MODOFOCATION OF ROOT, STEM & LEAF

ROOT

Radicle comes out / arise from the seed coat in the form of soft structure and move toward the soil. it develops and forms primary root.

TYPES OF ROOTS

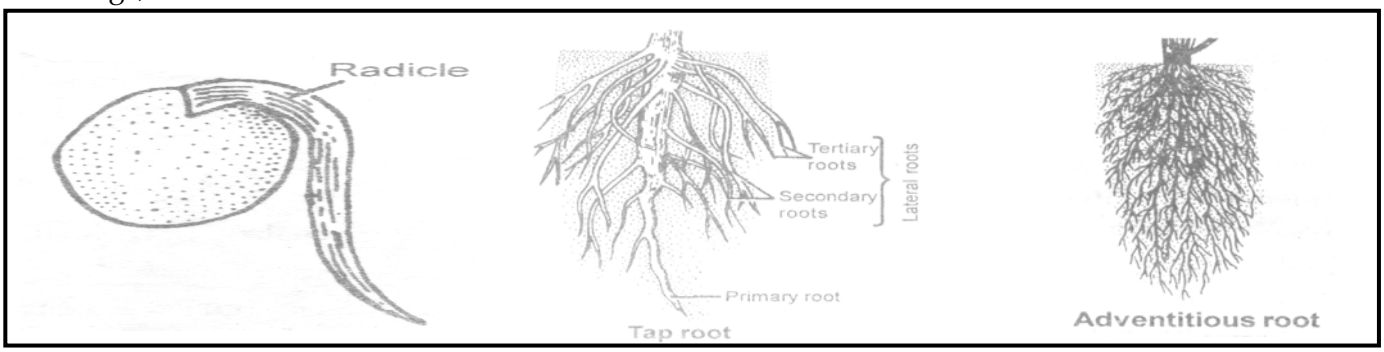
Roots are of two types:

1. Tap root
2. Adventitious root

1. Tap root:-

It develops from radicle which is made up of one main branch and other sub-branches.

2. Adventitious roots:- In some plants after sometime the growth of tap root which arises from radicle stops and then roots develops from other part of plant which are branched or unbranched, fibrous or storage, are known as adventitious roots.



MODIFIED ROOTS

Tap and adventitious roots are modified in different forms to perform special functions are called as modified roots.

1. Modified tap root for storage:

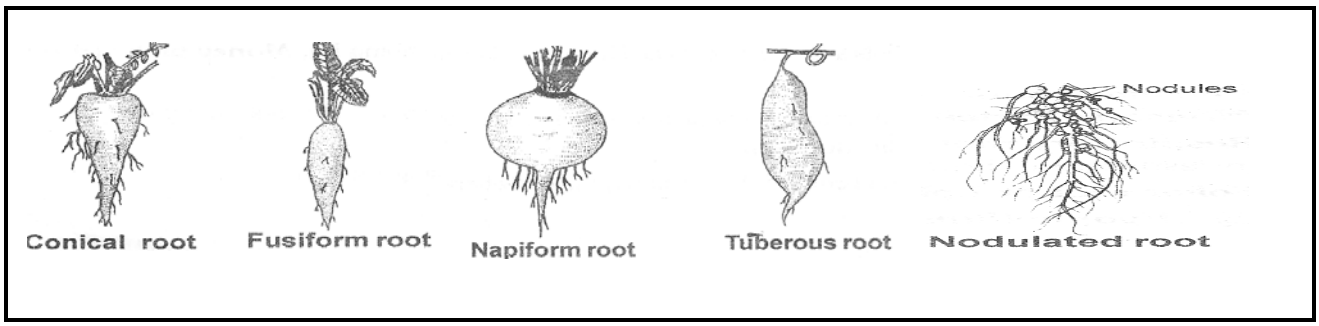
(i) **Fusiform roots –** These root are thicker in the middle and tapering on both ends. In this type of roots both hypocotyl and root help in storage of food. **Eg. :- Radish**

(ii) **Conical roots –** These roots are thicker at their upper side and tapering at basal end eg. **Carrot**

(iii) **Napiform –** These roots become swollen and spherical at upper end and tapering like a thread at their lower end. Eg. Turnip (Brassica rapa), Sugarbeet

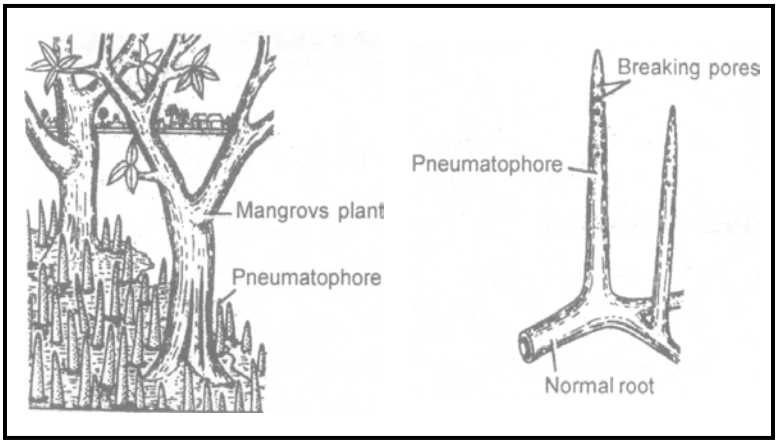
(iv) **Tuberous root –** Such roots do not have regular shape and get swollen & fleshy at any portion of roots. Eg. **Mirabilis.**

(v) **Nodulated root –** Nodules are formed on branches of roots by nitrogen fixing bacteria. (Rhizobium) . Eg. Plants of leguminosae family (Papilionatae) **– Pea**



2.Tap root modified for respiration

The plants which grow in marshy areas, scarcity of oxygen is found. the plants, which grow where in this region some branches of tap root grow vertically upward and comes on surface of soil. These roots are called pneumatophores have minute pores called pneumathodes or lenticels by which air entered in side the plant and get oxygen for respiration.
Eg. **Rhizophora, Mangrove**



Modification of adventitious roots:

(i) **Tuberous adventitious root:** When food is stored in these roots, they become swollen and form a bunch. Eg. **Sweet potato**

