# Unit 10 · Angiosperms

STUDY NOTES

**WHAT NEB'S GRADE 11 EXAM ASKS**

- **CDC's grid (2077):** Floral Diversity (Units 4–10 together): 18 of 75 marks; with Ecology and Vegetation a combined 26, at least 3 MCQs, 2 short and 1 long from them
- **The paper:** 11 MCQs × 1 · 8 short × 5 · 3 long × 8; 3 hours; 1 mark per expected point
- **CDC's model paper:** long (8): Solanaceae: floral characters, floral formula, floral diagram, two plants (OR a Unit 5 question); short (5): simple vs multiple fruit, and the role of fruit (OR a Unit 9 question)
- **MCQ (1 mark)**
  - root kind from clues (maize: adventitious, fibrous); potato a stem
  - leaf, inflorescence, aestivation, placentation from a description
  - ovary position from where the sepals stay
  - taxon above family; why a strawberry is a false fruit
- **Short and long (in parts)**
  - define phyllotaxy, zygomorphic, complete flower, genus, taxonomy, perianth
  - tap vs fibrous; simple vs compound leaf; cymose vs racemose; artificial vs natural system
  - Solanaceae, Liliaceae (semi-technical, formula, diagram, two plants); Fabaceae characters
  - placentation and its types; regions of a root; leaf morphology; inflorescence
  - which classification system suits a survey, and why

## Key terms

**Angiosperm** (*angeion* case + *sperma* seed): ovules and seeds enclosed in an **ovary**.

**Morphology**: outer form of parts; **anatomy**: the inside.

**Inflorescence**: arrangement of flowers on the floral axis (**peduncle**).

**Flower**: condensed, modified shoot for sexual reproduction.

**Perianth**: calyx and corolla alike; each member a **tepal**.

**Aestivation**: arrangement of sepals or petals in the bud.

**Placentation**: arrangement of ovules inside the ovary.

**Fruit**: ripened ovary after fertilization.

**Taxonomy** (*taxis* + *nomos*): identification, nomenclature, classification; **Linnaeus** (1707–1778) father.

**Systematics**: diversity of organisms and their relationships.

**Taxon**: a group at any rank; **taxonomic category**: the rank.

**Species**: closely alike, interbreed freely, fertile offspring.

## Introduction

- largest plant group: ~300,000 species; Nepal ~6,000 (~300 endemic)
- life span: **annual** (rice, mustard, maize), **biennial** (radish, carrot for seed, cabbage), **perennial** (mango, sal, bamboo)
- habit: **herb** (coriander), **shrub** (hibiscus, rose), **tree** (sal, peepal), **climber** (pea, cucumber, भोर्लो)
- smallest *Wolffia* (~1 mm); largest flower *Rafflesia arnoldii* (~1 m); tallest a eucalyptus (~100 m)
- Darwin's "abominable mystery" (1879, to Hooker): sudden rise ~130 million years ago

## Root

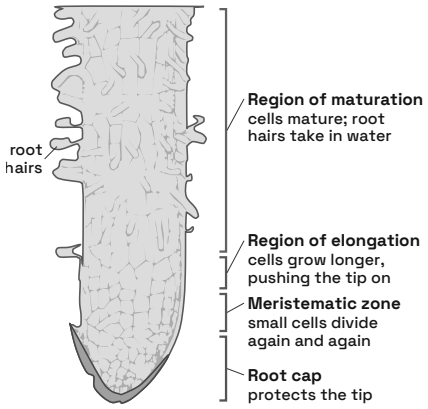
- underground, not green, cylindrical; **no nodes, internodes, leaves, buds**; from the **radicle**
- negatively **phototropic**, positively **geotropic**

| Tap root system | Fibrous root system |
|---|---|
| radicle → **primary root** → secondary, tertiary, rootlets | primary root short-lived |
| one main root | bunch of thin, equal roots from **stem base** |
| **dicots**: mustard, pea, mango | **monocots**: rice, wheat, maize, onion |

- **adventitious**: from any part but the radicle; grasses, sugarcane, banyan prop roots

**Regions of a root tip**

1. **root cap**: loose cells; protects tip; slime helps sliding
2. **meristematic zone**: small, thin-walled cells, dense cytoplasm, large nuclei; **divide**
3. **region of elongation**: cells **lengthen** (water into vacuoles); growth in length
4. **region of maturation**: tissues form; **root hairs**: absorb water, minerals




Root tip: root cap, meristematic zone, elongation, maturation with root hairs.

