Ch 1 · Sexual Reproduction in Flowering Plants

अध्याय 1 · पुष्पी पादपों में लैंगिक जनन

Class 12 Biology · NCERT based · English + हिंदी · ✍️ revision notes

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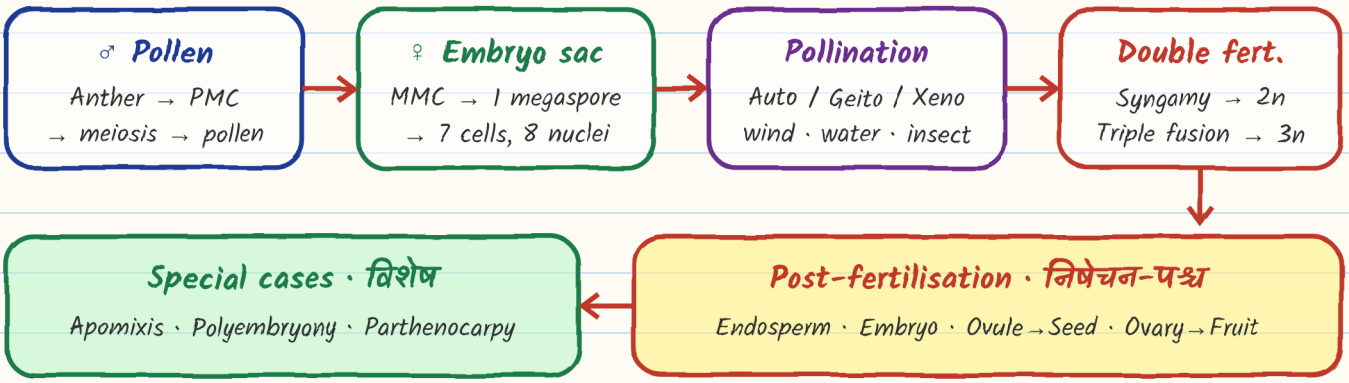
Chapter at a glance · एक नज़र में



Infographic: whole chapter flow

1. Flower – Site of Sexual Reproduction / पुष्प

- Flower = modified shoot meant for sexual reproduction.
  पुष्प एक रूपांतरित प्ररोह है जो लैंगिक जनन का स्थल है।
- **Androecium** (♂) = whorl of **stamens** (पुंकेसर)
- **Gynoecium** (♀) = **pistil / carpels** (स्त्रीकेसर / अंडप)

Pre-fertilisation निषेचन-पूर्व → Fertilisation निषेचन → Post-fertilisation निषेचन-पश्च

2. Stamen, Microsporangium & Pollen / पुंकेसर व परागकण

(a) Stamen पुंकेसर

Stamen = **filament** (पुंतंतु) + **anther** (परागकोश).

- Typical anther: bilobed → each lobe has 2 theca → dithecous (द्विकोष्ठी).
- In T.S. anther is tetragonal with **4 microsporangia** (pollen sacs) at corners → tetrasporangiate.

(b) Wall of Microsporangium लघुबीजाणुधानी की भित्ति

4 wall layers (outside → inside):

1. **Epidermis** (बाह्यत्वचा) – protection
2. **Endothecium** (अंतःस्थीसियम) – protection + helps in **dehiscence** (anther bursting)
3. **Middle layers** (मध्य परतें) – 1 to 3 layers
4. **Tapetum** (टेपीटम) – innermost; nourishes developing pollen. Cells have dense cytoplasm, generally **more than one nucleus**.

Centre: **sporogenous tissue** (बीजाणुजन ऊतक) – compactly arranged homogenous cells.

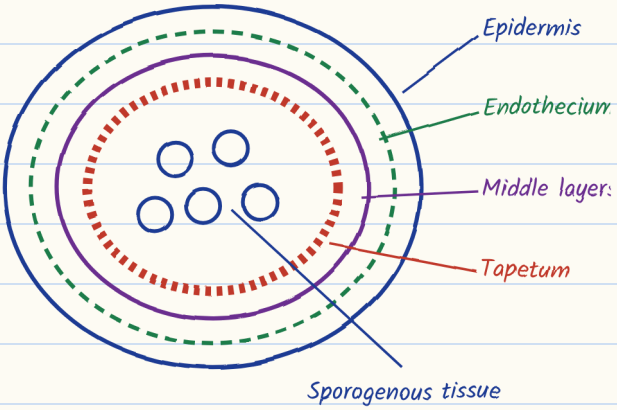


Fig: T.S. of a microsporangium (wall layers) · लघुबीजाणुधानी का अनुप्रस्थ काट

(c) Microsporogenesis लघुबीजाणुजनन

Sporogenous cell → Microspore Mother Cell (PMC) 2n → **meiosis** → Microspore tetrad (n) → Pollen grains

