

FLOWER



- Flower is a modified shoot
- Floral leaves of flower – calyx, corolla, Androecium & Gynoecium
- ❖ Factors substantiating flower as modified shoot
- Homology of flower bud:
 - Position (axillary/terminal) & devt. Similar to veg. bud
 - floral buds transformed to veg. buds/ bulbils – Agave





- Shoot nature of thalamus:
 - i) Internodes elongated-Gynandropsis gynandra
 - ii) Thalamus grow beyond the gynoecium part & bear leaf or flower above – Rosa



- i) Thalamus elongates after fertilization, forms aggregate fruit – *Polyalthia longifolia*



- Leafy nature of floral organs:
- Arrangement of floral leaves similar to phyllotaxy – cyclic/ spiral – Hibiscus/ Nymphaea
 - Transition of floral members visible – Nymphaeaceae
 - Bud devt. In axil of floral leaves observed.

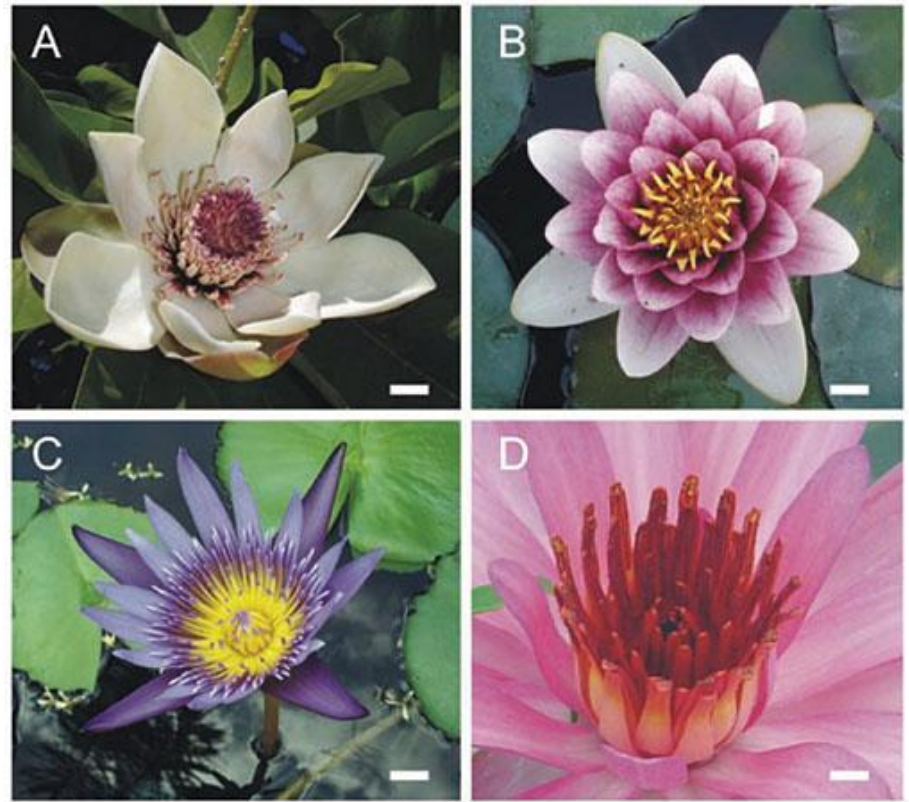


Figure 3. Spirally-arranged floral organs in basal angiosperms. A: *Magnolia watsoniana*. B: *Nymphaea caerulea*; C: *Nymphaea gigatea* var. Perry's Baby; D: *Nymphaea odorata*. Note the gradual transition between petals and stamens with intermediate petaloid structures containing pollen grains. Bars: A-C: 1.5cm; D: 600 μ m.



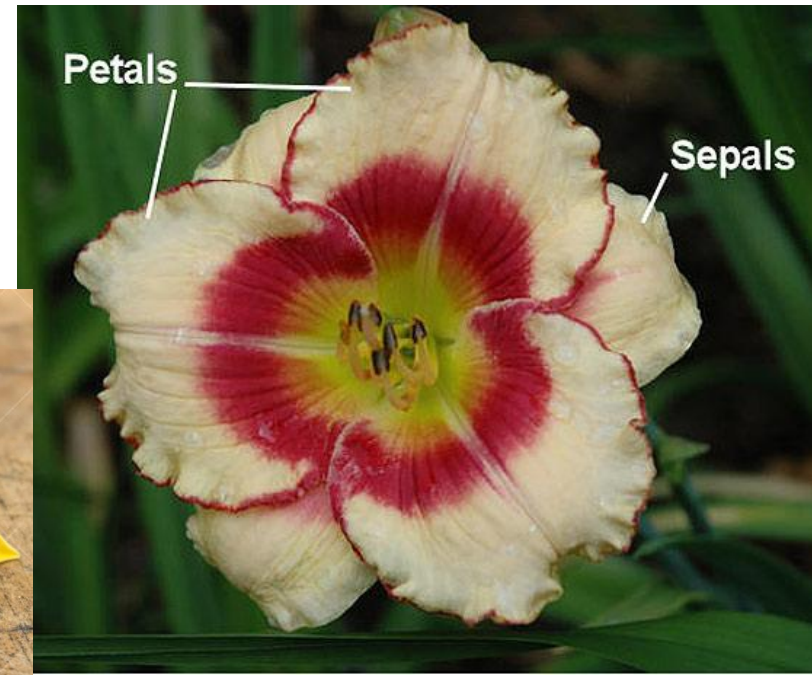
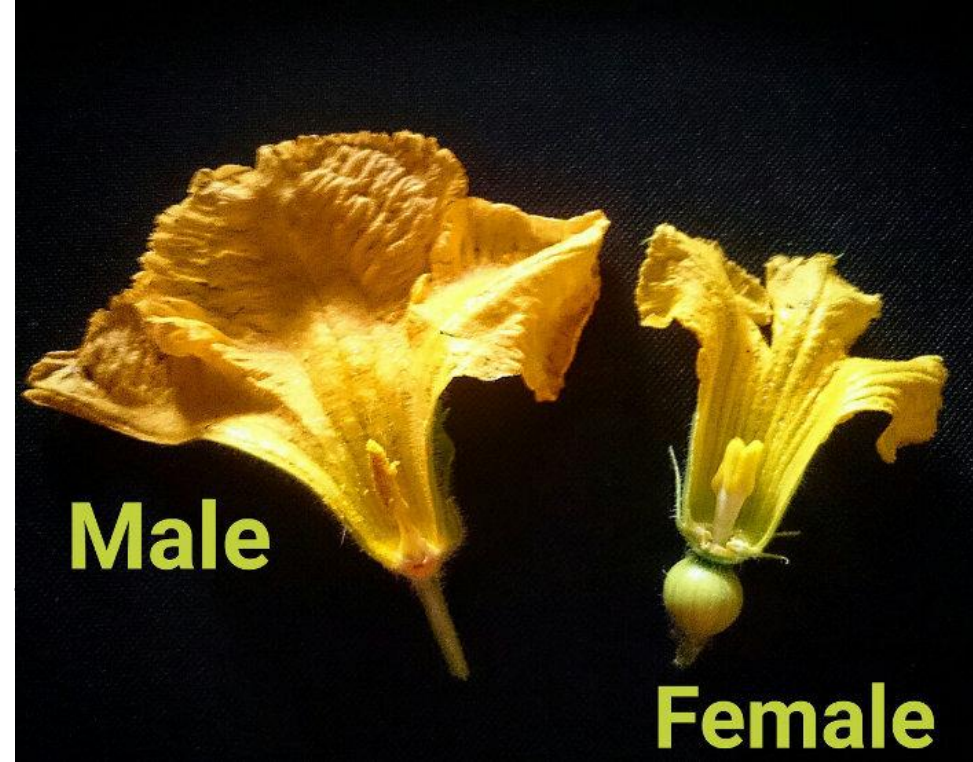
Terminologies on basis of floral whorls:

- Flower axis – thalamus
- Floral whorls – 4 (calyx, corolla, androecium, gynoecium)
- All 4 whorls present – complete flower (Hibiscus)
- any absent – Incomplete (Saraca)
- Essential whorls – androecium & gynoecium
- Nonessential whorls – calyx, corolla
- calyx & corolla indistinguishable – Perianth (Spathoglottis)
- corolla absent – apetalous (Saraca)



Flower classification – floral parts

- Bisexual/ Hermaphrodite – Androecium & gynoecium present
- Unisexual – only one sex organ (Cephalandra)
 - i) Male flower/ staminate flower – only androecium
 - ii) Female flower / Pistillate flower only gynoecium
- Dichlamydeous flower – Calyx & corolla distinguishable
- monochlamydeous – Perianth present (Calyx & corolla indistinguishable)