- rye (Dittmer, 1937): ~13 million roots (620 km), ~14 billion root hairs

**Functions**: anchorage; absorption; hold soil; **pneumatophores** (mangroves, breathing); **assimilatory roots** (gurjo); vegetative propagation (sweet potato, dahlia); **storage** (carrot, radish, turnip, sweet potato)

## Stem

- from the **plumule**; positively phototropic, negatively geotropic
- **nodes** (leaves, branches, buds, flowers) and **internodes**
- woody stems: **bark** with **lenticels** (gas exchange)
- **terminal bud**: length; **axillary bud** in the leaf **axil**: branch or flower
- potato = stem: **eyes** are nodes with buds

**Functions**: support; **conduction** (xylem up, phloem food); food storage (potato tuber, ginger, turmeric rhizomes, taro corm); water storage (cacti); photosynthesis (*Opuntia*); **thorns** (bougainvillea, lemon; from an axil); vegetative propagation (cuttings, runners, tubers)

## Leaf

- flat, green outgrowth at a **node**, bud in its **axil**; **acropetal** order; all leaves = **phyllome**

### Parts

1. **leaf base** (hypopodium): **stipules** (stipulate: pea, rose, hibiscus; exstipulate: mango, mustard); **sheath** in grasses, maize, banana
2. **petiole**: petiolate or **sessile**
3. **lamina**: apex, margin, **midrib**, veins, veinlets

### Venation

- **reticulate** (network): dicots (mango, peepal)
- **parallel**: monocots (rice, maize, grasses, bamboo; banana from midrib to edge)
- exceptions: *Smilax*, taro (monocots, net); *Calophyllum* (dicot, near parallel)

| Simple leaf | Compound leaf |
|---|---|
| one lamina | lamina cut **to the midrib** into **leaflets** |
| cuts never reach midrib or petiole | leaflets on a rachis or from one point |
| bud in the axil | no bud in a leaflet's axil (only at the whole leaf) |
| mango, peepal, guava | neem, rose, bel, simal |

### Compound leaves

- **pinnate** (on a **rachis**)
  - **paripinnate** (even, ends in a pair: tamarind, *Cassia*); **imparipinnate** (odd, one at tip: neem, rose)
  - **unipinnate** (neem), **bipinnate** (*Mimosa*, gulmohar), **tripinnate** (*Moringa*)
- **palmate** (from one point): unifoliate (lemon), bifoliate, trifoliate (clover, bel), quadrifoliate (*Marsilea*), multifoliate (simal, *Schefflera*)

**Phyllotaxy** (arrangement of leaves)

- **alternate**: one per node, spiral (mustard, hibiscus, mango); often ~137.5° (golden angle)
- **opposite**: two per node (guava, *Calotropis*); **decussate** pairs at right angles (mint, tulsi)
- **whorled**: three or more (oleander, *Alstonia*)

**Functions**: **photosynthesis**; gas exchange (stomata); **transpiration**; storage (onion, aloe); propagation (*Bryophyllum*, *Begonia*); protects axillary bud

## Inflorescence

| Racemose | Cymose |
|---|---|
| main axis **keeps growing**, never ends in a flower | axis **ends in a flower**, stops |
| oldest at **base** (acropetal) or **edge** (centripetal) | oldest at the **tip** (basipetal), or center (centrifugal) |
| mustard, radish; sunflower, marigold heads | jasmine, potato, *Calotropis* |

