



Katherine Esau
(1898 - 1997)

KATHERINE ESAU was born in Ukraine in 1898. She studied agriculture in Russia and Germany and received her doctorate in 1931 in United States. She reported in her early publications that the curly top virus spreads through a plant via the food-conducting or phloem tissue. Dr Esau's Plant Anatomy published in 1954 took a dynamic, developmental approach designed to enhance one's understanding of plant structure and an enormous impact worldwide, literally bringing about a revival of the discipline. The Anatomy of Seed Plants by Katherine Esau was published in 1960. It was referred to as Webster's of plant biology - it is encyclopaedic. In 1957 she was elected to the National Academy of Sciences, becoming the sixth woman to receive that honour. In addition to this prestigious award, she received the National Medal of Science from President George Bush in 1989.

When Katherine Esau died in the year 1997, Peter Raven, director of Anatomy and Morphology, Missouri Botanical Garden, remembered that she 'absolutely dominated' the field of plant biology even at the age of 99.

- Development of fruit inside soil → "geocarpic" (ground nut)
- Cremocarp → bicarpellary inferior ovary. Matured fruit splits into two indehiscent one seeded mericarps which may remain attached for some time to carpopore (central axis) by means of "styxopod" eg. Carandaria cumini

CHAPTER 5

MORPHOLOGY OF FLOWERING PLANTS

plays key role in classification of angiosperms

- 5.1 The Root
- 5.2 The Stem
- 5.3 The Leaf
- 5.4 The Inflorescence
- 5.5 The Flower
- 5.6 The Fruit
- 5.7 The Seed
- 5.8 Semi-technical Description of a Typical Flowering Plant
- 5.9 Description of Some Important Families

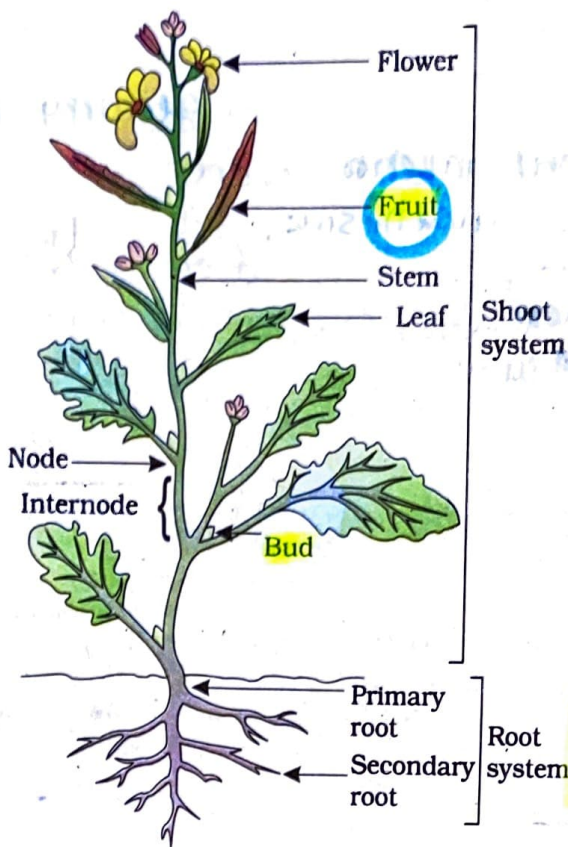
The wide range in the structure of higher plants will never fail to fascinate us. Even though the angiosperms show such a large diversity in external structure or morphology, they are all characterised by presence of roots, stems, leaves, flowers and fruits.

In chapters 2 and 3, we talked about classification of plants based on morphological and other characteristics. For any successful attempt at classification and at understanding any higher plant (or for that matter any living organism) we need to know standard technical terms and standard definitions. We also need to know about the possible variations in different parts, found as adaptations of the plants to their environment, e.g., adaptations to various habitats, for protection, climbing, storage, etc.

If you pull out any weed you will see that all of them have roots, stems and leaves. They may be bearing flowers and fruits. The underground part of the flowering plant is the root system while the portion above the ground forms the shoot system (Figure 5.1).

5.1 THE ROOT

In majority of the dicotyledonous plants, the direct elongation of the radicle leads to the formation of primary root which grows inside the soil. It bears lateral roots of several orders that are referred to as secondary, tertiary, etc. roots. The primary roots and its branches constitute the



tap root system, as seen in the **mustard** plant (Figure 5.2a). In **monocotyledonous** plants, the **primary root** is short lived and is replaced by a large number of roots. These roots originate from the base of the **stem** and constitute the **fibrous root system**, as seen in the **wheat** plant (Figure 5.2b). In some plants, like **grass**, **Monstera** and the **banyan tree**, roots arise from parts of the plant other than the **radicle** and are called **adventitious roots** (Figure 5.2c). The main functions of the root system are **absorption** of water and minerals from the soil, providing a proper **anchorage** to the plant parts, **storing** reserve food material and **synthesis** of **plant growth regulators**.

Figure 5.1 Parts of a flowering plant

In aquatic plants (ex- **Jussiaea** white spongy branches & help in floating & respiration. **Tinospora** & **Podostema** are photosynthetic. **submerged** also-)

Aerial roots of **Trapa**

Sucking/haustorial roots are found in **Cuscuta**, **Sorbaria**, **Viscum**.

Laterals are found in **epiphytes** like **orchids** & help in absorption of moisture from atmosphere by **velamen** (special tissue)

Contractile roots → **Coem** of **Crocos**, **Ficosa**

Root thorn → (a) **Potnar acornatus**, (b) **acanthorhiza**.

Clinging roots → **Ficus pumila**, **Tecoma**, **betel**, **ivy** (**Quercus**), **black pepper**.

Leaf roots → **Salvinia**

Epiphytic → **Bryophyllum**

Reproductive roots → **Panicum** **sweet potato**

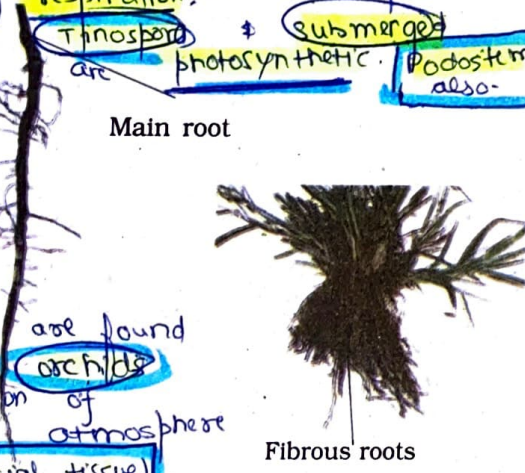


Figure 5.2 Different types of roots : (a) Tap (b) Fibrous, (c) Adventitious

5.1.1 Regions of the Root

The root is covered at the apex by a **thimble-like** structure called the **root cap** (Figure 5.3). It **protects the tender apex** of the root as it makes its way through the soil. A **few millimetres** above the root cap is the **region of meristematic activity**. The cells of this region are **very small, thin-walled and with dense protoplasm**. They divide repeatedly. The cells **proximal** to this region undergo **rapid elongation and enlargement** and are responsible for the **growth of the root in length**. This region is called the **region of elongation**. The cells of the elongation zone gradually differentiate and mature. Hence, this zone, proximal to region of elongation, is called the **region of maturation**. From this region some of the **epidermal cells** form very **fine and delicate, thread-like structures** called **root hairs**. These root hairs **absorb water and minerals from the soil**.

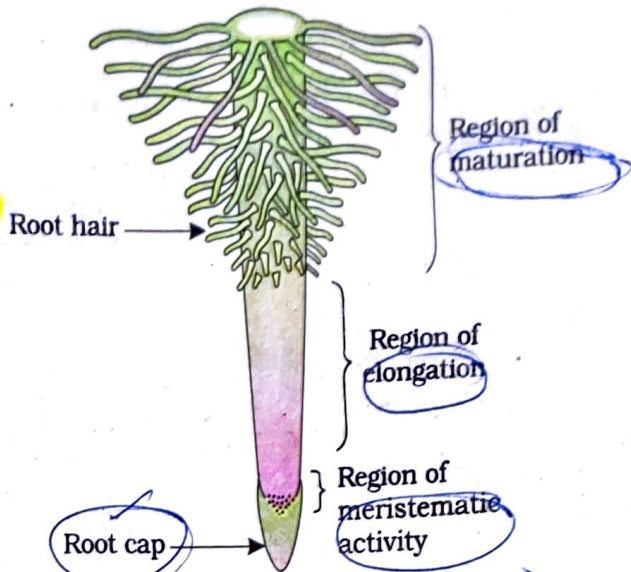


Figure 5.3 The regions of the root-tip
(Examples of storage → Carrot, Radish, Beet, Turnip.)

