



**Ready For Boards**  
10th & 12th Exam Prep

## CHAPTER 1

# Sexual Reproduction in Flowering Plants

CBSE Class 12 · Biology · Chapter 1

CBSE · Biology · Class 12

### WHAT THIS CHAPTER DOES

**A**

Draw the labeled mature embryo sac (8-nucleate, 7-celled) from memory in  $\leq 5$  minutes.

**B**

Explain double fertilisation with the 5-step structure (tube  $\rightarrow$  syngamy  $\rightarrow$  triple fusion  $\rightarrow$  why 'double'  $\rightarrow$  significance).

*Boards prep that builds confidence, not anxiety.*

## TODAY'S MISSION

# Today's mission

1

Draw the labeled mature embryo sac (8-nucleate, 7-celled) from memory in  $\leq 5$  minutes.

2

Explain double fertilisation with the 5-step structure (tube  $\rightarrow$  syngamy  $\rightarrow$  triple fusion  $\rightarrow$  why 'double'  $\rightarrow$  significance).

3

Distinguish pollination types and list outbreeding devices.

4

Score 7/8 marks on this chapter's slice of the board paper.

## WHY THIS MATTERS

# Why this chapter matters

1

6-8 marks every CBSE board paper — diagrammatic gift.

2

Double fertilisation is the defining feature of angiosperms (flowering plants) — they dominate land flora because of this efficient strategy.

3

Foundation for entire reproductive biology block in Class 12 (Chs 1-4).

TOPIC

**A**

# Pre-fertilisation — male gametophyte

## TOPIC

# Anther structure & microsporogenesis

### STAMEN = FILAMENT + ANTHER

The stamen is the MALE reproductive organ of a flower, consisting of a slender filament (stalk) and a swollen anther at the tip. The anther is typically DITHECOUS (two lobes joined by connective tissue) and TETRASPORANGIATE — each lobe contains two microsporangia (pollen sacs), giving four sacs in

### MICROSPORANGIUM WALLS

A young microsporangium has four wall layers, from outside to inside: (1) EPIDERMIS — outermost protective layer, single-celled; (2) ENDOTHECIUM — develops fibrous thickenings on radial and inner tangential walls that aid pollen release on drying; (3) MIDDLE LAYERS — 2-3 thin layers that degenerate as the pollen matures; (4)

### MICROSPOROGENESIS

The process of forming microspores (immature pollen grains) inside the microsporangium. The diploid microsporocyte (pollen mother cell,  $2n$ ) undergoes MEIOSIS to produce four haploid microspores arranged in a tetrad. The tetrad pattern is most often tetrahedral, but can be isobilateral, decussate, or linear.

### MATURE POLLEN

At the time of shedding from the anther, the pollen grain is 2-CELLED in most angiosperms: a large vegetative cell (with abundant cytoplasm and reserve food) and a smaller generative cell (lens-shaped, floating in the vegetative cell's cytoplasm). The generative cell divides MITOTICALLY (no meiosis) to produce two

TOPIC

**B**

# Pre-fertilisation — female gametophyte

## TOPIC

# Ovule + megasporogenesis + embryo sac

### PISTIL PARTS

The pistil (gynoecium) is the FEMALE reproductive organ, comprising three parts: (1) STIGMA — sticky, often feathered tip that receives pollen and recognises species-specific chemical cues; (2) STYLE — a slender tube through which the pollen tube grows from stigma to ovary; (3) OVARY — a swollen basal chamber containing one or

### OVULE STRUCTURE

An ovule (megasporangium) is attached to the placenta inside the ovary by a stalk called the FUNICLE; the point of attachment to the ovule body is the HILUM. The body of the ovule consists of: NUCELLUS (the central tissue, megasporangium proper, where the embryo sac forms), surrounded by ONE

### MEGASPOROGENESIS

The process of producing megaspores from the megaspore mother cell (MMC). One cell of the nucellus differentiates into the diploid MMC ( $2n$ ) — usually near the micropylar end. The MMC undergoes MEIOSIS to produce a LINEAR TETRAD of four haploid megaspores. In most flowering plants only ONE megaspore (usually

