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BIOLOGY

Standard 11

(Semester II)

PLEDGE

India is my country.
All Indians are my brothers and sisters.
I love my country and I am proud of its rich and varied heritage.
I shall always strive to be worthy of it.
I shall respect my parents, teachers and all my elders and treat everyone with courtesy.
I pledge my devotion to my country and its people.
My happiness lies in their well-being and prosperity.

રાજ્ય સરકારની વિનામૂલ્યે યોજના હેઠળનું પુસ્તક

Gujarat State Board of School Textbooks
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PREFACE

The Gujarat State Secondary and Higher Secondary Education Board has prepared new syllabi in accordance with the new national syllabi prepared by the NCERT based on NCF-2005 and core-curriculum. These syllabi are sanctioned by the Government of Gujarat.

It is a pleasure for the Gujarat State Board of School Textbooks to place before the students this textbook of **Biology, Standard 11, (Semester II)** prepared according to the new syllabus.

Before publishing the textbook, its manuscript has been fully reviewed by experts and teachers teaching at this level. Following suggestions given by teachers and experts. We have made necessary changes in the manuscript before publishing the textbook.

The board has taken special care to ensure that this textbook is interesting, useful and free from errors. However, we welcome any suggestion, from people interested in education, to improve the quality of the textbook.

Dr. Bharat Pandit
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FUNDAMENTAL DUTIES

It shall be the duty of every citizen of India

(A) **to abide by the Constitution and respect its ideals and institutions, the National Flag and the National Anthem;**

(B) **to cherish and follow the noble ideals which inspired our national struggle for freedom;**

(C) **to uphold and protect the sovereignty, unity and integrity of India;**

(D) **to defend the country and render national service when called upon to do so;**

(E) **to promote harmony and the spirit of common brotherhood amongst all the people of India transcending religious, linguistic and regional or sectional diversities; to renounce practices derogatory to the dignity of women;**

(F) **to value and preserve the rich heritage of our composite culture;**

(G) **to protect and improve the natural environment including forests, lakes, rivers and wild life, and to have compassion for living creatures;**

(H) **to develop the scientific temper, humanism and the spirit of inquiry and reform;**

(I) **to safeguard public property and to abjure violence;**

(J) **to strive towards excellence in all spheres of individual and collective activity so that the nation constantly rises to higher levels of endeavour and achievement;**

(K) **to provide opportunities for education by the parent or the guardian, to his child or a ward between the age of 6-14 years as the case may be.**

* Constitution of India : Section 51-A

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About this book...

This book of Biology promises to be a feast for those students who are passionate about the subject and are ready to explore ever expanding vistas of knowledge. The book is aimed at providing what is latest in the study of living beings. It offers an opportunity for the learner to undertake the in-depth study of the subject satisfying his dual needs – scoring marks in the exam and nurturing his love for the subject as well. Besides if the theory is understood keeping in mind all important practicals, it will surely turn his learning into a most enjoyable experience.

The syllabus of Biology is treated as a long continuum for the students of higher secondary for both 11^{th} and 12^{th} standard. The chapters are designed and carefully crafted in order to present the sequential development of the kingdom of living beings on the earth. The books of Biology in Semester I and Semester II are like two rings in a chain properly linked and bonded together thereby displaying the image of a complete whole. What is learnt in Semester I complements the advanced studies in Semester II. There are different chapters dealing with various disciplines of Biology. Starting from biochemistry and ultra-structure of cells, there are various chapters on plant anatomy and animal tissue along with the function of their components. There are chapters illuminating the different facets of plant organs like roots, stems, leaves, flowers, fruits and seeds. The detailed study of the anatomy and morphology of plants leads to the study of 'families' and the families are explained in detail by the description of three plant species.

Just as the animal cell was the focus of study in semester I, tissue organization by cells is the highlight of the present book. This will surely stimulate the learner with burning curiosity. There will be new found inquisitiveness among our learners. There will be questions galore : how is the organ system made up of tissues ? What are the different types of patterns in lower and higher groups of animals ? For the satisfactory answers to all these questions, morphology and anatomy of three different types of animals have been selected. Ceolomic earthworm gives an idea how it exists without appendages and restricted organ system. Unlike Ceolomic earthworm, Cockroach is slightly developed with appendages. Both these animals represent invertebrates while a frog is a typical example of vertebrates. There is a separate chapter dwelling on its organ system.

The intricacies and various nuances of the animal kingdom along with the complexities of varied world of plants have fascinated the humanbeings for centuries. It is really challenging to fully understand and probe the mind-boggling mysteries of all living beings. This book is an attempt to unravel some of those secrets of existence. Here is an opportunity for the learners to challenge the limits of knowledge and follow the path of some of the great geniuses of life sciences.