लघुबीजाणु मातृ कोशिका से अर्धसूत्री विभाजन द्वारा लघुबीजाणु बनने की प्रक्रिया को लघुबीजाणुजनन कहते हैं।

As anther matures & dehydrates → microspores separate → develop into **pollen grains**. Thousands of pollen per microsporangium.

(d) Pollen Grain = ♂ Gametophyte परागकण = नर युग्मकोद्भिद

- Generally spherical, **25–50 µm** diameter.
- Two-layered wall:
  - **Exine** (बाह्यचोल) – hard, made of sporopollenin = most resistant organic material known. Withstands high temp, strong acids & alkali; **no enzyme** can degrade it. → So pollen is well preserved as **fossils**.
  - **Germ pores** (जनन छिद्र) – apertures on exine where sporopollenin is absent.
  - **Intine** (अंतःचोल) – thin, continuous, made of **cellulose + pectin**.
- Mature pollen has 2 cells:

Vegetative cell (कायिक)	Generative cell (जनन)
Bigger, abundant food reserve, large irregular nucleus	Small, spindle-shaped, dense cytoplasm, floats in vegetative cell
Forms pollen tube	Divides mitotically → 2 male gametes

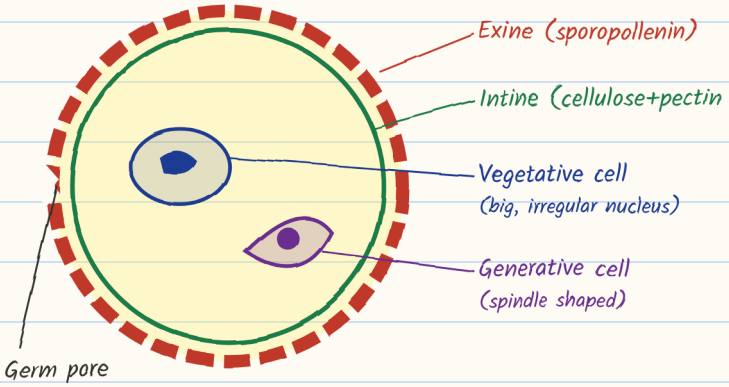


Fig: Mature 2-celled pollen grain · परिपक्व परागकण

- In over 60% angiosperms pollen is shed at **2-celled stage**; rest at **3-celled stage**.

📌 **Exam Tip:** Pollen viability – **rice & wheat ≈ 30 min**; some members of **Rosaceae, Leguminosae, Solanaceae** → months.
Pollen stored in **liquid nitrogen (–196 °C)** in **pollen banks**.
Parthenium (carrot grass) pollen → allergy. Pollen tablets used as food supplements.
परागकण -196°C पर द्रव नाइट्रोजन में संग्रहित किए जाते हैं।

3. Pistil, Ovule & Embryo Sac / स्त्रीकेसर, बीजांड व भ्रूणकोष

(a) Pistil स्त्रीकेसर

- Parts: **Stigma** (वर्तिकाग्र) – landing platform for pollen; **Style** (वर्तिका); **Ovary** (अंडाशय).
- **Monocarpellary** (1 carpel) / **Multicarpellary** (many).
- Multicarpellary: Syncarpous (fused, e.g. *Papaver*) / Apocarpous (free, e.g. *Michelia*).
- Inside ovary → **ovarian cavity (locule)** → **placenta** → ovules (megasporangia).
- No. of ovules: one (wheat, paddy, mango) → many (papaya, watermelon, orchids).