### EMBRYO SAC (POLYGONUM TYPE)

The functional megaspore enlarges and undergoes THREE successive mitotic divisions WITHOUT cell-wall formation, producing 8 free nuclei in two groups of four (one at each pole). Cellularisation then organises these into a 7-celled, 8-nucleate Polygonum-type embryo sac: at the MICROPYLAR

TOPIC

**C**

# Pollination — transfer of pollen

## TOPIC

# Three types + agents

### AUTOGAMY

AUTOGAMY = self-pollination strictly within the same flower (pollen transferred from anther to stigma of the SAME flower). Common in cleistogamous flowers (which never open — guaranteed self-pollination, no pollinator needed; examples: Viola, Oxalis, some grasses). Many cultivated crops are predominantly autogamous.

### GEITONOLOGY

GEITONOLOGY = transfer of pollen from one flower to another flower on the SAME plant. Although it requires a pollinator (functionally cross-pollination from the bee's point of view), the genetic outcome is identical to self-pollination — both donor and recipient gametes come from the same individual plant, so no new gene combinations.

### XENOLOGY

XENOLOGY = transfer of pollen between flowers of TWO DIFFERENT plants — true cross-pollination. This is the only mode that genuinely outcrosses and produces new gene combinations through meiosis + recombination. Xenology is biologically the most valuable form of pollination because it: (1) increases genetic variability.

### AGENTS

POLLINATION AGENTS fall into two broad classes — ABIOTIC (wind, water) and BIOTIC (animals). ANEMOPHILY (wind-pollinated): grasses, maize, papaya — flowers are small, dull-coloured, no nectar, large quantities of light dry pollen, exerted feathery stigmas. HYDROPHILY (water-pollinated, rare): Vallisneria (epihydrophily —

## TOPIC

# Why plants AVOID self-pollination

### INBREEDING DEPRESSION

INBREEDING DEPRESSION = the loss of vigour, fertility, growth rate, and yield that follows several generations of continued self-pollination or close inbreeding.

Mechanism: self-fertilisation makes harmful recessive alleles homozygous and exposes them to selection. Plants that evolved outbreeding mechanisms (dichogamy

### DICHOGAMY

DICHOGAMY = pollen and stigma of the same flower mature at DIFFERENT times, ensuring outcrossing. Two patterns: (1) PROTANDRY — anthers mature first, releasing pollen before that flower's stigma is receptive (sunflower, salvia, fennel, most Asteraceae and Apiaceae); (2) PROTOGYNY — stigma matures first, becoming receptive before

### SELF-INCOMPATIBILITY

SELF-INCOMPATIBILITY is a GENETIC mechanism that prevents a flower's own pollen (or pollen from a closely related plant) from successfully fertilising its eggs, even when both gametes are functional. Mediated by a multi-allelic S-locus — pollen carrying the same S-allele as the maternal plant fails to grow a pollen tube down the

### HETEROSTYLY + UNISEXUAL FLOWERS

HETEROSTYLY = flowers of the same species occur in two or three style-length morphs that promote cross-pollination between morphs only. Primula has 'pin' (long style, short stamens) and 'thrum' (short style, long stamens) — pollinators transfer pollen between morphs at matching heights. UNISEXUAL

TOPIC

**D**

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# Double fertilisation — the angiosperm signature

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THEOREM · LOAD-BEARING RESULT

# Double Fertilisation



*In flowering plants, ONE pollen tube delivers TWO male gametes to the embryo sac. Both undergo fusion events — one with the egg (syngamy → zygote), one with the polar nuclei (triple fusion → endosperm). Both are fertilisation events ⇒ DOUBLE fertilisation.*

## STATEMENT

**Syngamy:** male gamete 1 (n) + egg cell (n) → Zygote (2n). **Triple fusion:** male gamete 2 (n) + 2 polar nuclei (n + n = 2n) → Primary Endosperm Nucleus (PEN, 3n, triploid). Both events occur inside the same embryo sac.

