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7

SHOOT SYSTEM

Shoot system is an aerial and erect part of plant body which grows upwards. It is usually above the soil and develops from **plumule** of the embryo. It consists of stem, branches, leaves, flowers, fruits and seeds. In this lesson you will study about the structure, types, modifications and functions of stem, leaf, flower and fruit.

OBJECTIVES

After studying this lesson, you will be able to -

- *list the general characteristics of stems and distinguish them from those of root;*
- *describe the shoot apex and explain the origin of lateral branches;*
- *explain the types, modifications and functions of stem;*
- *describe the primary structure of dicot and monocot stems with the help of diagrams and distinguish between them;*
- *describe secondary growth in a dicot stem;*
- *define wood and its types;*
- *describe the general morphology of leaf and explain phyllotaxy;*
- *describe and illustrate various modifications of leaf highlighting their functions;*
- *describe and compare the internal structure of a typical dicot and monocot leaf;*
- *define inflorescence and describe it's major types;*
- *define a flower and describe it's structure and functions;*
- *define placentation and describe different kinds of placentation;*
- *define and explain the structure of fruit and enlist it's major categories with examples.*

7.1 STEM

7.1.1 Characteristics of Stem

(i) Arises as a prolongation of plumule (one end of an embryo).

(ii) Grows and bends towards light **(positively phototropic)** and away from gravity **(negatively geotropic).**

(iii) Divided into **nodes** (point of attachment of leaf) and **internodes** (regions between two nodes).

(iv) Bears leaves, branches and flowers on nodes.

(v) Bears **vegetative buds** which could be terminal (apical bud) for plant to grow upwards or axillary (bud in the axil of leaf) which give rise to lateral branches.

(vi) Bears **floral buds** (terminal or axillary) that grow into flowers.

7.1.2 Differences between stem and root

Table 7.1 gives the difference in morphology between stem and root.

Table 7.1 Morphological differences between stem and root

Stem	Root
1. Develops from plumule.	Develops from radicle.
2. Young stem is green because of chlorophyll.	Non green because chlorophyll is absent.
3. Divided into nodes and internodes.	Not divided into nodes and internodes.
4. Bears leaves, vegetative and floral buds.	Absent.
5. No cap present at the apex.	Root cap is present at the apex.
6. Positively phototropic and negatively geotropic.	Negatively phototropic but positively geotropic.
7. Origin of lateral branches is exogenous (originating from outer layers i.e. endodermis).	Origin of lateral roots is endogenous (originating from inner layers i.e. pericycle).

INTEXT QUESTIONS 7.1

1. Name the part of plant which bears nodes, leaves and flowers.

 ....

2. Lateral branch develops from which bud?

 ....

3. Why is it difficult to break lateral roots and not lateral branches on stem?

 ....

4. Roots are negatively phototropic and positively geotropic, what pattern of growth does the stem show?

 ....

7.1.3 The Shoot Apex

Shoot apex is the terminal, dome shaped part of shoot, formed of meristem called **apical shoot meristem** responsible for the development and differentiation of primary permanent tissue and mainly causes growth in length. It is divided into two regions - **Tunica** and **Corpus** (Fig. 7.1)

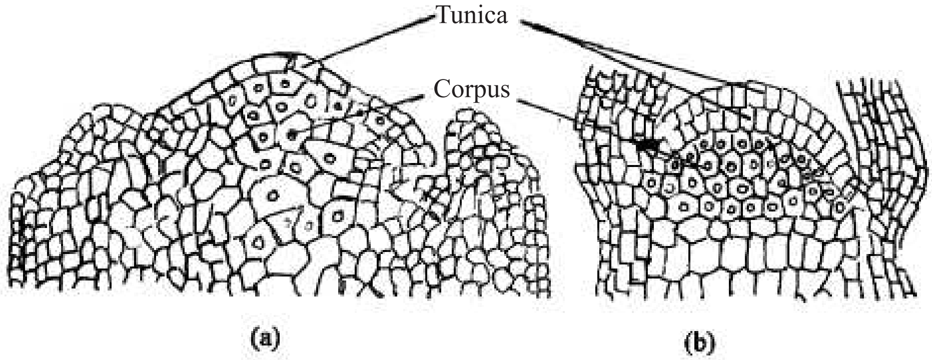


Fig.7.1 a-b L.S. of shoot apex to show tunica and corpus

(i) **Tunica** (covering)- An outer zone of shoot apex, 1-3 layers in thickness. It gives rise to epidermis and is responsible for surface growth, and its cells divide only anticlinally.

(ii) **Corpus** (body)- Inner multi-layered zone of cells which divide in all directions. They finally give rise to *procambium* (forms vascular tissue) and *ground meristem* (forms ground tissue). These cells also form leaf primordia (a newly developing leaf).

7.1.4 Origin of Lateral branches

Branches arise from axillary buds present in the axil of leaves (Fig 7.1). Each axillary bud is a small, compact, underdeveloped shoot covered with a large number of overlapping leaf primordia. Internodes of this bud enlarge and develop into a branch. Therefore the development of branches is **exogenous** (exo = outside).

INTEXT QUESTIONS 7.2

1. Name the meristematic zone in which cells divide in all planes.

   ....

2. From which meristematic layer does the vascular tissue develops?

   ....

3. Which structure gives rise to a lateral branch? Name the type of its origin.

   ....

4. What is the structure known as which covers the apical meristem of root but is absent in stem?

   ....

7.1.5 Types of stem

The stem may be (i) **aerial** (erect, rigid, strong and upright as in herbs, shrubs and trees) (ii) **sub aerial** (weak, unable to stay upright and trail on ground as **creepers** or climb up as **climbers)** or (iii) **underground** (buried in soil and produces aerial branches under favourable conditions only).

7.1.6 Modifications of Stem

Stems are variously modified into underground, sub aerial and aerial stems for performing functions like manufacturing and storing food, perennation (overcoming unfavourable climatic conditions), providing mechanical support and protection and for propagating vegetatively

Types of stem and modifications

Underground	Subaerial	Aerial
Rhizome	Runner	Tendrils
Corm	Stolon	Thorns
Bulb	Offset	Phylloclade
Tuber	Sucker	Cladode

Underground modified stems – Since underground, they may seem like roots but you can recognise them as stem due to the presence of :

(i) Nodes and internodes, (ii) scaly non green leaves, (iii) buds.

They serve two functions -

- Act as perennating structures by remaining leafless and dormant in winter but giving off aerial shoots under favourable conditions (next season)
- Store food and become thick and fleshy.

The various types of underground modified stems are given in Table 7.2.

Table 7.2 Underground Modified Stems

Type	Characters	Examples
1. Rhizome (Fig.7.2a)	Thick, fleshy, flattened horizontally growing stem near the soil surface. Bears scale leaves on nodes, terminal and axillary buds, adventitious roots.	Ginger (Adrak) Turmeric ('haldi')
2. Corm (Fig.7.2b)	Fleshy, spherical stem with flattened base, grows vertically; bears many scale leaves, distinct nodes and internodes, buds and adventitious roots.	Saffron ('kesar') Yam ('zimikand') Gladiolus

3. **Bulb** (Fig.7.2ci,ii)	Reduced, flattened discoid stem with crowded nodes bearing overlapping fleshy (inner) and dry (outer) scale leaves. Terminal bud (in centre) forms foliage (green) leaves. Adventitious roots grow from discoid base.	Onion
4. **Tuber** (Fig.7.2d)	Swollen tips of underground lateral branches of stem, store food as starch, bear "eyes". Each eye is a node which bears bud and scar of scale leaves.	Potato

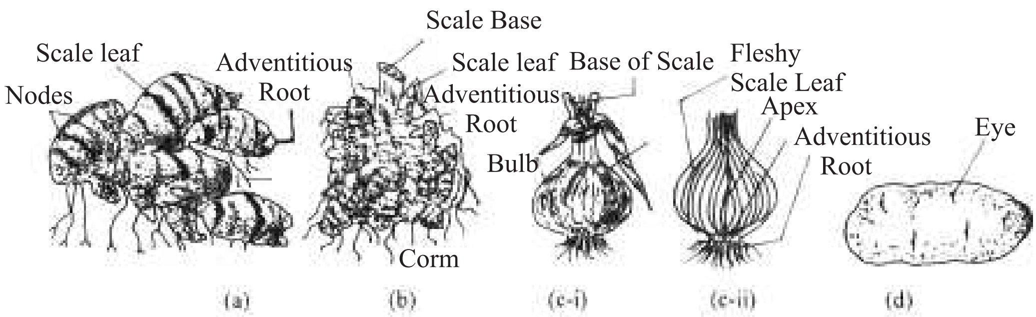
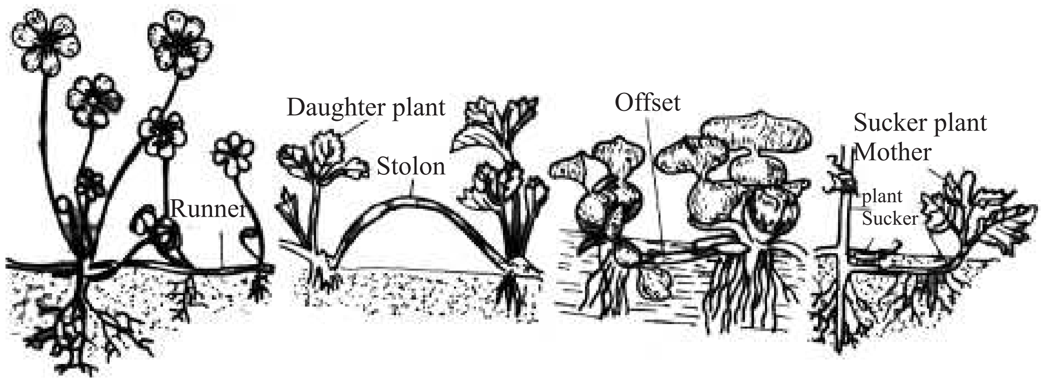


Fig.7.2 Underground modifications of stem – **(a)** Rhizome of Ginger, **(b)** Corm of Yam, **(ci)** Bulb of Onion **(cii)** V.S. bulb, **(d)** Tuber of potato.

Sub aerial modifications Of stem- Stems are weak, therefore lie prostrate on the ground or may get partially buried in the top soil. The plants bearing such stems are called creepers. Their stems serve the function of vegetative propagation.

Table 7.3 Modifications of Sub aerial stems

Type	Characters	Examples
1. **Runner** (Fig.7.3a)	Long, weak, slender branch with long internodes. Runs horizontally on soil surface giving off adventitious roots at nodes	Grass, *Oxalis*
2. **Stolon** (Fig. 7.3b)	Weak lateral branch which grows upwards then arches down to meet the soil, strike roots and produce daughter plants.	Mint ('Pudina'), Jasmine
3. **Offset** (Fig.7.3c)	Like runner but thicker and shorter, grow for a short distance then produce cluster (rosette) of leaves above and adventitious roots below; generally in aquatic plants	Water hyacinth, water lettuce
4. **Sucker** (Fig.7.3d)	Underground runner which grows horizontally for a distance under soil then emerges obliquely upwards, strikes roots and forms daughter plants	Chrysanthemum



(a) (b) (c) (d)

Fig.7.3 Sub-aerial modification of stem : (a) Runner; (b) Stolon; (c) Offset; (d) Sucker.

Aerial stem modifications - Whole stem or its part (axillary or terminal bud) gets modified to perform definite functions. You can recognise them as stems by following features :

(i) Arise in the axil of leaf (ii) Bear nodes and internodes (iii) may bear leaves, buds, flowers.

