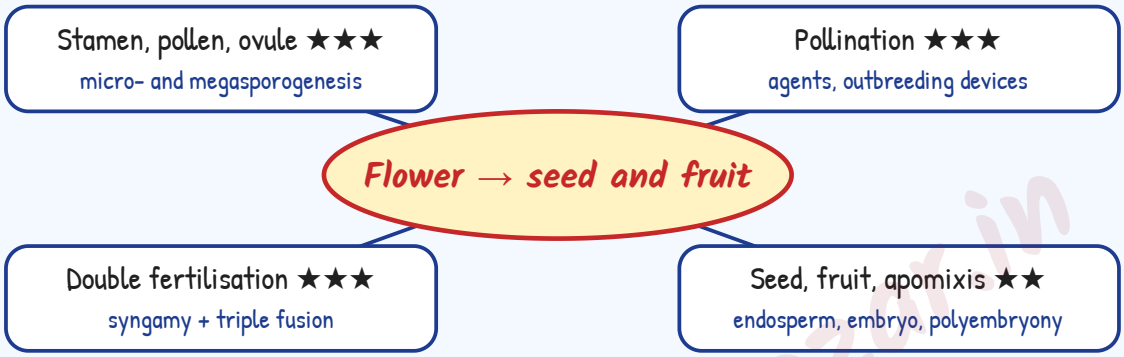
Class 12 · Biology · Chapter 1

Chapter 1
Sexual Reproduction in Flowering Plants

NCERT Biology, Reprint 2026-27 · CBSE board 2027

Chapter map (★ = asked in almost every CBSE paper 2024–2026)



What is inside

1. Concept notes with labelled diagrams: stamen to seed (p. 2–4)
2. NCERT exercises (all 18), fully solved (p. 5–6)
3. CBSE PYQs 2024–2026, fully solved (p. 7–15)
4. Quick-reference sheet; practice A–G, 20 MCQs, 6 A–R, answers, summary (p. 16–20)

Colour code used

red = key term green = definition
purple = sub-heading black = explanation
★ = high-frequency board topic
1 = mark the examiner gives for that point

★ **Exam tip:** This chapter is worth **8–10 marks** every year: 2–3 MCQs (pollination, parts of seed and embryo sac), a diagram question (ovule, embryo sac, microsporangium, pollen grain, maize grain) and often a 5-mark answer on double fertilisation or outbreeding devices. All 54 board questions are solved on p. 7–15.

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Based on NCERT Biology (2026-27), Chapter 1. Figures drawn by us; all answers written by us. Board questions are quoted from the CBSE papers named in each tag; every answer checked against the CBSE marking schemes.

1.2 Pre-fertilisation: stamen, microsporangium and pollen grain

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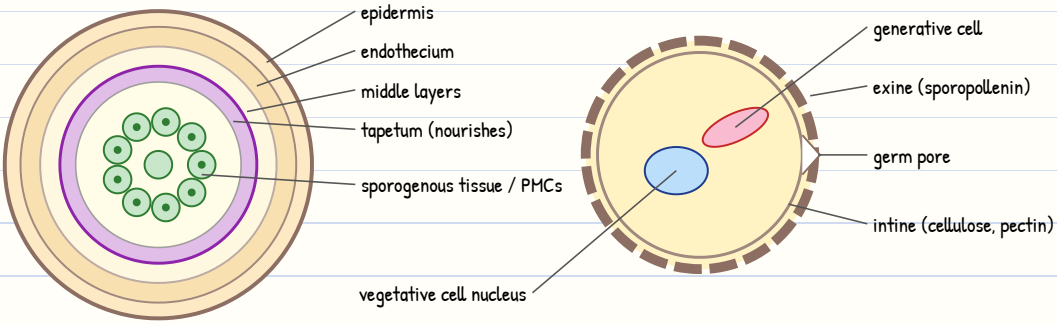

T.S. of a microsporangium — mature 2-celled pollen grain

Microsporangium wall: epidermis, endothecium, middle layers and tapetum around the sporogenous tissue; a pollen grain with exine, germ pore, intine, vegetative and generative cells

Definition The **flower** is the site of sexual reproduction. The **androecium** (whorl of stamens) is male; the **gynoecium** (pistil) is female. A stamen has a stalk, the **filament**, and a terminal, usually bilobed **anther**.

A typical anther is **bilobed and dithecous** (two thecae per lobe) and tetrasporangiate: **4 microsporangia** at the corners, which become the **pollen sacs**.

Wall of the microsporangium (outside → in)

- **Epidermis** and **endothecium**, **middle layers**: protection and dehiscence of the anther.
- **Tapetum** (innermost): dense cytoplasm, often more than one nucleus; **nourishes** the developing pollen grains.

Microsporogenesis

The **sporogenous tissue** (compactly arranged homogenous cells) in the centre; each cell is a **pollen mother cell** (PMC, microspore mother cell, 2n). Each PMC divides by **meiosis** into a cluster of four haploid cells, the **microspore tetrad**. As the anther matures and dehydrates, the microspores separate and develop into **pollen grains**.

Sequence: sporogenous tissue → PMC → microspore tetrad → pollen grain → male gametes.

The pollen grain (male gametophyte)

- Two-layered wall: hard outer **exine** of **sporopollenin**, one of the most resistant organic materials known (withstands high temperature, strong acids and alkalis; no enzyme degrades it), so pollen is preserved as fossils. **Germ pores**: apertures where sporopollenin is absent.
- Inner **intine**: thin, continuous, of cellulose and pectin.
- Mature pollen has a large **vegetative cell** (food reserve, irregular nucleus) and a small spindle-shaped **generative cell**. In over 60% of angiosperms pollen is shed at this **2-celled** stage; in the rest the generative cell divides into two **male gametes** first (**3-celled**).

★ **Exam tip:** Pollen viability varies: rice and wheat lose it within 30 minutes; some Rosaceae, Leguminosae and Solanaceae stay viable for months. Pollen is stored for years in liquid nitrogen (−196 °C) in pollen banks.

✗ **Don't do this:** Pollen of *Parthenium* (carrot grass, came with imported wheat) causes allergies and bronchial afflictions. Pollen tablets and syrups are used as food supplements.

Number check: each PMC gives 4 pollen grains, so 200 PMCs per microsporangium in a 4-sporangiate anther give $4 \times 200 \times 4 = 3200$ pollen grains.

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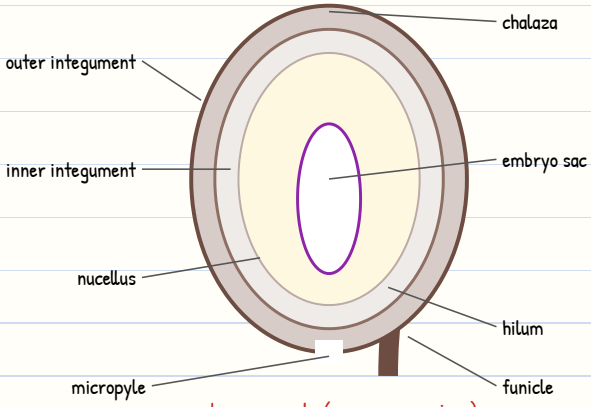
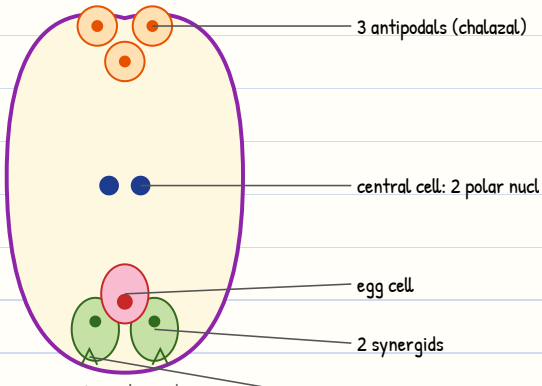
1.2.2 Pistil, ovule and embryo sac; 1.2.3 pollination ★★★



anatropous ovule (megasporangium)



embryo sac: 8 nuclei, 7 cells

The anatropous ovule and the mature embryo sac (female gametophyte): egg apparatus at the micropylar end, antipodals at the chalazal end, two polar nuclei in the central cell

The pistil: **stigma** (landing platform for pollen), **style**, swollen basal **ovary** with the ovarian cavity (locule) and **placenta**, from which **ovules** (megasporangia) arise. Gynoecium may be monocarpellary, multicarpellary **apocarpous** (free carpels, e.g. *Michelia*) or **syncarpous** (fused, e.g. *Papaver*).