- Regular - floral whorls uniform size units (Hibiscus)
- Irregular- whorls not uniform size (Leucas)
- Flower that can be divided to equal halves – symmetrical (Hibiscus), (Leucas)
- Flower that cannot be divided to equal halves – Asymmetrical (Canna)
- symmetrical of two types
 - i) if it can be cut to 2 equal halves in any plane – Actinomorphic (Hibiscus)
 - ii) if it can be cut to 2 equal halves only in one plane – zygomorphic (Leucas)



Arrangement of floral whorls

- All four in circles – Cyclic (Allamanda)
- All in spiral – Acyclic/ Spiral (nymphaea)
- few circle & few spiral – Spirocyclic/ hemicyclic (Annona)



CALYX

- Outer most whorl of flower
- green, resemble foliage leaves in str. & venation

❖ Modifications:

- Petaloid sepals (Mussaenda)
- Pappus hairs (Tridax)
- Spurred calyx (balsam)



TYPES OF CALYX: BASED ON COLOUR



SEPALOID



PETALOID

following
Leafy Bracts (trochophore)



1
CAMPANULATE



2
CUPULATE



3
URCEOLATE



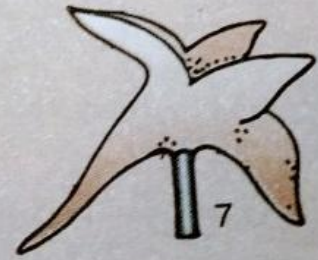
4
INFUNDIBULIFORM



5
TUBULAR



6
BILABIATE



7
SPURRED



8
PAPPUS



9
SPINOUS

TYPES OF CALYX: BASED ON STRUCTURE



TUBULAR



INFUNDIBULIFORM



URCEOLATE



BILABIATE



CAMPANULATE



CUPULATE

- Sessile with entire margin

- ❖ Modifications:

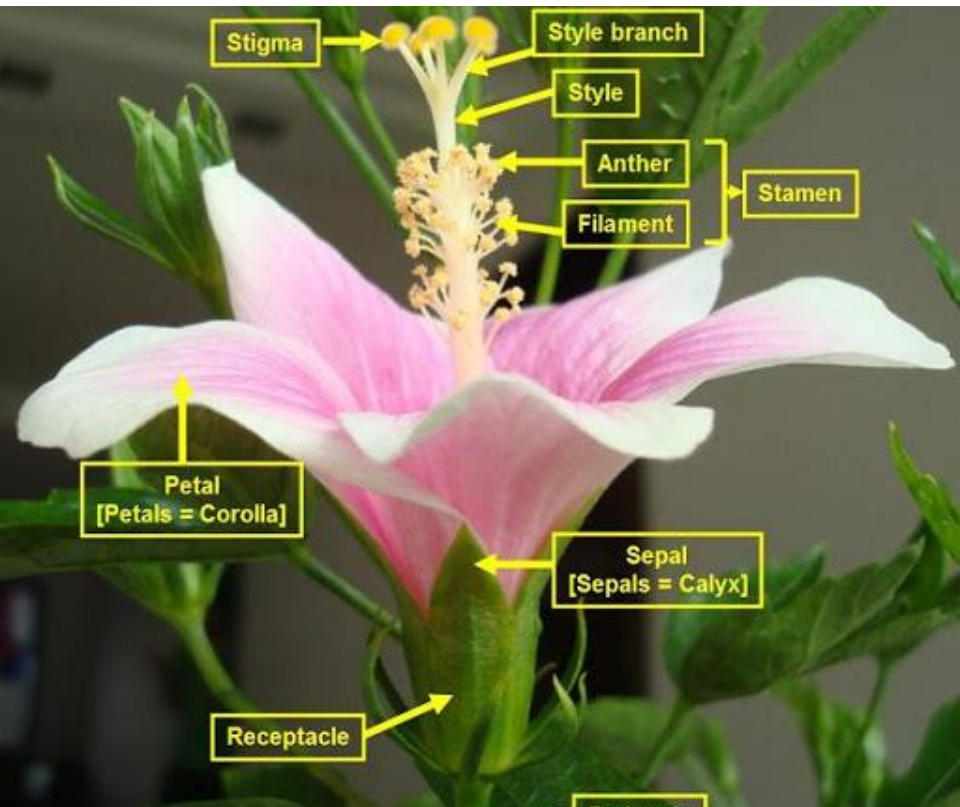
- Toothed margin (Rosa)

- * Spathulate (spoon shaped) – caesalpinia

- Fleshy & edible calyx – Hibiscus sabdarifa



- Sepals may be free (Polysepalous) Caesalpinia
- Sepals are fused (gamosepalous) Hibiscus



Based on withering nature,

- Caducous calyx – fall off as flower opens (Poppy)

- Deciduous calyx – fall off with petals (Mustard)

- Persistent calyx – remains in fruit (Brinjal)



- Acrescent calyx – persistent & covers the fruit as jacket (Physalis)

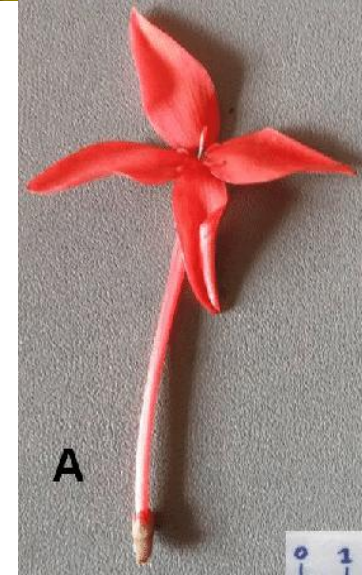
- functions of calyx:

- protect petals & essential organs
- green ones perform photosynthesis
- coloured ones help in pollination
- As pappus hair, help in seed dispersal.



COROLLA

- Second whorl of flower
- thin, delicate, coloured & sweet smelling
- Modifications:
 - green, succulent & thick – sepaloid petals (Annona)
 - petal lobes free – Polypetalous (Cassia)
 - petal lobes fused – gamopetalous (Ixora)
 - Petal with stalk (claw) & spread area (limb) – clawed (caesalpinia) - polypetalous
 - Gamopetalous with lower tube & upper limb – (ixora)
 - corolla with additional hairy appendages – Corolline hairs/Corolline appendages/ Corolline corona/ corollary corona – passiflora
 - petals butterfly shaped – Papilionaceous corolla
 - Corolla regular – uniform size lobes
 - corolla irregular – varying size





(rotate, wheel-shaped)



(campanulate, bell-shaped)



(urceolate, urn-shaped)



(salverform, hypocrateriform)



(funnelform)



(tubular)



(ligulate, tongue-shaped)



(bilabiate)



(personate)



(foxgloveform)



(papilionaceous)

POLYPETALOUS COROLLA

REGULAR FORMS



ROSACEOUS



CRUCIFORM



CARYOPHYLLACEOUS

IRREGULAR FORMS



PAPILIONACEOUS

GAMOPETALOUS COROLLA

REGULAR FORMS



TUBULAR



HYPOCRATERIFORM



INFUNDIBULIFORM



ROTATE



CAMPANULATE



URCEOLATE

IRREGULAR FORMS



LIGULATE



BILABIATE



PERSONATE



Figure 4.17: (a)
Trimerous



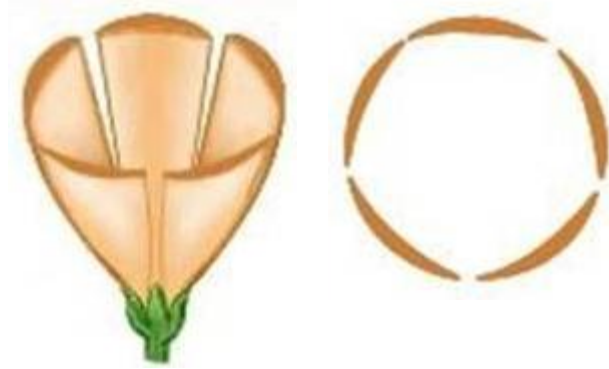
Figure 4.17: (b)
Tetramerous



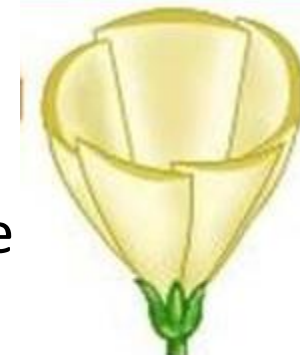
Figure 4.17: (c)
Pentamerous

AESTIVATION

- Arrangement of sepals/ petals in bud condition
- 4 Main types
- i) Valvate – adjacent petals/ sepals close to each other without overlapping – Mimosa sepals & petals
- valvate induplicate – margin of petal folded inside – Datura petal



- ii) Contorted/ Twisted – adjacent petals alternately overlapping, one end of 1st petal inside & other end outside - Hibiscus



- Induplicate-convolute: twisted in bud with margins curved in – Datura petal in bud condition



- iii) Imbricate – one petal completely inside, one completely outside, others partially in & out .