Table 7.4 Types of aerial stem modifications

Type	Characters	Examples
1. Stem tendrils (Fig.7.4a)	Thread like, spirally coiled, leafless structures (tendrils) which twine around neighbouring objects and help weak plants to climb	Grape vine
2. **Thorns** (Fig.7.4b)	Straight, pointed, hard structures; modifications of axillary *(Citrus)* or terminal *(Carissa)* bud; act as defence organs or as climbing organs	*Citrus*, *Duranta* *Carissa* *('Karonda')*
3. Phylloclade (Fig.7.4c)	Green, flattened or cylindrical fleshy stem, with nodes and internodes; bears spines (modified leaves to check evaporation); carries out photosynthesis, stores water. Found in plants growing in dry regions	*Opuntia* (prickly pear)
4. Cladode (Fig.7.4 di,dii)	It is a phylloclade with limited growth i.e. with only one or two internodes; help in photosynthesis	*Asparagus*

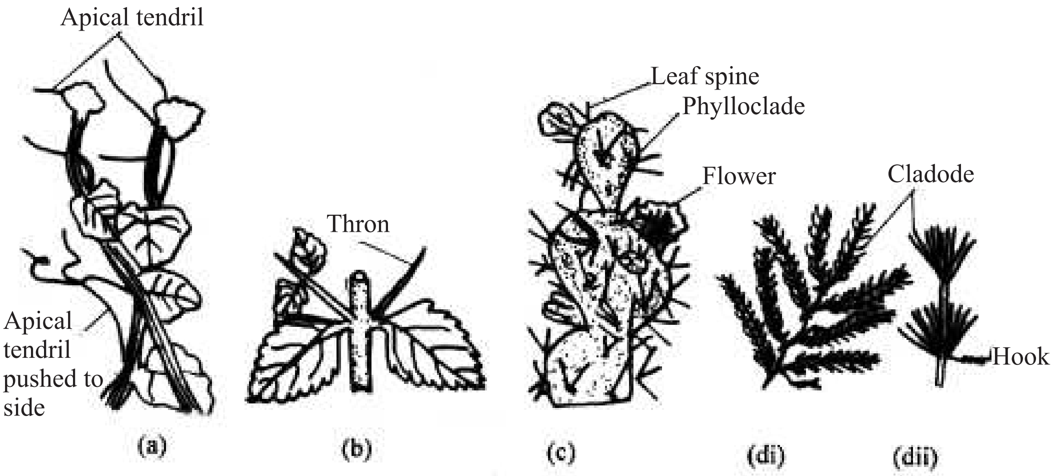


Fig. 7.4 Aerial stem modifications— (a) Stem Tendril; (b) Thorns; (c) Phylloclade of *Opunlia;* di, dii-Cladode *of Asparagus* and part enlarged

INTEXT QUESTIONS 7.3

1. What are plants with weak stem trailing on the ground known as?

   ....

2. Name the modification to which Runner, Stolon, Offset and Sucker belong.

   ....

3. What is a phylloclade with one or two internodes called?

   ....

4. 'Haldi' and onion belong to which category of stem modification respectively?

   ....

5. Match the items of column A with those of column B

A		B	
(a)	Tendril	(i)	Protection
(b)	Sucker	(ii)	Perennation
(c)	Thorns	(iii)	Reproduction
(d)	Bulb	(iv)	Photosynthesis
(e)	Phylloclade	(v)	Climbing

7.1.7 Functions of stem

A. Primary functions

1. **Support and orient the leaves** in a manner that they are exposed to maximum sunlight and for efficient gaseous exchange during photosynthesis and respiration.

2. **Conduct water and minerals** from roots to leaves and manufactured **food** from leaves to different parts of the plant.
3. **Bear flowers and fruits**

B. Secondary Functions

1. **Storage -** Stems store food and water in some plants e.g. potato
2. **Perennation -** The underground stems help tide over the unfavourable growing periods e.g. ginger.
3. **Vegetative propagation -** Stem can be a means of vegetative propagation e.g. rose, and sugarcane.
4. **Photosynthesis-** in certain plants like xerophytes (desert plants) where leaves are reduced, the stem takes up the function of photosynthesis. These stems possess chlorophyll e.g. *Opuntia*
5. **Protection-** In some plants the axillary bud modifies into thorn and protects the plants from grazing animals e.g. citrus, *Duranta.*
6. **Climbing -** Tendrils or hooks are modified branches or buds. They coil around the support and help the plant to climb e.g. grape vine

INTEXT QUESTIONS 7.4

1. Give one primary function of stem.

   ....

2. How does sugarcane plant multiply?

   ....

3. Match the following in column A with column B

	A		B
(a)	*Opuntia*	(i)	Conduction
(b)	*Duranta*	(ii)	Storage of food
(c)	Ginger	(iii)	Photosynthesis
(d)	Potato	(iv)	Perennation
(e)	Stem	(v)	Protection

7.1.8 Internal (anatomical) structure of stem

The internal structure can be studied if you cut the stem transversely and observe it under a compound microscope.

A. Internal structure of dicot stem (e.g., Sunflower)

In a transverse section of a young dicot stem you will see the following structures (Fig. 7.5a and 7.5b)

1. **Epidermis -** Outermost single layered, covered with cuticle, bears multicellular hairs, protective function.

2. **Cortex** - Inner to epidermis, there are three regions.

- **Hypodermis -** 4-6 layers of collenchyma for mechanical support.
- **Middle layers -** Few layers of parenchyma.
- **Endodermis -** Innermost layer of cortex, has barrel shaped cells. As cells contain starch grains, it is also called **starch sheath.**

3. **Stele -** All the tissues lying internal to endodermis constitute the stele.

(i) **Pericycle -** Inner to endodermis, multilayered, parenchymatous with patches of sclerenchyma.

(ii) **Vascular bundles -** Arranged in a ring (Fig. 7.5a); each vascular bundle is **(a)conjoint** (xylem and phloem together in one bundle), (b) **collateral** (xylem and phloem on the same radius with phloem towards the periphery) and (c) open (cambium present in between xylem and phloem). Xylem is **endarch** (protoxylem towards centre and metaxylem towards periphery).

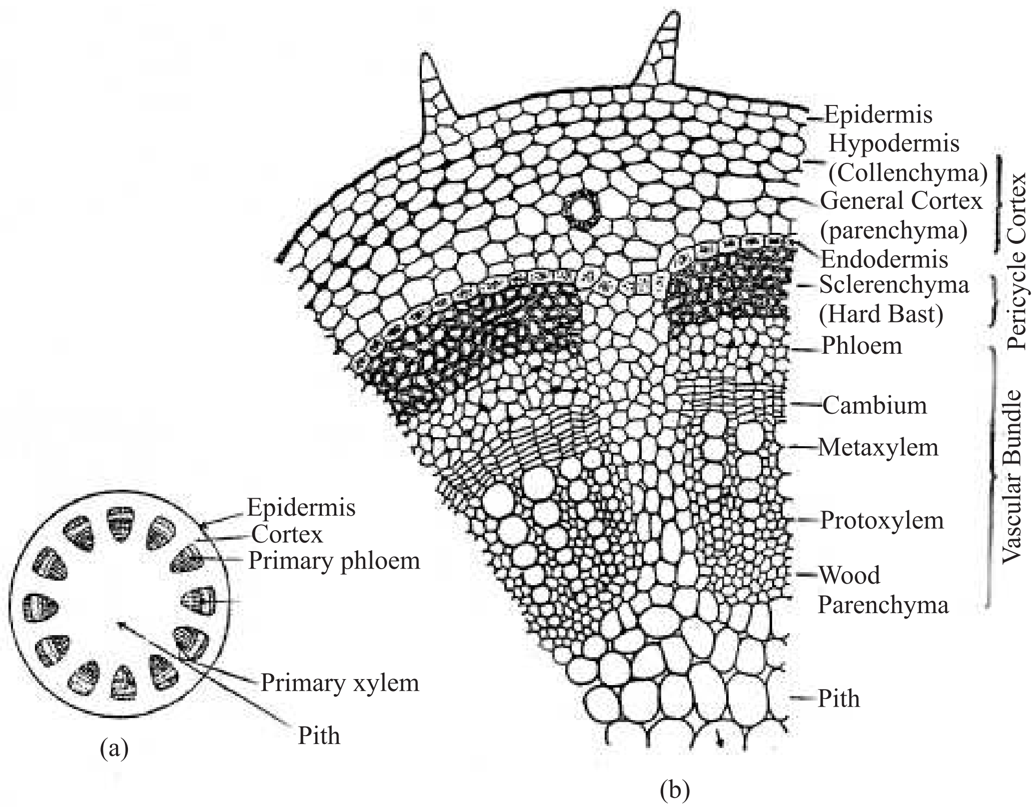


Fig. 7.5 T.S. Dicot stem. a-Diagrammatic b-A portion enlarged.

(iii) **Medullary rays -** Narrow regions of parenchymatous cells in between the vascular bundles.

(iv) **Pith -** The central parenchymatous zone with intercellular spaces.

B. Internal structure of monocot stem (e.g., maize)

A transverse section of monocot stem reveals the following structures (7.6a and b)

1. **Epidermis -** Single layered, covered with cuticle, stem hairs absent.
2. **Ground tissue-** A mass of parenchymatous tissue. Only a few peripheral layers below epidermis are sclerenchymatous called **hypodermis.**
   1. **Vascular bundle-** Numerous, scattered in the ground tissue each enclosed by sclerenchymatous bundle sheath. Each bundle is **(a) collateral** and **(b) closed** (no cambium strip between xylem and phloem) with **(c) endarch** xylem. Xylem occurs in the form of letter 'Y 'and innermost protoxylem disintegrates to form a water cavity.

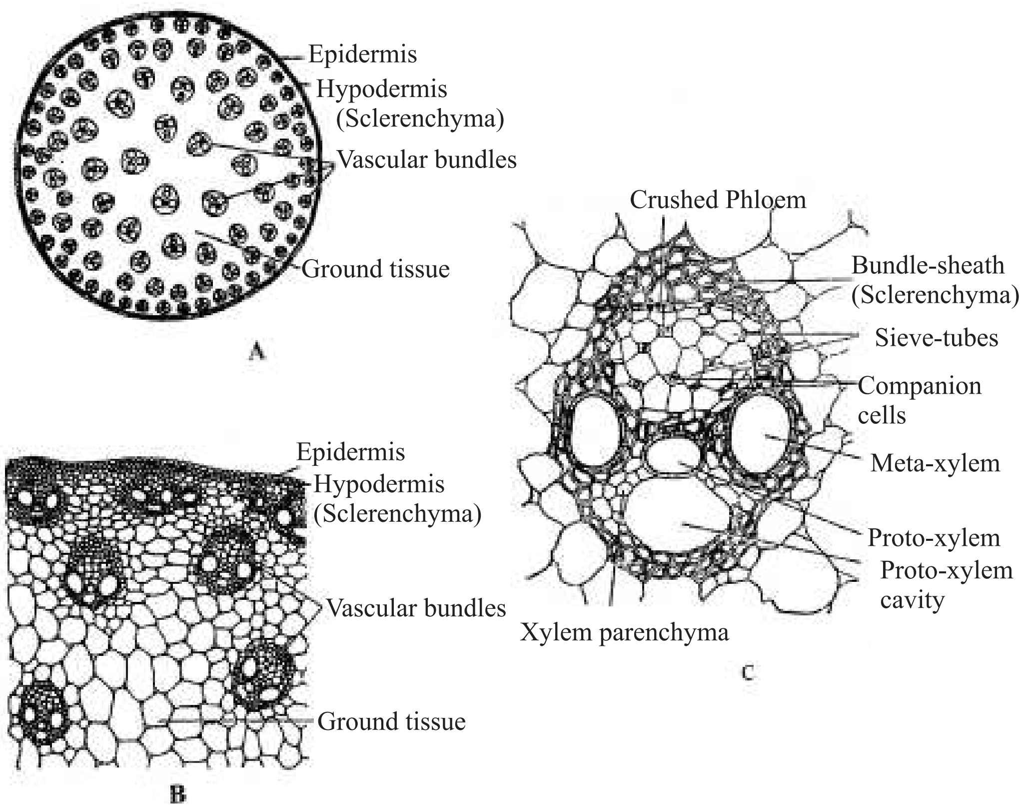


Fig. 7.6 T.S. Monocot stem. (a) Diagrammatic (b) A portion enlarged (c) A vascular bundle magnified.

