KSKV Kachchh University, Bhuj - Kachchh

Botany Syllabus as CBCS System

Semester III (w.e.f. June 2016)

Name of the Course : **Gymnosperms,Systematic Botany&Cyto-genetics**

Code: **USCEBO - 304 [PRACTICAL]**

Hints for Collection

In India Pinus is represented by five species which grow wild in north-east and north-west Himalayas. The species are P. gerardiana (Chilgoza in Hindi), P. roxburghii (=P. longifolia), P. wallichiana (P. excelsa), P. insularis (= P. khasya) and P. armandi. In plains it is cultivated for its ornamental value.

Practical No: 1

Identification

Division-Gymnosperms.

(I) Absence of vessels, (2) Ovules naked, (3) Seeds attached to woody scales, (4) Scales generally form a cone.

Class-Coniferopsida.

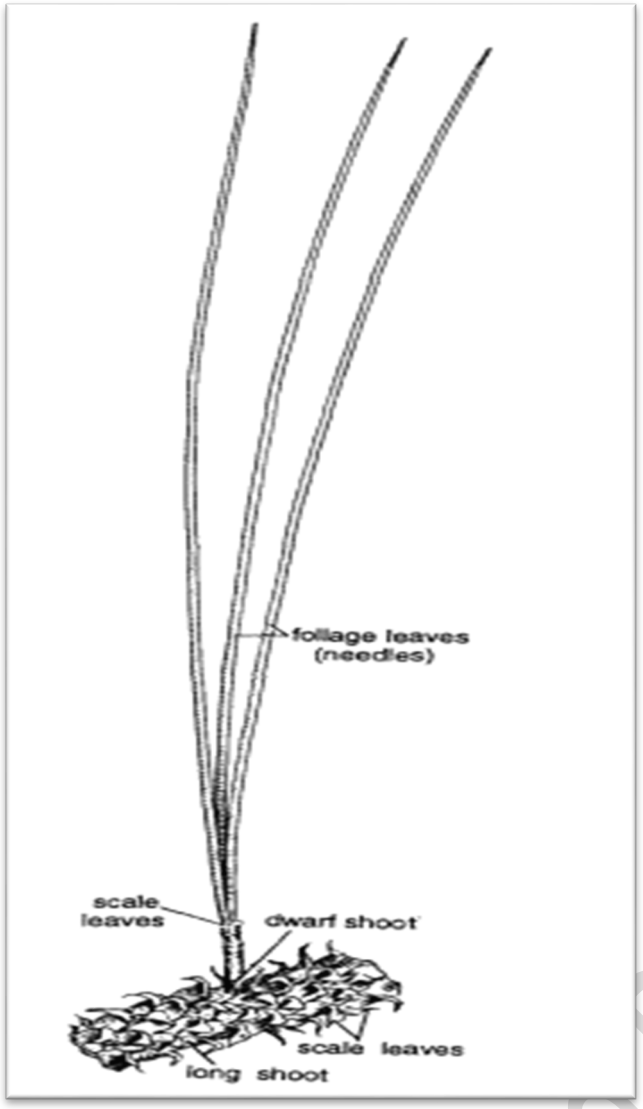
(I) Leaves needle shaped, (2) Wood pycnoxylic (compact), (3) Presence of resin canals, (4) Compact male and female cones, (5) Non-flagellate male gametes, (6) Seeds bilaterally symmetrical. Order-Coniferales.

Family- Pinaceace.

(I) Resinous wood, (2) Plants monoecious,_ (3) Sporophylls spirally arranged, (4) Microsporophylls with two microsporangia, (5) Pollen grains winged, (6) Female cone woody, (7) Polyembryony present, (8) Seed dry and winged.

Genus-Pinus.

(1) Plants sporophytic and monoecious. Male and female reproductive organs in cones, (2) Branches dimorphic, (3) Long shoots with secondary xylem, annual rings are formed, wood pycnoxylic and resinous, (4) Dwarf shoots with a little secondary growth, (5) Leaves are of two types, (6) Scale leaves brown and membranous, (7) Foliage leaves are acicular, xerophytic, mesophyll cells with peg-like ingrowths, 2 resin canals and T-shaped transfusion tissue, (8) Male cones borne laterally, in clusters, microsporophyll bears two microsporangia on abaxial side, (9) Pollen grains winged, (10) Female cones borne single and terminal, (II) Bract scales and ovuliferous scales spirally arranged, (12) Two naked ovules on the adaxial side of the ovuliferous scale, (13) Seeds dry and winged



Exercise 1

Object : Study of external morphology.

Work procedure Note the pattern of branching, the two types of branches, two types of leaves, and male and female cones.

Comments

1. It is a tall conical tree and, therefore, commonly grouped under conifers.
2. The plant body is differentiated into root, stem and leaves.
3. Underground root system is formed by tap roots which disappear early and only lateral roots persist later on.
4. The younger roots are generally surrounded by fungal hyphae- the ectotrophic mycorrhizae. 5. Aerial branch system consists of cylindrical, rough (being covered with scaly bark) and branched stem.
6. The branching is monopodial and the branches are arranged in whorls.
7. The branches are dimorphic (of two types)- branches of unlimited growth or long shoots and branches of limited growth or dwarf shoots.
8. Branches of unlimited growth or long shoots are present on the main trunk. These are produced at regular intervals.
9. Branches of limited growth or dwarf shoots are borne on the main stem and on long shoots in the axils of scale leaves. Dwarf shoots also possess many scale leaves and bear group of foliage leaves at the apex.
10. The leaves are also dimorphic (of two types)- scale leaves and foliage leaves. 11. Scale leaves are brown, membranous and small. They are present on both the types of branches (i.e. long and dwarf shoots).
12. Foliage leaves are green, acicular and needlelike. They are borne only by the dwarf shoots.
13. A dwarf shoot with a group of needle-like foliage leaves is known as a foliar spur. The number of needles in a group varies from species to species. P. monophylla has a single leaf and spur is known as monofoilar, while in P. sylvestris, two leaves are present and spur is called as bifoiiar. In P. longifolia and P. gerardiana, they are three in number, the spur being called as trifoliar. Quadrifoilar spur occurs in P. quadrifolia and pentafoliar in P. excelsa.
14. The shape of the needle varies, according to their number in a spur. In P. sylvestris (with bifoliar spur), single needle is semi-circular in T.s. while in P. longifolia (with trifoliar spur), single needle is almost triangular in shape.
15. Pinus is monoecious. Plant bears male and female reproductive parts in cones on the same plant.

16. The male cones are borne on lateral branches of unlimited growth. They are produced in clusters and replace the dwarf shoots. Also, they are formed earlier in the season than the female cones.
17. The female cones are borne terminally on branches of unlimited growth. They are produced singly and replace the long shoot. The female cone appears after every three years.
18. Generally male and female cones are not formed on one and same branch.

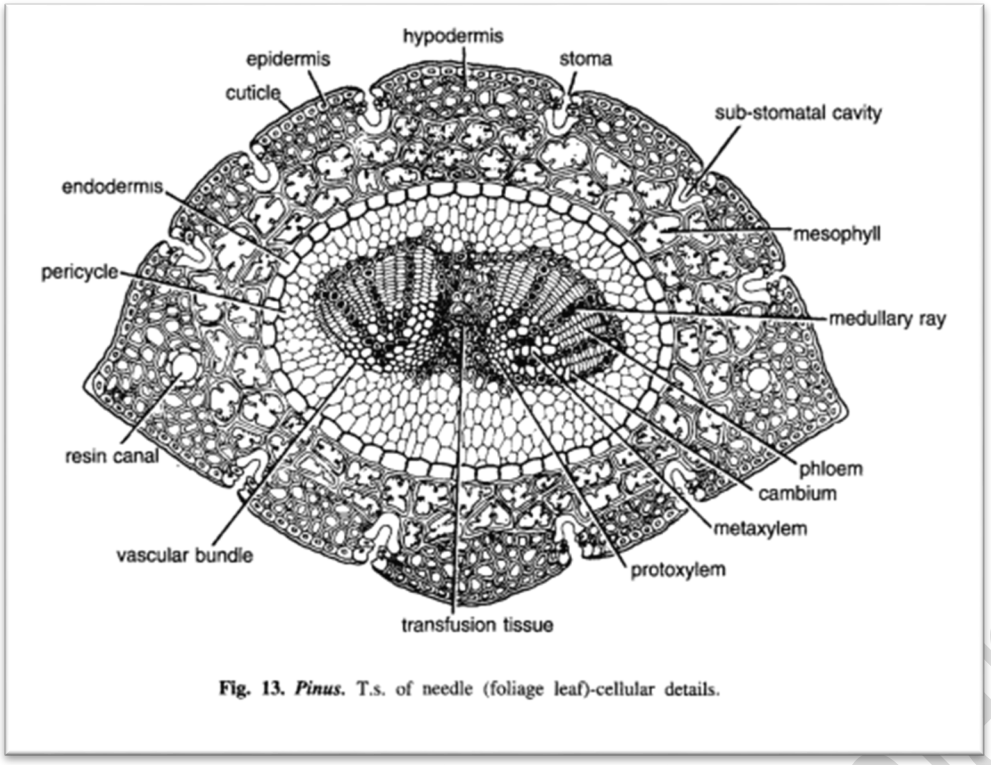


Fig. 13. *Pinus*. T.s. of needle (foliage leaf)-cellular details.

Exercise 2

Object : Study of T.s. needle (leaf).

Work procedure Cut a thin T.s. of a needle, stain with safranin-fast green combination, mount in glycerine and study.

Comments

1. The outline of the section varies according to the species. (Triangular if spur is trifoliar, semicircular if spur is bifoliar)
2. The needle is differentiated into epidermis, mesophYll and stele.
3. Epidermis is single with tangentially elongated and thickly cuticularized cells.
4. Stomata are sunken. These are present on all the faces of epidermis. The needle is thus said to the amphistomatic.
5. Epidermis is followed by hypodermis. It is few layered thick at the corners and 1-2 layered in other parts. Sub-stomatal chambers occur in this region. Cells are sclerenchymatous and fibrous.
6. Mesophyll lies below the hypodermis. It is made up of polygonal parenchymatous cells, densely filled with the chloroplasts. Numerous plate-like or peg-like infoldings project into the cell lumen (cavity) from the wall of the mesophyll cells.
7. Resin canals generally occur in the sclerotic hypodermis but also occur in the mesophyll tissue.
8. Endodermis is conspicuous. Cells are barrelshaped and tangentially thickened. It is followed by a many layered, parenchymatous pericycle.
9. Generally two vascular bundles remain surrounded by this tissue. (In P. strobus there is only one vascular bundule).
10. The vascular bundles are separated from one another by a T-shaped thick walled transfusion tissue.
11. Each vascular bundle is conjoint, collateral and open. Protoxylem faces adaxial side. Phloem is located on the abaxial side.
12. Xylem and phloem groups are separated from one another by cambium at the base of the needle and by parenchymatous cells in the upper region.
13. Secondary growth is very little during which the medullary rays run between xylem and phloem

Fig. 15. *Pinus.* Male cones in cluster.

Exercise 3

Object : Study of male cone, microsporophylls and microsporangia.

Work procedure Dissect out the male cone, separate the rnicrosporophylls, study the shape, size and microspores.

Comments :

1. Male cones replace the dwarf shoots. Each male cone arises in the axile of a scale leaf. The main shoot, on which these are produced, continues to grow further.
2. Male cones are grouped in clusters on the shoots of the same year only.
3. Each male cone has single, centrally located cone axis around which many scaly microsporophylls are spirally arranged.
4. Each rnicrosporophyll has an expanded triangular central part and stalk-like base. Terminal part projects into a tip.
5. Few lowermost sporophylls are sterile, and do not bear any male reproductive structures.
6. On the abaxial side, each rnicrosporophyll bears two ovoid micro sporangia or pollen sacs on its lateral sides.
7. Each micro sporangium has its own wall which encloses many microspores
8. The young microspore is globular or spherical in shape and is uninucleate.
9. A mature microspore or pollen grain shows two wall layers- exine and intine, 2 prothallial cells and antheridial cell.
10. Pollen grain has a thick expanded exine in the form of wings on the sides, followed by a smooth intine.

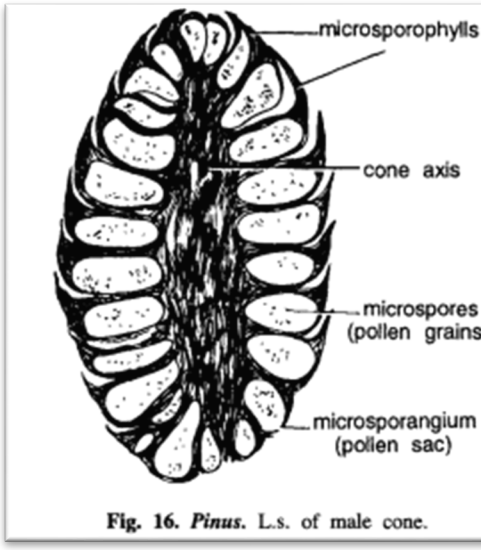
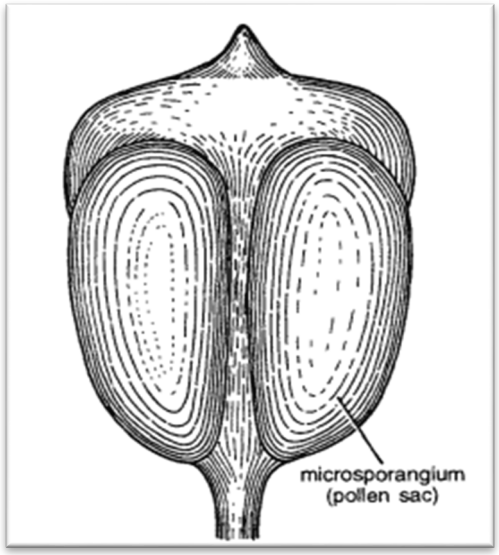


Fig. 16. *Pinus*. L.s. of male cone.



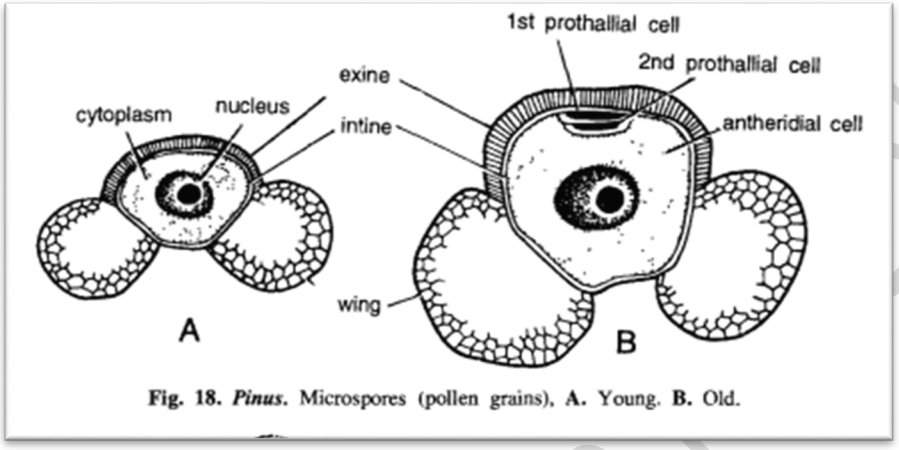


Fig. 18. *Pinus*. Microspores (pollen grains), **A.** Young. **B.** Old.

Exercise 4

Object : Study of L.s. of male cone. Work procedure Study a slide showing L.s. of male cone.

Comments

1. It shows a cone axis bearing microsporophylls.
2. The cone axis is centrally located.
3. Microsporophylls are spirally arranged. These are scaly, triangular and expanded.
4. It is attached to the cone axis by a stalk-like base.
5. The outer expanded part is sterile and is known as apophysis.
6. Microsporangia are present on the lower or abaxial surface.
7. Each micro sporangium has a wall that encloses a cavity.
8. The wall consists of epidermis. wall layers and tapetum.
9. The cavity shows numerous microspores in various stages of development.