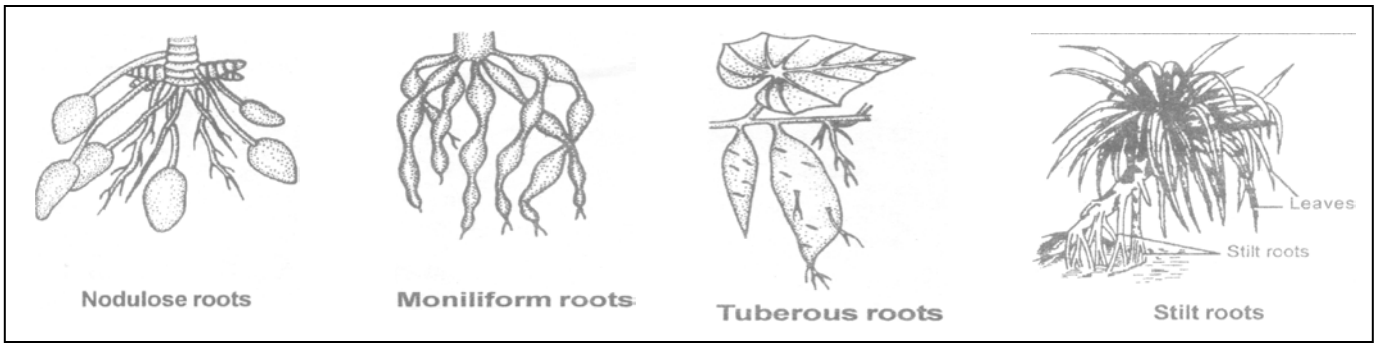
(ii) **Fasciculated roots –** These are adventitious roots occurring in clusters and all of the more Swollen. Eg **Asparagus, Dahlia**

(iii) **Fibrous –** Roots are very thin and filamentous. Eg. **Grass, Wheat**

(iv) **Nodulose –** In this type, tips of roots swell up. Eg. **Meliltus**

(v) **Beaded or moniliform –** When root swells up like a bead at different places after a regular interval. Eg. **Vitis, Momordica**

(vi) **Stilt roots or brace roots –** When root arises from lower nodes and enter in side the soil and form a rope like structure, known as stilt roots Eg. **Maize, Sugarcane, Pandanus (screwpine)**



(vii) **Prop root or pillar roots Banyan –** When root arises from branches of plant and grows downward towards soil function as supporting stem for the plant. This type of roots called prop root Eg. **Banyan**

(viii) **Butress root –** Such roots appear from the basal part of stem and spread in different directions in the soil. Eg. **Terminalia**

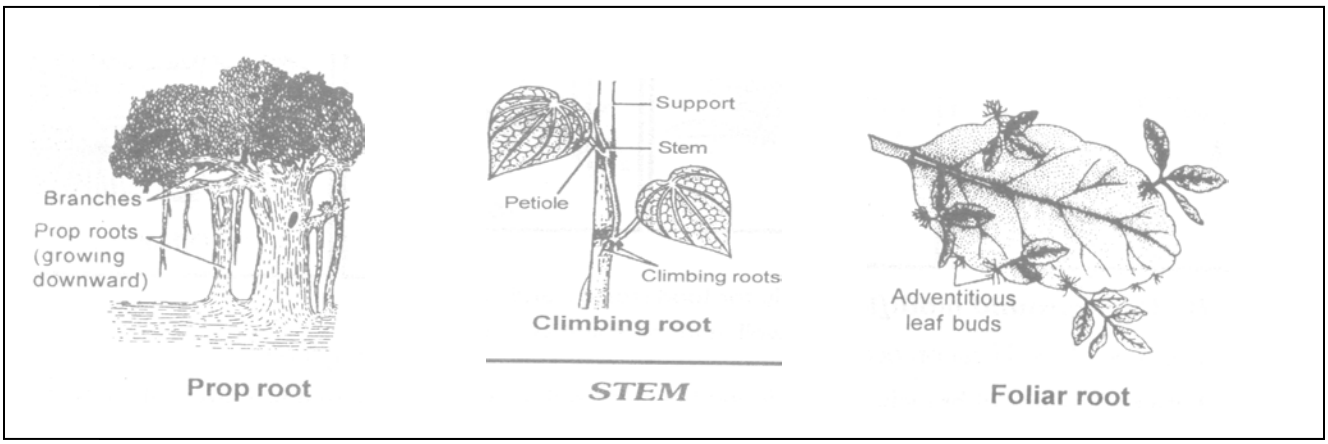
(ix) **Climbing roots –** These roots arise from nodes and helps the plant in climbing Eg. **Money plant (pothos), Monstera (Betel)**

(x) **Respiratory root –** When the quantity of oxygen is low in soil then some root comes out from the soil and helps in respiration. Eg. **Avicennia, Jussiaea**

(xi) **Foliar root or Epiphyllous root: -** When roots arise from leaf are call as foliar roots Eg. **Bryophyllum**

(xii) **Sucking or haustorial roots or Parasitic roots :-** In parasitic plants, roots enter in the stem of host plant to absorbed nutrition from host. **Eg. Dendrophthoe, Cuscuta**

(xiii) **Annulated roots:** If the swelling is in a series of ring on the roots. Eg. **Ipecac**



STEM

Stem is apart of plant which lies above from surface of soil i.e. it shows negative geotropic growth. it has nodes and internodes. Branches, leaf, flower bud and bracts are developed from nodes.

The main function of the stem is spreading out branches bearing leaves, flowers and fruits. it conducts water, minerals and photosynthates. Some stems perform the function of storage of food, support. Protection and of vegetative propagation.

Forms of stem:-

1. **Caudex:** It is unbranched, erect, cylindrical stout stem and marked with scars of fallen leaves as in palms. **Eg: -** Palm.
2. **Culm: -** Stem is jointed with solid nodes & hollow internodes. **Eg:-** Bamboo (Gramineae).
3. **Scape:-** In some monocotyledons there is no aerial stem instead there are aerial shoot (Branch) which bear flowers. **Eg:-** Onion and aroids
4. **Prostrate or procumbent: -** If the stem trails on the ground and lie prostrate. **Eg:- Evolvulus** and **oxalis**
5. **Decumbent:-** Stem trails for some distance and then tends to rise at its apex. **Eg:- Tridax, Portulaca**
6. **Diffuse:-** When the branches of the stem are spread out in all directions on the ground. **Eg:- Euphorbia, Boerhaavia**
7. **Climbers:-** Stem which attach themselves to nearby object by means of some special devices like hooks. Eg. Bougainvillea (by hook), wild pea (by tendrils)

