LEAF

- The leaf is a lateral, generally flattened structure borne on the stem.
- It develops at the node and bears a bud in its axil.
- The **axillary bud** later develops into a branch.
- Leaves originate from shoot apical meristems and are arranged in an acropetal order.
- Their major functions are **photosynthesis and transpiration**.
  - **Green leaves** of the plants are called **foliage leaves**.
  - **Nongreen** are called **scale leaves or cataphylls.**
  - The leaves containing spores or sporangia are called **sporophylls.**
  - **Floral appendages** like sepals, petals, stamens, carpels are called **floral leaves**.
  - Leaves borne by embryo in the seed are called **Cotyledons**.

Insertion of Leaf:

Three type of leaves are as follows –

(i) Cauline: In this type, leaves borne on the main stem **e.g. Maize**.

(ii) Ramal: Leaves originate on branches **e.g. *Zizyphus***.

(iii) Radical: In reduced stem, leaves originate at the ground level from it. **e.g. Radish**.

Part of a leaf (Phyllopodium):

A leaf is made up of three parts -

(1) Leaf blade or lamina **(2) Petiole** **(3) Leaf base**

(1) Leaf blade or lamina (Epipodium):

- It is thin, expanded, green and terminal part of the leaf which is specialized to perform photosynthesis.
- Lamina bears network of Veins and Veinlets.
- Veins provide rigidity to the leaf base and act as channels of transport for water, minerals and food materials.

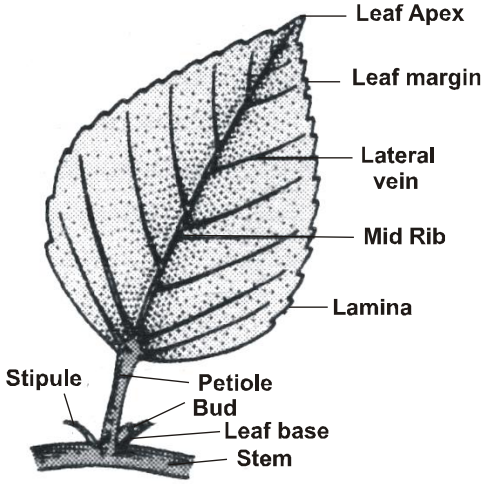


Fig:- Structure of a typical leaf.

(2) Petiole (Mesopodium):

- ❖ It is a cylindrical part, which bears the Lamina at its tip.
- ❖ If the petiole is absent it is termed sessile if leaf having petiole it is called petiolate.
- ❖ Long thin flexible petiole allow leaf blades to flutter in wind there by cooling the leaf and bringing fresh air to leaf surface.

(3) Leaf base (Hypopodium):

- ❖ It is the lowest part of leaf by which the leaf is joined to the node of the stem bear two lateral leaves like stipules.
- ❖ In many legumes it is swollen.
- ❖ The swollen leaf base is called **pulvinus. e.g. *Mimosa pudica* (Leguminous plants).**

  In monocotyledons the leaf base spread as sheath like grasses.

Sheathing leaf base is of two types.

(i) Amplexicaul: Stem is completly surrounded by leaf base **e.g. Grass, wheat.**

(ii) Semiamplexicaul: Stem is partialy enclosed by leaf base. **e.g. Buttercup.**

Stipule:

- ❖ Leaf base contains two small lateral outgrowths called stipule.
- ❖ **Leaf with stipules is known as stipulate (eg. Fabaceae) while the leaf without stipules is termed as exstipulate (eg. Solanaceae, Liliaceae).**

Phyllotaxy:

It is the arrangement of leaves on stem and its branches. It is of following types

(i) Alternate or spiral:

- ❖ Only one leaf is borne on a node and the leaves of the adjacent nodes roughly lie towards the opposite sides and form two alternate rows (distichous) or three (tristichous) or more (orthostichous) vertical rows of leaves. **e.g. China rose, mustard, sunflower.**

(ii) Opposite:

- ❖ Two leaves are borne on the opposite sides of a single node. It is of two types.
  - **(a) Decussate:** The leaf pair formed at successive nodes is at right angles to the first one. **e.g. *Calotropis*.**
  - **(b) Superposed:** Leaves of the successive nodes lie in the same plane so that only two rows are formed on the stem. **e.g. Guava.**

(A)	(b)	(c)

Fig.: Different types of phyllotaxy : (a) Alternate (b) Opposite (c) Whorled

(iii) Whorled: If more than two leaves develop from a single node. **e.g. Oleander (*Nerium*), *Alstonia*.**

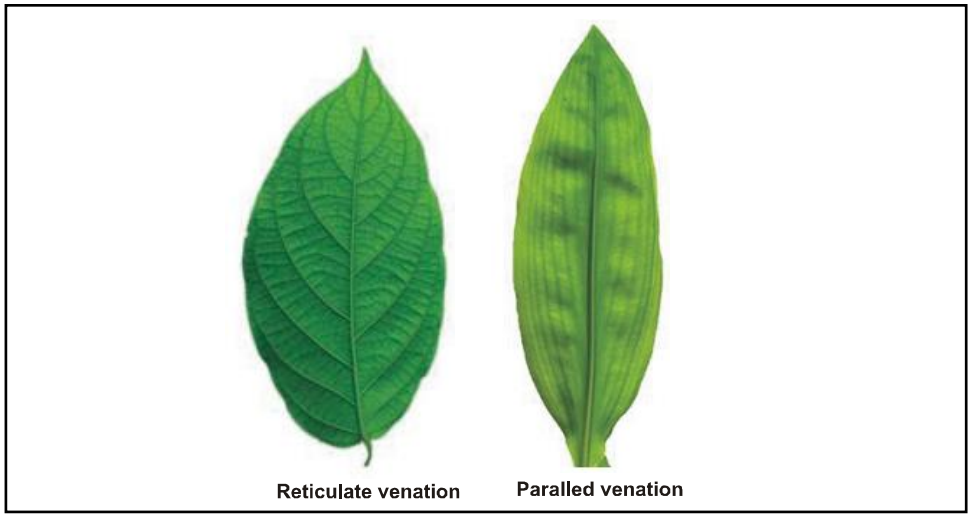
Venation:

The arrangement of veins and veinlets **in** the lamina of a leaf is called venation. It is of two types:

(i) Reticulate (ii) Parallel

(i) Reticulate: The veinlets are irregularly distributed in lamina and form a network. **e.g. Dicot plants.**

(ii) Parallel : The veins run parallel to one another and reticulations are absent. **e.g. Monocot plants.**



Note:

- **Reticulate venation is exceptionally found in the leaves of some monocot plants e.g. *Smilax, Allocasia, Dioscorea*.**
- **Some Dicot plants bear parallel venation in leaves e.g. *Calophyllum, Corymbium, Eryngium*.**

Types of leaf:

(I) Simple leaf:

❖ Leaf which may be entire or incised but the incision do not touch the mid rib. **e.g. Banyan, Mango.**

(II) Compound leaf:

❖ Leaf blade is incised upto mid rib or petiole thus dividing it into two or more leaflets. **e.g. Pea.**

❖ A bud is present in the axil of petiole but not in the axils of leaflets of compound leaves.

Differences between Simple leaf and Compound Leaf		
S.N.	**Simple leaf**	**Compound leaf**
1	The lamina does not differentiate into leaflets.	The lamina differentiates into two or more leaflets.
2	The base of the leaf may have stipule.	The stipules may occur at the base of the whole leaf.
3	It may be borne in one or more planes.	Leaflets of compound leaf are always borne in one plane.
4	Simple leaves are produced on the stem in an acropetal succession.	Leaflets of a compound leaf develop almost simultaneously.
5	A bud lies in its axil.	A bud lies in the axil of the whole leaf but the individual leaflets do not bear axillary buds.