- 2 types

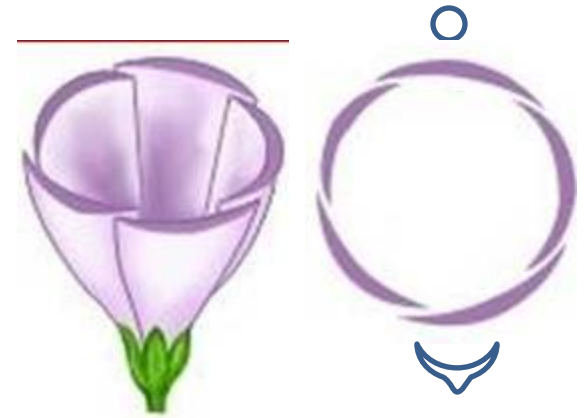
- a) Descendingly imbricate (Vexillary) – Posterior petal completely outside, anterior petal completely inside – papilionaceous corolla



- b) Ascendingly imbricate – posterior petal completely inside, anterior petal completely outside – corolla in caesalpinaceae subfamily



iv) Quincuncial – Two petals completely inside, two completely outside, remaining partially in & out – Calyx of Allamanda



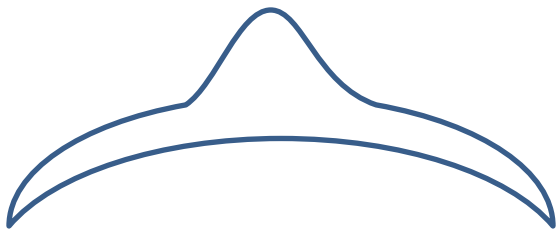
Common points:

Calyx represented by crescent shape with thickening on outer middle

Corolla represented by crescent shape

Posterior part of flower shown by circle representing stem proximity

Anterior part of flower shown by crescent shape representing bract



ANDROECIUM

- Male productive organ of flower
- made of individual units, stamen
- similar to microsporophylls of gymnosperms

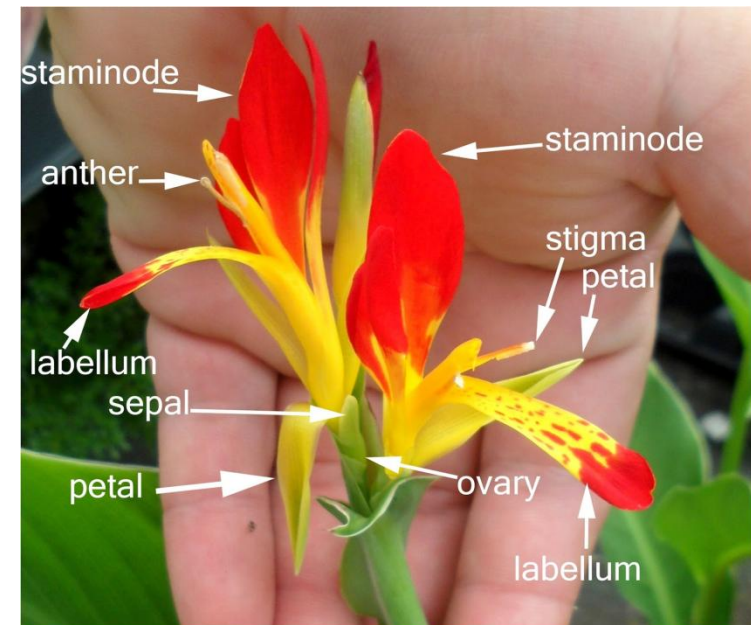
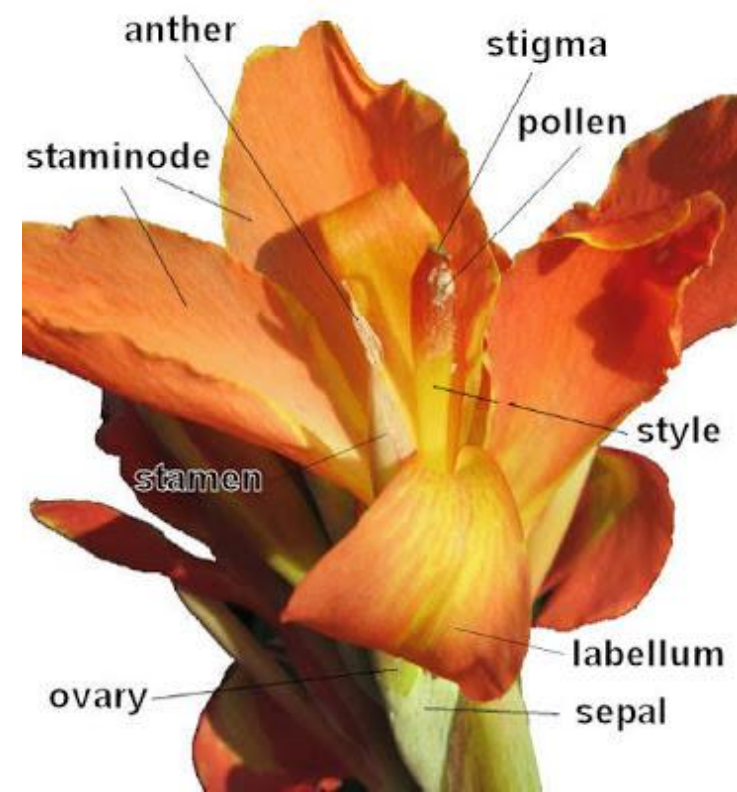
Modifications:

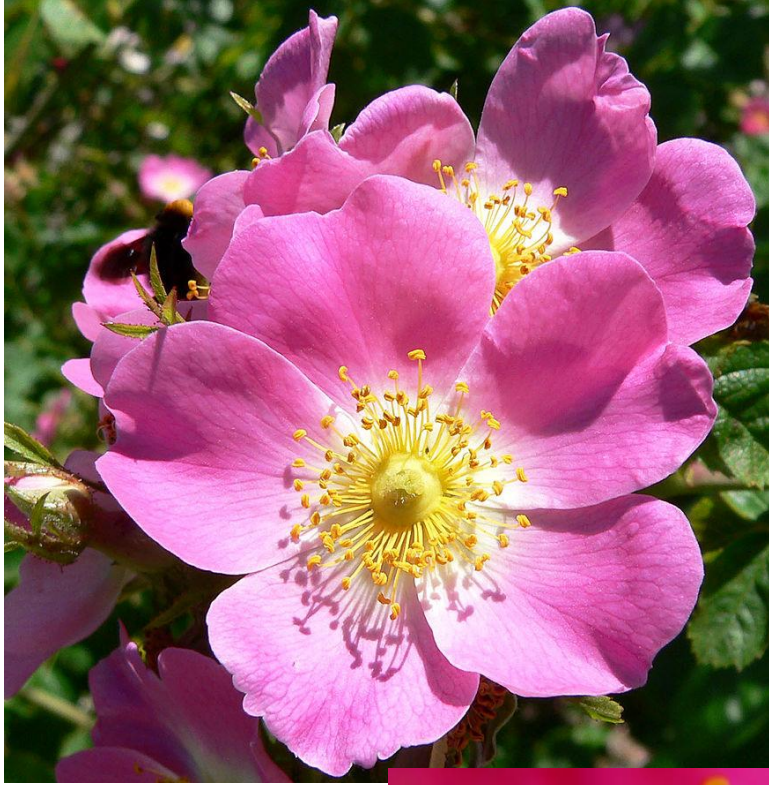
- Petaloid stamens – canna

*Arranged spirally or in circles

*single whorl or in several whorls – rosa

- Two types – epipetalous & free (insertion)
- Gamopetalous corolla with epipetalous stamens
- Polypetalous corolla with free stamens
- Free from each other – polyandrous