Modification of stem:-

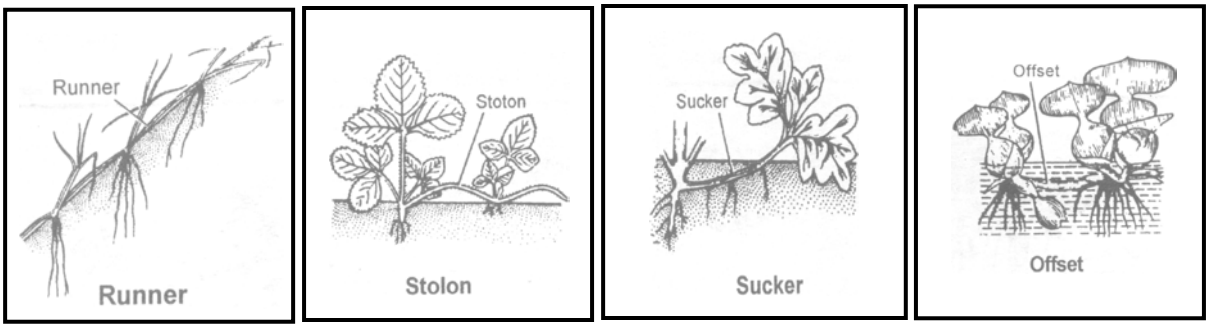
A – sub-aerial modification

(1) **Runner –** When stem grows and spread on the surface of soil. Roots are developed at lower side and leaves from upper side from node Eg. **Cynodon dactylon (Doob grass).**

(2) **Stolon –** In it branches are small and stem condensed and grow in all direction. After sometime, of growing their apical region comes out from the soil. Eg. **Fragaria (Wild strawberry), Jasmine Peppermint**

(3) **Sucker –** In it the main stem grow in the soil but branches develop from nodes above the soil. Eg. **Mint, Pineapple, Chrysanthemum.**

(4) **Offset –** Generally these are aquatic plants which have fragile stem. Eg. **Pistia, Eichhornia**



B – Underground modification

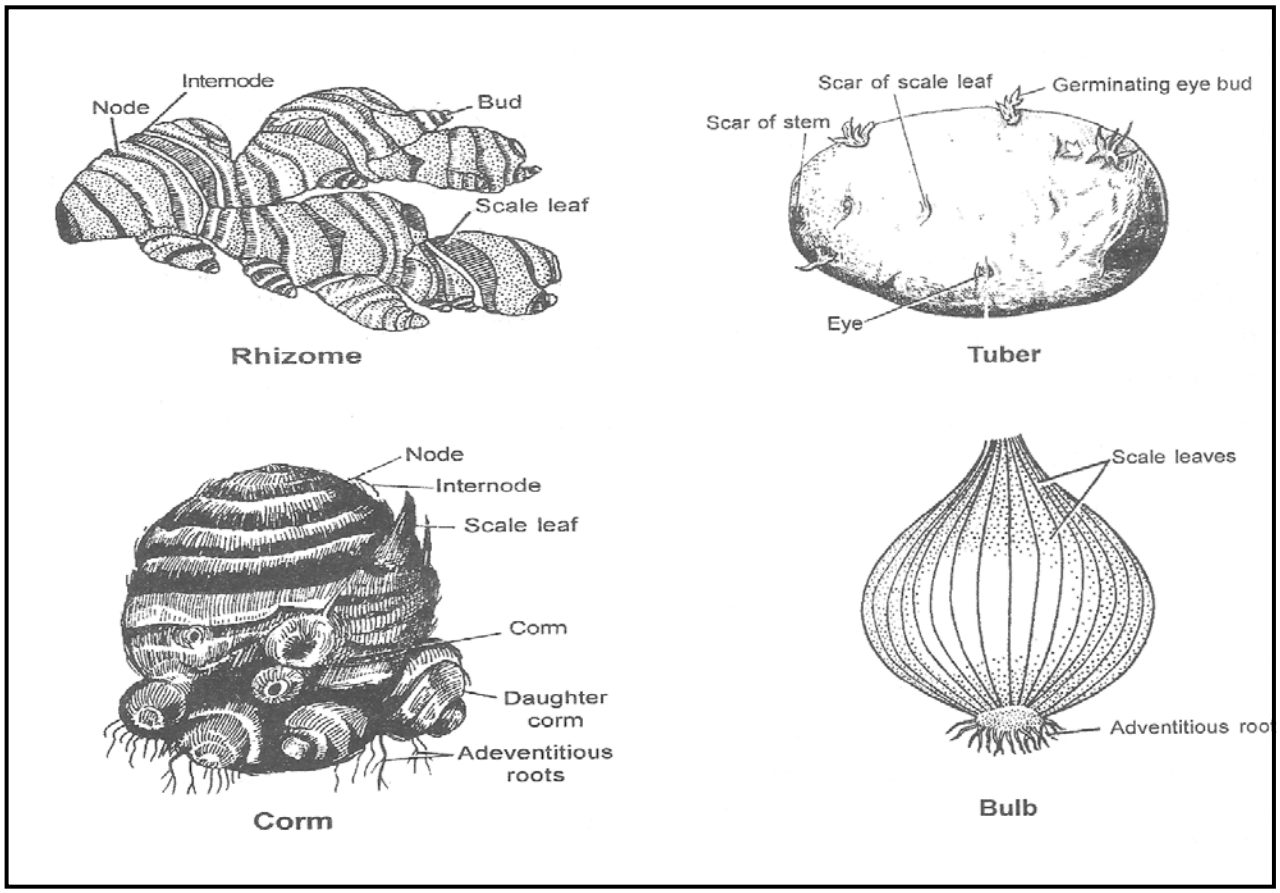
This type of modification occurs generally for food storage and vegetative propagation.

(1) **Tuber –** The tips of branches become swollen in the soil. Eyes are found on them which are axillary buds and covered with scaly leaves. Eg. **Potato**

(2) Rhizome – It is fleshy and horizontally found below in soil small nodes and internodes are found which are covered by scaly leaves. Eg. **Ginger, Turmeric**

(3) **Corm –** It is condensed structure which grow vertically under the soil surface. Eg. **Colocasia, Alocasia, Zaminkand.**

(4) **Bulb –** This stem has disc like structure and surrounds with numerous fleshy scaly leaves. Many roots arise from its base. Eg. **Onion, Garlic.**