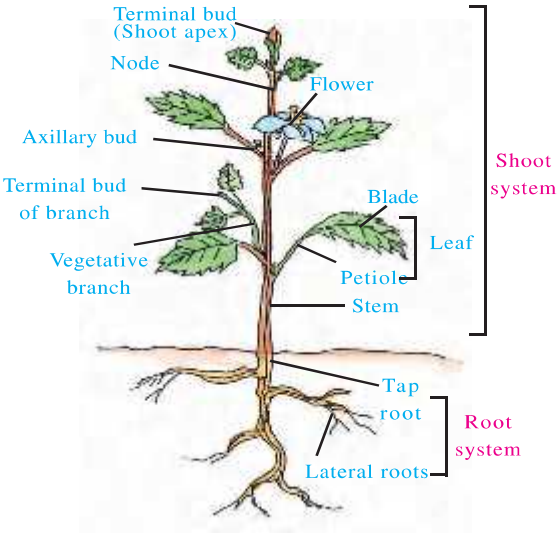
1

Plant Morphology-1
(Root, Stem and Leaf)

The flowering plants are the most dominant plants on the earth today. About 3 lac species of this group exist. They exhibit great variations in their size, form, structure, etc. *Lemna* is a very small aquatic plant. *Sequoia* and *Eucalyptus* are very tall plants. Some are herbs, some are shrubs. Some are trees and some are climbers. Some are annuals whereas some are perennials old. In their lifestyles, they may be xerophytic hydrophytic, epiphytic or parasitic.

The plants can be studied through their external as well as their internal characters.

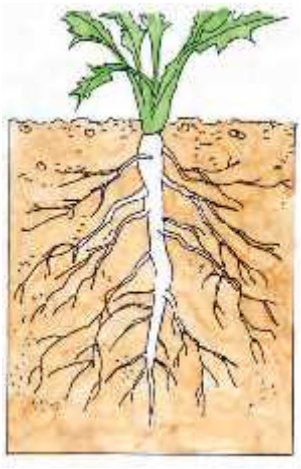
A typical flowering plant possesses an unbranched or branched axis. From this axis, lateral appendages are produced. The main axis is generally divided into two parts – an underground part root and an above ground part shoot. They are also called a root system and a shoot system. The root system develops from the radicle and the shoot system develops from the plumule. The shoot system consists of stem, leaves, flowers, etc. The flowers produce fruits and seeds. Seeds produce new plants.



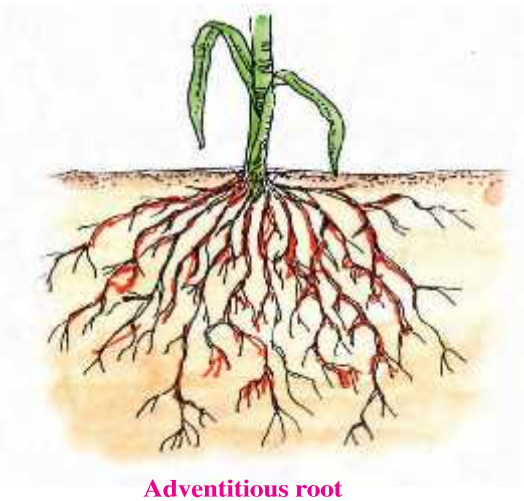
Typical plant

(I) Root : Root is the underground part of the plant axis. It develops from the radicle. It is positively geotropic and hydrotropic and negatively phototropic. It lacks chlorophyll.

The primary structure developing from the radicle is called primary root. From its secondary and tertiary branches arise. If the primary root develops longer and stronger than its branches then it is called a tap root.



Tap root



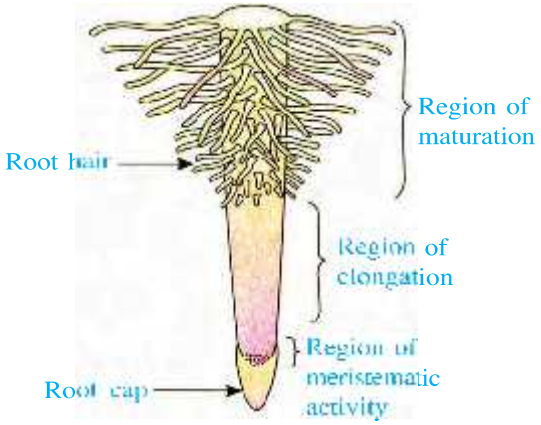
Adventitious root

The root system developing from a tap root is called tap root system. In dicotyledonous plants tap root system occurs.