## Flower

- **bracts** (bracteate, ebracteate); **pedicel** (pedicellate, sessile); **thalamus** (receptacle)
- four whorls, outside in
  1. **calyx** (sepals): protects bud; sepaloid or petaloid; poly- or gamosepalous
  2. **corolla** (petals): attracts; poly- or gamopetalous
  3. **androecium** (stamens): male
  4. **gynoecium** (carpels): female
- calyx, corolla **accessory**; androecium, gynoecium **essential**
- **perianth** of **tepals** (lily, onion)
- **complete** (all four: mustard, pea) vs **incomplete** (lily; male maize flower)
- **bisexual** vs **unisexual**: male (staminate), female (pistillate)

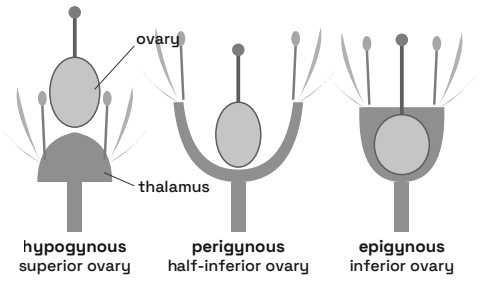
### Symmetry

- **actinomorphic**: halves along more than one plane (mustard, hibiscus, *Datura*)
- **zygomorphic**: only one plane (pea, bean, gulmohar)
- **asymmetric**: none (*Canna*)

### Insertion

| Hypogynous | Perigynous | Epigynous |
|---|---|---|
| parts **below** ovary | thalamus a **cup**; parts on its rim | thalamus **fused** with ovary; parts **above** |
| ovary **superior** | **half-inferior** | **inferior** |
| mustard, brinjal, *Hibiscus* | rose, plum, peach | sunflower, cucumber, guava, apple |

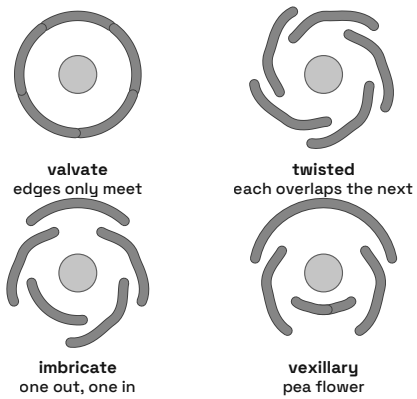
- sepals left at the **far end** of a fruit → inferior ovary (apple); at the **stalk end** → superior (tomato)




Hypogynous (superior), perigynous (half-inferior), epigynous (inferior) ovary.

### Aestivation

- **valvate**: edges touch (custard apple, *Datura* calyx, *Calotropis*)
- **twisted**: each overlaps the next, one direction (hibiscus, भिन्डी, cotton)
- **imbricate**: overlap, no regular direction; one fully out, one fully in (gulmohar, *Cassia*)
- **vexillary**: standard over wings over keel (pea, bean)




Valvate, twisted, imbricate, vexillary.

### Androecium

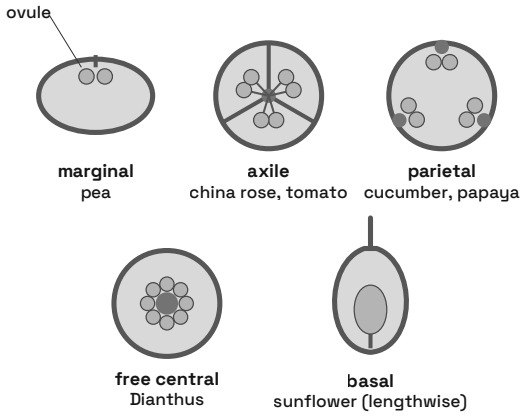
- stamen = **filament** + **anther**; anther **dithecous**, 4 **pollen sacs**
- free = **polyandrous**; joined by filaments: **monadelphous** (hibiscus, cotton), **diadelphous** (pea, 9 + 1), **polyadelphous** (lemon, *Bombax*); by anthers: **syngenesious** (sunflower, marigold); whole length: **synandrous** (cucumber)
- **epipetalous** (potato, brinjal, *Datura*); **epiphyllous** (lily, onion)
- fixation: **basifixed** (mustard, *Datura*), **adnate** (lotus, *Magnolia*), **dorsifixed** (passion flower, pea), **versatile** (grasses, lily)
- **introrse** (opens inward), **extrorse** (outward)

