

Chapter 1 — Sexual Reproduction in Flowering Plants | NEET Mastersheet | Class 12 NCERT Biology

1. Flower — Organ of Angiosperms

- Flowers = seat of sexual reproduction in angiosperms
- Androecium** (stamens) = male reproductive organ
- Gynoecium** (pistils) = female reproductive organ
- Panchanan Maheshwari** (1904–1966): test-tube fertilisation, intra-ovarian pollination; Dept of Botany, Delhi; FRS; first NCERT Bio textbooks (1964)
- Floriculture = commercial cultivation of flowers
- Inflorescences → floral buds → flowers

Pistil Parts:

- Stigma:** landing platform for pollen
- Style:** elongated slender part
- Ovary:** basal; contains locule; placenta inside

2. Stamen & Microsporangium

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- Filament:** long slender stalk; proximal end → thalamus/petal
- Anther:** bilobed, **ditheous** (2 theca/lobe); **tetragonal** (4-sided)
- 4 microsporangia (2 per lobe) → develop into **pollen sacs**

Microsporangium Wall Layers (outer → inner):

- Epidermis** → protection
- Endothecium** → protection + dehiscence
- Middle layers** → protection + dehiscence
- Tapetum** (innermost) → nourishes pollen; dense cytoplasm; often >1 nucleus

Sporogenous Tissue:

- Compactly arranged homogenous cells at centre of microsporangium
- Each cell = potential Pollen Mother Cell (PMC)

3. Microsporogenesis & Pollen Grain

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- PMC → **meiosis** → microspore tetrad → pollen grains
- Size: **25–50 μm** diameter; generally spherical
- Exine** (outer): sporopollenin — most resistant organic material; withstands high temp, acids, alkali; no enzyme degrades it; **germ pores**; fossil preservation
- Intine** (inner): cellulose + pectin; thin, continuous

Stage	Cells	% Species
2-celled	Vegetative + Generative cell	>60% angiosperms
3-celled	Vegetative + 2 male gametes	Remaining species

- Vegetative: larger, food reserve, irregular nucleus
- Generative: small, spindle-shaped, floats in vegetative cell

Pollen Viability:

- Rice, wheat: **30 min** after release
- Rosaceae, Leguminosae, Solanaceae: **months**
- Storage: **liquid nitrogen (–196°C)** → pollen banks
- Parthenium** (carrot grass): contaminant w/ imported wheat; pollen allergy, asthma, bronchitis
- Pollen tablets = food supplements; claimed to boost athlete/race horse performance

4. Pistil, Ovule & Megasporangium

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Gynoecium Type	Meaning / Example
Monocarpellary	Single pistil
Multicarpellary	>1 pistil
Syncarpous	Fused pistils (Papaver)
Apocarpous	Free pistils (Michelia)

Ovule Structure:

- Funicle:** stalk attaching ovule to placenta
- Hilum:** junction of ovule body & funicle
- Integuments:** 1 or 2 protective envelopes
- Micropyle:** opening at integument tip
- Chalaza:** basal part, opposite micropyle
- Nucellus:** mass of cells with food reserves
- Embryo sac located inside nucellus

No. of Ovules:

- 1 ovule:** wheat, paddy, mango
- Many:** papaya, watermelon, orchids

5. Megasporesogenesis & Female Gametophyte

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- MMC (micropylar region) → **meiosis** → 4 megaspores
- 3 degenerate; 1 functional → embryo sac
- = **Monosporic development**

Embryo Sac Formation (free nuclear divisions):

- 1 → 2 → 4 → 8 nuclei (all free nuclear)
- After 8-nucleate: cell walls laid → **7-celled, 8-nucleate**

Position	Cells	Nuclei
Micropylar	Egg apparatus: 2 synergids + 1 egg	3
Central	Central cell (2 polar nuclei)	2
Chalazal	3 Antipodals	3

- Filiform apparatus:** thickenings in synergids; guides pollen tube
- Ploidy: nucellus=2n, MMC=2n, megaspore=n, embryo sac=n

6. Pollination

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Type	Transfer	Genetic
Autogamy	Same flower	Inbreeding
Geitonogamy	Same plant	Inbreeding (fxnly cross)
Xenogamy	Different plant	True outbreeding