5.1.2 Modifications of Root

Roots in some plants change their shape and structure and become modified to perform functions other than absorption and conduction of water and minerals. They are modified for support, storage of food and respiration (Figure 5.4 and 5.5). **Tap roots of carrot, turnip and adventitious roots of sweet potato** get swollen and store food. Can you give some more such examples? Have you ever wondered what those **hanging structures that support a banyan tree** are? These are called **prop roots**. Similarly, the stems of **maize and sugarcane** have supporting roots coming out of the **lower nodes of the stem**. These are called **stilt roots**. In some plants such as **Rhizophora** growing in swampy areas, many roots come out of the ground and grow **vertically upwards**. Such roots, called **pneumatophores** help to get oxygen for respiration (Figure 5.5b).

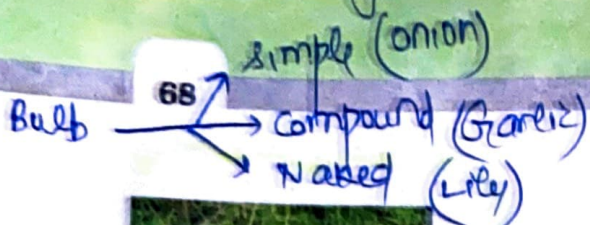


Figure 5.4 (Modification of root for support) Banyan tree → mechanical support

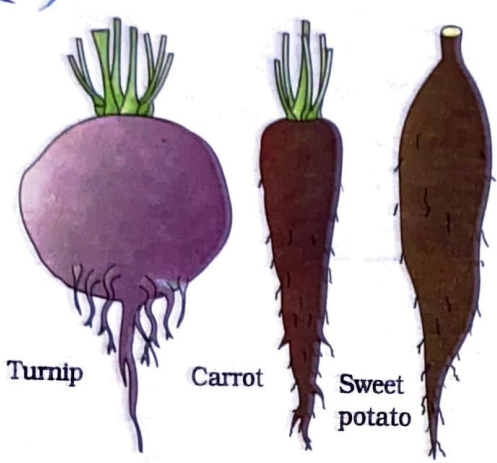
They enter the soil obliquely. → They bear **vertically** called **pneumatophores**. **WRONG!**

Banyan → *Ficus benghalensis*

Healthy root nodules are pink when you cut them open due to leghaemoglobin.



Asparagus



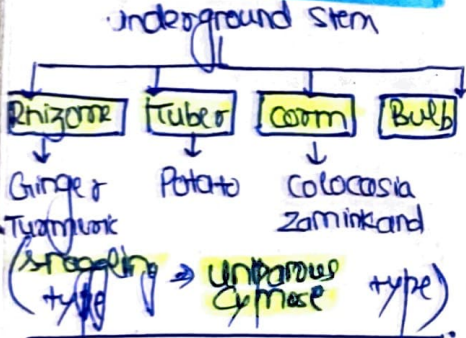
(a) (b)

Storage of root along with *Banisia* & Sweet potato.
Figure 5.5 Modification of root for: (a) storage (b) respiration: pneumatophore in *Rhizophora*
 • Growth of stem & branches through terminal buds.

5.2 THE STEM

AXIS is the angle made by leaf with upper part of stem.

What are the features that distinguish a stem from a root? The stem is ascending part of the axis bearing branches, leaves, flowers and fruits. It develops from the plumule of the embryo of a germinating seed. The stem bears nodes and internodes. The region of the stem where leaves are born are called nodes while internodes are the portions between two nodes. The stem bears buds, which may be terminal or axillary. Stem is generally green when young and later often become woody and dark brown.
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.



5.2.1 Modifications of Stem

Ex. of stem tendrils
 Cucurbita (apical bud), Vitis (modified axillary bud), Passiflora (modified axillary bud)

The stem may not always be typically like what they are expected to be. They are modified to perform different functions (Figure 5.6). Underground stems of potato, ginger, turmeric, zaminkand, Colocasia are modified to store food in them. They also act as organs of perennation to tide over conditions unfavourable for growth. Stem tendrils which develop from axillary buds, are slender and spirally coiled and help plants to climb such as in gourds (cucumber, pumpkins, watermelon) and grapevines. Axillary buds of stems may also get modified into woody, straight and pointed thorns. Thorns are found in many plants such as Citrus, Bougainvillea. They protect plants from browsing animals. Some plants of arid regions modify their stems into flattened (Opuntia), or fleshy cylindrical (Euphorbia) structures. They contain chlorophyll and carry

- Leaf → Lathyrus
- Petiole → Clematis, Nepenthes
- stipule → Smilax
- Leaf Apex → Gloriosa
- Leaf inflorescence → Artigonon

Phylloclad (Aerial)

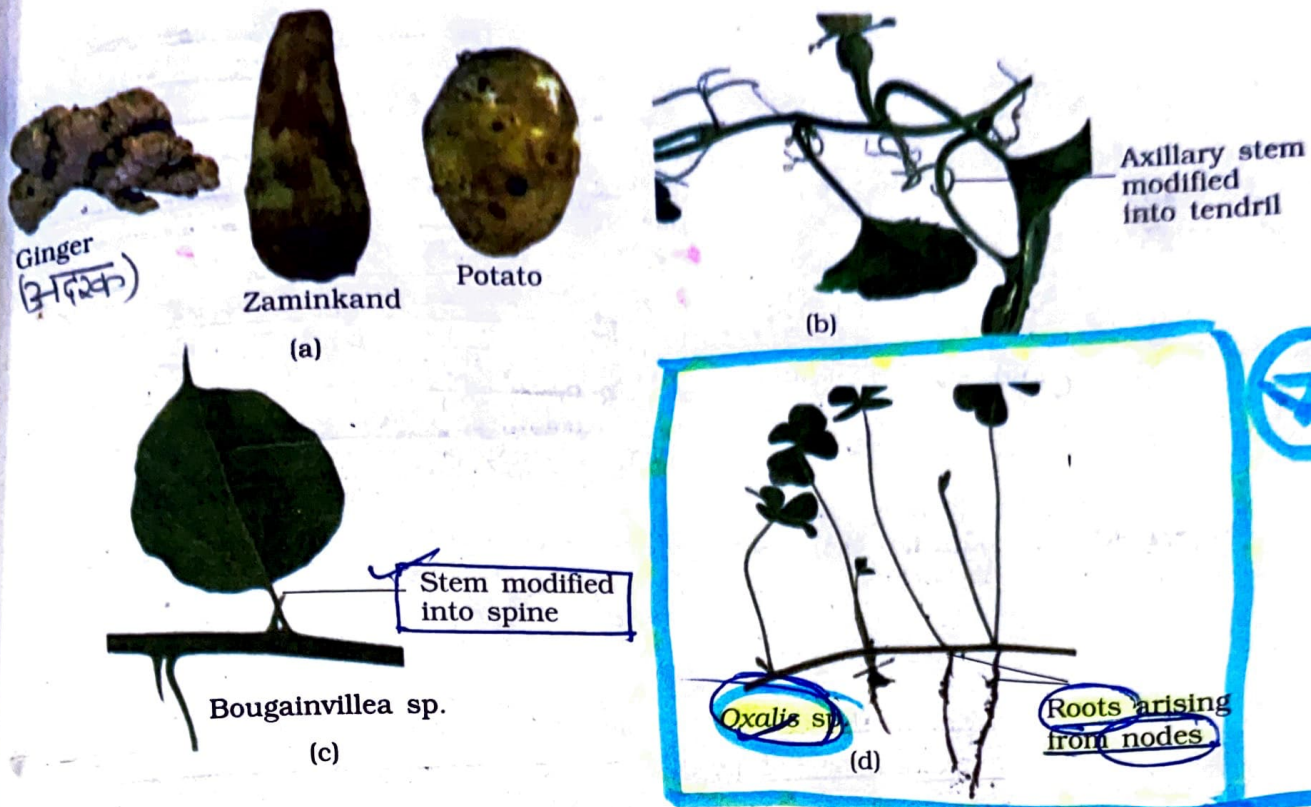
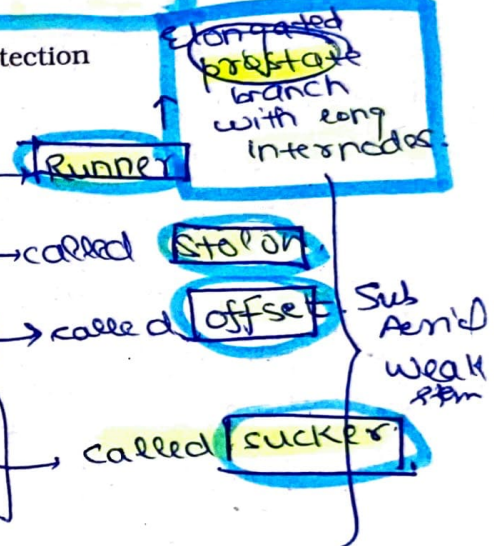


Figure 5.6 Modifications of stem for (a) storage, (b) support, (c) protection (d) spread and vegetative propagation

out photosynthesis. Underground stems of some plants such as grass and strawberry, etc., spread to new niches and when older parts die new plants are formed. In plants like mint and jasmine a slender lateral branch arises from the base of the main axis and after growing aerially for some time arch downwards to touch the ground. A lateral branch with short internodes and each node bearing a rosette of leaves and a tuft of roots is found in aquatic plants like Pistia and Eichhornia. In banana, pineapple and Chrysanthemum, the lateral branches originate from the basal and underground portion of the main stem, grow horizontally beneath the soil and then come out obliquely upward giving rise to leafy shoots.