A root developing from a radicle is called a normal root. A root developing from any part other than the radicle is called an adventitious root. Such roots may develop from hypocotyl, stem or leaf parts. In monocot plants, the primary root is shortlived. Later on thin fibrous roots develop from the hypocotyl and the basal region of stem. Such roots are called fibrous roots and the root system formed by them is called fibrous root system.

Regions of the Root

Regions of root include the apical meristematic region surrounded by protective rootcap, the elongation region and the maturation region.



Regions of root

- **Root cap :** It surrounds the meristematic region of the root apex e.g : *Pandanus*. In aquatic plants like *Pistia*, it occurs as a loose covering which is called root pocket.
- **Meristematic region :** The cells of this region undergo constant cell divisions and add new cells. These cells are small with thin walled and filled with protoplasm.
- **Region of Elongation :** The cells of this region increase rapidly in size and length and induce growth in length and width.
- **Region of Maturation :** The cells of this region differentiates and form tissue structure. From this region then delicate fibrous root hairs are produced. This region is also known as root hair region. The new branches are produced from the permanent region located after this region.

Normal Functions of Root

(1) Fixation : To fix the plant properly in the soil and to develop a proper hole in soil.

(2) Absorption : To absorb water and various minerals from soil and to conduct them to the base of stem axis.

Special functions of Root :

Special adaptations are essential for performing special functions. Such adaptations cause modification in the concerned organs.

Modifications of roots for special functions

(1) Storage of food : Sometimes, the extra food prepared by leaves is stored in roots. Such roots are underground, fleshy and of various shapes. The stored food helps the plant in tiding over the dormancy.

(A) Modifications of tap roots : In Carrot, Radish and Beet, tap root stores food and becomes fleshy. **In carrot,** the food storing root becomes conical. It is called conical tap root. In **Radish,** it becomes fusiform in shape and hence it is called fusiform tap root. In **Beet,** entire food is stored in the basal part of the root. Hence the root suddenly tapers into a thin thread-like structure. Such a root is called napiform tap root.

Beet

Carrot

Radish

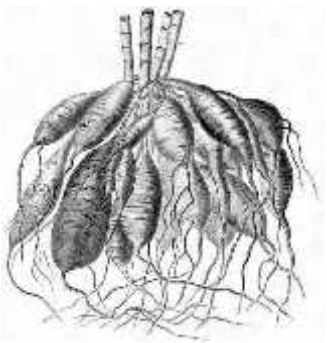
Root : Modifications of tap roots for storage of food

(B) Modifications of adventitious fibrous roots : When a fibrous root stores food and becomes fleshy, it is called a **tuberous root.**

In **Sweet Potato,** a creeper plant, isolated adventitious fibrous roots, developing from the stem, become tuberous in shape. These roots have irregular shapes and are called simple, tuberous, roots.

In ***Asparagus*** and ***Dahlia*,** tuberous roots occur in a cluster. Such clusters are called fasciculated tuberous roots.

Sweet Potato - Simple tuberous root



Dahlia - fasciculated tuberous root

Root- Modification for storage of food

(2) Mechanical Support :

(A) Stilt roots : In Maize and ***Pandanus*** adventitious roots arise from node of the stem nearer to the ground. These roots grow obliquely downwards, enter the soil and provide mechanical support. The need for additional support arises because the underground root systems are superficial. These roots are called stilt roots.

Maize Pandanus

Stilt roots

Banyan Tree - Prop root

(B) Prop Roots : The root system of **Banyan** tree possesses a strong hold in the soil. Its aerial branches grow horizontally. Gradually they become thick and heavy. They may snap under their own weight. To prevent this, prop roots develop. Prop roots are rope-like and develop in groups. They grow downwards, enter the soil and develop prop roots. Later, they become thick and pillar-like.

(3) Climbing : Plants growing as twinners and climbers possess weak stems. They possess modified structures for climbing. In ***Pothos***, long branched or unbranched, brown adventitious roots develop from nodes and internodes of the stem. They are called **climbing** or **clinging** roots. They secrete a sticky material which helps them to stick to the support, and helps them in climbing.

Pothos Root-Modification for climbing

(4) Photosynthesis : ***Tinospora*** is a twinner and grows very rapidly. The leaves on the stem are few and small. They cannot fulfill the food requirement of plant. Thin, smooth, green and thread like adventitious roots develop suspended from the stem. These roots are called **assimilatory roots.** They carry out photosynthesis.