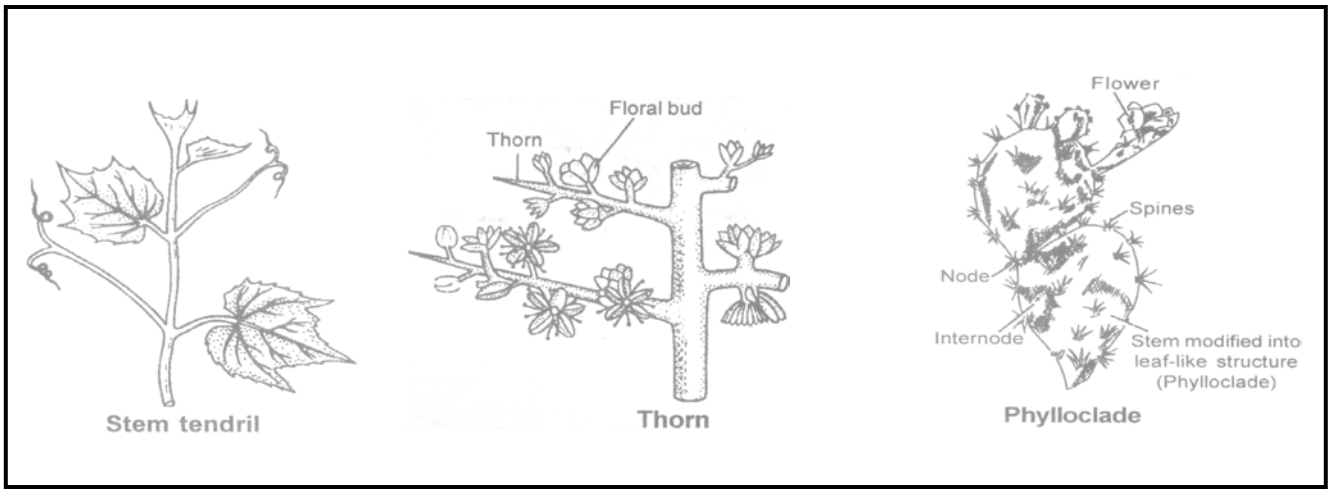
C – Aerial modification

(1) **Stem tendril –** In this type axillary tendril in place branches and helps in climbing of those plants which have weak stem. Eg. **Grapes, Passiflora, Cucumber, Pumpkins, Watermelon**

(2) **Phylloclade -** Stem is modified into a flat, fleshy and green leaf like structure and carries out photosynthesis like leaf. The leaves are modified into spines Eg. **Opuntia, Euphorbia**

(3) **Prickle and hooks -** These developed only from cortex and epidermis and found at nodes or internodes. it helps in climbing. It is exogenous in origin.
Eg. **Rose, Smilax**

(4) **Stem thorn/Thorn -** It is developed from axillary bud or terminal bud of the stem. It may bear leaves, flowers. It is endogenous in origin Eg. **Carissa** (Karonda), Bougaivillea, Pomegranate, Citrus



LEAF

The leaves develop from the nodes. Their main function is photosynthesis and food making axillary buds are found in its axil.

Leaf is divided into 3 main parts:-

(1) **Leaf base –** The part of leaf attached to stem

(2) **Petiole –** The part of leaf connecting the lamina with the branch or stem, petiolated or stalked leaves are known as petiolate and when petiole or stalk is absent then leaves are called sessile.

(3) **Lamina –** It is a broad and flattened part of leaf. Its main functions are photosynthesis and transpiration.

Stipules:-

Leaves of some plants have lateral appendages on either side of leaf base, known as stipules. If stipules are present in leaf it is called stipulated. Leaf, if it is absent then leaf is called Ex-stipulated.

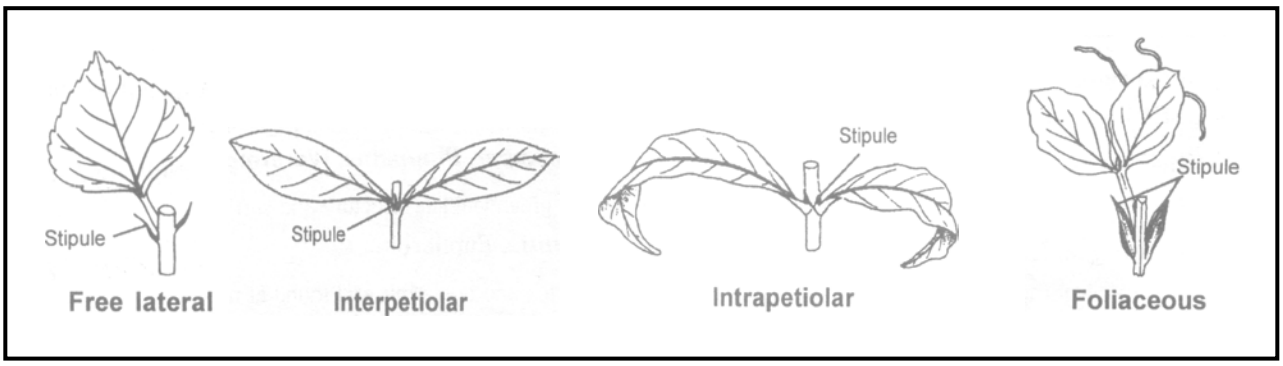
Stipules are of various types –

1. **Free lateral - They** are independently present on both sides of leaf base .Eg. **Hibiscus rosasinensis** (China rose).

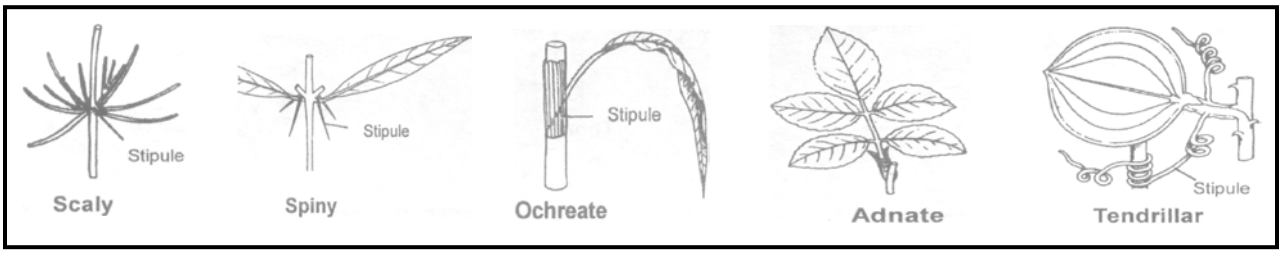
2. **Interpetioler –** When two leaves are meet oppositely at the node then nearest stipules of each leaf joint with each other. In this way only two stipules of two leaves are found in place of four Eg. **Ikora.**

3. **Intrapetioler -** In this type both stipules of a single leaf join with each other to form a single stipule. **Eg: - Gardenia**

4. **Foliaceous –** These type of stipules form a leaf like structure. **Eg. :-** Pea