5.3 THE 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. They are the most important vegetative organs for photosynthesis.

A typical leaf consists of three main parts: leaf base, petiole and lamina (Figure 5.7 a). The leaf is attached to the stem by the leaf base and may

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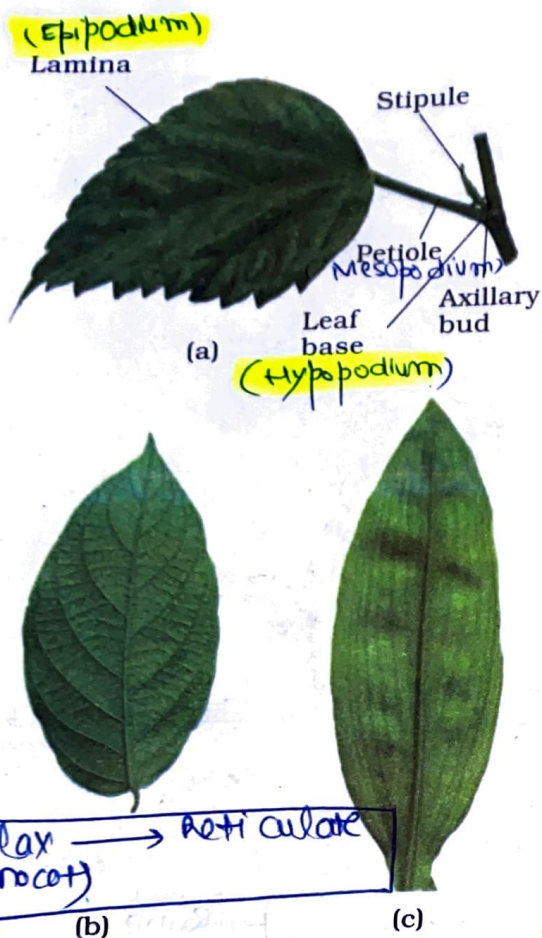


Figure 5.7 Structure of a leaf :
 (a) Parts of a leaf
 (b) Reticulate venation
 (c) Parallel venation

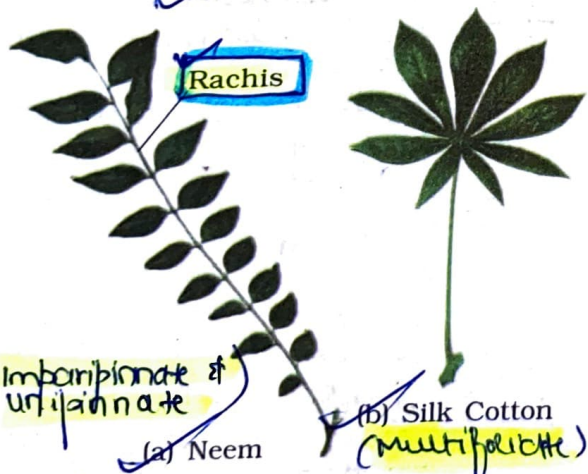


Figure 5.8 Compound leaves :
 (a) pinnately compound leaf
 (b) palmately compound leaf

bear two (lateral) small leaf like structures called **stipules**. In monocotyledons, the leaf base expands into a sheath covering the stem partially or wholly. In some leguminous plants the leaf base may become swollen, which is called the **pulvinus**. The petioles help hold the blade to light. Long thin flexible petioles allow leaf blades to flutter in wind, thereby cooling the leaf and bringing fresh air to leaf surface. The lamina or the leaf blade is the green expanded part of the leaf with veins and veinlets. There is, usually, a middle prominent vein, which is known as the **midrib**. Veins provide rigidity to the leaf blade and act as channels of transport for water, minerals and food materials. The shape, margin, apex, surface and extent of incision of lamina varies in different leaves.

5.3.1 Venation

The arrangement of veins and the veinlets in the lamina of leaf is termed as **venation**. When the veinlets form a network, the venation is termed as **reticulate** (Figure 5.7 b). When the veins run parallel to each other within a lamina, the venation is termed as **parallel** (Figure 5.7 c). Leaves of dicotyledonous plants generally possess **reticulate venation**, while **parallel venation** is the characteristic of most monocotyledons.

5.3.2 Types of Leaves

A leaf is said to be **simple**, when its lamina is entire or when incised, the incisions do not touch the midrib. When the incisions of the lamina reach up to the midrib breaking it into a number of leaflets, the leaf is called **compound**. A bud is present in the axil of petiole in both simple and compound leaves, but not in the axil of leaflets of the compound leaf.

The compound leaves may be of two types (Figure 5.8). In a **pinnately compound leaf** a number of leaflets are present on a common axis, the **rachis**, which represents the midrib of the leaf as in neem.

In **palmately compound leaves**, the leaflets are attached at a **common point** i.e., at the **tip of petiole**, as in **silk cotton**.

5.3.3 Phyllotaxy

Phyllotaxy is the **pattern of arrangement of leaves on the stem or branch**. This is usually of three types - **alternate**, **opposite** and **whorled** (Figure 5.9). In **alternate** type of phyllotaxy, a **single leaf arises at each node** in **alternate manner**, as in **china rose**, **mustard** and **sun flower** plants. In **opposite** type, a **pair of leaves arise at each node** and lie opposite to each other as in **Calotropis** and **guava** plants. If **more than two leaves arise at a node** and form a **whorl** it is called **whorled**, as in **Alstonia**.

alternate
MSC

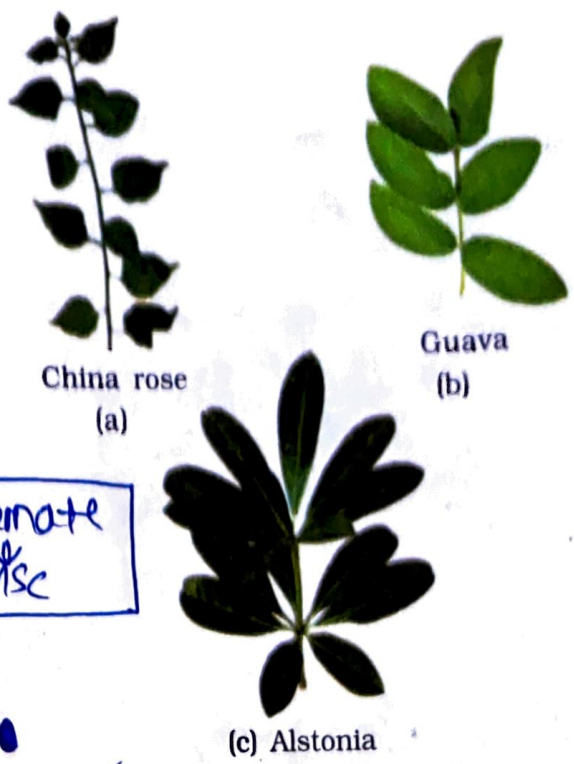
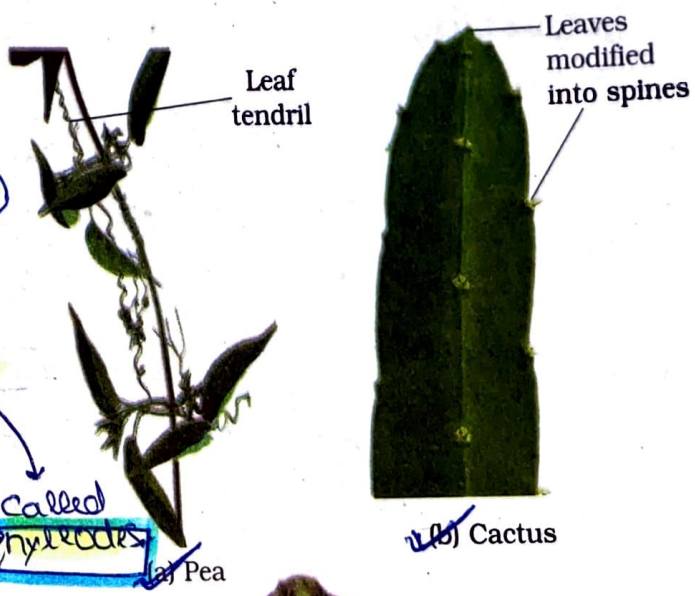