(b) Ovule (Megasporangium) बीजांड (गुरुबीजाणुधानी)

Part	हिंदी	Meaning
Funicle	बीजांडवृंत	Stalk joining ovule to placenta
Hilum	नाभिका	Junction of ovule body & funicle
Integuments	अध्यावरण	1 or 2 protective envelopes
Micropyle	बीजांडद्वार	Small opening at tip
Chalaza	निभाग	Basal part, opposite micropyle
Nucellus	बीजांडकाय	Mass of cells with food reserve
Embryo sac	भ्रूणकोष	Female gametophyte, inside nucellus

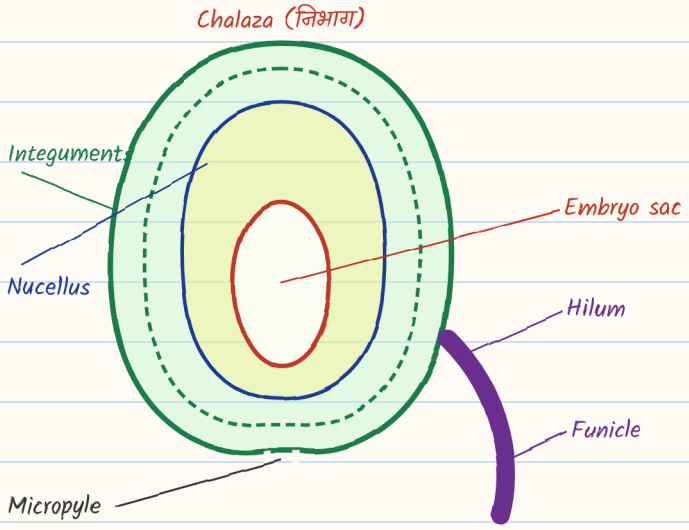


Fig: L.S. of anatropous ovule · प्रतीप बीजांड

Generally **one embryo sac** per ovule.

(c) Megasporogenesis गुरुबीजाणुजनन

MMC (2n) at micropylar end of nucellus → **meiosis** → 4 megaspores (n) → 3 degenerate, 1 functional

Embryo sac formed from a **single megaspore** → monosporic development (एकबीजाणुज विकास).

(d) Development of Embryo Sac भ्रूणकोष का विकास

- Functional megaspore nucleus divides **mitotically 3 times** (1 → 2 → 4 → 8 nuclei). First 2 divisions: 2 nuclei go to opposite poles.
- These are free nuclear divisions (no cell wall yet). After 8-nucleate stage → cell walls form.
- Result: 7-celled, 8-nucleate embryo sac. (7 कोशिकीय, 8 केंद्रकीय)

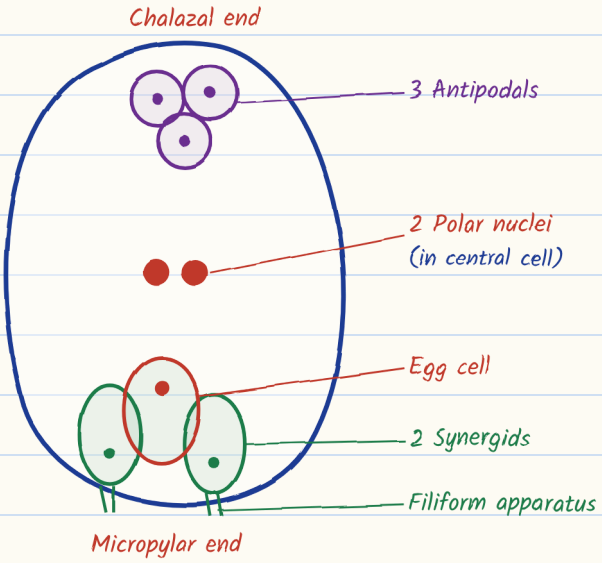


Fig: Mature embryo sac (7-celled, 8-nucleate) · परिपक्व भ्रूणकोष

Location	Cells	No. of nuclei
Micropylar end	**Egg apparatus** (अंड समुच्चय) = 2 synergids + 1 egg	3
Chalazal end	**3 Antipodals** (प्रतिमुखी)	3
Centre	**Central cell** with 2 polar nuclei (केंद्रीय कोशिका)	2
Total		**7 cells, 8 nuclei**

📌 **Exam Tip: Filiform apparatus** (तंतुरूप समुच्चय) = special cellular thickenings at micropylar tip of **synergids**. It guides the pollen tube into the synergid. — very frequently asked (1 mark)!