Parts of the ovule

Stalk **funicle**, joined at the **hilum**; one or two protective **integuments**, leaving the **micropyle** opening; **chalaza** at the opposite basal end; the **nucellus** (food reserve) holds the **embryo sac**.

Megasporogenesis and the embryo sac

A single **megaspore mother cell** (MMC, 2n) near the micropyle divides by **meiosis** into four megaspores; three degenerate and **one is functional** (**monosporic development**). Its nucleus divides by **three free-nuclear mitoses**: 2, 4, 8 nuclei, four at each pole. Walls form around six of them:

- micropylar end: **egg apparatus** = 2 **synergids** (with **filiform apparatus**, which guides the pollen tube) + 1 egg;
- chalazal end: 3 **antipodals**;
- large **central cell** with the 2 **polar nuclei** (one from each pole).

So the mature embryo sac is **8-nucleate and 7-celled**.

Pollination: kinds

Kind	Pollen to	Note
Autogamy	stigma of the same flower	needs synchrony; chasmogamous (open) or cleistogamous (closed: *Viola*, *Oxalis*, *Commelina*; assured seed set, invariably autogamous)
Geitonogamy	another flower, same plant	functionally cross, genetically self
Xenogamy	another plant	brings genetically different pollen

Agents

- **Wind**: light, non-sticky pollen in large numbers, well-exposed stamens, large feathery stigma, often one ovule (grasses, maize "tassels" = stigma and style).
- **Water** (about 30 genera, mostly monocots): *Vallisneria* (female flowers reach the surface, pollen floats), *Hydrilla*, *Zostera* (long ribbon pollen inside water); pollen has a mucilaginous coat. Water hyacinth and water lily are pollinated by insects or wind.
- **Insects** (bees mainly), birds, bats: large, colourful, fragrant, nectar-rich flowers; sticky pollen. Floral rewards: nectar, pollen, safe egg-laying sites (*Amorphophallus*; *Yucca* and moth). Robbers take nectar without pollinating.

Outbreeding devices (to stop self-pollination)

Non-synchronous pollen release and stigma receptivity; anther and stigma at different positions; **self-incompatibility** (genetic, inhibits self-pollen germination or tube growth); unisexual flowers: monoecious (castor, maize: no autogamy) or dioecious (papaya: no autogamy, no geitonogamy).

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Pollen–pistil interaction, double fertilisation, seed and fruit

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Pollen–pistil interaction

The pistil **recognises** compatible pollen (chemical signals) and rejects incompatible pollen. Compatible pollen germinates into a **pollen tube** through a germ pore; the contents move into it; it grows through stigma and style to the ovary. (In 2-celled pollen the generative cell divides into two male gametes in the tube.) It enters the ovule through the **micropyle** and a **synergid**, guided by the filiform apparatus.

Artificial hybridisation

Only desired pollen should reach the stigma: **emasculation** (removing anthers from the bud of a bisexual flower before dehiscence) and **bagging** (butter-paper bag); when the stigma is receptive, dust collected pollen, then **re-bag**. Unisexual female flowers need no emasculation.

1.3 Double fertilisation

> ***Definition*** ✎ The pollen tube releases two male gametes into a synergid. One fuses with the egg: **syngamy** → diploid **zygote**. The other fuses with the two polar nuclei: **triple fusion** → triploid **primary endosperm nucleus** (PEN) in the primary endosperm cell (PEC). Two fusions in one embryo sac = **double fertilisation**, unique to angiosperms.

1.4.1 Endosperm

Develops **before** the embryo, to nourish it. Most common: **free-nuclear** endosperm (PEN divides without walls), later cellular. Coconut water = free-nuclear endosperm; white kernel = cellular. Non-albuminous seeds (pea, groundnut, bean) use it up; albuminous seeds (wheat, maize, barley, castor) retain it. A persistent nucellus is **perisperm** (black pepper, beet).

1.4.2 Embryo

At the micropylar end; the zygote divides only after some endosperm has formed. Stages: zygote → **proembryo** → **globular** → **heart-shaped** → mature embryo.

- **Dicot**: embryonal axis with two cotyledons; above them the **epicotyl** ending in the **plumule**; below, the **hypocotyl** ending in the **radicle** with root cap.
- **Monocot (grass)**: one cotyledon, the **scutellum**, lateral; radicle and root cap enclosed in the **coleorhiza**; shoot apex and leaf primordia in the hollow **coleoptile**.

1.4.3 Seed and fruit

Ovule → seed; integuments → **seed coat** (testa, tegmen); micropyle remains as a pore for O_2 and water; ovary wall → **pericarp**; ovary → fruit. As seeds mature, water falls to 10–15% and the embryo enters **dormancy**. Old viable seeds: *Lupinus arcticus* (~10,000 years), date palm at Masada (~2000 years).

False fruits: the thalamus also forms the fruit (apple, strawberry, cashew). **Parthenocarpic** fruits develop without fertilisation (banana), and can be induced by growth hormones: useful for seedless fruits such as grapes, oranges, watermelon.

1.5 Apomixis and polyembryony

> ***Definition*** ✎ **Apomixis**: seeds without fertilisation (asexual reproduction that mimics sexual), e.g. Asteraceae and grasses (diploid egg without meiosis develops into embryo) and many *Citrus*, mango (nucellar cells protrude into the embryo sac and form embryos). More than one embryo in a seed = **polyembryony**.

Importance: hybrids made apomictic do not segregate, so farmers can reuse the seed every year.

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NCERT exercises, fully solved

NCERT end-of-chapter exercises

1. Name the parts of an angiosperm flower in which development of male and female gametophytes takes place.

> **Ans.** Male gametophyte (pollen grain): in the microsporangia (pollen sacs) of the anther. Female gametophyte (embryo sac): in the nucellus of the ovule, inside the ovary of the pistil.

2. Differentiate between microsporogenesis and megasporogenesis. Which cell division occurs? Name the structures formed.

> **Ans.** Microsporogenesis: formation of microspores from pollen mother cells in the anther; many PMCs, all four microspores of each tetrad survive and become pollen grains.
> Megasporogenesis: formation of megaspores from the megaspore mother cell in the nucellus of the ovule; usually one MMC, and only one of the four megaspores is functional. Both involve **meiosis**. End structures: microspore tetrads (→ pollen grains) and megaspores (one forms the embryo sac).

3. Arrange in developmental sequence: pollen grain, sporogenous tissue, microspore tetrad, pollen mother cell, male gametes.

> **Ans.** Sporogenous tissue → pollen mother cell → microspore tetrad → pollen grain → male gametes.

4. With a neat labelled diagram describe the parts of a typical angiosperm ovule.

> **Ans.** (Draw the anatropous ovule of p. 3.) The ovule is attached to the placenta by the **funicle**; the junction of ovule and funicle is the **hilum**. One or two **integuments** cover it except at the **micropyle**. Opposite the micropyle is the **chalaza**, the basal part. Inside the integuments the **nucellus**, with reserve food, holds the **embryo sac** (female gametophyte). An ovule usually has one embryo sac formed from one megaspore.

5. What is meant by monosporic development of the female gametophyte?

> **Ans.** The embryo sac develops from a **single** functional megaspore (the other three of the tetrad degenerate): monosporic development.

6. With a neat diagram explain the 7-celled, 8-nucleate nature of the female gametophyte.

> **Ans.** (Draw the embryo sac of p. 3.) The functional megaspore's nucleus divides mitotically three times without walls (free-nuclear), giving 8 nuclei, 4 at each pole. Walls then form: at the micropylar end 3 cells form the egg apparatus (2 synergids, 1 egg); at the chalazal end 3 antipodals; one nucleus from each pole (the polar nuclei) moves to the centre and lies in the large central cell. 6 + 2 = 8 nuclei but 3 + 3 + 1 = 7 cells.

