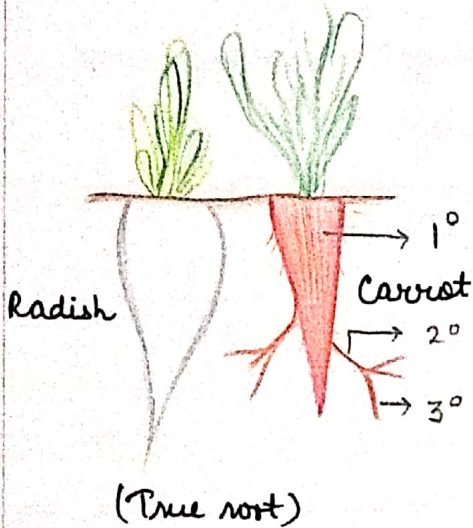


5: Morphology of Flowering Plants

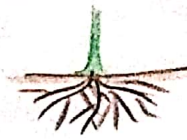
external structures Angiosperms

• ROOT

- 2 types
 - True roots → arise from radicle → feature of DICOTS.
 - Adventitious roots → arise from any part other than radicle → feature of MONOCOTS.



eg: Ficus religiosa (Peepal)



Fibrous roots (adventⁿ)

eg: wheat
Maize

Grass
Monstera
Banyan tree

- The direct elongation of the radicle leads to the formation of Primary root.

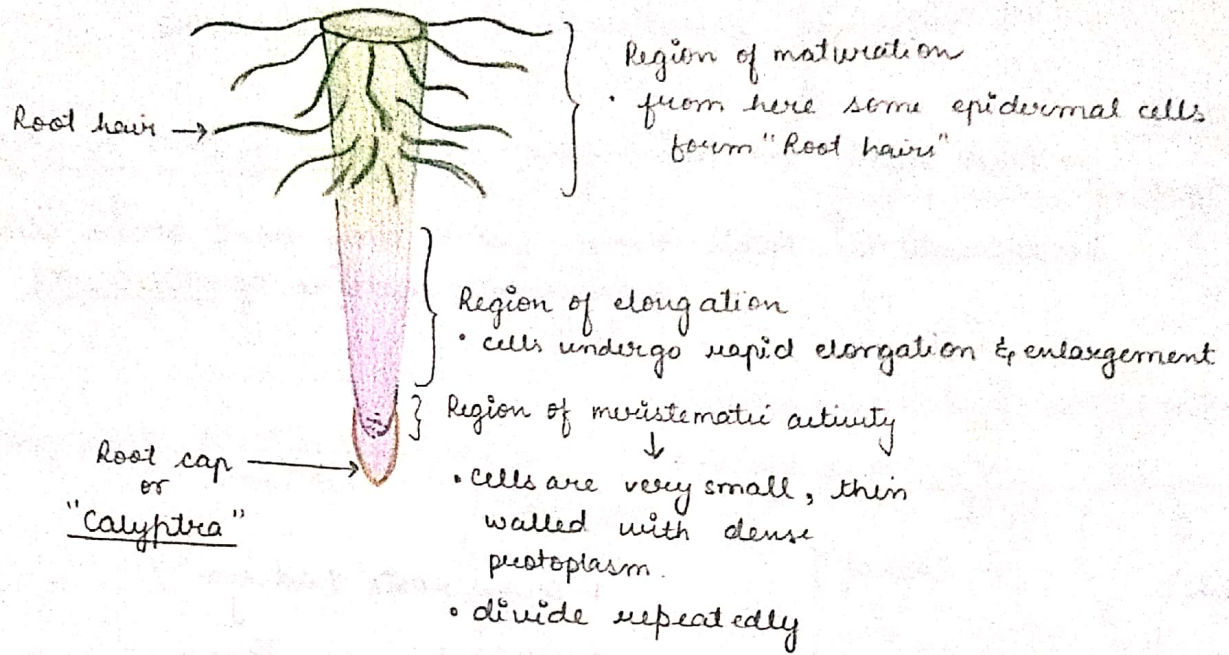
↓ bears
lateral roots ⇒ Secondary roots
Tertiary roots

- Primary root + its branches → TAP ROOT SYSTEM
eg: Mustard

- Main function:

- Absorption of water and minerals from soil.
- Provides proper anchorage to plant parts
- Storing reserve food material
- Synthesis of plant growth regulators.

• Regions of Root



• Modifications of Root

S.NO	Name	Function	Example	(Tap root modifications)
1.	Fusiform	Storage of Food	Radish	
2.	Conical		Carrot	
3.	Napiform		Beet root	
4.	Tuberous		4 o'clock plant	
5.	Pneumatophores for Respiration		Marshy area plants	

1. Prop root

Mechanical support

- Ficus bengalensis
(Banyan)
- Ficus elastica
(Rubber)