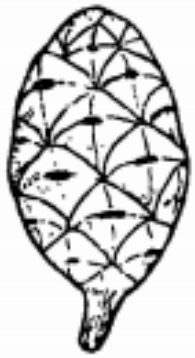


Fig. 19. *Pinus.* 1st year female cone.

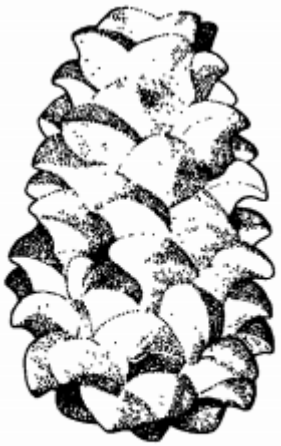


Fig. 20. *Pinus.* 2nd year female cone.

Fig. 21. *Pinus*. 3rd year female cone.

Exercise 5

Object : Study of morphology of the female cone.

Work procedure Study the external features of 1st, 2nd and 3rd year female cones. Note the position, arrangement and structure of sporophylls.

Comments

1. Female cones are larger than the male cones. They are borne at the apices of the young elongated shoots, replacing the shoot of unlimited growth (long shoots).
2. Single shoot may bear one to four female cones which are reddish-green in colour and mature in three years.
3. In the flrst year, cones are compact and sporophylls are closely arranged.
4. The second year cones are large in size and woody in nature but sporophylls are still compactly arranged.
5. In the third year, cone becomes loose. Sporophylls separate from one another due to elongation of the cone axis.
6. Each female cone consists of many sporophylls, arranged spirally around the cone axis.

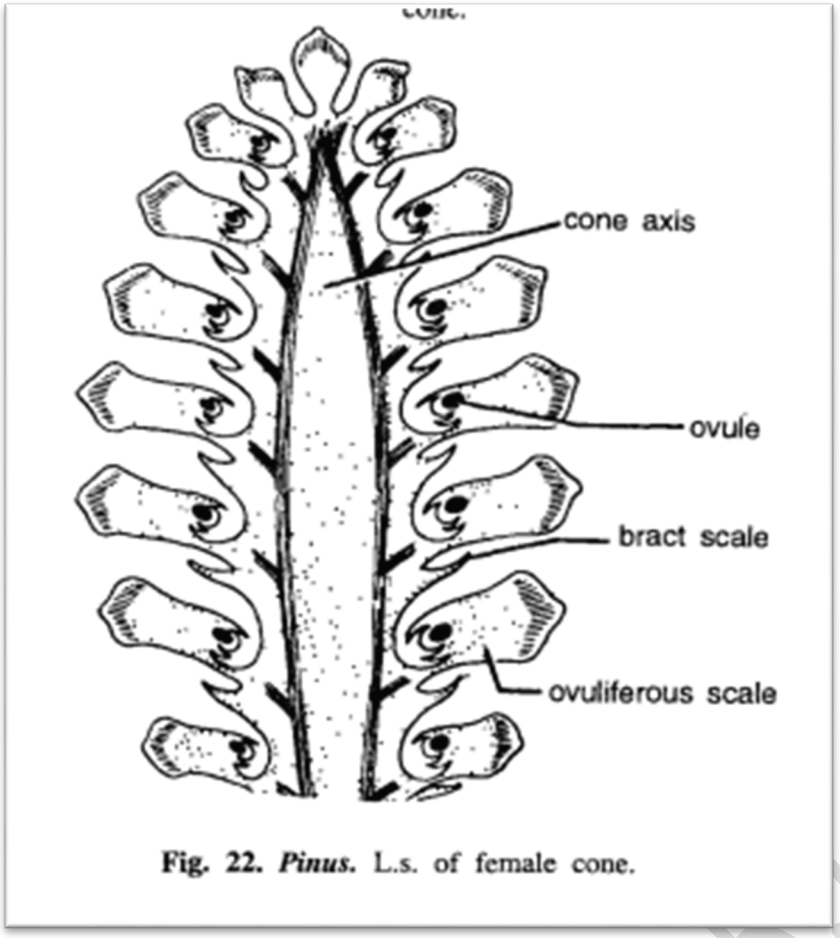


Fig. 22. ***Pinus.*** L.s. of female cone.

Exercise 6

Object : Study L.s. of female cone.

Work procedure Study a prepared slide of L.s. of female cone.

Comments

1. Female cone is made of centrally located cone axis and spirally arranged sporophylls.
2. Each sporophyll consists of two kinds of paired scales : (i) bract scale or cone scale and (ii) ovuliferous scale or seminiferous scale.
3. Many small and thin bract scales are arranged spirally around the cone axis. They are directly borne on the cone axis. Each of these is present on the abaxial (lower) side of the ovuliferous scale.
4. On the adaxial (upper) side of the bract scale, a thick, large, woody and triangular ovuliferous scale is present.
5. The ovuliferous scales in the middle part of the cone are the largest and get gradually smaller towards its base and apex.
6. Ovuliferous scale and bract scale are fused for a little distance near the cone axis while free at a distance away from it.
7. Ovuliferous scale is shortly stalked and rest of the part is expanded.
8. At the base "of this expanded, triangular part, two naked and sessile ovules are present. These are situated on the adaxial, (upper) surface of the ovuliferous scale, at its base, with their rnicropyles directed towards cone axis.
9. The terminal part of the ovuliferous scale is broad and sterile and is known as apophysis.

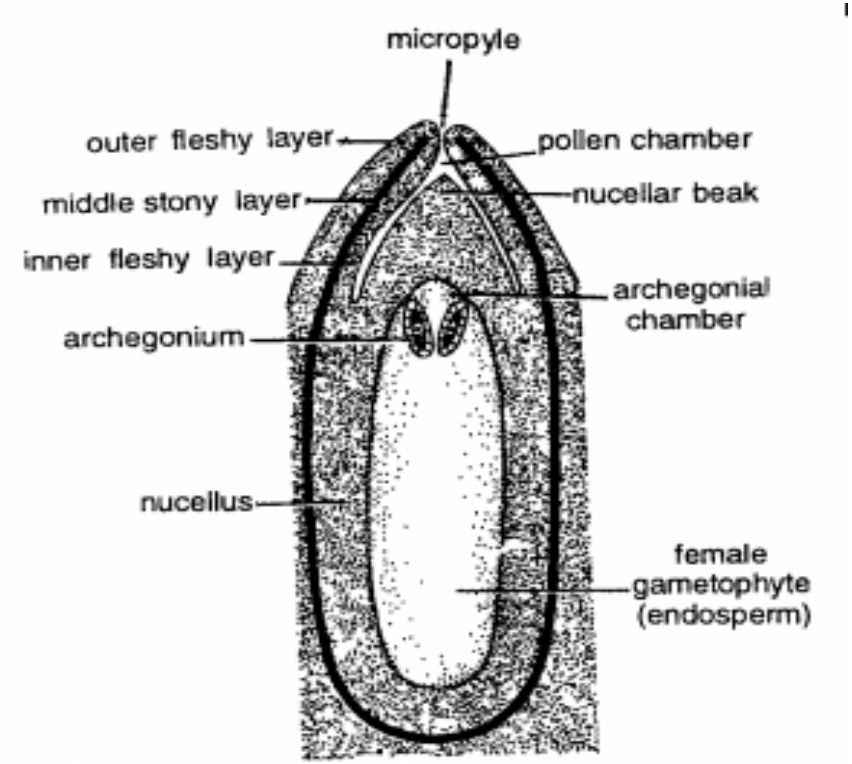


Fig. 23. ***Pinus.*** L.s. of ovule.

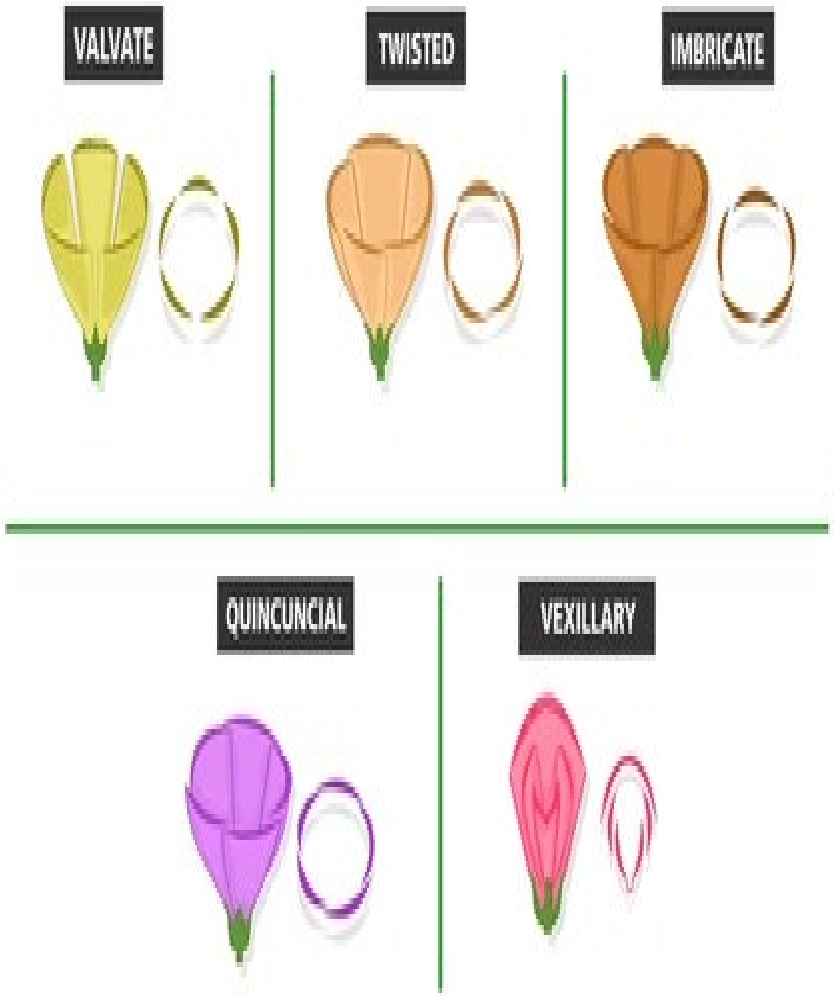
Exercise 7

Object : Study of L.s. of ovule.

Work procedure Study a prepared slide of L.s. of ovule. Note integuments, nucellus, female gametophyte and archegonia.

Comments

1. Ovule is elongated in shape.
2. It is unitegmic and the integument is three layered. The outermost layer is thin. The middle layer is stony and prominent. The innermost layer is fleshy and well developed.
3. Nucellus is fused with inner layer of the integument, except at its tip where it forms an elongated and slender micropyle, directed towards the cone axis.
4. In the nucellar region lies a small cavity just opposite the micropyle. It IS known as pollen chamber.
5. Female gametophyte (endosperm) is differentiated from nucellus. About 2-5 archegonia are situated in this region at the micropylar end near the base of the archegonial chamber.



Practical NO: 2

Object : study types of Aestivation

Work procedure: observe and note types of Aestivation in different flowers

Comments:

Aestivation.: The arrangement of floral parts (sepals in this case) in bud.

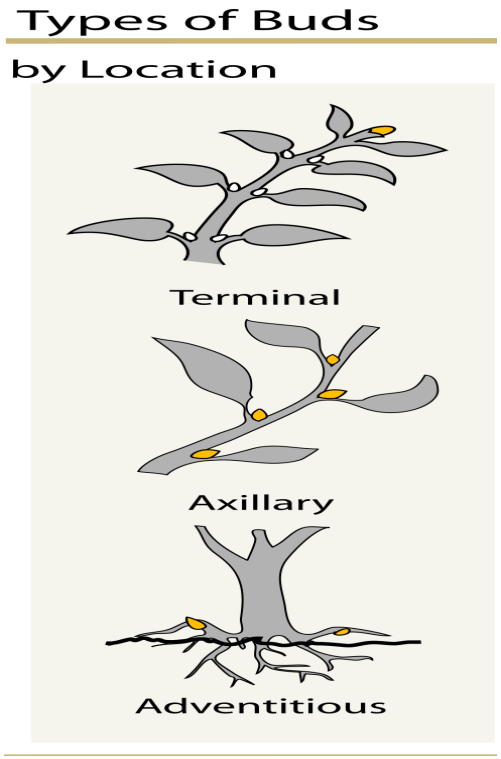
1.Valvate. Sepals meeting by the edges without overlapping; e.g., Solanum

2.Twisted. (Contorted). One margin of the sepal overlaps that of the next one, and the other margin is overlapped by the third one .

3. Imbricate. Out of the five sepals one is internal, one external and the other three partly internal, partly external; e.g., Iberis amara, Cleome .

S. Quincuncial. A form of imbricate where there are five petals, two internal, two external, and one partly internal, partly external; e.g., Melia, Murraya

6. Vexillary. Out of the five petals the posterior one is the largest and covers the two lateral petals and the latter in their turn overlap the two anterior and smallest petals; characteristic of papilionaceae



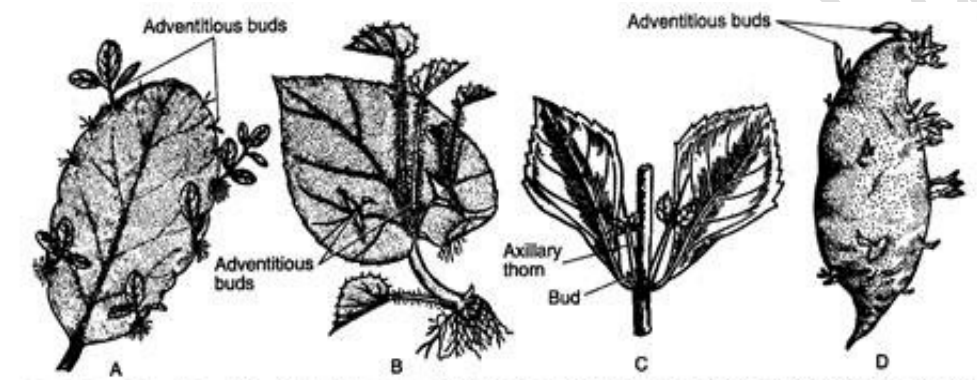


Fig. 2.32 : Adventitious buds : A. Epiphyllous buds in *Kalanchoe spathulata*, B. Epiphyllous buds develop on *Begonia* sp. especially when incisions are made, C. Cauline bud of *Duranta plumieri*, and D. Radical buds of *Ipomoea batatus* (Sweet potato)

Practical NO: 3

Exercise 1 : Depending on the position of the plant (**divided into two groups)**

1. Normal buds, and
2. Adventitious buds.

1. Normal Bud:

Bud which occur in normal position on the plant body are called normal buds. stem tip and the axil of a leaf are the normal positions.

The normal buds are classified into terminal buds, (**Buds are of two types, according to their position)**

a. Terminal or Apical bud

b. Axillary bud.

a. Terminal or Apical Bud

The bud, when situated at the terminal position i.e., at the apex, is called terminal or apical bud

They are responsible for the growth in length of the axis. In some plants the terminal buds modify onto permanent structures like thorns, hooks, tendrils, etc…

b. Axillary Bud

Axillary or lateral buds originate from the axils of the leaves. Lateral buds usually grow into branches. Normally one bud develops from the axil of a leaf, but in some plants like Duranta (B. Mehdi), Rangoon creeper more than one bud may be present there. Some time axillary buds modify onto permanent structures like thorns, hooks, tendrils, etc…

2.Adventitious Bud:

If buds arise from any position other than the normal ones, i.e. apex and axil of the leaf, they are called adventitious.

The adventitious buds are of three types:

a. Epiphyllous,

b. Cauline and

c. Radical.