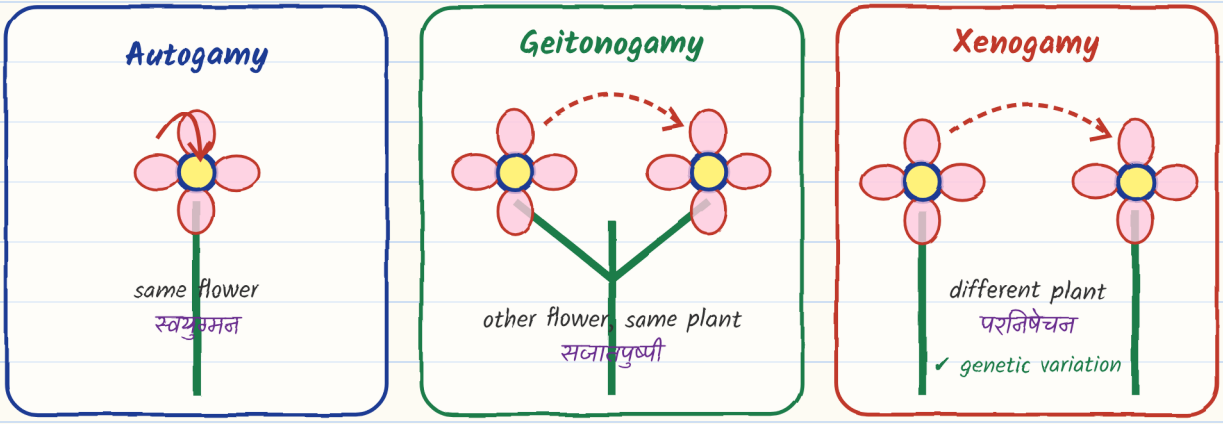
4. Pollination / परागण

Definition: Transfer of pollen grains from anther to stigma of a pistil.

परागकोश से परागकणों का वर्तिकाग्र तक स्थानांतरण परागण कहलाता है।

(a) Kinds of Pollination परागण के प्रकार

Type	Pollen goes from → to	Note
Autogamy स्वयुग्मन	Anther → stigma of same flower	Needs synchrony of pollen release & stigma receptivity
Geitonogamy सजातपुष्पी परागण	Flower → another flower of same plant	Functionally cross, genetically self (needs agent)
Xenogamy परनिषेचन	Flower → flower of different plant	Only type bringing **genetically different** pollen



Infographic: 3 kinds of pollination · परागण के तीन प्रकार

Chasmogamous (उन्मील परागणी) flowers – open, exposed anthers & stigma.

Cleistogamous (अनुन्मील्य परागणी) flowers – never open; invariably autogamous; assured seed-set even without pollinators. e.g. *Viola* (pansy), *Oxalis*, *Commelina* (produce both types).

(b) Agents of Pollination परागण कारक

Abiotic (wind, water) & **Biotic** (animals). Majority of plants use **biotic** agents.

Wind (Anemophily) वायु परागण	Water (Hydrophily) जल परागण	Insects (Entomophily) कीट परागण
· Light, **non-sticky** pollen · Well-exposed stamens · Large, **feathery stigma** · Often **single ovule**; many flowers in inflorescence e.g. **corn cob** (tassels = stigma+style), **grasses**	· Quite **rare** (~30 genera, mostly monocots) · e.g. *Vallisneria*, *Hydrilla*, *Zostera* (sea-grass) · Pollen protected by **mucilaginous covering**	· Large, colourful, fragrant flowers, rich in **nectar** · Sticky pollen · Small flowers form inflorescence to be visible · Bees = dominant pollinators

- *Vallisneria*: female flower reaches water surface by **long stalk**; male flowers/pollen released on surface → carried passively by water currents.
- Sea-grasses: female flowers remain **submerged**; pollen **long & ribbon-like**, carried inside water.

- Not all aquatic plants are water pollinated! **Water hyacinth & water lily** → pollinated by **insects or wind**.
- **Wind & water pollinated flowers** are not colourful & do not produce nectar.

📌 **Special examples (MCQ favourites):**

· *Amorphophallus* – tallest flower (~6 ft).

· **Yucca** & **moth** – moth deposits eggs in ovary locule; neither can complete life cycle without the other.

· **Ophrys** (orchid) – petal resembles female bee → male bee "pseudocopulates" → pollination.

· **Pollen/nectar robbers** – consume pollen/nectar without pollinating.

· Rewards to animals: nectar, pollen, safe place to lay eggs.