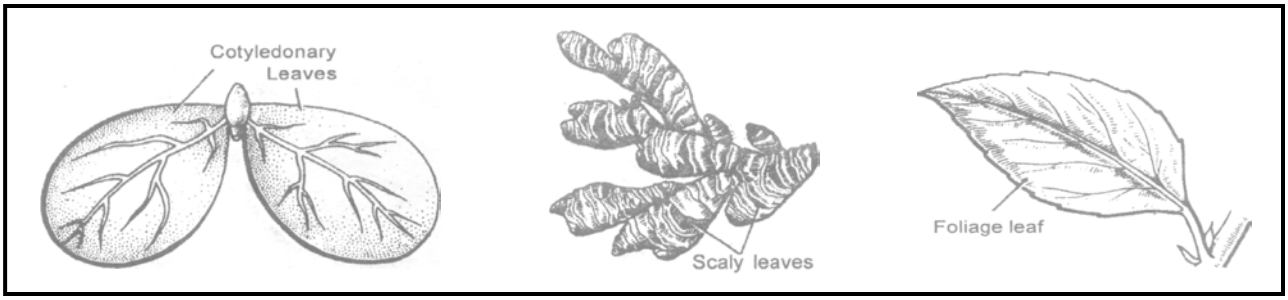


5. **Scaly -** Stipules are dry, small and paper like. **Eg :- Desmodium**
6. **Spiny –** Stipules modified into spiny. Eg. **Zizyphus** (Ber)
7. **Ochreate –** When both stipules of leaf combine together and form a tube like structure, it is called Ochreate. Eg. **Polygonum**
8. **Adnate –** Both stipules are joint with petiole. Eg. Rose.
9. **Tendrillar -** Stipules are modified into tendrils like structure. Eg. **Smilax**



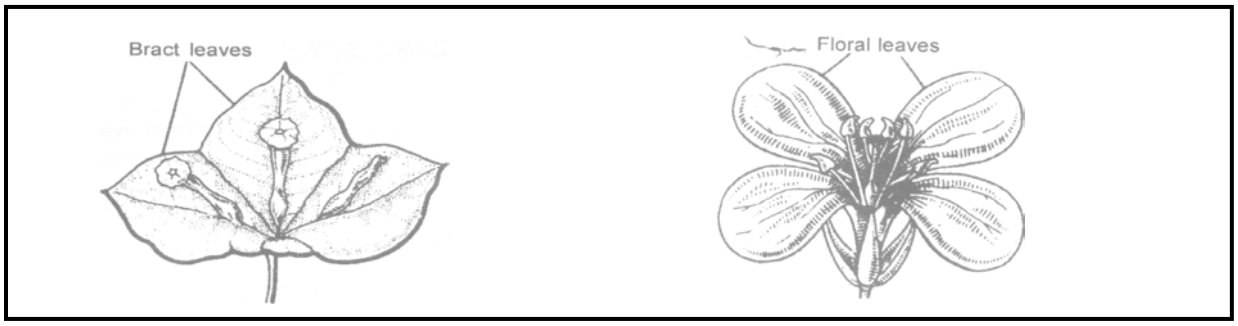
Types of Leaves –

1. **Foliage leaf –** They are usually green Coloured and their main function is photosynthesis.
2. **Cotyledonary leaf –** This leaf comes out during germination and helps in nutrition until the leaf is not formed.
3. **Scale leaf –** Such leaves are usually dry membrane like and they can not perform photosynthesis.



4. **Bract –** Bract are the leaves which contain flower in their axil.
5. **Bracteole –** These are leaf like structure found on pedicel.
6. **Floral leaf –** Sepals, petals, stamen and carpel are found in flower which are included in this type of leaf.

   Note: Perianth: In some flowers, Calyx and Corolla are not distinct and are termed as Perianth, and unit of perianth is called tepal. Eg. **Lily**



Duration of Leaf:

1. **Persistent/Evergreen –** Leaves of such plants are found in all season and do not (fall) shed combindly. Eg. Pine, Saraca indica, Datepalm.
2. **Deciduous –** All leaves of such plants shed at the same time Eg. **Azadirachta, Ficus**
3. **Caducous –** Leaves are shed as the bud formation takes place. **Eg :-** Rose

NOTE:

1. **Cauline leaves –** When the leaves are found on node of stem, then these are called cauline leaves.
2. **Ramal leaves –** When leaves are found on branches, then these are called ramal leaves.
3. **Radical leaves –** During favourable season, leaves develop from the nodes of under ground stem and seem that they are developing from roots. This type of leaves are known as radical leaves.

VENATION OF LAMINA

The arrangement of veins and veinlets in leaves (Lamina) is known as venation. It is of 2 – types

(1) Reticulate. It is found in dicots. Exception – **Calophyllum** (It has parallel venation)

(2) Parallel. It is found in monocots. Exception – **Smilax (**It has reticulate venation)

1. **Reticulate venation –** In it many veins divided into various branches (veinlets) and form a net like structure.

Reticulate venation is of 2 – types –

(a) **Unicostate or pinnate –** In this type of venation having only one principal vein or midrib that give off many lateral veins which proceed toward margin and apex of lamina of the leaf and form a network.

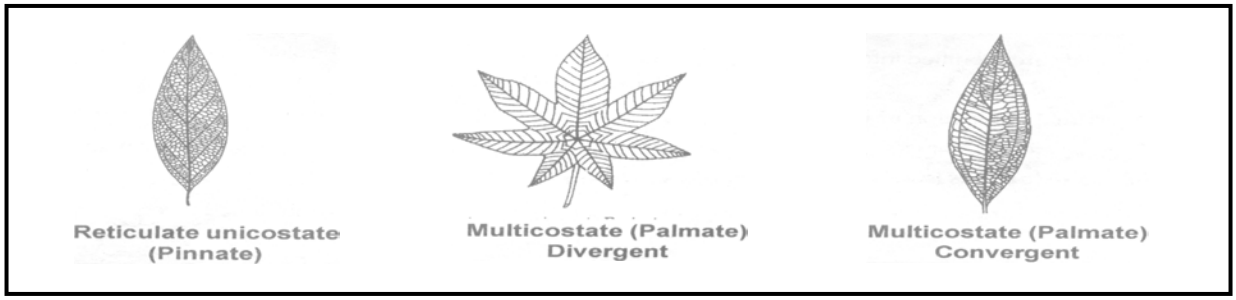
Eg. :- Mango, Guava, Peepal.

(b) **Multicostate or palmate –** In this type of venati0on many principal veins arising from the tip of petiole and proceed upward this is again two types -

(i) **Multicostate divergent –** Many principal veins arising from the tip of petiole diverge from the toward the margin of leaf blade eg. Cotton, Castor, Cucurbita.