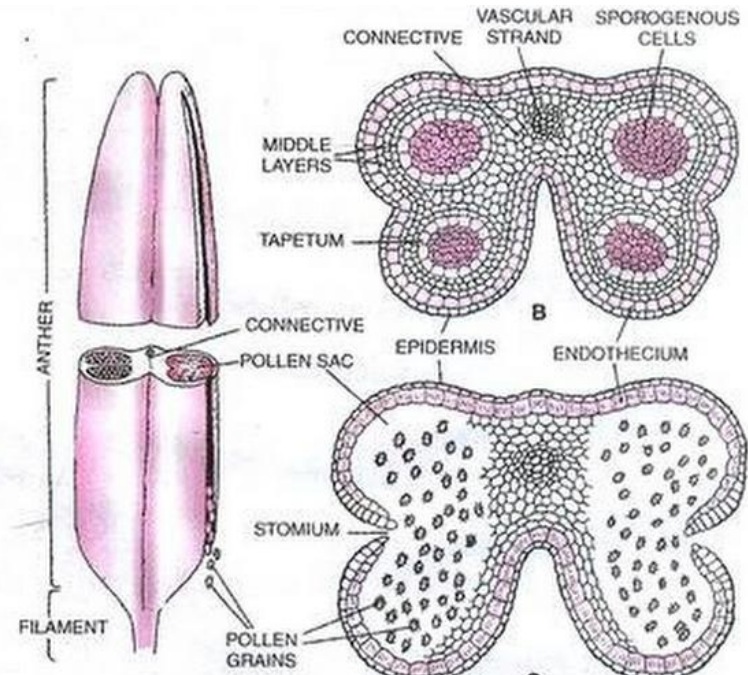
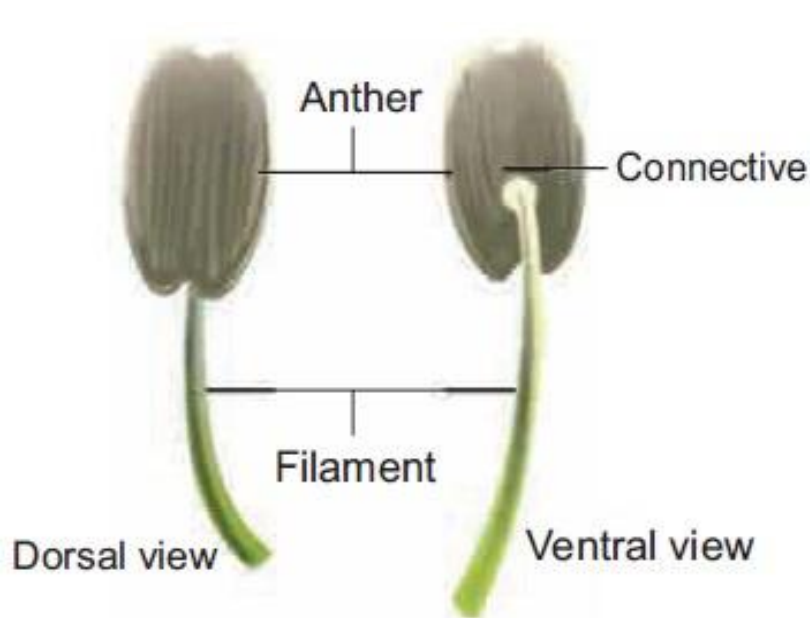




Structure of Stamen:

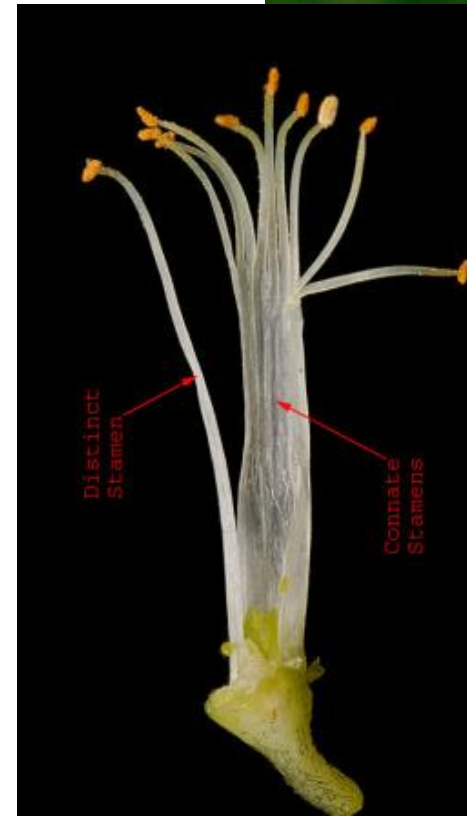
- * Three parts
- * Filament – slender stalk-pok
- Connective – the point of attachment b/w anther & filament
- Anther – the pollen bearing four chambered fertile part

- Stamens with ill developed anthers - Staminodes



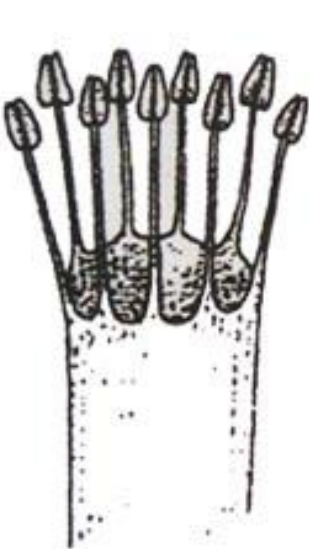
Stamens fusion (Adelphy)

- Fused to varying degrees:
 - i) Monadelphous – Filaments of all stamens Fused to form a single tube enclosing pistil – Hibiscus
 - ii) Diadelphous – Filaments of all stamens fuse to form two bundles – Clitoria
 - iii) Polyadelphous – Filaments of all stamens fuse to form more than two bundles – Bombax

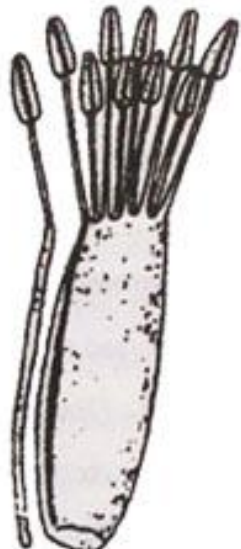


- iv) Synandrous – filaments & anthers of all stamens fuse to form single bundle – Cucurbita

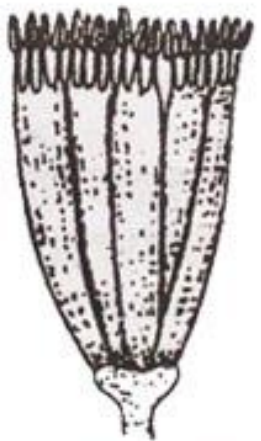
- Syngenesious – filaments free, but anthers fuse to form tube - Helianthus



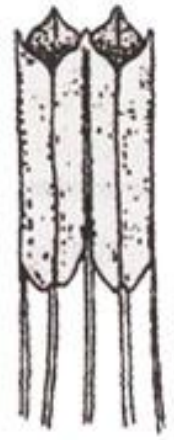
Monadelphous



Diadelphous



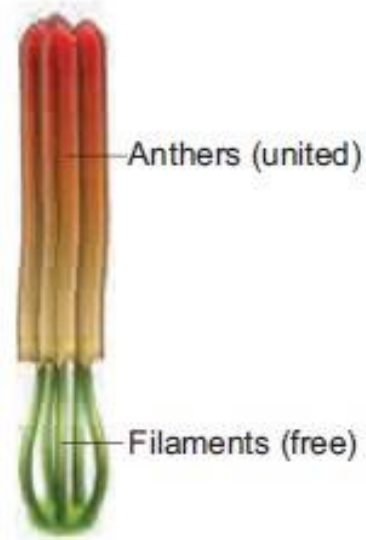
Polyadelphous



Syngenesious



Synandrous



Terminologies regarding androecium:

- Stamens protruding the flower (**Exerted/protruded**) -
Cleome
- stamens remain within the flower (**inserted/
included**) – Ipomoea

Based on adhesion of stamens with other parts:

- * **Episepalous** - Filaments fused with sepals -
-Verbena
- **Epipetalous**- Attached to petals- Brinjal
- * **Epiphyllous** - Filaments fused with tepals
- Asparagus)
- * **Gynandrous** - Anthers united with stigma forming
gynostegium - *Calotropis*

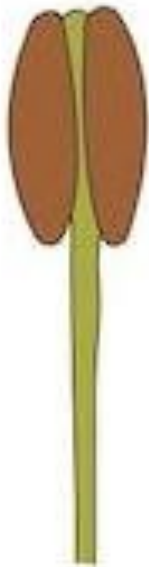


•Attachment of the Anther:

- i) Adnate – Filament attached to bulk of anther (Michelia)
- ii) Basifixed – Anther attached at extreme tip of filament (Solanum)
- iii) Dorsifixed – filaments attached to the back of anther (Bauhinia)
- iv) Versatile – filament at middle of anther, anther freely swings in the wind – Grasses
- v) Divergent – anther lobes placed far apart
- vi) Distractile – connective elongated, one anther lobe fertile, other lobe as sterile knob - Salvia