(c) Outbreeding Devices बहिःप्रजनन युक्तियाँ

Continued self-pollination → **inbreeding depression**. Plants avoid it by:

1. Pollen release & stigma receptivity **not synchronised**.
2. Anther & stigma at **different positions**.
3. Self-incompatibility (स्व-असामंजस्य) – genetic mechanism; pollen of same flower/plant can't germinate or grow tube.
4. **Unisexual flowers**:
   - **Monoecious** (उभयलिंगाश्रयी) – ♂ & ♀ flowers on same plant (castor, maize) → prevents **autogamy only**, not geitonogamy.
   - **Dioecious** (एकलिंगाश्रयी) – on different plants (papaya) → prevents **both** autogamy & geitonogamy.

5. Pollen–Pistil Interaction / परागकण-स्त्रीकेसर संकर्षण

- Pistil can **recognise** compatible pollen (via chemical interaction of pollen & pistil).
- Compatible → pollen germinates → **pollen tube** through germ pore → grows through stigma & style → reaches ovary.
- Pollen tube enters ovule through **micropyle** → enters a **synergid** guided by **filiform apparatus**.
- Incompatible → pistil rejects pollen.
- उचित परागकण की पहचान, अंकुरण से लेकर परागनलिका के बीजांड में प्रवेश तक की सभी घटनाएँ परागकण-स्त्रीकेसर संकर्षण कहलाती हैं।

Artificial Hybridisation कृत्रिम संकरण

Used in crop improvement – only desired pollen should reach stigma.

Emasculation
विपुंसन
remove anthers before dehiscence (bisexual flower) → **Bagging** *बोरावस्त्रावरण* cover with butter-paper bag →

Dust desired pollen when stigma receptive → **Rebagging**

Unisexual female flowers → **no emasculation** needed; only bagging.

6. Double Fertilisation / द्वि-निषेचन

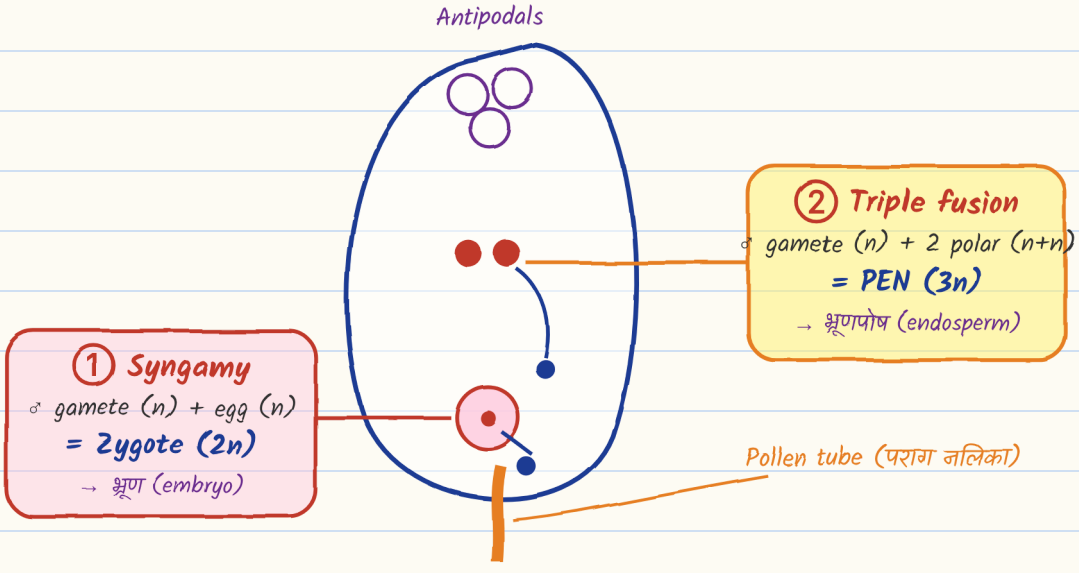
Pollen tube releases **2 male gametes** into cytoplasm of synergid.

① **Syngamy** *(युग्मक संलयन)*: Male gamete (n) + Egg (n) → Zygote (2n) → Embryo

② **Triple fusion** *(त्रिसंलयन)*: Male gamete (n) + 2 Polar nuclei (n+n) → PEN – Primary Endosperm Nucleus (3n) → Endosperm

Two fusions in one embryo sac = **Double fertilisation** → unique to angiosperms.