Figure 5.9 Different types of phyllotaxy :
(a) Alternate (b) Opposite
(c) Whorled

5.3.4 Modifications of Leaves

Leaves are often modified to perform functions other than photosynthesis. They are converted into **tendrils** for climbing as in **peas** or into **spines** for defence as in **caeti** (Figure 5.10 a, b). The **fleshy leaves of onion** and **garlic store food** (Figure 5.10c). In some plants such as **Australian acacia**, the leaves are **small and short-lived**. The **petioles in these plants expand, become green and synthesise food**. Leaves of certain insectivorous plants such as **pitcher plant**, **venus-fly trap** are also modified leaves.



called
phyllodes

5.4 THE INFLORESCENCE

A flower is a **modified shoot** wherein the **shoot apical meristem changes to floral meristem**. **Internodes do not elongate** and the **axis gets condensed**. The apex produces different kinds of floral appendages laterally at successive nodes instead of leaves. **When a shoot tip transforms into a flower, it is always solitary**. The arrangement of flowers on the

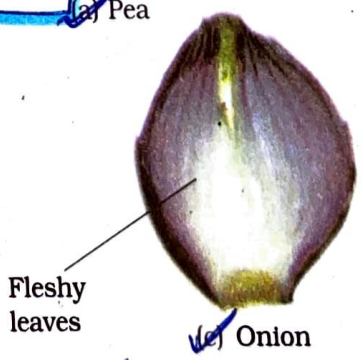


Figure 5.10 Modifications of leaf for :
(a) support: tendril (b) protection: spines (c) storage: fleshy leaves



Figure 5.11 Racemose inflorescence (Radish)

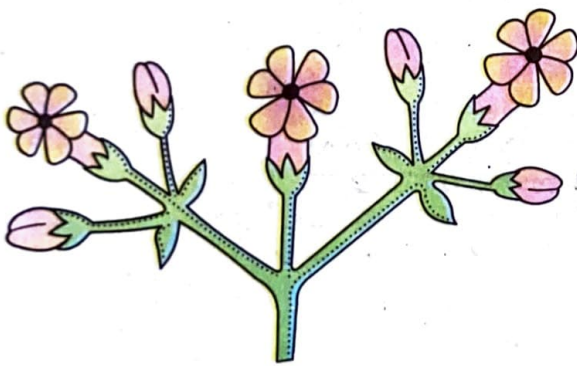


Figure 5.12 Cymose inflorescence (Dianthus, Teak, Begonia, Bougainvillea)

floral axis is termed as **inflorescence**. Depending on whether the apex gets developed into a flower or continues to grow, two major types of inflorescences are defined - racemose and cymose. In **racemose** type of inflorescences the **main axis continues to grow**, the flowers are **borne laterally in an acropetal succession** (Figure 5.11).

In **cymose** type of inflorescence the main axis terminates in a flower, hence is limited in growth. The flowers are borne in a **basipetal order** (Figure 5.12).

5.5 THE FLOWER

The flower is the **reproductive unit** in angiosperms. It is meant for sexual reproduction. A typical flower has **four different kinds of whorls** arranged successively on the swollen end of the stalk or pedicel, called **thalamus or receptacle**. These are calyx, corolla, androecium and gynoecium. **Calyx and corolla are accessory organs**, while androecium and gynoecium are reproductive organs. In some flowers like lily, the calyx and corolla are not distinct and are termed as **perianth**. When a flower has both androecium and gynoecium, it is **bisexual**. A flower having either only stamens or only carpels is **unisexual**.

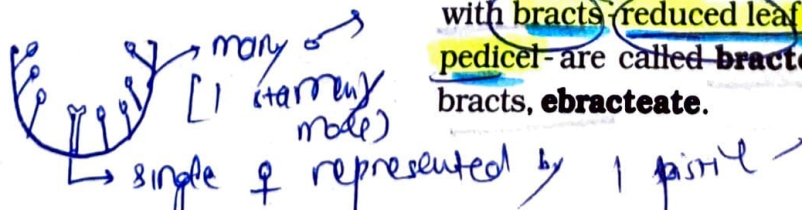
In symmetry, the flower may be **actinomorphic (radial symmetry)** or **zygomorphic (bilateral symmetry)**. When a flower can be divided into two equal radial halves in **any radial plane** passing through the centre, it is said to be **actinomorphic**, e.g. **mustard, datura, chilli**. When it can be divided into two similar halves only in **one particular vertical plane**, it is **zygomorphic**, e.g. **pea, gulmohar, bean, Cassia**. A flower is **asymmetric (irregular)** if it cannot be divided into two similar halves by any vertical plane passing through the centre, as in **canna**.

A flower may be **trimerous, tetramerous or pentamerous** when the floral appendages are in multiple of 3, 4 or 5, respectively. Flowers with **bracts (reduced leaf found at the base of the pedicel)** are called **bracteate** and those without bracts, **ebracteate**.

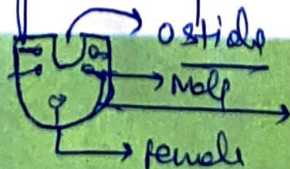
special inflorescence

① verticillaster

② cyathium



③ Hypanthodium



(verte) short staked gall. flower

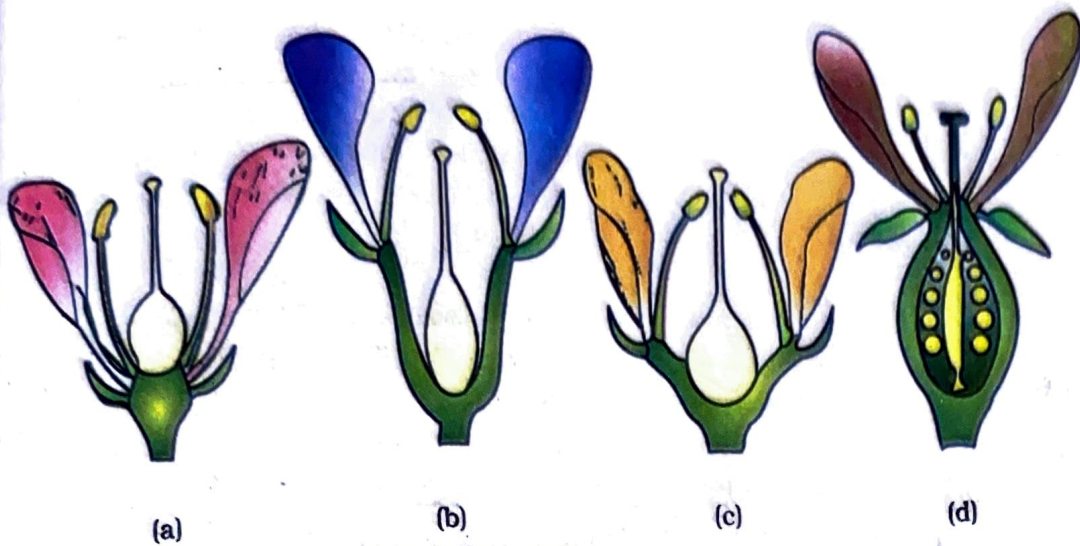


Figure 5.13 Position of floral parts on thalamus : (a) Hypogynous (b) and (c) Perigynous (d) Epigynous

Based on the position of calyx, corolla and androecium in respect of the ovary on thalamus, the flowers are described as hypogynous, perigynous and epigynous (Figure 5.13). In the **hypogynous** flower the **gynoecium occupies the highest position** while the other parts are situated below it. The ovary in such flowers is said to be **superior**, e.g., **mustard**, **china rose** and **brinjal**. If gynoecium is situated in the centre and other parts of the flower are located on the rim of the thalamus almost at the same level, it is called **perigynous**. The ovary here is said to be **half inferior**, e.g., **plum**, **rose**, **peach**. In **epigynous flowers**, the margin of thalamus grows upward enclosing the ovary completely and getting fused with it, the other parts of flower arise above the ovary. Hence, the ovary is said to be **inferior** as in flowers of **guava** and **cucumber**, and the **ray florets of sunflower** and **Bitter melon**.

peripheral
 pistillate or neuter
 & zygomorphic.
 (disc flower → Actinomorphic
 & bisexual)

5.5.1 Parts of a Flower

Each flower normally has four floral whorls, viz., calyx, corolla, androecium and gynoecium (Figure 5.14).

5.5.1.1 Calyx

The calyx is the outermost whorl of the flower and the members are called **sepals**. Generally, sepals are green, leaf like and protect the flower in the **bud stage**. The calyx may be **gamosepalous** (sepals united) or **polysepalous** (sepals free).