Basifixed



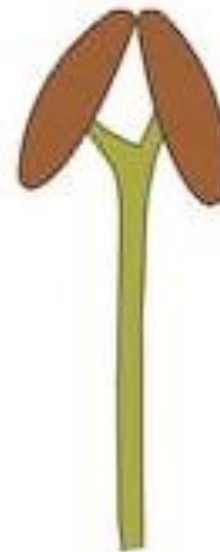
Adnate



Dorsifixed



Versatile

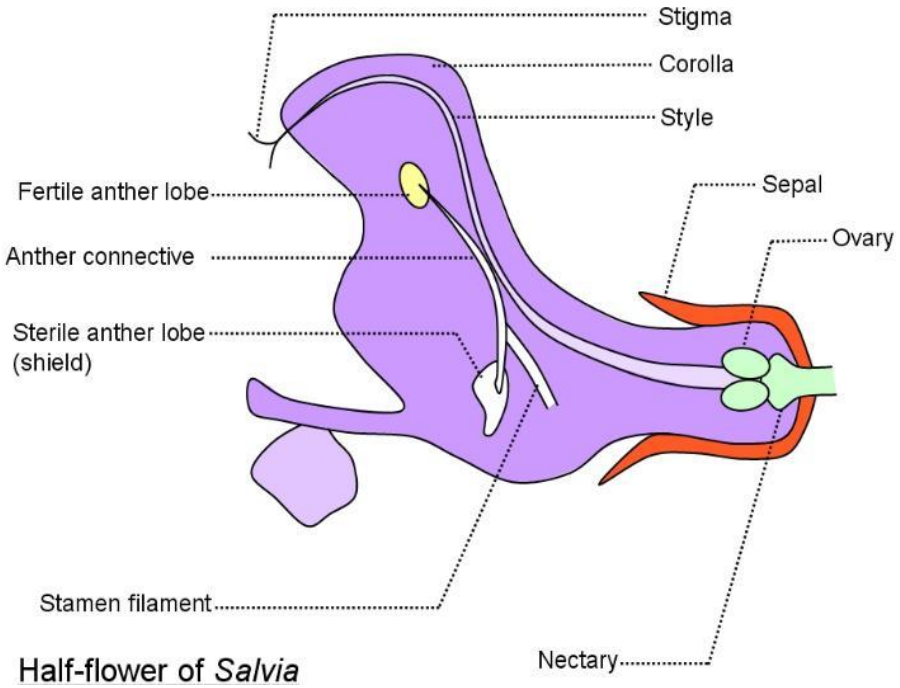


Divergent



Distractile





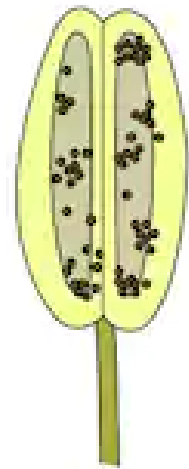
Dehiscence of anther:

Pollen grains liberated by dehiscence

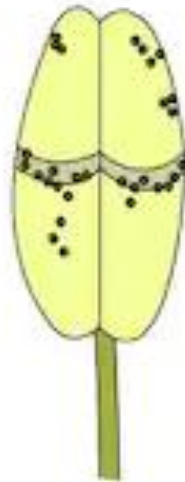
Breakage of anther for liberating pollen grains

Common types –

- i) Longitudinal dehiscence – common type, vertical slit in each lobe – cucurbits
- ii) Apical/ Porous – open by small pore at tip - Solanum
- iii) Valvular – open by a shutter at top - Barberry
- iv) Transverse – split open transverse - Malvaceae



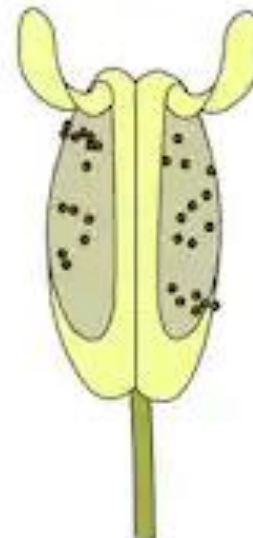
Introrse
Longitudinal



Transverse



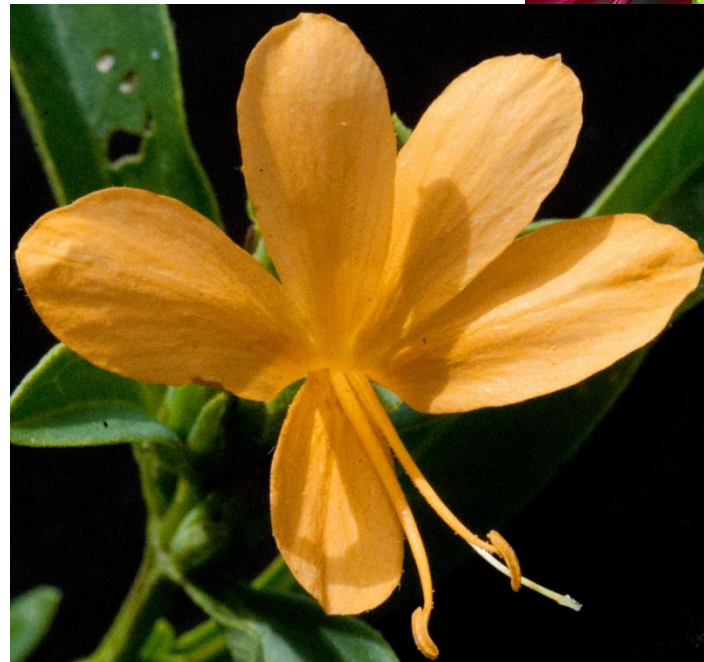
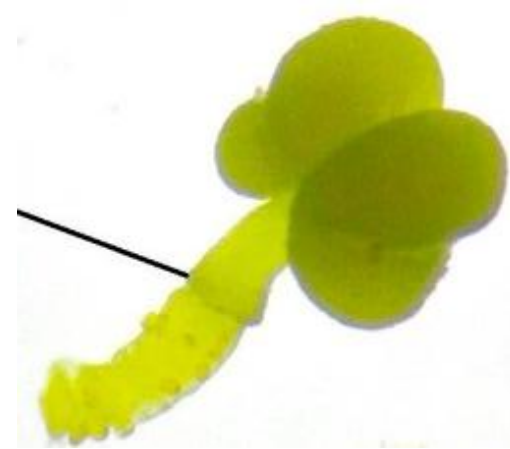
Porous



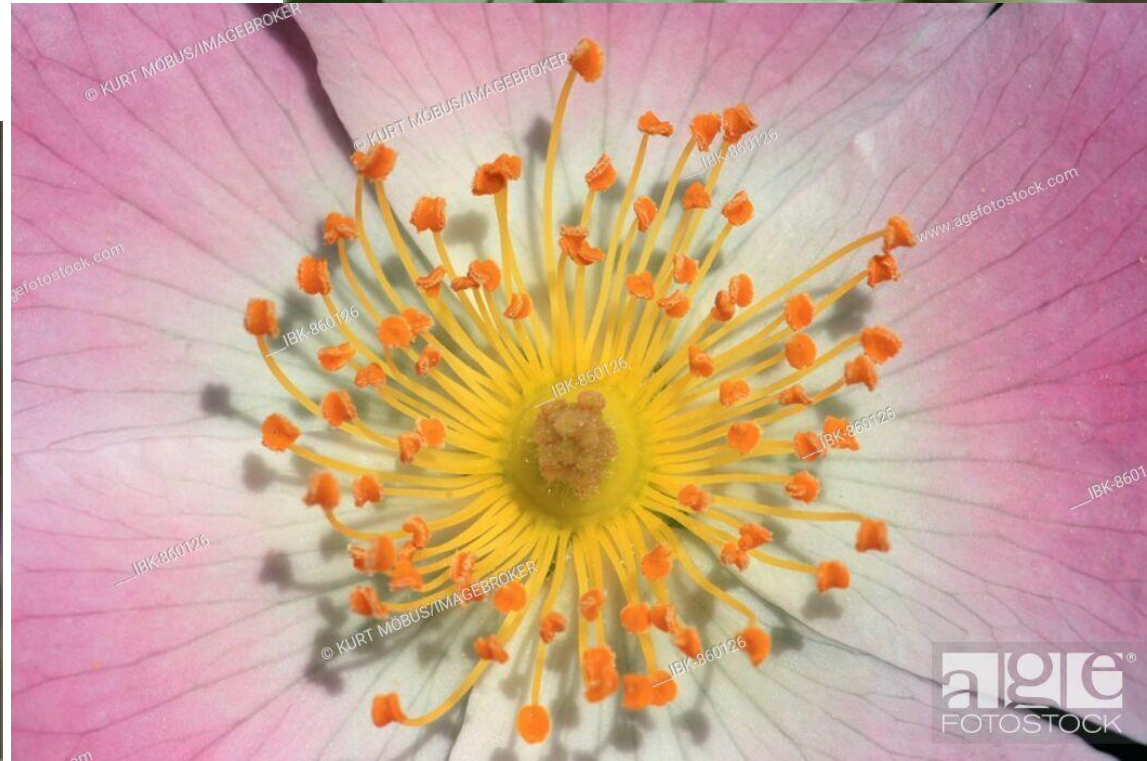
Valvular

Number & Insertion of Stamens:

- ❖ In a flower, the no. of stamens –
- 1 – monandrous – Euphorbia
- 2 – diandrous - Barleria
- 3- triandrous – Crocus



- 4 –tetrandrous – Lamium
- 5 –pentadrous –
- 6 – hexandrous - Tradescantia
- more than 6 – polyandrous - Rosa



❖ Whorls of stamens

- Single whorl – haplostemonous
- More than 2 whorls – Polystemonous

❖ Number of stamens in relation to petals:

- Same number – Isostemonous
- Different number – Heterostemonous

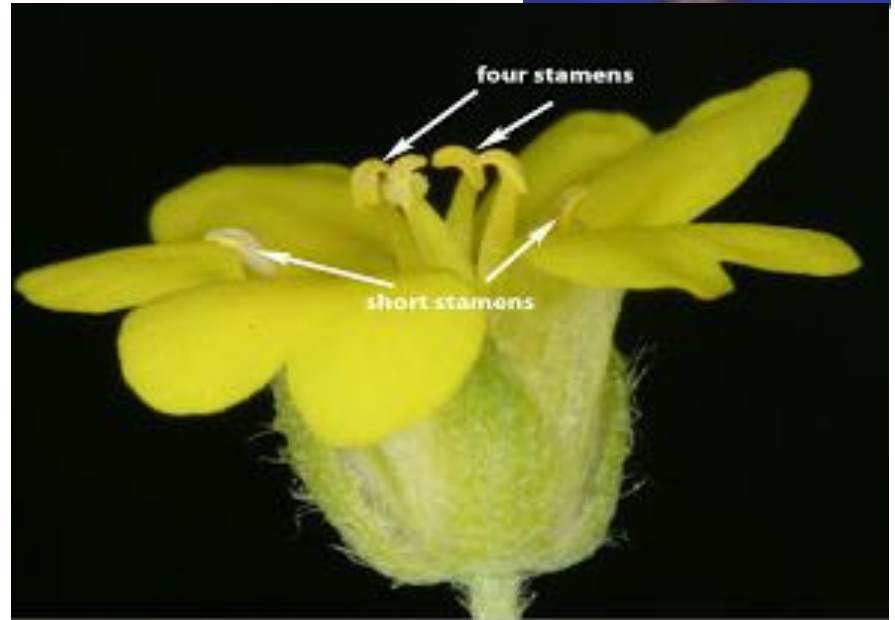
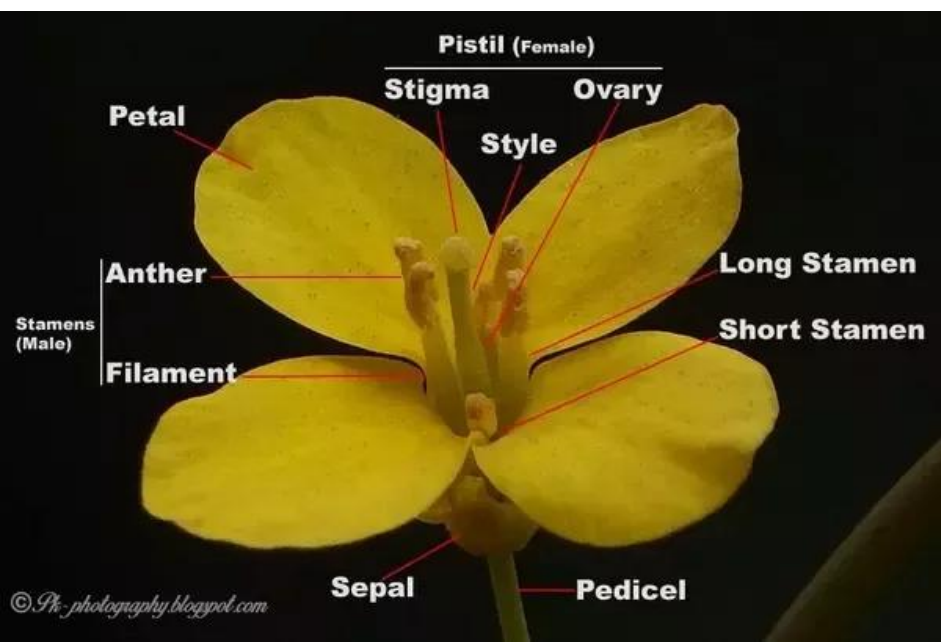
❖ Position of stamens:

- Opposite to sepals – antisepalous
- *Opposite to petals – antipetalous



❖ Length of stamens:

- Didynamous – 2 long & 2 short stamens (Lamiaceae)
- Tetradynamous – 4 long & 2 short stamens (Mustard)



❖ Arrangement of whorls:

- Outer whorl alternate with petals & inner whorl opposite to petals – Diplostemonous (Cassia)
- Outer whorl opposite to petals & inner whorl alternate with petals – Obdiplostemonous - Rutaceae family



GYNOECIUM

- Innermost whorl of lower
- female reproductive part
- made of carpels , resemble megasporophylls of gymnosperms
- mono carpellary (1 carpel)
- polycarpellary (many carpels)
- Apocarpous gynoecium (free carpels) - Annona
- syncarpous gynoecium (fused carpels) - Hibiscus
- 3 parts for carpels – Ovary, Style & Stigma
- Ovary – single chamber (unilocular)
- Ovary – more chamber (multilocular)
- Ovary → Ovule → Nucellus & integuments
- Ovules attached by funicle at placenta of ovary

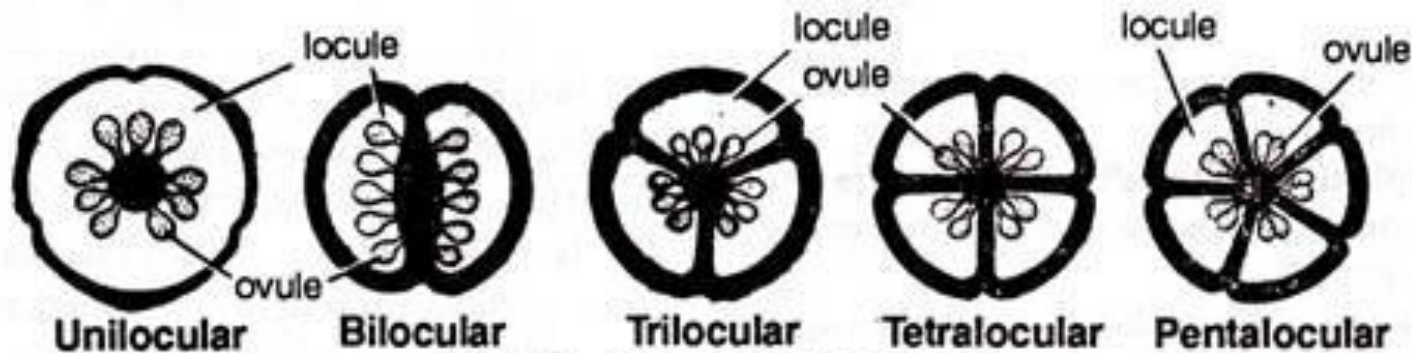
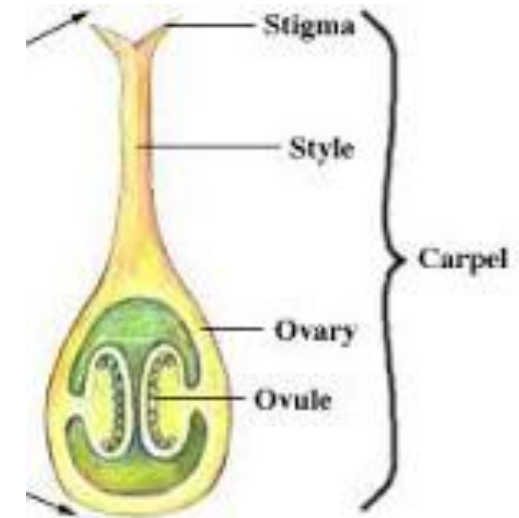
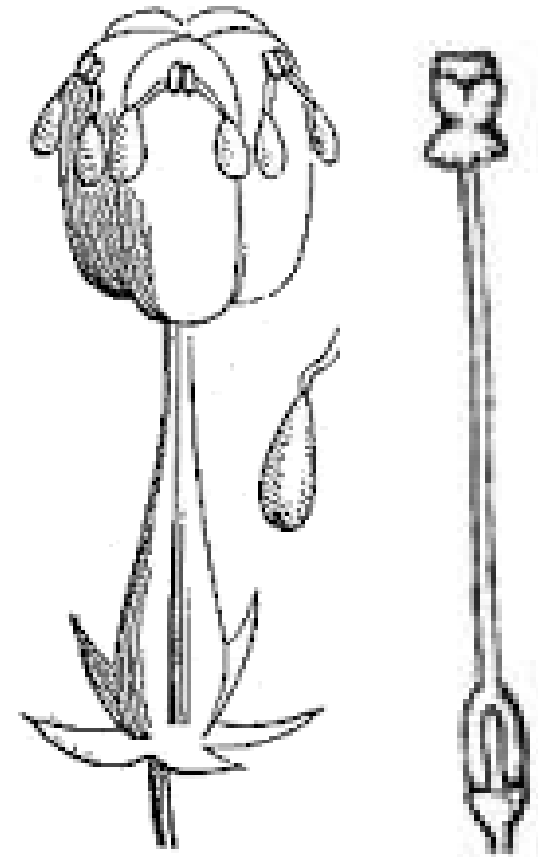
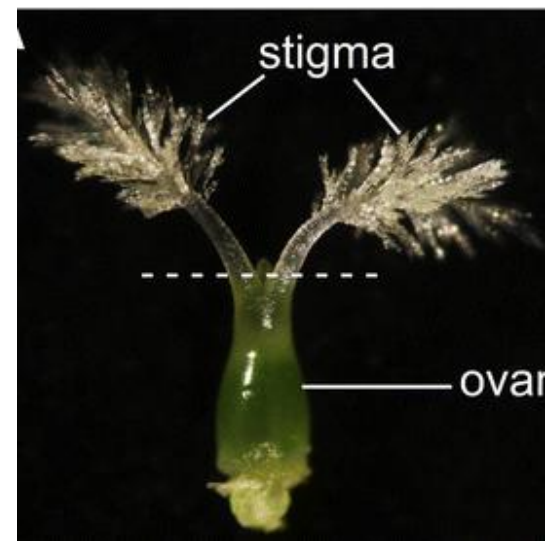


