.

(Foreign 2014)

SA II (3 marks)

9. Draw a schematic transverse section of a mature anther of an angiosperm. Label its epidermis, middle layers, tapetum, endothecium, sporogenous tissue and the connective. **(2020)**

10. Where are the following structures present in a male gametophyte of an angiosperm? Mention the function of each one of them.

(a) Germ pore (b) Sporopollenin (c) Generative cell

(2019)

11. (a) Name the organic material exine of the pollen grain is made up of. How is this material advantageous to pollen grain?

(b) Still it is observed that it does not form a continuous layer around the pollen grain. Give reason.

(c) How are 'pollen banks' useful?

(AI 2016)

12. Why are angiosperm anthers called dithecous? Describe the structure of its microsporangium.

(AI 2014)

LA (5 marks)

13. (a) Where does microsporogenesis occur in an angiosperm? Describe the process of

microsporogenesis.

(b) Draw a labelled diagram of the two celled male gametophyte of an angiosperm. How is a three celled male gametophyte different from it?

(2020)

14. Trace the development of a 2-celled pollen grain of an angiosperm within an anther.

Draw a labelled diagram to substantiate your answer. **(2020)**

15. (a) Name the specific part in the anther and the process responsible for the development of a male gametophyte in an angiosperm.

(b) Draw a labelled diagram of a mature male gametophyte (3-celled) of an angiosperm. Write the functions of each labelled part. **(2020C)**

16. (a) Draw a labelled diagram of the sectional view of microsporangium of an angiosperm.

(b) Explain the development of male gametophyte in the microsporangium.
(Delhi 2015C)

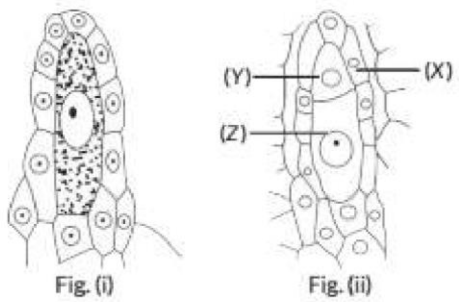
17. (a) Describe the sequence of the process of microsporogenesis in angiosperms.

(b) Draw a labelled diagram of a two celled final structure formed.
(Delhi 2015C)

Pistil, Megasporangium and Embryo sac

MCQ

18. Figure (i) and figure (ii) given below are showing two stages of megasporogenesis in a typical angiosperm plant.



Choose the option showing the correct ploidy of X, Y and Z in the table given below.

	X	Y	Z
(a)	2n	n	2n
(b)	2n	n	n
(c)	2n	3n	n
(d)	3n	2n	n

(Term-1, 2021-22)

19. Which one of the following is not found in a female gametophyte of an angiosperm?

(a) Germ pore

(b) Synergids

(c) Filiform apparatus

(d) Central cell

(2020)

VSA (1 mark)

20.

These pictures show the gynoecium of (A) Papaver and (B) Michelia flowers. Write the difference in the structure of their ovaries.

(NCERT Exemplar, Delhi 2015C)

21. State the function of filiform apparatus found in mature embryo sac of an angiosperm.

(Foreign 2014)

SA I (2 marks)

22. A mature embryo sac in flowering plant may possess 7-cells, but 8-nuclei. Explain with the help of diagram only.
(NCERT Exemplar, Delhi 2017)

23. Gynoecium of a flower may be apocarpous or syncarpous. Explain with the help of an example each.
(Al 2016)

SA II (3 marks)

24. (a) Draw a L.S. of pistil showing pollen tube entering into the embryo sac. Label the following:

(i) Nucellus (ii) Antipodals

(iii) Synergids (iv) Micropyle

(b) Write the functions of the following:

(i) Synergids (ii) Micropyle
(AI 2019)

25. Draw a labelled diagram of a typical anatropous ovule.
(NCERT, Delhi 2014)

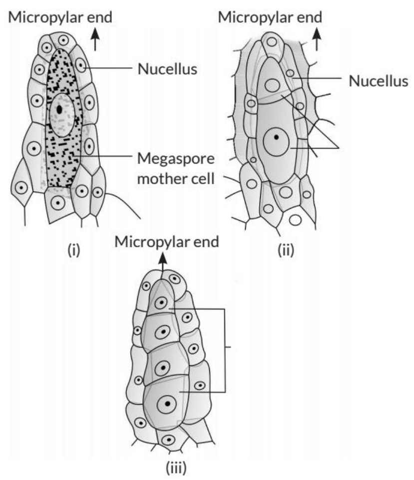
LA (5 marks)

26. (i) Explain the monosporic development of embryo sac in the ovule of an angiosperm.

(ii) Draw a diagram of the mature embryo sac of an angiospermic ovule and label any four parts in it.

(2023)

27. Study the figures given below of the development of megaspore in an angiosperm and answer the questions that follow:



(i) Describe the developmental events in the nucellus of the ovule. What is this type of development of megaspore referred to as ?

(ii) How many free nuclear mitotic divisions will the functional megaspore undergo to form a mature embryo sac?

(iii) Describe the structure of a typical female gametophyte of a flowering plant
(2021C)

28. Where does the process of megasporogenesis start in an angiosperm? Describe the process upto the formation of embryo sac.
(Delhi 2019)

OR

Describe the process of megasporogenesis upto fully developed embryo sac formation in an angiosperm.
(AI 2019)

Pollination

MCQ

29. Select the plant species, where emasculation is not required for artificial hybridisation experiment.

(a) Castor (b) Maize

(c) Papaya (d) Wheat
(Term-1, 2021-22)

30. Which of the given statements are correct with respect to pollination in Vallisneria?

(i) Pollen grains are light and non-sticky.

(ii) Female flowers reach the surface of water by long stalks.

(iii) Pollen grains are carried passively by water currents.

(iv) Female flowers remain submerged in water.

Choose the correct option.

(a) (i) and (iv) (b) (ii) and (iv)

(c) (i) and (ii) (d) (ii) and (iii)
(Term-1, 2021-22)

31. Self-pollination is fully ensured if

(a) the flower is bisexual

(b) the style is longer than the filament

(c) the flower is cleistogamous

(d) the time of pistil and anther maturity is different.
(2020)

32. Cleistogamous flowers are self-pollinated because

(a) they are bisexual flowers which do not open at all

(b) they are bisexual and open flowers

(c) they are unisexual

(d) their stigma mature before anthers dehisce.
(2020)

VSA (1 mark)

33. Name the part of the flower which the tassels of the corn-cob represent.
(AI 2014)

34. What is pollen-pistil interaction and how is it mediated?
(Foreign 2014)

35. Differentiate between xenogamy and geitonogamy.
(1/3, AI 2014C)

SA I (2 marks)

36. Explain the mechanism of pollination in marine sea-grasses like Zostera.
(2021C)

37. Mention the advantages of emasculation and bagging in artificial hybridisation in plants bearing unisexual and bisexual flowers.
(2020)

38. What is 'bagging'? State its importance in artificial hybridisation of flowering plants. **(2020C)**

39. Express the process of pollination in Vallisneria.
(Delhi 2019)

40. What is cleistogamy? Write one advantage and one disadvantage of it, to the plant. **(AI 2019)**

41. List the different types of pollination depending upon the source of pollen grain.

(2/5, Delhi 2016)

42. Angiosperms bearing unisexual flowers are said to be either monoecious or dioecious. Explain with the help of one example of each.
(Delhi 2016)

43. A single pea plant in your kitchen garden produces pods with viable seeds, but the individual papaya plant does not. Explain.
(Al 2016)

38. What is 'bagging'? State its importance in artificial hybridisation of flowering plants. **(2020C)**

39. Express the process of pollination in Vallisneria.
(Delhi 2019)

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(Delhi 2016)

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(Al 2016)

44. Why do hermaphrodite angiosperms develop outbreeding devices? Explain any two such devices with the help of examples.
(AI 2015C)

SA II (3 marks)

45. One of the major approaches of crop improvement programme is artificial hybridisation. Explain the steps involved in making sure that only the desired pollen grain pollinate the stigma of a bisexual flower by a plant breeder.
(2023)

46. Draw a longitudinal section of the pistil from a flowering plant where pollination has occurred. Label the following:

(a) Stigma showing germinating pollen grains.

(b) Style

(c) Pollen tube reaching the micropyle of the ovule.

(d) Embryo sac

(e) Components of the egg apparatus.
(2020)

47. Explain three different modes of pollination that can occur in a chasmogamous flower. **(2020)**

48. Differentiate between wind pollinated and insect pollinated flowers.
(2020)

OR

Write the differences between wind-pollinated and insect-pollinated flowers. Give an example of each type.
(Foreign 2014)

49. (a) Differentiate between geitonogamy and xenogamy.

(b) Write the difference in the characteristics of the progeny produced as a result of the two processes.
(Delhi 2019)

50. Emasculation and bagging are the two important steps carried during artificial hybridisation to obtain superior varieties of desired plants. Explain giving reasons, in which types of flowers and at what stages are the two processes carried out. **(Al 2019)**

51. (a) Can a plant flowering in Mumbai be pollinated by pollen grains of the same species growing in New Delhi? Provide explanations to your answer.

(b) Draw the diagram of a pistil where pollination has successfully occurred. Label the parts involved in reaching the male gametes to its desired destination.
(Al 2017)

52. Make a list of any three outbreeding devices that flowering plants have developed and explain how they help to encourage cross-pollination.
(Al 2014)

LA (5 marks)

53. Angiosperm flowers may be monoecious, cleistogamous or show self-incompatibility. Describe the characteristic features of each one of them and state which one of these flowers promotes inbreeding and outbreeding respectively.
(Delhi 2014C)

54. (a) Describe the formation of mature female gametophyte within an ovule in angiosperms.

(b) Describe the structure of the cell(s) that guide(s) the pollen tube to enter the embryo sac.

(AI 2014C)

55. (a) Draw a longitudinal section of a pistil of an angiosperm showing the growth of the pollen tube up to the micropyle of the ovule.

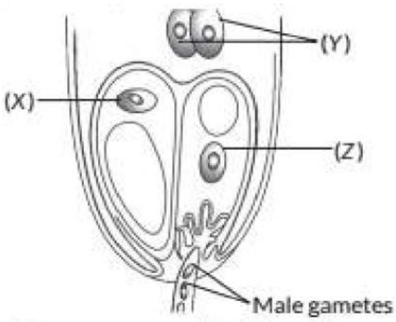
Label (i) stigma, (ii) embryo sac, (iii) pollen tube, (iv) micropyle.

(b) Explain the events that occur, upto fertilisation, when the compatible pollen grain lands on the stigma.
(Al 2014C)

1.3 Double Fertilisation

MCQ

56. The given figure of an egg apparatus of an angiosperm shows the entry of pollen tube for releasing the two male gametes. Which of the two from 'X, 'Y' and 'Z', the two male gametes fuse with?



(a) X and Z
(b) X and Y
(c) Y and Z
(d) Z and Z

(Term-1, 2021-22)

SA I (2 marks)

57. Draw a diagram of a fertilised embryo sac of a dicot flower. Label all its cellular components.

(Delhi 2015C)

SA II (3 marks)

58. Explain double fertilisation in an angiosperm. (2020)

OR

Explain the phenomenon of double fertilisation.
(3/5, Al 2014)

LA (5 marks)

59. (a) Describe any two devices in a flowering plant which prevent both autogamy and geitonogamy.