Anatomical differences between dicot and monocot stem, and anatomical differences between root and stem are given in Tables 7.5 and 7.6

Table 7.5 Differences between monocot stem and dicot stem

Characters	Dicot stem	Monocot stem
1. Epidermal hairs	Present	Absent
2. Hypodermis	Collenchymatous	Sclerenchymatous
3. Ground tissue	Differentiated into cortex, endodermis, pericycle, pith and medullary rays	Undifferentiated
4. Vascular bundles	(i) Number not very large	(i) Numerous
	(ii) Uniform in size	(ii) smaller near periphery, bigger in the centre
	(iii) arranged in a ring	(iii) scattered
	(iv) open	(iv) closed
	(v) bundle sheath absent	(v) bundle sheath present
	(vi) xylem vessels arranged in a radial row	(vi) xylem vessels arranged in shape of letter "Y"
	(vii) water cavity absent	(vii) water cavity present
5. Secondary growth	Present	Mostly absent

Table 7.6 Anatomical differences between stem and root

Characters	Stem	Root
1. Cuticle	Present	Absent
2. Hair	Multicellular	Unicellular
3. Ground Tissue	Differentiated	Differentiated
4. Cortex	Narrow (dicot) or undifferentiated (monocot)	Wide
5. Pericycle	Many layered, of sclerenchymatous and parenchymatous cells	Single layered, of parenchymatous cells only
6. Vascular bundles	Many, conjoint and collateral	Fixed number, radial
7. Xylem	Endarch	Exarch

INTEXT QUESTIONS 7.5

1. Differentiate between conjoint and collateral vascular bundle.

....

2. What is the region between two vascular bundles in a dicot stem known as?

....

3. Where will you find radially arranged vascular bundles with exarch xylem?

....

4. If you want to study the internal structure of a monocot and a dicot stem, name the plants you would select for the study.

....

7.1.9 Secondary growth in stem

You have learnt in lesson 6 about the secondary growth in dicot roots and its importance, let us study it in stem. It occurs only in dicot stem a little away from the shoot apex and helps the plant to (a) grow in girth (thickness) and (b) makes it very strong to stand upright for many years. That is why you see that very tall trees can withstand strong winds, and lashing rains without falling down but monocot plants like wheat, rice, maize, and grasses bend easily due to absence of secondary growth in their stems.

Growth in thickness in dicot stem becomes possible due to the formation of new tissues entirely by the activity of two lateral meristems -(i) Vascular cambium and (ii) Cork cambium (Fig.7.7 a-d).These tissues thus formed are known as secondary tissues and growth in girth is referred as secondary growth.

(i) **Activity of vascular cambium** -Forms secondary vascular tissues as follows

- The strip of cambium present in the vascular bundle is called **Fascicular Cambium** (Fig 7.7a)
- The cells of medullary rays adjoining the strip of vascular (Fascicular) cambium become meristematic and form **interfascicular cambium**(Fig. 7.7b).
- Both fascicular and inter-fascicular cambium join to form a continuous cambium ring (Fig. 7.7b,c)

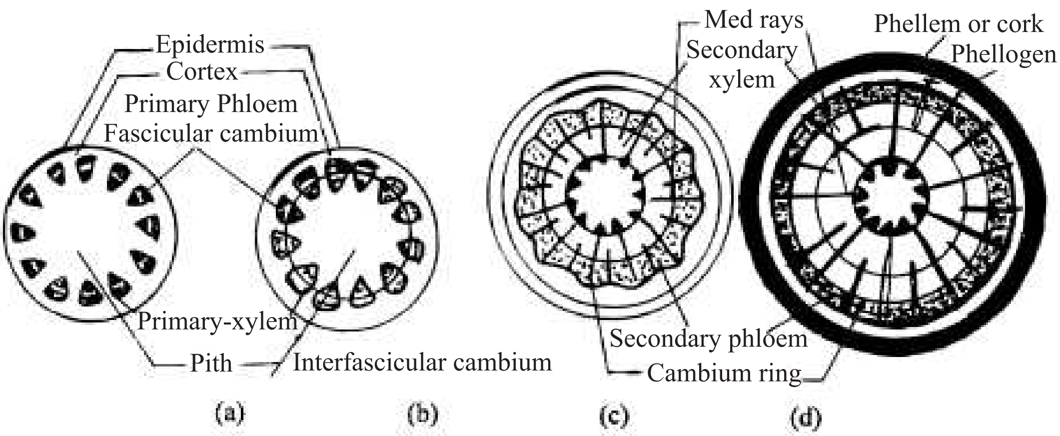


Fig. 7.7 (a-d) T. S. Dicot Stem- Various stages in secondary growth (Diagrammatic)

- Cambium divides and adds cells on internal side (towards pith) which mature into **secondary xylem** and cells added towards external side (periphery) mature into secondary phloem (Fig 7.7c).
- Amount of secondary xylem produced is comparatively comparatively more than secondary phloem (Fig7.7d)

(ii) **Activity of cork cambium**-Forms periderm as follows :

- Cork cambium or **phellogen** develops in the cortex.

- **Phellogen** divides and adds cells on both the inner and the outer side.
- The inner cells differentiate into **phelloderm** or **secondary cortex** while outer cells into **phellem** or **cork** (Fig.7.7d).
- Cork cells are compactly arranged and become dead and suberized (deposition of suberin) except in regions of **lenticels** (Fig. 7.8) where cells are loosely arranged **(complimentary cells)** and non-suberized. It is through the lenticels that woody branches and tree trunks can undergo gaseous exchange.
- Phellogen, phelloderm and phellem together constitute the **periderm** (Fig7.8).Due to internal increase in thickness, periderm replaces the epidermis, becomes protective in function.
- All the dead cells lying outside the active phellogen constitute the **bark.**

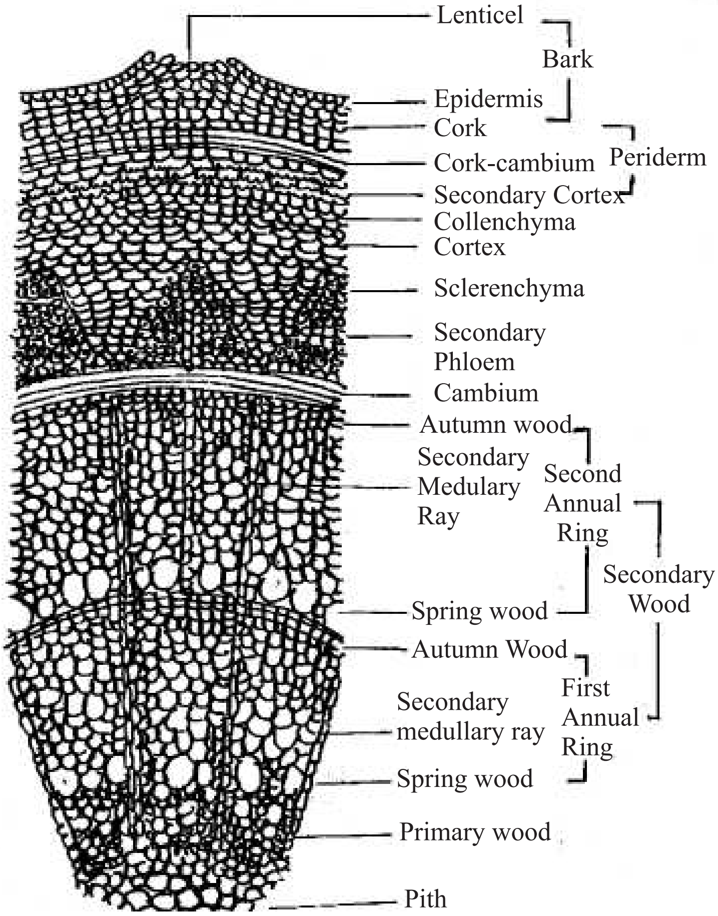


Fig. 7.8 T.S. of old stem, A Portion enlarged

In *Betula bhojpatra* bark peels off like sheets of paper. Ancient manuscripts are still preserved on them. Cork tissue becomes very thick in Cork tree *(Quercus suber)* and is used commercially as, bottle-stoppers, insulators, and shoe soles.

INTEXT QUESTIONS 7.6

1. Name the two lateral meristems which 'are responsible for increase in girth of stem.

 ....

2. From which region does the interfascicular cambium develop?

 ....

3. Define bark.

 ....

4. Why are lenticels, non suberized?

 ....

5. The stems of grasses, and rice, remain weak and thin, why?

 ....

6. Which layers constitute the periderm? What is it's function?

 ....

7.1.10 Wood

Wood is the secondary xylem produced by the activity of vascular cambium in dicot stem.

Annual Rings (A secret to know the age of tree)

In temperate regions, the climatic conditions show pronounced seasonal variations. The activity of vascular cambium also becomes periodical as a result, distinct growth layers are formed in xylem. In spring season cambium is very active and produces a greater number of vessels with wider cavities. The wood formed during spring is called **early wood** (or **spring wood).** In summer, cambium is less active and forms narrow vessels, this wood is called **late wood** (or **summer wood).** These two kinds of woods in a transverse view appear as alternate concentric rings together forming an **annual ring** (Fig 7.8). By counting the number of these annual growth rings we can know the age of a tree. Science dealing with predicting the age of a tree by counting the annual growth rings is called as **Dendrochronology.**

Sap Wood and Heart Wood

Outer part of wood which is functional and consists of recently formed secondary xylem having some living cells is called **sap wood.** As the plant ages in the central part of stem, the inner cells of sap wood that become non-functional and dark in colour constitute, **heart wood** (Fig 7.9)

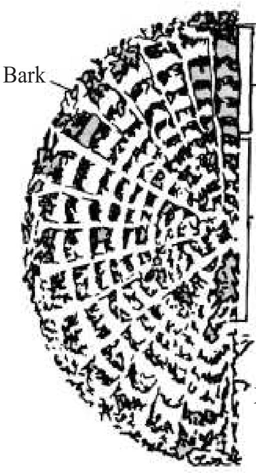


Fig. 7.9 T.S. old stem showing Heart wood and Sap wood.

Table 7.7 enlists the main differences between sap wood and heart wood.

Table 7.7 Differences between sap-wood and heart wood

SAP WOOD	HEART WOOD
1. It is the outer light coloured wood of an old stem	It is the central dark colured wood of an old stem
2. Light coloured	Dark coloured due to presence of gums, resins, oils, tannin etc.
3. Contains living cells	Living cells are absent
4. Vessels not plugged and help in upward movement of water and minerals	Vessels are plugged with tyloses
5. Wood is lighter in weight	Heavier in weight
6. Less durable because of susceptibility to attack of pathogens	More durable, resistant to attack of the pathogens
7. Commercially less valuable	Commercially more valuable

Mechanical tissues in stem -The stem of a tall tree needs to i) resist against pulling forces of wind and ii) to stand erect against gravity. Stem gets this strength from - Sclerenchyma in hypodermis and it's patches in the pericycle and secondary phloem, abundant lignified vessels, tracheids and fibres in secondary xylem i.e. wood and sclereids in pith.