5.5.1.2 Corolla

Corolla is composed of **petals**. **Petals are usually brightly coloured** to attract insects for **pollination**. Like calyx, corolla may also be

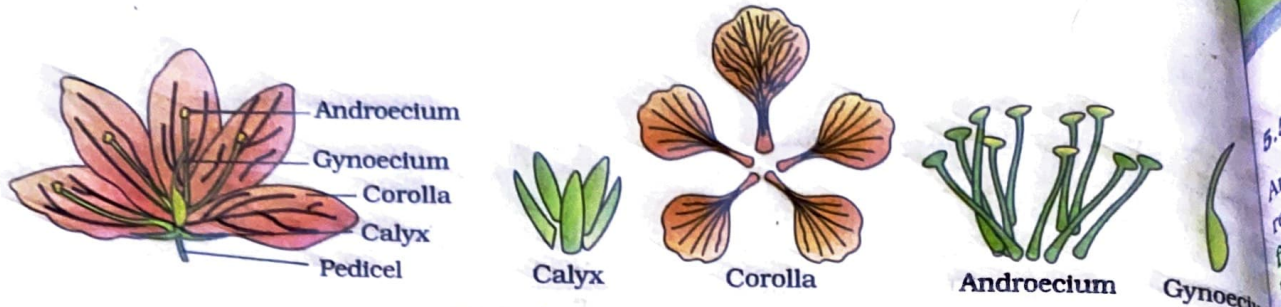


Figure 5.14 Parts of a flower

Edible parts

- wheat → whole fruit
- cashew nut → cotyledon & thalassus.
- Litchi → Aril seeds
- Ground Nut → (Cormentum)
- Coconut → endosperm
- Walnut → cotyledons
- Banana (Berry) → Meso + Endo carp
- Betel Nut → seeds

gamopetalous (petals united) or **polypetalous** (petals free). The shape and colour of corolla vary greatly in plants. Corolla may be tubular, bell-shaped, funnel-shaped or wheel-shaped.

Aestivation: The mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whorl is known as aestivation. The main types of aestivation are **valvate**, **twisted**, **imbricate** and **vexillary** (Figure 5.15). When sepals or petals in a whorl just touch one another at the margin, **without overlapping**, as in **Calotropis**, it is said to be **valvate**. If one margin of the appendage overlaps that of the next one and so on as in **china rose, lady's finger and cotton**, it is called **twisted**. If the margins of sepals or petals overlap one another but **not in any particular direction** as in **Cassia and gulmohur**, the aestivation is called **imbricate**. In **pea and bean flowers**, there are **five petals**, the largest (**standard**) overlaps the two lateral petals (**wings**) which in turn overlap the two smallest anterior petals (**keel**); this type of aestivation is known as **vexillary** or **papilionaceous**.

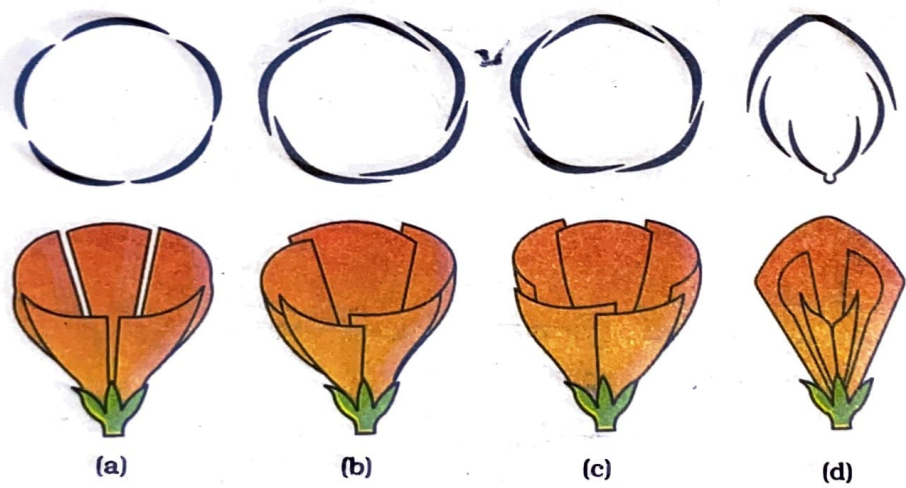


Figure 5.15 Types of aestivation in corolla: (a) Valvate (b) Twisted (c) Imbricate (d) Vexillary

5.5.1.3 Androecium

Androecium is composed of **stamens**. Each stamen which represents the male reproductive organ consists of a **stalk or a filament** and an **anther**. Each anther is usually bilobed and each lobe has two chambers, the **pollen-sacs**. The pollen grains are produced in pollen-sacs. A **sterile stamen** is called **staminode**.

Stamens of flower may be united with other members such as petals or among themselves. When stamens are attached to the petals, they are **epipetalous** as in **brinjal** or **epiphylous** when attached to the perianth as in the flowers of **lily**. The stamens in a flower may either remain free (**polyandrous**), or may be united in varying degrees. The stamens may be united into one bunch or one bundle (**monoadelphous**) as in **china rose**, or two bundles (**diadelphous**) as in **pea**, or into more than two bundles (**polyadelphous**) as in **citrus**. There may be a variation in the length of filaments within a flower, as in **Salvia** and **mustard**.

5.5.1.4 Gynoecium

Gynoecium is the female reproductive part of the flower and is made up of one or more **carpels**. A carpel consists of three parts namely **stigma**, **style** and **ovary**. **Ovary** is the enlarged basal part, on which lies the elongated tube, the **style**. The style connects the ovary to the stigma. The **stigma** is usually at the tip of the **style** and is the receptive surface for pollen grains. Each ovary bears one or more **ovules** attached to a **flattened, cushion-like placenta**. When more than one carpel is present, they may be free (as in **lotus** and **rose**) and are called **apocarpous**. They are termed **syncarpous** when carpels are fused, as in **mustard** and **tomato**. After fertilisation, the ovules develop into seeds and the ovary matures into a fruit.

Placentation: The arrangement of ovules within the ovary is known as placentation. The placentation are of different types namely, **marginal**, **axile**, **parietal**, **basal**, **central** and **free central** (Figure 5.16). In **marginal** placentation the placenta forms a ridge along the ventral suture of the ovary and the ovules are borne on this ridge forming two rows, as in **pea**. When the placenta is axial and the ovules are attached to it in a multilocular ovary, the placentation is said to be **axile**, as in **china rose**, **tomato** and **lemon**. In **parietal** placentation, the ovules develop on the inner wall of the ovary or on peripheral part. Ovary is one-chambered but it becomes two-chambered due to the formation of the false septum, e.g., **mustard** and **Argemone**. When the ovules are borne on central axis and septa are absent, as in **Dianthus** and **Primrose** the placentation is

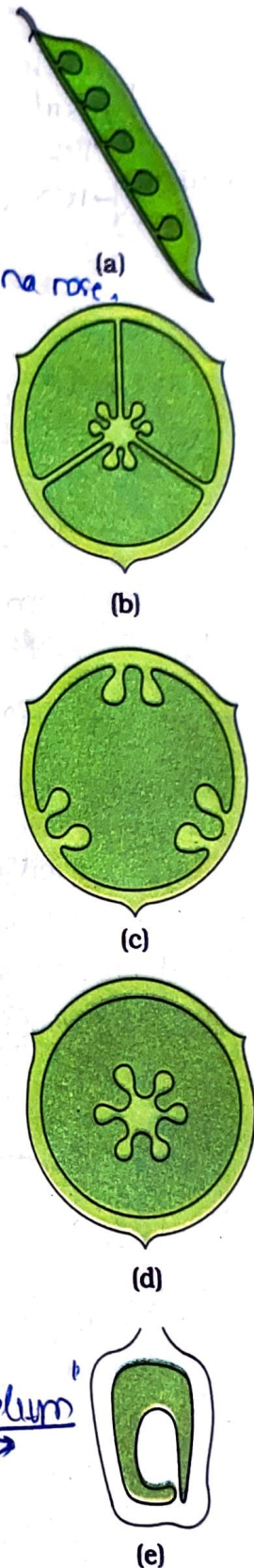
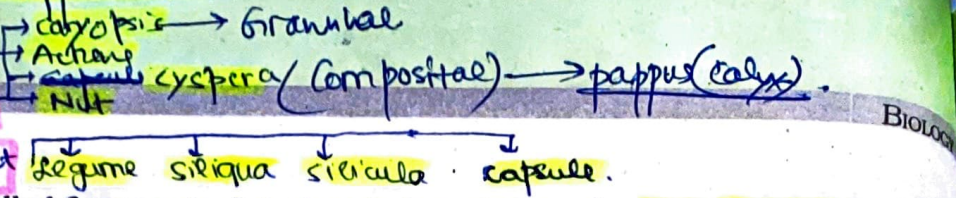
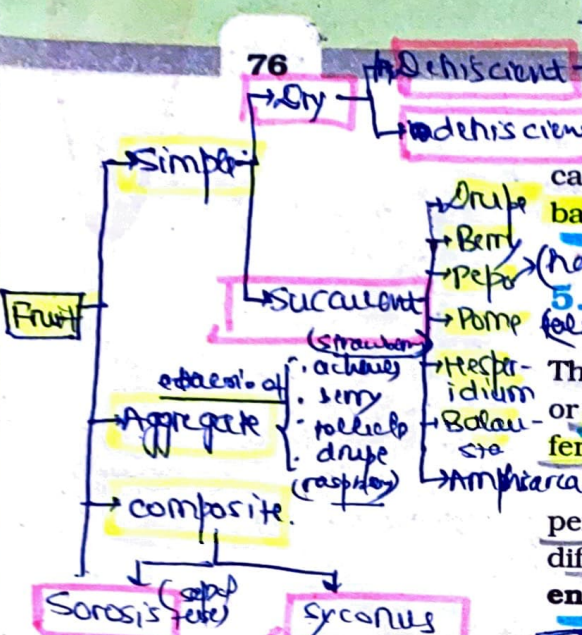