(b) Explain the events upto double fertilisation after the pollen tube enters one of the synergids in an ovule of an angiosperm.
(2018)

1.4 Post-fertilisation: Structures and Events

Endosperm

MCQ

60. Select the correct statements with respect to the development of an endosperm in a typical angiosperm plant.

(i) Embryo development precedes endosperm development.

(ii) Endosperm cells divide repeatedly to form a triploid endosperm.

(iii) Endosperm tissue has scanty reserves of food materials.

(iv) PEN undergoes successive division to form free-nuclear endosperm.

Choose the correct option.

(a) (i) and (iii) (b) (ii) and (iii)

(c) (i) and (iv) (d) (ii) and (iv)

(Term-1, 2021-22)

SA I (2 marks)

61. Write the difference between the tender coconut water and the thick white kernel of a mature coconut and their ploidy.
(AI 2015C)

SA II (3 marks)

62. Describe the development of endosperm after double fertilisation in an angiosperm. Why does endosperm development precedes that of zygote?
(Delhi 2015)

63. List the post-fertilisation events in angiosperms.
(Delhi 2014)

LA (5 marks)

64. (a) Draw a diagram of a fully developed embryo sac of an angiosperm. Label its chalazal end and any other five parts within the embryo sac.

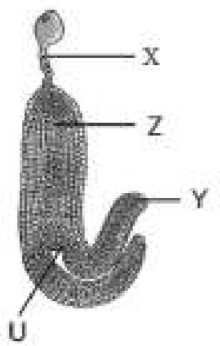
(b) Why does the development of an endosperm precede that of the embryo in angiosperm?

(c) Number of chromosomes in an onion plant cell is 16. Name the cells of the embryo sac having 16 and 24 chromosomes formed after fertilisation.
(2020)

Embryo

MCQ

65. Select the option that shows the correctly identified 'U, X, 'Y' and 'Z' in a developing dicot embryo.



(a) X-Plumule (2n), Y - Suspensor (n), Z-Cotyledon (2n), U - Radicle (2n).

(b) X-Plumule (2n), Y - Suspensor (2n), Z-Radicle (2n), U-Cotyledon (2n).

(c) X-Suspensor (2n), Y-Cotyledon (2n), Z-Radicle (2n), U - Plumule (2n).

(d) X-Cotyledon (2n), Y- Radicle (n), Z-Plumule (n), U - Suspensor (n).
(2023)

VSA (1 mark)

66. Mention the function of coleorhiza.
(Delhi 2015C)

SAI (2 marks)

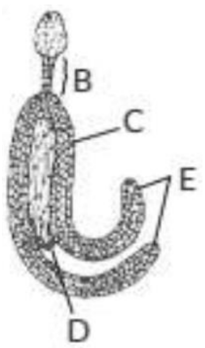
67. Draw a labelled mature stage of a dicotyledonous embryo.
(2/5, Al 2014)

OR

Draw a labelled diagram of a matured embryo of a dicotyledonous plant.
(AI 2014C)

SA II (3 marks)

68. (a) Identify the figure given below and also identify the parts B, C, D and E.



(b) State the function of E.
(2020)

69. Draw a diagram of L.S. of an embryo of grass and label any six parts. (2019C)

70. Explain the development of a mature embryo from the embryo sac of dicot flower.

(NCERT Exemplar, Delhi 2015C)

Seed

MCQ

71. Match the correct structures given in column I with the fruit in column II in the given chart:

Column I (Structure)		Column II (Fruit)	
P.	Perisperm	i.	Maize
Q.	Thalamus	ii.	Black pepper
R.	Pericarp	iii.	Strawberry
S.	Endosperm	iv.	Mango

(a) P-i, Q-ii, R-iii, S-ii

(c) P-iii, Q-i, R-i, S-iii

(b) P-ii, Q-iii, R-iv, S-I

(d) P-iv, Q-i, R-ii, S-iv **(2023)**

72. Endosperm is completely consumed by the developing embryo in ____________.

(a) castor and coconut

(b) coconut and groundnut

(c) groundnut and pea

(d) castor and pea.

(Term-1, 2021-22)

73. The floral part that develops into a fruit in strawberry is ____________.

(a) pedicel

(b) calyx

(c) thalamus

(d) bracts.

(Term-1, 2021-22)

74. In which of the following combinations of seeds/grains of different plants, residual endosperm will be present at maturity?

(a) Groundnut, Barley, Beans

(b) Castor, Groundnut, Maize

(c) Wheat, Maize, Barley

(d) Pea, Groundnut, Beans

(Term-1, 2021-22)

VSA (1 mark)

75. Differentiate between parthenogenesis and parthenocarpy.

(1/3, AI 2014C)

SAI (2 marks)

76. (a) You are given castor and bean seeds. Which one of the two would you select to observe the endosperm?

(b) The development of endosperm precedes that of embryo in plants. Justify.

(2019)

77. A non biology person is quite shocked to know that apple is a false fruit, mango is a true fruit and banana is a seedless fruit. As a biology student how would you satisfy this person? **(Delhi 2015)**

78. Banana fruit is said to be parthenocarpic whereas turkey is said to be parthenogenetic. Why?

(Delhi 2015C)

79. Some angiosperm seeds are said to be 'albuminous', whereas few others are said to have a perisperm. Explain each with the help of an example.

(Foreign 2014)

80. Banana crop is cultivated by farmers without sowing of seeds. Explain how the plant is propagated.
(Delhi 2014C)

SA II (3 marks)

81. Draw a diagram of LS of Maize grain and label it's any six parts.
(2019)

82. Differentiate between parthenocarpy and parthenogenesis. Give one example of each. **(2018)**

83. Explain the post-pollination events leading to seed production in angiosperms. **(Delhi 2016)**

84. Double fertilisation is reported in plants of both castor and groundnut. However, the mature seeds of groundnut are non-albuminous and castor are albuminous. Explain the post fertilisation events that are responsible for it.
(Delhi 2015)

OR

Name the two end products of double fertilisation in angiosperms. How are they formed? Write their fate during the development of seed.
(Delhi 2014C)

85. Explain any three advantages the seeds offer to angiosperms.
(Delhi 2014)

LA (5 marks)

86. (i) Double fertilisation is an event unique to all flowering plants. Explain the process.

(ii) Give a reason for the following:

(1) A seed of an orange has many embryos.

(2) Cashew is a false fruit but guava is a true fruit.
(2023)

87. (a) Describe the process of double fertilisation in angiosperms.

(b) Trace the development of polyploidal cell that is formed after double fertilisation in a non-albuminous seed and albuminous seed.
(2020)

88. Read the following statement and answer the questions that follow: "A guava fruit has 200 viable seeds."

(a) What are viable seeds?

(b) Write the total number of:

(i) Pollen grains

(ii) Gametes

in producing 200 viable guava seeds.

(c) Prepare a flow chart to depict the post-pollination events leading to viable-seed production in a flowering plant.
(Delhi 2017)

89. A flower of tomato plant following the process of sexual reproduction produces 200 viable seeds.

Answer the following questions giving reasons.

(a) What would have been the minimum number of ovules present in per pollinated pistil?

(b) How many microspore mother cells would minimally be required to produce requisite number of pollen grains?

(c) How many pollen grains must have minimally pollinated the carpel?

(d) How many male gametes would have used to produce these 200 viable seeds?

(e) How many megaspore mother cells were required in this process?
(Delhi 2015)

90. A flower of brinjal plant following the process of sexual reproduction produces 360 viable seeds.

Answer the following questions giving reasons:

(a) How many ovules are minimally involved?

(b) How many megaspore mother cells are involved?

(c) What is the minimum number of pollen grains that must land on stigma for pollination?

(d) How many male gametes are involved in the above case?

(e) How many microspore mother cells must have undergone reduction division prior to dehiscence of anther in the above case?
(Delhi 2015)

91. (a) Explain the events after pollination leading to the formation of a seed in angiosperms.

(b) Mention the ploidy levels of the cells of different parts of an albuminous seed.
(Foreign 2015)

1.5 Apomixis and Polyembryony

MCQ

92. Seeds of an orange when taken out and squeezed, show many embryos of different sizes and shapes.

The reason for this is as many embryos have developed from

(a) egg cells fusing with different male gametes forming embryos

(b) PEN fusing with different male gametes forming embryos

(c) nucellar cells dividing and developing into embryos

(d) synergids dividing and developing into embryos.
(Term-1, 2021-22)

VSA (1 mark)

93. Mention advantage of apomictic seeds to farmers.
(AI 2014)

SAI (2 marks)

94. State two advantages of an apomictic seed to a farmer.
(2020)

OR

Suggest the advantage to a farmer for using apomictic seeds of hybrid varieties.
(Foreign 2015)

95. It is said apomixis is a type of asexual reproduction. Justify.
(2019)

96. What is apomixis? How is the phenomenon useful to the farmer? **(NCERT, Foreign 2015)**

97. Explain the different ways apomictic seed can develop. Give an example of each. **(2/5, AI 2014)**

98. (a) Why are seeds of some grasses called apomictic? Explain.

(b) State two reasons to convince a farmer to use an apomictic crop. **(AI 2014C)**

SA II (3 marks)

99. State what is apomixis. Write its significance. How can it be commercially used? **(AI 2019, 2015)**

100. (a) How is apomixis different from parthenocarpy?

(b) Describe any two modes by which apomictic seeds can be produced. **(AI 2014C)**

LA (5 marks)

101. (a) When a seed of an orange is squeezed, many embryos, instead of one are observed. Explain how it is possible.

(b) Are these embryos genetically similar or different? Comment. **(Al 2017)**

CBSE Sample Questions

1.2 Pre-fertilisation: Structures and Events

Stamen, Microsporangium and Pollen grain

MCQ

1. The structure of bilobed anther consists of __________.

(a) 2 thecae, 2 sporangia

(b) 4 thecae, 4 sporangia

(c) 4 thecae, 2 sporangia

(d) 2 thecae, 4 sporangia. **(Term-1, 2021-22)**

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

(a) sporopollenin

(b) cellulose

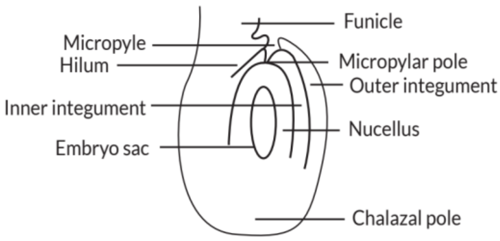
(c) lignocellulose

(d) pectocellulose.
(Term-1, 2021-22)

Pistil, Megasporangium and Embryo sac

MCQ

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



	Number of cells at chalazal end	Number of cells at micropylar end	Number of nuclei left in central cell
(a)	3	2	3
(b)	3	3	2
(c)	2	3	3
(d)	2	2	4

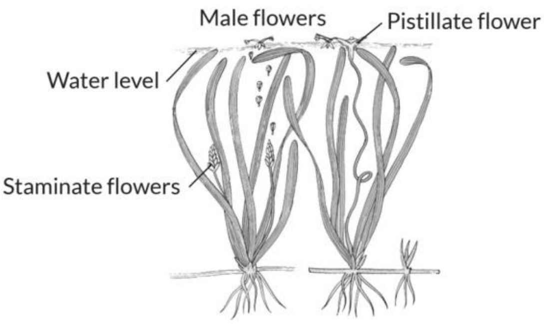
(Term-1, 2021-22)

LA (5 marks)

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

MCQ

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



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

(Term-1, 2021-22)

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

Which of the following will be correct?