Tinospora Root – Modification for photosynthesis

(5) Breathing : The specialized groups of plants which inhabit the saline, waterlogged soil of creeks near coastal regions are called Mangroves. ***Rhizophora*** and ***Avicennia*** are such

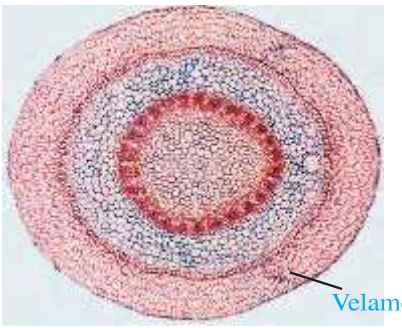
Mangroves

Pneumatophore

plants. They produce negatively geotropic and positively phototropic aerial roots from their underground roots. These roots are spongy, long and possess a large number of lenticels. They may be branched or unbranched. Sufficient oxygen reaches the underground root system through these lenticels and the exchange of gases becomes easy. These roots are called pneumatophores.

(6) Absorption of Moisture : Some **Orchids** live as epiphytes on the branches of trees in forests. They obtain only a habitat from the host. They do not obtain water, salts or prepared food from the host. They have no contact with soil. They produce some adventitious roots which remain suspended in air. These roots are spongy, thick, long and greenish. A specialized velamen tissue occurs on their outer surface. The cells of this tissue are polygonal, thick walled and arranged in many layers and absorb moisture from atmosphere. They are called epiphytic roots.

Orchid



T. S. of epiphytic root

(7) Parasitism : Some plants are dependent on other plants for their nutrition. They are called parasitic plants.

Cuscuta

Loranthus

Parasitism

Cuscuta is a nongreen, leafless plant. Its stem is yellow and twining. It is a total parasite. It develops suckers or haustoria at places of close contact with the host plant. Through these haustoria it establishes direct contact between its own conducting tissues and the conducting tissues of the host. These haustoria suck water, minerals and prepared food from the host. Such 'suckers' act as parasitic roots. Cuscuta is a total parasite.

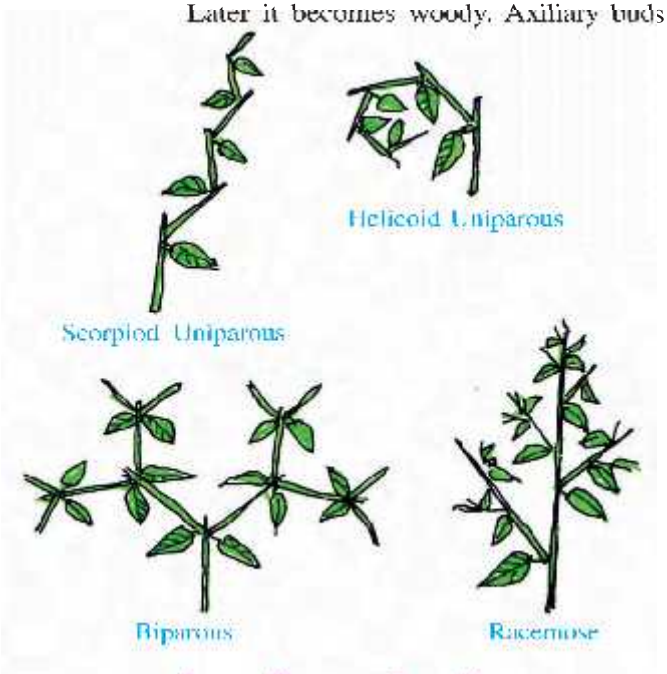
Loranthus lives on the branches of trees like mango. It absorbs only water and minerals from host through its haustoria. As it possesses green leaves, it prepares its food using them. Thus *Loranthus* is a partial parasite.

Symbiosis-Root nodules

(8) Symbiosis : The leguminous plants like **Bean, Groundnut** and others possess small or large nodules on their root systems. These are called root nodules. Nitrogen-fixing *Rhizobium* bacteria live in these root nodules. These bacteria convert atmospheric nitrogen into absorbable salts through nitrogen fixation. These salts are available to the plants. In return, the bacteria obtain a habitat and nutrition. Such a mutually beneficial relationship is called symbiosis and the roots are called symbiotic roots.

(9) Vegetative Propagation : Adventitious buds occur on tuberous roots of plants like sweet potato take part in reproduction.

(II) Stem : It is the aerial part of plant axis. It develops from plumule. It is negatively geotropic and hydrotropic and positively Phototropic. It is distinguished into nodes and internodes. Leaves arise from nodes. The region between two successive nodes is called internode. An apical bud occurs at the tip of stem. It causes growth in elongation of main axis. An axillary bud occurs in the axil of a leaf. An axil is the angle formed by a leaf with the stem at the node. In the beginning, the stem is green. Later it becomes woody. Axiliary buds develop new branches.