## WHY THIS MATTERS

- Unique to angiosperms (no other plant group does this)
- It ensures endosperm forms ONLY after fertilisation succeeds — no wasted resources on unfertilised ovules
- Triploid endosperm offers hybrid vigour and rich nutrition for the developing embryo

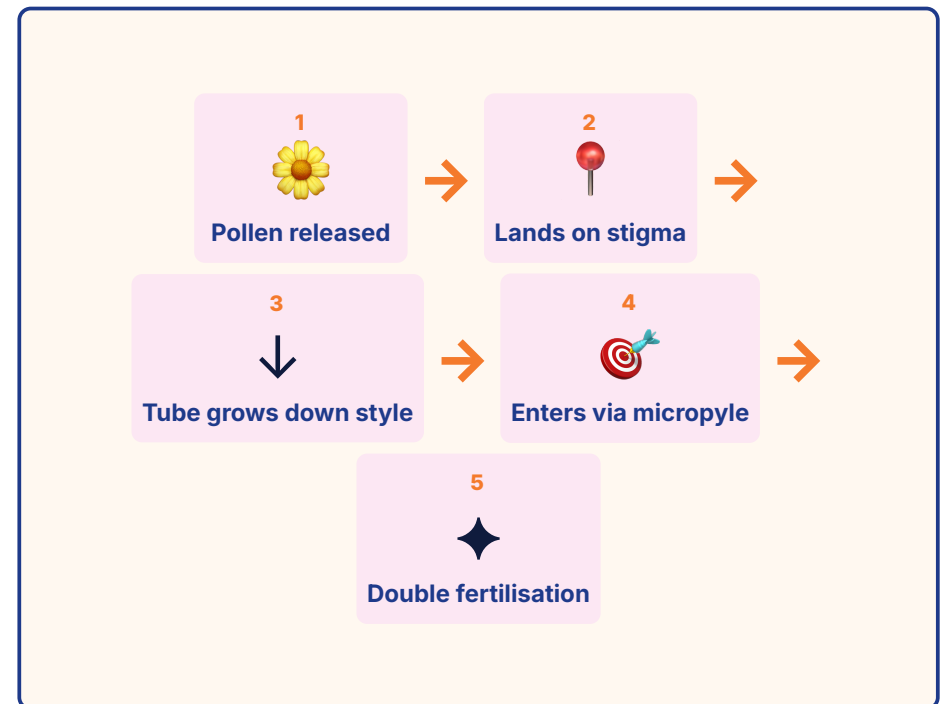
## WATCH OUT FOR

**NOTE** Don't confuse this with 'two pollen tubes' or 'two eggs'. It's ONE tube delivering TWO gametes, both fusing. The two fusions happen in different parts of the same embryo sac.

## WORKED EXAMPLE

# Pollination → fertilisation → seed

- 1** Pollen released from anther (microsporangium ripens, dehisces).
- 2** Lands on stigma. Compatibility check — incompatible pollen rejected.
- 3** Pollen tube germinates, grows through style.
- 4** Enters embryo sac via micropyle. Releases 2 male gametes.
- 5** Syngamy (m.g.1 + egg) → zygote (2n). Triple fusion (m.g.2 + polar nuclei) → PEN (3n).



TOPIC

**E**

# Post-fertilisation — seed & fruit

## TOPIC

# From zygote to seed to fruit

### ENDOSPERM (3N) DEVELOPS FIRST

After double fertilisation, the PRIMARY ENDOSPERM NUCLEUS (PEN,  $3n$  — formed from fusion of one male gamete with the two polar nuclei) divides MITOTICALLY many times to form the endosperm tissue. Endosperm development typically PRECEDES embryo development because the

### EMBRYO (2N)

After fertilisation the diploid ZYGOTE ( $2n$ ) undergoes a sequence of MITOTIC divisions following a precise developmental programme: PROEMBRYO (early few-celled stage) → GLOBULAR (spherical mass of cells) → HEART-SHAPED (in dicots — emergence of two cotyledon lobes) → TORPEDO (elongation, cotyledons fully formed) →

### SEED COAT

After fertilisation the integuments of the ovule harden and become the SEED COAT, with the outer integument forming the TESTA (tough, often pigmented outer layer that provides physical protection and water-impermeability) and the inner integument forming the TEGMEN (thinner inner layer). The ovule body as a whole