They are of two types

(1) Pinnately compound leaf **(2) Palmately Compound leaf**

(1) Pinnately compound leaf: The leaflets are borne laterally on an elongated axis called rachis which represents the midrib of the leaf **E.g. Neem.**

(2) Palmately compound leaf:

❖ In which the petiole bears leaflets at the tip (attached at a common point) like the finger of palm. **E.g. *Cleome gynandra*, Silk cotton.**

Fig. palmately compound leaf

Fig. pinnately compound leaf

Differences between Pinnately compound leaf and Palmately compound Leaf		
S.No.	**Pinnately compound leaf**	**Palmately compound leaf**
1	Leaflets occur in two rows.	All leaflets are clustered together.
2	Leaflets are borne on an elongated axis.	Leaflets are attached to a common point.
3	A joint is not present between the leaflet and its axis.	A joint is usually found between the leaflet and its point of attachment.
4	It show feather like outline.	It possess palm like appearance.
5	Leaflets bearing axis is a continuation of petiole or a branch of midrib.	Leaflet bearing point represents the tip of petiole.

Modifications of leaves:

(1) Leaf tendrils: These are thread like sensitive structures, which can coil around a support to help the plant in climbing.

Leaf tendril is of following types.

(a) Whole leaf tendrils - e.g. *Lathyrus aphaca* (Wild pea).

(b) Leaflet tendrils - Upper leaflets are modified into tendrils. **e.g. *Pisum sativum* (Garden pea), *Lathyrus odoratus* (Sweet pea)**.

(c) Leaftip tendrils - e.g. *Gloriosa superba* (Glory lily).

(d) Petiolar tendrils - e.g. *Nepenthes*, Garden nasturtium, *Clematis*.

(e) Stipular tendrils - e.g. *Smilax*.

(2) Leaflet hook :

- In ***Bignonia unguiscati*** **(Cat's nail)** the terminal leaflets of the compound leaves become transformed into three stiff claw like and curved hooks.
- The latter cling to the bark of the supporting tree very firmly and allow the plant to climb up.

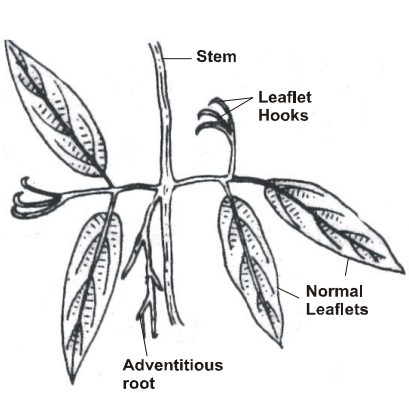


Fig :- Bignonia unguiscati : Leaflet hooks

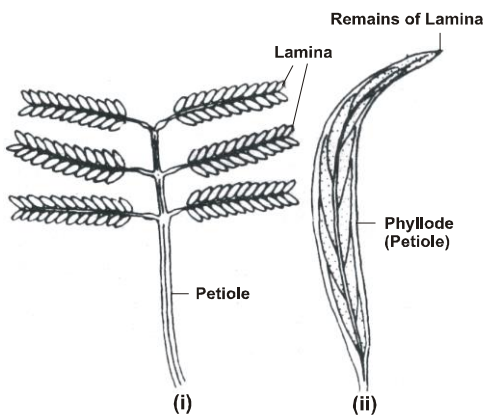


Fig:- Acacia melanoxylon.(i) Normal leaf
(ii) Phyllode

(3) Phyllode: It is a flattened, green petiole, which performs the function of food synthesis instead of lamina because the latter is absent. **e.g. Australian Acacia, *Parkinsonia*.**

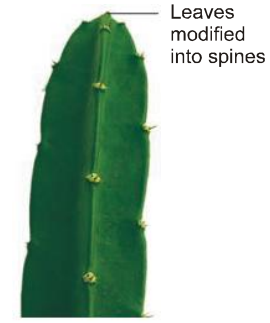
(4) Leaf spines: The leaf parts become changed into spines in order to protect the plant from grazing animals and excessive transpiration. **e.g. *Aloe vera*, *Solanum xanthocarpum*, *Opuntia, Asparagus*.**

(5) Leaf bladders: Some parts of leaf are modified into sac like bladder, which is useful for trapping and digesting animals. **e.g. *Utricularia* (Insectivorous plant).**

(6) Leaf pitcher: The lamina is modified to form a large pitcher, which is useful for catching and digesting insects. **e.g. *Nepenthes*.**

Note:

- Leaves of insectivorous plant such as pitcher plant, Venus fly trap (*Dionaea*), *Utricularia* are also modified leaves to trap the insects.