7. What are chasmogamous flowers? Can cross-pollination occur in cleistogamous flowers? Give reasons.

> **Ans.** Chasmogamous flowers are open flowers with exposed anthers and stigma (like other flowers). Cross-pollination cannot occur in cleistogamous flowers: they never open, anthers and stigma lie close together, and when the anthers dehisce in the bud the pollen falls on the stigma of the same flower. They are invariably autogamous.

8. Mention two strategies evolved to prevent self-pollination.

> **Ans.** Any two: pollen release and stigma receptivity not synchronised (one before the other); anther and stigma placed at different positions so pollen cannot reach the stigma of the same flower; self-incompatibility; unisexual flowers (monoecious or dioecious plants).

9. What is self-incompatibility? Why does self-pollination not lead to seed formation in such species?

> **Ans.** A genetic mechanism that prevents self-pollen (from the same flower or other flowers of the same plant) from fertilising the ovules. Self-pollen lands on the stigma, but its germination or pollen tube growth in the pistil is inhibited, so no fertilisation and no seed.

10. What is bagging? How is it useful in plant breeding?

> **Ans.** Covering an emasculated flower (or a female flower) with a bag of butter paper to protect its stigma from unwanted pollen. It ensures that only the desired pollen, dusted by the breeder when the stigma is receptive, pollinates it; after dusting the flower is re-bagged so the cross is pure.

11. What is triple fusion? Where and how does it take place? Name the nuclei involved.

> **Ans.** Fusion of three haploid nuclei: one male gamete with the two polar nuclei. It occurs in the central cell of the embryo sac: after the pollen tube releases two male gametes into a synergid, one gamete moves to the central cell and fuses with the polar nuclei to form the triploid primary endosperm nucleus. Nuclei: one male gamete nucleus and the two polar nuclei.

13. Differentiate between (a) hypocotyl and epicotyl (b) coleoptile and coleorhiza (c) integument and testa (d) perisperm and pericarp.

> **Ans.** (a) Hypocotyl: part of the embryonal axis below the cotyledons, ending in the radicle; epicotyl: part above the cotyledons, ending in the plumule. (b) Coleoptile: hollow foliar sheath enclosing the shoot apex and leaf primordia in grasses; coleorhiza: undifferentiated sheath enclosing the radicle and root cap. (c) Integument: protective covering of the ovule; testa: the outer seed coat formed from the outer integument after fertilisation. (d) Perisperm: residual persistent nucellus in some seeds (black pepper, beet), part of the seed; pericarp: wall of the fruit, formed from the ovary wall.

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14. Why is apple called a false fruit? Which part(s) of the flower form the fruit?

> **Ans.** In a true fruit only the ovary develops into the fruit; in apple the thalamus also grows and forms the fleshy edible part. So the fruit forms from the thalamus and the ovary (core).

15. What is emasculation? When and why does a breeder use it?

> **Ans.** Removal of the anthers from the flower bud before they dehisce, using forceps. It is used for bisexual flowers in artificial hybridisation, so that the flower cannot self-pollinate and only the chosen pollen fertilises it.

16. If parthenocarpy can be induced by growth substances, which fruits would you select and why?

> **Ans.** Fruits whose seeds are inedible or unwanted and whose fleshy part is eaten: orange, lemon, grapes, watermelon, litchi, guava. Seedless fruits are preferred by consumers and easier to process into juices and jams.

17. Explain the role of the tapetum in forming the pollen-grain wall.

> **Ans.** The tapetum, the innermost layer of the microsporangium wall, nourishes the developing pollen; it secretes precursors of sporopollenin and other materials (and enzymes such as callase) that are deposited on the microspores, forming the exine. (Its cells have dense cytoplasm and often more than one nucleus.)

18. What is apomixis and its importance?

> **Ans.** Formation of seeds without fertilisation, a form of asexual reproduction that mimics sexual reproduction. Importance: if hybrids are made apomictic, the hybrid characters do not segregate in the progeny, so farmers can keep using the same seed year after year instead of buying costly hybrid seed every year; it also maintains desirable genotypes.

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CBSE board questions 2024–2026, fully solved

Every question on this chapter from the 16 papers (sets 57/1/1 to 57/7/1, 2024–2026), quoted in full with complete answers.

A. MCQs and Assertion–Reason (1 mark each)

CBSE 2024 · 57/1/1 In which plant are male and female flowers borne on the same plant, so pollination can be geitonogamy or xenogamy? (A) Papaya (B) Date palm (C) Maize (D) Spinach [1]

> **Ans.** Maize is monoecious (unisexual flowers on one plant): autogamy is impossible but geitonogamy can occur. Papaya, date palm and spinach are dioecious. **(C).**

CBSE 2024 · 57/2/1 An angiosperm embryo sac is located within the (A) placenta (B) megasporangium (C) nucellus (D) ovary [1]

> **Ans.** The embryo sac (female gametophyte) lies embedded in the nucellus of the ovule. **(C).**

CBSE 2024 · 57/3/1 The part of the ovule that develops into the protective seed coats after fertilisation is (A) embryo sac (B) nucellus (C) integuments (D) megaspore [1]

> **Ans.** The integuments harden into the seed coats. **(C).**

CBSE 2024 · 57/3/1 In which plant are many embryos formed in the seed without fertilisation of the egg? (A) Black pepper (B) Mustard (C) Groundnut (D) Citrus [1]

> **Ans.** In *Citrus* nucellar cells form extra embryos (polyembryony, apomixis). **(D).**

CBSE 2024 · 57/3/1 Assertion (A): The zygote gives rise to a heart-shaped embryo and subsequently a proembryo. Reason (R): The zygote lies at the micropylar end of the embryo sac and develops into the embryo. [1]

> **Ans.** A is false: the order is proembryo → globular → heart-shaped → mature embryo. R is true. **(D).**

CBSE 2024 · 57/4/1 In a fertilised ovule, the cells with n, 2n and 3n conditions respectively are (A) antipodal, zygote, endosperm (B) zygote, nucellus, endosperm (C) endosperm, nucellus, zygote (D) antipodals, synergids, integuments [1]

> **Ans.** Antipodals are haploid (from the megaspore), the zygote diploid, the endosperm triploid. **(A).**

CBSE 2024 · 57/4/1 In the T.S. of a young anther, identify A (central tissue between the lobes), B (wall layer below the epidermis) and C (cells inside the sporangium). (A) connective, endothecium, pollen grain (B) endothecium, connective, pollen grain (C) pollen grain, connective, endothecium (D) endothecium, pollen grain, connective [1]

> **Ans.** A connective, B endothecium, C pollen grains. **(A).**

CBSE 2024 · 57/5/1 A male insect mistakes the pattern of an orchid flower for a female and tries to copulate, pollinating the flower. This is (A) pseudocopulation (B) pseudopollination (C) pseudoparthenocarpy (D) pseudofertilisation [1]

> **Ans.** Pseudocopulation (*Ophrys* and the male bee). **(A).**

CBSE 2024 · 57/5/1 A fertilised embryo sac labels A (at the micropylar end, two cells), B (single cell near A), C (central cell, labelled PEC), D (at the chalazal end, three cells). (A) zygote, degenerating synergids, degenerating antipodals, PEN (B) degenerating synergids, zygote, PEN, degenerating antipodals (C) degenerating antipodals, PEN, degenerating synergids, zygote (D) degenerating synergids, zygote, degenerating antipodals, PEN [1]

> **Ans.** After fertilisation the synergids and antipodals degenerate; the zygote lies at the micropylar end and the PEN in the central cell. **(B).**

CBSE 2025 · 57/1/1 A diagram of dicot embryo development labels P (the first cell), Q (filament attaching the embryo), R (lobes of the mature embryo) and S (between the cotyledons). (A) egg, suspensor, radicle, cotyledon (B) zygote, suspensor, cotyledon, plumule (C) egg, radicle, suspensor, cotyledon (D) zygote, suspensor, cotyledon, radicle [1]

> **Ans.** P zygote, Q suspensor, R cotyledon, S plumule (shoot apex between the cotyledons). **(B).**

CBSE 2025 · 57/1/1 How many pollen grains and ovules are formed from 50 microspore mother cells and 50 megaspore mother cells? (A) 100, 25 (B) 200, 50 (C) 50, 50 (D) 200, 100 [1]

> **Ans.** Each MMC gives 4 pollen grains (200); each megaspore mother cell gives one functional megaspore, so one embryo sac per ovule (50). **(B).**

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CBSE 2025 · S7/2/I A diagram of a monocot seed (maize grain) labels I (outer covering), II (large food tissue) and III (sheath at the lower tip of the embryo). (A) pericarp, endosperm, scutellum (B) pericarp, endosperm, coleorhiza (C) scutellum, pericarp, coleorhiza (D) coleorhiza, scutellum, pericarp [1]

> **Ans.** I pericarp (fused with seed coat), II endosperm, III coleorhiza (sheath round the radicle). **(B)**.