INTEXT QUESTIONS 7.7

1. Which type of wood is formed when the cambium is less active?

   ....

2. How can you determine the age of a tree?

   ....

3. Why is heart wood commercially more valuable?

   ....

Notes

4. Why does a tall tree stand erect even in strong wind and lashing rain?

....

5. Define wood.

....

7.2 LEAF

Leaf is a flattened and expanded lateral appendage of stem or branch developing from its node. It originates from leaf primordium formed by the shoot meristem and bears a bud in its axil called **axillary bud.** It is the seat of very important physiological processes like photosynthesis, transpiration and respiration. Besides protecting axillary buds ,leaf can get modified into structures for storing food and water, climbing, and vegetative propagation.

7.2.1 Structure of Leaf

A typical leaf has three parts (Fig. 7.9)

(i) **Leaf base -** Lower most part of leaf by which it is attached to the stem node. It may be expanded as sheath (in monocots) or bear lateral outgrowths (stipules) as in dicots.

(ii) **Petiole -** Is the stalk of leaf. Leaf can be **petiolate** (with petiole) as in many dicots or **sessile** (without petiole) as in most monocots. Petiole may get modified and swell (e.g. water hyacinth) or develop wings (e.g. orange) or become flat like a leaf (e.g. Australian Acacia)

(iii) **Lamina or leaf blade-** It is a green, thin, flattened and expanded part of leaf with veins and veinlets traversing through its surface. The most prominent vein running from base to apex and present in the middle of leaf blade is called **mid rib.** Veins provide support and conduct water, minerals and prepared food.

Leaf shows a lot of variation in -

(i) Shapes of lamina (Fig.7. 10) (ii) Leaf apices (Fig. 7.11), and

(iii) Leaf margins (Fig.7.12)

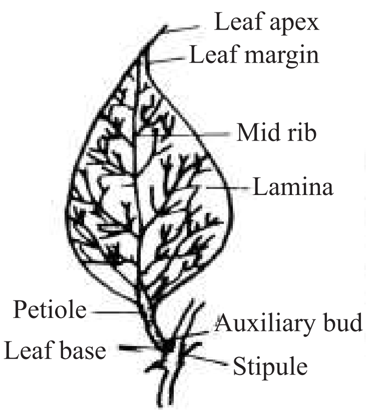


Fig. 7.9 Leaf and its parts

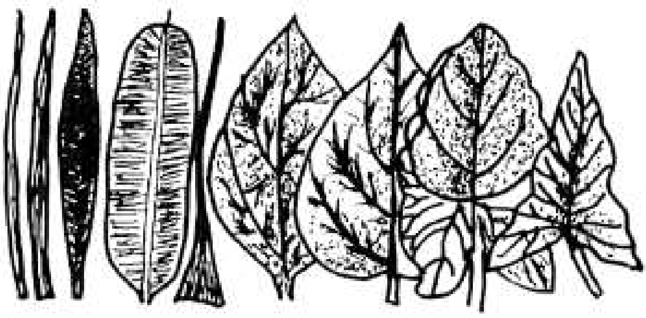


Fig. 7.10 Variations in leaf shape.

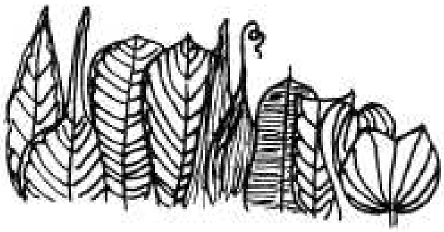


Fig. 7.11 Variations in Leaf apices

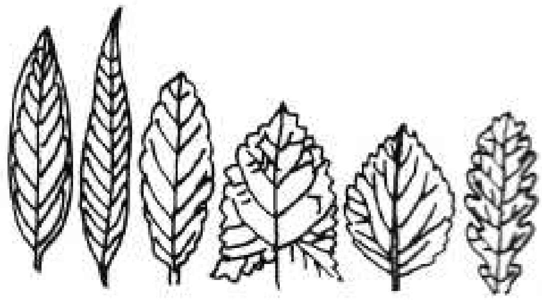
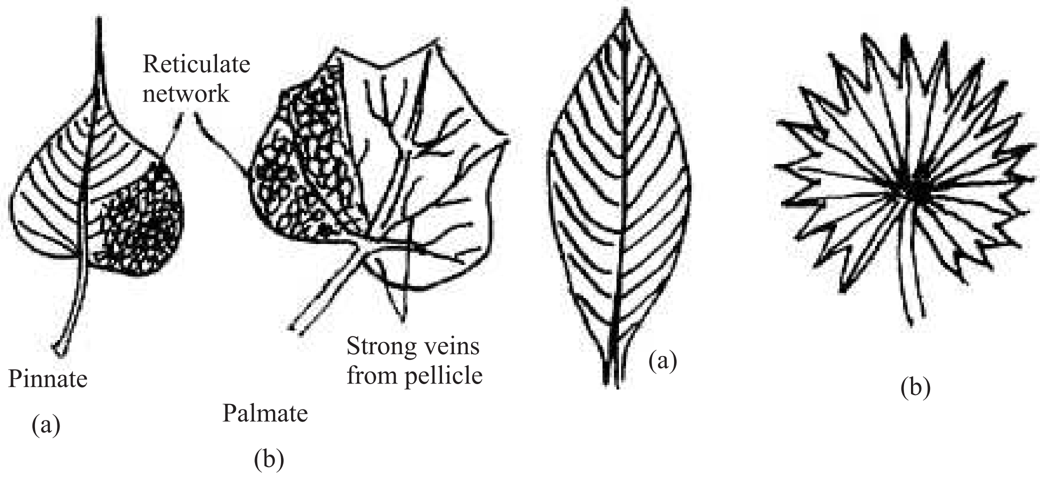


Fig. 7.12 Variations in Leaf margins

7.2.2 Venation in leaves

Arrangement of veins and veinlets in the lamina is known as **Venation.** It is of two types

- **Reticulate venation** -veins forming a network e.g. dicots (Fig.7.13A-a,b)
- **Parallel venation** -veins arranged in parallel rows e.g. monocots (Fig.7.13B c,d).
- Reticulate and parallel venation may be **unicostate** (Fig. 7.13 a,c) with one mid rib, giving out secondary veins like in feather, hence **pinnate** or, **multicostate** (Fig. 7.13 b, d) having many strong veins spreading out from a common point like fingers from palm, hence **palmate as seen** in Fig.7.13.



(A) Reticulate Venation
(a) Unicostate (Peepal)
(b) Multicostate(Grape vine)

(B) Parallel Venation
(a) Unicostate (Canna)
(b) Multicostate(Palm)

Fig. 7.13 Types of Leaf venation

INTEXT QUESTIONS 7.8

1. Define venation.

   ....

2. Differentiate between unicostate and multicostate venation.

   ....

3. What is the type of venation found in peepal and palm leaves?

   ....

4. Name the structure which arises in the axil of leaf

   ....

5. What is the prominent vein called which is present in the middle of lamina and runs from base to apex?

   ....

7.2.3 Types of leaves

There are two types of leaves **Simple** and **Compound.** Since a leaf bears a bud in its axil, you can recognize a compound leaf from a simple one by locating the axillary bud. A bud is present in the axil of both simple and a compound leaf but not in th axil of leaflets. The differences between the two types of leaves are given in table 7.7

Table 7.7 Differences between Simple and Compound leaf

Simple leaf	Compound leaf
1. The leaf has a single undivided lamina (Fig. 7.9)	The lamina is divided into many segments called **leaflets** (Fig. 7.14)
2. If divided, the incisions do not touch the mid rib (Fig. 7.13d)	Incisions touch the mid rib (Fig. 7.15)

Types of Compound leaves - They are of two types as shown in table 7.8

Table 7.8 Types of compound leaf

Pinnate	Palmate
1. Leaflets are attached to mid rib or rachis and are arranged laterally (Fig 7.15)	Leaflets radiate from the end of petiole like fingers of a palm (Fig. 7.14)
2. Leaflets and mid rib may get further divided to form compound leaves that are unipinnate, bipinnate, tripinnate and decompound (Fig. 7.15)	Depending upon the number of leaflets compound leaves are bifoliate, trifoliate, quadrifoliate and multifoliate (Fig.7.14)

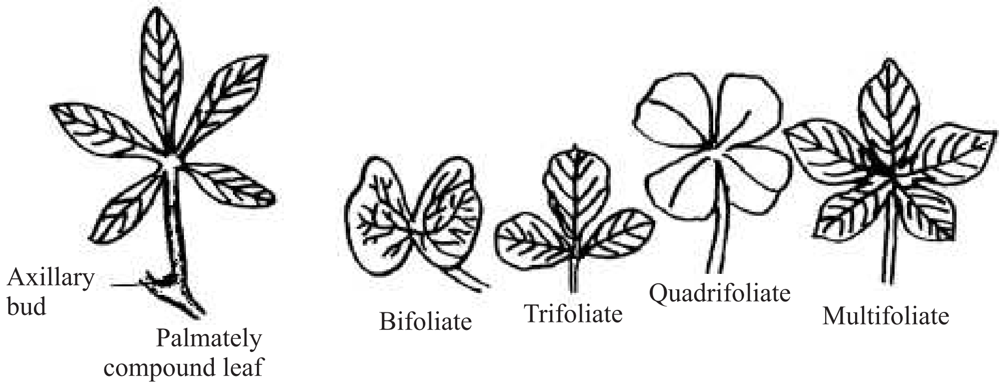


Fig. 7.14 Palmately compound leaf and its types

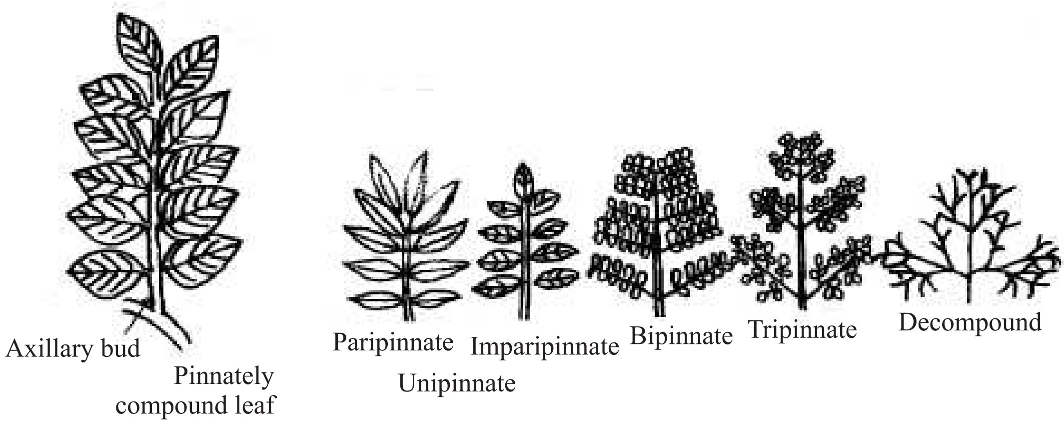


Fig. 7.15 Pinnately compound leaves and its types

INTEXT QUESTIONS 7.9

1. Name the structure to which the leaflets are attached in a compound leaf.

   ....

2. What is the structure which helps you differentiate a leaf from a leaflet?

   ....

3. What are the two types of compound leaves known as ?

   ....

You will enjoy doing the following activity

ACTIVITY 7.1

Aim - To collect and study a few leaves.