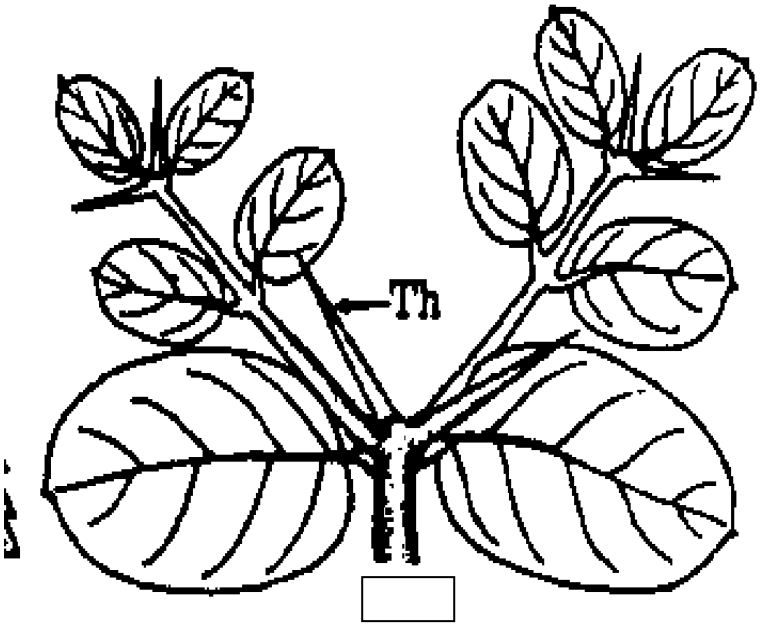
a. Epiphyllous:

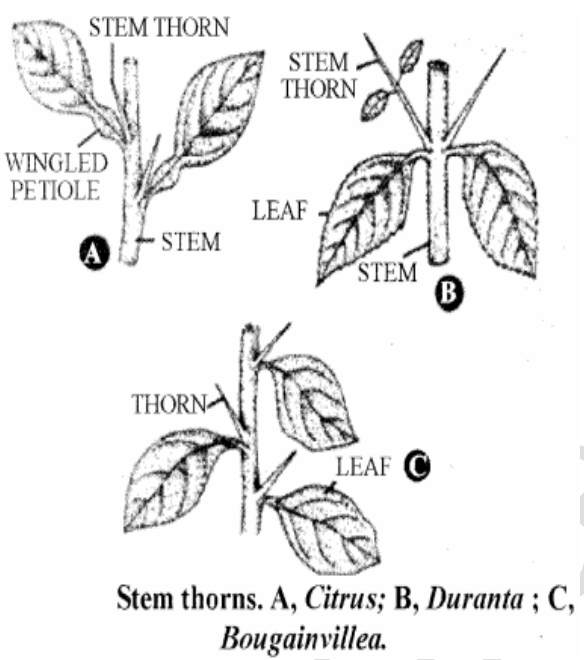
Buds which arise on leaf are called epiphyllous type, e.g., Bryophyllum calycinum and Kalanchoe spathulata of Crassulaceae; Begonia sp. of Begoniaceae etc.

b. Cauline: Buds which develop from the axil, near the cut end of the stem, after seasonal pruning (i.e., pollarding) are called cauline bud, e.g., Duranta plumieri of Verbenaceae.

c. Radical:

Buds which develop on root are called radical buds, e.g., palwal (Trichosanthes dioica of Cucurbitaceae), sweet potato (Ipomoea)





Stem thorns. A, *Citrus;* B, *Duranta* ; C, *Bougainvillea.*

Prickles in Rose

Exercise 2
Object : Thorn: Modification for Protection

Work procedure Note the modification branching in plant species

Comments

In some plants, the apical or the axillary bud develops into a sharp pointed structure. It is called thorn.
They are protective.

1. In ***Carissa***, the apical bud is transformed into a bifid, leafless thorn.
2. In **Lawsonia** and **Pomegranate**, an axillary bud is transformed into thorn. Sometimes leaves and flowers are borne on thorns.

The pointed, curved sharp structures produced on the surface of stem in rose plant are called prickles. They are not modifications of stem. They are outgrowths from surface

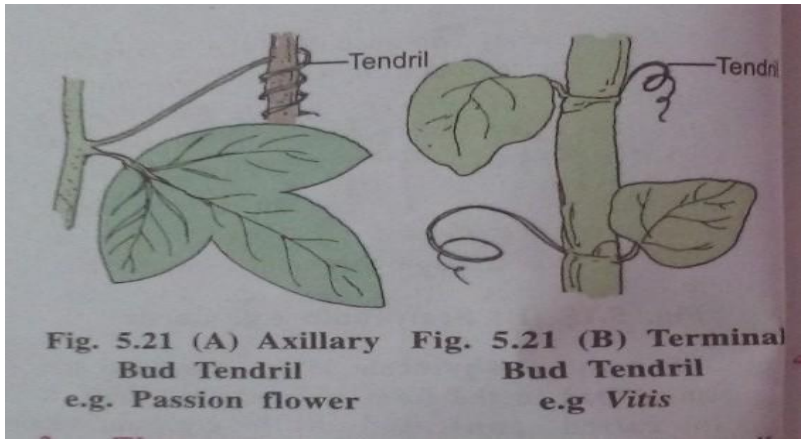
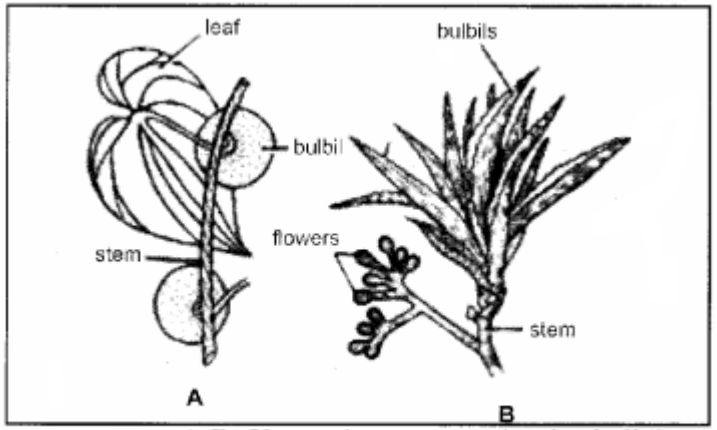


Fig. 5.21 (A) Axillary Bud Tendril e.g. Passion flower

Fig. 5.21 (B) Terminal Bud Tendril e.g *Vitis*



A-B. Vegetative propagation by bulbils borne on inflorescence : A. *Globba*, B. *Agave*.

Exercise 3
Object : Tendril: Modification for Climbing

Work procedure Note the modification branching in plant species

Comments

1. In cissus quadrangularis the **apical buds** modified and
2. In Passion flower, Cucurbita, Bittergourd, etc. the **axillary buds** modified into thin, long, thread like structures.

These are called Stem tendrils.

They twine around the support and help the plant in climbing.

Exercise 4
Object : Bulbil:Storage of food and Reproduction

Work procedure Note the modification branching in plant species

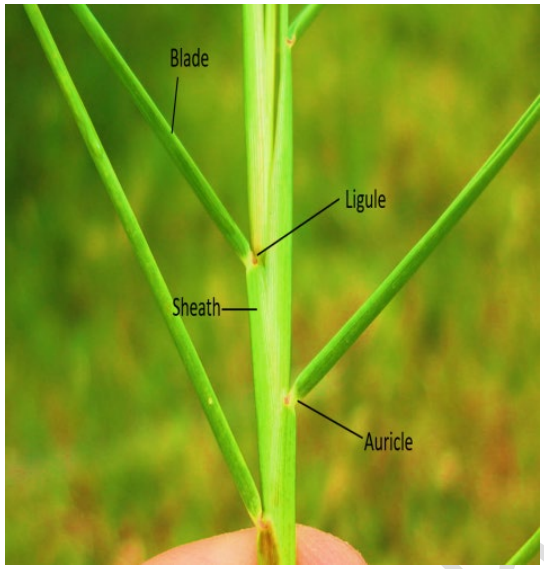
Comments

1. In ***Dioscorea*** and ***Agave*** plants,

axiliary buds and floral buds respectively store food and become fleshy.

2. Later on they separate from the parental plant and produce new plants.

Such a modified bud is called bulbil



Exercise 5
Object : Protection of Buds

Work procedure Note the modification branching in plant species

Comments
Nature has provided suitable devices for the protection of the buds against external injuries and adverse climatic conditions.

i: Many of them have scaly leaves, the so-called **bud scales**, to protect them, as in ***banyan, India rubber***, ***Michelia champaca*** etc., The majority of the buds of the tropical plants are naked, i.e. have no covering scales.

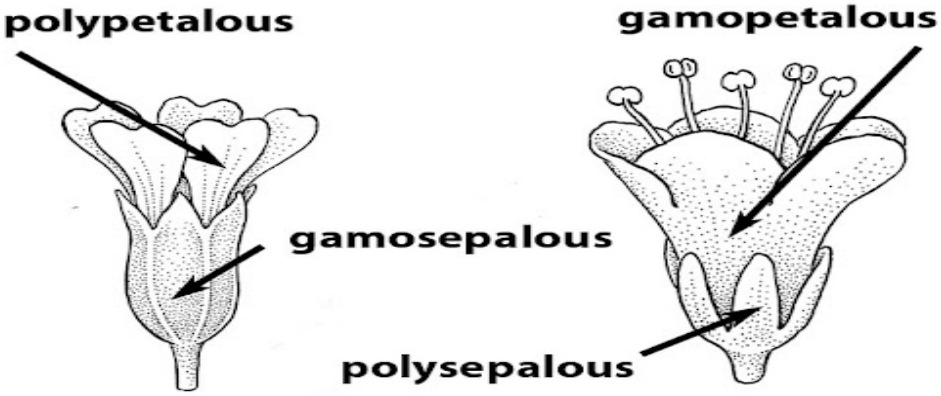
ii: Leaf base protects as a **sheath** in ***Wormia burbizia*** of ***Dilleniaceae eaths*** to protect them. To prevent the loss of moisture

iii. **Coating** of dense **hairs** in jujube (Ziziphus jujuba),

iv. Coating of **oil, wax or resinous matters** to prevent loss of water in Aesculus indicus of Hippocastanaceae etc.

v. Deeply **seated position** in the bark of camphor (Camphorum aromaticum of Lauraceae).

The leaves of the bud may remain rolled or folded in order to secure protection from the sun and the rain.
In cold countries buds formed in the late season remain dormant over the winter to open out in the next spring.



sepal and petal fusion

Practical NO: 4

Object : Study of Adhesion & Cohesion in flower

Work procedure: observe and note Adhesion & Cohesion in different flowers

Exercise 1: Cohesion of Calyx
Comments:

1. Polysepalous. When the sepals are free; *e.g.,* Geranium.
2. Gamosepalous**.** When the sepals are fused; e.g., Dianthus.

Exercise 2: Cohesion of Corolla

Comments:

1. Polypetalous. When the petals are free; *e.g.,*Mustard.
2. Gamopetalous. When the petals are united;*e.g.,* Railway creeper, *Ipomoea*

Exercise 3 : Cohesion of Perianth

Comments:

1. Polytepalous. With tepals (perinath lobes) free; *e.g.,Phyllanthus, Polygonum.*
2. Gamotepalous. With tepals (perianth lobes)

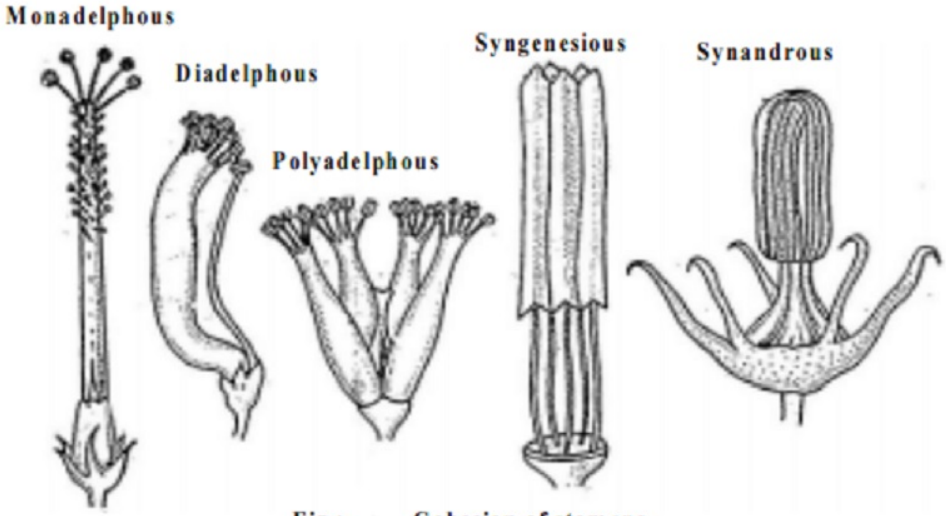


Fig : Cohesion of stamens

Exercise 4: Cohesion of Stamens
Object : Study Cohesion of stamens in flower

Work procedure: observe and note anther of Adhesion & Cohesion in different flowers

Comments:

1**. Polyandrous.** Said of an androecium whose stamens are free (anthers as well as filaments); *e.g., Papaver.*

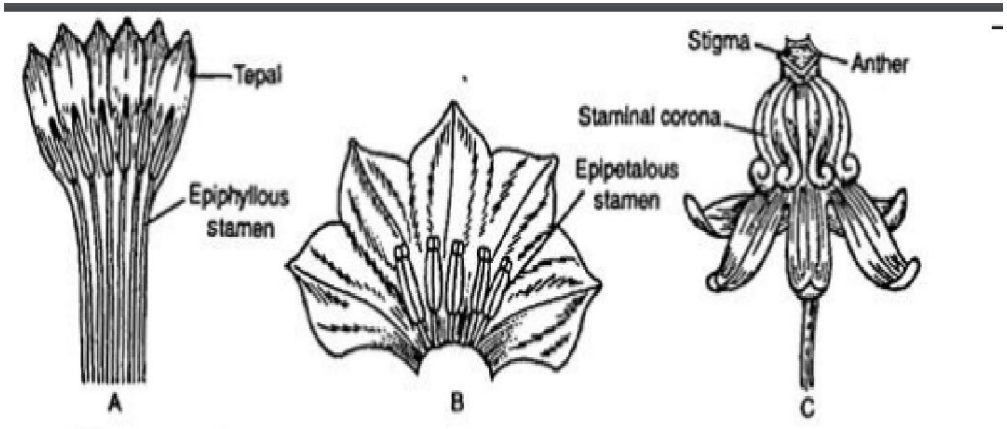
2. **Monadelphous.** Stamens united in one group by connation of their filaments (anthers being free); *e.g.,* China rose, *Achyranthes, Abutilon*

3. **Diadelphous.** Stamens united in two bundles by connation of their filaments (anthers being free); *e.g.,* Pea

4. **Polyadelphous.** Stamens united in many bundles by connation of their ftlaments (anthers being free); *e.g., Citrns, Bombax malabarica*

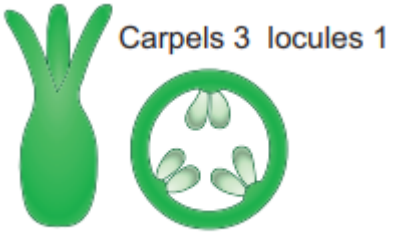
5. **Syngenesious.** Stamens connate by their anthers (the ftlaments being free to form a cylinder about the style, as in Compositae); *e.g., Sonchus*

6. **Synandrous.** Stamens uniled throughout their whole length by both- the filaments and the anthers; *e.g., Cucurbita*

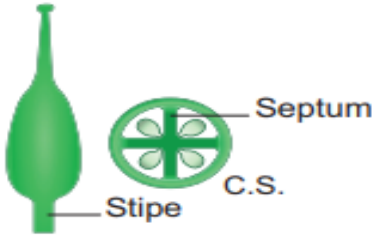


Different types of adhesion of stamens : A. Epiphyllous of *Polyantives*, B. Epipetalous of *Solanum* and C. Gynostegium of *Calotropis*

a. Apocarpous



b. Syncarpous unilocular



c. syncarpous tetralocular

Exercise 5: Cohesion of stamens
Object : Study of Adhesion stamens in flower
Work procedure: observe and note anther of Adhesion & Cohesion in different flowers
Comments:

1. **Epipetalous**. Stamens adhering to the corolla wholly or partially by their filaments (anthers remaining free); *e.g., Ocimum, Solanum.*
2. **Epitepalous**. Stamens adhering to the perianth in the aforesaid manner; *e.g.Asphodelus.*
3. **Gynandrous.** Stamens adhering to the carpels either throughout their whole length or by their anthers only; *e.g., Calotropis.*

Exercise 6 : Cohesion of Carpels

Object : Study of Cohesion of Carpels in flower

Work procedure: observe and note Carpels in different flowers
Comments:

1. **Apocarpous**. A pistil of two or more carpels which are free; *e.g., Clematis*
2. **Syncarpous.** A pistil of two or more carpels which are fused; *e.g., Melia*

Practical NO: 5

Aim : Study of Cruciferae

Classification and identification.