Figure 5.16 Types of placentation :
 (a) Marginal
 (b) Axile
 (c) Parietal
 (d) Free central
 (e) Basal

Fruits which develop from floral parts other than ovary are called false fruits (pseudocarp), ex- Apple, Pear.



called **free central**. In **basal** placentation, the placenta develops at the base of ovary and a single ovule is attached to it, as in sunflower, marigold.

5.6 THE FRUIT

The fruit is a characteristic feature of the flowering plants. It is a mature or ripened ovary, developed after fertilisation. If a fruit is formed without fertilisation of the ovary, it is called a **parthenocarpic** fruit.

Generally, the fruit consists of a wall or **pericarp** and seeds. The pericarp may be dry or fleshy. When pericarp is thick and fleshy, it is differentiated into the outer **epicarp**, the middle **mesocarp** and the inner **endocarp**.

ex: Banana, Orange, Grapes.

Simple fruits develop from syncarpous ovary of single flower with/without accessory organs. **Aggregate** fruits are formed from polycarpellary or carpous ovary. Multiple fruits develop from one seed berry → Betel Nut.

Pepo → sometimes fruit bitter due to "tetracyclic + triterpenes."

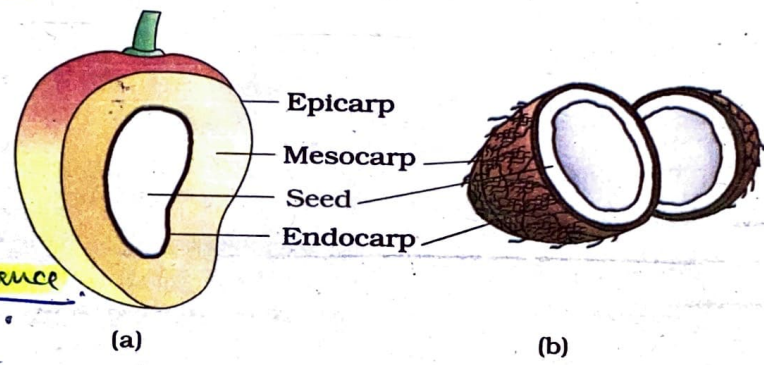


Figure 5.17 Parts of a fruit : (a) Mango (b) Coconut

In mango and coconut, the fruit is known as a **drupe** (Figure 5.17). They develop from monocarpellary superior ovaries and are one seeded. In mango the pericarp is well differentiated into an outer thin epicarp, a middle fleshy edible mesocarp and an inner stony hard endocarp. In coconut which is also a drupe, the mesocarp is fibrous.

Hesperidium → Rind/skin
Epi + Mesocarp

Balausta → edible juicy testa.

Amphisarca → Meso + endo

5.7 THE SEED

The ovules after fertilisation, develop into seeds. A seed is made up of a seed coat and an embryo. The embryo is made up of a radicle, an embryonal axis and one (as in wheat, maize) or two cotyledons (as in gram and pea).

Sycosis → develop from hypanthodium.
fruitless achenial in nature

5.7.1 Structure of a Dicotyledonous Seed

The outermost covering of a seed is the seed coat. The seed coat has two layers, the outer **testa** and the inner **tegmen**. The **hilum** is a scar on the seed coat through which the developing seeds were attached to the fruit. Above the hilum is a small pore called the **micropyle**. Within the seed

coat is the embryo, consisting of an embryonal axis and two cotyledons. The cotyledons are often fleshy and full of reserve food materials. At the two ends of the embryonal axis are present the radicle and the plumule (Figure 5.18). In some seeds such as castor the endosperm formed as a result of double fertilisation, is a food storing tissue and called endospermic seeds. In plants such as bean, gram and pea, the endosperm is not present in mature seeds and such seeds are called non-endospermous.

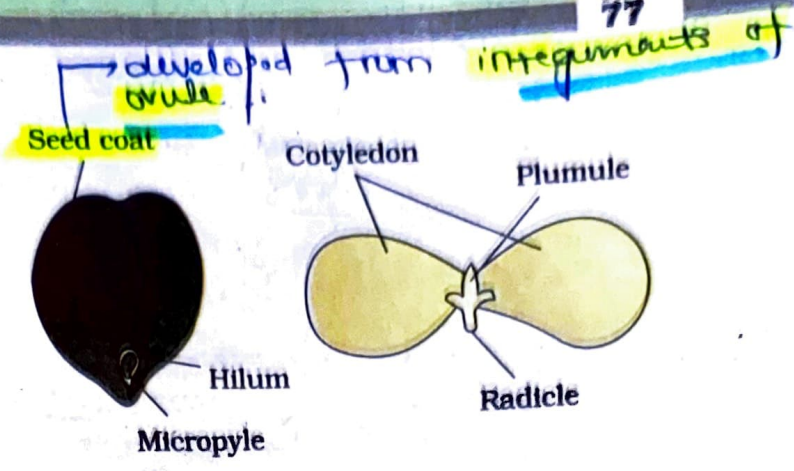


Figure 5.18 Structure of dicotyledonous seed

Perispermic seed → seeds in which nucellus remains persistent (called perisperm).
ex- Piper, Nigam, Black Pepper

5.7.2 Structure of Monocotyledonous Seed

Generally, monocotyledonous seeds are endospermic but some as in orchids are non-endospermic. In the seeds of cereals such as maize the seed coat is membranous and generally fused with the fruit wall. The endosperm is bulky and stores food. The outer covering of endosperm separates the embryo by a proteinous layer called aleurone layer. The embryo is small and situated in a groove at one end of the endosperm. It consists of one large and shield shaped cotyledon known as scutellum and a short axis with a plumule and a radicle. The plumule and radicle are enclosed in sheaths which are called coleoptile and coleorhiza respectively (Figure 5.19).

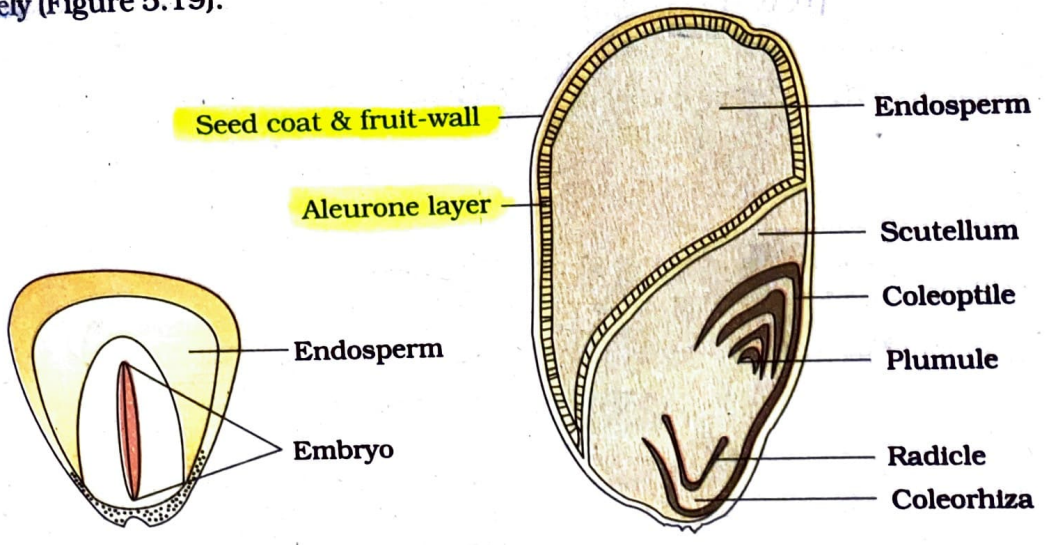
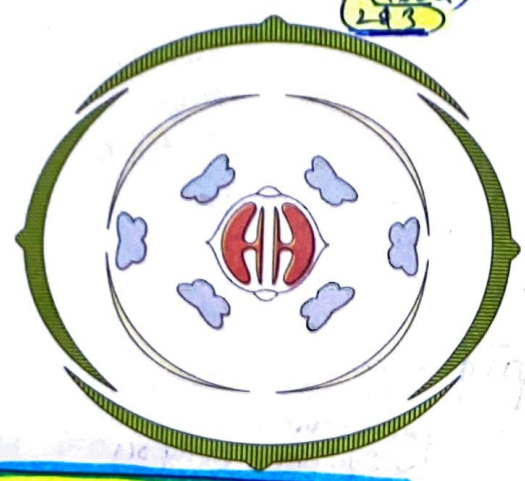


Figure 5.19 Structure of a monocotyledonous seed

- ✓ Inflorescence → corymb/corymbose Raceme.
- ✓ Tetramerous flowers
- ✓ cruciform corolla
- ✓ Tetradynamous condition. (sometimes didynamous)
- ✓ Bicarpellary, Syncarpous, superior, unilocular
- 78 ovary (later become bilocular),
- ✓ Parietal placentation, stigma bifid.
- ✓ Fruit → silique, siliqua.



$$Ebr \uparrow \oplus \uparrow \uparrow K_{2+2} C_4 A_{2+4} \underline{G}_{(2)}$$

Figure 5.20 Floral diagram with floral formula
(Mustard)

represent posterior side of flower.