CBSE 2025 · S7/4/I For a typical dicot embryo: (i) it has an embryonal axis and scutellum (ii) the axis above the cotyledons is the epicotyl (iii) the axis below the cotyledons is the coleorhiza (iv) the lower end has the radicle with a root cap. Correct: (A) i, ii (B) i, iii (C) iii, iv (D) ii, iv [1]

> **Ans.** Scutellum and coleorhiza belong to monocot (grass) embryos; below the cotyledons is the hypocotyl. **(D)**.

CBSE 2025 · S7/5/I (i) In Vallisneria female flowers are pollinated by pollen inside the water. (ii) In Zostera pollen is released on the water surface. (iii) In most water-pollinated species pollen has a mucilaginous coating. (iv) Water pollination is rare, limited to about 30 genera. True: (A) i, ii (B) ii, iii (C) iii, iv (D) i, iv [1]

> **Ans.** (i) and (ii) are reversed: Vallisneria pollen floats on the surface; Zostera (sea grass) releases long pollen inside the water. **(C)**.

CBSE 2025 · S7/6/I For the angiosperm seed: (i) non-albuminous seeds have no residual endosperm (ii) residual persistent nucellus in wheat is perisperm (iii) integuments harden into the seed coat (iv) metabolic activity of the embryo slows in dormancy. Correct: (A) i, ii (B) ii, iii (C) iii, iv (D) i, iv [1]

> **Ans.** Only (ii) is false (perisperm occurs in black pepper and beet; wheat has endosperm). (i), (iii) and (iv) are all true, so the scheme accepts both **(C)** and **(D)**.

CBSE 2025 · S7/7/I Arrange the steps of artificial hybridisation: (i) re-bagging (ii) selection of parents (iii) bagging (iv) dusting pollen on stigma (v) emasculation (vi) collecting pollen from the male parent. (A) ii, iii, v, vi, iv, i (B) ii, v, iii, vi, iv, i (C) v, ii, iii, vi, i, iv (D) ii, iii, vi, iv, v, i [1]

> **Ans.** Select parents, emasculate the bud, bag it, collect pollen from the male parent, dust it on the stigma when receptive, re-bag. **(B)**.

CBSE 2025 · S7/7/I The gynoecium of *Michelia* is (A) multicarpellary, apocarpous (B) bicarpellary, apocarpous (C) multicarpellary, syncarpous (D) bicarpellary, syncarpous [1]

> **Ans.** *Michelia* has many free carpels. **(A)**.

CBSE 2026 · S7/1/I Identify the plant in which emasculation is not required for artificial hybridisation. (A) Rice (B) Wheat (C) Pea (D) Papaya [1]

> **Ans.** Emasculation (removing anthers) is needed only in bisexual flowers. Papaya is dioecious: the female plant bears only pistillate flowers, so only bagging is needed. **(D)**.

CBSE 2026 · S7/2/I Stages of embryo sac formation: megaspore mother cell →a→ megaspore dyad →b→ megaspore tetrad →c→ functional megaspore →d→ 7-celled embryo sac. Identify divisions a, b, c, d. (A) Meiosis-I, no division, mitosis, meiosis-II (B) Meiosis-I, meiosis-II, no division, mitosis (C) Mitosis, meiosis-I, meiosis-II, no division (D) No division, mitosis, meiosis-I, meiosis-II [1]

> **Ans.** MMC → dyad by meiosis I; dyad → tetrad by meiosis II; three megaspores degenerate, leaving one functional megaspore (no division); its nucleus divides mitotically three times to give the 7-celled, 8-nucleate embryo sac. **(B)**.

CBSE 2026 · S7/2/I Assertion (A): Apomixis leads to production of genetically identical offspring. Reason (R): Apomixis involves fertilisation between two genetically similar plants. [1]

> **Ans.** A is true. R is false: apomixis is seed formation **without** fertilisation (asexual reproduction that mimics sexual). **(C)**.

CBSE 2026 · S7/3/I The pair of plants pollinated by water: (A) Vallisneria and Hydrilla (B) Zostera and water lily (C) water lily and Parthenium (D) water hyacinth and water lily [1]

> **Ans.** Vallisneria, Hydrilla and Zostera are water-pollinated; water lily and water hyacinth are insect- or wind-pollinated. **(A)**.

CBSE 2026 · S7/4/I How many pollen grains are formed when 325 microspore mother cells undergo microsporogenesis? (A) 325 (B) 650 (C) 1300 (D) 975 [1]

> **Ans.** Each MMC divides by meiosis into a tetrad of 4 microspores (pollen grains): $325 \times 4 = 1300$. **(C)**.

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CBSE 2026 · S7/4/I Assertion (A): Cleistogamous flowers have assured seed set. Reason (R): Cleistogamous flowers are invariably autogamous and do not depend on pollinators. [1]

Ans. Both true and R explains A: the closed flowers self-pollinate, so seeds form even without pollinators. **(A)**.

CBSE 2026 · S7/5/I A figure of an apple (false fruit) in L.S. labels P (outer fleshy part), Q, R, S. Identify P, Q, R, S. (A) seed, thalamus, mesocarp, endocarp (B) thalamus, seed, endocarp, mesocarp (C) seed, thalamus, endocarp, mesocarp (D) thalamus, seed, mesocarp, endocarp [1]

Ans. In the apple the fleshy edible part is the thalamus (P); Q is the seed; the papery core around the seeds is the endocarp (R); S is the mesocarp. **(B)**.

B. Very short answer (2 marks)

CBSE 2024 · S7/1/I Identify A, B, C, D: pericarp – A; cotyledon in seed of grass family – B; embryonal axis – C; remains of nucellus in a seed – D. [2]

Ans. A: wall of the fruit (ripened ovary wall); B: scutellum; C: the embryonal axis bears radicle and plumule (epicotyl and hypocotyl); D: perisperm ½ × 4.

CBSE 2024 · S7/5/I (a) "Farmers prefer apomictic seeds to hybrid seeds." Give two reasons. OR (b) One advantage and one disadvantage of amniocentesis. [2]

Ans. (a) Any two: hybrid characters segregate in the progeny of hybrid seed; hybrid seed is expensive and must be bought every year; apomictic hybrids keep the desirable characters, so the same seed can be reused cheaply 1 × 2.
OR (b) Advantage: detects chromosomal or genetic disorders (Down's syndrome, haemophilia, sickle-cell anaemia) in the foetus 1. Disadvantage: misused for sex determination, leading to female foeticide 1.

CBSE 2026 · S7/4/I (a) Write one way in which apomictic seeds develop. (b) Why do farmers prefer apomictic seeds over hybrid seeds? [2]

Ans. (a) A diploid egg forms without meiosis and develops into an embryo without fertilisation (Asteraceae, grasses); or nucellar cells grow into the embryo sac and form embryos 1. (b) The hybrid characters do not segregate, so the same seed can be used year after year without buying new hybrid seed 1.

CBSE 2025 · S7/2/I (A) (i) Two crucial changes in a seed on maturing that keep it viable until favourable conditions. (ii) The oldest viable seed excavated from the Arctic tundra. OR (B) (i) Why do pea flowers produce assured seed sets? (ii) In polyembryony, embryo P develops from a synergid and Q from the nucellus. State their ploidy. [2]

Ans. (A) (i) Moisture content falls and the seed becomes relatively dry; the embryo's metabolic activity slows (dormancy) ½+½. (ii) *Lupinus arcticus* (about 10,000 years old) 1.
OR (B) (i) Pea flowers are cleistogamous-like: they self-pollinate (autogamy) before opening 1. (ii) P haploid (n), Q diploid (2n) ½+½.