Class. Dicotyledonae .

1. Venation reticulate.
2. Flowers pentamerous.

Sub-Class. Polypetalae

1. Petals free.

Series. Thalamiflorae

1. Flowers hypogynous and ovary superior.

Order. Parletales

1. Carpels united to form unilocular ovary with parietal placentation.

Family. Cruciferae

1. Herbs with alternate exstipulate leaves.
2. Corolla cruciform.
3. Stamens tetradynamous.
4. Ovary bicarpellary, syncarpous, unilocular but becomes bilocular due to the development of a false septum; fruit siliqua .

- **Common plants of the family:**
  1. *Brassica campestris* (Sarson) – a cultivated herb.
  2. *Iberis amara* (Chandni) – annual, ornamental, herb cultivated in winter.
  3. *Cherianthus cheiri* (Wall flower) – ornamental annual herb.
  4. *Rorippa monatna* (Water cress) – semi wild.
  5. *Capsella bursa* – pastoris (Shepherd's purse) – common weed.
  6. *Farsetia jaquemontii* – common weed.
  7. *Coronopus didymus* (= Senebiera didyma) – wild in waste places.
  8. *Eruca sativa* (Tara mira) – cultivated for seeds that yield an oil.
  9. *Brassica oleracea botrytis* (cauliflower)
  10. *Brassica oleracea capitata* (cabbage)
  11. *Raphanus sativus* (radish)

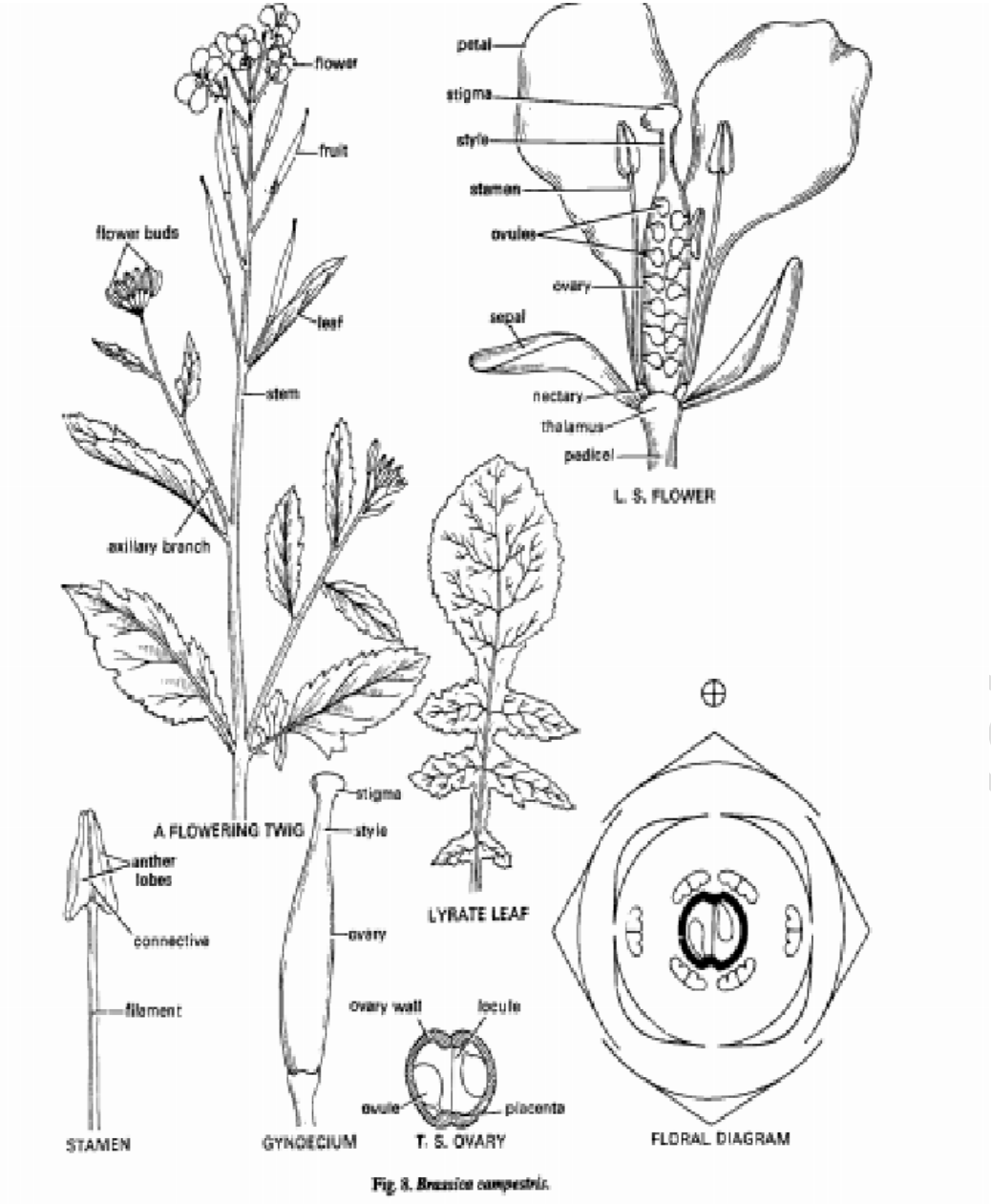


Fig. 8. *Brassica campestris.*

CRUCIFERAE (BRASSICACEAE)

Brassica campestris Linn. Var. Sarson. Prain

Stem. Herbaceous, aerial, erect, cylindrical, branched, solid, smooth and green.

Leaf. Cauline and ramal, alternate, exstipulate, simple, sessile, lower leaves lyrate with deeply cut margins, acute, glabrous, unicostate, reticulate.

Inflorescence. Racemose raceme. Flower. Ebracteate, pedicellate, complete, actinomorphic, hermaphrodite, tetramerous, hypogynous, cyclic and yellow.

Calyx. Sepals 4 in two whorls of 2 each, polysepalous, slightly petaloid.

Corolla. Petals 4, polypetalous, cruciform, each petal is distinguished into a claw and a limb, valvate.

Androecium. Stamens 6 in two whorls (2 + 4), polyandrous, tetradynamous, 4 inner long and 2 outer short, dithecous, basifrxed and introrse, glands are present at the base of 4 longer stamens.

Gynoecium. Bicarpellary, syncarpous, ovary superior, unilocular but becomes bilocular later on due to the development of a false septum (replum), ovules many in each locule, placentation parietal, style short and stigma is bilobed.

Fruit. Siliqua.

Floral formula. ⊕ ☿ K2+2 C4x A2+4 G (2).

Practical NO: 6

Aim : Study of Caesalpiniaceae

Classification and identification.

Class. Dicotyledonae

1. Venation reticulate.
2. Flowers pentamerous.

Sub-Class. Polypetalne

1. Petals free.

Series. Calyciflnrae

1. Thalamus cup-shaped.
2. Ovary inferior or semi-inferior.

Order. Rosales

1. Alternate stipulate leaves.
2. Carpels one or more.

Family. Caesalpiniaceae

1. Flowers zygomorphic.
2. Corolla with ascending imbricate aestivation.
3. Gynoecium usually monocarpellary.

■ **Common plants of the family:**

1. Bauhinia variegata (H. Kachanar):
2. Caesalpinia pulcherrima (Peacock flower or H. Radhachura):
3. Parkinsonia aculeata (H. Vilayti kikar):
4. Delonix regia (syn. Poinciana regia) (H. Gulmohur or Krishnachura):
5. Saraca indica (H. Ashoka):
6. Tamarindus indica (H. Imli):
7. Cassia fistula
8. Cassia angustifolia
9. Caesalpinia bonduc
10. Delonix elata, S.yn-Poinciana elata, Eng-white gulmohur;

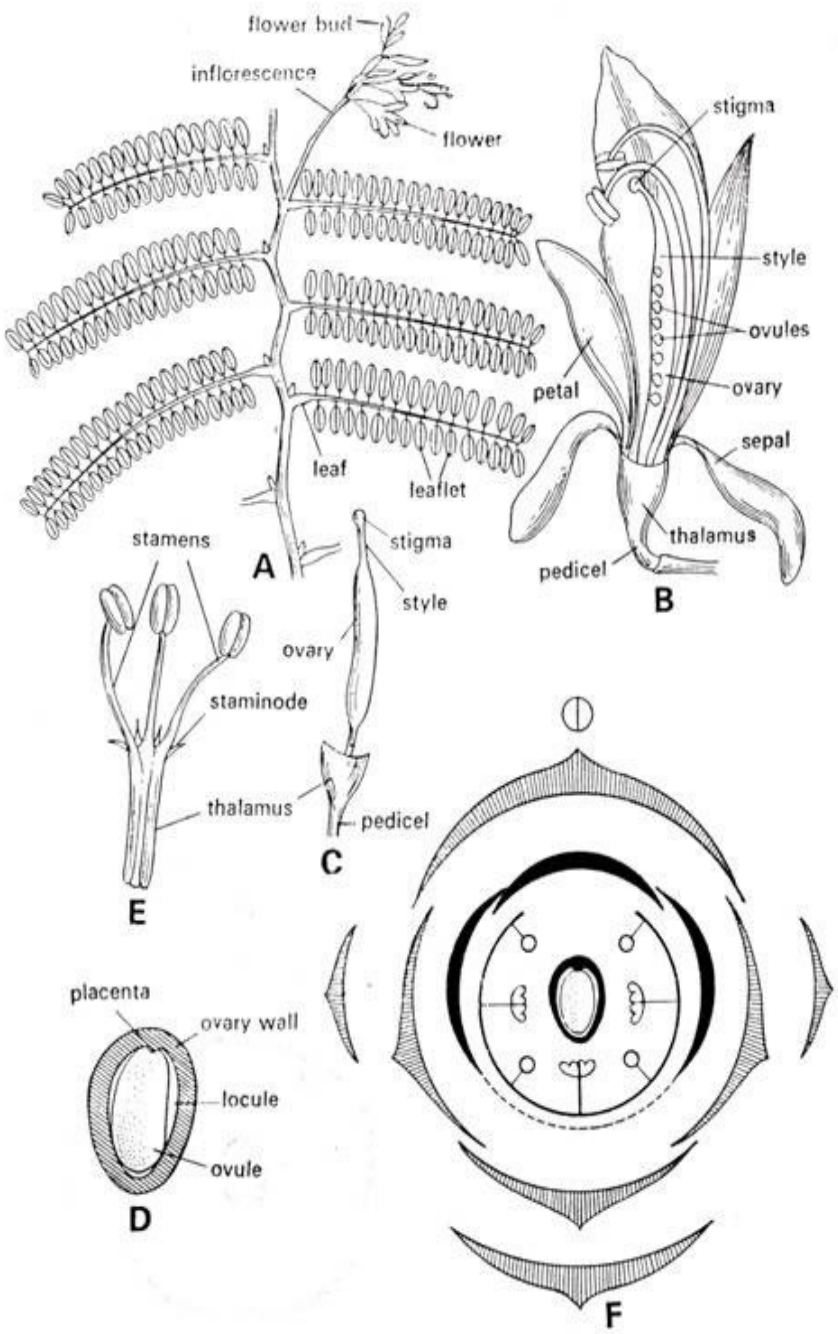


Fig. 15.3. Caesalpiniaceae–*Tamarindus indica* L. (**Imli**). A, flowering twig; B, L.S. of flower, C, gynoecium; D, T.S. of ovary; E, stamens; F, floral diagram.

Tamarindus indica Linn.

Stem. Woody, aerial, erect, cylindrical, branched, solid, rough, brown, upper portions greenish brown.

Leaf. Cauline and ramal, alternate, exstipulate, compound, unipinnate and pari pinnate, petiolate, elliptical, entire, obtuse, unicostate reticulate, glabrous.

Inflorescence. Axillary racemose raceme. Flower. Bracteate, bracteolate, pedicellate, complete, zygomorphic, hermaphrodite, hypogynous and cyclic.

Calyx. Sepals 4, polysepalous, imbricate, posterior sepal large, greenish yellow.

Corolla. Petals 5, polypetalous, anterior two petals reduced, ascending imbricate, brightly coloured.

Androecium. Fertile stamens 3, staminodes 4, all the 7 forming a staminal column, monadelphous, dithecous, versatile, introrse.

Gynoecium. Monocarpellary, ovary superior, placentation marginal, ovules many, style long and stigma knob-like

Fruit. Legume.

Floral formula. $\mathbf{Br\ Brl} \cdot|\cdot\ \varphi\ K_4, C_{3+2}, A_{(3+4)}\ G1\text{—}$

Practical NO: 7

Aim : Study of Rubiaceae

Classification and identification.

Class. Dicotykdonae.

1. Venation reticulate.
2. Flowers pentamerous.

Sub-Class. Gamopetalae

1. Petals fused.

Series. Inferae

1. Ovary inferior.
2. Stamens usually as many as corolla lobes.

Order. Rubiales

1. Leaves opposite.
2. Stamens epipetalous.
3. Ovary 2-8 locular.

Family. Rubiaceae

1. Opposite decussate, entire leaves with interpetiolar stipules.
2. Flowers in cymes. .
3. Gynoecium bicarpellery, syncarpous, inferior, each locule with 1-8 ovules.
4. Placentum T -shaped.

- **Common plants of the family:**
  1. *Coffea arabica (*Coffee):
  2. Cinchona officinalis (Quinine)
  3. Hamelia patens Jacq
  4. Gardenia resinifera Roth
  5. Gardenia jasminoides (Jangli Champo, Dikamli, Malad)
  6. lxora coccinea Unn.
  7. Mussaenda erythrophylla
  8. Oldenlandia corymbosa Linn.
  9. Haldina cordifolia syn. Adina cordifolia (Haldarvo, Haldu, Haldavan,
  10. Morinda tomentosa Heyne ex Roth (Aal, Ali, Aled)
  11. *Xeromphis spinosa* (Thunb.) Keay (Mindhal, Medhelo)

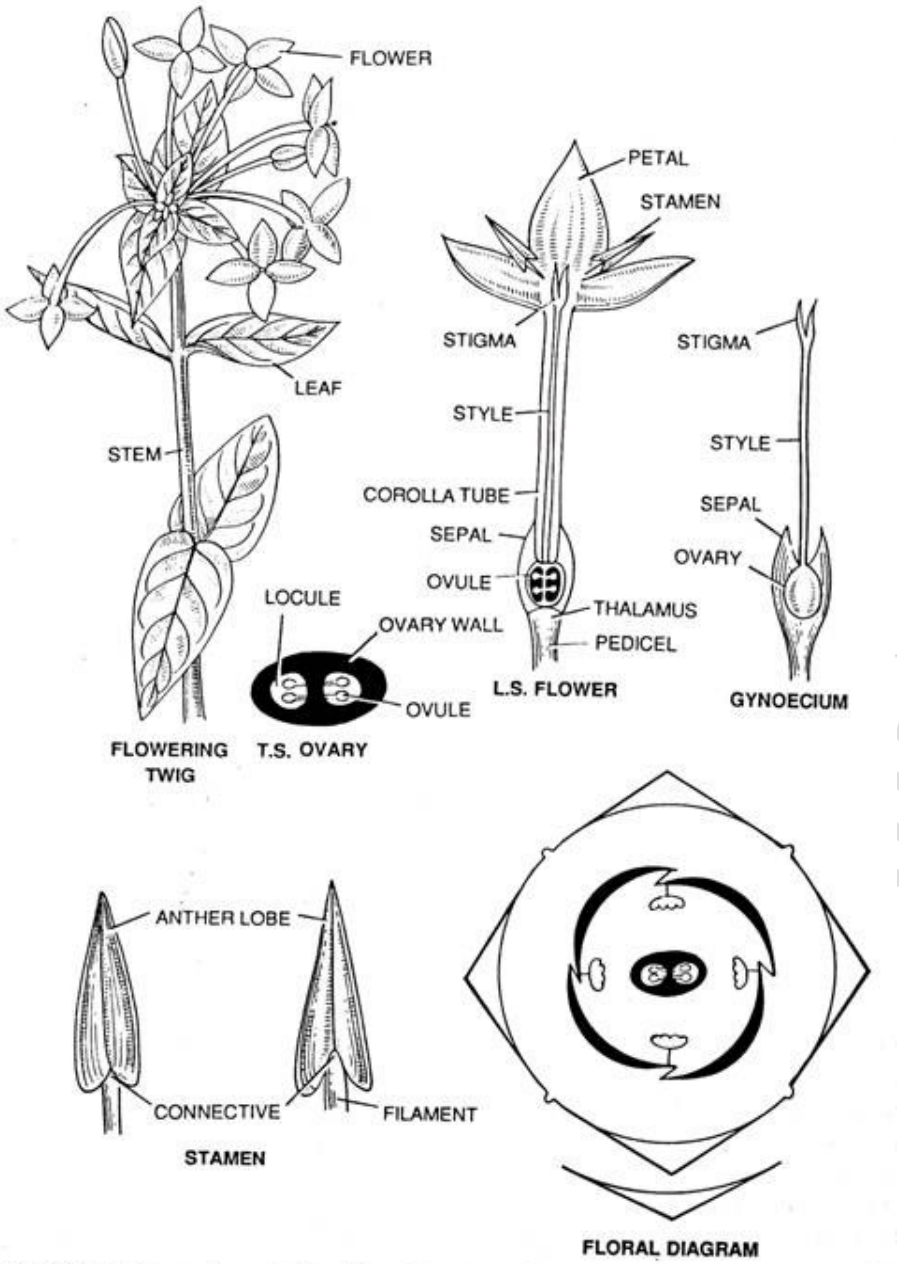


Fig.20.5. Rubiaceae. *Ixora coccinea* Linn.; Eng. Jungle flame Ixora; Verna. **Rangan, rookmini.**

Ixora coccinea Linn; Verna. Rangan, Rookmini; Eng. Jungle flame Ixora

Habit: A large cultivated ornamental shrub.