Material required — Collect leaves of peepal, neem, banana, palm, rose, grass, imli and tulsi.

Method - Observe the following features in the collected material

(i) Simple or compound leaf

(ii) Reticulate or Parallel venation.

On the basis of the type of venation, group the leaves into monocot and dicot leaves.

7.2.4 Phyllotaxy

It is the arrangement of leaves on stem or branch. The orientation and arrangement of leaves is such that they get appropriate amount of sunlight for photosynthesis. It is of three types

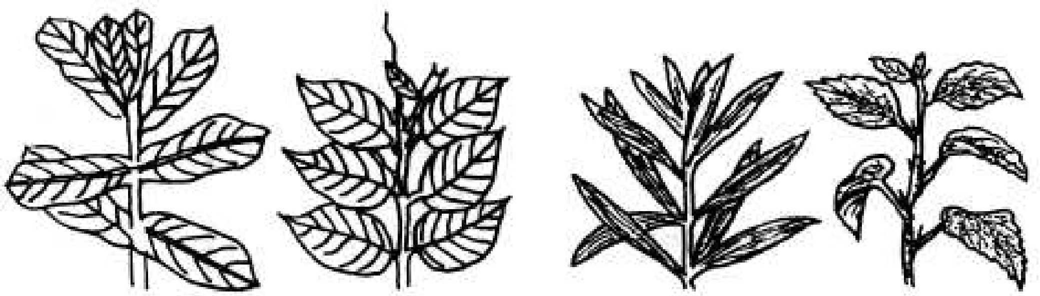
(i) **Alternate** (Fig. 7.16d) - a single leaf arising at each node e.g. china rose, mango.

(ii) **Opposite** (Fig. 7.16a-b) - Leaves occur in pairs at each node. This arrangement may be

  (a) **Decussate** (Fig. 7.16a) - When the successive pairs of leaves at upper and lower nodes are at right angles e. g .,"Tulsi", *Calotropis*

  (b) **Superposed** (Fig. 7.16b) - when the successive leaf pairs at upper and lower nodes are exactly in the same plane e.g. guava

(iii) **Whorled** (Fig. 7.16c) - When there are more than two leaves at each node arranged in a circle or whorl e.g. *Nerium.*



(a) (b) (c) (d)

Fig. 7.16 (a-d) Phyllotaxy- (a) Opposite-Decussate; (b) Opposite-Superposed; (c) Whorled; (d) Alternate

7.2.5 Modifications of leaves

Although the function of leaves is to synthesize food, in some cases they get modified into distinct structures to perform special functions like support and protection to plant, storage of food and water or to catch insects as in case of insectivorous plants (Table 7.9).

Table 7.9 Modifications of leaves

Type	Characters	Examples
l. **Leaf Tendril** (Fig.7.17a)	Here leaves or leaflets get modified to form thin wiry, closely coiled sensitive structure called the **tendril** that helps the plant to climb the support.	Pea, Glory lily
2. **Spines** (Fig 7.17b)	The leaves are modified into sharp and pointed structures which protect the plant and help in reducing transpiration.	Prickly poppy *(Argemone)* *Opuntia,* Aloe
3. **Phyllode** (Fig. 7.17c)	The petiole of compound leaf becomes flattened leaf like and helps in photosynthesis; the leaflets gradually disappear	Australian acacia
4. **Leaves of Insectivorous plants** (Fig. 7. l7d, e)	In pitcher plant the whole leaf gets modified into pitcher while in bladderwort some segmented leaves get modified into bladders. They help in trapping insects	Pitcher plant *(Nepenthes)* Bladderwort *(Utricularia)*

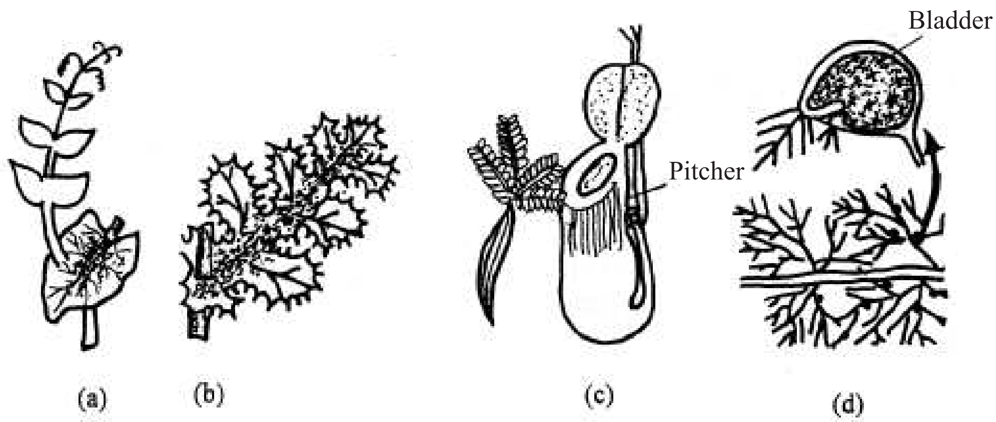


Fig. 7.17 Modifications of Leaf a-d (a) Leaf tendril; (b) Spines; (c) Pitcher plant; (d) Bladderwort

Heterophylly (heteros = different)- Some plants show more than one type of leaves in the same plant , this phenomenon is called heterophylly. It is found in some plants which remain partly submerged in water e.g. Water chestnut, and *Limnophila*

INTEXT QUESTIONS 7.10

1. What is the type of phyllotaxy found in mango, 'tulsi' and guava plants?

....

2. Match the following items of column A with those of column B

	A		B
(a)	Pitcher	(i)	Photosynthesis
(b)	Spines	(ii)	Climbing
(c)	Phyllode	(iii)	Trapping insects
(d)	Tendril	(iv)	Protection

3. Give two examples of insectivorous plants.

   ....

4. Water chestnut shows two different types of leaves on the same plant, what is such a condition known as?

   ....

7.2 6 Functions of Leaf

Leaf performs following functions :

(i) **Photosynthesis** - Leaves manufacture food in the presence of sunlight.

(ii) **Exchange of gases -** Stomata help in exchange of gases which are important for respiration and photosynthesis.

(iii) **Transpiration** - Evaporation of excess of water in vapour form takes place through stomata which helps in ascent of sap and cooling of leaf surface.

(iv) **Guttation -** Exudation of excess of water containing salts takes place in liquid form from leaf margins in plants growing in humid climate.

(v) **Modifications for special functions -** In certain plants leaves perform functions like manufacturing and storing food, providing support and protection, vegetative propagation and trapping insects.

7.2.6. Internal structure of leaf (Figs. 7.18-19)

A General features

- Leaves of most dicot plants are dorsiventral (oriented horizontally, with differentiated mesophyll) where as those of monocots are isobilateral (oriented vertically, mesophyll undifferentiated).
- V.S. of leaf shows three main parts (i) **Epidermis** (ii) **Mesophyll** (iii) **Vascular system.**

  (i) **Epidermis -** Present on **both** upper and lower surface of leaf. Some epidermal cells give rise to guard cells that get arranged to form openings called stomata which help in exchange of gases for photosynthesis, respiration and evaporation of water vapour during transpiration. In some monocot leaves, some epidermal cells in upper epidermis become enlarged to form bulliform cells which lose water so that leaves become tubular to reduce transpiration on hot sunny days.

  (ii) **Mesophyll -** Consists of chloroplast - containing parenchyma **(chlorenchyma)** and is responsible for carrying out photosynthesis. It is differentiated into **palisade** and **spongy** cells in dicot leaves. In monocot leaves, palisade tissue is lacking, thus, mesophyll has only spongy tissue.

- **Palisade cells -** occur below upper epidermis in dicot leaf.
  - Cells are radially elongated, compactly arranged.
  - Possess abundant chloroplasts
- **Spongy cells -** Occur below the palisade cells in a dicot leaf.
  - Cells irregular and loosely arranged - Contain fewer chloroplasts
  - Store gases in the inter cellular spaces

(iii) **Vascular Bundles -** They are **conjoint, collateral** and **closed**

- In each bundle, xylem is located on upper side (ventral) and phloem on lower side (dorsal)
- Most vascular bundles are surrounded by colourless parenchyma called **bundle sheath or border parenchyma.**

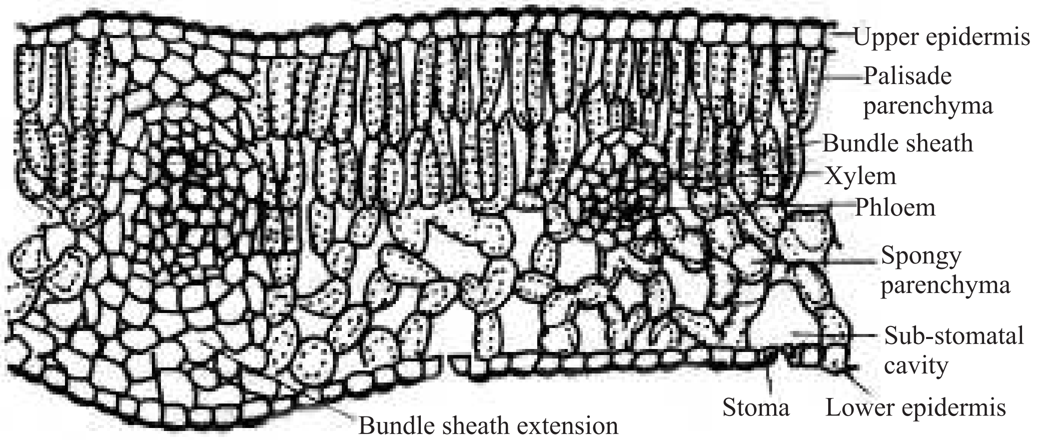


Fig. 7.18 V.S. of a dicot (Dorsiventral) Leaf

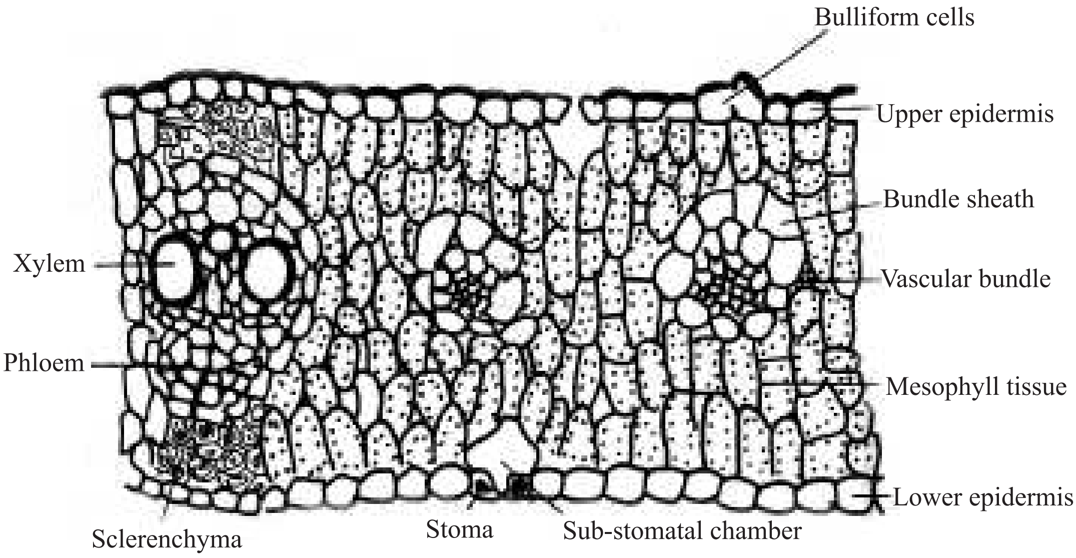


Fig. 7.19 V.S. of a Monocot (Isobilateral) Leaf

Structure of stomatal apparatus : In dicot leaves, stomatal apparatus is made up of two semi circular guard cells surrounding a pore-stoma (Fig. 7.21) The guard cells contain chloroplasts and regulate the opening and closing of stomata. Stomatal pore opens into the inter cellular spaces (substomatal cavity) of mesophyll (Fig. 7.19). The number, shape and distribution of stomata vary (Table 7.10) depending upon the plant whether it is xerophyte or mesophyte.