### Gynoecium

- carpel (pistil): **stigma** (receives pollen), **style**, **ovary** (ovules on **placenta**)
- **monocarpellary** (pea); **apocarpous** (lotus, strawberry); **syncarpous** (mustard, tomato); unilocular, bilocular…

### Placentation

| Type | Ovary | Ovules on | e.g. |
|---|---|---|---|
| **marginal** | one chamber, one carpel | ridge along one side, **two rows** | pea, bean |
| **axile** | chambers divided by septa | **central axis** | tomato, lemon, potato, orange |
| **parietal** | one chamber (two in mustard by **replum**) | **inner wall** | cucumber, papaya, *Argemone*, mustard |
| **free central** | one chamber, no septa | free **central column** | *Dianthus*, *Primula* |
| **basal** | one chamber | **single ovule** at the base | sunflower, marigold |




Marginal, axile, parietal, free central (across) and basal (lengthwise).

**Functions**: gametes; ovary → fruit, ovules → seeds; nectar; color, scent → pollination; worship, garlands (Tihar)

## Fruit

- **parthenocarpic**: no fertilization, seedless (banana, grapes, greenhouse cucumber)
- **true fruit**: ovary only (mango, litchi, tomato); **false fruit**: thalamus too (apple, pear, strawberry)
- **pericarp** (ovary wall) + **seeds** (ovules); dry or fleshy
  - **epicarp**: skin
  - **mesocarp**: fleshy, edible (mango, peach)
  - **endocarp**: hard stone in a **drupe** (mango, plum); papery (apple core); juicy hairs (orange)

| Simple | Aggregate | Multiple (composite) |
|---|---|---|
| ovary of **one flower** | **one flower**, many **free carpels** | **whole inflorescence** |
| dry (pea, mustard, rice) or fleshy (mango, tomato) | fruitlets in an **etaerio** | many flowers fused |
| | strawberry, ainselu, custard apple | jackfruit, pineapple, mulberry |

- strawberry: red part = swollen **thalamus**; fruitlets = achenes → false, aggregate

**Functions**: **protects seeds**; attracts animals → **dispersal** (dry: pods split; *Bidens* hooks); stores food; coconut husk floats, holds water

## Taxonomy

- **identification**, **nomenclature** (binomial), **classification**
- Linnaeus: *Species Plantarum* (1753), *Systema Naturae* (10th ed., 1758)
- **Kingdom** → **Phylum (Division)** → **Class** → **Order** → **Family** → **Genus** → **Species** (seven obligatory)
- intermediate categories: subclass, superorder, subfamily, tribe
- species (horse, donkey separate; mule sterile) → **genus** (*Brassica*) → **family** (Brassicaceae: *Brassica*, *Raphanus*,

*Lepidium*) → order → class → division (plants) / phylum (animals) → **kingdom**
- down: fewer organisms, more shared features
- endings: division **-phyta**, class **-opsida** (old **-ae**), order **-ales**, family **-aceae**

- radish: Plantae, Spermatophyta, Dicotyledonae, Parietales, Brassicaceae, *Raphanus*, *R. sativus* (APG: Brassicales)

## Classification systems

| | Artificial | Natural | Phylogenetic |
|---|---|---|---|
| based on | **one or a few** easy features | **as many as possible** | **evolutionary relationships** |
| groups | unrelated together | naturally alike | ancestor + descendants |
| use | quick, in the field | lasting, informative | shows descent |
| e.g. | **Linnaeus's sexual system** (stamens, carpels; 1735) | **Bentham and Hooker** (*Genera Plantarum*, 1862–1883; herbaria) | **Engler and Prantl** (1887–1915); **APG** (DNA; 4th 2016) |