Protection spines

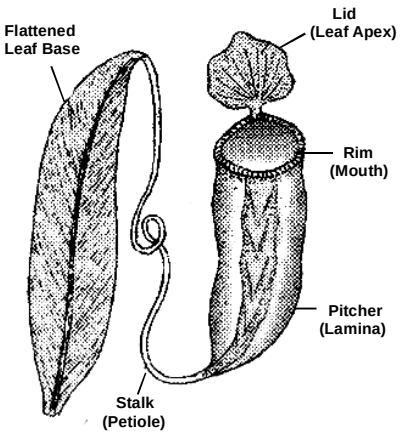
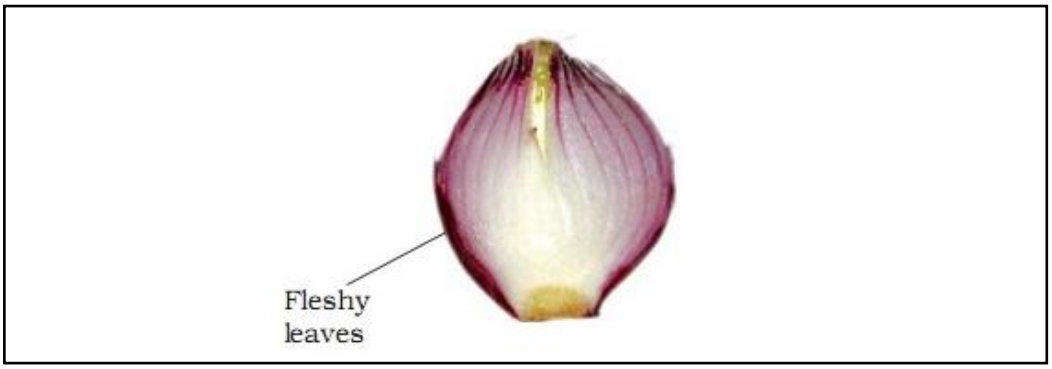


Fig :- Leaf Pitchers : *Nepenthes*

(7) Fleshy leaves: Found in Onion, and garlic.



Resonate the Concept

1. **More modification of leaf**
   - **(a) Succulent leaves:** Leaves are fleshy and swollen. They store water or mucilage or food substances.
     e.g. Xerophytic plants like *Bryophyllum, Aloe vera, Portulaca*.
   - **(b) Scaly leaves:** These are small, dry whitish or brownish membranous leaves, which do not take part in photosynthesis. **e.g. *Casuarina, Ruscus*.**
   - **(c) Coloured leaves:** In ***Euphorbia pulcherima***, the leaves borne near the Cyathium are brightly coloured to attract insects for pollination.
2. **Heterophylly - when more than one type of leaves are present in a plant then, it is called Heterophylly. e.g. *Ranunculus aquatilis, Limnophilla heterophylla, Sagittaria*.**
3. **In *Bryophyllum* and *Bignonia*, buds develop on leaves, which are helpful in vegetative propagation.**
4. ***Victoria regia* bears broadest leaves & *Raphia vinifera* bears longest leaf.**
5. **Furcate venation: Veins are dichotomously branched but they do not form reticulum. e.g. *Adiantum* (fern).**
6. **In *Salvinia*, leaf of each node is modified into roots, which act as balance organ for swimming of plant.**

7. **In *Dischidia*, leaf is modified in to pitcher. The latter collect the rain water.**
8. **Ptyxis : Folding of lamina in bud condition is called ptyxis e.g. Fern's circinate ptyxis.**
9. **Vernation : Arrangement of leaves in bud condition is called vernation**
10. **Types of Stipules:**
    a. **Free lateral:** Two small stipules which develop on both side of leaf base. **e.g. China rose.**
    b. **Adnate: Stipules fused with petiole e.g. Rose.**
    c. **Interpetiolar:** Adjacent stipules of opposite leaves are fused to appear in between the petioles. **e.g. *Ixora, Anthocephalous*.**
    d. **Intrapetiolar:** These are situated between petiole and axis. **e.g. *Tabernaemontana, Garadenia***
    e. **Scaly:** Very small dry membranous two stipules which are situated at both side of leaf base. **e.g. *Spergulla*.**
    f. **Foliaceous:** Two large green leaf like structures. **e.g. *Lathyrus odoratus*.**
    g. **Tendrilar: Stipules are modified into tendrils. e.g. *Smilax***