5.8 SEMI-TECHNICAL DESCRIPTION OF A TYPICAL FLOWERING PLANT

Various morphological features are used to describe a flowering plant. The description has to be brief, in a simple and scientific language and presented in a proper sequence. The plant is described beginning with its habit, vegetative characters - roots, stem and leaves and then floral characters inflorescence and flower parts. After describing various parts of plant, a floral diagram and a floral formula are presented. The floral formula is represented by some symbols. In the floral formula, **B** stands for bracteate **K** stands for calyx, **C** for corolla, **P** for perianth, **A** for androecium and **G** for Gynoecium, \overline{G} for superior ovary and \underline{G} for inferior ovary, σ^7 for male, ρ^7 for female, ρ^7 for bisexual plants, \oplus for actinomorphic and $\%_0$ for zygomorphic nature of flower. Fusion is indicated by enclosing the figure within bracket and adhesion by a line drawn above the symbols of the floral parts. A floral diagram provides information about the number of parts of a flower, their arrangement and the relation they have with one another (Figure 5.20). The position of the midrib axis with respect to the flower is represented by a dot at the top of the floral diagram. Calyx, corolla, androecium and gynoecium are drawn in successive whorls, calyx being the outermost and the gynoecium being in the centre. Floral formula also shows cohesion and adhesion within parts of whorls and between whorls. The floral diagram and floral formula in Figure 5.20 represents the mustard plant (Family: Brassicaceae).

5.9 DESCRIPTION OF SOME IMPORTANT FAMILIES

5.9.1 Fabaceae

This family was earlier called Papilionoideae, a subfamily of family Leguminosae. It is distributed all over the world (Figure 5.21).

Vegetative Characters

Trees, shrubs, herbs; root with root nodules

Stem: erect or climber

Leaves: alternate, pinnately compound or simple; leaf base, pulvinate; stipulate venation reticulate.

• leaves of leaflet modified into tendrils

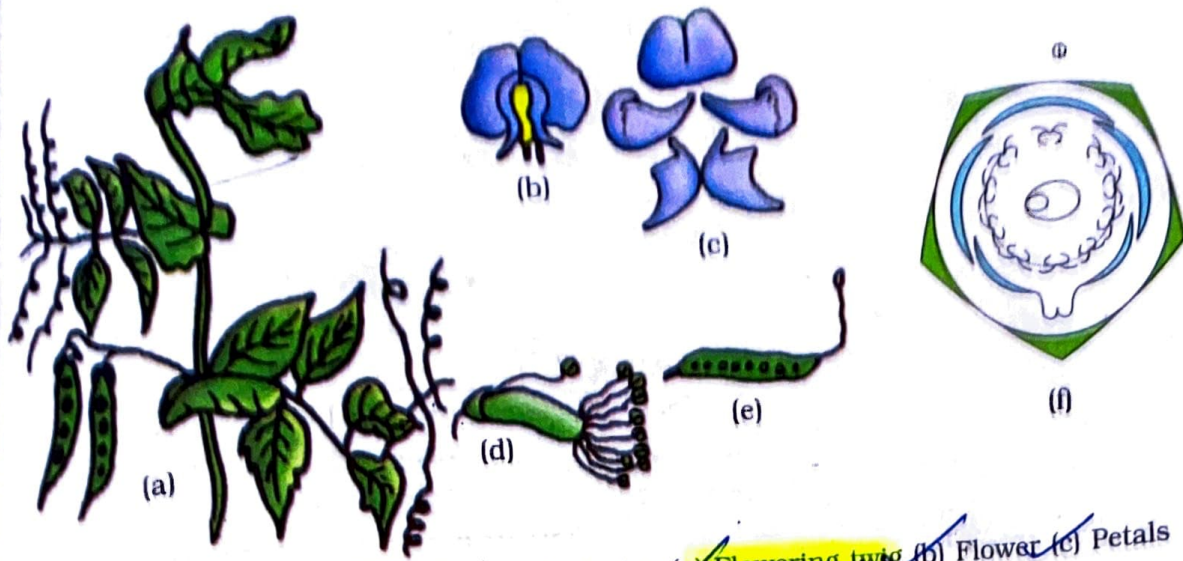


Figure 5.21 *Pisum sativum* (pea) plant : (a) Flowering twig (b) Flower (c) Petals (d) Reproductive parts (e) L.S. carpel (f) Floral diagram

Floral characters

Inflorescence: racemose

Flower: bisexual, zygomorphic

Calyx: sepals five, gamosepalous; valvate/imbricate aestivation

Corolla: petals five, polypetalous, papilionaceous, consisting of a posterior standard, two lateral wings, two anterior ones forming a keel (enclosing stamens and pistil), vexillary aestivation

Androecium: ten diadelphous, anther ditheous

Gynoecium: ovary superior, mono carpellary, unilocular with many ovules; style single

Fruit: legume; seed: one to many, non-endospermia, arranged in 2 alternate rows.

Floral Formula $\% \underset{\text{♀}}{\text{O}} \text{K}_{(5)} \text{C}_{1+2+(2)} \text{A}_{(9)+1} \text{G}_1$

Economic importance

Many plants belonging to the family are sources of pulses (gram, arhar, sem, moong, soyabean), edible oil (soyabean, groundnut), dye (Indigofera), fibres (sunhemp), fodder (Sesbania, Trifolium), ornamentals (lupin), sweet pea; medicine (muliathi).

5.9.2 Solanaceae

It is a large family, commonly called as the 'potato family'. It is widely distributed in tropics, subtropics and even temperate zones (Figure 5.22).

Vegetative Characters

Plants mostly herbs, shrubs and rarely small trees.

Stem: herbaceous rarely woody, aerial; erect, cylindrical, branched, solid

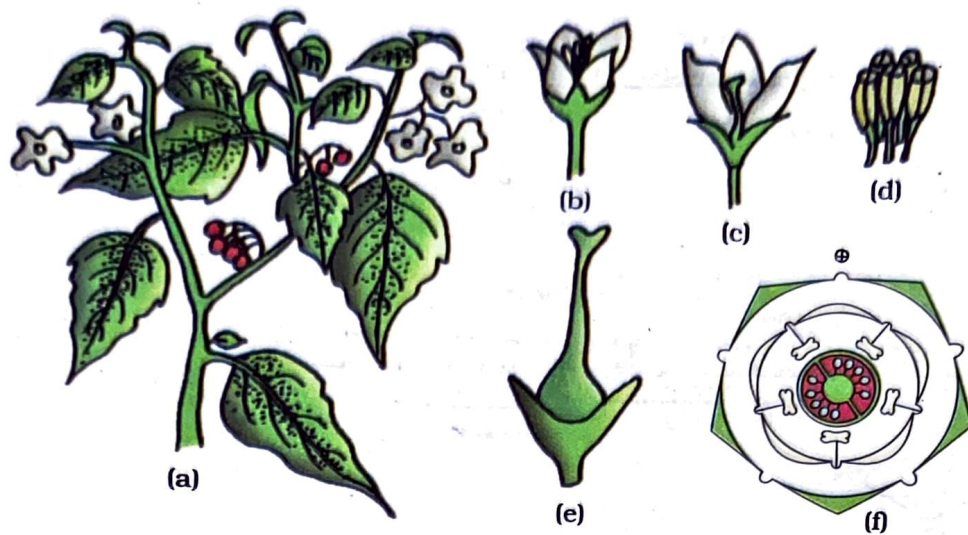


Figure 5.22 *Solanum nigrum* (makoi) plant : (a) Flowering twig (b) Flower (c) L.S. of flower (d) Stamens (e) Carpel (f) Floral diagram

or hollow, hairy or glabrous, underground stem in potato (*Solanum tuberosum*)

Leaves: alternate, simple, rarely pinnately compound, exstipulate; venation reticulate

Floral Characters

Inflorescence Solitary axillary or cymose as in *Solanum*

Flower: bisexual, actinomorphic

Calyx: sepals five, united, persistent, valvate aestivation

Corolla: petals five, united; valvate aestivation

Androecium: stamens five, epipetalous

← **Gynoecium:** bicarpellary, obligately placed, syncarpous; ovary superior, bilocular, placenta swollen with many ovules, axile

Fruits: berry or capsule → dry dehiscent (2nd)

Seeds: many, endospermous

Floral Formula: $\oplus \bar{Q} K_{(5)} C_{(5)} A_5 \underline{G}_{(2)}$

Economic Importance

Many plants belonging to this family are source of food (tomato, brinjal, potato), spice (chilli); medicine (belladonna, ashwagandha); fumigatory (tobacco), ornamentals (petunia).