Stem: Erect, branched, solid, cylindrical, green, herbaeous or somewhat woody.

Leaves: Cauline and ramal, simple, opposite, sessile, stipulate, ovate, smooth entire, acute, unicostate reticulate venation.

Inflorescence: Cymose, corymbose cyme.

Flower: Bisexual, actinom- orphic, pedicellate, bracteate, bracteolate, complete, epigynous, tetramerous.

Calyx: 4 sepals, gamosepalous, superior, valvate aestivation.

Corolla: 4 petals, gamopetalous, corolla tubular, twisted aestivation.

Androecium: 4 stamens, epipetalous, inserted at the mouth of corolla, polyandrous, sessile, anthers bicelled, introrse, dorsifixed.

Gynoecium: 2 carpels (bicarpellary), syncarpous, ovary inferior, bilocular, single ovule in each loculus axile placentation, style very long, stigma single, bifid.

Fruit: Berry.

Floral formula: $\mathrm{Br} \oplus \, \delta\, \mathrm{K}\,(4),\ \overline{\mathrm{C}\,(4), \mathrm{A}\,4},\ \mathrm{G}\,(\bar{2})$.

Practical NO: 7

Aim : Study of Convolvulaceae

Classification and identification

Class. *Dicotyledonae*

1. Venation reticulate.
2. Flowers pentamerous.

Sub- Class. *Gamopetalae*

1. Petals fused.

Series. *Bicarpelatae*

1. Carpels two.
2. Ovary usually superior.

Order. *Polemoniales*

1. Leaves alternate, exstipulate.
2. Flowers actinomorphic.

Family. *Convolvulaceae*

1. Gynoecium bicarpellary, syncarpous with basal ovules in each locule on axile·placentation.
2. Fruit capsule.

English name. Morning Glory family.

- **Common plants of the family:**

1. Ipomoea palmata L./ *Ipomoea cairica* Railway creeper,
2. *Convolvulus arvensis* L.
3. *Convolvulus microphyllus* Sieb ex. Spreng. *(=C. pluricaulis Choisy)*
4. Argyeria roxburghi:
5. Argyeria nervosa (Elephant climber Samudrasok, Vardharo, Samadar Sog)
6. *Evolvulus alsinoides* (L.) L.(Kali Shankhavali, Zini fudardi, Kari Buti,)
7. *Merremia aegyptia* (L.) Urb
8. Ipomoea biloba (Goats foot):
9. *Cressa cretica* L.(Rudanti, Palio, Khariyu)
10. *Ipomoea kotschyana* Linn. (rare)

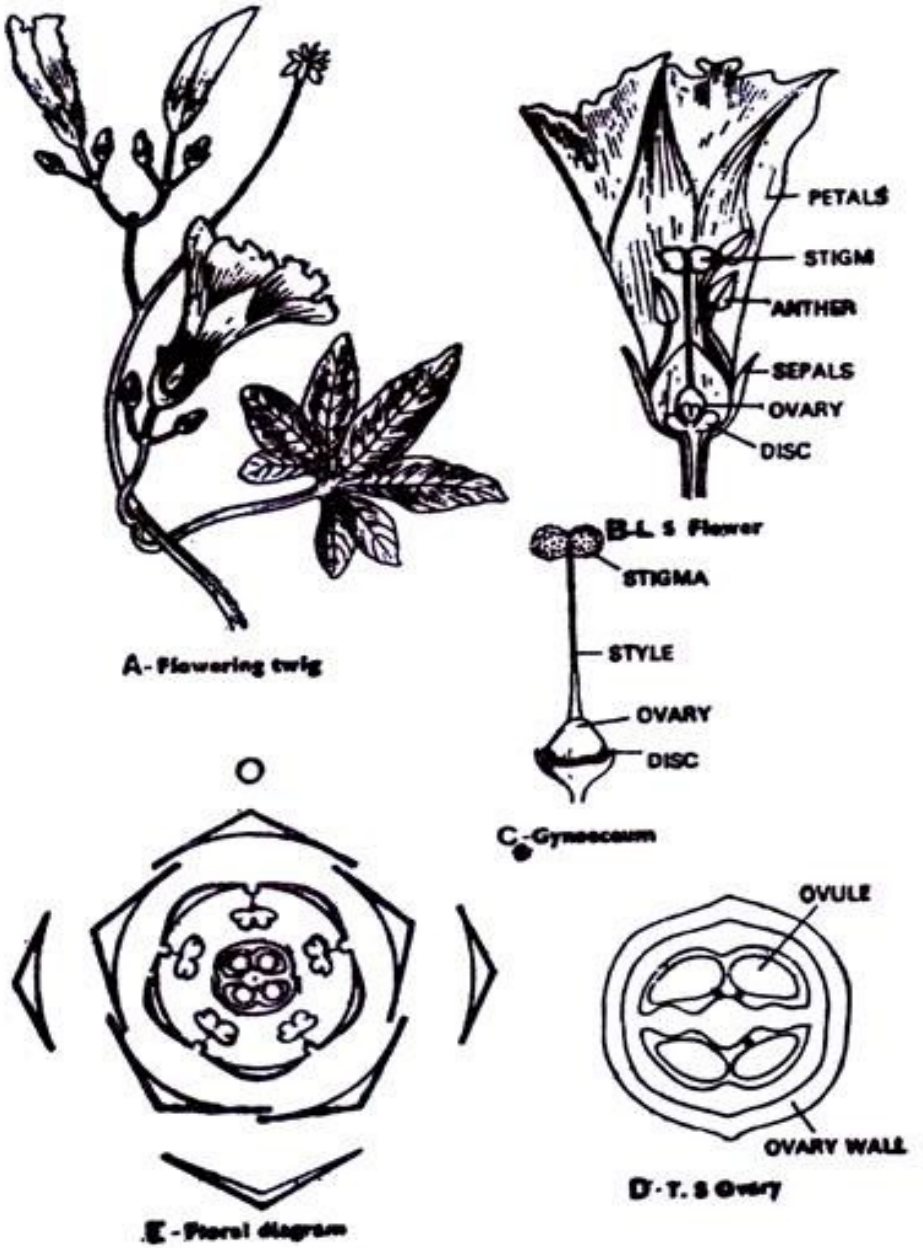


Fig. 77.1. *Ipomoea palmata.*

Ipomoea palmata L./ *Ipomoea cairica*

Common name: Cairo Morning Glory, Messina Creeper, Ivy-leaved Morning Glory, Coastal Morning Glory, Railway creeper,

Root: Tap, branched.

Stem: Thin, cylindrical, greenish, climbing, perennial with distinct nodes and internodes solid, herbaceous.

Leaf: Alternate, exstipulate, palmately compound divided into 5-7 leaflets, petiolate, leaves ovato-elliptical, entire, acute, unicostate reticulate.

Inflorescence: A dichasial cyme.

Flower: Bracteate, pedicellate, complete, hermaphrodite, pentamerous, hypogynous, violet coloured.

Calyx: Sepals 5, polysepalous, green, quincuncial, inferior.

Corolla: Petals 5, gamopetalous, infundibuliform, induplicate valvate.

Androecium: Stamens 5, polyandrous, epipetalous, filaments of unequal length, slender, basifixed, dithecous, introrse.

Gynoecium: Bicarpellary, syncarpous, superior, bilocular, axile placentation, with 2 ovules per locule, style slender long, stigma bilobed.

Fruit: Capsule.

Floral formula: $\mathrm{Br} \oplus \mathrm{\breve{\varphi}}\ \mathrm{K}_{(5)}\ \overset{\frown}{\mathrm{C}_{(5)}\ \mathrm{A}_5}\ \underline{\mathrm{G}_{(2)}}$

Practical NO: 8

Aim : Study of Euphorbiaceae

Classification and identification

Class. Dicotyledonae

1. Venation reticulate.
2. Flowers pentamerous.

Sub-Class. Monochlamydeae

1. Flowers usually with one whorl of perianth, commonly sepaloid or none.

Series. Unisexuales

1. Flowers unisexual.
2. Perianth sepaloid or much reduced or absent.
3. Ovules 1 or 2 per carpel.

Family. Euphorbiaceae

1. Alternate stipulate leaves with latex.
2. Perianth usually in one whorl or absent.
3. Stamens 1 to indefinite, free or united or branched.
4. Gynoecium tricarpellary syncarpous, superior,trilocular with one or two ovules in each locule.

■ **Common plants of the family:**

1. *Phyllanthus fraternus* Webster (*P. niruri* Linn.) Bhonya amli
2. *Croton bonplandianum Ball./* Croton sparciflorus
3. *Jatropha gossypifolia* L. Vernat Bherenda(Ratan Jyot)
4. *Jatropha curcas* L.
5. *Jatropha hastata* Jacq. Syn. *Jatropha integerrima*
6. *Euphorbia pulcherrima* (lal patta)
7. *Ricinus communis*; Eng.-Castor oil plant; Verna.- Arand
8. *Euphorbia hirta* L.
9. *Acalypha indica*
10. *Putranjiva roxburgii*, (Eng.-Child-life tree; Verna.-Putranjiva)
11. *Emblica officinalis*; Syn. Phyllanthus emblica; (Verna.-Amla)

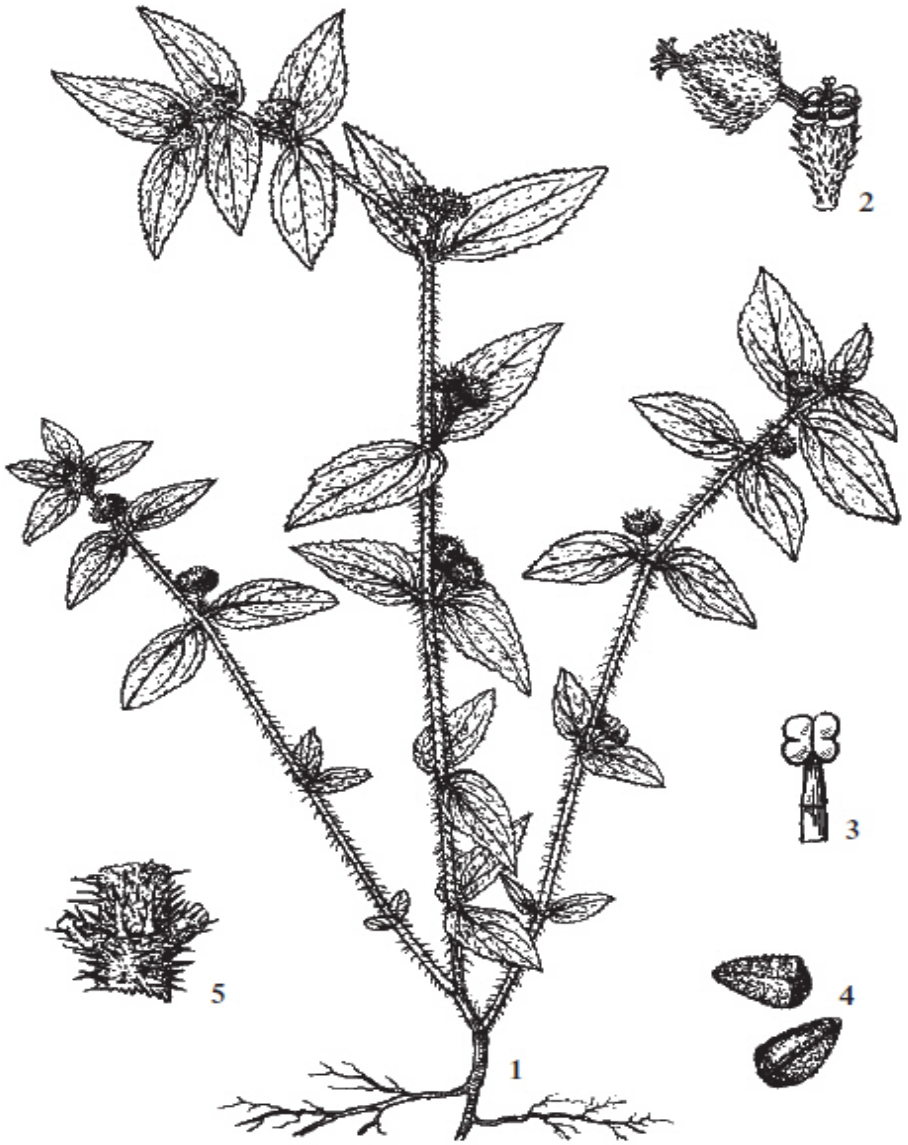


Figure 187. *Euphorbia hirta* L.

1. whole plant; *2.* inflorescence; *3.* male flower; *4.* seed; *5.* stipule. (drawn by H. P. Yu)

***Euphorbia hirta* L.**

Habit: Annual wild herb.

Stem: Erect, usually un-branched (sometimes branched), herbaceous, cylindrical, solid, covered with yellow crisped hairs.

Leaf: Simple, opposite, superposed, sub-sessile (short petiole), acute, oblong, lanceolate, serrulate, stipulate, stipules caducous, unicostate reticulate venation.

Inflorescence: Large number of cyathia densely crowded and arranged in peduncled axillary cymes.

Flowers: Pedicellate, unisexual, monoecious, enclosed within minute involucre of bracts forming cupular structure.

Male Flower:

Perianth: Absent, naked flower.

Androecium: Single stalked stamen representing male flower, bracteate, anthers 2-celled dehiscing longitudinally.

Female Flower:

Perianth: Absent, naked flower.

Gynoecium: A single stalked, bracteate, tricarpellary pistil represents female flower, it remains surrounded by male flowers (stalked stamens), ovary superior, three-chambered, single ovule in each loculus, axile placentation, three styles, three bifid stigmas.

Fruit: A capsule.

Floral Formulae:

Male flower— ⊕ ♂ K 0, C 0, A 1

Female flower— ⊕ ♀ K 0, C 0, G (3).

Practical NO: 9

Aim : Study of Poaceae

Classification and identification.