Adventitious Root modification

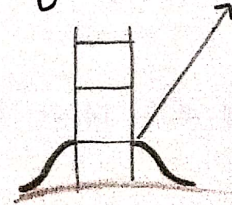
- arise from stem



2. Stilt roots

- Sugarcane
- Maize
- Pandanus

- arise from Basal nodes

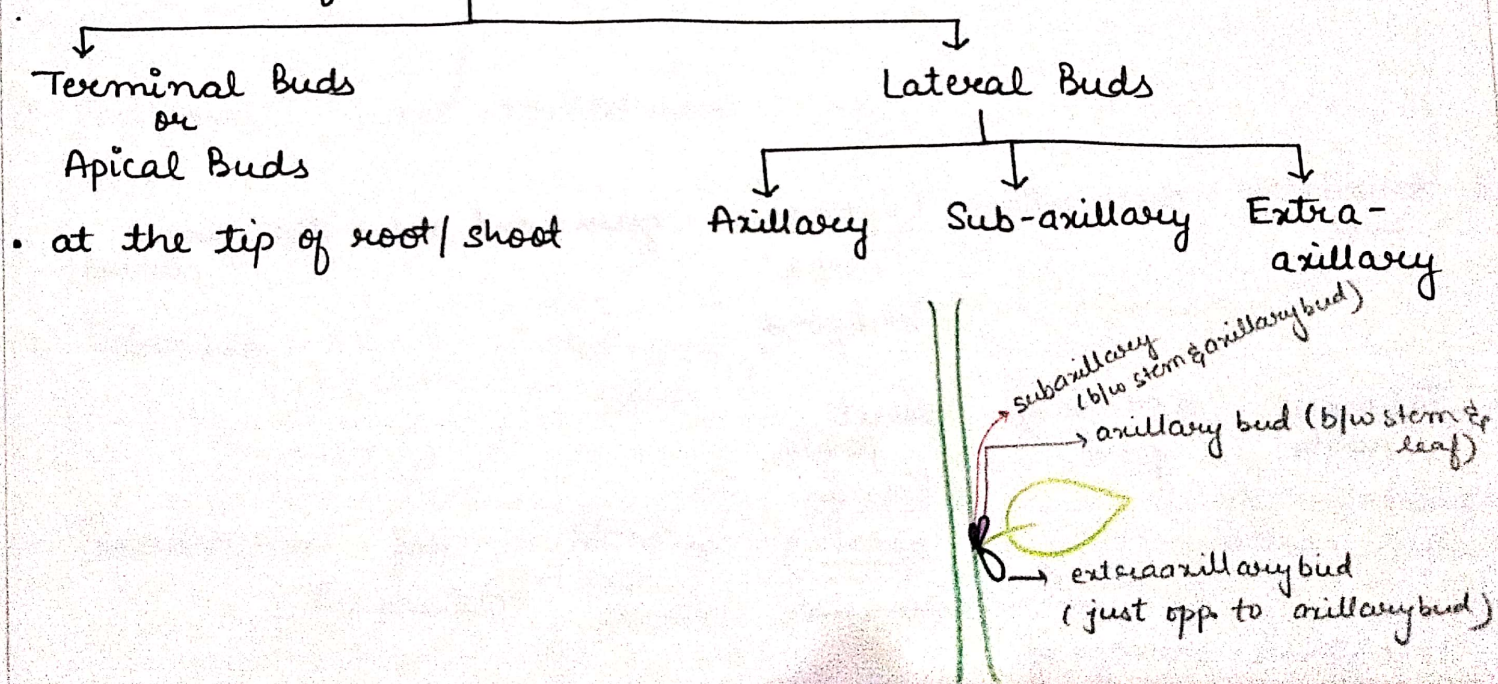


- **BUDS**

- compact underdeveloped shoots

→ Classification of Buds:

(i) On Basis of location



- Modifications of Buds:

- 1) Bulbil : Bud is swollen and this gives rise to baby plant.
eg: Agave
- 2) Tendrils : for support
eg: Cucurbita
- 3) Thorns : Duranta

⇒ STEM

- have nodes and internodes → space b/w nodes

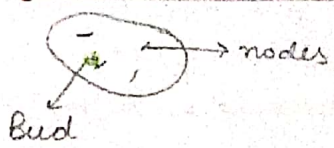
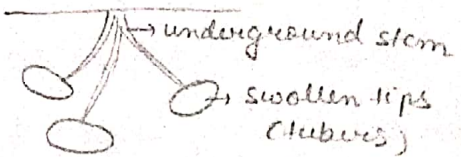
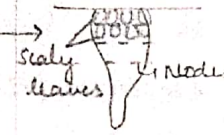
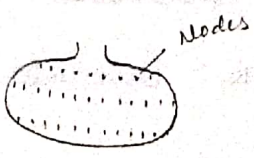
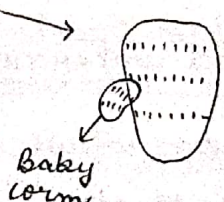
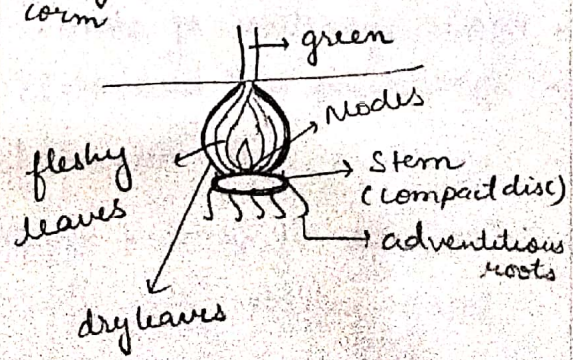


structures from where branches or leaves arise.

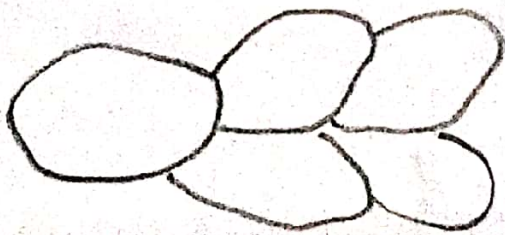
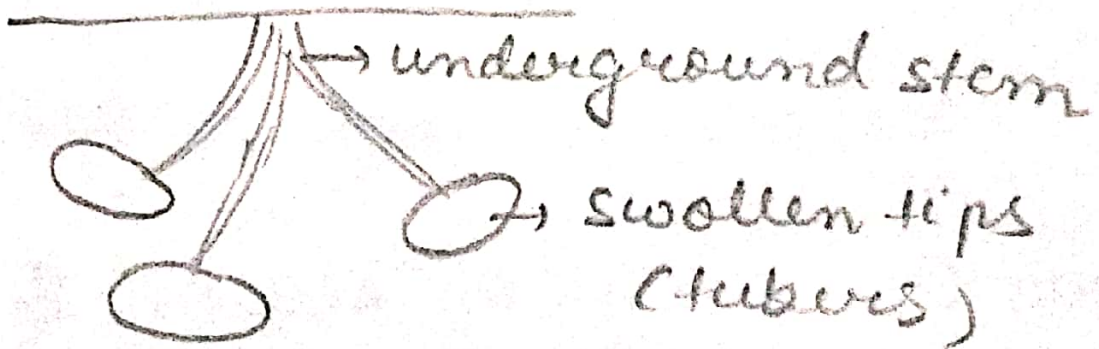
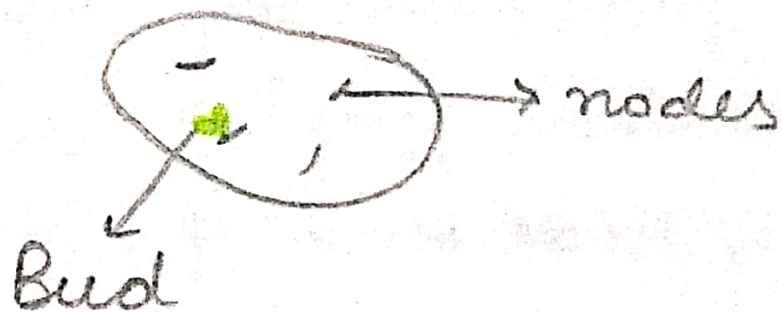
- main function of stem:

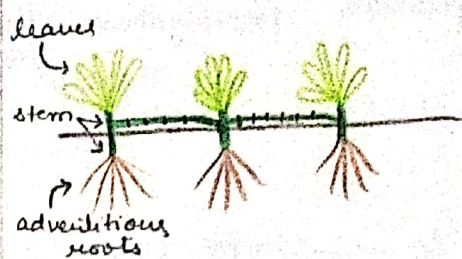
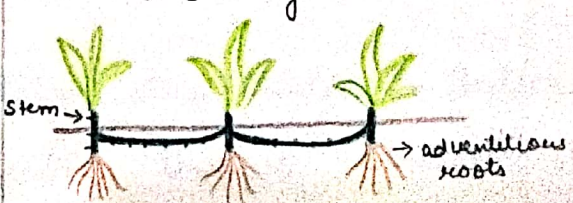
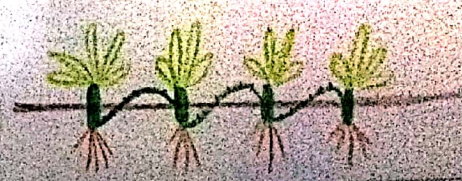
- spreading out branches bearing leaves, flowers, fruits.
- Conducts H_2O , minerals and photosynthates.
- Storage of food, support, protection and vegetative propagation.

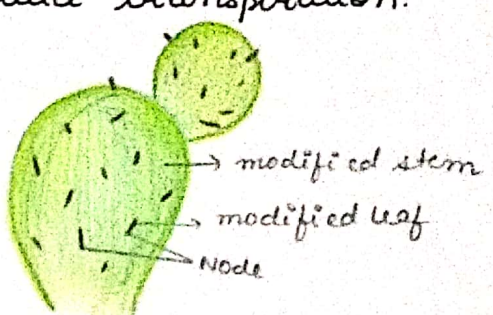
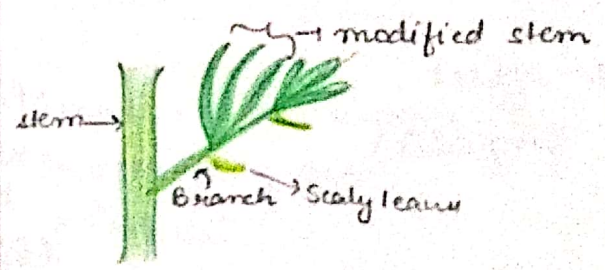
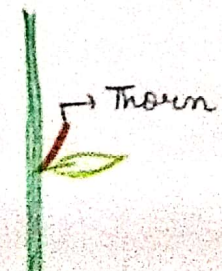
STEM MODIFICATIONS :

S.No.	Name	Function	Examples	underground stem modifica. ⁿ
1.	Tuber	storage of Food	• Potato	 
2.	Rhizome		• Ginger • Turmeric	
	classify (i) Vertical rhizome (ii) horizontal rhizome		• Ferns Banana Pineapple • lotus • ginger turmeric	Functions of Rhizome: • storage of food • Support • vegetative propagation
	→ Monopodial → only one main axis → Sympodial → axis is made up of various branches joined together.			
3.	Corms	• storage of food • vegetative propagation	• Crocus (saffron) • Colocasia • Alocasia	 
4.	Bulb			
	Tunicated (cover) Non-tunicated	Simple → Onion Compound → Garlic	• Lily	

Underground stem modifica.ⁿ

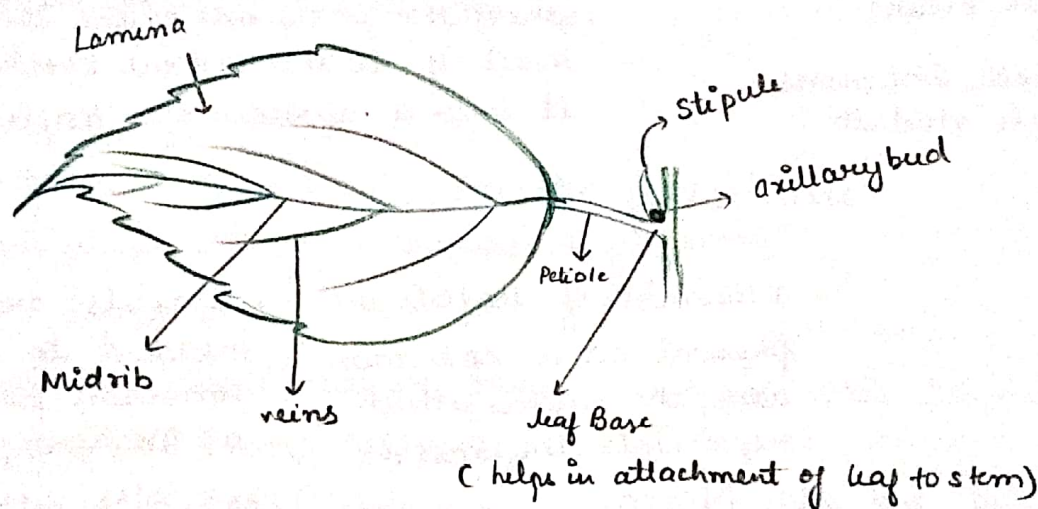


S.No.	Name	Function	Example	Subaerial modifications of stem
5.	Runner (Terrestrial)		- Cynodon (Doob grass) - Oxalis	 leaves stem adventitious roots Stem gives rise to a branch which runs parallel to the surface of ground. This branch also has nodes and internodes. Whenever, the nodes comes in contact with ground. It will give rise to small stem.
6.	Offset (Aquatic)		- Pistia - Water hyacinth (Eichhornia)	 swollen stem - Stem and its branches are swollen (aerenchyma) - Unlike runners, the branches in offsets arises in all the directions. - The branch is, normally, one internode long.
7.	Sucker (Terrestrial)		- Mint (<u>Mentha</u> <u>arvensis</u>) - Banana - Pineapple - Bamboo - Guzanthemum	 stem adventitious roots - Small stem. - From the underground stem, the node produces a branch which remains underground for majority of time and then moves obliquely upwards and gives rise to another stem.
8.	Stolon (Terrestrial)		- Strawberry <u>M. piperita</u> (Pepper mint)	

S.No.	Name	Function	Example	Aerial modifications of stem
9.	Phylloclad	photosynthesis	- Cactus - Opuntia	- Stem is modified into green, thick, fleshy structure. - Leaves are modified into spines to reduce transpiration.  Diagram labels: modified stem, modified leaf, Node
10.	Cladode		Asparagus	Only one internode long  Diagram labels: modified stem, stem, Branch, Scaly leaves From the axil of scaly leaf arises another branch (bunch) which is thick, fleshy, green.
11.	Thorns	Protection	- Duranta - Citrus plants - Bougainvillea	 Diagram label: Thorn
12.	Tendrils	Support	- Passiflora - Vitis	

— The Leaf —

- develops at node & bears a bud on its axil.
- axillary bud later develops into a branch.
- originate from shoot apical meristem
- arranged in **Acropetal** order
↳ (New stem at apex and older at base)
- Structure of leaf:



- In monocots, leaf base expands into a sheath covering the stem partially or wholly.
- In some leguminous plants, leaf base may become swollen.
↳ **Pulvinus**
- Petiole help hold the blade to light.
↳ long, thin flexible petioles allow leaf blades to flutter in wind, thereby cooling the leaf and bringing fresh air to leaf surface.
- Veins provide rigidity to the leaf blade and act as channels of transport for water, minerals and food materials.
- Venation : arrangement of veins and veinlets in the lamina of leaf.