CBSE 2026 · S7/1/I (a) (i) How does a farmer use dormancy of seed to his advantage? (ii) Differentiate between pea seed and castor seed. OR (b) Identify the stage of follicle where the primary oocyte undergoes first meiotic division. Also mention the products of this division. [2]

Ans. (a) (i) Dormant, dry seeds can be stored safely for long periods and sown in the next season (and used as food) 1. (ii) Pea seed is non-endospermic (non-albuminous): the endosperm is used up by the developing embryo. Castor seed is endospermic (albuminous): part of the endosperm remains 1.
OR (b) In the tertiary follicle, as it matures into the Graafian follicle 1. Products: a large haploid secondary oocyte and a tiny first polar body ½+½.

CBSE 2026 · S7/5/I (a) Mention the functions of (i) tassels of the corn cob (ii) scutellum. OR (b) Give two reasons why farmers prefer apomictic seeds over hybrid seeds. [2]

Ans. (a) (i) The "tassels" of the cob are its stigmas and styles (silks); they wave in the wind and trap pollen grains (the scheme gave this mark to all) 1. (ii) The scutellum is the single cotyledon of the grass embryo; it absorbs food from the endosperm for the embryo 1.
OR (b) Hybrid seed is costly to produce; in apomictic hybrids the characters do not segregate, so farmers need not buy fresh hybrid seed every year 1+1.

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C. Short answer (3 marks)

CBSE 2024 · S7/3/I Draw the L.S. of a pistil showing growth of the pollen tube. Label (a) the part through which the tube moves down (b) the cell in which it releases its contents. [3]

Ans. Draw the pistil (stigma with germinating pollen, style, ovary with an ovule) and the tube growing to the micropyle 1. (a) Style 1. (b) Synergid 1.

CBSE 2024 · S7/4/I Draw a labelled sectional view of a mature pollen grain (male gametophyte) and give the functions of two labelled parts (any four labels). [3]

Ans. Draw the two-celled pollen grain; label vegetative cell, generative cell, exine, intine, germ pore (any four) ½ × 4. Functions (any two): vegetative cell – food reserve, forms the pollen tube; generative cell – divides into two male gametes; exine – protection (sporopollenin); intine – forms the pollen tube wall; germ pore – the tube emerges through it ½ × 2.

CBSE 2024 · S7/5/I If maize leaf cells have 10 chromosomes each, give the chromosome numbers of the endosperm and zygote. Name and explain the processes that form them. [3]

Ans. 2n = 10, n = 5. Endosperm (3n) = 15 ½; zygote (2n) = 10 ½. Endosperm: triple fusion, one male gamete fusing with the two polar nuclei ½+½. Zygote: syngamy, the other male gamete fusing with the egg ½+½.

CBSE 2025 · S7/2/I (a) A bilobed dithecous anther has 200 microspore mother cells per microsporangium. How many male gametophytes can it produce? (b) Composition of intine and exine. [3]

Ans. (a) 4 microsporangia × 200 = 800 MMC; each gives 4 pollen grains: 3200 male gametophytes 1. (b) Intine: cellulose and pectin ½+½. Exine: sporopollenin 1.

CBSE 2026 · S7/1/I (a) Do all pollen grains remain viable for the same length of time? Support your answer with two suitable examples. (b) How are pollen grains stored in pollen banks? [3]

Ans. (a) No ½. Rice and wheat pollen lose viability within about 30 minutes of release 1, while pollen of some members of Rosaceae, Leguminosae and Solanaceae stays viable for months 1. (b) By cryopreservation in liquid nitrogen at −196 °C ½.

CBSE 2025 · S7/4/I A flower with versatile anthers, feathery stigmas and small petals is shown. (a) Mode of pollination? (b) Need for large exposed feathery stigmas? (c) Two adaptations of its pollen. (d) Why are the petals small and not showy? [3]

Ans. (a) Wind pollination (anemophily) ½. (b) To trap air-borne pollen ½. (c) Pollen is light and non-sticky (and produced in large numbers) ½+½. (d) No need to attract insects or birds; small petals do not obstruct the wind 1.

CBSE 2025 · S7/5/I A picture shows two flowers on different plants of a species: in one the stigma is receptive while the anthers are not shedding pollen; in the other the stigma is not receptive while the anthers shed pollen. (a) How is this type of pollination advantageous? (b) Can this plant show geitonogamy? Justify. [3]

Ans. (a) It ensures cross-pollination, which prevents inbreeding depression and increases genetic variability and vigour 1. (b) No 1: pollen release and stigma receptivity are not synchronised, so pollen cannot reach a receptive stigma of the same flower or another flower of the same plant 1.

CBSE 2025 · S7/6/I A table for three plants A, B, C of one species shows that pollen does not germinate (or the tube does not grow) on the stigma of the same plant, but germinates on the stigmas of the other two plants. (a) Name and define this outbreeding device. (b) What would be the disadvantage without it? [3]

Ans. (a) Self-incompatibility 1: a genetic mechanism that prevents self-pollen (from the same flower or other flowers of the same plant) from fertilising the ovules by inhibiting pollen germination or pollen tube growth in the pistil 1. (b) Continued self-pollination would cause inbreeding depression 1.

CBSE 2026 · S7/1/I Draw a neat diagram of megasporangium of an angiosperm and label any six parts.

Ans. Draw an anatropous ovule (turned upside down on its stalk). Label six of: funicle, hilum, micropyle, outer integument, inner integument, nucellus, embryo sac, chalaza ½ × 6. Inside the embryo sac show the egg apparatus at the micropylar end, two polar nuclei in the centre and three antipodals at the chalazal end. [3]

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CBSE 2026 · S7/2/I Draw a neat diagram of an enlarged view of one microsporangium of a young anther. Label the wall layers and give the functions of the outermost and innermost layers. [3]

Ans. Draw a near-circular microsporangium with four concentric wall layers around sporogenous tissue; label epidermis, endothecium, middle layers, tapetum ½ × 4. Epidermis (outermost): protection, and helps dehiscence to release pollen ½. Tapetum (innermost): nourishes the developing pollen grains ½.

CBSE 2026 · S7/3/I (a) Explain the ways in which apomictic seeds can develop. (b) One advantage of apomictic seeds for farmers. [3]

Ans. (a) In some species (Asteraceae, grasses) a diploid egg forms without reduction division and develops into an embryo without fertilisation 1. In others (many *Citrus*, mango), nucellar cells around the embryo sac divide, protrude into it and develop into embryos 1. (b) If hybrids are made apomictic, the characters do not segregate in the progeny, so farmers can reuse the hybrid seed every year instead of buying it 1.

CBSE 2026 · S7/3/I Draw a neat diagram of a maize grain showing the internal structure and label any five parts. [3]

Ans. Draw the L.S. of the maize grain ½. Label five of: pericarp (fused seed coat), aleurone layer, endosperm, scutellum (cotyledon), coleoptile, plumule (shoot apex), radicle, coleorhiza ½ × 5.

CBSE 2026 · S7/4/I Differentiate between wind-pollinated and insect-pollinated flowers. Give an example of each. [3]

Ans. Any four ½ × 4: wind-pollinated flowers are small, dull, without nectar or scent; pollen is light, dry, non-sticky and produced in huge numbers; stigma feathery; stamens well exposed. Insect-pollinated flowers are large, colourful, fragrant, rich in nectar; pollen is sticky, fewer; stigma not feathery. Examples: maize or grasses (wind) ½; sunflower or *Yucca* (insect) ½.

CBSE 2026 · S7/5/I List three outbreeding devices developed by flowering plants and explain how they encourage cross-pollination. [3]

Ans. Any three 1 × 3: (1) pollen release and stigma receptivity are not synchronised (dichogamy), so a flower's own pollen meets no receptive stigma; (2) anther and stigma are placed at different positions, so pollen cannot reach the same flower's stigma; (3) self-incompatibility, a genetic mechanism that stops self-pollen from germinating or growing a tube on the pistil; (4) unisexual flowers, monoecious plants such as castor and maize (prevents autogamy), dioecious plants such as papaya (prevent both autogamy and geitonogamy).