- a region's flora: **phylogenetic (APG)** best: related species together, groups predict (medicines, crop relatives), used in today's floras (*Flora of Nepal*); artificial only for quick field sorting

## Describing a family

- order: habit, habitat → root, stem, leaves (**vegetative**) → inflorescence, flower, whorls, fruit, pollination (**floral**) → **floral formula**, **floral diagram**

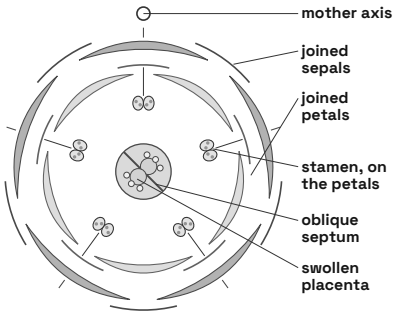
| Symbol | Meaning | Symbol | Meaning |
|---|---|---|---|
| Br / Ebr | bracteate / ebracteate | ⊕ / % | actinomorphic / zygomorphic |
| ⚥ | bisexual | ♂ / ♀ | male / female |
| K, C, P | calyx, corolla, perianth | A, G | androecium, gynoecium |
| $\underline{G}$ | superior ovary | $\overline{G}$ | inferior ovary |

- number after letter ($K_5$); **brackets** = fused ($K_{(5)}$); **+** = two whorls; ∞ = many
- **arc** over C and A = epipetalous; over P and A = epiphyllous
- floral diagram: flower cut across, seen from above; **mother axis** dot at top (posterior); bract at bottom

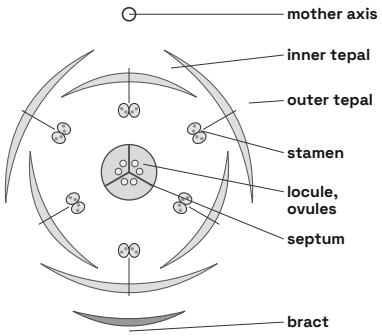
| | Brassicaceae (mustard) | Fabaceae (pea) | Solanaceae (potato) | Liliaceae (lily) |
|---|---|---|---|---|
| habit | herbs, **sulphurous smell**; cosmopolitan | herbs, shrubs, climbers; pulses | herbs, shrubs; tropics, Americas | herbs with **bulbs**, rhizomes |
| root | tap; **fusiform** (radish), **napiform** (turnip) | tap, **root nodules** (*Rhizobium*) | tap | **adventitious**, fibrous |
| stem | herbaceous, pubescent | erect or **climbing**, angular | herbaceous, sometimes **fistular**; potato **tuber** | **bulb**, rhizome; **scape** |
| leaves | **radical** + cauline; simple, alternate, exstipulate, **lyrate** | **pinnate** compound, **stipulate**; **tendrils** (pea) | simple (pinnate in potato, tomato), alternate, exstipulate | **sessile**, **sheathing**, **parallel** veins |
| inflorescence | **raceme** (corymb first) | raceme or solitary axillary | **cymose**, or solitary (*Datura*) | raceme, spike, umbel-like on scape |
| flower | ebracteate, ⊕, complete, hypogynous, **tetramerous** | **zygomorphic**, hypogynous or slightly perigynous | ebracteate, ⊕, hypogynous, **pentamerous** | ⊕, hypogynous, **trimerous**, **incomplete** |
| calyx / perianth | **4**, free, **2 + 2**, imbricate | **5**, joined, odd one in front | **5**, joined, **persistent**, valvate | **6 tepals**, 3 + 3, free or joined |
| corolla | **4**, free, **cruciform** (claw, limb) | **5**, **papilionaceous**: standard, 2 wings, **keel** (2 joined); **vexillary** | **5**, joined; wheel, bell, funnel; valvate or twisted | (perianth) |
| androecium | **6**, **tetradynamous** (2 short + 4 long); basifixed, introrse | **10**, **diadelphous (9) + 1** | **5**, **epipetalous**, alternate with petals | **6**, 3 + 3, **epiphyllous** |
| gynoecium | **2**, syncarpous, **replum** → 2 chambers, superior, **parietal** | **1**, superior, **marginal**; style bent | **2**, syncarpous, superior, **oblique** (45°), **axile**, swollen placentas | **3**, syncarpous, **trilocular**, superior, **axile** |
| fruit | **siliqua** (long) or **silicula** (short) | **legume**, splits along both seams | **berry** or **capsule** | **capsule** or **berry** |
| pollination | insects | insects; pea selfs in the keel | insects | insects |