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

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

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

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

(Term-1, 2021-22)

VSA (1 mark)

7. How does pollination take place in water hyacinth and water lily?
(2020-21)

SA II (3 marks)

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

(a) Corn (b) Water hyacinth (c) Vallisneria
(2022-23)

MCQ

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

(a) antipodal, zygote and endosperm

(b) zygote, nucellus and endosperm

(c) endosperm, nucellus and zygote

(d) antipodals, synergids and integuments. (Term-1, 2021-22)

1.4 Post-fertilisation: Structures and Events

Endosperm

MCQ

10. The coconut water from tender coconut is ______________ .

(a) cellular endosperm

(b) free nuclear endosperm

(c) both cellular and nuclear endosperm

(d) free nuclear embryo.
(Term-1, 2021-22)

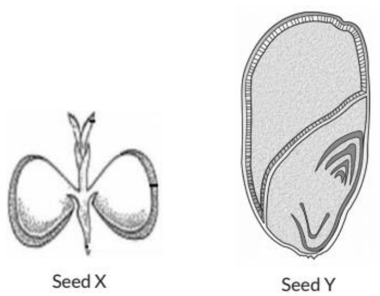
VSA (1 mark)

11. Why does endosperm development precede embryo development?
(2020-21)

Embryo

MCQ

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



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

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

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

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

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

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

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

(Term-1, 2021-22)

13. The thalamus contributes to the fruit formation in ____________.

(a) banana (b) orange

(c) strawberry (d) guava.

(Term-1, 2021-22)

VSA (1 mark)

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

1.5 Apomixis and Polyembryony

MCQ

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

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

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

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

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

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

(2022-23)

Detailed SOLUTIONS

Previous Years' CBSE Board Questions

1. (a): When the anther is young, a group of compactly arranged homogenous cells called the sporogenous tissue occupies the centre of each microsporangium.

2. (c): (i)-Generative cell, (ii)-Vegetative cell, (iii)-Nucleus, (iv)-Vacuoles

3. Parthenium or carrot grass is an example of a plant which came to India as a contaminant with imported wheat and is a major contributor to pollen allergy.

4. (a) The cells of the sporogenous tissue undergo meiotic divisions to form microspore tetrads as the anther develops. As the anther mature and dehydrate, the microspores dissociate from each other and develop into pollen grains which represents the male gametophyte. Pollen grains are released with the dehiscence of anther.

(b) Male gametophyte is called so because it produces male gametes for fertilisation.

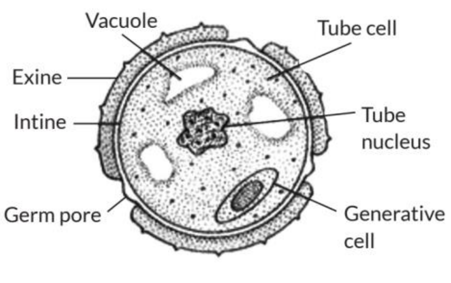
5. In the given figure, 'a' represents sporogenous tissue and 'b' represents tapetum.

Functions: Sporogenous tissue (a) fills the whole interior of the microsporangium. Its cells divide with the growth of anther and increase their number. Ultimately, they are transformed into microspore or pollen mother cells (PMC). Microspore mother cells undergo meiosis to produce haploid microspores or pollen grains. Tapetum (b) helps in nourishment of the developing microspore mother cells and pollen grains. It also produces lipid rich Ubisch granules containing sporopollenin for exine formation.

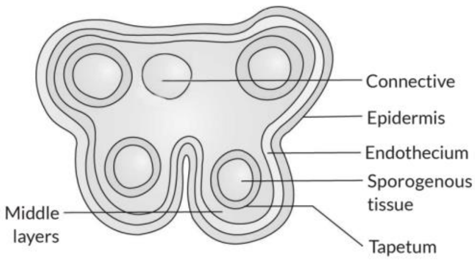
6. At the time of dehiscence, a pollen grain in angiosperm could be 2-celled when it contains one tube cell and one generative cell or it could be 3-celled when the generative cell divides mitotically to give rise to the two male gametes, and hence, one tube cell and two male gametes make pollen grain a 3-celled structure. At 2-celled stage, one small generative cell and one large tube cell is placed within the pollen grains.

7. Exine is the outer tough and resistant layer of pollen grains made up of sporopollenin. Intine is thin continuous and inner wall of the pollen grain which is made up of cellulose and pectin. Exine provides protection to pollen grain during its hazardous journey from anther of one flower to the stigma of another flower. Due to presence of sporopollenin in exine, pollens of past are well preserved as fossil in soil and sediments enabling the scientists to study pollen structure and pollination pattern of angiosperms of past.

8. Labelled diagram of mature microspore (or pollen grain) is as follows:



9. Labelled diagram of a mature anther of an angiosperm is as follows:



10. (a) Germ pore is present on exine of pollen grains. It is the place where exine and sporopollenin is absent. The contents of the pollen grain move into the pollen tube throughthegermpore.

(b) Sporopollenin is present on the outer surface of pollen grains. Sporopollenin is one of the most resistant organic materials known. It can withstand high temperatures and strong acids and alkali. No enzyme that degrades sporopollenin is so far known.

(c) Generative cell is one of the two cells present inside the pollen grain which mitotically produce two male gametes beforepollengrainsareshedat3-celledstage.

11. (a) Exineis made up of a highly resistant fatty substance called sporopollenin. Sporopollenin is highly protective layer not degraded by any enzyme. It is not affected by high temperature, strong acid or strong alkali. Because of sporopollenin, exine provides protection during the hazardous journey of pollen from anther to stigma. Also, pollen grains are well preserved as microfossils and protected from external adversities due to the presence of sporopollenin.

(b) Exine of pollen grain is not a continuous layer. It bears prominent apertures called germ pores. These are the places from where intine comes out as pollen tube, which carries male gametes required for fertilisation in angiosperms. If the exine is present as a continuous layer, it would render the formation of pollen tube.

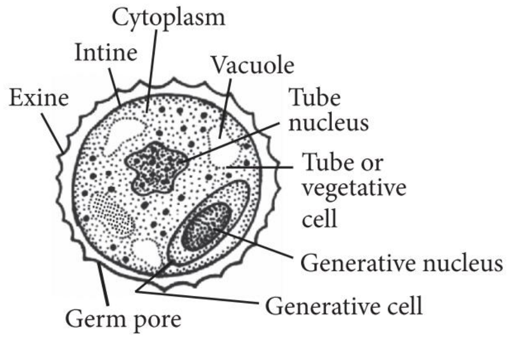
(c) Pollen banks are used to store pollen grains for long time, which can be used in plant breeding programmes. In pollen banks, pollens are stored in liquid nitrogen at a temperature of -196°C.

12. Angiosperm anthers consist of two anther lobes therefore are called dithecous. A microsporangium or pollen sac is a cylindrical sac which appears circular in transverse section. It consists of two parts, outer wall and central homogenous sporogenous tissue. Microsporangial wall has four types of layers - epidermis (common anther covering), endothecium, 1-3 middle layers and tapetum. The outer three perform the function of protection in the young anther and help in dehiscence of the mature anther to release pollen. The innermost wall layer is tapetum that nourishes the developing pollen grains. Sporogenous tissue occupies the centre of each microsporangium which undergo meiotic division to form microspore tetrads.

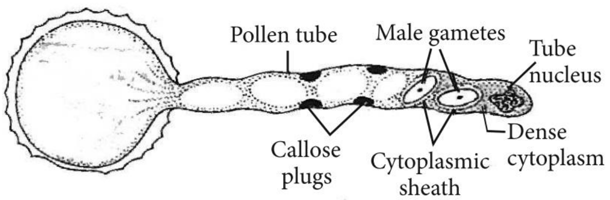
13. (a) Microsporogenesis occurs inside the anther of a flower.

In an anther, each cell of the sporogenous tissue is a potential pollen or microspore mother cell (PMC). Each PMC divides by meiosis to form a microspore tetrad. This process is called microsporogenesis. As the anthers mature and dehydrate, the microspores dissociate from each other and develop into pollen grains.

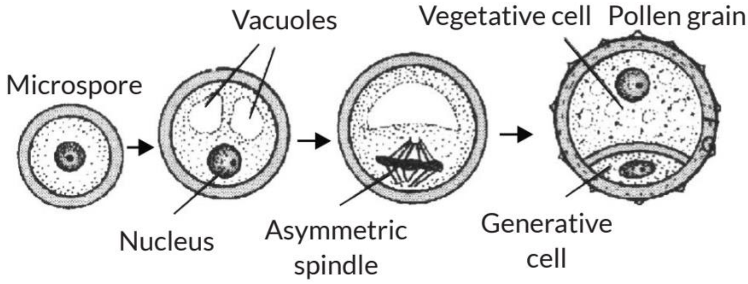
(b) Given below is the labelled diagram of a 2 celled male gametophyte or pollen grain.



At the time of germination, a pollen tube is formed and generative nucleus divides to form two male gametes which migrate into the pollen tube. This is known as 3-celled pollen grain or male gametophyte.

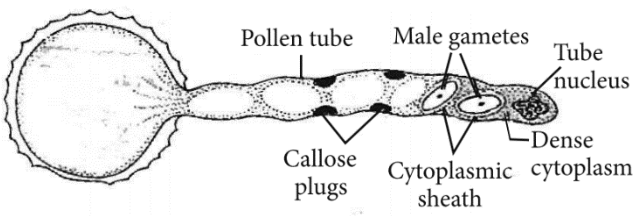


14. In an anther, each cell of the sporogenous tissue is a potential pollen or microspore mother cell (PMC). Each PMC divides by meiosis to form a microspore tetrad. This process is called microsporogenesis. As the anthers mature and dehydrate, the microspores dissociate from each other and develop into pollen grains. The hard outer layer called the exine is made up of sporopollenin. The inner wall of the pollen grain is called the intine. When the pollen grain is mature it contains two cells, the vegetative cell and the generative cell. Different stages of microsporogenesis after microspore formation are shown as:



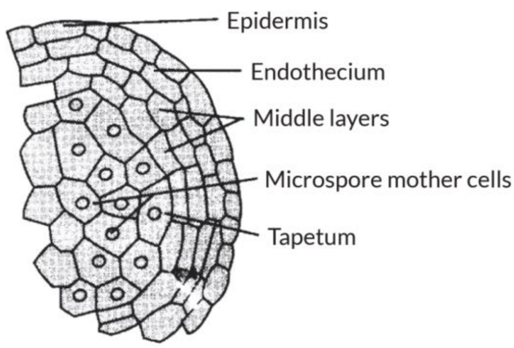
15. (a) The cells of the sporogenous tissue undergo meiotic divisions to form microspore tetrads, as the anther develops. Each cell of the sporogenous tissue is capable of giving rise to a microspore tetrad. Each one is a potential pollen or microspore mother cell. The process of formation of microspores from a pollen mother cell (PMC) through meiosis is called microsporogenesis.

(b)



The vegetative tube cell is bigger and has abundant food reserve. The pollen tube releases the two male gametes into the cytoplasm of the synergid after entering one of the synergids. One of the male gametes moves towards the egg cell and fuses with its nucleus leading to the formation of a diploid cell, the 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).

16. (a) Sectional view of microsporangium of an angiosperm is as follows:



(b) Pollen grain or microspore is the first cell of male gametophyte and represents immature male gametophyte. Development of male gametophyte is precocious, i.e., it begins inside the microsporangium or pollen sac.

Young pollen grain has a centrally placed nucleus embedded in dense cytoplasm covered by plasma membrane. It grows in size with the inflow of nutrients. The protoplast of the pollen grain divides mitotically to form two unequal cells -

smaller generative cell and larger tube or vegetative cell. A layer of callose develops around the generative cell which separates the cell from the pollen wall.