(ii) **Multicostate convergent –** Many principal veins arising from the tip of petiole. At the base of leaf they are closely arranged but diverge from are another in middle part and converge towards the apex of leaf.

Eg. :- Camphor, Zizyphus, Tejpat, Chinarose, plum.



2. **Parallel venation -** In this type of venation, all veins run parallel to each other and they do not form network,

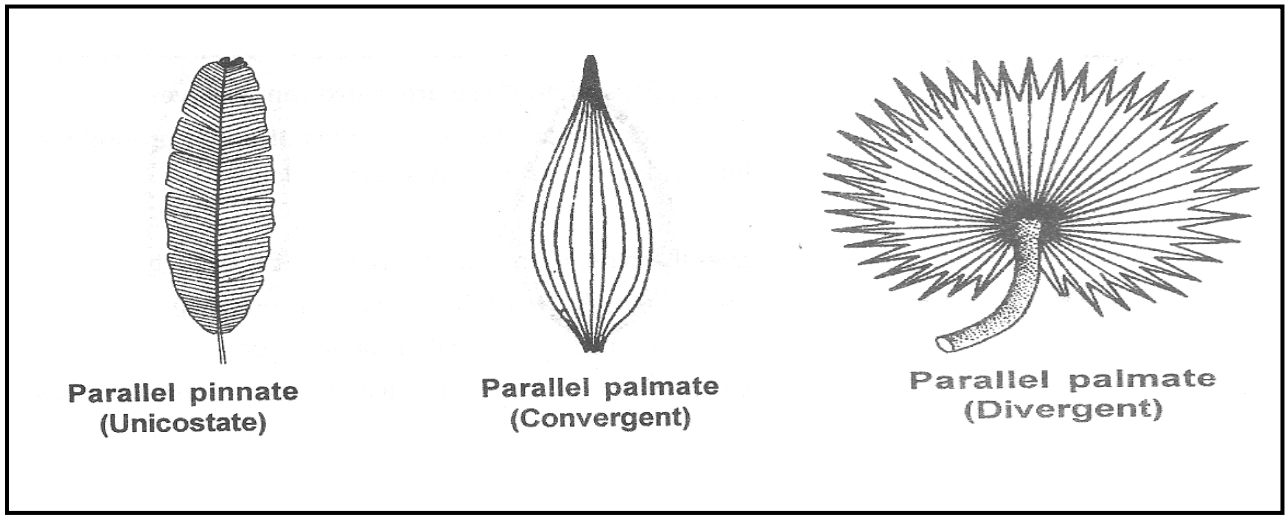
They are of 2 types –

(1) **Unicostate or pinnate :** This type of pattern having only one principal vein, that gives off many lateral veins, which proceed toward the margin of leaf blade in a parallel in manner but they donot have veinlets. Eg. Banana, Ginger, Canna

(2) **Multicostate or palmate:** Having many principal veins arising from the tip of the petiole and proceeding upwards.

(a) **Multicostate convergent :** Many principal veins arising from the tip of petiole and diverge toward the margin of leaf. They donot divide into veinlets and do not form network.
Eg. : - Coconut, Date palm.

(b) **Multicostate convergent:** Many principal veins arising from the tip of petiole run in a curved manner in lamina and converge towards the apex of leaf blades.
Eg: - Wheat, grass, sugar-cane, Bamboo



Modification of leaves – When leaf is modified in different structure. It is called modification of leaves.

(1) **Leaf tendril –** In it, whole leaf is modified in to a wire like structure which is called leaf tendril Eg. **Lathyrus aphaca** (wild pea)

(2) **Leaf spine -** Leaves or any part of leaflet are modified into pointed spine. Eg. Opuntia, Eg. Opuntia, **Aloe, Argemone.**

(3) **Leaf scale –** In it leaves become thin, dry and form a membrane or paper like structure and serve to protect axillary buds as in **Ficus** and **Tamarix, Ruscus** or store food and water as in onion.

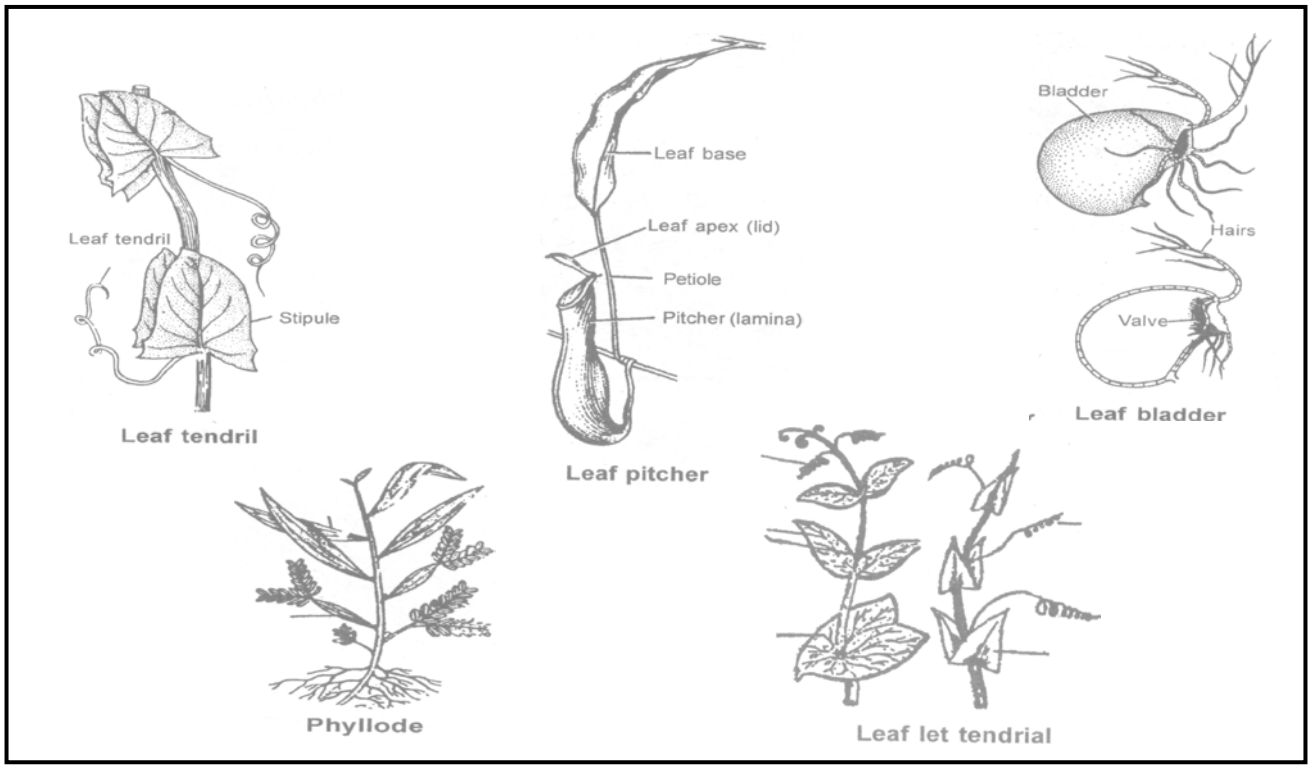
(4) **Leaf pitcher –** Leaves of some plants are modified to pitcher shape. Eg. Nepenthes, Dischidia