D. Long answer (5 marks)

CBSE 2024 · S7/1/I (a) (i) Explain the development of the male gametophyte. (ii) Draw a labelled three-celled male gametophyte. OR (b) (i) Draw the sectional view of the human ovary and label blood vessels, primary follicle, tertiary follicle, ovum. (ii) When are primary follicles formed? (iii) Explain hormonal and structural events from ovulation till the next cycle. [5]

Ans. (a) (i) ½ × 5: each microspore mother cell in the sporogenous tissue divides by meiosis (microsporogenesis), forming a tetrad of four microspores; as the anther matures and dehydrates the microspores separate into pollen grains; each pollen grain divides by unequal mitosis into a large vegetative cell and a small generative cell; in some species the generative cell divides again into two male gametes (3-celled stage). (ii) Draw: exine with germ pore, intine, vegetative nucleus, two male gametes ½ × 5.
OR (b) (i) Draw the section with the four labels ½ × 4. (ii) In the embryonic (foetal) stage ½. (iii) ½ × 5: LH and FSH peak mid-cycle; the LH surge ruptures the Graafian follicle and causes ovulation; in the luteal phase the remaining follicle becomes the corpus luteum; it secretes large amounts of progesterone to maintain the endometrium; without fertilisation the corpus luteum degenerates, the endometrium disintegrates and menstruation begins.

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CBSE 2024 · 57/2/1 (a) (i) Explain double fertilisation from germination of pollen, with the ploidy of the products and the role of synergids. (ii) Why does endosperm development precede that of the embryo? OR (b) (i) Site of fertilisation; explain fertilisation and how polyspermy is prevented. (ii) Which stage is implanted? Explain implantation. [5]

Ans. (a) (i) The pollen tube grows down the style; the generative cell divides into two male gametes, discharged into the embryo sac through the micropyle and a synergid ½+½. One male gamete + egg → diploid zygote (syngamy) ½+½. The other + two polar nuclei (secondary nucleus, 2n) → triploid PEN (triple fusion) ½+½. Two fusions: double fertilisation ½. The filiform apparatus of the synergids guides the pollen tube ½. (ii) So that the developing embryo has assured nutrition 1.

OR (b) (i) Ampullary(-isthmic) region of the fallopian tube ½. The sperm contacts the zona pellucida; acrosomal secretions help it enter the ovum's cytoplasm; this induces completion of meiosis II, forming the haploid ovum (ootid); the sperm and ovum nuclei fuse into a diploid zygote ½ × 4. Contact with the zona pellucida induces changes in the membrane that block entry of further sperms ½. (ii) Blastocyst ½; its trophoblast attaches to the endometrium; the inner cell mass becomes the embryo; uterine cells divide rapidly and cover the blastocyst, embedding it ½ × 3.

CBSE 2024 · 57/3/1 (a) (i) Explain four devices that encourage cross-pollination. (ii) Why do plants discourage self-pollination? OR (b) Explain the ovarian and uterine events and the role of pituitary and ovarian hormones in the (i) follicular (ii) luteal (iii) menstrual phases. [5]

Ans. (a) (i) 1 × 4: pollen release and stigma receptivity not synchronised; anther and stigma placed at different positions; self-incompatibility, a genetic mechanism that stops self-pollen germinating or growing in the pistil; unisexual flowers (monoecious or dioecious plants). (ii) Continued self-pollination causes inbreeding depression; cross-pollination brings variation for better adaptation 1.

OR (b) (i) Follicular: FSH and LH rise; primary follicles grow into a Graafian follicle and secrete oestrogen; the endometrium regenerates by proliferation 1+1. (ii) Luteal: after the LH surge (ovulation) the follicle becomes the corpus luteum, which secretes much progesterone; the endometrium is maintained and secretory, ready for implantation 1+1. (iii) Menstrual: without fertilisation the corpus luteum degenerates, progesterone falls, and the endometrium and its blood vessels break down and flow out for 3–5 days ½+½.

CBSE 2025 · 57/4/1 (a) (i) Explain double fertilisation. (ii) Write the fate of its products. OR (b) (i) Explain the structure of testicular lobules; name the two cell types of seminiferous tubules and their roles. (ii) Role of GnRH in spermatogenesis. [5]

Ans. (a) (i) 1 × 3: the pollen tube enters a synergid and releases two male gametes; one fuses with the egg nucleus (syngamy), forming the diploid zygote; the other fuses with the two polar nuclei of the central cell (triple fusion), forming the triploid primary endosperm nucleus; two fusions = double fertilisation. (ii) The PEC develops into the endosperm, which nourishes the embryo; the zygote develops into the embryo 1+1.

OR (b) (i) Each testis has about 250 lobules, each with 1–3 highly coiled seminiferous tubules where sperms form ½+½. Male germ cells (spermatogonia) divide by meiosis to form sperms ½+½; Sertoli cells nourish the germ cells ½+½. (ii) GnRH acts on the anterior pituitary to secrete LH, which makes Leydig cells secrete androgens, and FSH, which acts on Sertoli cells and helps spermiogenesis ½ × 2.

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CBSE 2025 · S7/1/1 (A) (a) Distinguish between the two cells of a mature male gametophyte. (b) A diagram shows pollen transfer 1 (within one flower), 2 (between flowers of the same plant) and 3 (between plants). (i) Name methods 1, 2, 3. (ii) How do water lily and *Vallisneria* achieve pollination? (iii) Advantages of method 3. OR (B) A diagram shows a human ovum surrounded by sperms P (entering), Q and R (outside). (i) Compare the fate of P, Q, R. (ii) Role of the zona pellucida. (iii) Changes in the ovum after sperm entry. (iv) Role of the acrosome and middle piece. [5]

Ans. (A) (a) Vegetative cell: large, with abundant food and an irregular nucleus, forms the pollen tube; generative cell: small, spindle-shaped, floating in the vegetative cell, divides into two male gametes ½+1. (b) (i) 1 autogamy, 2 geitonogamy, 3 xenogamy ½ × 3. (ii) Water lily: flowers emerge above the water and are pollinated by insects or wind; *Vallisneria*: female flowers reach the surface on long stalks and male flowers or pollen released on the surface are carried by water currents ½+½. (iii) Genetic variation, healthier and more vigorous offspring, no inbreeding depression (any two) ½+½.
OR (B) (i) P penetrates and fertilises the ovum; Q and R cannot ½+½. (ii) On contact with a sperm it changes and blocks the entry of additional sperms 1. (iii) The secondary oocyte completes meiosis II, forming the second polar body and the haploid ovum (ootid) 1. (iv) The acrosome's enzymes help the sperm enter the ovum 1; the middle piece's mitochondria give energy for the tail's movement 1.

CBSE 2025 · S7/2/1 (A) (i) Describe megasporogenesis. (ii) Draw a mature embryo sac and label four parts. OR (B) (i) Name the four phases of the menstrual cycle in order. (ii) How long does the menstrual phase last? (iii) When and why do oestrogen and progesterone peak? (iv) Significance of the LH surge. [5]

Ans. (A) (i) ½ × 6: the megaspore mother cell (2n) in the nucellus near the micropyle divides by meiosis into a tetrad of four haploid megaspores; three degenerate and one is functional; its nucleus divides mitotically three times (free nuclear divisions, no wall formation) to give 8 nuclei; cell walls then form, giving the 7-celled, 8-nucleate embryo sac (monosporic development). (ii) Draw with labels: synergids with filiform apparatus, egg, central cell with polar nuclei, antipodals ½ × 4.
OR (B) (i) Menstrual → follicular (proliferative) → ovulatory → luteal (secretory) ½ × 4. (ii) 3–5 days ½. (iii) Oestrogen peaks in the late follicular phase, just before ovulation, because the growing follicles secrete it; progesterone peaks in the luteal phase because the corpus luteum secretes it 1+1. (iv) The LH surge ruptures the Graafian follicle: ovulation ½.