Cymose/Racemose branching

Branching

The development and arrangement of branches on stem is called branching. Two main types of branching occur :

(1) Dichotomous branching : The apical bud continuously divides into two branches, which also continue to do the same, e. g : Hyphaene (palm)

(2) Lateral branching : The branches are produced on lateral sides. There are two types of lateral branching — Racemose and Cymose.

In racemose type of branching, the axillary buds on the main axis produce new branches continuously in an acropetal fashion.


Hyphaene


Polyalthea


Vitis

These branches develop and also do the same. As a result the plant develops a conical or a pyramidal shape. e.g. *Polyalthea; Cassuarina.* As all the branches arise from a single main axis, such an axis is called monopodial axis. In cymose type of branching, the apical bud of the main axis becomes inactive after sometime. A branch develops from the axillary bud located in the axil of the leaf just under it. If a single branch develops in this way, it is called uniparous cymose branching. If all such branches are formed only on one side, either right or left, it is called helicoid, uniparous branching, e. g: *Ashoka*. If the branches are formed alternately both sides, it is called scorpioid, uniparous branching. e.g : *Vitis.* If two branches develop, the branching is called biparous, cymose branching. e.g : *Mirabilis, Carissa.* If more than two branches develop in this way, the branching is called multiparous, cymose branching, e.g. **:** *Red oleander, Croton***.** If the axis of the stem is formed by union of many lateral branches, it is called a sympodial axis. e.g. *Vitis.*

Stem may be aerial or underground. Aerial stem in most plants is erect, strong and woody. In some cases, the stems are delicate, threadlike and weak. Such plants either live prostrate on ground or they live as climbers or twinners. They develop special structures for climbing.

Underground stems occur inside the soil. They are devoid of chlorophyll, and generally possess small scaly leaves. They sometimes store food. In favourable season, they produce aerial leaves. They also carry out vegetative propagation. The food stored in them provides nourishment during dormancy period.

Normal Functions of Stem

(1) To arrange the leaves in such a way that they obtain sufficient light.

(2) To arrange reproductive organs like flowers, fruits and seeds in such a way that pollination, fertilization and dispersal of seeds can be properly carried out.

(3) To conduct water and minerals, absorbed by the roots, towards leaves and to transport food prepared by leaves to other organs of the plant.

Special Functions of stem

Under specific condition, the stem performs special functions. They are as follow.

(1) Storage of food : Underground stems are modified for storage of food. In **Ginger,** the underground stem grows parallel to the ground surface. It becomes fleshy

through storage of food. It possesses nodes, internodes, scaly leaves and adventitious roots. Such a modified stem is called rhizome or rootstock. Another example of this kind is Turmeric. In the axils of the underground scaly leaves of Potato plant branches develop. They store food in their apical regions which become round or oval. These are called tubers. Buds with scaly leaves occur in the pits on tubers. These are called 'eyes'. with the help of eyes they can carry out vegetative propagation. In *Amorphophallus*, a condensed form of rhizome occurs which is called corm. It is a food-storing structure made up of only one internode.

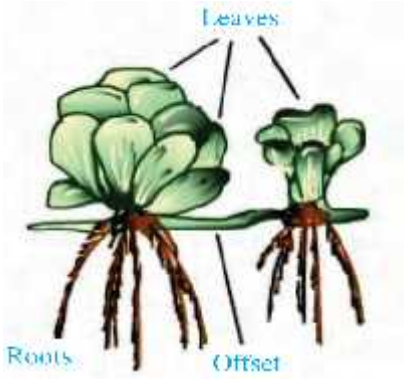
Ginger

Potato

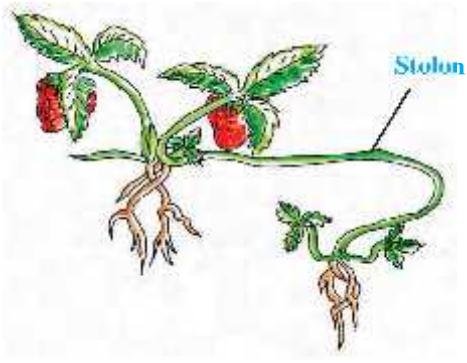
Amorphophallus

Food storage stem

(2) Vegetative Propagation : These modifications are of subaerial stems. A part of the stem is underground and a remaining part is above ground. In Grass, *Oxalis* and *Hydrocotyl*, thin long branches develop. They possess internodes and run parallel to the ground. From the nodes which come in contact with ground, new plants are produced. This modification is called runner. In aquatic plants, *Pistia* and *Eichhornia*, short, thick and horizontal branches develop. Such branches are called offsets. In *Nephrolepis* and *Strawberry,* branches arising from basal regions grow obliquely like arches, come in contact with ground and produce new plants. These branches are called stolons. In Mint vegetative propogation takes place by suckers.