Later on, callose dissolves and the naked generative cell comes to lie freely in the cytoplasm of the tube cell. The tube cell has vacuolated cytoplasm which is rich in the food reserve and cell organelles. Its nucleus becomes large and irregular. The generative cell is spindle shaped to spherical in outline with thin dense cytoplasm surrounding a prominent nucleus.

In some species, the generative cell divides into two non-motile male gametes prior to the dehiscence of anther and release of the pollen grains. Therefore, at the time of pollination, the pollen grain is either 2-celled or 3-celled.

17. (a) Refer to answer 14.

(b) Refer to answer 8.

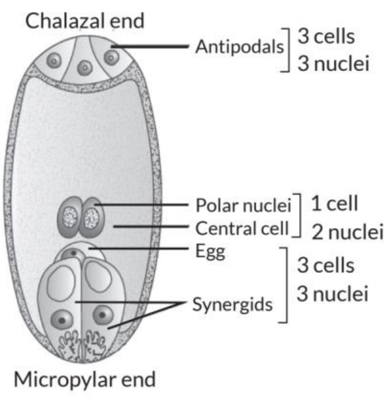
18. (b): In the given figure, X is nucellus and Y and Z are megaspore dyad. Ploidy of nucellus is 2n. When megaspore mother cell (MMC) undergoes meiosis-l, Le, reductional division, it results in production of two haploid (n) megaspores.

19. (a)

20. The gynoecium of Papaver is multicarpellary and syncarpous (carpels fused) whereas the gynoecium of Michelia is multicarpellary and apocarpous (carpels free). In Papaver, ovary is unilocular to multilocular whereas in Michelia, ovary is always unilocular.

21. Filiform apparatus refers finger-like projections which arise from cell wall of the synergid and penetrate into the cytoplasm of the central cell. These are present at the micropylar tip of synergids. They play an important role in distribution of nutrients in the embryo sac, secretion of substances that attract pollen tube thereby guiding the pollen tube into synergid and also provide mechanical strength to synergids.

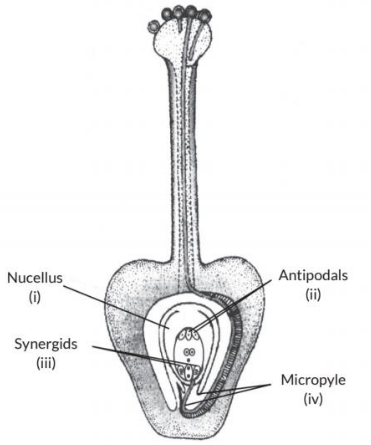
22. Diagrammatic representation of a mature embryo sac is as follows:



It is clear from the above diagram that a mature embryo sac contains 7-cells and 8-nuclei.

23. Gynoecium represents the female reproductive part of a flower. Gynoecium is called apocarpous if the carpels are free, e.g., Michelia and it is called as syncarpous if the carpels are fused, e.g., Papaver (poppy).

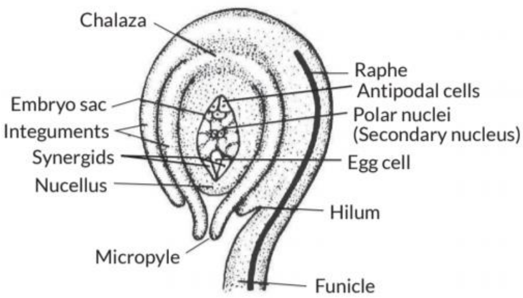
24. (a) Longitudinal section of pistil showing growth of pollen tube is given below:



(b) (i) Synergids help in obtaining nourishment from the outer nucellar cells, guide the path of pollen tube by their secretion and function as shock absorbers during the penetration of pollen tube into the embryo sac.

(ii) Micropyle plays an important role in fertilisation as the pollen tube enters the ovule through micropyle. It also helps in the germination of seed. The oxygen and water enter the seed at the time of germination through micropyle.

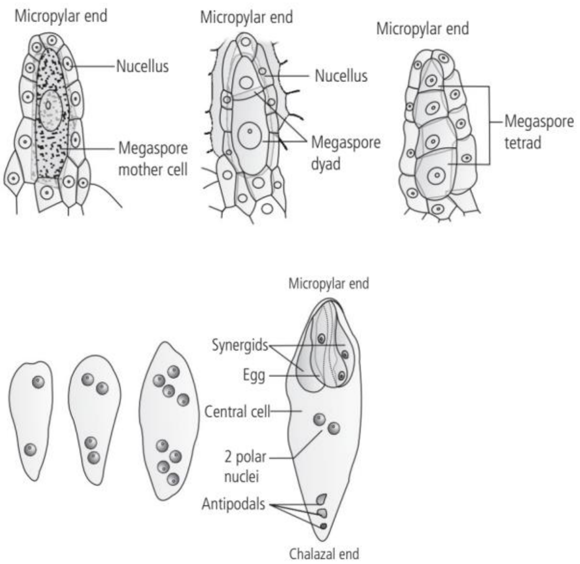
25. Sectional view of anatropous ovule is given as follows:



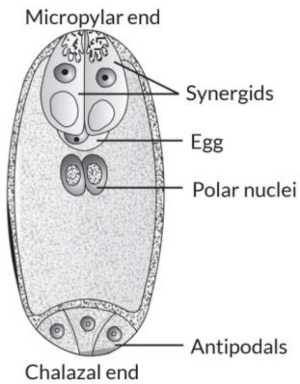
26. (i) In a majority of flowering plants, monosporic development of embryo sac occurs in which one of the megaspores is functional while the other three degenerate. Only the functional megaspore develops into the female gametophyte (embryo sac). The nucleus of the functional megaspore divides mitotically to form two nuclei which move to the opposite poles, forming the 2-nucleate embryo sac. Two more sequential mitotic nuclear divisions result in the formation of the 4-nucleate and later the 8-nucleate stages of the embryo sac.

These 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 or embryo sac. Six of the eight nuclei are surrounded by cell walls and organised into cells; the remaining two nuclei, called polar nuclei are situated below the egg apparatus in the large central cell.

The diagrammatic representation of the monosporic development of embryo sac in the ovule of an angiosperm is as follows:



(ii) A diagram of the mature embryo sac of an angiospermic ovule is as follows:



27. (i) Megasporogenesis is the formation of megaspore (n) from megaspore mother cell (2n) inside the ovule by the process of meiosis. In the hypodermal region of nucellus towards the micropylar end develops a primary archesporial cell. The primary archesporial cell divides periclinally to form outer parietal cell and inner sporogenous cell. The sporogenous cell functions as megaspore mother cell (MMC). The MMC undergoes meiotic division and produce four haploid megaspores. One of the megaspore is functional while other three degenerate. The functional megaspore develops into female gametophyte (embryo sac). This method of embryo sac development from a single megaspore is termed monosporic development.

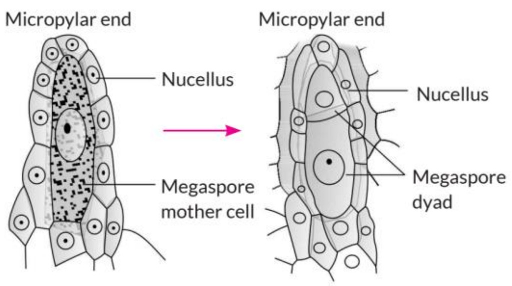
(ii) The nucleus of the functional megaspore divides mitotically to form two nuclei which moves to opposite poles, forming 2 nucleate embryo sac. Two more sequential mitotic nuclear divisions result in the formation of the 4-nucleate and later the 8-nucleate stages of the embryo sac. After the 8-nucleate stage, cell walls are laid down leading to the organisation of the typical female gametophyte or embryo sac. Hence, a total of three mitotic divisions in megaspore results in mature embryo sac.

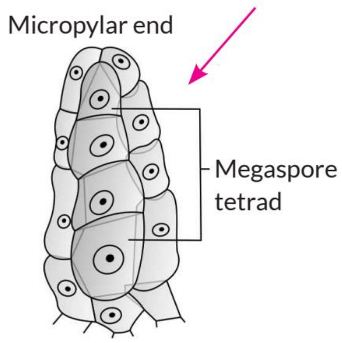
(iii) Female gametophyte of angiosperms is also called embryo sac. A typical female gametophyte is monosporic and Polygonum type. It has four nuclei at the micropylar end and four nuclei at the chalazal end. Three nuclei at the micropylar end organize into egg apparatus consisting of an egg cell and two synergids and one nucleus migrate towards the centre. It is called polar nucleus. Similarly, three nuclei at chalazal end organize into three antipodal cells and one polar nucleus migrates towards the centre.

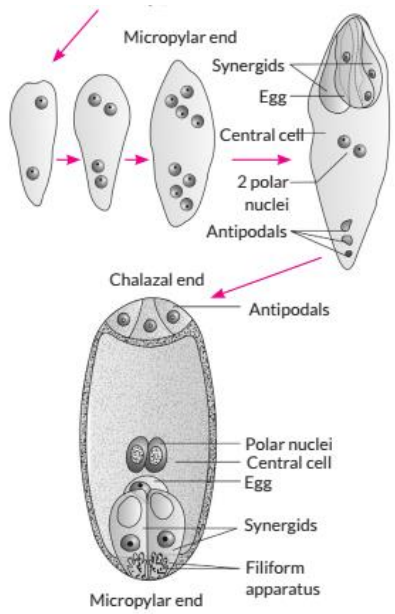
Thus, a mature female gametophyte has egg apparatus, (2 synergids and 1 egg cell) three antipodal cells and two polar nuclei. Thus, a typical angiosperm embryo sac, at maturity, though 8-nucleate is 7-celled.

28. The process of formation of megaspores from the megaspore mother cell is called megasporogenesis. It starts inside the nucellus of developing ovule of angiosperms.

Megasporogenesis is the formation of megaspore (n) from megaspore mother cell (2n) inside the ovule by the process of meiosis. In the hypodermal region of nucellus towards the micropylar end develops a primary archesporial cell. The primary archesporial cell divides periclinally to form outer parietal cell and inner sporogenous cell. The sporogenous cell functions as megaspore mother cell (MMC). The MMC undergoes meiotic division and produce four haploid megaspores. One of the megaspore is functional while other three degenerate. Different stages in the formation of embryo sac from functional megaspore are represented diagrammatically as follows:







The functional megaspore is the first cell of female gametophyte or embryo sac. The nucleus of megaspore divides by mitosis into eight daughter nuclei. Two polar nuclei are present in centre which further fuse to form a secondary nucleus. After fertilisation with a male gamete, it produces triploid endosperm. Three nuclei at the base of embryo sac form antipodal cells. The remaining three nuclei at the micropylar end constitute egg apparatus, which consists of two cells known as synergids or help cells and an egg cell or oosphere. The egg cell on fusing with one male gamete (fertilisation) gives rise to zygote.

29. (c): Emasculation is not required when female parent produces unisexual flowers. Castor, maize and wheat produces bisexual flowers while papaya produces unisexual flowers.

30. (d): Pollen grains are light and non-sticky in wind-pollinated plants. In marine plants like seagrasses, female flowers remain submerged in water and pollen grains are released inside the water.

31. (c): Self-pollination is fully ensured if the flower is cleistogamous as the flowers do not open at all. Thus, anthers and stigma lie close to each other.