Class. Monocotyledonae

1. Ventation parallel.
2. Flowers trimerous.

Series. Glumaceae

1. Flowers solitary, sessile in the axil of bract.
2. Perianth of scales or none.
3. Ovary usually unilocular and one ovuled.

Family. Poaceae

1. Joined stems with alternate 2 ranked leaves with split sheath and ligule.
2. Inflorescence spilelet and each begins with one or two empty glumes then palea with axillary flowers.
3. Stamens usually three.
4. Gynoecium superior With one ovule.
5. Fruit caryopsis

- **Common plants of the family:**
  1. *Triticum aestivum* L. Ghahun
  2. *Zea mays* L. Maka
  3. *Oryza sativa* L. Local Name: Bhat, Chokha
  4. *Aristida adscensionis* L. subsp. *Adscensionis* (Uth lampdu,Dabholu, Lepadu)
  5. *Cenchrus biflorus* Roxb. Fl. Motu Dhramnu
  6. *Cenchrus ciliaris* L. Anjan, Dhaman,
  7. *Coix lachryma-jobi* L. Kahudo, Kasai
  8. *Cymbopogon schoenanthus (L.) Spr. Roshdo, Citronella grass, lemon grass*
  9. *Pennisetum typhoides* (Burm. f.) Stapf & Hubb. Bajri, Bajro
  10. *Hordeum vulgare* L. Local Name: Barley, Jav
  11. *Eleusine coracana* (L.) Gaertn. Local Name: Nagli, Ragi, Bavato
  12. *Desmostachya bipinnata* (L.) Stapf Dabh, Dabhado
  13. *Saccharum officinarum* L. Sherdi, Ganna

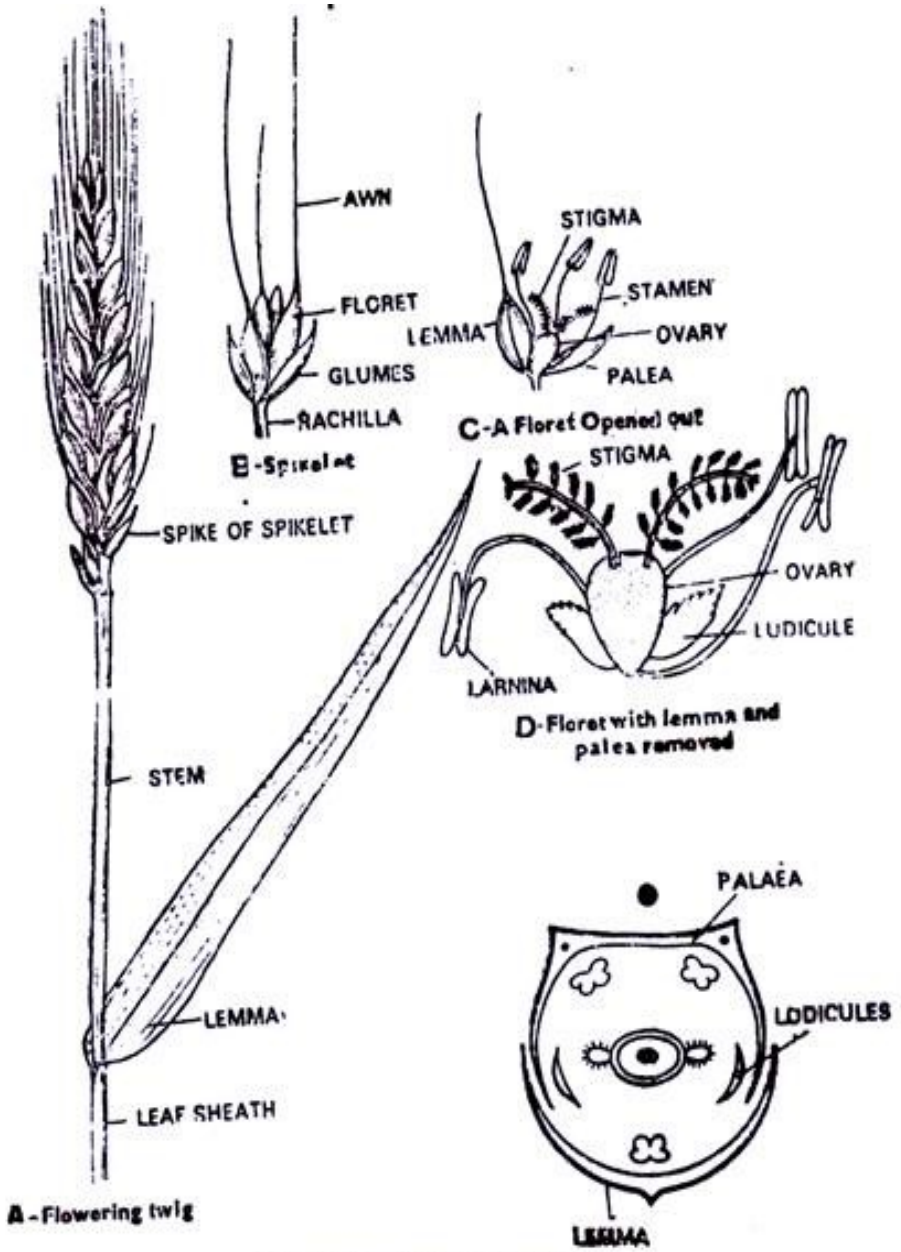


Fig. 118.1. *Triticum aestivum.*

Triticum aestivum (Ghau)

Habit: A cultivated annual crop plant.

Root: Adventitious.

Stem: Herbaceous, erect, cylindrical, fistular, with distinct nodes and internodes, unbranched, glabrous, a number of tillers.

Leaf: Simple, alternate, green, exstipulate, entire margin, acute apex, sheathing leaf base, at the junction of leaf-sheath and leaf-blade membranous ligule present, parallel venation.

Inflorescence: Spike of spikelets.

Flower: Bracteate, sessile, hermaphrodite, zygomorphic, incomplete, hypogynous, flower lies between superior and inferior palea.

Perianth:2 membranous scales – the lodicules.

Androecium: Stamens 3, polyandrous, filament long, anthers dorsifixed when young and versatile when mature.

Gynoecium Monocarpellary, theoritically tricarpellary, ovary superior, unilocular, single ovule, basal placentation, style short; stigma 2, feathery.

F.F: $\circ|\circ \quad \varnothing \; P_2 \text{ (lodicules)} \; A_3 \; \underline{G_1}$

Practical NO: 10

Aim : Study of Palmae

Classification and identification.

Class. Monocotyledonae

- 1. Venation parallel.
- 2. Flowers trimerous.

Series. Calycineae

- 1. Perianth sepaloid, herbaceous or membranous.
- 2. Ovary superior.

Family. Palmae

- 1. Tree-like plants with fan leaves.
- 2. Flowers actinomorphic, unisexual and in spikes.
- 3. Perianth in two whorls and sepaloid.
- 4. Stamens 3 + 3, or 3, 9 or 8.
- 5. Gynoecium tricarpellary, trilocular with one ovule in each locule.
- 6. Fruit berry or drupe.

■ **Common plants of the family:**

1. *Areca catechu* (H. Supari; Betelnut palm):
2. *Lodoicea maldivica* kamandal
3. *Corypha umbraculifera* (Talipot palm):
4. Cocos nucifera (H. Nariyal):
5. *Calamus tenuis* and C. rotang (H. Bent): Netar
6. *Metroxylon salomonense*
7. *Nipa fruitcans* (Water coconut):
8. *Phoenix dactylifera* (Date palm):
9. *Borassus flabellifer* L. Tad, Tadi
10. *Caryota urens* L. Shivjata , Wine Palm, Fish-Tail Palm
11. *Rhapis excelsa*
12. *Ravenala madagascariensis*
13. *Roystonea regia Royal Palm*

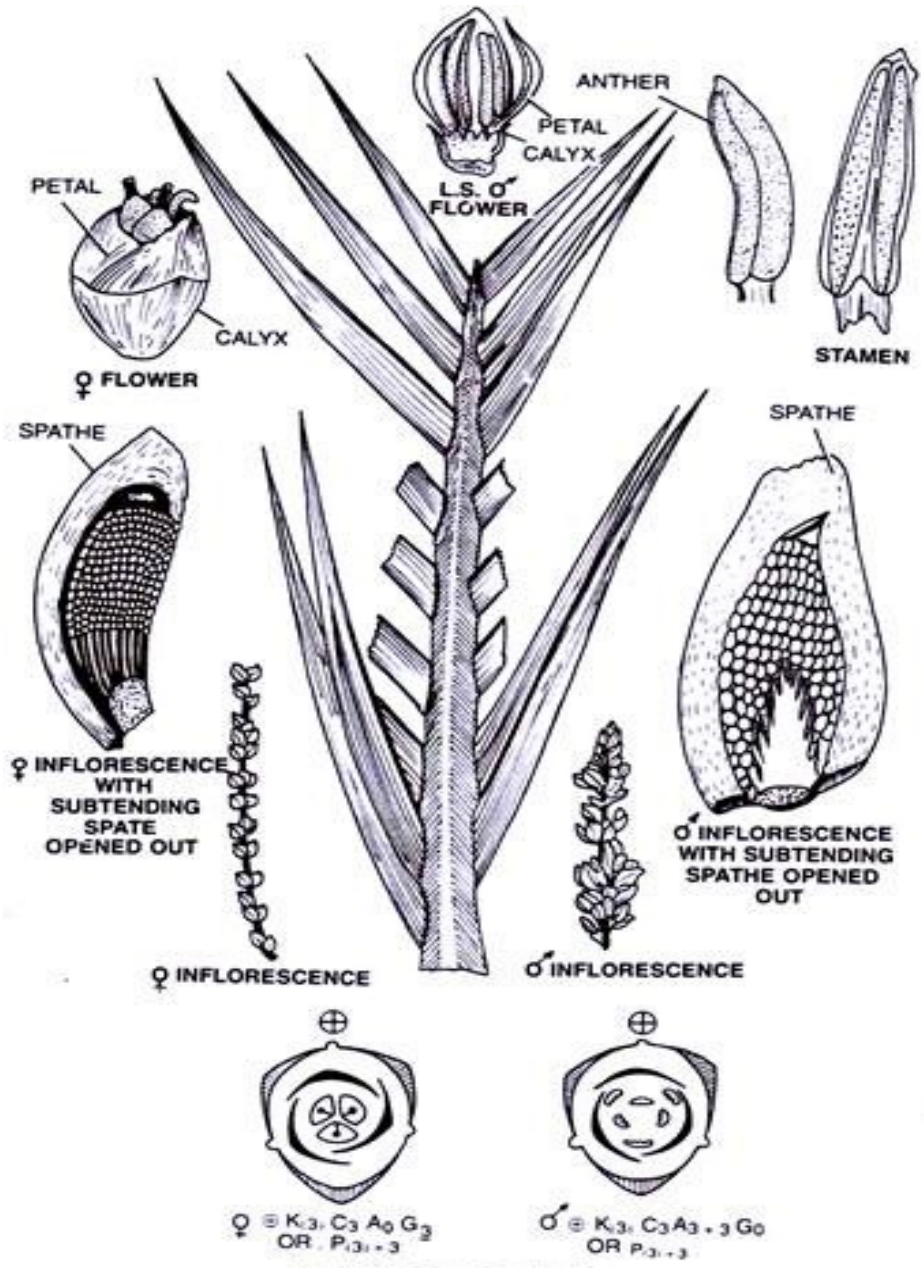


Fig. 111.2. *Phoenix sylvestris.*

Phoenix sylvestris (Date palm)

Habit: A tree.

Root: Adventitious.

Stem: Aerial, woody, erect, cylindrical, rough, covered with persistent leaf bases, unbranched, solid, brown.

Leaves: Forming a dense terminal crown, exstipulate, compound, unipinnate, petiolate, glabrous.

Leaflets: Sub-sessile, lanceolate, entire, acute, unicostate parallel venation.

Inflorescence: Spadix-branched, erect, long, enclosed by spathe.

Flower: Small, actinomorphic, hypogynous, unisexual, bracteate, incomplete.

Male Flower: Bracteate, sessile, incomplete, numerous, angular, actinomorphic, hypogynous, trimerous.

Perianth: Tepals 6, in two whorls of 3 each, white, angular, free and inferior.

Androecium: Stamens 6, in two whorls of 3 each, polyandrous, filament short; anthers dithecous, dorsifixed, introrse.

Gynoecium: Absent.

Female flower: Bracteate, sessile, incomplete, actinomorphic, hypogynous, trimerous.

Perianth: As in male flower.

Androecium: Absent.

Gynoecium: Tricarpellary, syncarpous, ovary superior, one ovule in each carpel; style absent; stigma hooked.

Fruit: One seeded berry, orange yellow.

Seed: Hard and endospermic.

Floral formula:

Male flower : $\oplus\ \delta\ P_{3+3}\ A_{3+3}\ G_0$

Female flower : $\oplus\ \varphi\ P_{3+3}\ A_0\ \underline{G_{(3)}}$

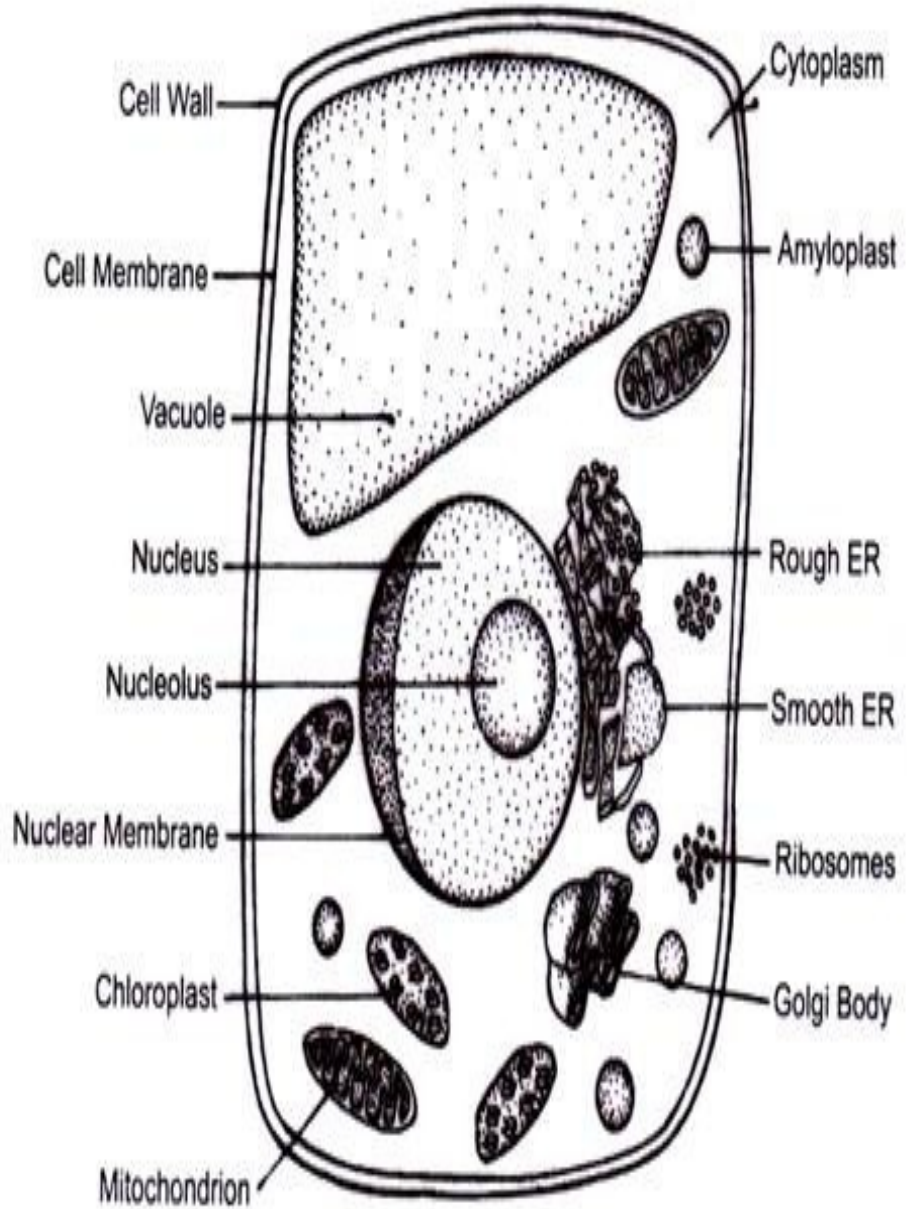


Fig. 2.1 Structure of Plant Cell

Practical No 12

Aim : Study through Model / Chart / Computer (Picture/ Photograph)

Exercise 1: . To study generalized plant cell

Take out a leaf of Hydrilla or peel off epidermis of leaf of any ongiospermic plant. Stain with safranin and mount in glycerine.