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CBSE 2025 · S7/S/I (a) (i) Explain the structure of a typical monocot embryo. (ii) How are multiple embryos formed in citrus? What is this called? OR (b) (i) Name and explain the male sex accessory ducts. (ii) Role of FSH in spermatogenesis. [5]

Ans. (a) (i) ½ × 6: a single cotyledon, the scutellum, lateral to the embryonal axis; at the lower end of the axis the radicle and root cap enclosed in a sheath, the coleorhiza; the part of the axis above the scutellum is the epicotyl, with the shoot apex and leaf primordia enclosed in a hollow foliar sheath, the coleoptile. (ii) Some nucellar cells around the embryo sac divide, protrude into it and develop into embryos 1; polyembryony (by apomixis) 1.
OR (b) (i) Rete testis: the seminiferous tubules open through it into the vasa efferentia; vasa efferentia leave the testis and open into the epididymis on its posterior surface; epididymis leads to the vas deferens; vas deferens ascends to the abdomen, loops over the bladder, receives the seminal vesicle duct and opens into the urethra as the ejaculatory duct 1 × 4. (ii) FSH acts on Sertoli cells and stimulates secretion of factors that help spermiogenesis ½+½.

CBSE 2025 · S7/6/I (a) (i) Explain the structure of a mature embryo sac. (ii) How is triple fusion achieved? OR (b) Describe the changes in ovary and uterus induced by pituitary and ovarian hormones during the menstrual cycle. [5]

Ans. (a) (i) ½ × 8: three cells at the micropylar end form the egg apparatus, two synergids and one egg cell; the synergids have filiform apparatus at the micropylar tip, which guides the pollen tube; three antipodal cells at the chalazal end; a large central cell with two polar nuclei; so the mature embryo sac is 8-nucleate and 7-celled. (ii) One male gamete fuses with the two polar nuclei of the central cell, forming the triploid primary endosperm nucleus 1.
OR (b) Name the phases 1. Menstrual (days 1–5): low LH, FSH, progesterone, oestrogen; the endometrium breaks down and is shed. Follicular (6–13): FSH and LH rise; follicles grow and secrete oestrogen; the endometrium regenerates and thickens. Ovulatory (about day 14): LH surge (FSH peak too) ruptures the Graafian follicle; the lining continues to thicken. Luteal (15–28): the corpus luteum secretes progesterone (and oestrogen), keeping the endometrium ready for implantation; without fertilisation it degenerates and menstruation follows ½ × 8.

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CBSE 2026 · 57/2/1 (a) (i) Explain the role of stigma in pollen–pistil interaction. (ii) Describe the post-pollination events leading to double fertilisation, starting with a 2-celled pollen grain. OR (b) (i) Explain the menstrual phase. (ii) Why is the follicular phase called the proliferative phase? (iii) Explain events in the Graafian follicle at ovulation and after. (iv) Draw a Graafian follicle and label antrum and secondary oocyte. [5]

Ans. (a) (i) The stigma recognises compatible pollen and rejects incompatible pollen (by chemical signals); only compatible pollen germinates 1. (ii) 1 × 4: compatible pollen germinates and its pollen tube grows through stigma and style into the ovary; the generative cell divides into two male gametes; the tube enters the ovule through the micropyle and one synergid through the filiform apparatus, releasing both gametes; one fuses with the egg (syngamy) to form the diploid zygote; the other fuses with the two polar nuclei (triple fusion) to form the triploid primary endosperm nucleus. Two fusions in one embryo sac: double fertilisation.

OR (b) (i) The endometrium and its blood vessels break down and the blood with tissue flows out through the vagina for 3–5 days, because no fertilisation took place 1. (ii) The endometrium regenerates by cell proliferation under oestrogen from growing follicles 1. (iii) The LH surge ruptures the Graafian follicle and the secondary oocyte is released (ovulation); the remaining follicle becomes the corpus luteum, which secretes progesterone 1+1. (iv) Draw the follicle with a fluid-filled antrum and the secondary oocyte surrounded by zona pellucida and granulosa cells (labels) ½+½.

E. Case studies (4 marks)

CBSE 2025 · 57/7/1, Q30 (case, 4 marks): Figure A shows pollen from one flower reaching the stigma of another flower on the same plant; Figure B shows pollen reaching the stigma of the same flower.

(a) Name the processes in A and B. [1] **Ans.** A: geitonogamy; B: autogamy.

(b) Two conditions necessary for B. [2] **Ans.** Pollen release and stigma receptivity must be synchronised, and anthers and stigma must lie close to each other (as in cleistogamous flowers).

(c)(i) One advantage and one disadvantage of B. [1] **Ans.** Assured seed set without pollinators; but no genetic variation, and inbreeding depression. OR (c)(ii) Name a plant where only some flowers show B and the reason. [1] **Ans.** *Viola* (pansy), *Oxalis* or *Commelina*: they also bear cleistogamous flowers, which never open.

What the board asked (16 papers, 2024–2026)

Type	2024	2025	2026	Total
MCQs and Assertion-Reason (1 mark each)	9	8	7	24
Very short answer (2 marks)	2	1	3	6
Short answer (3 marks)	3	4	7	14
Long answer (5 marks)	3	5	1	9
Case studies (4 marks)	0	1	0	1

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Quick-reference sheet

Structure	Ploidy
PMC, MMC, nucellus, integuments, zygote, embryo	2n
microspore, pollen, male gametes, megaspore, egg, synergids, antipodals	n
central cell (2 polar nuclei)	n + n
PEN, endosperm	3n

After fertilisation	Becomes
ovule	seed
integuments	seed coat
ovary	fruit
ovary wall	pericarp
zygote	embryo
PEC	endosperm

✗ **Don't do this:** Do not call the embryo sac "8-celled": it is 8-nucleate, 7-celled.

✗ **Don't do this:** Geitonogamy is genetically self-pollination though an agent is involved.

Case study (practice): a breeder's cross. A breeder wants to cross a disease-resistant wheat (female parent) with a high-yielding wheat (male parent). Wheat flowers are bisexual. (i) Which step must be done first on the female parent and why? (ii) Why is the flower then bagged? (iii) When should the pollen be dusted? (iv) Why would an apomictic version of the resulting hybrid be useful to farmers?

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Practice set: test yourself *Exam-style*

Try every question before looking at the answers on page 20. 64 or more out of 80 means you are ready for the board.

A. Fill in the blanks (1 mark each)

1. The innermost wall layer of the microsporangium is the _____.
2. The exine of pollen is made of _____.
3. A typical angiosperm anther is bilobed and _____.
4. The embryo sac is ___-nucleate and ___-celled.
5. Pollination within the same flower is _____.
6. Fusion of a male gamete with the polar nuclei is _____.
7. The single cotyledon of a grass embryo is the _____.
8. Seeds formed without fertilisation are produced by _____.

B. True or false? (1 mark each)

1. Pollen of rice remains viable for months.
2. Papaya prevents both autogamy and geitonogamy.
3. Endosperm in coconut water is free-nuclear.
4. Cleistogamous flowers can be cross-pollinated.
5. The PEN is diploid.
6. Perisperm is found in black pepper.
7. Apple is a true fruit.
8. Filiform apparatus guides the pollen tube.

C. Very short answer (1 mark each)

1. Name the stalk of the ovule.
2. Where is the egg apparatus located?
3. Name a plant with cleistogamous flowers.
4. Name a water-pollinated plant whose pollen floats.
5. Ploidy of the nucellus.
6. Name the oldest viable seed recorded.
7. What is a false fruit? Give an example.
8. Which part of the ovule forms the seed coat?
9. Name a monoecious plant.
10. Give one example of parthenocarpic fruit.

D. Short answer I (2 marks each)

1. Distinguish between autogamy and geitonogamy.
2. Why is the exine resistant? Where is it absent?
3. Give two adaptations of wind-pollinated flowers.
4. What are floral rewards? Give two examples.
5. How many pollen grains form from 100 PMCs, and why?
6. Give two differences between albuminous and non-albuminous seeds.
7. What is polyembryony? Give an example.
8. Why are pollen banks useful?

My score (fill in after checking the answers)

Section	A /8	B /8	C /10	D /16	E /18	F /20	G (bonus)	Total /80
My marks								

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E. Short answer II (3 marks each)

1. Draw a labelled diagram of the L.S. of a pistil showing pollen tube growth.
2. Describe the structure of a dicot embryo.
3. Explain the steps of an artificial hybridisation programme.
4. How is pollination carried out in *Vallisneria* and *Zostera*?
5. Describe the development of the endosperm and its types with examples.
6. Explain the relationship between *Yucca* and its moth.