Table 7.10 Distribution of stomata.

Plants	Stomatal characters	Examples
1. Dicots	Guard cells semicircular reniform occur generally on lower surface	Mango, neem
2. Monocots	Guard cells dumbbell shaped, occur on both the surfaces	Maize
3. Xerophytes	To reduce transpiration- (i) occur only on lower surface, (ii) are absent or less in number on the upper surface (iii) may be sunken	*Nerium*
4. Hydrophytes		
– with floating leaves	Occur only on upper surface	Lotus
– with submerged leaves	Stomata absent	*Hydrilla*

Now you can compare the internal structures of dicot and monocot leaves from Figs. 7.18-19 and Table 7.11

Table 7.11 Difference between internal structure of Dicot and Monocot Leaf

Tissue	Dicot leaf (Dorsiventral leaf)	Monocot leaf (Isobilateral leaf)
1. Epidermis		
(i) Stomata	Occur generally in lower epidermis	Occur both in upper and lower epidermis
(ii) Bulliform cells	Absent	Present in upper epidermus
2. Mesophyll	Differentiated into palisade and spongy parenchyma	Only spongy parenchyma present
3. Vascular system	(i) in the form of network (ii) vascular bundle in mid rib region is large, rest of the vascular bundles decrease in size towards the leaf-margin.	(i) in rows (ii) vascular bundle of midrib is large, but other vascular bundles are small generally of same size.

B. Special features

(i) **Bulliform Cells** (Fig 7.19)

- These are special type of cells **(motor cells)** found on upper leaf surface of some monocots (e.g. maize, bajra, jowar).

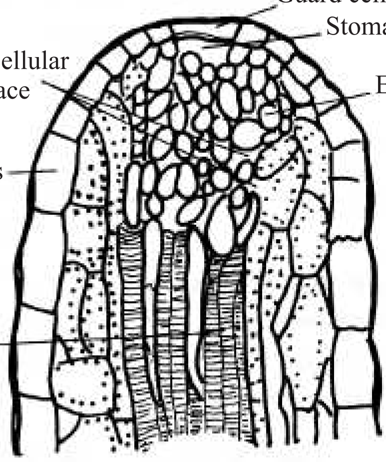
- They help the leaf to roll and unroll due to change in their turgidity.
- Leaf rolls when these cells lose water due to high rate of transpiration especially at Mid-day on hot sunny days.
- Thus, under dry conditions they help in reducing the loss of water vapour through stomata.

(ii) **Hairs**

- Hairs are present especially on leaves of plants growing in dry conditions. They check the rate of transpiration.
- They protect the leaf from bright sunlight, high temperature and air pollution.

(iii) **Hydathodes (water stomata)**

- These are specialised structures (Fig.7.20) present in leaves of angiosperms (garden nasturtium) occurring in humid climate.
- Through these openings excretion of water and minerals plus simple organic compounds in liquid form **(guttation)** takes place. When water absorption by a plant is more and transpiration is less.



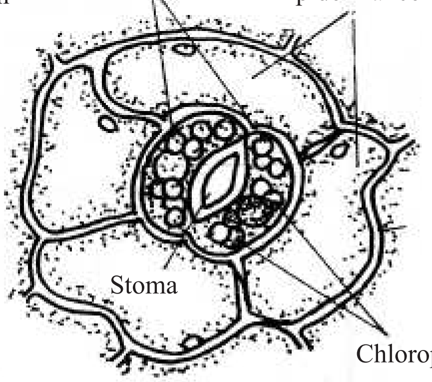


Fig. 7.20 Hydathode **Fig. 7.21** Stomatal apparatus from a dicot leaf

Table 7.12 Difference between Stomata and Hydathode

Characters	Hydathode	Stomata
1. Size	Large	Small
2. Location	Located at vein endings near leaf margins only	Present throughout the leaf surface
3. Structure	Always remain open	They open and close depending upon light intensity
4. Loss of water	Water comes out in liquid form and contains dissolved salts & sugars	Water loss is in vapour form
5. Occurrence	Found in plants of humid areas	In plants occurring in all climates
6. Physiological process	Guttation	Transpiration

INTEXT QUESTIONS 7.11

1. How is the mesophyll tissue of dicot leaf different from that of monocot leaf? What is it's function?

   ....

2. Where are stomata located in a grass leaf?

   ....

3. Name the structure through which plants growing in humid areas get rid of excess of water in liquid form.

   ....

4. Match the following item of column A with that of column B

	A		B
(a)	Bulliform cells	(i)	Protection
(b)	Transport of water and mineral salts	(ii)	Guttation
(c)	Stomata only on lower surface	(iii)	Monocot leaf
(d)	Hydathode	(iv)	Dicot leaf
(e)	Hair	(v)	Stomata
(f)	Exchange of gases	(vi)	Xylem

7.3 FLOWER

Flowers are a thing of beauty for us but for the plants they are vital as they are the seat of sexual reproduction. They produce fruits and seeds.

A flower is a modified shoot because it has (i) nodes very close to one another and (ii) floral leaves arranged in successive whorls.

7.3.1 Parts of a typical flower (Fig 7.22)

Take a flower of any colour or size growing in your area, you'll find it's basic plan to be the same i.e. the flower is borne on a stalk called **pedicel.** The pedicel has a swollen tip known as **thalamus** or **receptacle** on which are borne four whorls successively in definite order as given below :

Accessory whorls

1. **Calyx** (collection of sepals) - The outer most whorl of green sepals whose main function is protection.
2. **Corolla** (collection of petals) - The next whorl of variously coloured petals. They help in attracting insects for pollination.

Reproductive whorls

3. **Androecium** (male reproductive part) consists of collection of stamens. Each stamen has a long slender **filament** with a bilobed **anther** at it's tip with a **connective.** Anthers produce pollen grains for pollination.

4. **Gynoecium** (female reproductive part) - centrally located. It consists of a collection of one or more **carpels** which organise to form one or more **pistils.** Each pistil has three parts -

   - **Ovary -** It is the swollen basal part, one to many chambered (called **locules)** containing ovules which get fertilized to form seeds and the, fertilized ovary forms the fruit.

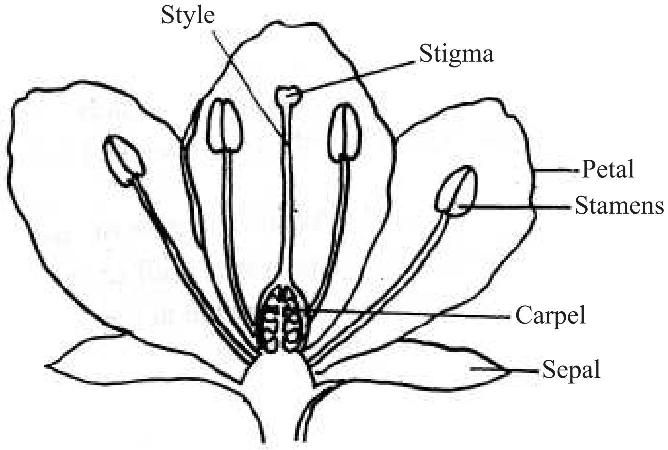


Fig.7.22 A typical flower

   - **Style-** It is the elongated tube connecting the upper part of ovary to stigma.
   - **Stigma**- It is the receptive surface for pollen.

Common variations in flower and its floral parts -Flowers show a lot of variation, some of which you can study from the Table 7.13

Table 7.13 Variations in flower

Variation	Characters
1. **Complete/Perfect** flower	All 4 floral whorls present
2. **Incomplete/Imperfect** flower	Any one or more of floral whorls are absent
3. **Bisexual** (Hermaphrodite)	Both reproductive organs i.e. stamens and carpels present
4. **Unisexual**	Only one reproductive organ present
(i) **Staminate** or male flower	Only stamens present
(ii) **Pistillate** or female flower	Only pistil present
(iii) **On** the basis of occurrence of unisexual flowers, plant is	
(a) **Monoecious**	Both male and female flower occur on same plant e.g., cucumber
(b) **Dioecious**	Male and female flower occur on different plants e.g., papaya
5. **Neuter** flower	Both stamens and carpels are absent
6. **Actinomorphic (Regular)** flower	If it can be divided into two equal halves through any vertical plane e.g., mustard
7. **Zygomorphic** (irregular bilateral)	If it can be divided into two similar halves only through one particular plane e.g., pea
8. **Asymmetrical (Irregular)**	It cannot be divided into two similar halves in any vertical plane *e.g., Canna*

A. Variations in sepals and petals

(i) **Polysepalous** and **Polypetalous** (poly - free)- sepals or petals are free respectively.

(ii) **Gamosepalous** and **Gamopetalous** (gamo - united)- all sepals or petals are fused, respectively.

(iii) **Perianth -** Sepals and petals not distinguishable e.g. onion

B. Variations in Stamens (Fig. 7.23)

The stamens show variation in their **cohesion** (fusion).

(i) **Monadelphous -** filaments fused into one bundle but anthers are free e.g. china rose

(ii) **Diadelphous** – filaments fused to form two bundles e.g. pea

(iii) **Polyadelphous**–filaments fused to form many bundles e.g., lemon

(iv) **Syngenecious** – filaments are free but anthers are fused e.g. sunflower

(v) **Synandrous** – stamens are fused throughout the length e.g., cocks-comb.

Other variations in stamens are as follows

(vi) **Epipetalous** – stamens are attached to petals by their filaments but anthers are free e.g., brinjal

(vii) **Didynamous** – four stamens, two short and two long e.g. tulsi

(viii) **Tetradynamous** – six stamens, inner four are long and outer two are short e.g., mustard

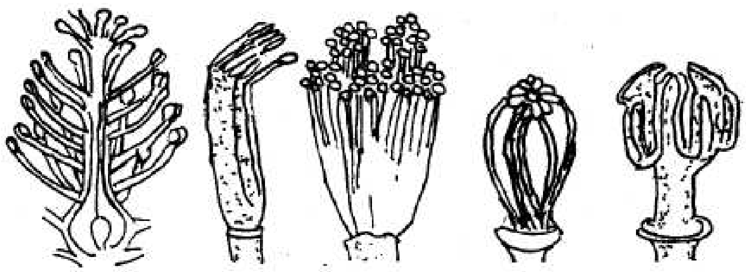


Fig. 7.23 Cohesion (fusion) of stamens.

C. Variation in Carpel

On the basis of number of carpels in a pistil, flowers may be

(i) **Monocarpellary** – If in a Gynoecium pistil has only one carpel e.g. pea.

(ii) **Polycarpellary** – If the Gynoecium has many carpels (e.g. china rose). It may be

(a) **syncarpous** - two or more carpels are fused to form a pistil. e.g. tomato, mustard

(b) **apocarpous** – carpels are free e.g. *Ranunculus*, lotus.

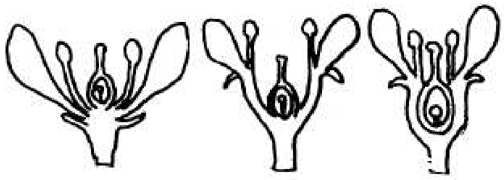
7.3.1a Position of floral whorls on thalamus with respect to ovary

Flower could be of three kinds (Fig, 7.24)

(i) **Hypogynous** - ovary occupies the highest position on thalamus, other three whorls are sucessively below it. Ovary is said to be superior e.g. china rose, and mustard.