- Chasmogamous:** opens normally, exposed anthers & stigma
- Cleistogamous:** never opens; assured autogamy; **Viola, Oxalis, Commelina**

Agents:

- Wind:** most common abiotic; light/non-sticky pollen; feathery stigma; corn cob tassels = stigma+style; common in grasses
- Water:** rare; ~30 genera; mostly monocots; **Vallisneria, Hydrilla, Zostera** (marine)
- Water hyacinth, water lily → insect/wind pollinated (above water)
- Animals:** majority of plants; bees (dominant), butterflies, flies, beetles,

wasps, ants, moths, sunbird, hummingbird, bats, lemurs, arboreal rodents, gecko, garden lizard

- **Amorphophallus**: ~6 feet; egg-laying site reward
- **Yucca-moth**: obligate mutualism; neither completes life cycle alone
- Pollen/nectar robbers: visit but do NOT pollinate

7. Outbreeding Devices & Pollen-Pistil Interaction

- Continued self-pollination → **inbreeding depression**

Outbreeding Devices:

- **Dichogamy**: pollen release & stigma receptivity not synchronised
- **Herkogamy**: anther & stigma at different positions
- **Self-incompatibility**: genetic; prevents self-pollen germination/tube growth
- **Monoecious** (castor, maize): prevents autogamy, NOT geitonogamy
- **Dioecious** (papaya): prevents both autogamy AND geitonogamy

Pollen-Pistil Interaction:

- Chemical dialogue between pollen & pistil
- Compatible → pollen tube grows → fertilisation
- Incompatible → germination/tube growth inhibited

Artificial Hybridisation:

- **Emasculation**: remove anthers before dehiscence (forceps)
- **Bagging**: butter paper → prevent contamination
- Bisexual: emasculate first; Unisexual female: just bag

8. Double Fertilisation ★ NEET

- Pollen tube → micropyle → ovule → synergid (filiform apparatus)
- 2 male gametes released into synergid cytoplasm

Fusion	Gametes	Product	Ploidy
Syngamy	Male + Egg	Zygote → Embryo	2n
Triple fusion	Male + 2 polar nuclei	PEN → Endosperm	3n

Double fertilisation = unique to angiosperms

- PEC (Primary Endosperm Cell) → Endosperm tissue
- Zygote → Embryo

Post-Fertilisation Events:

- Endosperm → Embryo → Seed → Fruit
- **Endosperm always precedes embryo development**

9. Endosperm ★ NEET

- PEN → free nuclear divisions → free-nuclear endosperm → cellularisation
- **Coconut water** = free-nuclear endosperm (thousands of nuclei)
- **White kernel** of coconut = cellular endosperm

Seed Type	Endosperm	Examples
Non-albuminous	Completely consumed	Pea, groundnut, beans
Albuminous	Persists in mature seed	Wheat, maize, barley, castor, coconut

- **Perisperm**: persistent nucellus — black pepper, beet

10. Embryo Development

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- Stages: Zygote → proembryo → globular → heart-shaped → mature
- Zygote dormant until endosperm forms

Dicot Embryo:

- Embryonal axis + 2 cotyledons
- **Epicotyl** (above cotyledons) → plumule/stem tip
- **Hypocotyl** (below) → radicle/root tip; root cap

Monocot/Grass Embryo:

- 1 cotyledon = **scutellum** (lateral)
- **Coleoptile**: hollow foliar sheath → shoot

11. Seed & Fruit ★ NEET

- Seed = fertilised ovule; final product of sexual reproduction
- Moisture at maturity: **10–15%**; **dormancy** possible
- Micropyle persists → O₂ + water entry during germination

Record Seed Viability:

- **Lupinus arcticus**: **10,000 years** — Arctic Tundra (oldest)
- **Phoenix dactylifera**: **2,000 years** — Dead Sea

Fruit Types:

Type	Origin	Examples
True fruit	Ovary only	Most fruits
False fruit	Thalamus contributes	Apple, strawberry, cashew
Parthenocarpic	Without fertilisation	Banana (seedless)

12. Apomixis & Polyembryony

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- Seed formation **without fertilisation**
- Asexual reproduction mimicking sexual
- Found in: **Asteraceae**, grasses
- Type 1: Diploid egg (without meiosis) → embryo
- Type 2 **Nucellar embryony**: nucellar cells → embryos (**Citrus**, **Mango**)