### FRUIT

The OVARY develops into the FRUIT after fertilisation; the ovary wall (pericarp) thickens into the fruit wall. In FLESHY fruits the pericarp differentiates into three distinct layers: EPICARP (outermost skin — mango peel, tomato skin), MESOCARP (middle, fleshy edible portion — mango pulp, peach flesh), and ENDOCARP (innermost

## TOPIC

# Apomixis + Polyembryony

### APOMIXIS

APOMIXIS = formation of seeds WITHOUT fertilisation — asexual reproduction through seed. The embryo may develop from the diploid nucellus or integuments (NUCELLAR EMBRYONY — common in many citrus varieties), or from an unreduced ( $2n$ ) egg without fertilisation (PARTHENOGENESIS).  
Apomictic seeds are

### POLYEMBRYONY

POLYEMBRYONY = the occurrence of MORE THAN ONE embryo inside a single seed. May arise from: (1) cleavage of the zygote into two or more embryos before differentiation — true polyembryony; (2) development of additional embryos from nucellar or integumentary cells alongside the zygotic embryo — nucellar

### WHY CARE

Apomictic seeds give farmers a route to PERMANENT FIXATION of hybrid vigour. Normally an  $F_1$  hybrid's vigour is lost in  $F_2$  because of allelic segregation, forcing farmers to buy fresh  $F_1$  seed every season. If a hybrid could be made apomictic, its full hybrid vigour would propagate through the seed.

### BOTH CAN CO-OCCUR

Polyembryony and apomixis are RELATED but DISTINCT concepts. Many citrus varieties show BOTH: the seed contains one zygotic (sexual,  $2n$ ) embryo from normal fertilisation, plus several nucellar (apomictic) embryos that are clones of the mother. On germination the most vigorous embryo usually wins — and in citrus rootstock breeding it is

## TOPIC

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# Pollination vs fertilisation

### TRAP → TRUTH

× **MISTAKE** Pollination and fertilisation are the same event.

✓ **CORRECT** Pollination = TRANSFER of pollen from anther to stigma (mechanical/agent-mediated). Fertilisation = FUSION of male gamete with egg cell (cellular event inside the ovule). Pollination is prerequisite; fertilisation happens after the pollen tube reaches the ovule.

## TOPIC

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# Embryo sac nuclei count

### TRAP → TRUTH

× **MISTAKE** Mature embryo sac has 7 nuclei.

✓ **CORRECT** Mature embryo sac (Polygonum type) has 7 CELLS but 8 NUCLEI: 1 egg cell, 2 synergids, 3 antipodals, 1 central cell with 2 polar nuclei = 7 cells, total 8 nuclei (2 polar nuclei in one central cell).

## TOPIC

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# Double fertilisation

### TRAP → TRUTH

× **MISTAKE** Double fertilisation means two pollen tubes fuse with two eggs.

✓ **CORRECT** Double fertilisation = ONE pollen tube delivers TWO male gametes. Male gamete 1 fuses with egg → zygote ( $2n$ ). Male gamete 2 fuses with the 2 polar nuclei → primary endosperm nucleus ( $3n$ , triploid). This is unique to angiosperms.

## TOPIC

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# Endosperm ploidy

### TRAP → TRUTH

× **MISTAKE** Endosperm is diploid ( $2n$ ) like the embryo.

✓ **CORRECT** Endosperm is **TRIPLIOD** ( $3n$ ) — formed by fusion of one male gamete ( $n$ ) with two polar nuclei ( $n + n$ ). The embryo is diploid ( $2n$ ). This  $3n$  endosperm provides nutrition to the developing embryo.

## TOPIC

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# Polyembryony vs apomixis

### TRAP → TRUTH

× **MISTAKE** Polyembryony and apomixis are the same thing.

✓ **CORRECT** Apomixis = seed formed WITHOUT fertilisation (asexual seed). Polyembryony = MULTIPLE embryos in a single seed (may or may not involve fertilisation). Citrus shows polyembryony; some grasses show apomixis. Both can occur together but are distinct concepts.