Pistia - Offset



Strawberry - Stolon

Vegetative Propagation

(3) Protection : In some plants, the apical or the axillary bud develops into a sharp pointed structure. It is called thorn. They are protective. In ***Carissa,*** the apical bud is transformed into a bifid, leafless thorn. In ***Lawsonia*** and ***Pomegranate*****,** an axillary bud is transformed into thorn. Sometimes leaves and flowers are borne on thorns. The pointed, curved sharp structures

produced on the surface of stem in rose plant are called prickles. They are not modifications of stem. They are outgrowths from surface.

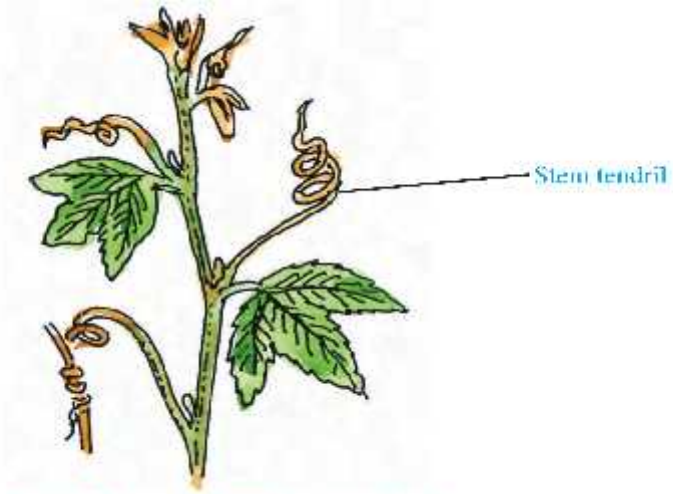
Carissa - Thorn

Lawsonia - Thron

Rose - Prickles

Modification for protection

(4) Climbing : In Passion flower, Cucurbita, Bittergourd, etc. the axillary buds modified into thin, long, threadlike structures. These are called Stem tendrils. They twine around the support and help the plant in climbing.



Passion flower-Modification for climbing

(5) Photosynthesis : Plants like *Muehlenbeckia* and *Opuntia* live in dry habitats. They shed their leaves to reduce transpiration. Their stems become green, possess chloroplasts and are generally flat. Such stems which carry out photosynthesis are called phylloclades.

Muehlenbeckia - Stem modification

Opuntia - Stem modification

Modification for photosynthesis

(6) Storage of food and reproduction : In ***Dioscorea*** and ***Agave*** plants, axiliary buds and floral buds respectively store food and become fleshy. Later on they separate from the parental plant and produce new plants. Such a modified bud is called bulbil.

Dioscorea bulbil

Agave floral bud

(III) Leaf : A leaf is a flat, green and broad lateral appandage developing from the node of a stem or its branch. It possesses an axillary bud in its axil. It has determinate growth.

Typical leaf

There are three parts in a typical leaf leaf base, petiole and lamina. The leaf remains attached to the stem at node through the leafbase. Sometimes a pair of lateral outgrowths develops from the leaf base. They are small and leaf-like. These are called stipules. In plants like Maize, the leafbase expands into a sheath which covers the nodal region. It is called sheathing leaf base. A stalk-like region connecting the leafbase and the lamina is called petiole. It supports the lamina and arranges it for securing proper light. If a petiole occurs, the leaf is called petiolate. If the petiole is absent, the leaf is called sessile. Generally the petiole is round and cylindrical. Lamina is the main part of the leaf. It is broad, flat and green. Veins are distributed in it. There is a great variation in size, shape, margin incision, etc. of lamina. The arrangement of veins and veinlets in lamina is called venation.

Reticulate venation

Parallel venation

Two main types of venation occur - Reticulate venation and Parallel venation. Reticulate venation is observed in dicotyledon leaves. Monocotyledon leaves possess parallel venation. Conducting tissues occur in veins. Both these types of venation are further divided into

two types - unicostate and multicostate. Multicostate venation can be either converging or diverging. The veins transport water, soluble minerals and prepared food. They also form a skeletal network in the lamina.