F. Long answer (5 marks each)

1. Describe the post-pollination events from pollen–pistil interaction to the formation of the zygote and the PEN.
2. Describe megasporogenesis and the development of the embryo sac with a diagram.

G. HOTS (higher-order thinking)

1. Why do most flowers favour cross-pollination although self-pollination is easier?
2. A plant has flowers whose pollen and stigma mature together but sit far apart. Which pollination is prevented and why?
3. Why does the endosperm develop before the embryo?
4. Why would a seed with 3n cells and 2n cells come from one ovule?

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20 MCQs

1. The innermost wall layer of the microsporangium
(a) endothecium (b) epidermis (c) tapetum (d) middle layer

2. Number of microsporangia in a typical anther
(a) 4 (b) 2 (c) 1 (d) 8

3. Exine is made of
(a) cellulose (b) lignin (c) pectin (d) sporopollenin

4. In over 60% of angiosperms pollen is shed at the
(a) 3-celled stage (b) 2-celled stage (c) tetrad stage (d) microspore stage

5. The embryo sac develops from
(a) all four megaspores (b) one functional megaspore (c) the nucellus (d) the MMC directly

6. Number of free-nuclear divisions in embryo sac formation
(a) 2 (b) 1 (c) 4 (d) 3

7. The filiform apparatus is present in
(a) synergids (b) antipodals (c) egg (d) central cell

8. Geitonogamy is transfer of pollen to
(a) the same flower (b) another plant (c) another flower of the same plant (d) none

9. Which is water-pollinated?
(a) water hyacinth (b) lotus (c) water lily (d) Vallisneria

10. Dioecious plant
(a) maize (b) papaya (c) castor (d) pea

11. Ploidy of the endosperm
(a) n (b) 2n (c) 3n (d) 4n

12. Coconut water is
(a) free-nuclear endosperm (b) cellular endosperm (c) perisperm (d) nucellus

13. Scutellum is
(a) radicle sheath (b) the cotyledon of grasses (c) plumule sheath (d) seed coat

14. Perisperm is found in
(a) wheat (b) pea (c) black pepper (d) castor

15. Apple is a false fruit because the fruit forms partly from
(a) ovule (b) style (c) pericarp (d) thalamus

16. Seedless fruits formed without fertilisation are
(a) parthenocarpic (b) apomictic (c) polyembryonic (d) cleistogamous

17. Polyembryony from nucellar cells occurs in
(a) Citrus (b) wheat (c) pea (d) maize

18. The oldest viable seed recorded
(a) date palm (b) wheat (c) lotus (d) Lupinus arcticus

19. Emasculation is not needed in
(a) pea (b) unisexual female flowers (c) wheat (d) rice

20. The zygote is formed by
(a) triple fusion (b) apomixis (c) syngamy (d) parthenocarpy

1 (c) · 2 (a) · 3 (d) · 4 (b) · 5 (b) · 6 (d) · 7 (a) · 8 (c) · 9 (d) · 10 (b) · 11 (c) · 12 (a) · 13 (b) · 14 (c) · 15 (d) · 16 (a) · 17 (a) · 18 (d) · 19 (b) · 20 (c)

Assertion–Reason (6)

(a) Both true, R explains A. (b) Both true, R does not explain A. (c) A true, R false. (d) A false, R true.

1. A: Pollen grains are well preserved as fossils. R: Their exine is made of sporopollenin, which no enzyme can degrade.
2. A: Cleistogamous flowers produce assured seed sets. R: They are invariably autogamous and need no pollinator.
3. A: The embryo sac is 7-celled. R: It has 8 nuclei.
4. A: Papaya shows geitonogamy. R: Papaya is dioecious.
5. A: The zygote divides only after some endosperm forms. R: The endosperm nourishes the developing embryo.
6. A: Apomictic seeds are genetically identical to the parent. R: Apomixis involves fertilisation between genetically similar plants.

Key: 1 (a) · 2 (a) · 3 (b) · 4 (d) · 5 (a) · 6 (c)

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Answers to the practice set

A. 1. tapetum 2. sporopollenin 3. dithecous 4. 8, 7 5. autogamy 6. triple fusion 7. scutellum 8. apomixis

B. 1. F (30 minutes) 2. T 3. T 4. F 5. F (3n) 6. T 7. F (false fruit) 8. T

C. 1. funicle 2. micropylar end of the embryo sac 3. *Viola*, *Oxalis* or *Commelina* 4. *Vallisneria* 5. 2n 6. *Lupinus arcticus* 7. a fruit in which the thalamus also forms part of the fruit, e.g. apple, strawberry, cashew 8. integuments 9. castor or maize 10. banana

D. 1. Autogamy: pollen to the stigma of the same flower; geitonogamy: to another flower of the same plant (genetically self, but needs an agent) 2. Sporopollenin withstands high temperature, strong acids and alkalis, and no enzyme degrades it; absent at the germ pores 3. Any two: light, non-sticky pollen in large numbers; well-exposed stamens; large feathery stigma; small, inconspicuous flowers 4. Rewards offered to pollinators: nectar and pollen (also safe egg-laying sites, e.g. *Amorphophallus*) 5. 400: each PMC undergoes meiosis to give a tetrad of four pollen grains 6. Albuminous seeds retain endosperm (wheat, castor); non-albuminous seeds have it used up by the embryo (pea, groundnut) 7. More than one embryo in a seed, e.g. *Citrus*, mango 8. Pollen can be stored for years (liquid nitrogen, −196 °C) for crop breeding programmes

E. 1. Draw stigma with pollen and tube, style, ovary with ovule; the tube enters the micropyle and a synergid 2. Embryonal axis with two cotyledons; epicotyl above ending in plumule; hypocotyl below ending in radicle with root cap 3. Select parents; emasculate the bisexual bud; bag; dust collected pollen on the receptive stigma; re-bag 4. *Vallisneria*: female flowers reach the surface on long stalks, male flowers or pollen float and are carried by currents; *Zostera*: female flowers stay submerged and long ribbon-like pollen is carried inside the water; mucilage protects pollen 5. PEC divides; free-nuclear endosperm (coconut water), later cellular (white kernel); consumed in pea, groundnut, beans, persists in castor, coconut 6. The moth cannot complete its life cycle without *Yucca*; it lays eggs in the ovary and pollinates the flower; its larvae eat some seeds: obligate mutualism

F. 1. Pistil recognises compatible pollen; pollen germinates; tube grows through stigma and style; in 2-celled pollen the generative cell divides into two male gametes; tube enters the ovule through the micropyle and a synergid, guided by the filiform apparatus; two gametes released; syngamy → 2n zygote; triple fusion → 3n PEN (double fertilisation) 2. MMC near the micropyle divides by meiosis into four megaspores; three degenerate; one functional (monosporic); three free-nuclear mitoses give 8 nuclei; walls form: egg apparatus (2 synergids + egg), 3 antipodals, central cell with 2 polar nuclei; draw and label

G. 1. Continued selfing causes inbreeding depression; cross-pollination gives variation and vigour 2. Autogamy, because pollen cannot reach the stigma of the same flower (herkogamy); geitonogamy is still possible 3. The embryo needs food from the start 4. The endosperm (3n, from triple fusion) and embryo (2n, from syngamy) both form in one ovule after double fertilisation

Case. (i) Emasculation, removing anthers before they dehisce, to prevent self-pollination (ii) To keep away unwanted pollen (iii) When the stigma becomes receptive, then re-bag (iv) The hybrid characters would not segregate, so farmers could reuse the seed every year

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Last-night summary

- Anther: 4 microsporangia; wall epidermis, endothecium, middle layers, tapetum (nourishes). PMC → meiosis → tetrad → pollen.
- Pollen: exine (sporopollenin, germ pores), intine; vegetative + generative cell; shed 2-celled in >60%.
- Ovule: funicle, hilum, integuments, micropyle, chalaza, nucellus, embryo sac. Monosporic; 8-nucleate, 7-celled.
- Autogamy, geitonogamy, xenogamy; wind, water, insects; outbreeding devices; emasculation and bagging.
- Double fertilisation: syngamy (2n zygote) + triple fusion (3n PEN). Endosperm before embryo. Apomixis, polyembryony.