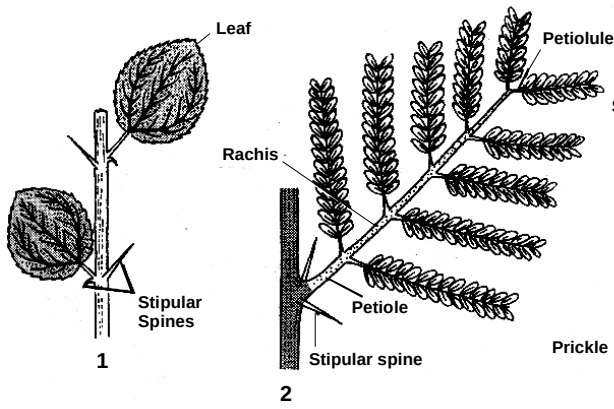


Fig:- Stipular spines :1– *Zizyphus*. 2 – *Acacia*.

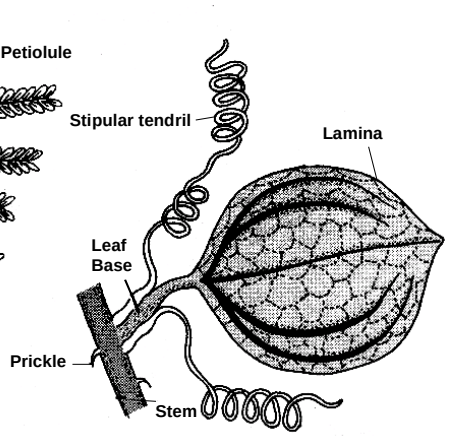


Fig:- Stipular tendrils – *Smilax*.

    h. **Spinous: Stipules are converted into spines. e.g. *Zizyphus, Acacia*.**
    i. **Ochreate:** Stipules fuse to form a sheath around the stem. **e.g. *Polygonum*.**
    j. **Convoluted:** They are located towards axial side of petiole. **e.g. *Ficus, Magnolia*.**

11. **Reticulate venation is of two types.**
    a. **Unicostate:** The lamina contains single midrib**. e.g. Peepal (*Ficus religiosa*).**
    b. **Multicostate:** A number of veins arise from the tip of petiole and reach either the apex or margins of lamina. It is of two forms
        (i) **Convergent:** The principal veins converge towards the apex of the lamina. **e.g. *Zizyphus*, Tajpat.**
        (ii) **Divergent:** The principal veins diverge towards the margins. **e.g. *Lagenaria,* Pumpkin, *Luffa*.**

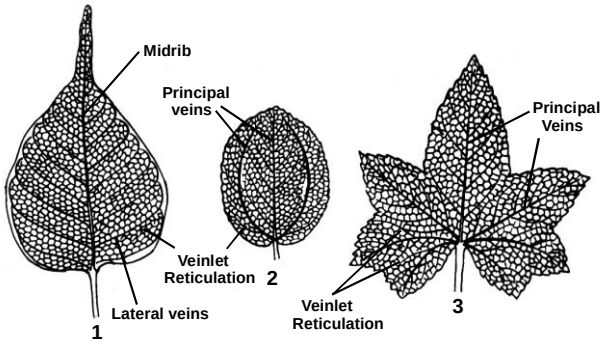


Fig:- Reticulate venation :
1 – Unicostate Reticulate -Peepal
2– multicostate convergent - *Zizyphus* (ber)
3– multicostate divergent - *Luffa*.