Central cell → **PEC (primary endosperm cell)**.



Infographic: Double fertilisation · द्वि-निषेचन (2 fusions = 5 nuclei involved)

📌 **Exam Tip:** Triple fusion involves **3 haploid nuclei** → endosperm is **triploid (3n)**. Name both fusions + their products in 2-mark Qs.

7. Post-Fertilisation Events / निषेचन-पश्च घटनाएँ

Endosperm & embryo development, maturation of **ovule** → **seed** and **ovary** → **fruit**.

(a) Endosperm भ्रूणपोष

- Develops **before** embryo (to nourish it).
- Most common: free-nuclear endosperm – PEN divides repeatedly without wall formation, then cell wall formation → cellular.
- **Coconut**: tender coconut water = free-nuclear endosperm (thousands of nuclei); white kernel = cellular endosperm.
- May be fully consumed (pea, groundnut, beans) or persist (castor, coconut).

(b) Embryo भ्रूण

Develops at **micropylar end** of embryo sac.

Zygote → Proembryo → Globular → Heart-shaped → Mature embryo

Dicot embryo (द्विबीजपत्री)	Monocot embryo (एकबीजपत्री)
· Embryonal axis + **2 cotyledons** · Above cotyledons: **epicotyl** → **plumule** (shoot tip) · Below: **hypocotyl** → **radicle** (root tip) with **root cap**	· **1 cotyledon** = scutellum (वरुथिका) (in grasses), lateral · Radicle + root cap enclosed by coleorhiza (मूलांकुरचोल) · Shoot apex + leaves enclosed by coleoptile (प्रांकुरचोल)

(c) Seed बीज

Seed = **final product of sexual reproduction**; a fertilised ovule. Has **seed coat**, **cotyledon(s)**, **embryo axis**.

- Integuments → **seed coat** (outer **testa**, inner **tegmen**). Micropyle remains as small pore → allows O_2 & water entry during germination.
- Hilum = scar where seed was attached.

Non-albuminous (अभ्रूणपोषी)	Albuminous (भ्रूणपोषी)
No residual endosperm (used up) – **pea, groundnut**	Part of endosperm remains – **wheat, maize, barley, castor**

Perisperm (परिभ्रूणपोष) = residual, persistent nucellus in seed – e.g. black pepper, beet.

Dormancy (प्रसुप्ति): seed loses water (10–15% moisture), metabolism slows → dormant. Germinates under favourable conditions.

📌 **Advantages of seeds:** independent of water for pollination & fertilisation · adaptive strategies for dispersal · food reserve for young seedling · hard seed coat protection · new genetic combinations (variations) · basis of agriculture (storage).

Oldest viable seeds: *Lupinus arcticus* (lupine) ~**10,000 yrs** (Arctic Tundra); *Phoenix dactylifera* (date palm) ~**2000 yrs** (King Herod's palace, Dead Sea).

Orchid fruits & *Orobanche, Striga* (parasites) – thousands of tiny seeds; *Ficus* – many tiny seeds.

(d) Fruit फल

- Ovary → **fruit**; ovary wall → **pericarp** (फलभित्ति) – fleshy (guava, orange, mango) or dry (groundnut, mustard).
- **True fruit** – develops only from ovary.
- **False fruit** (आभासी फल) – **thalamus** also contributes: apple, strawberry, cashew.
- **Parthenocarpic fruit** (अनिषेकफलन) – fruit without fertilisation; **seedless**, e.g. banana. Induced by **growth hormones**.

8. Apomixis & Polyembryony / असंगजनन व बहुभ्रूणता

- **Apomixis** = production of seeds without fertilisation; a form of asexual reproduction that **mimics sexual reproduction**. Seen in **Asteraceae** & **grasses**.
- बिना निषेचन के बीज बनना असंगजनन कहलाता है।
- Ways: (i) diploid egg cell forms without meiosis → embryo without fertilisation; (ii) **nucellar cells** divide, protrude into embryo sac → embryos.
- **Polyembryony** = more than one embryo in a seed – e.g. Citrus, mango.

📌 **Importance in hybrid seed industry:** Hybrid seeds must be bought every year (progeny of hybrids segregate & lose characters) – costly for farmers. If hybrids are made **apomictic** → no segregation → farmers can reuse seeds year after year.