(5) **Leaf bladder –** In some plant, leaves are modified into bladder like structure eg. Utricularia

(6) **Leaf Hooks –** In some plants terminal leaf lets are modified into curved hooks for helping the plant in climbing. Eg. **Argemone, Opuntia, Alone.**

(7) **Phyllode –** In it petiole becomes flat structure and function as normal as normal leaf. Eg. **Australian acacia**

(8) **Leaflet tendril –** When leafleat is modified into tendril like structure than it is called leaflet tendril. Eg. :- **Pisum sativum** (Garden Pea), **Lathyrus odoratus** (sweet pea).
Note : Dionaea (Venus flytrap) is insectivorous plant and they also have modified leaves.



Simple and Compound Leaf

(1) **Simple Leaf:** A leaf which may be incised to any depth, but not down to the midrib or petiole then this type of leaf called simple leaf.

(2) **Compound leaf:** A leaf in which the leaf blade is incised up to the midrib or petiole, thus dividing it into several small parts, known as leaf lets.

It has two types:-

(A) **Pinnately compound leaf:** In this type of leaf mid rib is known as rachis. Leaf are arranged on both sides of rachis. Eg. Neem

It is of two types

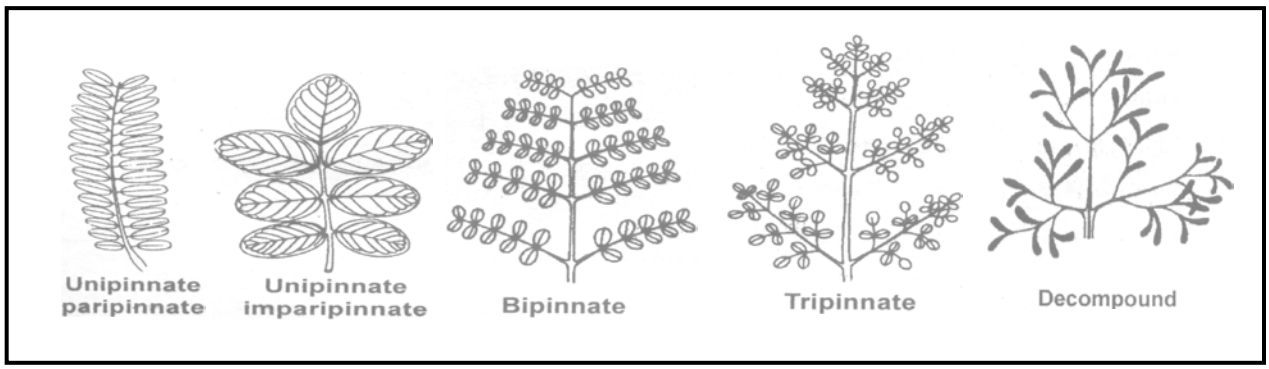
(i) **Unipinnate:** In this type of leaf divison occurs only once and leaf lets are directly attached on both sides of rachis. If the number of leaflet is even leaf is known as paripinnate. Eg. : Cassia fistula, Sesbania

If the number of leaflet is odd, it is known as imparipinnate. Eg. :- Rose, Neem

(ii) **Bipinnte:** A twice pinnate compound leaf. **Eg. :- Acacia,** Gulmohar, **Mimosa**

(iii) **Tripinnate:** A thrice pinnate compound leaf. Eg. **Moringa**

(iv) **Decompound:** A compound leaf, which is more than thrice pinnate. **Eg: -** Carrot, Coriander



(B) **Palmate compounds:** In this type incision of leaf are directed from leaf margin to apex of petiole and all leaflets are attached on the upper end of petiole. **Eg.** Silkcotton.

It is of following types :

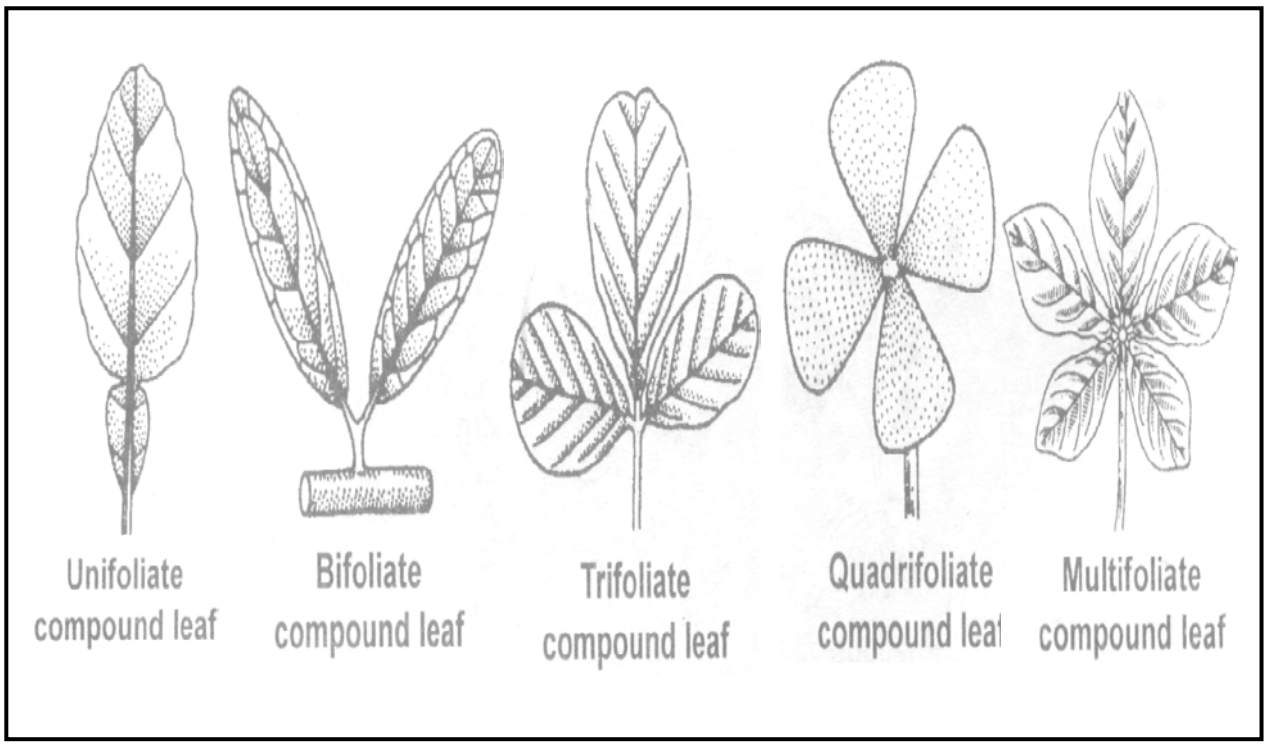
(i) **Unifoliate:** When single leaf let is found. **Eg. :-** Lemon