32. (a)

33. Tassels of corn-cob represent female part of the flower which is style and stigma.

34. Pollen-pistil interaction is the group of events that occur from the time of pollen deposition over the stigma to the time of pollen tube entry into ovule. The dialogue between pollen grain and the pistil is mediated by chemical components of the pollen interacting with those of the pistil. The pistil has the ability to recognise the pollen, whether it is of the right type (compatible) or of the wrong type (incompatible). This is followed by its acceptance or rejection.

35. Differences between geitonogamy and xenogamy are as follows:

S.No.	Geitonogamy	Xenogamy
(i)	It is pollination between two flowers of the same plant.	It is pollination between two flowers of different plants.
(ii)	The flowers are genetically similar.	The flowers are genetically different.

36. Pollination in Zostera is accomplished through water. The female flowers remain submerged in water and pollen grains are released inside the water. Pollen grains in such species are long, ribbon-like and they are carried passively inside the water, some of them reach the stigma and achieve pollination.

37. Emasculation is removal of stamens from floral buds of female parents. A breeder needs to emasculate a flower to eliminate the chances of self-pollination. If flowers are unisexual, there is no need of emasculation.

Bagging is the protection of emasculated flower from contamination by undesirable pollen grains. Here, the flowers are masked by a bag, till the stigma attains receptivity. In unisexual flowers, bagging is done before flowers are open. Both emasculation and bagging ensure that the female flower is completely protected from contamination. When the stigma of bagged flower attains receptivity, mature pollen grains collected from anthers of desired male parent are dusted on the stigma and flowers are rebagged till the desired result is obtained.

38. Bagging is a plant breeding technique in which the stigma of a flower is covered with bags. In this technique, the anthers of a bisexual flower are removed and the flower is wrapped with paper bags or butter paper till the flowers attain receptivity. Once the flower attains stigma receptivity, the desired pollens are dusted on the stigma. This is resealed to allow fruits to develop. Bagging ensures that the female flower is completely protected from contamination.

Hence, artificial hybridisation ensures that the right type of pollen has been transferred to the stigma of the flower. In addition, the chance of fertilisation is high. Through this approach, a variety of crops can be developed and it improves the quality of crop with desirable characters.

39. Pollination in Vallisneria is accomplished through water. The female flower reaches the surface of water by the long stalk and the male flowers or pollen grains are released on to the surface of water. They are carried passively by water currents and some of them eventually reach the female flowers and the stigma. Pollen grains are covered by mucilage which helps them in sticking to stigma as well as protects them from wetting by water. After pollination, the female flower is pulled inside water by the coiling of its stalk.

40. Cleistogamy is the condition where pollination occurs in closed flowers that do not open at all. In such flowers, the anthers and stigma lie close to each other.

An advantage of cleistogamy is that seed setting is assured even in the absence of pollinators as pollen on maturity will always reach the stigma due to their close placement.

A disadvantage of cleistogamy is that it does not allow cross pollination, thereby restricting chances of genetic variability.

41. Based on the source of pollen grain, pollination can be of following three types:

(i) Autogamy: Autogamy (self-pollination) is the transfer of pollen grains from anther to the stigma of the same flower.

(ii) Geitonogamy: It is the transfer of pollen grains from the anther of one flower to the stigma of another flower on the same plant. Geitonogamy is functionally cross-pollination involving a pollinating agent but genetically it is equivalent to autogamy since the pollen grains come from the same plant.

(iii) Xenogamy: It is the transfer of pollen grains from anther to the stigma of different plants of same species. It brings genetically different types of pollen grains to the stigma.

42. Unisexual flowers are flowers bearing either male or female reproductive structures. Male flower is staminate, i.e., bearing stamens while female flower is pistillate i.e., bearing pistils. In some flowering plants, both male and female flowers are present on same plant.

Such plants are referred to as monoecious, e.g., cucurbits. In some plants, unisexual male and female flowers are present on separate plants. Such plants are referred to as dioecious, e.g., papaya.

43. Pea plant has bisexual flowers, i.e., male and female in the same flower. Therefore, it undergoes self-pollination. Thus, a single pea plant can produce viable seeds after pollination and fertilisation.

However, a papaya plant is dioecious plant i.e., bearing male and female flowers on different plants and requires cross pollination for production of viable seeds. Thus, in absence of either stamens or pistils, fertilisation will not take place and hence viable seeds will not be produced.

44. Hermaphrodite angiosperms develop outbreeding devices to avoid self-pollination and encourage cross pollination. Two outbreeding devices which ensure cross pollination are as follows:

(i) Dichogamy: Anthers and stigmas mature at different times in a bisexual flower. It is of two types:

(a) Protandry: Anthers mature earlier than stigma of the same flower. Their pollen grains become available to stigmas of the older flowers, e.g., Sunflower, Salvia.

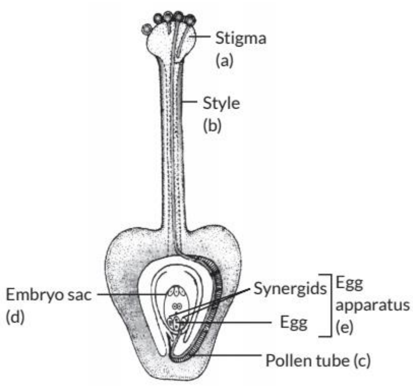
(b) Protogyny: Stigmas mature earlier so that they get pollinated before the anthers of the same flower develop pollen grains, e.g., Mirabilis jalapa, Gloriosa, Plantago.

(ii) Self sterility (Self incompatibility): Pollen grains of a flower do not germinate on the stigma of the same flower due to presence of similar self-sterile gene (S, S, in pistil and S, or S, in pollen grain) e.g., tobacco, potato, crucifers.

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

Emasculation is the removal of the anthers of a bisexual flower in order to prevent self-pollination. Bagging involves covering of emasculated flowers by butter paper or polythene in order to protect them from contamination by foreign or undesirable pollen. When the stigma of bagged flower attains receptivity, mature pollen grains collected from anthers of the male parent are dusted on the stigma, and the flowers are rebagged, to obtain desired fruits.

46. Longitudinal section of post pollinated pistil showing entry of pollen tube into a mature embryo sac is shown as follows:



47. A chasmogamous flower can undergo

(i) Self-pollination or autogamy: Here pollens of a flower fertilise the stigma of the same flower.

(ii) Geitonogamy: Here pollens of one flower fertilise the stigma of another flower present on the same plant.

(iii) Xenogamy or cross pollination: Here pollens of one flower fertilise the stigma of another flower present on different plant of same species.

48. Differences between anemophilous (wind pollinated) and entomophilous (insect pollinated) flowers are as follows:

S.No.	Wind pollinated flowers	Insect pollinated flowers
(i)	Flowers are small.	Flowers are either large or if small they are grouped to form inflorescence.
(ii)	Flowers are inconspicuous due to the absence of bright colours.	Flowers are usually gaudy due to the presence of bright colours in corolla, sepals, bracts, etc.
(iii)	They are odourless.	Odour is commonly present.
(iv)	The flowers are devoid of nectar and edible pollen.	The flowers usually possess nectar and edible pollen.
(v)	Sepals and petals are either indistinguishable or absent.	Sepals and petals are commonly well developed.
(vi)	Anthers are usually exserted.	Anthers are usually inserted.
(vii)	Pollen grains are produced in very large number.	Pollen grains are fewer.
(viii)	Pollen grains are light and unwettable.	Pollen grains are heavier and sticky.
(ix)	Pollination is non-directional.	Pollination is specific and directional.
(x)	Stigmas are exserted.	Stigmas are commonly inserted.
(xi)	Stigmas are branched or hairy to catch wind borne pollen grains. *E.g.*, maize, many grasses, etc.	Stigmas are usually unbranched and sticky. *E.g.*, *Rafflesia*, *Mimosa*.

(Any six)

49. (a) Refer to answer 35.

(b) Geitonogamy produces genetically identical offspring as two flowers come from the same plant while in xenogamy genetic variability among the offspring is high as two flowers come from two different plants.

Therefore, the progeny obtained from the process of xenogamy give higher yield with better varieties and advanced characters than that of the progeny obtained by geitonogamy.

50. Emasculation is removal of male sex organs (anther) from the floral buds of bisexual flower (possess both stamen and pistil). A breeder needs to emasculate a bisexual flower to eliminate the chances of self-pollination.

Breeder needs to remove anthers from the flower bud before the anther dehisces using a pair of forceps. Dehiscence results in the release of pollen which may then reach the stigma (part of pistil) and lead to germination of pollen grain.

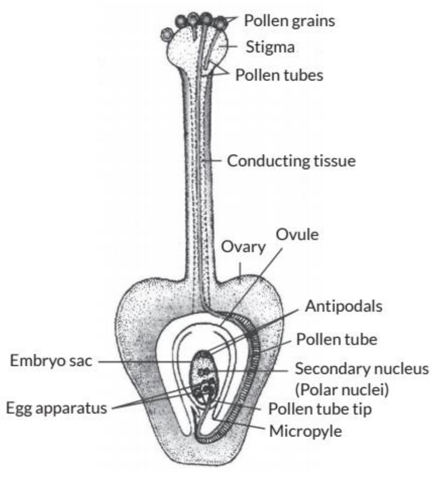
Bagging is the covering of flowers by butter paper or polythene. Bagging can be done in both bisexual and unisexual flowers. In the case of bisexual flowers emasculation in followed by bagging.

Emasculated flowers must be kept covered by bags to prevent from contamination by unwanted pollen grains.

51. (a) Yes, a plant flowering in Mumbai can be pollinated by pollen grains of the same species of flower growing in New Delhi. This can be done by preserving the pollen grains and bringing them from New Delhi to Mumbai.

Now, with the help of artificial hybridisation techniques, the pollen grains are dusted over the pistil to complete the process of pollination.

(b) Longitudinal section of pistil showing the parts involved in reaching the male gamete to desired destination and shown below as



52. The three outbreeding devices that flowering plants have developed are as follows:

(i) Dicliny (Unisexuality): Flowers are unisexual so that self-pollination is not possible. The plants may be monoecious (bearing both male and female flowers on same plant, e.g., maize) or dioecious (bearing male and female flowers on different plants, e.g., mulberry, papaya).

(ii) Dichogamy: Anthers and stigmas mature at different times in a bisexual flower so as to prevent self-pollination.

(a) Protandry: Anthers mature earlier than stigma of the same flower. Their pollen grains become available to stigmas of the older flowers, e.g., sunflower, Salvia.

(b) Protogyny Stigmas mature earlier so that they get pollinated before the anthers of the same flower develop pollen grains, e.g., Mirabilis jalapa, Gloriosa, Plantago.

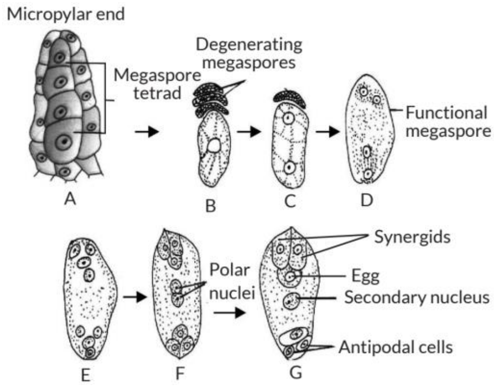
(iii) Heterostyly: There are 2 or 3 types of flowers with different heights of styles (and stamens), e.g., In diheterostyly (dimorphic heterostyly), there are two types of flowers, pin eyed (long style and short stamens) and thrum eyed (short style and long stamens), e.g., Primula (primrose), jasmine. Pollination occurs between anthers and stigmas of the same height present in different flowers.