⚡ Quick Revision – Ploidy Table / गुणसूत्र स्तर

Structure	Ploidy
MMC / PMC, nucellus, integuments, zygote, embryo	2n
Megaspore, microspore, pollen, egg, synergids, antipodals, male gametes	n
Central cell (2 polar nuclei, before fusion)	n + n
PEN / Endosperm	3n

Before fertilisation	After fertilisation
Ovary	Fruit
Ovary wall	Pericarp
Ovule	Seed
Integuments	Seed coat (testa + tegmen)
Zygote	Embryo
PEN	Endosperm
Nucellus (if persists)	Perisperm

⭐ Exam Corner / परीक्षा उपयोगी प्रश्न

1-Mark Questions 1M

Q1. Name the most resistant organic material known. / सबसे प्रतिरोधी कार्बनिक पदार्थ?

→ Sporopollenin (in exine of pollen) / स्पोरोपोलेनिन

Q2. What is the function of filiform apparatus?

→ Guides pollen tube into the synergid.

Q3. Which part of coconut is free-nuclear endosperm?

→ Tender coconut water.

Q4. Name the layer that nourishes developing pollen grains.

→ Tapetum / टेपीटम

Q5. Give one example each of a false fruit and a parthenocarpic fruit.

→ False: apple / strawberry / cashew; Parthenocarpic: banana.

Q6. Ploidy of nucellus, endosperm and egg?

→ 2n, 3n, n.

2/3-Mark Questions 2–3M

Q7. Differentiate between geitonogamy and xenogamy.

→ Geitonogamy: pollen to another flower of same plant; genetically similar to autogamy. Xenogamy: pollen to flower of different plant; brings genetic variation.

Q8. Why are cleistogamous flowers invariably autogamous? Give one advantage & one disadvantage.

→ They never open, so only own pollen reaches stigma. Adv: assured seed-set without pollinators. Disadv: no variation / inbreeding depression.

Q9. What is self-incompatibility? Why does self-pollination not lead to seed formation in such plants?

→ Genetic mechanism preventing self-pollen from fertilising ovules; pistil inhibits pollen germination or tube growth.

Q10. Monoecious vs dioecious – which prevents both autogamy & geitonogamy?

→ Dioecious (e.g. papaya). Monoecious (castor, maize) prevents only autogamy.

Q11. Define apomixis. Give its importance to farmers.

→ Seed formation without fertilisation; apomictic hybrids don't segregate → farmers reuse seeds yearly.

Q12. Differentiate albuminous and non-albuminous seeds with examples. What is perisperm?

→ See table above; perisperm = persistent nucellus (black pepper, beet).

5-Mark Questions 5M ★★★

Q13. Describe the development of a female gametophyte (embryo sac) from MMC. Draw a labelled diagram of a mature embryo sac.

→ MMC → meiosis → 4 megaspores → 1 functional (monosporic) → 3 free-nuclear mitoses → 8 nuclei → 7 cells (egg apparatus, 3 antipodals, central cell). + Diagram.

Q14. What is double fertilisation? Explain the post-fertilisation changes in a flower.

→ Syngamy + triple fusion; endosperm & embryo development; ovule → seed; ovary → fruit.

Q15. Describe the structure of a microsporangium and microsporogenesis. Draw T.S. of anther.

→ 4 wall layers + sporogenous tissue; PMC → meiosis → tetrad → pollen.

Q16. Explain artificial hybridisation. Why is emasculation needed?

→ Emasculation, bagging, dusting, rebagging; emasculation prevents self-pollination in bisexual flowers.

✏ Diagrams to practise / अभ्यास हेतु चित्र:

1. T.S. of anther / microsporangium wall layers
2. Structure of pollen grain (2-celled)
3. Anatropous ovule (L.S.) with all parts
4. Mature embryo sac (7-celled, 8-nucleate) ⭐
5. Dicot embryo & monocot (grass) embryo
6. Pollen tube entering embryo sac (double fertilisation)

🎯 **Last-minute tips:** Always write **examples in italics/underline** (*Vallisneria*, *Ophrys*, *Viola*) · Draw diagrams with **pencil** and label on one side · Mention ploidy (n / 2n / 3n) wherever possible · Use keywords: *monosporic*, *free-nuclear*, *triple fusion*, *sporopollenin*, *filiform apparatus*.

~ All the best! / शुभकामनाएँ! ~