### Floral formulas

- Brassicaceae: Ebr ⊕ ⚥ $K_{2+2}\ C_4\ A_{2+4}\ \underline{G}_{(2)}$
- Fabaceae: Br or Ebr % ⚥ $K_{(5)}\ C_{1+2+(2)}\ A_{(9)+1}\ \underline{G}_1$
- Solanaceae: Ebr ⊕ ⚥ $K_{(5)}\ \overbrace{C_{(5)}\ A_5}\ \underline{G}_{(2)}$
- Liliaceae: Br ⊕ ⚥ $\overbrace{P_{3+3}\ A_{3+3}}\ \underline{G}_{(3)}$ ($P_{(3+3)}$ if tepals joined)




Solanaceae: five joined sepals, five joined petals, five epipetalous stamens, oblique two-chambered ovary, axile.




Liliaceae: 3 + 3 tepals, 3 + 3 stamens before them, three-chambered ovary, axile; bract below.

### Economic importance and plants

| Family | Uses | Plants (two to name) |
|---|---|---|
| Brassicaceae | **oil** (tori, Indian mustard, rayo); vegetables (turnip, radish, cabbage, cauliflower, broccoli); condiments; chamsur (*Lepidium sativum*) medicine; candytuft, stock | mustard *Brassica rapa*; cauliflower *B. oleracea* var. *botrytis*; cabbage var. *capitata*; radish *Raphanus sativus* |
| Fabaceae | **pulses** (pea, gram, lentil, मास, mung, रहर); fodder; oil (soybean, groundnut); methi; **soil nitrogen**, green manure (dhaincha); sissoo, indigo, *Erythrina* | pea *Pisum sativum*; soybean *Glycine max*; cowpea *Vigna unguiculata*; gram *Cicer arietinum*; black gram *Vigna mungo* |
| Solanaceae | vegetables (potato, tomato, brinjal, capsicum); **chillies** (akabare); medicines (*Atropa*: atropine; *Datura*, *Hyoscyamus*; poisonous); **tobacco**; *Petunia*, रातकी रानी | tomato *Solanum lycopersicum*; brinjal *S. melongena*; potato *S. tuberosum*; tobacco *Nicotiana tabacum* |
| Liliaceae | onion, garlic, kurilo, सतावरी; lily, tulip, *Gloriosa*; *Colchicum*: colchicine (gout); aloe gel (burns, cosmetics) | onion *Allium cepa*; garlic *A. sativum*; asparagus *Asparagus officinalis*; aloe *Aloe vera* |

- *Brassica oleracea*: cabbage, cauliflower, broccoli, kohlrabi, kale, Brussels sprouts (one species)
- DNA: onion, garlic → Amaryllidaceae; asparagus → Asparagaceae; aloe → Asphodelaceae; exam follows the old Liliaceae

**COMMON MISTAKES**

✗ Underline over G means inferior
✓ **underline** (below) = **superior**; overline = inferior.

✗ A potato is a root
✓ a **stem** (tuber): its eyes are nodes with buds.

✗ A neem "leaf" is one leaf
✓ it is one **leaflet** of a pinnately compound leaf.

✗ In a cyme the oldest flower is at the base
✓ at the **tip**; that is racemose.

✗ Strawberry is a true fruit
✓ **false** (thalamus) and **aggregate**.

✗ Mustard placentation is axile
✓ **parietal**, with a false septum (replum).

✗ Pea stamens are monadelphous
✓ **diadelphous**, (9) + 1.

✗ Lily flower is complete
✓ **incomplete**: no separate calyx and corolla.