53. Monoecious flowers are same as bisexual, as they bear both male and female reproductive organs, e.g., cucurbits. Cleistogamous flowers are those flowers which do not open at all. These flowers are bisexual and remain closed causing self-pollination. In cleistogamous flowers, the anthers dehisce inside closed flowers. Growth of style brings the pollen grains in contact with stigma. Pollination and seed setting are assured. Pollinators are not required, e.g., Commelina benghalensis, balsam. Self-incompatibility is inability of pollen of a plant to fertilise the pistil of the same plant, e.g., Primula. Monoecious and cleistogamous flowers promote inbreeding whereas self-incompatibility in plants promotes outbreeding.

54. (a) Megasporogenesis is the formation of megaspore (n) from megaspore mother cell (2n) inside the ovule by the process of meiosis. In the hypodermal region of nucellus towards the micropylar end develops a primary archesporial cell.

The primary archesporial cell divides periclinally to form outer parietal cell and inner sporogenous cell. The sporogenous cell functions as megaspore mother cell (MMC). The MMC undergoes meiotic division and produce four haploid megaspores. One of the megaspores is functional while other three degenerate.

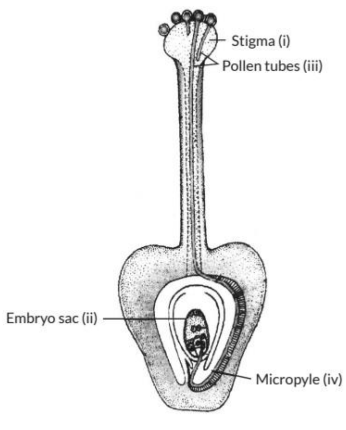
Different stages in the formation of mature female gametophye within an ovule are represented diagrammatically as follows:



The functional megaspore is the first cell of female gametophyte or embryo sac. The nucleus of megaspore divides by mitosis into eight daughter nuclei. Two polar nuclei are present in centre which further fuse to form a secondary nucleus. After fertilisation with a male gamete, it produces triploid endosperm. Three nuclei at the base of embryo sac form antipodal cells. The remaining three nuclei at the micropylar end constitute egg apparatus, which consists of two cells known as synergids or help cells and an egg cell or oosphere. The egg cell on fusing with one male gamete (fertilisation) gives rise to zygote.

(b) Synergids are the part of egg apparatus which occur at micropylar end of embryo sac. They have special cellular thickenings or finger-like projections called filiform apparatus, which play an important role in guiding the pollen tube towards embryo sac. Each of the synergids contains filiform apparatus in the micropylar region, a lateral hook, chalazal vacuole and a central nucleus.

55. (a) Longitudinal section of pistil showing growth of pollen tube upto the micropyle of the ovule is shown below.



(b) The compatible pollen grain germinates on the stigma; the intine grows out through one of the germ pores as a pollen tube.

– The contents of the pollen grain move into the pollen tube.

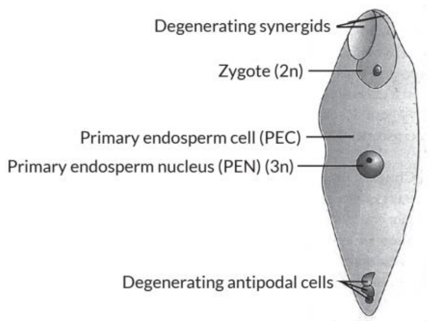
– The generative cell divides into two male gametes.

– The pollen tube grows through the stigma and style and reaches the ovary; it enters the ovule through micropyle and then enters the embryo sac guided by the filiform apparatus and discharges the male gametes into one of the synergids.

– One of the male gametes fuses with the egg cell (syngamy) to form the zygote and the other male gamete fuses with the two polar nuclei (triple fusion) to form the primary endosperm nucleus (PEN).

56. (b): In the given figure of an egg apparatus of an angiosperm, X-Egg nucleus, Y-Polar nuclei, Z-Synergid. When the two male gametes are released from pollen tube into the cytoplasm of the synergid, one fuses with egg nuclei (X) to form zygote and other fuses with polar nuclei (Y) to produce a triploid primary endosperm nucleus.

57. The labelled diagram of a fertilised embryo sac of a dicot flower is as follows:



58. Double fertilisation is a phenomenon unique to angiosperms. Here, at the time of fertilisation, pollen tube releases two male gametes or nucleus inside an embryo sac. One of the male gamete's fuses with the egg cell to form diploid zygote. This is called generative fertilisation or syngamy. Zygote give rise to embryo. The other male gamete fuses with the two polar nuclei or secondary nuclei to form triploid primary endosperm nucleus. This is called triple fusion. Primary endosperm nucleus gives rise to endosperm. As the two acts of fertilisation, i.e., syngamy and triploid fusion occur in the same embryo sac so it is termed as double fertilisation.

59. (a) Flowering plants have developed many devices to discourage autogamy and geitonogamy. The two of them are dichogmy and self-incompatibility. For more refer to answer 44.

(b) After entering one of the synergids, the pollen tube releases the two haploid male gametes into the cytoplasm of the synergid. One of the male gametes moves towards the egg cell (haploid) and fuses with its nucleus thus completing the syngamy (vegetative fertilisation). This results in the formation of a diploid cell, the 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. As this involves the fusion of three haploid nuclei it is termed triple fusion. Since two types of fusions, syngamy and triple fusion take place in an embryo sac the phenomenon is termed double fertilisation, an event unique to flowering plants.

60. (d): The cells of endosperm are filled with reserve food materials and are used for nutrition of developing embryo. Endosperm development precedes embryo development.

61. The tender coconut water is free nuclear endosperm, i.e., during development the primary endosperm nucleus divides by repeated mitotic free nuclear division without formation of wall. White kernel of coconut is cellular endosperm, i.e., during development first nuclear division of the primary endosperm nucleus is followed by the formation of either a longitudinal or transverse cell wall in the central cell. Both tender coconut water and white kernel of coconut are triploid (3n) but coconut water is multinucleated structure whereas in kernel of coconut each cell is uninucleated.

62. Endosperm is the food laden tissue formed after double fertilisation. It provides essential nutrients to the growing embryo and also the young seedling at the time of seed germination. In angiosperms, the endosperm develops from triploid (3n) primary endosperm nucleus which is formed as a result of vegetative fertilisation or triple fusion, i.e., fusion of a male gemete with secondary nucleus of the central cell. Based on the first and subsequent divisions of primary endosperm nucleus, the development of endosperm takes place in different ways and accordingly endosperm is of three types - nuclear, cellular and helobial.

Nuclear type: In the nuclear type of endosperm the first division of primary endosperm nucleus and few subsequent nuclear divisions are not accompanied by wall formation. The nuclei produced are free in the cytoplasm of the embryo sac and they may remain free indefinitely or wall formation takes place later. The multinucleate cytoplasm undergoes cleavage, and gives rise to multicellular tissue, maize, wheat, rice.

Cellular type: In this case, there is cytokinesis after each nuclear division of endosperm nucleus. The endosperm, thus, has a cellular form, from the very beginning because first and subsequent divisions are all accompanied by wall formation, e.g., Petunia, Datura, Adoxa, etc.

Helobial type: It is an intermediate type between the nuclear and cellular types. The first division is accompanied by cytokinesis but the subsequent ones are free nuclear. The chamber towards micropylar end of embryo sac is usually much larger than the chamber towards chalazal end. A large number of nuclei are formed in the micropylar chamber by free nuclear divisions while the nucleus of the chamber towards chalazal end divides to form fewer free nuclei or may not divide at all, e.g., Order Helobiales and most monocots. Endosperm provides nourishment to the zygote. So, endosperm development precedes that of zygote.

63. Soon after the act of double fertilisation, the flower begins to lose its shine. The petals, stamens and style either fall or wither away. The calyx, however, may persist in some cases (e.g., tomato, brinjal). The major events include -

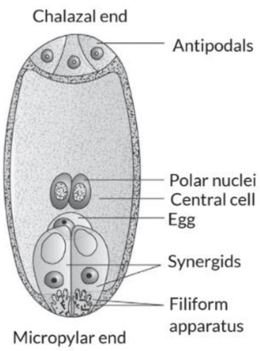
(i) Development of endosperm from triploid primary endosperm nucleus in the central cell of embryo sac.

(ii) Development of embryo from diploid zygote.

(iii) Development of seed from ovule.

(iv) Development of fruit from ovary.

64. (a)



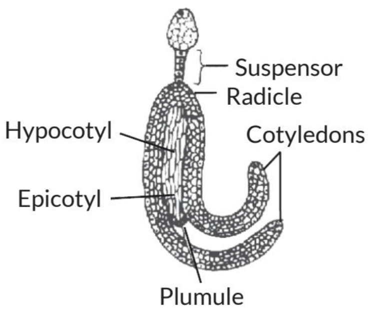
(b) The primary endosperm cell divides repeatedly and forms a triploid endosperm tissue. The cells of this tissue are filled with reserve food materials and are used for the nutrition of the developing embryo.

(c) After fertilisation, zygote being diploid will have 16 chromosomes and endosperm being triploid will have 24 chromosomes.

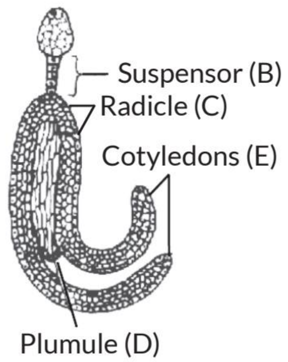
65. (c)

66. Coleorhiza is a protective sheath that covers the young root of the embryo in plants.

67. Labelled diagram of dicot embryo is as follows:



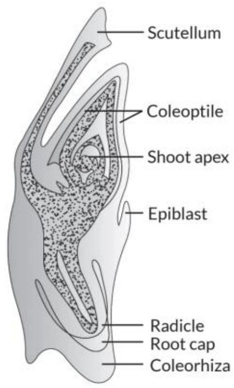
68. (a) The figure given below is of dicot embryo.



Here B is suspensor, C is radicle, D is plumule and E is cotyledons.

(b) Cotyledons (E) provides the initial growth to the plant and also act as an energy source.

69. L.S. of an embryo of grass is shown as follows:

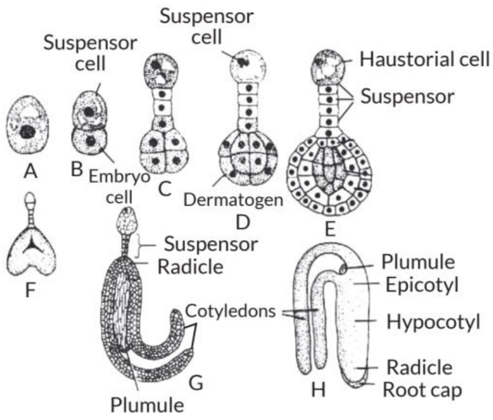


70. In a typical dicot flower, after double fertilisation, the zygote elongates and then divides by a transverse wall into two unequal cells. The larger basal cell is called suspensor cell. The other towards the antipodal end is termed as terminal cell or embryo cell. The suspensor cell divides transversely a few times to produce a filamentous suspensor of 6–10 cells. The suspensor cell helps in pushing the embryo in the endosperm.

The first cell of the suspensor towards the micropylar end becomes swollen and functions as a haustorium. The last cell of the suspensor is known as hypophysis. Hypophysis later gives rise to the radicle and root cap.

The embryo cell undergoes two vertical divisions and one transverse division to form eight cells arranged in two tiers– epibasal (terminal) and hypobasal (near the suspensor).