(ii) **Bifoliate:** When two leaf lets are present. **Eg. :- Bauhinia, Regnelidium**

(iii) Trifoliate: When three leaf lets are attached. **Eg. :- Oxalis, Aegle.**

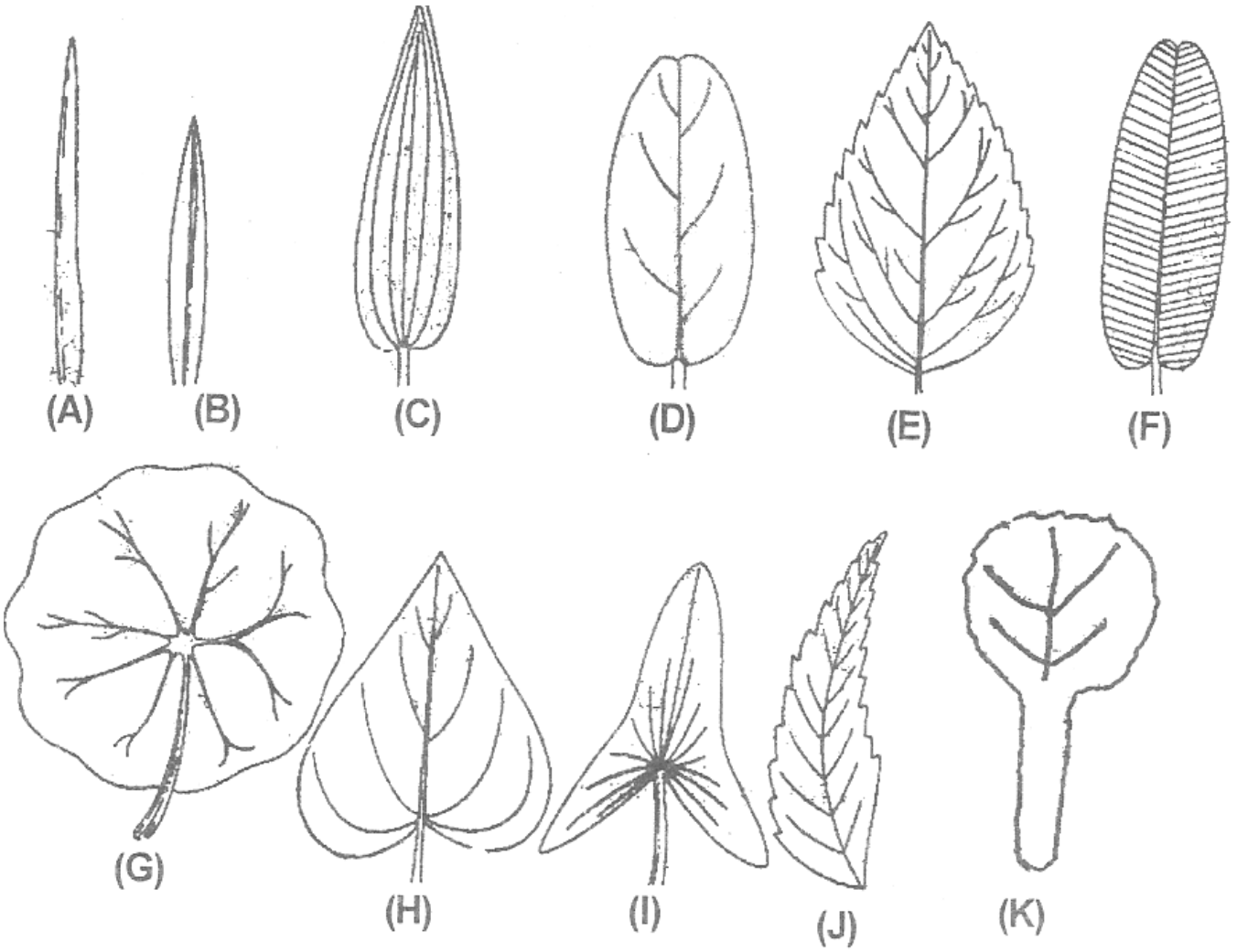
(iv) Tetrafoliate: When four leaf lets are attached to the petiole. **Eg. :- Marsilea**

(v) **Multifoliate:** When more than four leaflet are found, then leaf is called multifoliate palmate compound leaf. Eg. Silkcotton.



Shape of lamina:

1. **Acicular: -** Lamina is long and pointed. Like a needle. Eg. **Pine.**
2. **Lanceolate: -** In this type lamina is pointed or narrower at the ends while broader in the middle. Eg. **Bamboo, Nerium**
3. **Linear: -** The lamina is long and narrow having parallel margins. Eg. **Grass**
4. **Ovate: -** In this type lamina is egg-shaped having broad base with slight narrow top. **Eg. Ocimum, Banyan, China rose**
5. **Cordate: -** Its shape is like a heart. Eg. **Betel.**
6. **Oblong: -** Long and broad lamina. Eg. **Banana.**
7. **Sagittate: -** The lamina is triangular in shape. Eg. **Sagittaria.**
8. **Spathulate: -** Thelamina is broad spoon shaped. Eg. **Calendula.**
9. **Orbicular or Rotund: -** In this type the lamina is spherical. Eg. **Lotus.**
10. **Elliptical or Oval:** In this type the middle part of lamina is broad while the ends are narrow and oval. Eg. **Guava, Jamun**
11. **Oblique: -** In this type midrib divides, lamina into two unequal halves. Eg. **Begonia, Neem.**



Shapes of lamina :

(A) Acicular, (B) Linear, (C) Lanceolate,
(D) Elliptical, (E) Ovate, (F) Oblong, (G) Rotund,
(H) Cordate, (I) Sagittate, (J) Oblique (K) Spathulate