Fig. 86. Chambers of the ovary.

COHESION OF CARPELS:

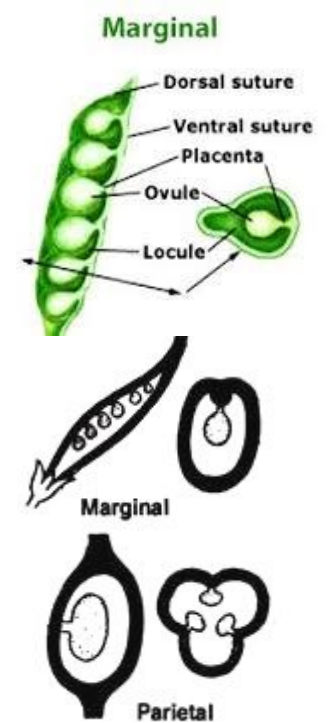
- Parts of carpels fuse in several ways
- fusion of carpels along their whole length – ovary, style & stigma – Citrus
- Fusion of ovaries alone - Paddy
- fusion of ovaries & style. With free stigma – Hibiscus
- fusion of style & stigma with ovary free – Catheranthus
- Fusion of stigma, with style & ovary free - Calotropis



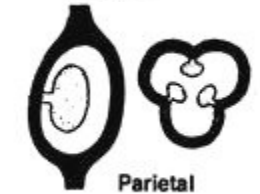
Placentation:

- Arrangement of placenta & ovules in the ovary
- 6 types

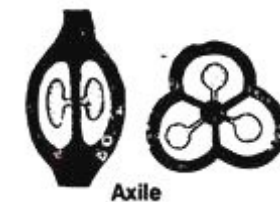
i) Marginal – ovules on the junction of 2 margins of carpel
In monocarpellary, multicarpellary apocarpous unilocular pistils – *Crotalaria*



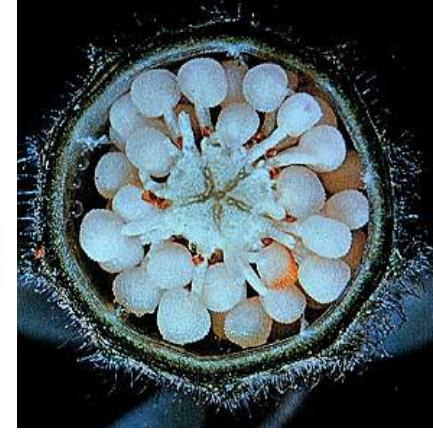
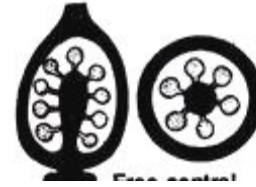
ii) Parietal - ovules on the inner walls of the fused carpels.
In multicarpellary syncarpous unilocular pistils - *Cucurbits*



iii) Axile – ovules on the central axis where the septa of carpels meet.
In multicarpellary syncarpous multilocular ovaries – *Hibiscus*



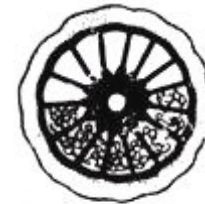
iv) Free Central - Ovules on central column without any septa. In multicarpellary syncarpous unilocular ovaries – Portulaca



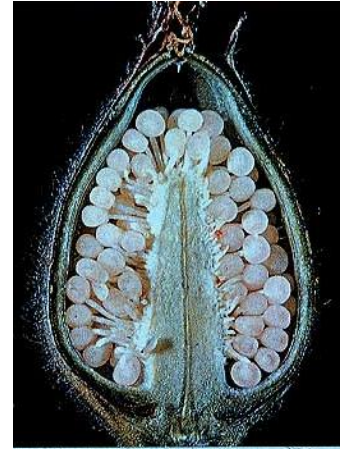
v) Basal - Ovule at ovary base. In monocarpellary unilocular ovary – Tridax



vi) Superficial - Ovules scattered all over the inner walls. In multicarpellary, syncarpous multilocular ovary – Water lily



Superficial



Ovary cross-section



basal plac

Style – Types

- Terminal – attached at tip of ovary, majority belong to this type – Citrus
- Lateral – style arise form one side of ovary – Mangifera
- Gynobasic – Style arise from between the tetralocular ovary lobes –Leucas



Stigma – types

- Capitate/ Buttonshaped
- Bifid
- trifid
- Inconspicuous
- Plumose
- apical pappilae
- hourglass shaped



Thalamus elongations

- Androphore – Thalamus elongates b/w corolla & androecium – Passiflora
- Gynophore – Thalamus elongates b/w androecium & gynoecium – Capparis
- Gynandrophore – Thalamus elongates b/w Corolla & stamens AND b/w stamens & pistil - Gynandropsis