The epibasal cells eventually form the two cotyledons and the plumule. The hypobasal cells produce the hypocotyl except its tip. Stages in the development of a dicot embryo are represented diagrammatically as follows:



Initially the embryo is globular and undifferentiated. Early embryo with radial symmetry is called proembryo. It is transformed into embryo with the development of radicle, plumule and cotyledons. At this time the embryo becomes heart-shaped. The rate of growth of the cotyledons is very high so that they elongate tremendously while the plumule remains as a small mound of undifferentiated tissue.

71. (b): Perisperm - Black pepper

Thalamus-Strawberry

Pericarp-Mango

Endosperm - Maize

72. (c): In some seeds, the endosperm persists in the seed as food storage tissue. Such seeds are called endospermic or albuminous, e.g., castor, maize, wheat, barley, rubber, coconut. In others, the endosperm is completely eaten up by growing embryo. The food for later development of embryo is then stored in cotyledons which become massive. Such seeds are non-endospermic or ex-albuminous, e.g., pea, gram, bean, groundnut.

73. (c): Strawberry is a fruit which develops not only from the ovary, but some other part like thalamus also contributes to its formation. Such fruit is called false fruit.

74. (c): Seeds of wheat, maize and barley are albuminous as they retain a part of endosperm which is not completely used up during embryo development.

75. Difference between parthenogenesis and parthenocarpy are as follows:

Parthenogenesis	Parthenocarpy
It is the development of unfertilised egg into a complete individual without fertilisation. Examples: *Nicotiana*, *Datura*, *Oenothera*, *Lacerta saxicola armeniaca*, *Typhlina brahmina*, etc.	It is the production and development of seedless fruits without fertilisation. Examples: Banana, pineapple, grapes, etc.

76. (a) In bean seed the endosperm is completely consumed by the developing embryo before seed maturation while in castor seed, endosperm persist in the seed. Thus, the castor seed would be chosen to observe the endosperm.

(b) The primary endosperm cell divides repeatedly and forms a triploid endosperm tissue. The cells of this tissue are filled with reserve food materials and are used for the nutrition of the developing embryo.

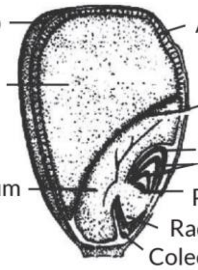
77. A fruit is a seed containing part of a plant that develops from a fertilised ovary. Apple is a false fruit because in this apart from the ovary, thalamus also contributes to fruit formation. Mango is a true fruit as it develops only from the ovary after fertilisation. Banana is a seedless fruit or parthenocarpic fruit because it develops without fertilisation.

78. Banana fruit is a seedless fruit which is developed without fertilisation hence is referred to as parthenocarpic fruit, whereas in turkey the unfertilised egg develops into complete individual after fertilisation hence turkey is referred to as parthenogenetic.

79. The seeds in which endosperm persists as food storage tissue are called endospermic or albuminous, seeds, e.g., castor, maize, wheat, barley, rubber, coconut. In some seeds remains of nucellus persist. The residual nucellus which persists in the seed is called perisperm, e.g., black pepper, coffee, castor, cardamom, Nymphaea.

80. Banana crop is cultivated by vegetative propagation without sowing seeds. It has subaerial stem structures called suckers which are slender branches that develop from base of aerial shoot, grow for some distance and form new aerial shoots or crowns. Breaking of suckers forms new plant. Rhizomes of banana also forms new plant.

81. L.S. of a monocot seed (maize grain) is as follows:



(Any six)

82. Differences between parthenocarpy and parthenogenesis are as follows:

S.No.	Parthenocarpy	Parthenogenesis
(i)	It is the production and development of seedless fruits without pollination and fertilisation.	It is the development of unfertilised egg into a complete individual without fertilisation.
(ii)	Parthenocarpic fruits are normal.	Young ones produced by parthenogenesis are generally weak.
(iii)	It occurs in plants only.	It occurs in both plants and animals.
(iv)	Examples: Banana, pineapple, guava, grapes, apple, tomato, papaya, etc.	Examples : Plants such as *Solanum nigrum*, *Nicotiana*, *Datura*, *Oenothera*, etc., and animals like, drones, *Lacerta saxicola armeniaca*, *Typhlina brahmina*, etc.

83. Post-pollination events leading to seed formation in angiosperms are as follows:

(i) After pollination, the pistil recognises the pollen whether it is of the right type (compatible) or of the wrong type (incompatible). Compatible pollens are accepted and germinate on the stigma to produce a pollen tube. Pollen tube grows and reaches the ovary and enters the ovule either through micropyle or chalaza or integuments.

(ii) The pollen tube bursts open in one of the two synergids to release the two male gametes. One male gamete fuse with the egg to form a diploid zygote or oospore (syngamy). The second male gamete fuses with the diploid secondary nucleus of the central cell to form a primary triploid endosperm nucleus (triple fusion). The whole process is termed as double fertilisation.

(iii) The primary endosperm nucleus gives rise to endosperm while the zygote develops into embryo.

(iv) The integuments of fertilised ovule harden to form the seed coat.

(v) The outer integument becomes hard and forms leathery testa or outer seed coat which ensures survival of seeds.

(vi) The inner integument, if persists, forms the tegmen.

(vii) The micropyle remains in the form of a fine pore on the surface of seed. Funicle is transformed into stalk of the seed. The hilum marks the point of attachment to the stalk. Micropyle facilitates the entry of oxygen and water into the seed.

84. In angiosperms, double fertilisation produces two structures - a diploid zygote and a triploid primary endosperm cell. The latter gives rise to tissue called endosperm. Zygote forms the embryo and endosperm provides nourishment to the growing embryo. With the growth of embryo, the central part of the endosperm is utilised. In some seeds, the endosperm persists in the seed as food storage tissue. Such seeds are called endospermic or albuminous seeds, e.g., castor, cereals, etc. In others the endosperm is completely eaten up by growing embryo. The food for later development of embryo is then stored in cotyledons which become massive. Such seeds are called non-endospermic or exalbuminous seeds, e.g., groundnut, pea, etc.

85. The three advantages that seeds offer to angiosperms are as follows:

(i) Seeds have better adaptive strategies for dispersal to new habitats and help the species to colonise in other areas.

(ii) They have sufficient food reserves. Young seedlings are nourished until they are capable to photosynthesise on their own and hard seed coat provides protection to the young embryo.

(iii) Seeds are product of sexual reproduction; they generate new genetic combinations leading to variations.

86. (a) (i) Double fertilisation is a phenomenon unique to angiosperms. Here, at the time of fertilisation, pollen tube releases two male gametes or nucleus inside an embryo sac. One of the male gamete fuses with the egg cell to form diploid zygote. This is called generative fertilisation or syngamy. Zygote give rise to embryo.

The other male gamete fuses with the two polar nuclei or secondary nuclei to form triploid primary endosperm nucleus. This is called triple fusion. Primary endosperm nucleus gives rise to endosperm. As the two acts of fertilisation, i.e., syngamy and triple fusion occur in the same embryo sac so, it is termed as double fertilisation.

(ii) (1) A seed of an orange has many embryos due to polyembryony. Polyembryony is the occurrence of more than one embryo in a seed. This takes place in when some of the nucellar cells surrounding the embryo sac start dividing and protrude into the embryo sac. These cells develop into the embryos and as a result in such species each ovule contains many embryos.

(2) True fruits are the fruits in which only ovary participates in the formation of fruit whereas false fruits are the fruits in which along with ovary some other parts also participate in the formation of fruit. In cashew, along with ovary, thalamus also contributes to fruit formation, therefore, it is a false fruit. In guava only ovary participates in the formation of fruit so, it is a true fruit.

87. (a) Double fertilisation is a phenomenon unique to angiosperms. Here, at the time of fertilisation, pollen tube releases two male gametes or nucleus inside an embryo sac. One of the male gametes fuses with the egg cell to form diploid zygote. This is called generative fertilisation or syngamy. Zygote give rise to embryo. The other male gamete fuses with the two polar nuclei or secondary nuclei to form triploid primary endosperm nucleus. This is called triple fusion. Primary endosperm nucleus gives rise to endosperm. As the two acts of fertilisation, i.e., syngamy and triploid fusion occur in the same embryo sac so it is termed as double fertilisation.

(b) The polyploidal cell or triploid cell called primary endosperm cell differentiates to form endosperm. It is the food laden tissue which is meant for nourishing the young embryo in seed plants. The endosperm may persist in the seed when the latter is called endospermic or albuminous, e.g., castor, cereals, coconut, etc.

In others, the endosperm is completely absorbed by the growing embryo and food reserve gets stored in cotyledons. Such seeds are called non-endospermic or exalbuminous, e.g., pea, bean, sunflower, etc.

Depending upon the mode of formation angiospermic endosperm is of three types:

(i) Nuclear endosperm : The PEN divides repeatedly without wall formation to produce a large number of free nuclei. e.g. maize, wheat, rice, etc.

(ii) Cellular endosperm : Every division of PEN is followed by cytokinesis. Therefore, endosperm becomes cellular from the very beginning, e.g., Balsam, Datura, Petunia.

(iii) Helobial endosperm: The endosperm is of intermediate type between cellular and nuclear types. The first division of PEN is followed by transverse cytokinesis to form two unequal cells, larger micropylar and smaller chalazal.

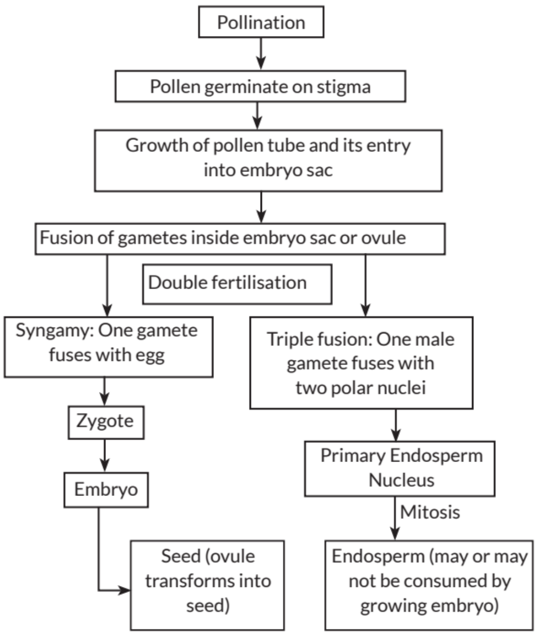
Micropylar cell grows faster than the chalazal one. Chalazal chamber often remains smaller and may degenerate, e.g., Asphodelus.

88. (a) Seeds those have the ability to retain power of germination over a period of time and are capable to germinate under favourable conditions are called viable seeds.

(b) (i) 200 pollen grains are required to form 200 seeds because each pollen grain carries two male gametes but only one fuses with the egg to form a zygote that develops into a mature embryo.

(ii) Total of 600 gametes (400 male gametes + 200 female gametes) are required in producing 200 viable guava seeds.

(c) Post-pollination events that lead to viable-seed production in a flowering plant can be represented with help of the given flow chart:



89. A flower of tomato plant contains 200 viable seeds.

(a) Minimum number of ovules involved = 200 because following fertilisation one ovule matures into one seed.

(b) Each microspore mother cell undergoes meiosis and gives rise to tetrad of four haploid microspores or pollen grains.

So, number of microspore mother cells required to produce 200 pollen grains is $\frac{200}{4} = 50$.

(c) 200 pollen grains must have pollinated 200 carpels for production of 200 viable seeds.