12. Parallel venation is of two types

a. Unicostate: Single principal vein or mid rib that runs from base to the apex of the lamina. The lateral veins run parallel to one another without forming network. **e.g. Banana (*Musa paradisiaca*)**.

b. Multicostate: Several principal veins arise from the base of the lamina. It is of two types

(i) Convergent: The principal veins converge towards the apex **e.g. Bamboo, Grass.**

(ii) Divergent: The principal veins proceed towards the margins. **e.g. *Livistonia* (Fan palm).**

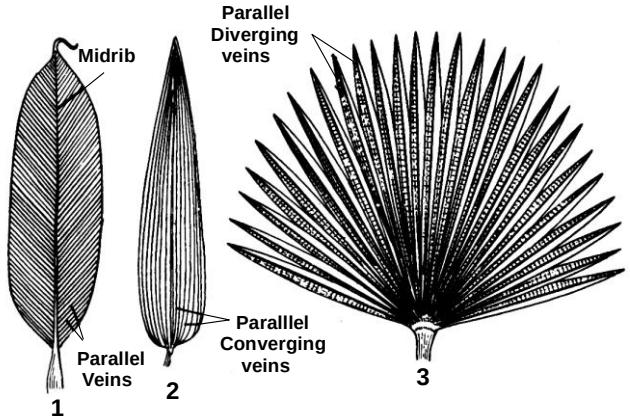


Fig:- Types of parallel venation.
1 – Unicostate parallel of Banana
2 – Multicostate convergent of Bamboo
3 – Multicostate divergent of Fan Palm (*Livistonia*).

13. Pinnately compound leaf is of following types.

(a) Unipinnate: Leaflets are directly attached on the both side of midrib.

They are of two types

(i) Paripinnate: The number of leaflets are even **e.g. *Cassia*.**

(ii) Imparipinnate: In which odd number of leaflets present **e.g. Rose, Neem.**

(b) Bipinnate: Here the pinnate leaf is divided twice pinnately **e.g. *Mimosa pudica, Acacia*.**

(c) Tripinnate: The leaf is thrice pinnate. The leaflets or pinnacles are borne on tertiary axis. **e.g. *Moringa*.**

(d) Decompound: Leaf is more than thrice pinnate **e.g. Coriander, Carrot and Fennel.**

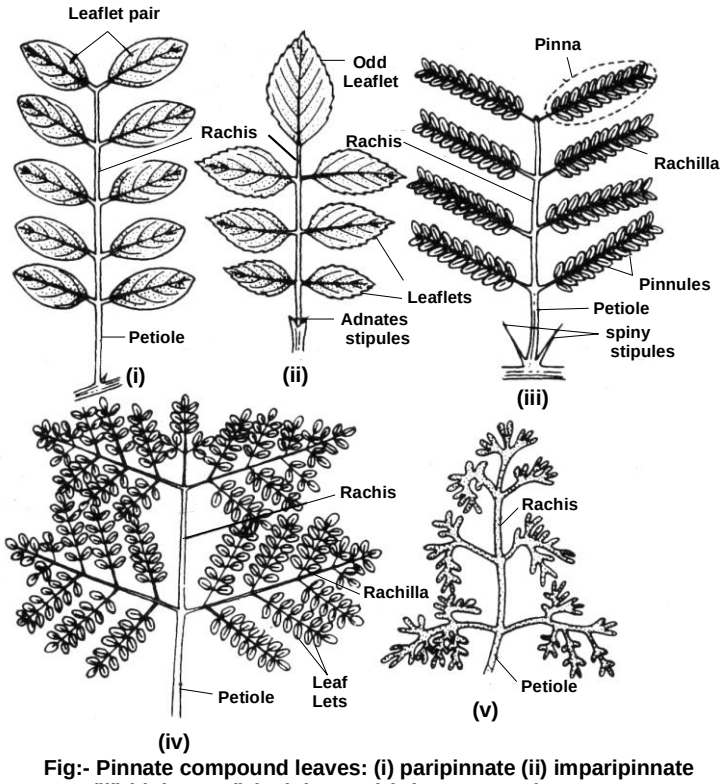


Fig:- Pinnate compound leaves: (i) paripinnate (ii) imparipinnate (iii) bipinnate (iv) tripinnate (v) decompound.