Reticulate • Veinlets forms a network • eg: leaf of dicots	Parallel • Veins run parallel to each other • eg: Monocot leaves
---	---



Reticulate



Parallel

• TYPES OF LEAVES

Simple

- lamina is entire
or
when incised, incisions do not touch midrib.

Compound

- when the incisions of the lamina reach up to the midrib breaking it into a number of leaflets.

Pinnately compound

- a number of leaflets are present on a common axis, the rachis which represents the midrib

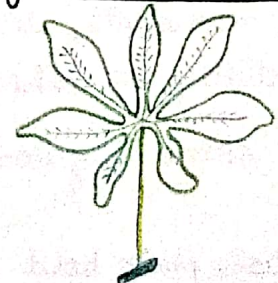
eg: Neem



Palmately compound

- leaflets are attached to a common point i.e. at the tip of petiole.

eg: Silk cotton



• Phyllotaxy

Pattern of arrangement of leaves on the stem or branch.

Alternate



- single leaf arise at each node

eg: China rose

Opposite



- a pair of leaves arise at each node.

eg: Guava
Calotropis

Whorled



- More than two leaves arise at each node.

eg: Alstonia

— Modifications of leaf —

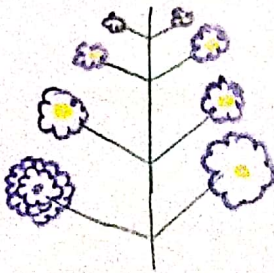
- Tendrils : For climbing eg: Peas
- Spines : For defence eg: cacti
- Fleshy leaves of onion, garlic → storage of food
- Photosynthesis : eg → Australian acacia → leaves are small and short-lived. Petioles in these plants expand, become green and synthesise food
- Pitcher plant, Venus fly trap :

• Inflorescence

Arrangement of flowers on the floral axis

Racemose

- Main axis continues to grow
- Flowers are borne laterally in an acropetal manner.



→ older flowers at base
new flowers at tip

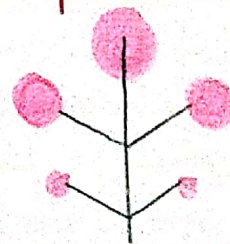
eg: Brassica campestris
(mustard)

Raphanus sativus (radish)

Antirrhinum majalis (Snapdragon)

Cymose

- Main axis terminates in a flower.
- Flowers are borne in basipetal manner.

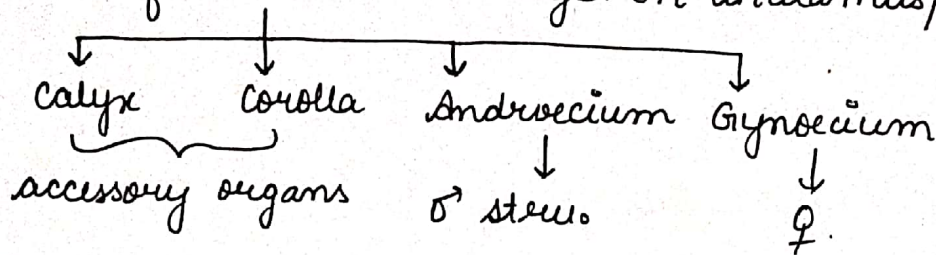


→ older flowers at tip
new flowers at base.

eg: lily
jasmine

- The FLOWER

- Reproductive unit in angiosperms
- Consists of 4 whorls arranged on thalamus/receptacle.



- **Bisexual flower** = When a flower has both androecium and gynoecium.
- **Unisexual flower** = A flower having either only stamens or only carpels.

- Symmetry



Actinomorphic

- Radial symmetry
- Flower can be divided into two equal halves in any radial plane passing through centre.

eg: Mustard, Datura, Chilli

Zygomorphie

- Bilateral symmetry
- when a flower can be divided into two similar halves only in one particular vertical plane.

eg: Pea, Gulmohar, bean,
Cassia.

- **Asymmetric** : A flower is asymmetric (irregular) if it cannot be divided into two similar halves by any vertical plane passing through centre.

eg: Canina

- A flower may be trimorous, ⁽⁵⁾pentamerous, ⁽⁴⁾tetramerous
(3 or multiples of 3)
petals

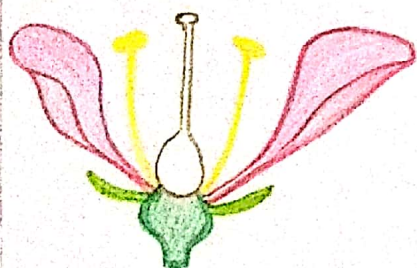
- Flowers with **bracts - reduced leaf**
 - found → Bracteate
 - not found → Ebracteate

Flowers based on position of floral parts on thalamus

Hypogynous

- Gynoecium occupies the highest position while other parts are situated below it.

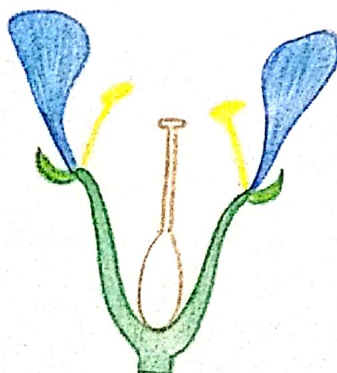
- Superior ovary
- Mustard
- China Rose
- Brinjal



Perigynous

- Gynoecium is situated in the centre and other parts of flower are located on the rim of thalamus almost at same level.