(d) Male gametes involved are 200 x 2 = 400.

Each pollen grain releases two male gametes, one fuses with the egg to form zygote and second male gametes fuses with polar nuclei to form endosperm nucleus.

(e) Megaspore mother cell undergoes reduction division to form four haploid megaspores. Only one megaspore remains functional and other three degenerate. Only the functional megaspore develops into female gametophyte.

Hence, number of megaspore mother cell = 200.

90. A flower of brinjal plant contains 360 viable seeds.

(a) Number of minimally involved ovules = 360. This is because following sexual reproduction, one ovule matures into one seed.

(b) Megaspore mother cell undergoes reduction division to forms four haploid megaspores. Only one megaspore remains functional and other three degenerate. Only the functional megaspore develops into female gametophyte.

Hence, number of megaspore mother cell = 360.

(c) Compatible pollen grain after landing on stigma forms pollen tube which traverses through style of carpel and enters the ovule to release male gamete. Here, minimum number of pollen grains involved is = 360.

(d) Each pollen grain releases two male gametes in an embryo sac. One male gamete fuses with the egg to form zygote and second male gamete fuses with polar nuclei to form endosperm nucleus. Hence, number of male gametes involved is = 360x2 = 720.

(e) Each microspore mother cell undergoes meiosis and gives rise to tetrad of four haploid microspores or pollen grains. So, number of microspore mother cell that have undergone reduction division prior to dehiscence of anther $= \frac{360}{4} = 90$.

91. (a) Refer to answer 83.

(b) The ploidy levels of the cell of different parts of an albuminous seed are:

Zygote - diploid (2n) Coleoptile - diploid (2n)

Pericarp-diploid (2n) Plumule - diploid (2n)

Endosperm-triploid (3n) Radicle - diploid (2n)

Scutellum - diploid (2n) Coleorhiza-diploid (2n)

92. (c): In Citrus such as orange, polyembryony occurs where some of the nucellar cells surrounding the embryo sac start dividing, protrude into the embryo sac and develop into the embryos. Thus, each ovule contains many embryos.

93. In hybrid apomicts, there is no segregation of characters in hybrid progeny. So, farmers can keep on using the hybrid seeds to raise new crop year after year and they do not have to buy new hybrid seeds every year.

94. Advantages of apomictic seeds of hybrid varieties to farmer are as follows:

(i) It will reduce the cost on purchasing hybrid seeds every year.

(ii) Apomixis is genetically controlled so genes of apomixis can be introduced in hybrid varieties.

95. Apomixis is a mode of reproduction which does not involve formation of zygote through gametic fusion. It is a form of asexual reproduction that mimics sexual reproduction, in which seeds are produced without fertilisation. It is common in grasses and species of Family Asteraceae.

96. Apomixis is a mode of reproduction which does not involve formation of zygote through gametic fusion. It is a form of asexual reproduction that mimics sexual reproduction, in which seeds are produced without fertilisation. It is common in grasses and species of Family Asteraceae.

Apomixis is useful to farmers as it has advantages in horticulture and agriculture, particularly hybrid seed industry.

(i) The hybrid varieties are more productive but production of these seeds is very costly and time consuming and such seeds do not maintain hybrid vigour in progeny due to segregation of characters/genes during meiosis. If the hybrids are made into apomicts, there will be no segregation of genes due to no meiosis. Thus, apomictic hybrid seeds can be used year after year which will reduce the cost on purchasing hybrid seeds every year.

(ii) Adventive embryos are better clones than cuttings.

(iii) Apomictic embryos are generally free from infections.

97. There are several methods of apomictic development in seeds. The two common ones are recurrent agamospermy and adventive embryony.

(i) Recurrent agamospermy: Agamospermy is the formation of seed that has an embryo formed without meiosis and syngamy. It is of two types, non-recurrent and recurrent. In non-recurrent agamospermy, the embryo is haploid. Therefore, the seed having it is non-viable. In recurrent agamospermy all the cells of embryo sac are diploid as it is formed directly either from a nucellar cell (apospory) or diploid megaspore mother cell (diplospory), e.g., Rubus, apple.

(ii) Adventive embryony : An embryo develops directly from a diploid cell other than egg like that of nucellus and integument, e.g., Citrus, Opuntia.

98. (a) Seeds of some grasses are called apomictic because they are produced without fertilisation and do not involve formation of zygote through gametic fusion.

(b) Two reasons to convince a farmer to use an apomictic crop are as follows:

(i) Production of infection free embryo for development of plant.

(ii) Production of better clones as adventive embryos are better clones than cuttings.

99. Apomixis is a mode of reproduction which does not involve formation of zygote through gametic fusion. It is a form of asexual reproduction that mimics sexual reproduction, in which seeds are produced without fertilisation. It is common in grasses and species of Family Asteraceae.

Apomixis is useful to farmers as it has advantages in horticulture and agriculture, particularly hybrid seed industry.

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(ii) Adventive embryos are better clones than cuttings.

(iii) Apomictic embryos are generally free from infections.

The commercial use of apomixis is as follows:

(i) Production of infection free embryos for development of plant.

(ii) Production of better clone as adventive embryos are better clones than cuttings.

(iii) Apomictic hybrid seeds can be used year after year which will reduce the cost on purchasing hybrid seeds every year.

100. (a) Both apomixis and parthenocarpy are asexual modes of reproduction. Apomixis is the formation of seeds without fertilisation whereas parthenocarpy is the formation of fruits without fertilisation.

(b) There are several methods of apomictic development in seeds. The two common ones are recurrent agamospermy and adventive embryony.

(i) Recurrent agamospermy: Agamospermy is the formation of seed that has an embryo formed without meiosis and syngamy. It is of two types, non-recurrent and recurrent. In non-recurrent agamospermy, the embryo is haploid.

Therefore, the seed having it is non-viable. In recurrent agamospermy all the cells of embryo sac are diploid as it is formed directly either from a nucellar cell (apospory) or diploid megaspore mother cell (diplospory), e.g., Rubus, apple.

(ii) Adventive embryony : An embryo develops directly from a diploid cell other than egg like that of nucellus and integument, e.g., Citrus, Opuntia.

101. (a) When a seed of an orange is squeezed, many embryos instead of one are observed, this is due to polyembryony.

Polyembryony is the occurrence of more than one embryo in a seed. This takes place in many Citrus fruits such as orange when some of the nucellar cells surrounding the embryo sac start dividing and protrude into the embryo sac. These cells develop into the embryos and as a result in such species each ovule contains many embryos.

(b) The embryos formed as a result of polyembryony may or may not be genetically similar. In polyembryony, there may be more than one egg cell in an embryo sac or more than one embryo sac in an ovule. All the egg cells may get fertilised.

The embryos may be developed directly from a diploid cell other than egg, e.g., nucellus, integuments or they may also develop from synergids and antipodal cells.

If the polyembryony occurs due to the fertilisation of more than one egg, then the formed embryo will not be of same genetic constitution. But, if all the embryos develop directly from diploid cell, then they will have same genetic makeup.

CBSE Sample Questions

1. (d): The structure of bilobed anther consists of 2 thecae at each lobe and 4 microsporangia located at the corners, two in each lobe.

2. (a): Pollen grains of different species can be stored as a fossil for a number of years due to the presence of sporopollenin. It is the most resistant organic material present in the outer layer of pollen grain. It can withstand high temperature and strong acid and alkali. It is highly resistant to enzymatic degradation.

3. (b): A typical angiospermic embryo sac formed inside the ovule at maturity contains 7 cells having 8 nuclei, i.e., three antipodal cells at chalazal end, two synergids and one egg cell at micropylar end and two polar nuclei in large central cell.

4. The process of formation of megaspores from the megaspore mother cell is called megasporogenesis.

(i) Ovules generally differentiate a single megaspore mother cell (MMC) in the micropylar region of the nucellus. It is a large cell containing dense cytoplasm and a prominent nucleus. The MMC undergoes meiotic division to form megaspores.

(ii) In a majority of flowering plants, one of the megaspores is functional while the other three degenerate. Only the functional megaspore develops into the female gametophyte (embryo sac). This method of embryo sac formation from a single megaspore is termed monosporic development.

(iii) The nucleus of the functional megaspore divides mitotically to form two nuclei which move to the opposite poles, forming the 2-nucleate embryo sac.

(iv) Two more sequential mitotic nuclear divisions result in the formation of the 4-nucleate and later the 8-nucleate stages of the embryo sac.

(v) These mitotic divisions are strictly free nuclear, that is, nuclear divisions are not followed immediately by cell wall formation.

(vi) After the 8-nucleate stage, cell walls are laid down leading to the organisation of the typical female gametophyte or embryo sac.

(vii) Six of the eight nuclei are surrounded by cell walls and organised into cells; the remaining two nuclei, called polar nuclei are situated in the large central cell.

(viii) Three cells are grouped together at the micropylar end and constitute the egg apparatus. The egg apparatus, in turn, consists of two synergids and one egg cell. The synergids have special cellular thickenings at the micropylar tip called filiform apparatus.

(ix) Three cells are at the chalazal end and are called the antipodals.

(x) The large central cell, as mentioned earlier, has two polar nuclei. Which come to lie below egg apparatus. Thus, a typical angiosperm embryo sac, at maturity, though 8-nucleate is 7-celled.

5. (c): The given figure shows dioecious aquatic plant Vallisneria. The male flower of Vallisneria is white, small and pollen grains are covered by mucilage which helps them in sticking to stigma of female flower and also protects them from wetting by water.

6. (a): Cleistogamous flowers remain closed so that anthers and stigmas are never exposed. Thus, the flowers undergo only self-pollination and it resulted in assured seed set.

7. In water hyacinth and water lily, the flowers emerge above the level of water and are pollinated by insects or wind as in most of the land plants.

8. (a) Corn: Wind. Numerous flowers are packed in an inflorescence; the tassels seen in the corn cob are the stigma and style which wave in the wind to trap pollen grains.

(b) Water hyacinth: Insects or wind. In water hyacinth the flowers emerge above the level of water and are pollinated by insects or wind as in most of the land plants.

(c) Vallisneria : Water. In Vallisneria, the female flower reaches the surface of water by the long stalk and the male flowers or pollen grains are released onto the surface of water. They are carried passively by water currents; some of them eventually reach the female flowers and the stigma.

9. (a): Antipodal cells are haploid (n), zygote is formed by the fertilisation of egg cell with pollen grain hence it is diploid (2n). Endosperm is developed from the primary endosperm nucleus, which is formed by the fusion of two polar nuclei of central cell with male gamete. Hence, it is triploid (3n).

10. (b): The coconut water from tender coconut is made up of thousands of nuclei, termed as free nuclear endosperm.

11. Endosperm development precede embryo development because cells of endosperm are filled with reserve food materials and are used for the nutrition of the developing embryo.

12. (b): Seed 'X' represents a dicot seed. Mostly the dicotyledonous seeds are non-endospermic, i.e., endosperm is not present in mature seeds. 'Y' represents a monocot seed. The monocotyledonous seeds are endospermic having a bulky endosperm and stores food.

13. (c): In false fruits like strawberry, apple and cashew, thalamus contributes to the formation of fruit along with ovary.

14. 95 meiotic divisions are required to produce 76 seeds in a guava fruit. As guava is angiospermic plant 19 meiotic divisions and 76 meiotic divisions are required to produce 76 microspores and 76 megaspores respectively.

Both microspore and megaspore further produce male gamete and female gamete respectively. Male gamete and female gamete fuse and form zygote that develops into embryo. Embryo further develops into fruit.

15. (a)