Polyembryony:

- >1 embryo/seed; orange (squeeze seeds)
- Apomictic embryos = **clones**

Quick-Fire NEET Facts ★ NEET

- Anther wall: Epidermis → Endothecium → Middle → **Tapetum**
- Mature embryo sac: **7-celled, 8-nucleate**
- Egg apparatus = 2 synergids + 1 egg (micropylar)
- Central cell = 2 polar nuclei (largest cell)
- Antipodals = 3 cells at chalazal end
- Triple fusion = 3 haploid nuclei → PEN (3n)
- Zygote=2n; Endosperm=3n; Pollen/egg=n
- Endosperm develops **BEFORE** embryo
- Coconut water = free-nuclear endosperm
- Sporopollenin: no known enzyme degrades it
- -196°C = pollen banks (liquid nitrogen)
- Cleistogamous: Viola, Oxalis, Commelina
- Lupinus arcticus = 10,000 yrs (oldest viable seed)
- Apomixis: Asteraceae & grasses
- Nucellar embryony: Citrus, Mango
- Parthenium = carrot grass = pollen allergy
- Dioecious papaya → prevents autogamy + geitonogamy
- Monoecious castor/maize → prevents autogamy only
- False fruit: apple, strawberry, cashew (thalamus)
- Banana = parthenocarpic (no fertilisation, seedless)

- apex + leaf primordia
- **Coleorhiza:** sheath → radicle + root cap
 - **Epiblast:** present in grass embryo

- Importance:**
- No segregation in hybrid progeny
 - Farmers reuse hybrid seeds — cost savings
 - Active research to transfer apomictic genes into hybrid varieties

MASTER COMPARISON TABLE — Most NEET-Tested Distinctions

Microsporogenesis vs Megaspores vs Pollination Types

Feature	Microsporogenesis	Megaspores	Autogamy	Geitonogamy	Xenogamy
Location	Anther (microsporangium)	Ovule (nucellus)	Same flower	Same plant	Different plant
Mother cell	PMC	MMC	—	—	—
Division	Meiosis	Meiosis	—	—	—
Products	Microspore tetrad → pollen	4 megaspores (1 functional)	—	—	—
Gametophyte	Male (pollen grain)	Female (embryo sac)	—	—	—
Genetic effect	—	—	Inbreeding	Inbreeding (fxnly cross)	True outbreeding

Key Structures — Origin, Function & Ploidy

Structure	Origin	Function / Note	Ploidy	Structure	Origin	Ploidy
Tapetum	Microsporangium wall (innermost)	Nourishes pollen	2n (often bi-nucleate)	Endosperm	PEC (triple fusion)	3n
Perisperm	Persistent nucellus	Black pepper, beet	2n	Zygote	Syngamy	2n
Pericarp	Ovary wall	Fruit wall	2n	Seed coat (testa)	Integuments	2n

Pollen Wall, Fertilisation & Fruit/Seed Comparisons

Feature	Exine	Intine	Syngamy	Triple Fusion	True Fruit	False Fruit	Parthenocarpic
Composition/Origin	Sporopollenin	Cellulose + Pectin	Male gamete + Egg	Male + 2 polar nuclei	Ovary only	Thalamus contributes	Without fertilisation
Special note	Most resistant; germ pores; fossils	Thin, continuous	Zygote (2n)	PEN (3n); unique to angiosperms	Most fruits	Apple, strawberry, cashew	Banana; seedless; hormone-induced

Ploidy Quick Reference & Embryo Parts

Structure	Ploidy	Structure	Ploidy	Part	Plant	Description
Nucellus / MMC / PMC	2n	Pollen grain / Megaspore	n	Scutellum	Monocot/Grass	Cotyledon (lateral)
Egg / Synergids / Antipodals	n	Polar nuclei	n each	Coleoptile	Grass	Hollow sheath; shoot apex + leaf primordia
Zygote / Embryo	2n	PEN / Endosperm	3n	Coleorhiza	Grass	Sheath; radicle + root cap
Seed coat / Pericarp	2n	Integuments	2n	Epiblast	Grass	Present in grass embryo
				Epicotyl	Dicot	Above cotyledons → plumule
				Hypocotyl	Dicot	Below cotyledons → radicle

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