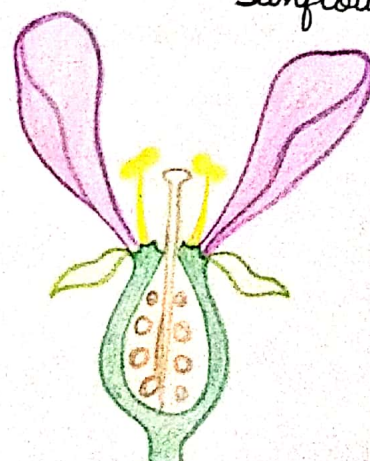
- Half Inferior
- Plum
- Rose
- Peach



Epigynous

- Margin of thalamus grows upwards

- Inferior ovary
- Guaava
- Cucumber
- Ray florets of Sunflower



Parts of Flower

- CALYX (sepals)

Gramosepalous

- sepals united

Polysepalous

- sepals free

- COROLLA (petals)

Gramopetalous

- petals united

Polypetalous

- petals free

Aestivation

Mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whorl.

Valvate



- When sepals or petals in a whorl just touch one another at the margin without overlapping.

eg: Calotropis

Twisted



- If margin of the appendage overlaps that of the next one and so on.

eg: China rose
Lady's finger
Cotton

Imbricate



- If margins of sepals or petals overlap one another but not in any particular direction.

eg: Cassia
Guilmohar

Vexillary



- There are 5 petals, the largest (standard) overlaps the two lateral petals (wings) which in turn overlap the two smallest anterior petals. (Keel).

• Also called **Papilionaceous**.

• ANDROECIUM

- **Staminode** = Sterile stamen

Stamen

Epipetalous

- Stamens are attached to petals

eg: Brinjal

Epiphyllous

- Stamen is attached to Perianth (when Calyx & Corolla are undifferentiated)

eg: Lily

- **Monadelphous**: Stamens may be united into one bunch or one bundle. eg: China rose.

- **Diadelphous**: --- into two bundles. eg: Pea

- **Polyadelphous**: --- into more than two bundles. eg: Citrus

- **Polyandrous** = Stamens remain free.

• GYNOECEIUM

- made of one or more carpels.

Apocarpous

- carpels are free
- eg: Lotus, rose

Syncarpous

- carpels are fused
- eg: Mustard, tomato

- Ovules $\longrightarrow$ seed
- Ovary $\longrightarrow$ fruit

PLACENTATION

- arrangement of ovules within ovary

Marginal



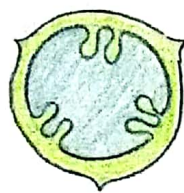
- Placenta forms a ridge along the ventral suture of ovary and ovules are borne on this ridge forming two rows.
- eg: Pea

Axile



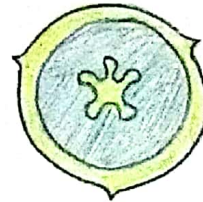
- Placenta is axile & ovules are attached to it in a multi locular ovary.
- eg: China rose, Tomato, lemon

Parietal



- Ovules develop on the inner wall of ovary.
- Ovary is one chambered but it becomes 2-chambered due to formation of false septum
- eg: Mustard, Argemone

Free-central



- Ovules are borne on central axis and septa are absent.
- eg: Dianthus, Primrose

Basal

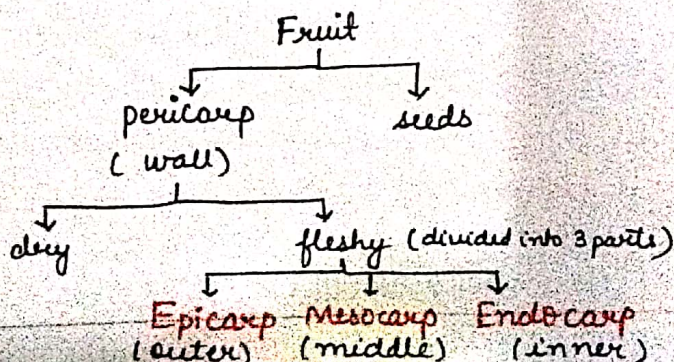


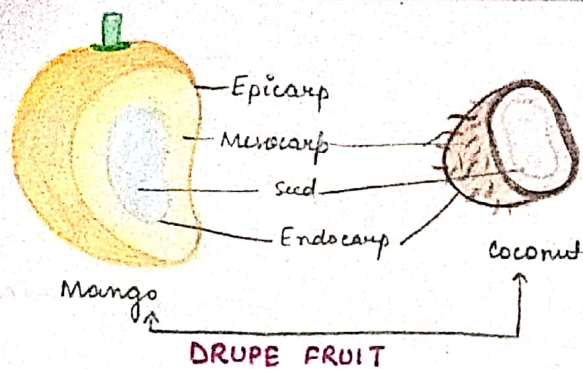
- Placenta develops at base of ovary and single ovule is attached to it.
- eg: Sunflower, Marigold

• The Fruit

(Mature or Ripened Ovary)

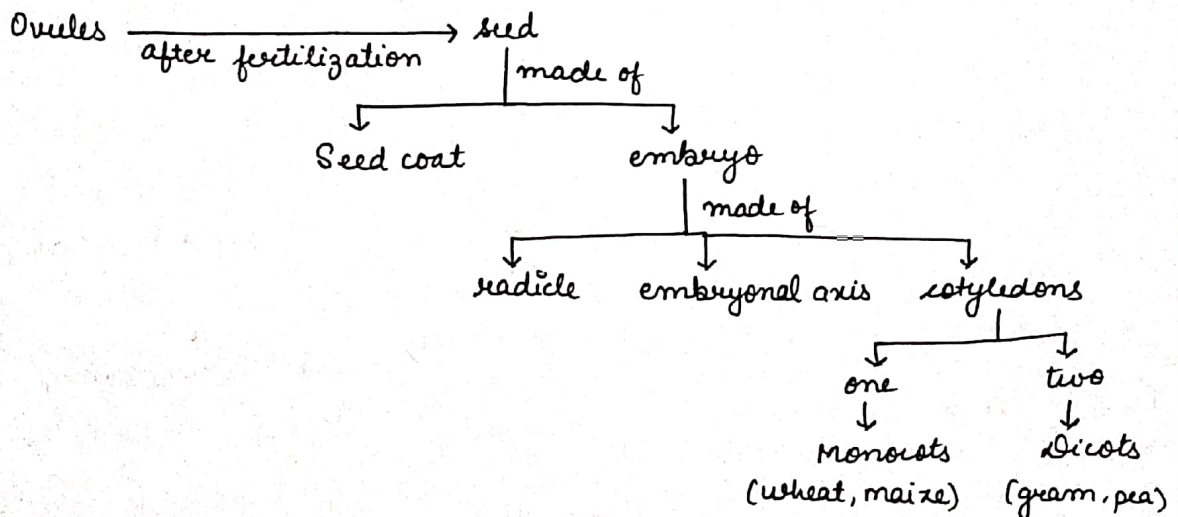
- **Parthenocarpic fruit** = Fruit formed without fertilization.