Identification Since the cell shows cell wall and chloroplasts, it is a plant cell.

Comments

1. The outermost is the cell wall made of cellulose.
2. Cell wall is followed by cell membrane.
3. Inside the cell membrane is the cytoplasm and the nucleus.

4. Cytoplasm contains chloroplasts, mitochondria, golgi bodies, endoplasmic reticulum and ribosomes.

5. The characteristic green colour of the cell is due to the presence of many chloroplasts distributed throughout the cytoplasm.

6. Nucleus is situated in the cytoplasm. It shows nuclear membrane, nucleolus and chromatin network present in nucleoplasm.

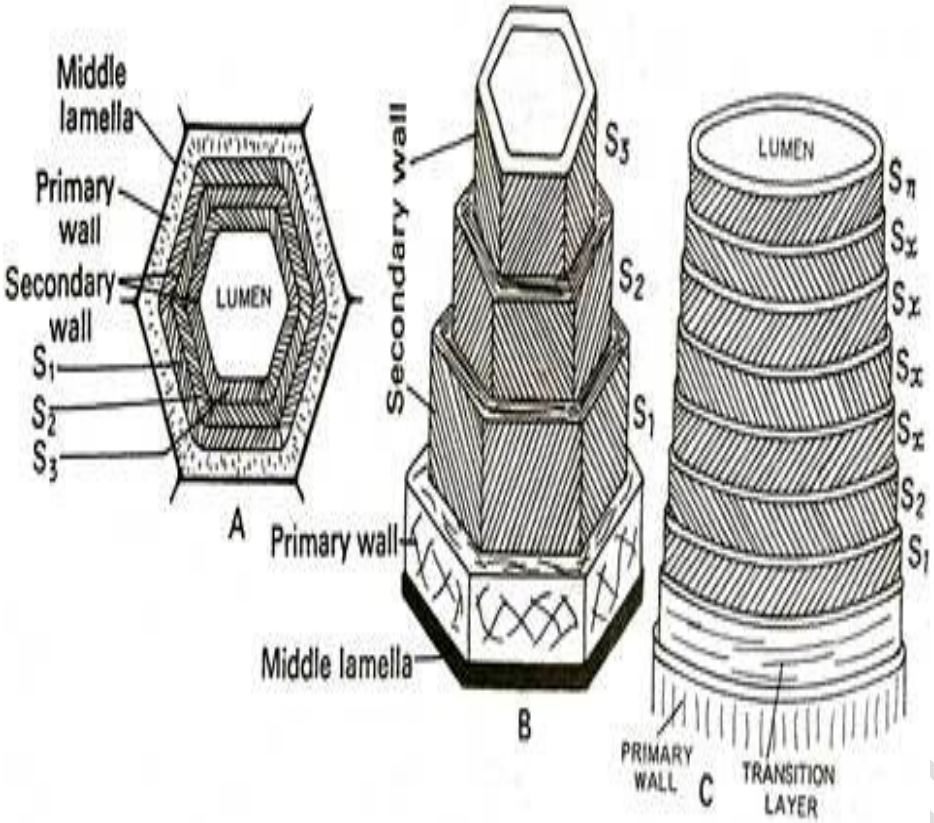


Fig. 8.15. Parts and layers of cell wall. A, a cell in T.S. showing parts of cell wall. B, typical wood fibre cut at various levels to show parts and layers of the wall. C, latex tube of *Euphorbia milli* (= *E. splendens*) cut at various levels to show parts.

Exercise2 : U.S. of Plant cell wall

It is the outer rigid protective supportive and semi transparent covering of plant cells, fungi and some protists. Cell wall was first seen in cork cells by Hooke in 1665. Its thickness varies in different types of cells from 0.1 µm to 10 µm. Cell wall is a non-living extracellular secretion or matrix of the cell which is closely appressed to it. It is, however, metabolically active and is capable of growth.

Comments

Structure of Cell Wall:

A cell wall can have upto three parts— middle lamella, primary wall and secondary wall.

Middle Lamella:

It is a thin, amorphous and cementing layer between two adjacent cells. Middle lamella is the first layer which is deposited at the time of cytokinesis . It is just like brick work of the common wall between two adjacent rooms.

Primary Wall :

It is the first formed wall of the cell which is produced inner to the middle lamella. Primary wall consists of a number of micro fibrils embedded in the amorphous gel like matrix or ground substance

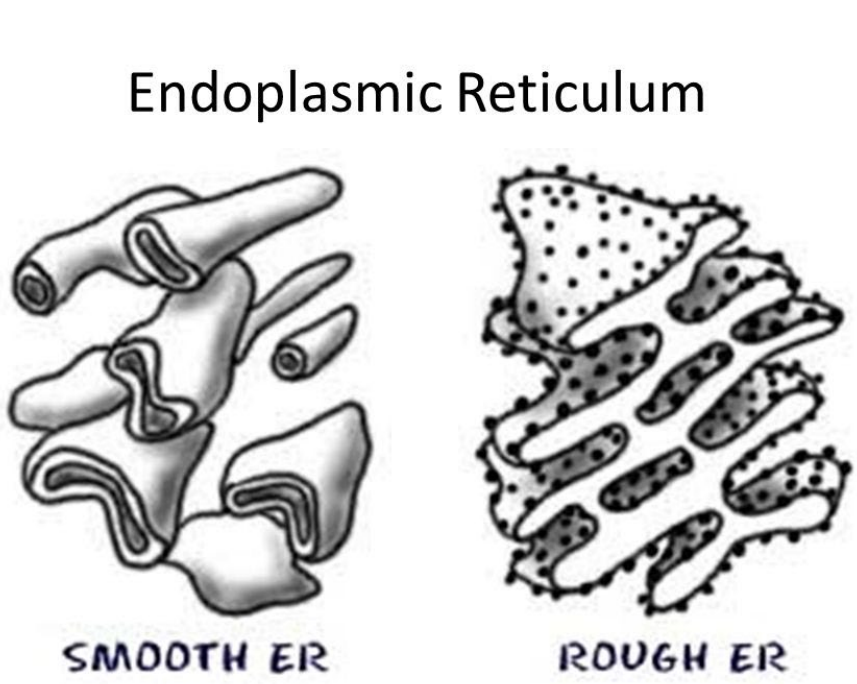
The wall is made of a polymer of P, 1-4 acetyl glucosamine or fungus cellulose in many fungi.

The matrix of the wall consists of water, pectin, hemicelluloses and glycoproteins.

Secondary Wall:

It is produced in some mature cells when the latter have stopped growth, e.g., tracheids, vessel elements, fibres, collenchyma's. Secondary wall is laid inner to the primary wall by accretion or deposition of materials over the surface of existing structure. It is thick (3—10 µm) and made up of at least three layers, sometimes more (e.g., latex tube of Euphorbia milli). They are named as S1, S2, S3, Sx, etc

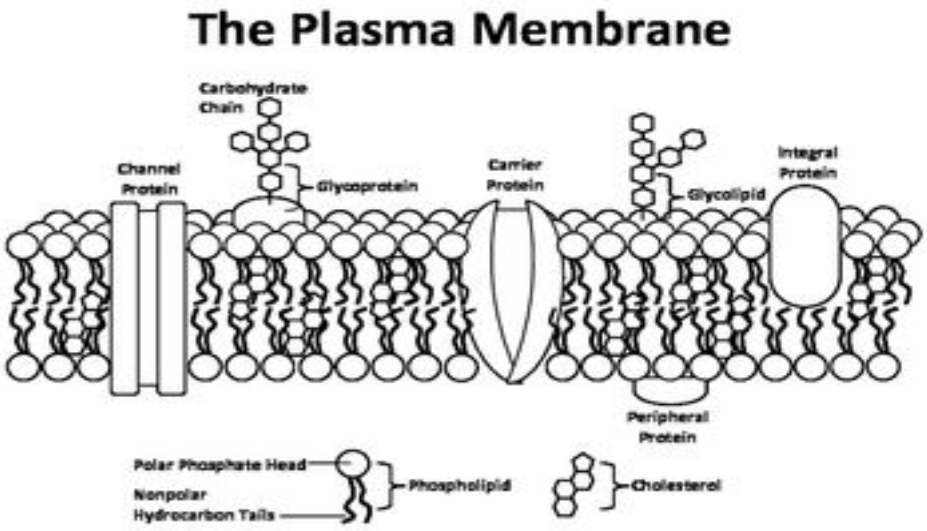
Secondary wall may be absent, irregularly deposited or formed uniformly in the cells. This results in differentiation of cells— parenchyma, collenchyma, sclerenchyma, tracheids and vessels.



Exercise3: U.S. of Plant cell ER

Comments

1. Endoplasmic reticulum (ER) is the connecting link between the nucleus and cytoplasm of the plant cell.
2. Basically, it is a network of interconnected and convoluted sacs that are located in the cytoplasm.
3. Based on the presence or absence of ribosomes, ER can be of smooth or rough types.
4. The former type lacks ribosomes, while the latter is covered with ribosomes.
5. endoplasmic reticulum serves as a manufacturing, storing and transporting structure for glycogen, proteins, steroids and other compounds.

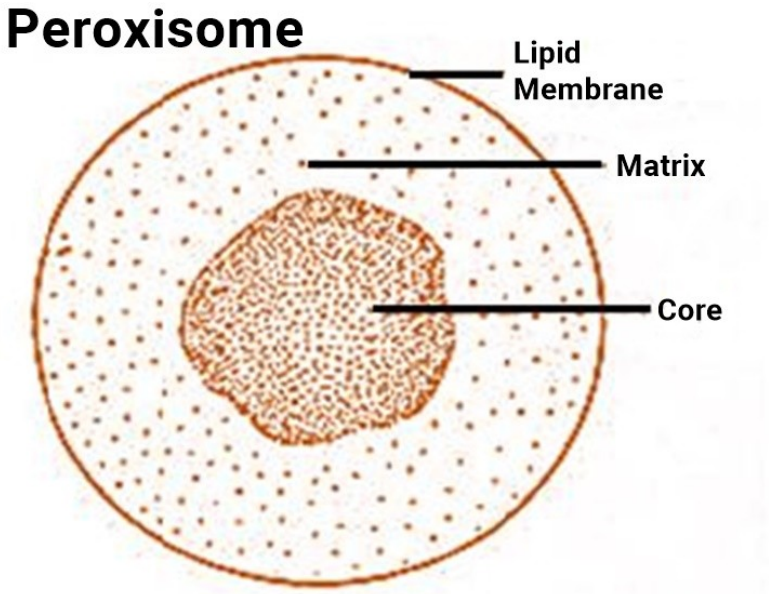


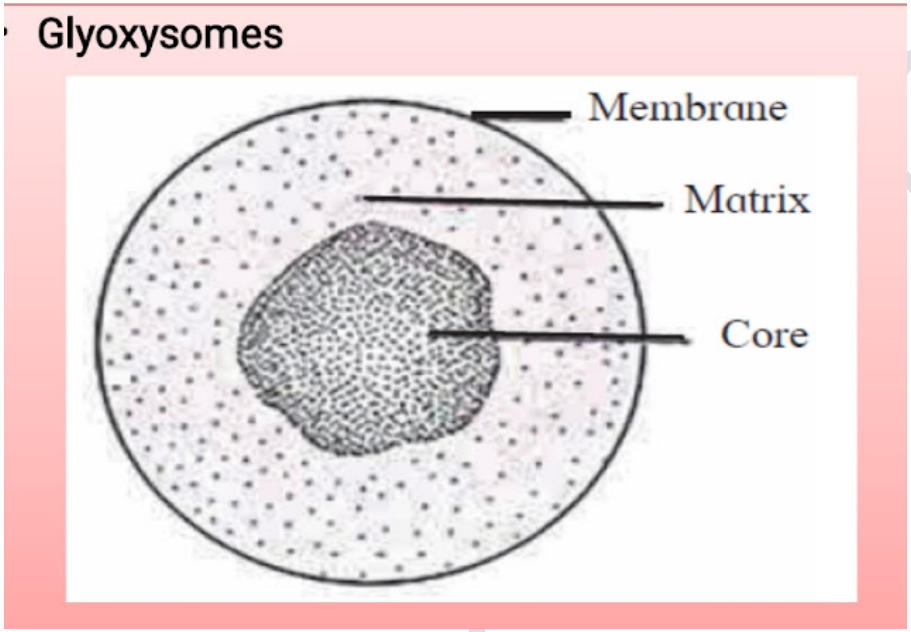
Exercise4: U.S. of Plasma membrane

Comments

1. It is a thin film like pliable membrane, and serves as protective covering of the cell.
2. Cell membrane mainly consists of proteins and lipids but in certain cases, polysachharides have also been found.
3. It facilitates the entrance of nutrients into the cells and allows exit of nitrogenous wastes, regulates the passage of materials into and out of the cells.
4. It controls and maintains differential distribution of ions inside and outside the cell.

Exercise.5: Microbodies (Peroxisome, Glyoxisome)





Peroxisomes

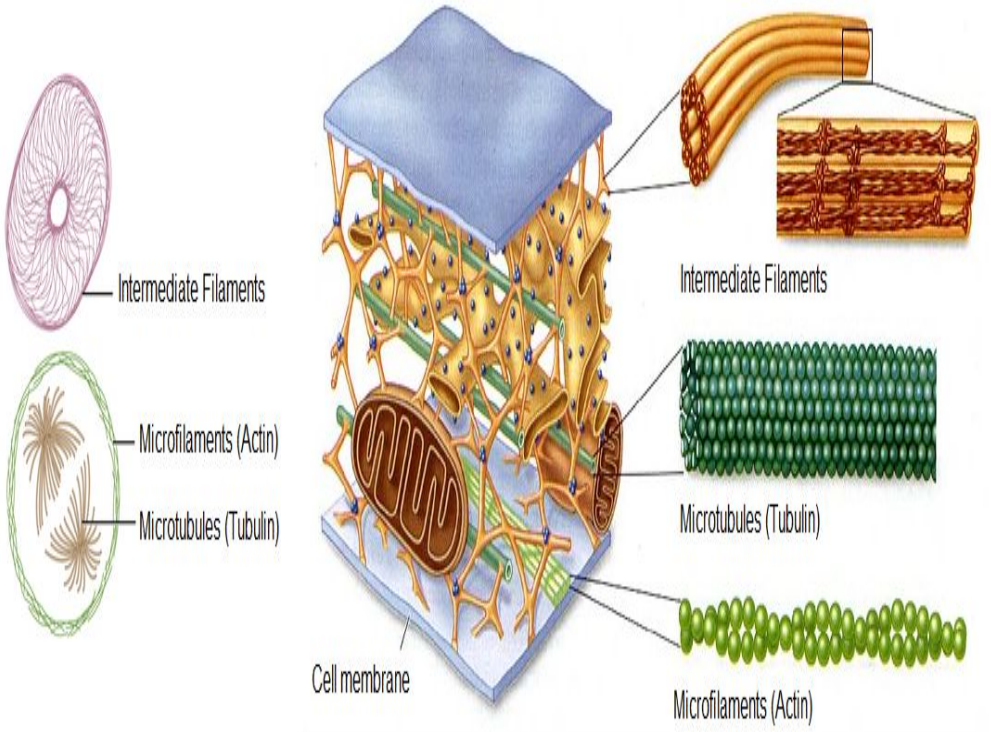
Comments

1.Peroxisomes occur widely both in plant and animal cells.
2.They are spherical or ovoid bodies surrounded by a single membrane.
3. It contains certain oxidative enzymes, used for the metabolic breakdown of fatty acids into simple sugar forms.
4.In green plants, peroxisomes help in undergoing photorespiration.