## TOPIC

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# Self vs cross-pollination

### TRAP → TRUTH

× **MISTAKE** Self-pollination is rare in flowering plants.

✓ **CORRECT** Self-pollination is COMMON; many plants (peas, wheat, rice) are predominantly self-pollinated. Plants evolved OUTBREEDING devices (e.g., self-incompatibility, dichogamy, heterostyly) PRECISELY because excessive self-pollination causes inbreeding depression. Both strategies coexist.

## TOPIC

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# Pollen viability

### TRAP → TRUTH

× **MISTAKE** Pollen grains survive indefinitely once shed.

✓ **CORRECT** Pollen viability varies hugely by species — from 30 minutes (rice, wheat) to several months (rose family). Storage at low temperature + low humidity extends viability. Why? Pollen is metabolically active; respiration drains reserves over time.

**TOPPER TEMPLATE · MARK-BY-MARK**

# 5-mark: 'Draw a labeled diagram of the mature embryo sac (8-nucleate 7-celled). Identify its parts.'

- 1 OUTER OUTLINE**  
1 m  
Draw an oval/elongated shape representing the embryo sac inside the ovule. Show the micropylar end at top, chalazal at bottom.
- 2 MICROPYLAR END — 3 CELLS**  
1 m  
At the micropylar end, draw: 1 egg cell (centre, pear-shaped) flanked by 2 synergids. Together: the egg apparatus.
- 3 CENTRE — CENTRAL CELL WITH 2 POLAR NUCLEI**  
1 m  
Draw the large central cell occupying most of the embryo sac. Show two polar nuclei inside it (they will later fuse with the 2nd male gamete).
- 4 CHALAZAL END — 3 ANTIPODAL CELLS**  
1 m  
At the chalazal end, draw 3 small antipodal cells (a row or cluster). These are non-functional in fertilisation.
- 5 LABELS + NUCLEAR COUNT STATEMENT**  
1 m  
Label all 7 cells clearly. State: 'Mature embryo sac has 7 cells and 8 nuclei (2 polar nuclei in the central cell counted separately).' This statement alone is often worth 1 mark.

TOPPER TEMPLATE · MARK-BY-MARK

# 5-mark: 'Explain double fertilisation. Why is it called so? Significance.'

- 1 POLLEN TUBE DELIVERY**  
1 m  
After germination of pollen on stigma, the pollen tube grows through the style and enters the embryo sac via the micropyle. It carries two male gametes ( $n$  each) — formed by mitotic division of the generative cell.
- 2 FIRST FUSION → ZYGOTE**  
1 m  
Male gamete 1 ( $n$ ) fuses with the egg cell ( $n$ ) → ZYGOTE ( $2n$ ). This is SYNGAMY. The zygote develops into the embryo.
- 3 SECOND FUSION → ENDOSPERM**  
1 m  
Male gamete 2 ( $n$ ) fuses with the 2 polar nuclei ( $n + n = 2n$ ) in the central cell → PRIMARY ENDOSPERM NUCLEUS ( $3n$ , TRIPLOID). This is TRIPLE FUSION. The PEN develops into endosperm tissue.
- 4 WHY 'DOUBLE'**  
1 m  
Both fusions are 'fertilisations' — two distinct fusion events in the same embryo sac. Hence 'DOUBLE fertilisation'. Unique to flowering plants (angiosperms).
- 5 SIGNIFICANCE**  
1 m  
(a) Embryo ( $2n$ ) develops from zygote. (b) Endosperm ( $3n$ ) provides nutrition to embryo during seed development. (c) Endosperm formation only after fertilisation = no wasted resources on unfertilised ovules. (d) Triploid endosperm has hybrid vigour. (e) Angiosperms' evolutionary success owes much to this efficient resource allocation.