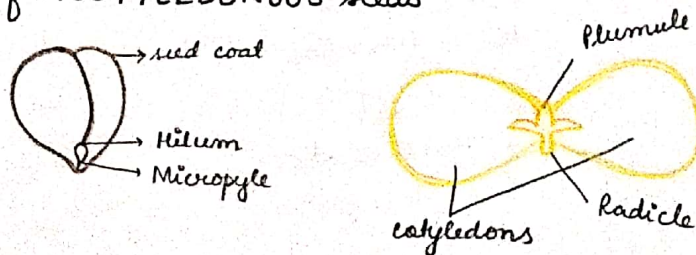


- develop from monocarpellary superior ovaries and are one seeded
- In Mango, the pericarp is well differentiated into an outer thin epicarp, a middle fleshy edible mesocarp and inner stony hard endocarp
- In Coconut, mesocarp is fibrous.

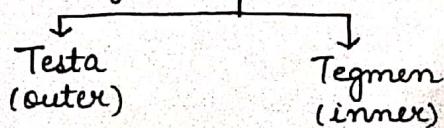
• The SEED



▲ Structure of DICOTYLEDONOUS seeds



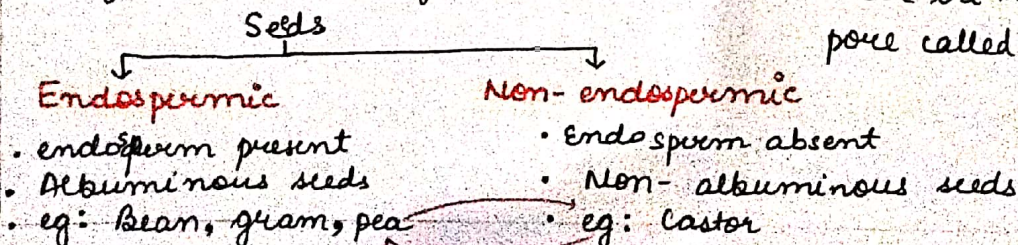
• outermost covering : Seed coat



• **Hilum**: Scar on the seed coat through which the developing seeds were attached to the fruit.

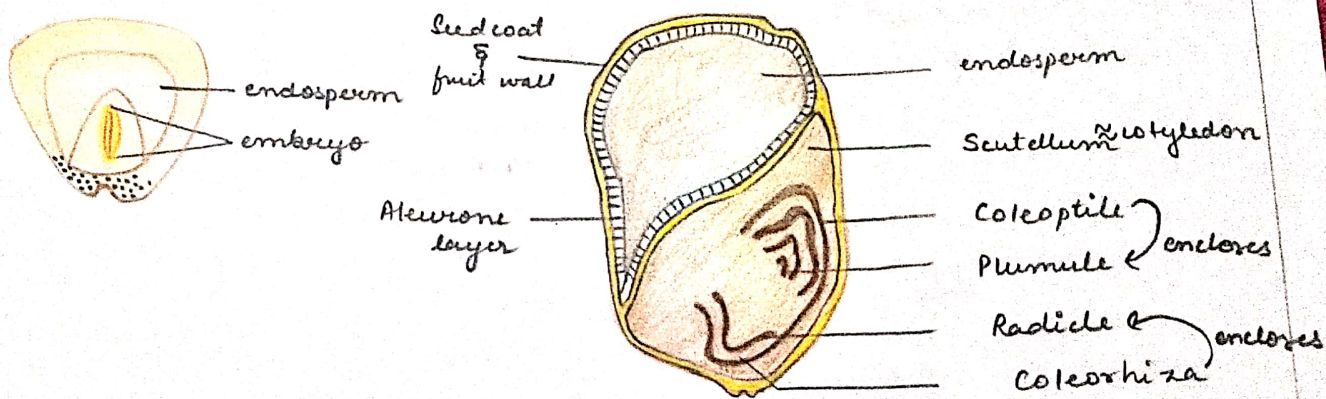
• Above the hilum, is a small pore called **micropyle**.

• cotyledons → Reserve food material



• Structure of MONOCOTYLEDONOUS seed

- generally endospermic
- But in some → *Orchids* → Non-endospermic



- Outer covering of embryo endosperm separates the embryo by a proteinaceous layer → *aleurone layer*

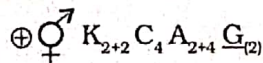
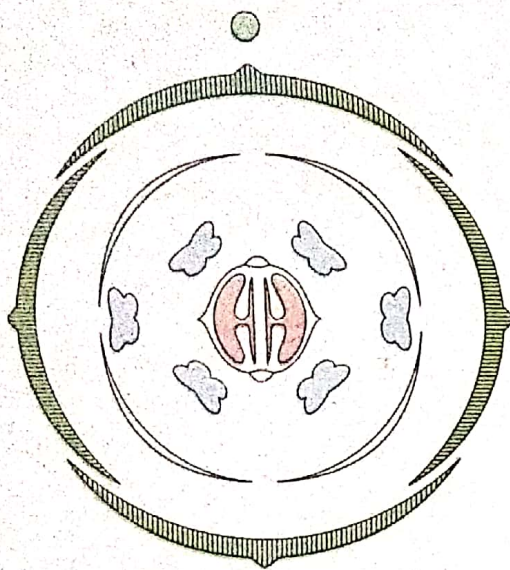


Figure 5.20 Floral diagram with floral formula

5.8 SEMI-TECHNICAL DESCRIPTION OF A TYPICAL FLOWERING PLANT

Various morphological features are used to describe a flowering plant. The description has to be brief, in a simple and scientific language and presented in a proper sequence. The plant is described beginning with its habit, vegetative characters – roots, stem and leaves and then floral characters inflorescence and flower parts. After describing various parts of plant, a floral diagram and a floral formula are presented. The floral formula is represented by some symbols. In the floral formula, **Br** stands for bracteate **K** stands for calyx, **C** for corolla, **P** for perianth, **A** for androecium and **G** for Gynoecium, $\overline{\text{G}}$ for superior ovary and $\underline{\text{G}}$ for inferior ovary, $\text{ } \overline{\text{G}}$ for male, $\text{ } \underline{\text{G}}$ for female, $\text{ } \overline{\text{G}}$ for bisexual plants, $\oplus$ for actinomorphic and $\%$ for zygomorphic nature of flower. Fusion is indicated by enclosing the figure within bracket and adhesion by a line drawn above the symbols of the floral parts. A floral diagram provides information about the number of parts of a flower, their arrangement and the relation they have with one another (Figure 5.20). The position of the mother axis with respect to the flower is represented by a dot on the top of the floral diagram. Calyx, corolla, androecium and gynoecium are drawn in successive whorls, calyx being the outermost and the gynoecium being in the centre. Floral formula also shows cohesion and adhesion within parts of whorls and between whorls. The floral diagram and floral formula in Figure 5.20 represents the mustard plant (Family: Brassicaceae).