"oblique septa"

succulent (2nd)

5.9.3 Liliaceae

Commonly called the 'Lily family' is a characteristic representative of monocotyledonous plants. It is distributed world wide (Figure 5.23).

Vegetative characters: Perennial herbs with underground bulbs/corms/rhizomes

Leaves mostly basal, alternate, linear, exstipulate with parallel venation

Floral characters

Inflorescence: solitary / cymose; often umbellate clusters

Flower: bisexual; actinomorphic

Perianth tepal: six (3+3), often united into tube; valvate aestivation

Androecium: stamen six, 3+3, epitepalous

Gynoecium: tricarpeal, syncarpous, ovary superior, trilocular with many ovules; axile placentation

Fruit: capsule, rarely berry

Seed: endospermous

Floral Formula: $\text{Br} \oplus \frac{\text{P}_{(3+3)} \text{A}_{3+3} \text{G}_{(3)}}{\text{C}}$

Economic Importance

Many plants belonging to this family are good ornamentals (tulip, Gloriosa), source of medicine (Aloe), vegetables (Asparagus), and colchicine (Colchicum autumnale).

POACEAE

Most advanced monocots,



2 scales
Lemma & Palea.

$\frac{0}{\text{C}}$ $\frac{\text{P}_{2 \text{ or } 3} \text{A}_{3 \text{ or } 6} \text{G}_{1}}{\text{C}}$
(Podiculus) (versatile) (anther)

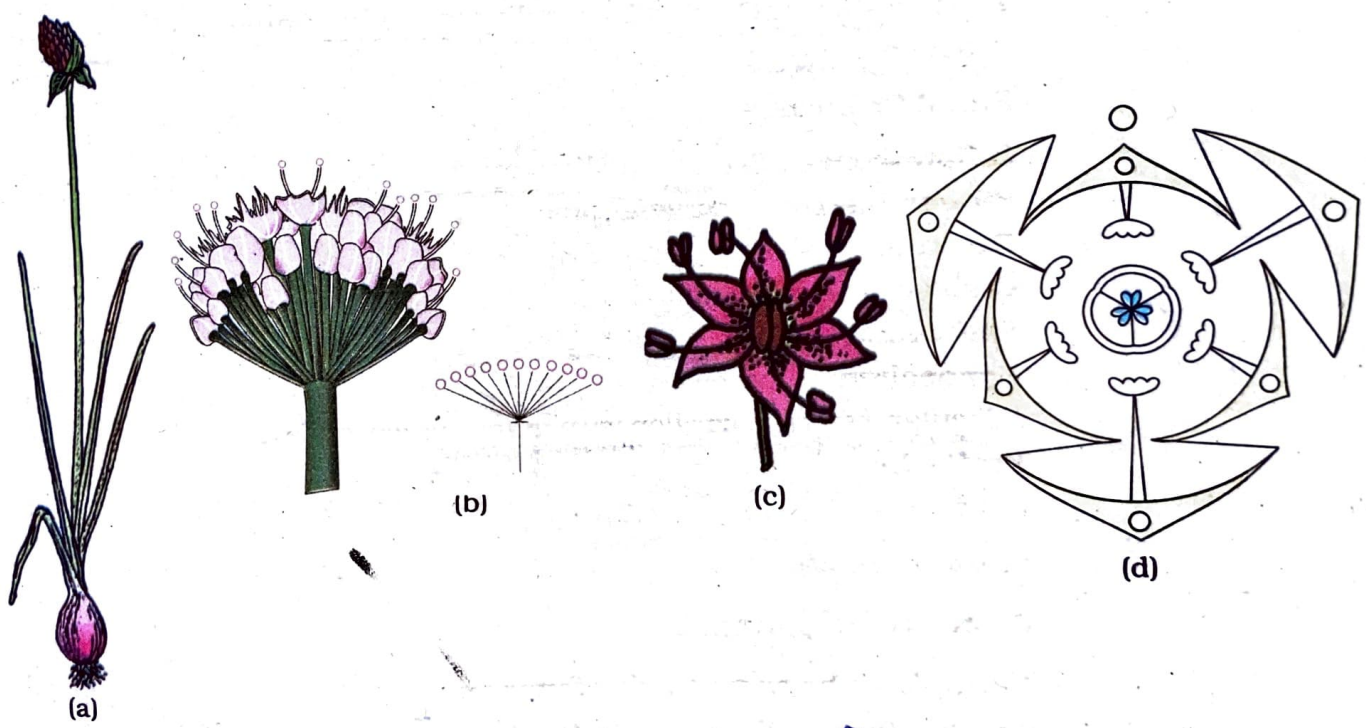


Figure 5.23 *Allium cepa* (onion) plant : (a) Plant (b) Inflorescence (c) Flower (d) Floral diagram

SUMMARY

Flowering plants exhibit enormous variation in shape, size, structure, mode of nutrition, life span, habit and habitat. They have well developed root and shoot systems. Root system is either tap root or fibrous. Generally, dicotyledonous plants have tap roots while monocotyledonous plants have fibrous roots. The roots in some plants get modified for storage of food, mechanical support and respiration. The shoot system is differentiated into stem, leaves, flowers and fruits. The morphological features of stems like the presence of nodes and internodes, multicellular hair and positively phototropic nature help to differentiate the stems from roots. Stems also get modified to perform diverse functions such as storage of food, vegetative propagation and protection under different conditions. Leaf is a lateral outgrowth of stem developed exogeneously at the node. These are green in colour to perform the function of photosynthesis. Leaves exhibit marked variations in their shape, size, margin, apex and extent of incisions of leaf blade (lamina). Like other parts of plants, the leaves also get modified into other structures such as tendrils, spines for climbing and protection respectively.

The flower is a modified shoot, meant for sexual reproduction. The flowers are arranged in different types of inflorescences. They exhibit enormous variation in structure, symmetry, position of ovary in relation to other parts, arrangement of petals, sepals, ovules etc. After fertilisation, the ovary is modified into fruits and ovules into seeds. Seeds either may be monocotyledonous or dicotyledonous. They vary in shape, size and period of viability. The floral characteristics form the basis of classification and identification of flowering plants. This can be illustrated through semi-technical descriptions of families. Hence, a flowering plant is described in a definite sequence by using scientific terms. The floral features are represented in the summarised form as floral diagrams and floral formula.

EXERCISES

1. What is meant by modification of root? What type of modification of root is found in the:
(a) Banyan tree (b) Turnip (c) Mangrove trees
2. Justify the following statements on the basis of external features:
(i) Underground parts of a plant are not always roots.
(ii) Flower is a modified shoot.
3. How is a pinnately compound leaf different from a palmately compound leaf?
4. Explain with suitable examples the different types of phyllotaxy.

5. Define the following terms:

- (a) aestivation (b) placentation (c) actinomorphic
(d) zygomorphic (e) superior ovary (f) perigynous flower
(g) epipetalous stamen

6. Differentiate between

- (a) Racemose and cymose inflorescence
(b) Fibrous root and adventitious root
(c) Apocarpous and syncarpous ovary

7. Draw the labelled diagram of the following:

- (i) gram seed (ii) V.S. of maize seed

8. Describe modifications of stem with suitable examples.

9. Take one flower each of the families Fabaceae and Solanaceae and write its semi-technical description. Also draw their floral diagram after studying them.

10. Describe the various types of placentations found in flowering plants.

11. What is a flower? Describe the parts of a typical angiosperm flower.

12. How do the various leaf modifications help plants?

13. Define the term inflorescence. Explain the basis for the different types of inflorescence in flowering plants.

14. Write the floral formula of a actinomorphic, bisexual, hypogynous flower with five united sepals, five free petals, five free stamens and two united carpels with superior ovary and axile placentation.

15. Describe the arrangement of floral members in relation to their insertion on thalamus.