(ii) **Perigynous** - The thalamus is disc-like on which the ovary is borne in the centre and rest of floral whorls are located on rim of thalamus. Ovary is said to be half inferior e.g. peach, and plum.

(iii) **Epigynous** -thalamus forms a cup- shaped structure; and encloses the ovary completely and fuses with it. The other whorls are positioned above the ovary. The position of ovary is now inferior e.g. sunflower, cucumber.



(a) Hypogynous (b) Periogynous (c) Epigynous

Fig. 7.24 Position of floral parts on thalamus

> **Do you know**
> Some plants like cashew nuts and mango have neuter, bisexual and unisexual flowers on the same tree.

7.3.2 Placentation

It is the manner in which placentae are distributed in the ovary. Placenta is the point of attachment of ovules (or future seed) in the ovary.

Types of placentation (Fig. 7.26)

(i) **Marginal** - The ovary is monocarpellary and one chambered and ovules are arranged along the fused margins of the single carpel. e.g. pea, gram.

(ii) **Axile** - Ovary is polycarpellary syncarpous, having many chambers and ovules present on the placenta develop from the central axis formed by the fusion of the margins of two or more carpels e.g. China rose, tomato, bhindi,

(iii) **Parietal** - Ovary is polycarpellary and syncarpous, having one chamber and ovules are attached on its inner wall where margins of adjoining carpels meet e.g, mustard, cucumber,

(iv) **Basal** – Ovary is bi-or polycarpellary, syncarpous, having one chamber and placenta develops at the base of ovary and bears a single ovule e.g. sunflower.

(v) **Free central** – Ovary is syncarpous and polycarpellary but unilocular as septae are absent. In the central part of the ovary the placenta bears many groups of ovules e.g. *Dianthus*, *Primula*.

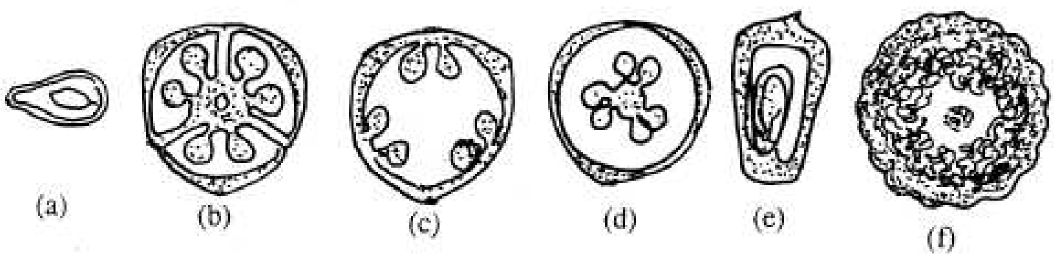


Fig. 7.25 Types of placentation (a) Marginal, (b) Axile, (c) Parietal, (d) Free central, (e) Basal, (f) Superficial

(vi) **Superficial** - Ovary is polycarpellary syncarpous and multilocular in which entire inner walls of chambers are lined with placental tissue so that ovules develop all around e.g.,water lily (*Nymphaea*)

INTEXT QUESTIONS 7.12

1. What is the collection of sepals and petals respectively known as?

   ....

2. Match the following items of column A with those of column B

	A		B
(a)	Flower	(i)	China rose
(b)	Polycarpellary	(ii)	Pollination
(c)	Petals	(iii)	Reproductive organ
(d)	Monodelphous	(iv)	Many carpels
(e)	Carpel	(v)	Modified shoot

3. Define placentation.

   ....

4. Name the type of placentstion where ovary is many chambered and ovules are arranged on the central axis.

   ....

7.4 INFLORESCENCE

Inflorescence is the arrangement of flowers on the floral axis called peduncle. :Inflorescence could be terminal or axillary.

7.4.1 Types of inflorescence

The various types of inflorescence depend upon the type of branching of peduncle and arrangement of flowers. There are two major types of inflorescence

(i) **Racemose.** The main axis does not end in a -flower but continues to grow.

(ii) **Cymose.** The main axis ends in a flower and the growth is limited.

The major differences between the two are given in table 7.14

Table 7.14 Differences between Racemose and Cymose inflorescence

Racemose	cymose
1. Main axis shows unlimited growth	Growth is limited
2. Axis does not terminate in a flower	Axis ends in at flower
3. Flowers occur in acropetal order (oldest flower below and youngest near the apex)	Flowers in basipetal order (terminal flower is older)

Table 7.15 **Types of Racemose Inflorescence (Fig. 7.20)**

A. With main axis elongated

Type	Characters	Examples
1. Raceme	Flowers present on the floral axis are stalked and arranged acropetally.	Mustard
2. Spike	Like raceme but the flowers are sessile	*Achyranthes* ('Latzira')
3. Spikelet	Cluster of one or more flowers (florets' and their associated bracts	Wheat
4. Catkin	Like spike but the axis is pendulous bearing unisexual flowers	Mulberry
5. Spadix	Like spike but the axis is fleshy and enclosed by a large showy bract (Spathe)	Colocassia, banana

B With main axis shortened

Type	Characters	Examples
6. Corymb	Lower (older) flowers have longer stalks than the upper younger ones, thus all flowers come to lie at same level	Candytuft
7. Umbel	Flower with stalks of equal length arising from the same, point	Coriander

C. With main axis flattened

Type	Characters	Examples
8. Head or capitulum	Main axis is flattened into convex receptacle on which sessile flowers (florets) are arranged in centripetal order (older towards periphery). Whole inflorescence is surrounded by involucre of bracts	Sunflower

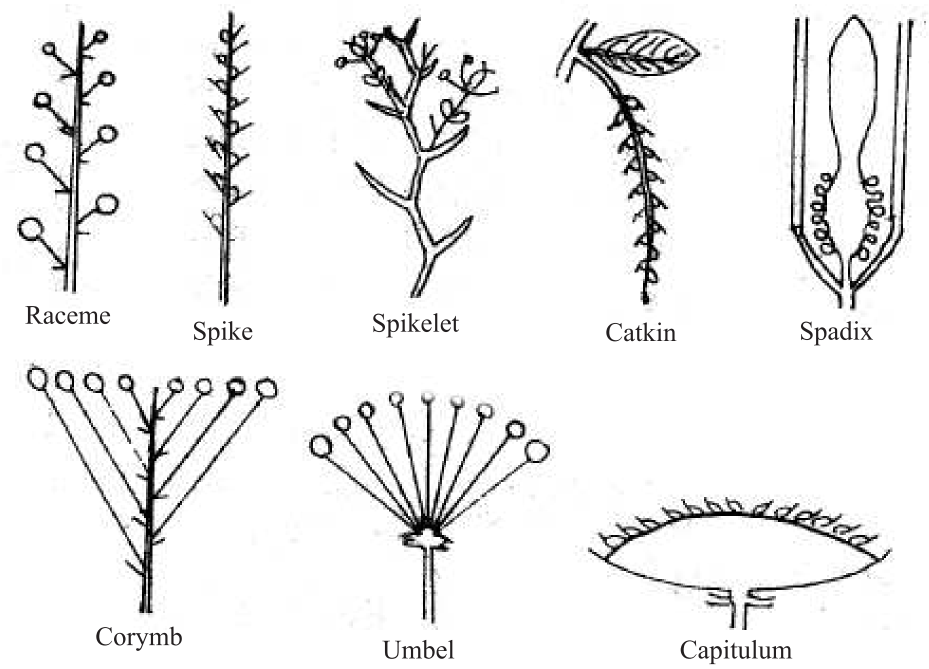


Fig. 7.26 Types of Racemose Inflorescence

Table 7.16 Types of cymose inflorescence (Fig. 7.27)

Type	Characters	Examples
1. Monochasial cyme (Fig. 7.27a)	Main axis ends in a flower. A lateral branch comes from one side and ends in a flower	Cotton
2. Dichasial cyme (Fig. 7.27b)	Two lateral branches develop form either side of terminal flower and each branch ends in a flower	*Dianthus, jasmine*
3. Multichasial cyme (Fig. 7.27c)	Number of lateral branches come from the sides of terminal flower, each lateral branch ends in a flower.	*Calotropis*

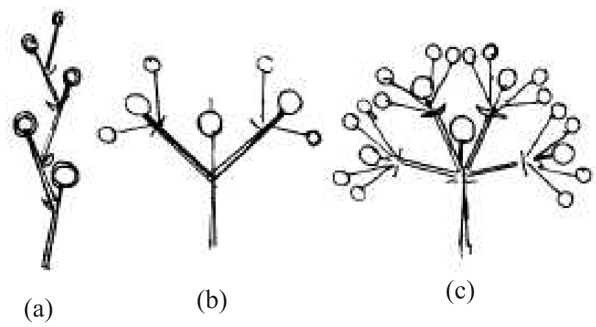


Fig. 7.27 Types of Cymose inflorescence (a) Monochasial, (b) Dichasial, (c) Polychasial

7.4.2 Special types of inflorescence

1. **Hypanthodium** (Fig.7.28a) - The fleshy receptacle forms a cup like cavity and has an apical opening. The male and female flowers are borne on the inner wall of the cavity e.g. Fig, Peepal
2. **Cyathium** (Fig. 7.28b) - A type of inflorescence characteristic of Euphorbia, in which a cup shaped involucre encloses a single female flower surrounded by a number of male flowers. A nectary is present at the rim of involucre,
3. **Verticillaster** (Fig. 7.28c)- It is a series of condensed dichasial cyme at each node with a cluster of sessile flowers in the axil of leaves e.g. *Ocimum* (Tulsa), *Salvia*,

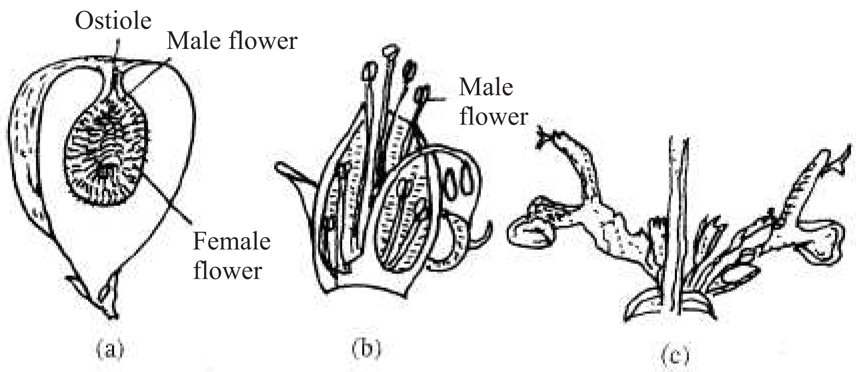


Fig.7.28 Special type of Inflorescence- (a) Hypanthodium, (b) Cyathium, (c) Verticillaster

INTEXT QUESTIONS 7.13

1. What is a cyamose inflorescence?

   ....

2. Give one difference between Raceme and Spike.

   ....

3. Define inflorescence.

   ....

4. Name the type of inflorescence found in sunflower and Fig.

   ....

7.5 FRUIT

A true fruit is a ripened ovary that develops after fertilization. Ovules develop into seeds and the ovary wall matures into fruit wall which is now called pericarp. The pericarp may be thick or thin. In fleshy fruits like mango, pericarp is thick and differentiated into three regions-(a) **epicarp** forms the skin of the fruit (b) **mesocarp**, middle pulpy and (c) **endocarp** inner hard and stony (coconut, mango) or often thin membranes (orange). In **dry fruits** pericarp, is thin, dry, papery or thick and woody but not divided into three regions.