5.9 DESCRIPTION OF SOME IMPORTANT FAMILIES

5.9.1 Fabaceae

This family was earlier called Papilionoideae, a subfamily of family Leguminosae. It is distributed all over the world (Figure 5.21).

Vegetative Characters

Trees, shrubs, herbs; root with root nodules

Stem: erect or climber

Leaves: alternate, pinnately compound or simple; leaf base pulvinate; stipulate; venation reticulate.

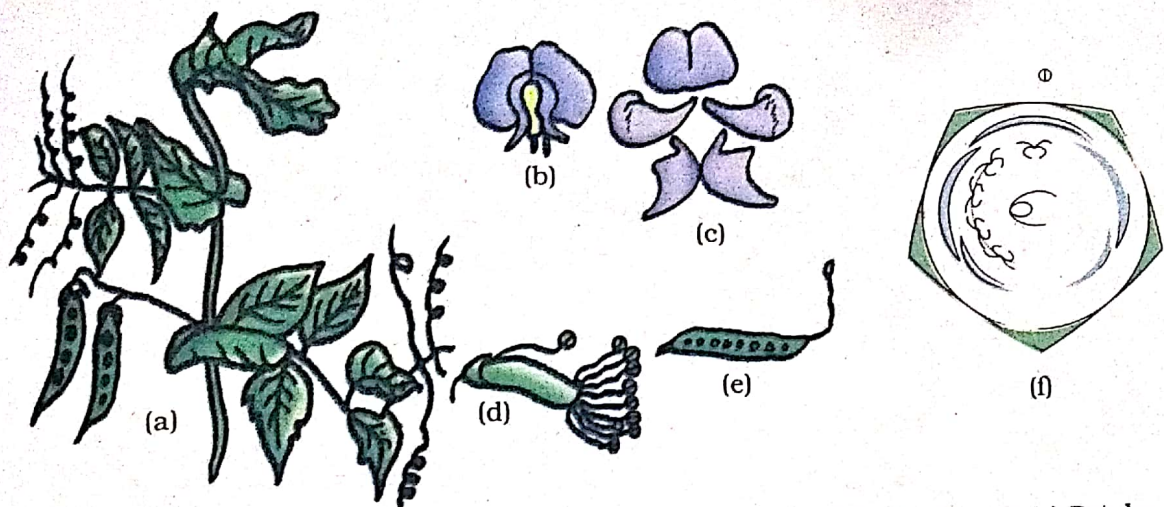


Figure 5.21 *Pisum sativum* (pea) plant : (a) Flowering twig (b) Flower (c) Petals (d) Reproductive parts (e) L.S. carpel (f) Floral diagram

Floral characters

Inflorescence: racemose

Flower: bisexual, zygomorphic

Calyx: sepals five, gamosepalous; valvate/imbricate aestivation

Corolla: petals five, polypetalous, papilionaceous, consisting of a posterior standard, two lateral wings, two anterior ones forming a keel (enclosing stamens and pistil), vexillary aestivation

Androecium: ten, diadelphous, anther dithecal

Gynoecium: ovary superior, mono carpellary, unilocular with many ovules, style single

Fruit: legume; seed: one to many, non-endospermic

Floral Formula: $\% \begin{smallmatrix} \text{♂} \\ \text{♀} \end{smallmatrix} K_{(5)} C_{1+2+(2)} A_{(9)+1} \underline{G}_1$

Economic importance

Many plants belonging to the family are sources of pulses (gram, arhar, sem, moong, soyabean); edible oil (soyabean, groundnut); dye (Indigofera); fibres (sunhemp); fodder (*Sesbania*, *Trifolium*), ornamentals (lupin, sweet pea); medicine (*muliathi*).

5.9.2 Solanaceae

It is a large family, commonly called as the 'potato family'. It is widely distributed in tropics, subtropics and even temperate zones (Figure 5.22).

Vegetative Characters

Plants mostly herbs, shrubs and rarely small trees

Stem: herbaceous rarely woody, aerial; erect, cylindrical, branched, solid

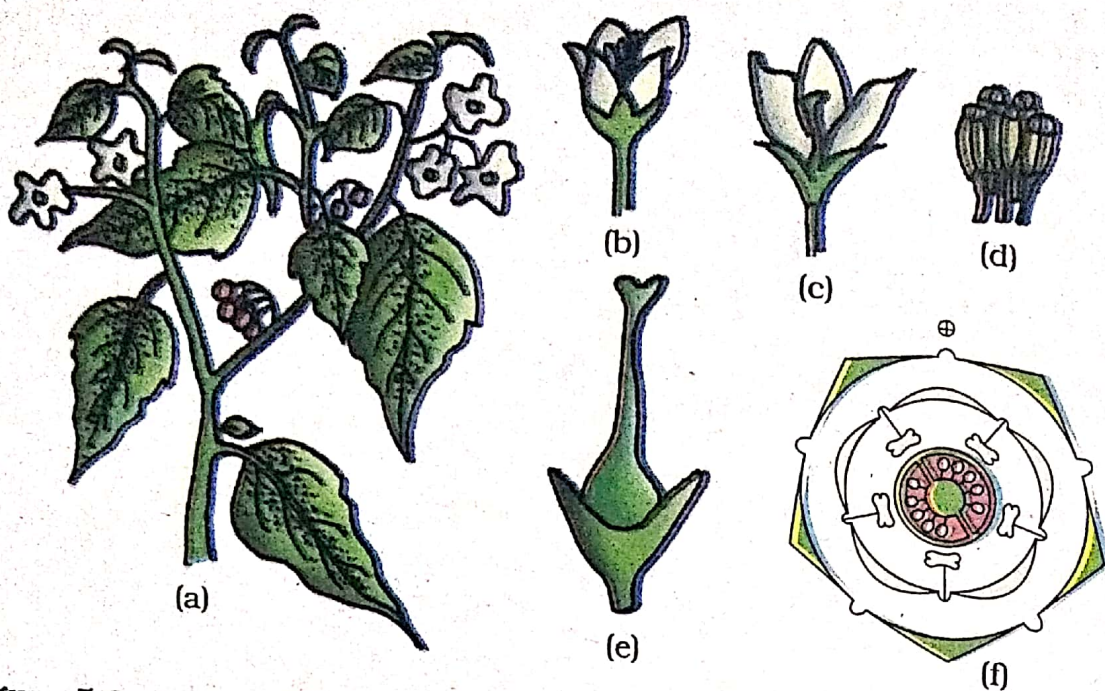


Figure 5.22 *Solanum nigrum* (mako) plant : (a) Flowering twig (b) Flower (c) L.S. of flower (d) Stamens (e) Carpel (f) Floral diagram

or hollow, hairy or glabrous, underground stem in potato (*Solanum tuberosum*)
Leaves: alternate, simple, rarely pinnately compound, exstipulate, venation reticulate