Glyoxysomes

Comments

1. Glyoxysomes are specialized peroxisomes found in plants (particularly in the fat storage tissues of germinating seeds) and also in filamentous fungi.
2. The seedling uses these sugars, synthesized from fats until they are mature enough to make them through photosynthesis.
3. It involved in the breakdown and conversion of fatty acids to acetyl-CoA for the glyoxylate bypass.



Exercise 6: Cytoskeleton

Comments

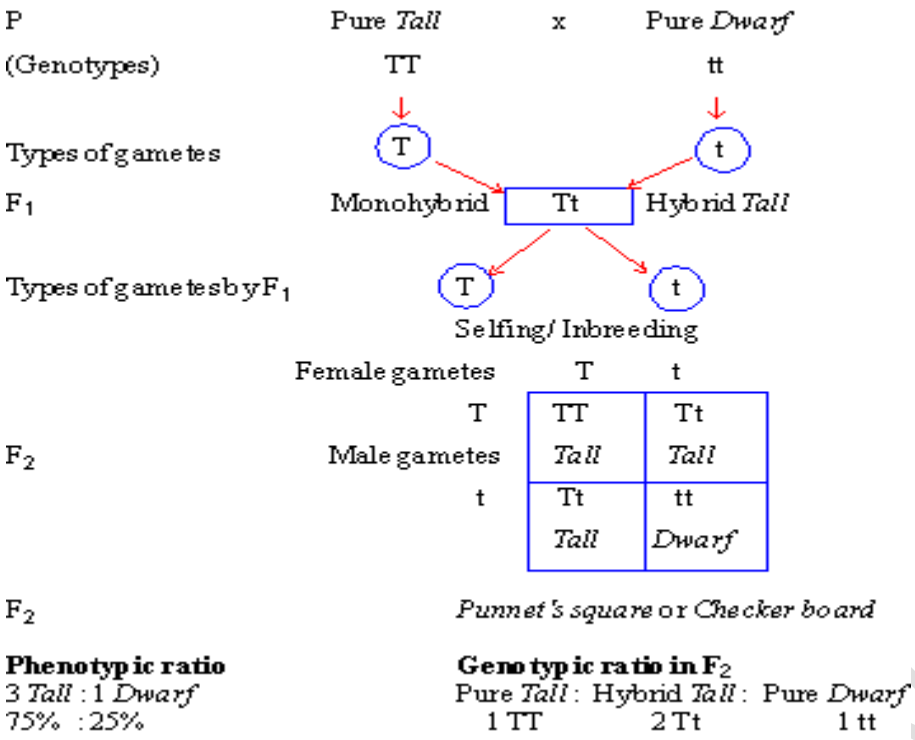
1.The cytoskeleton is a network of filaments and tubules that extends throughout a cell, through the cytoplasm, which is all of the material within a cell except for the nucleus.

2. It is found in all cells, though the proteins that it is made of vary between organisms.

3. The cytoskeleton supports the cell, gives it shape, organizes and tethers the organelles, and has roles in molecule transport, cell division and cell signaling.

4. The eukaryotic cytoskeleton consists of three types of filaments, which are elongated chains of proteins: microfilaments, intermediate filaments, and microtubules.

5. One analogy for the cytoskeleton is the frame of a building. Like a building's frame, the cytoskeleton is the "frame" of the cell, keeping structures in place, providing support, and giving the cell a definite shape.



Practical No 13

Aim : Study Mono & Dihybrid ratio,

Exercise 1: Monohybrid cross:

A cross between two parents differing in one trait/character or in which only one trait is considered is called monohybrid cross.

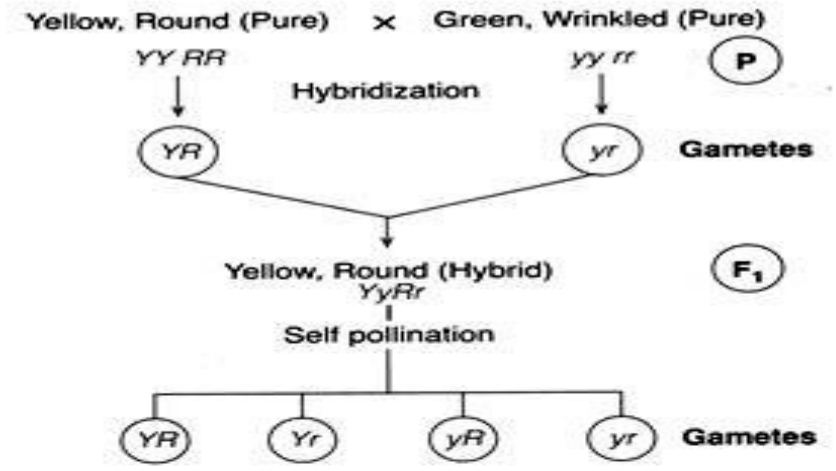
1.The tall and dwarf plants of P generation were both pure breeding and genotypically homozygous-TT and tt respectively. The gametes produced by the tall parent carry only T allele and dwarf parent carry only t allele.

2.Therefore, after fertilization, the zygote must have the genotype Tt and F1 plant will be phenotypically tall because of dominance of T allele.

3. As the t allele is recessive, expression of dwarf character will not occur.

4. When the F, tall (Tt) plants were selfed, separation of the alleles T and t occurred during the formation of gametes. Half of the gametes will carry T allele and half t allele in both male and female organs. Two types of male gametes are free to unite with two types of female gametes. Therefore, both tall and dwarf phenotypes will appear-in F2.

5. As the male gamete and female gamete, both with t allele, unite to produce the genotype tt, the reappearance of dwarf plant will occur in F2 generation. Thus the F2 plants produced will be of three types of genotypes-TT,. Tt and tt in the ratio 1:2:1. Both TT and Tt plants will be tall and tt plants will be dwarf in the ratio 3:1 (Fig. 6.3). On selfing of F2 plants – TT tall plants will breed true, Tt tall plants will segregate in the ratio 3:1 and tt plants will also breed true.



♀ \ ♂	YR	Yr	yR	yr
YR	YYRR	YYRr	YyRR	YyRr
Yr	YYRr	YYrr	YyRr	Yyrr
yR	YyRR	YyRr	yyRR	yyRr
yr	YyRr	Yyrr	yyRr	yyrr

F_2

Phenotype	Genotype	Genotypic ratio	Phenotypic ratio
Yellow, Round	YYRR	1	9
	YYRr	2	
	YyRR	2	
	YyRr	4	
Yellow, Wrinkled	YYrr	1	3
	Yyrr	2	
Green, Round	yyRR	1	3
	yyRr	2	
Green, Wrinkled	yyrr	1	1

Fig. 6.4: Mendel's dihybrid experiment

Exercise 2: Dihybrid cross

A cross between two parents differing in two traits or in which only two traits are considered called di-hybrid cross.

Mendel raised separately two pure varieties of garden peas, one with yellow cotyledon, round seed and another with green cotyledon, wrinkled seed. From the cross between these two parental (P) generation plants, the offspring's in the F1 generation were all with yellow cotyledon and round seed.

When these F1 plants were self-fertilized, the offspring's of F2 generation were of four types in the ratio 9:3:3:1 –

(a) Yellow cotyledon, round seed
(b) Yellow cotyledon, wrinkled seed
(c) Green cotyledon, round seed and
(d) Green cotyledon, wrinkled seed.

The appearance of two new types of phenotypic combinations – yellow cotyledon, wrinkled seed and green cotyledon, round seed in addition to parental phenotypic combinations requires the production of Yr and yR gametes in addition to YR, yr gametes by F2 plants.

6. Thus the allele Y may be associated with the allele R as well as r in equal frequency, giving rise to YR and Yr gametes respectively. Similarly, the allele y may be associated with the allele R as well as r in equal frequency giving rise to yR and yr gametes respectively. Thus four types of gametes viz.', YR, Yr, yR and yr will be produced in the ratio 1 : 1 : 1 : 1.

7. These four types of gametes (both male and female) will unite in sixteen possible combinations to produce nine types of genotypes in the ratio 1 : 2 : 1 : 2 : 4 : 2 : 1 : 2 : 1 and four types of phenotypes in the ratio 9:3: 3 : 1

P White flowers × White flowers

CCpp ccPP

Gametes Cp cP

Purple flowers

CcPp

Gametes : CP.Cp, cP, cp Gametes

♀ \ ♂	CP	Cp	cP	cp
CP	CCPP Purple	CCPp Purple	CcPP Purple	CcPp Purple
Cp	CCPp Purple	CCpp White	CcPp Purple	Ccpp White
cP	CcPP Purple	CcPp Purple	ccPP White	ccPp White
cp	CcPp Purple	Ccpp Whie	ccPp White	ccpp White

Gametes

Phenotypic ratio : 9 Purple : 7 White

(Representing a Cross between two varieties of sweet pea)

Genotypes and Phenotypes of F2 and breeding behaviour expected in F2 of complementary factors:

Genotype ratio	Genotype Class	Phenotype class	Phenotype ratio
1 2 2 4	CCPP CCPp CcPP CcPp	Purple	9
1 2 1 2 1	CCpp Ccpp ccPP ccPp ccpp	White	7

Exercise 3: Complementary Factor: The 9:7 Ratio:

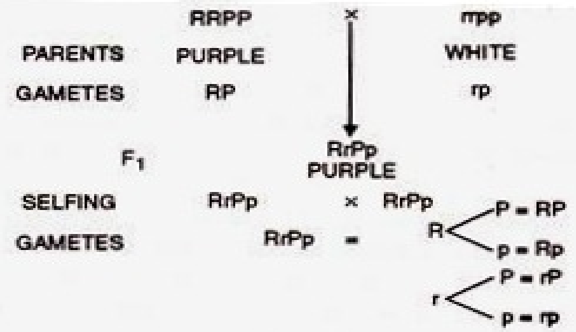
In sweet pea (Lathyrus odoratus) two varieties of white flowering plants were seen. Each variety bred true and produced white flowers in successive generations. According to Bateson & Punnett, when two such white varieties of sweet pea were crossed, the offspring were found to have purple coloured flowers in F1 but in F2 generation 9 were purple and 7 white. This is again a modification of 9:3:3:1 ratio, where only one character i.e., flower colour is involved.

It is clear in the above example that for the production of the purple flower colour both complementary (C and P) genes are necessary to remain present. In the absence of either genes (C or P) the flowers are white.

Thus, it is clear that genes C and P interact and presence of both is essential for the purple colour in the flower. These types of genes in which one gene complements the action of the other gene, constitute complementary genes or factors.

(Complementation between two non-allelic genes (C and P) are essential for production of a particular or special phenotype i.e., complementary factor)

Aleurone colour in maize is also controlled by complementary genes.



F2

♀ \ ♂ Gametes	RP	Rp	rP	rp
RP	RRPP Purple	RRPp Purple	RrPP Purple	RrPp Purple
Rp	RRPp Purple	RRpp Red	RrPp Purple	Rrpp red
rP	RrPP Purple	RrPp Purple	rrPP White	rrPp White
rp	RrPp Purple	Rrpp Red	rrPp White	rrpp White

Results : 9 Purple : 3 Red : 4 White

(Cross between Purple and White grain colour in Maize.)

Showing genotypes and phenotypes of F2 behaviour of supplementary factors in grain colour of maize:

Frequency	Genotypes	Phenotypes
1	RRPP	Purple
2	RRPp	
2	RrPP	
4	RrPp	
1	RRpp	Red
2	Rrpp	
1	rrPP	4 White
2	rrPp	
1	rrpp	

Exercise 4: Supplementary Factors (9:3:4):

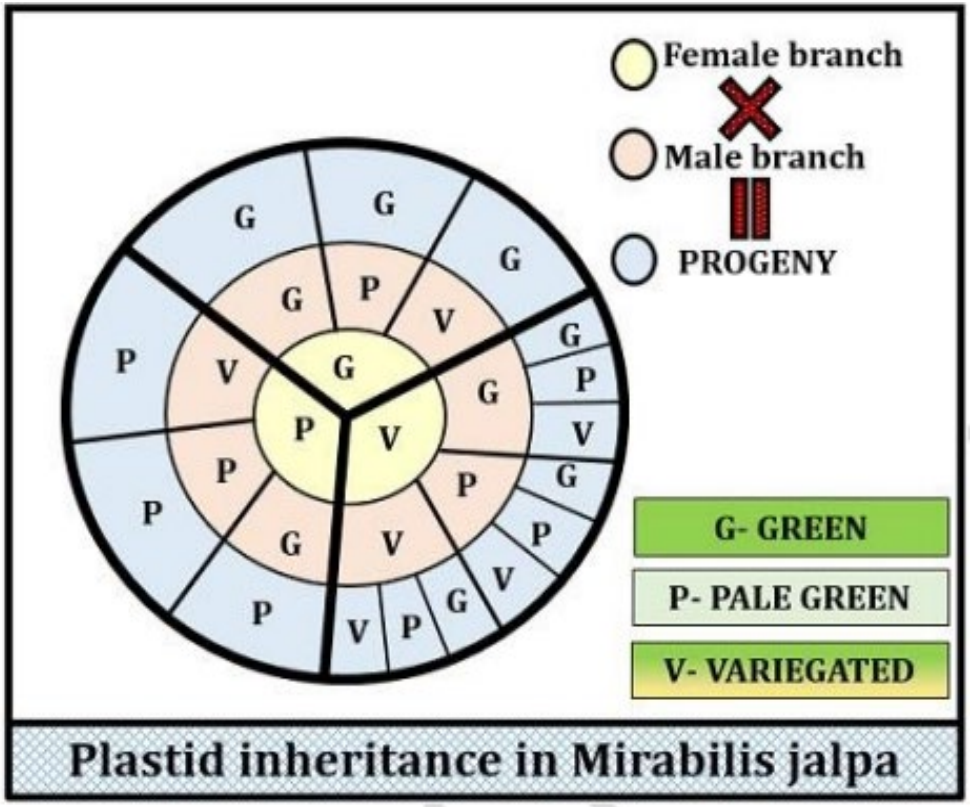
Here only one factor is sufficient to produce a phenotypic expression but addition of another factor causes the change in expression.Or

Supplementary genes are two independent dominant genes interacting to produce a phenotypic expression different from that produced by either gene alone.

In supplementary gene action, the dominant allele of one gene is essential for the development of the concerned phenotype, while the other gene modifies the expression of the first gene. For example, the development of grain colour in maize is governed by 2 dominant genes ‘R’ and ‘P’.

The dominant allele ‘R’ is essential for red colour production; homozygous state of the recessive allele ‘r’ (rr) checks the production of red colour. The gene ‘P’ is unable to produce any colour on its own but it modifies the colour produced by the gene ‘R’ from red to purple. The recessive allele ‘p’ has no effect on grain colour.

Examples of supplementary factors have also been seen in other plants and animals too. For instance, it is clearly visible in skin colour of house mouse and guinea pigs. When black mice are crossed with ordinary albinos, the progeny are usually all agouti like the wild type. When these F1 agouties are inbred, their progeny consist of 9/16 agouti, 3/16 black and 4/16 albino animals.



Practical No 14

Aim : **Plastid inheritance in Mirabilis jalapa (4'o clock plant):**

Correns (I908) worked out the plastid inheritance in Mirabilis jalapa.
The plant shows three types of branching:
• Branches with green leaves: due to presence of chloroplast
• Branches with white leaves: due to presence of leucoplast
• Branches with variegated leaves: due to presence of chloroplast,leucoplast and chromoplast.

In four o'clock plant (*Mirabilis jalapa*), three kinds of branches with respect to occurrence of plastids may be found. These are (i) completely green, (ii) completely pale green or (iii) variegated. In such cases, phenotype of progeny will depend upon phenotype of branch on which flowers are pollinated
Results from three kinds of branches used as female parents are diagrammatically shown

when variegated branches are used as female source, both green and pale plastids are present in cells of female parent. Therefore, female gametes may carry either green or pale plastids or both. Consequently, three kinds of plants namely green, pale and variegated plants would be obtained.