TOPPER TEMPLATE · MARK-BY-MARK

## 3-mark: 'List and explain three outbreeding devices in plants.'

- 1** **DICHOGAMY**  
1 m  
Pollen and stigma mature at different times within the same flower. Protandry (pollen first, e.g., sunflower) and protogyny (stigma first, e.g., fig).
- 2** **SELF-INCOMPATIBILITY**  
1 m  
Genetic mechanism preventing pollen from same flower (or same genotype) from fertilising. E.g., Brassica family. Prevents inbreeding even if pollen lands on stigma.
- 3** **HETEROSTYLY + UNISEXUAL FLOWERS**  
1 m  
Heterostyly: flowers of same species have different style/stamen lengths (e.g., Primula) → pollen from one type only fertilises stigma of another. Or: plants are monoecious (male & female flowers separate, e.g., maize) or dioecious (male & female plants separate, e.g., papaya).

## PYQ PATTERNS

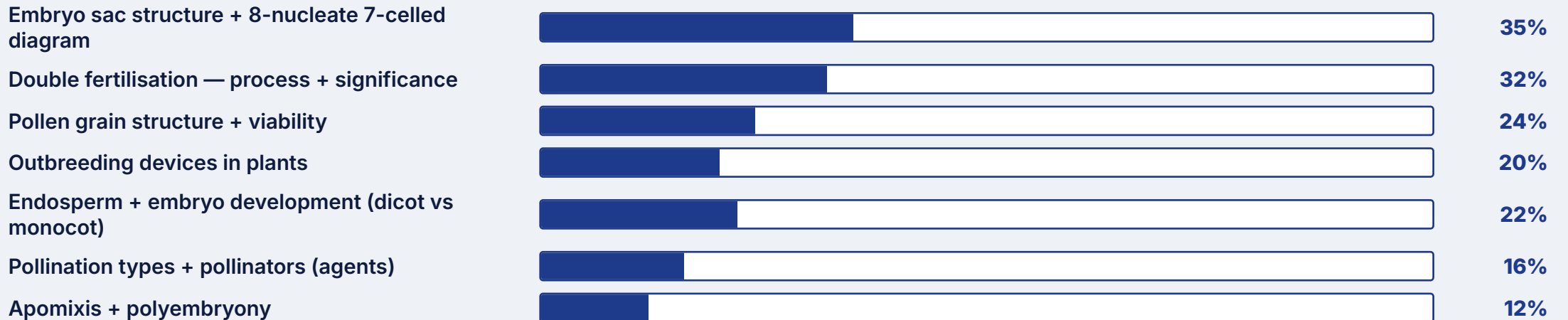
# Top PYQ patterns to drill

#1	Draw a labeled L.S. of a typical anatropous ovule. Identify embryo sac, micropyle, chalaza, funicle, integuments. (5 marks)	Annual
#2	Explain double fertilisation. Why is it called so? Significance. (3-5 marks)	2017, 2018, 2020, 2022, 2024
#3	Differentiate between self-pollination and cross-pollination. List 3 outbreeding devices. (3 marks)	2018, 2019, 2022
#4	Draw a labeled diagram of a mature pollen grain. State its parts. (3 marks)	2020, 2023
#5	What is apomixis? Differentiate from polyembryony. (2-3 marks)	2018, 2021, 2023

## MARKS DISTRIBUTION

# 10-year marks distribution

### 10-YEAR PYQ MARKS DISTRIBUTION



**RECAP · MEMORISE THESE**

## Recap — 3 things to remember

**1** Embryo sac — 7 CELLS, 8 NUCLEI. Egg + 2 synergids + 3 antipodals + 1 central cell (2 polar nuclei).

**2** Double fertilisation — Syngamy (m.g.1 + egg → zygote 2n) + Triple fusion (m.g.2 + 2 polar nuclei → PEN 3n).

**3** After fertilisation — Zygote → embryo (2n). PEN → endosperm (3n). Integuments → seed coat. Ovary → fruit.

## WHAT'S NEXT

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# What's next



- Chapter 2 — Human Reproduction (parallels: gametes, fertilisation, post-fertilisation events).
- Sit the 15-MCQ Quick Drill under 20-min timer.
- Then the full Board-Pattern Paper — 30 marks, 60 min.



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# You've mastered the reproductive biology of angiosperms.

*Embryo sac, double fertilisation, seed formation — now prove it.*

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