Sometimes along with ovary other floral parts like thalamus, receptacle or calyx may develop as part of fruit, such fruits are-called false fruits. e.g. apple, pear (thalamus), fig (receptacle).

Parthenocarpic fruit -It is a fruit that develops without fertilization. It is seedless or has non-viable seeds e.g, banana, grapes. Horticulturists are producing such fruits artificially.

7.5.1 Kinds of fruits - There are three basic types

1. **Simple fruit** - Develops from single mono-to polycarpellary, syncarpous (fused) ovary e.g, pea, tomato.

2. **Aggregate fruit** - Collection (etaerio) of simple fruits or fruitlets on same thalamus developing from polycarpellary, apocarpous (free carpels) ovary e.g. *Calotropis* and *Ranunculus*.

3. **Composite or multiple fruit** - Fruit develops from a number of flowers juxtaposed together or from inflorescence e.g. mulberry, pineapple.

Table7.17 Major categories of fruits

1. Simple	Dry	Dehiscent	(i) Legume - pea, bean, groundnut
			(ii) Siliqua - mustard
			(iii) Follicle - *Calotropis*
			(iv) Capsule - cotton, poppy, 'bhindi'
		Indehiscent	(i) Caryopsis - wheat, rice
			(ii) Nut - almond, cashewnut
			(iii) Cypsella - sunflower, marigold
			(iv) Samara - yam, hiptage
	Fleshy		(i) Drupe - mango, coconut
			(ii) Berry - tomato, banana, date palm
			(iii) Pepo - cucumber, watermelon
			(iv) Hesperidium - lemon, orange
			(v) Pome - apple, pear
2. Aggregate			(i) Etaerio (cluster) of drupes - Raspberry
			(ii) Etaerio of achenes - Strawberry, rose
			(iii) Etaerio of berries - Custardapple
			(iv) Etaerio of follicles - periwinkle, larkspur
3. Multiple or composite			(i) Sorosis - pineapple, mulberry, jackfruit
			(ii) Syconus - Fig, peepal

Table 7.18 Common Fruits and their edible parts.

Names	Types	Edible Parts
1. Banana	Berry – simple, fleshy	Mesocarp and endocarp
2. Apple	Pome – simple, fleshy	Fleshy thalamus
3. Coconut	Fibrous Drupe – simple, fleshy	Endosperm
4. Custard Apple	Etaerio of Berries – aggregate	Pericarp
5. Date Palm	Berry – simple, fleshy	Pericarp
6. Cashew Nut	Nut – simple, dry indehiscent	Peduncle and Cotyledons
7. Mango	Drupe – simple, fleshy	Mesocarp
B. Orange	Hesperidium – simple, fleshy	Juicy hairs from endocarp,
9. Tomato	Berry – simple, fleshy	Pericarp and Placentae
10. Pear	Pome – simple, fleshy	Fleshy thalamus
11. Pineapple	Sorosis – composite	Outer portion of receptacle, bracts and perianth
12. Fig	Syconous – composite	Fleshy receptacle
13. Litchi	Nut – simple	Juicy aril
14. Wheat	Caryopsis – simple dry indehiscent	Starchy endosperm
15. Strawberry	Etaerio of achenes- aggregate	Succulent thalamus

INTEXT QUESTIONS 7.14

1. Define Fruit.

   ....

2. Give two examples of false fruits.

   ....

3. What is the fruit wall known as which is formed by the ovary wall?

   ....

4. Give the names of three layers of pericarp of a fleshy fruit.

   ....

5. Match the following of column A with that of column B

A		B
(a)	Apple	(i) Berry
(b)	Hesperidium	(ii) Mesocarp
(c)	Mango-edible part	(iii) Endosperm
(d)	Coconut -edible Part	(iv) Orange
(e)	Tomato	(v) False Fruit

WHAT YOU HAVE LEARNT

- Stem is aerial, upright, positively phototropic part of plant and bears nodes, internodes leaves and buds.
- It has a terminal apical meristem which gives rise to leaves and axillary buds
- The stems are variously modified into underground, subaerial and aerial stems for performing special functions.
- Dicot and monocot stems are different anatomically.
- The internal structure of dicot stem shows epidermis, differentiated ground tissue, multilayered pericycle and vascular bundles arranged in a ring. Each vascular bundle is conjoint, collateral and open with endarch xylem.
- Monocot stem differs in having undifferentiated ground tissue, scattered vascular bundles which are closed.
- Secondary growth takes place only in dicot stem.
- Wood is of two types- heartwood (dark and non functional) and sap wood (light and functional)
- The differential activity of vascular cambium during secondary growth forms annual growth rings.
- Origin of lateral stem branches is exogenous.
- The primary function of stem is conduction of water and minerals through xylem and food through phloem; support and orient leaves towards sunlight for better photosynthesis ; bear flowers and fruits.
- Stem undergoes modifications for various special functions like food storage, perennation, protection, climbing, photosynthesis and vegetative propagation.
- Leaf is a specialised organ for photosynthesis.
- It has three parts -leaf base, petiole and lamina traversed by parallel or reticulate venation. The arrangement of leaves on stem is called phyllotaxy
- Leaves can be simple or compound.
- Leaves are modified into tendrils, spines, phyllode, pitcher or bladder to perform special functions.
- Internal structure of leaf shows three main tissues - epidermis with stomata, mesophyll differentiated into spongy and palisade tissue in dicot leaf but only spongy tissue in monocot leaf and vascular system.
- In dicot leaves each stomatal apparatus consists of kindney shaped guard cells surrounding a pore. In monocot leaves stoma is surrounded by two dumbbell shaped guard cells. Guard cells regulate the opening and closing of stomata, depending upon the presence or absence of sunlight.

- Stomata help in gaseous exchange and allow loss of water vapour during transpiration.
- Special structures like bulliform cells, hydathodes and hairs occur in leaves of some plants.
- Flower is a modified shoot.
- A typical flower has accessory whorls i.e., calyx and corolla and reproductive or essential whorls i.e., androecium (male) and gynoecium (female).
- Flowers may be bisexual, unisexual or neuter; actinomorphic or zygomorphic; hypogynous, perigynous or epigynous.
- Variations occur in floral parts.
- Placentation is the manner in which placentae bearing ovules are distributed in the ovary. It is of many types.
- Inflorescence is the arrangement of flowers on the floral axis.
- It has two major types - racemose and cymose.
- Hypanthodium, verticillaster and cyathium are special types of inflorescence.
- Fruit is a ripened ovary that develops after fertilization
- Ovules develop into seeds and the ovary wall matures into fruit wall called the pericarp which may be thin or differentiated into epicarp, mesocarp and endocarp.
- Fruits may be true or false and categorized into simple, aggregate or composite types.
- Simple fruits may be dry (dehiscent or indehiscent) or fleshy.
- A fruit that develops without fertilization is called parthenocarpic fruit.

TERMENAL EXERCISES

1. Differentiate between
   (i) Dicot stem and monocot stem
   (ii) Root and stem
   (iii) Racemose and cymose inflorescence
   (iv) Stoma and hydathode
   (v) True fruit and false fruit
   (vi) Dicot and monocot leaf
2. Explain the different types of underground modified stem?
3. Explain the process of secondary growth in dicot stem.
4. Draw and label the vertical section of dicot leaf.
5. Define the following

(a) Flower (b) Actinomorphic (c) Heterophylly
(d) Phyllotaxy (e) Hypogynous (f) Parthenocarpic fruit
(g) Venation.

6. What is cork cambium? State its functions.
7 Draw labelled diagrams of the following
   (a) Raceme and corymb inflorescence
   (b) Axile and parietal placentation
8. What is a fruit? Enlist the various types of simple- fleshy fruits giving one example of each type.
9. What are the edible parts of the following fruits
   (a) Mango (b) Orange (c) Apple
   (d) Banana (e) Coconut (f) Cashew nut
10. Match the following of column A with that of column B

	A		B
(a)	Tendril	(i)	Protection
(b)	Stolon	(ii)	Food, storage
(c)	Thorn	(iii)	Reproduction
(d)	Tuber	(iv)	Photosynthesis
(e)	Capitulum	(v)	Climbing
(f)	Phylloclade	(vi)	Sunflower

11. Name the type of modification of an underground, non-green structure bearing nodes and internodes and 'eyes'.
12. If a section of stem shows scattered vascular bundles which are closed, have 'Y' shaped xylem and are surrounded by bundle sheath; what group of plant is it?
13. What is the region ouside the phellogen known as?
14. When the cambium is less active which type of wood does it produce?

ANSWERS TO INTEXT QUESTIONS

7.1
1. Stem, 2. Axillary bud
3. Because lateral roots originate from inner layer, that is, pericycle (endogenous origin)
4. Stem is positively phototropic and negatively geotropic

7.2
1. Corpus 2. Procambium
3. Axillary bud, exogenous 4. Root cap

7.3
1. Creeper 2. Sub-aerial
3. Cladode 4. Rhizome, Bulb
5. (a) - (v) (b) - (iii) (c) - (i) (d) - (ii) (e) - (iv)

7.4 1. Conduction of water and minerals from root to leaf and manufactured food from leaf to other parts of plant

2. Stem cuttings

3. (a) - (iii) (b) - (v) (c) - (iv) (d) - (ii) (e) - (i)

7.5 1. Conjoint is when xylem and phloem are together in one bundle, collateral is when xylem and phloem are on the same radius

2. Medullary ray (3) Root

4. Maize stem for monocot and sunflower for dicot stem

7.6 1. Cork cambium (phellogen) and vascular cambium

2. Medullary ray parenchyma

3. All the tissues outside the functional cork cambium is called bark

4. For gaseous exchange in branches

5. Phellem, Phellogen, Phelloderm, Protection

7.7 1. Late or summer wood

2. By counting the annual rings

3. Durable, resistant to attack of pathogen

4. Presence of abundant mechanical tissue like sclerenchyma and secondary xylem

5. Wood is secondary xylem produced by the activity of vascular cambium in dicot stem

7.8 1. Venation is the arrangement of veins and veinlets in lamina of leaf

2. Unicostate has one strong midrib while multicostate has many strong veins

3. Reticulate, parallel 4. Axillary bud 5. Midrib

7.9 1. Rachis

2. Presence of axillary bud in leaf but not in leaflet

3. Pinnately and palmately compound leaf

7.10 1. Alternate, opposite-decussate; opposite-superposed;

2. (a) - (iii) (b) - (iv) (c) - (i) (d) - (ii)

3. Pitcher plant; bladderwort 4. Heterophylly

7.11 1. Mesophyll differentiated into palisade and spongy tissue in dicot leaf but composed of only spongy tissue in monocot leaf; photosynthesis

2. In both surfaces of leaf 3. Hydathodes

4. (a) - (iii) (b) - (vi) (c) - (iv) (d) - (ii) (e) - (i) (f) - (v)

7.12 1. Calyx, Corolla

2. (a) - (v) (b) - (iv) (c) - (ii) (d) - (i) (e) - (iii)

3. Placentation is the manner in which placentae are distributed in the ovary

4. Axile

7.13 1. When the main axis ends in a flower and the growth is limited

2. Flowers are stalked in raceme but sessile in spike

3. Arrangement of flowers on floral axis

4. Capitulum, Hypanthodium

7.14 1. Fruit is a ripened ovary that develops after fertilization

2. Apple, pear 3. Pericarp 4. Epicarp, mesocarp, endocarp

5. (a) - (v) (b) - (iv) (c) - (ii) (d) - (iii) (e) - (i)