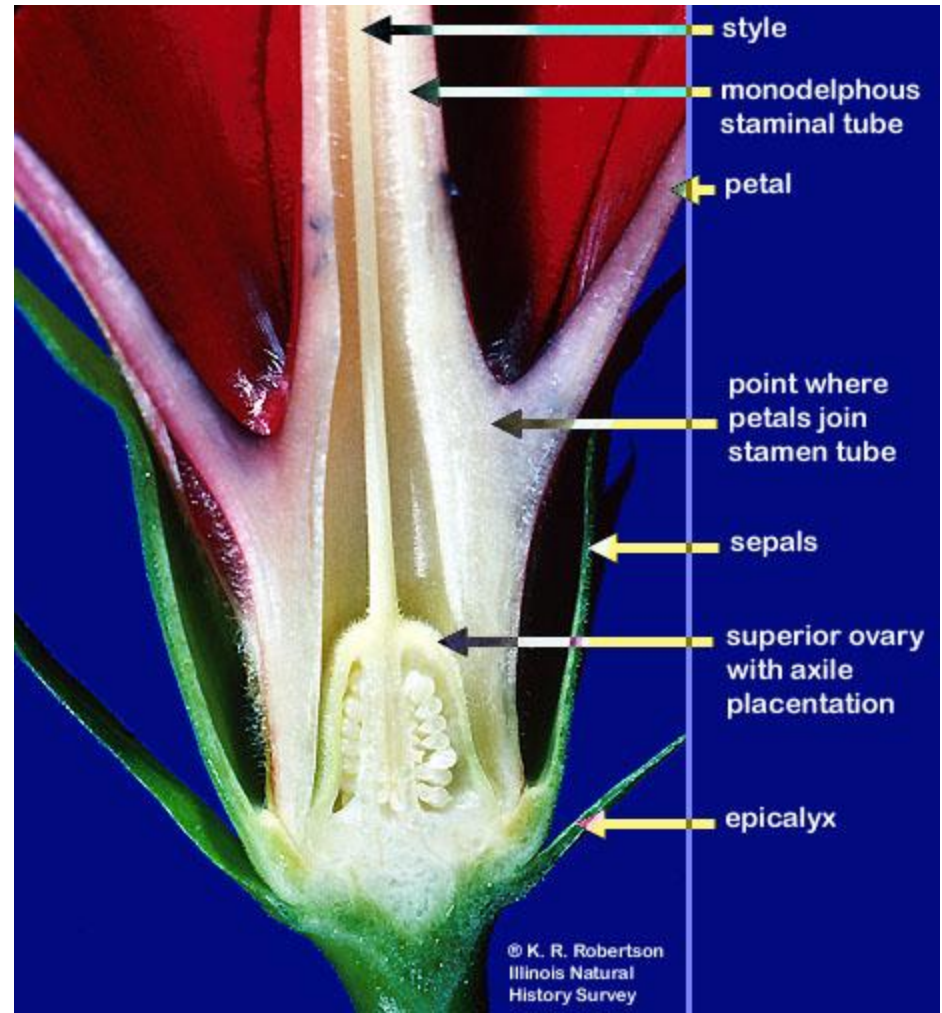
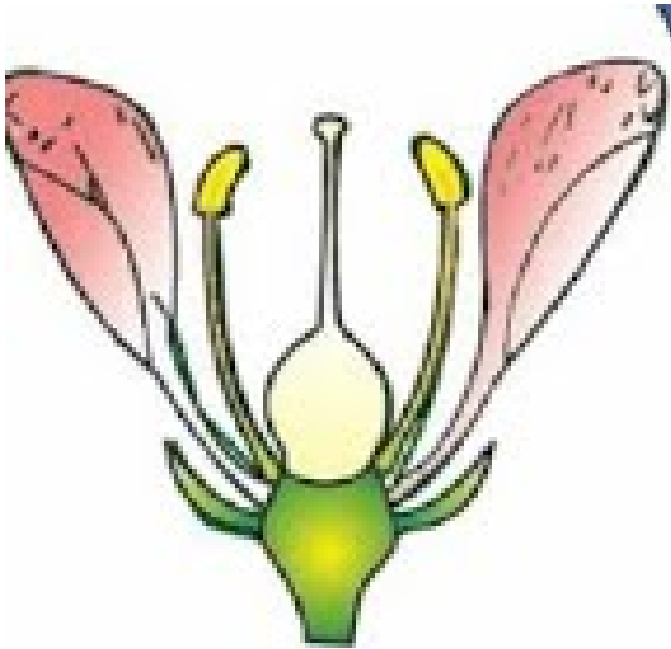


Flower types on basis of gynoecium:

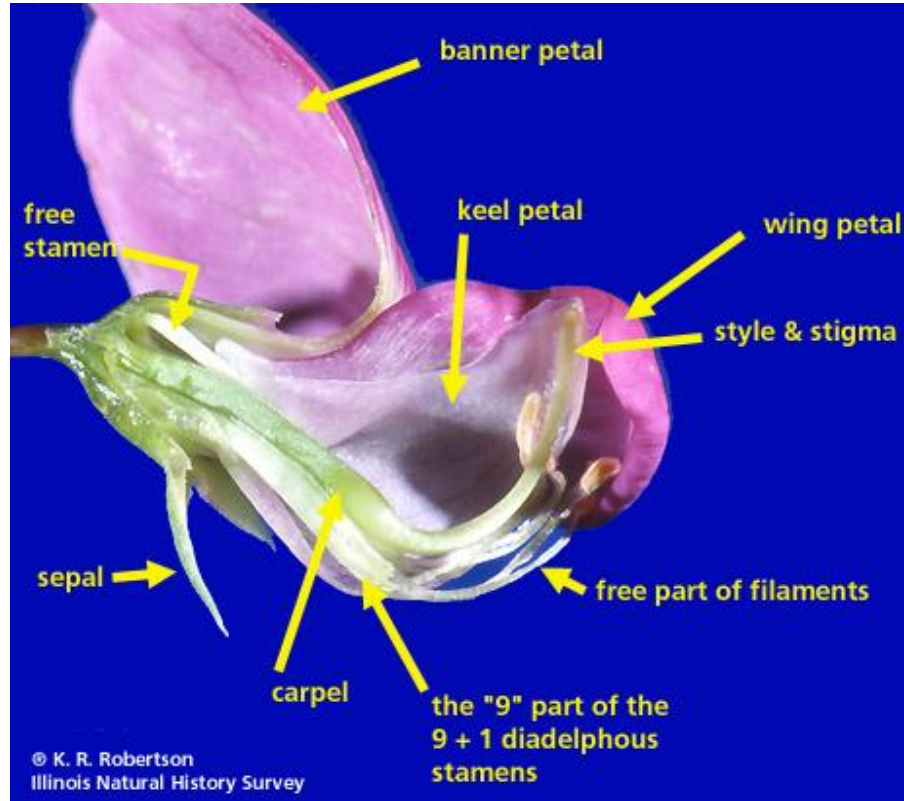
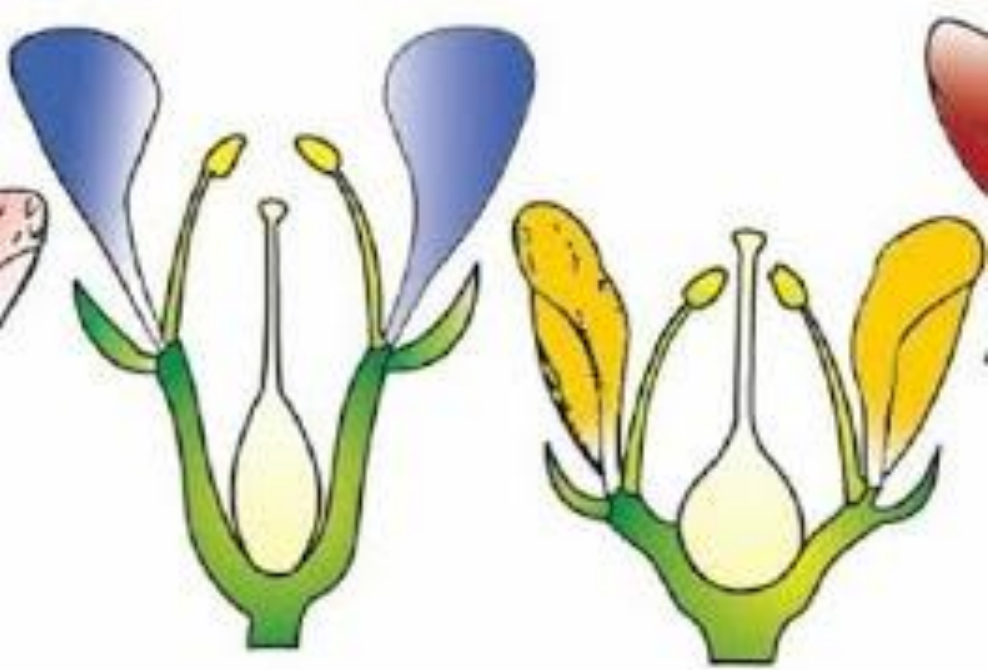
- Position of gynoecium in relation to other floral leaves,

3 types of flowers:

- i) Hypogynous flower – thalamus convex, conical, elongated. Gynoecium at top and other floral whorls below it (Ovary Superior) – Hibiscus



ii) Perigynous flower – thalamus shallow cup shaped. Gynoecium in the centre of cup, floral whorls around the margin of cup. (Ovary half inferior-half superior) – Caesalpinia



iii) Epigynous flower – thalamus deep hollow cup. It completely encloses ovary, floral leaves from the rim of thalamus (Ovary inferior) -Tridax



FLORAL FORMULA

- Simple & concise formula
- represented by symbols
- information on major features of flower
- sexuality (bisexual, unisexual)
- Symmetry (actinomorphic, zygomorphic)
- calyx lobes [as K], their number, fused () or free
- corolla lobes [as C], their number, fused() or free
- Androecium [as A], number, fused () or free, epipetalous
- Gynoecium [as G], hypo, epi or perignous ; fused() or free
- bracts or bracteoles , number etc.

Symbol	Description
1. Br	Bracteate flower
2. $\overline{\text{EBr}}$	Ebracteate flower (bract absent)
3. K	Calyx
4. K_n	Polysepalous calyx
5. $K_{(n)}$	Gamosepalous calyx
6. C	Corolla
7. C_n	Polypetalous
8. $C_{(n)}$	Gamopetalous
9. P	Perianth
10. A	Androecium
11. G	Gynoecium
12. $\underline{\text{G}}$	Superior ovary
13. $\overline{\text{G}}$	Inferior ovary
14. ♂	Male flower
15. ♀	Female flower
16. ♂♀	Bisexual flower
17. ⊕	Actinomorphic flower
18. % or †	Zygomorphic flower

FLORAL DIAGRAM

- *Diagrammatic representation through flower bud
- Outline circular for actinomorphic flower
- Outline oval for zygomorphic flower