14. Palmately compound leaf is of following types

a. Unifoliolate: They have only one leaflet attached to the petiole tip. **E.g. *Citrus*.**

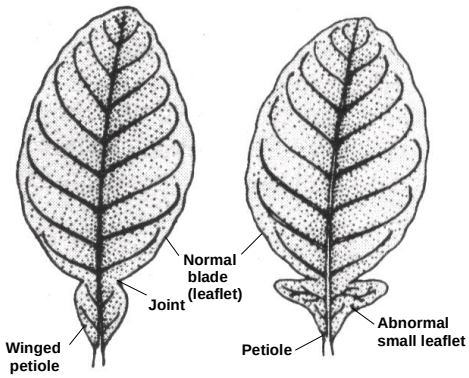


Fig :- Unifoliolate compound leaves – *Citrus.*

b. Bifoliolate: It has two leaflets attached to the tip of petiole. **E.g. *Princepia, Balanites*.**

c. Trifoliolate: Three leaflets present at the tip of petiole. **E.g. *Medicago sativa, Trifolium, Oxalis*.**

d. Quadrifoliolate: Four leaflets are attached to the petiole tip. **E.g. *Marsilea*.**

e. Multifoliolate or Digitate: Five or more leaflets present at the tip of petiole. **E.g. *Cleome, Bombax* (Silk cotton).**

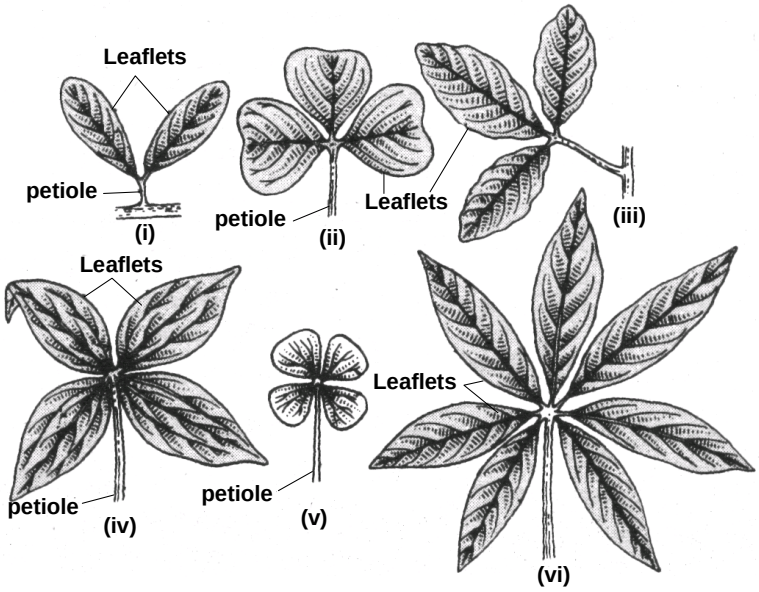


Fig:- Palmate compound Leaves : (i) Bifoliolate – *Balanites*
(ii) Trifoliolate – *Oxalis*, (iii) Trifoliolate – *Aegle* (Bael)
(iv) Quadrifoliolate – *Paris quadrifolia*. (v) Quadrifoliolate – *Marsilea*
(vi) Multifoliolate – *Bombax* (Semal)

Test your Resonance with concept

1. A dicotyledenous plant showing parallel venation is
(1) *Dioscorea* (2) *Smilax* (3) *Calophyllum* (4) *Hibiscus*.

2. A monocot can be distinguished from a dicot by
(1) Phyllotaxy (2) Aestivation (3) Venation (4) Vernation.

3. A leaf without petiole is called
(1) Subpetiolate (2) Sessile (3) Subsessile (4) All the above.

4. *Bignonia* is
(1) Twiner (2) Hook climber (3) Thorn climber (4) Tendril climber.

5. S*tora*ge leaves occur in
(1) *Allium* (2) *Zizyphus* (3) *Triticum* (4) *Trapa*.

Answers

1. (3) **2.** (3) **3.** (2) **4.** (2) **5.** (1)