Floral Characters

Inflorescence : Solitary, axillary or cymose as in *Solanum*
Flower: bisexual, actinomorphic

Calyx: sepals five, united, persistent, valvate aestivation

Corolla: petals five, united; valvate aestivation

Androecium: stamens five, epipetalous

Gynoecium: bicarpellary obligately placed, syncarpous; ovary superior, bilocular, placenta swollen with many ovules, axile

Fruits: berry or capsule

Seeds: many, endospermous

Floral Formula: $\oplus \overset{\nearrow}{\underset{\searrow}{\text{C}}} K_{(5)} \overline{C}_{(5)} A_5 \underline{G}_{(2)}$

Economic Importance

Many plants belonging to this family are source of food (tomato, brinjal, potato), spice (chilli); medicine (belladonna, *ashwagandha*); fumigant (tobacco); ornamentals (petunia).

5.9.3 Liliaceae
 Commonly called monocotyledonous
Vegetative characters:
 rhizomes
 Leaves mostly linear
Floral characters:
 Inflorescence: raceme
 Flower: bisexual
 Perianth: tepals six
 Androecium: six stamens
 Gynoecium: three carpels
 many ovules
 Fruit: capsular
 Seed: endospermous
Floral Formula:
Economic importance:
 Many plants are used as
 Gloriosa,
 colchicine



5.9.3 Liliaceae

Commonly called the 'Lily family' is a characteristic representative of monocotyledonous plants. It is distributed world wide (Figure 5.23).

Vegetative characters: Perennial herbs with underground bulbs/corms/rhizomes

Leaves mostly basal, alternate, linear, exstipulate with parallel venation

Floral characters

Inflorescence: solitary / cymose; often umbellate clusters

Flower: bisexual; actinomorphic

Perianth tepal six (3+3), often united into tube; valvate aestivation

Androecium: stamen six, 3+3, epitepalous

Gynoecium: tricarpeal, syncarpous, ovary superior, trilocular with many ovules; axile placentation

Fruit: capsule, rarely berry

Seed: endospermous

Floral Formula: $\text{Br} \oplus \overset{\text{♂}}{\text{P}}_{(3+3)} \overset{\text{♀}}{\text{A}}_{3+3} \text{G}_{(3)}$

Economic Importance

Many plants belonging to this family are good ornamentals (tulip, *Gloriosa*), source of medicine (*Aloe*), vegetables (*Asparagus*), and colchicine (*Colchicum autumnale*).

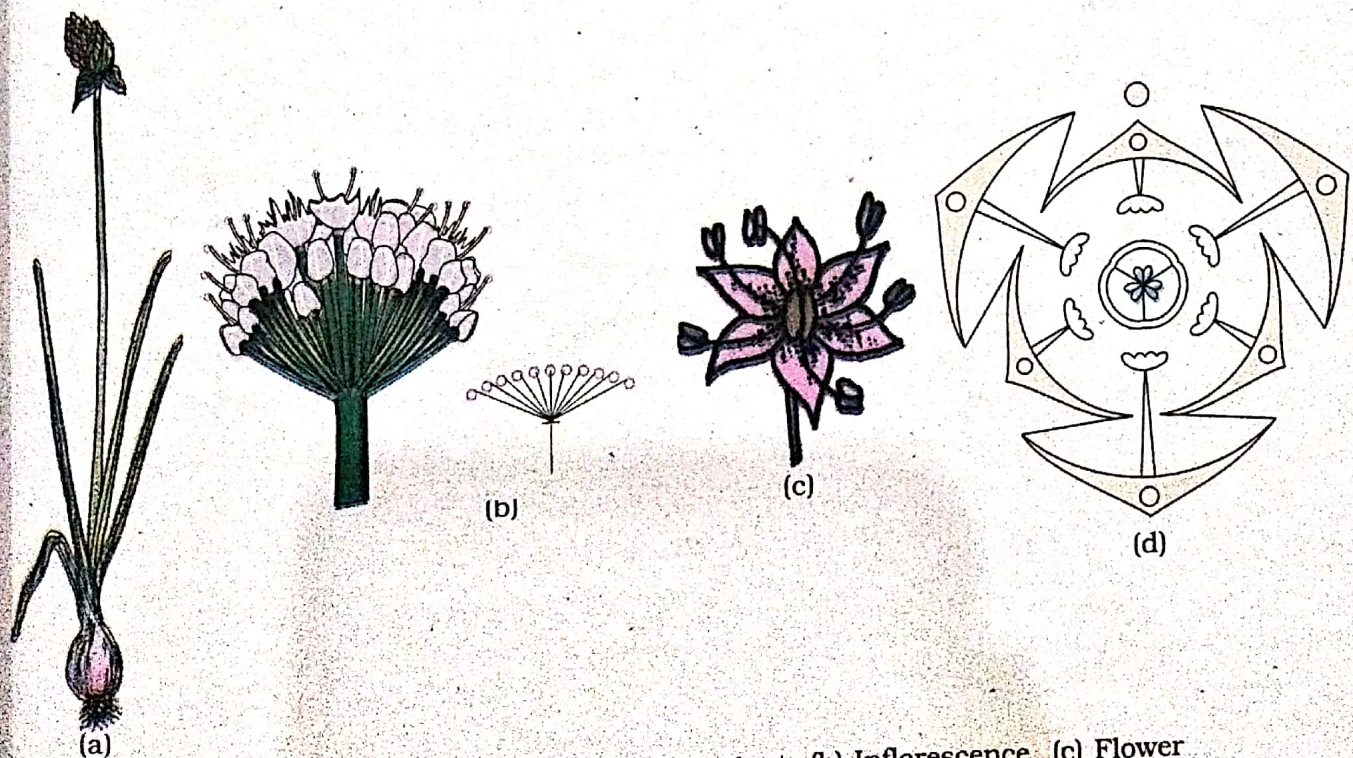


Figure 5.23 *Allium cepa* (onion) plant : (a) Plant (b) Inflorescence (c) Flower (d) Floral diagram