Simple leaf and compound leaf

If a single lamina occurs in a leaf, it is called a simple leaf. It has an axillary bud in its axil. Sometimes, the lamina appears dissected from the margin. Such incisions divide the lamina to a lesser or a greater degree. However, this incision is not complete. If this incision reaches the midrib or the tip of the petiole, the lamina is divided into independent leaflets. Such a leaf is called a compound leaf. The leaflets of a compound leaf do not possess axillary buds.

A compound leaf may be pinnate or palmate. In a pinnate compound leaf, the leaflets are arranged on both lateral sides of the main vein or midrib. In a palmate compound leaf, the leaflets are arranged on the tip of the petiole. If a single leaflet is so arranged, the leaf is called unifoliate palmate compound leaf (e.g : Lemon). If two leaflets occur, it is called bifoliate, palmate compound leaf (e.g : Balanites) and if many leaflets are thus arranged, it is called multifoliate palmate compound leaf (e.g : *Bombax, Aegle*). In a pinnate compound leaf, if the leaflets are arranged directly on the main midrib, it is called unipinnate compound leaf (e.g. *Cassia)*. If the midrib branches and the leaflets are arranged on these secondary branches, the leaf is called bipinnate compound leaf (e.g. : *Caesalpinia, Acacia*) and if the leaflets are arranged on tertiary or higher order branches, the leaf is called multipinnate compound leaf (e.g. *Moringa*).

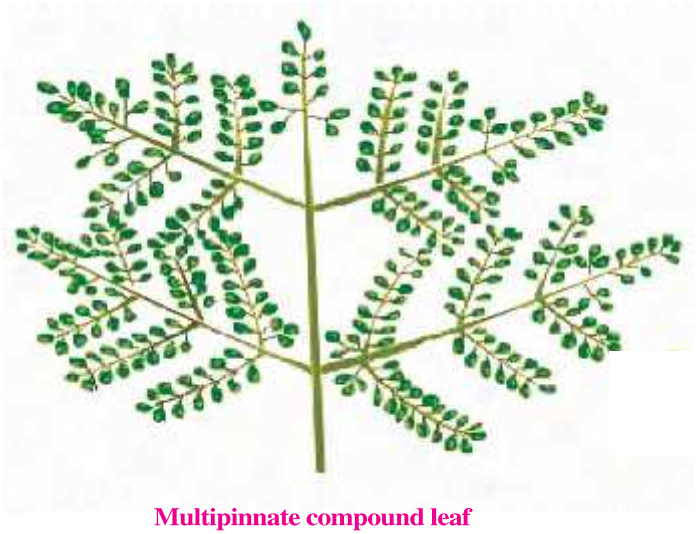
There are some other types of leaves also. The leaf included within a seed is called cotyledon or seedleaf; very small, reduced and papery leaf is called scaly leaf; the leaf from the axil of which a flower develops is called bract. Stamen and carpel are called sporophylls.

Pinnate compound leaf

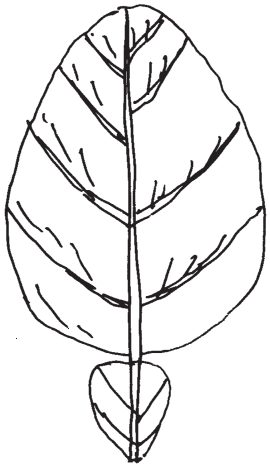
Palmate compound leaf

Unipinnate compound leaf

Bipinnate compound leaf

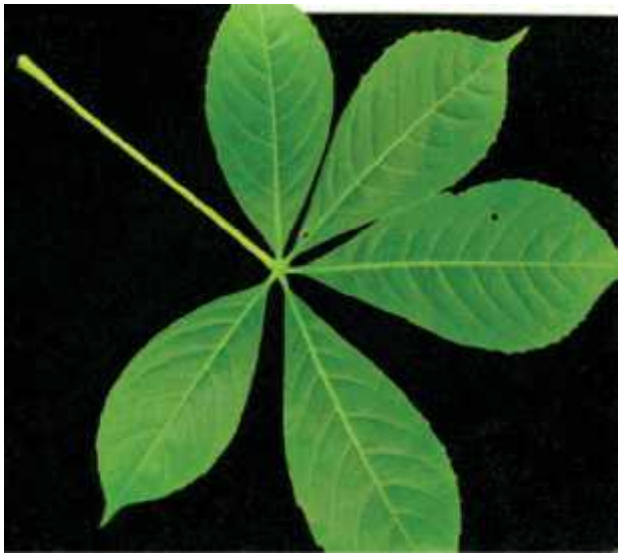


Multipinnate compound leaf



Unifoliate palmate compound leaf

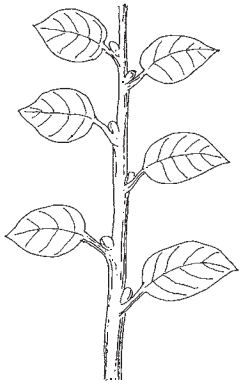
Bifoliate palmate compound leaf



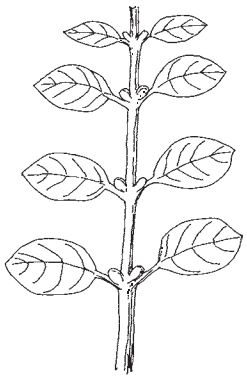
Multifoliate palmate compound leaf

Phyllotaxy

The arrangement of leaves on stem or on its branches is called phyllotaxy. If a single leaf arises from a node, the phyllotaxy is called alternate e.g., Mustard, Sunflower, Hibiscus. In some plants, two leaves arise opposite to each other from a node. This phyllotaxy is called opposite. When the pairs of leaves on successive nodes are arranged at right angle to each other, the phyllotaxy is called opposite decussate, e.g. ***Calotropis*.** If the pair of leaves on successive nodes are arranged overlapping one another, the phyllotaxy is called opposite superimposed, e.g. ***Quisqualis,*** Guava. If more than two leaves are arranged at each node, the phyllotaxy is called whorled, e.g. Red oleander, ***Alstonia***.



Alternate



Opposite superimposed

Opposite decussate

Whorled

Normal Functions of Leaf

(1) To prepare food by carrying out photosynthesis.

(2) To arrange gaseous exchange for respiration.

(3) The loss of water in the form of water vapour (transpiration) occurs through leaves.

Special Functions of Leaf

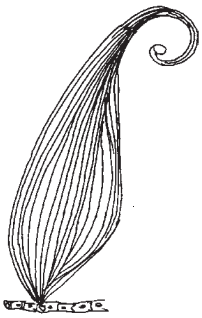
In addition to their normal functions, leaves perform special functions in some plants. They possess modified structures for these functions.

(1) Storage of food : In Onion, the stem is condensed, underground and disc-like. Leaves are arranged concentrically. The main part of leaf is aerial and green. It prepares food. The food is stored in the leaf base. The leaf bases of inner leaves become fleshy. The peripheral leaf bases remain dry and papery. Such a food storing structure is called a tunicated bulb.

(2) Support and climbing : In some plants which possess weak stems, the entire leaf or its part is utilised for climbing.

In *Gloriosa*, the leaf apex becomes tendrillar. In ***Smilax*,** the stipules become tendrillar. In Pea, the terminal leaflets of a compound leaf become tendrillar. In *Bignonia*, three terminal leaflets become hook-like or clawed. Tendrils twine around a support and help the plant in climbing.

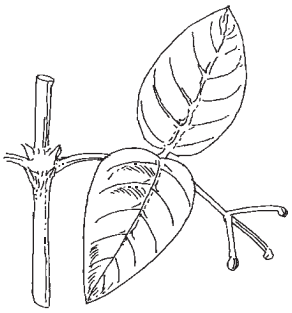
Gloriosa plant



Gloriosa leaf

Pea

Smilax



Bignonia

Leaf-Modification for climbing

(3) Protection : In some plants leaf or some part of the leaf is transformed into a sharp pointed structure which provides protection against grazing animals. In *Acacia* and *Zizyphus*. the stipules become spiny. In *Agave*, the leaf apex becomes spiny. In *Opuntia*, the entire leaf becomes a spine.

Acacia

Zizyphus

Agave

Opuntia

Leaf Modification for protection

(4) Photosynthesis : Photosynthesis is a normal function of leaf. However, it is carried out mainly by the lamina. In Pea, stipules become leaflike and carry out photosynthesis. They are called foliaceous stipules. In Australian *acacia*, the petiole becomes green and flat and prepares food. It is called phyllode.

Phyllode in Australian acacia

Phyllode

Foliaceous stipules in pea

(5) Insectivory : In the insectivorous plant, **Nepenthes,** the leaf is modified into a pitcher. In ***Utricularia***, the leaf is modified into a bladder. These structures are useful in capturing insects.

Nepenthes

Summary

The flowering plants are most dominant plants on the earth today. They exhibit great variation in their external morphology. They have well developed shoot and root systems. Root system is positively geotropic and hydrotropic and negatively phototropic. It develops from the radical. Root systems may be either tap root or fibrous root. Generally dicot plants have tap root system and monocot plants have fibrous root system. Root possesses root cap, meristematics region, region of elongation and region of maturation. The main functions of the root system are fixation of plant in the soil and absorption of water and mineral from the soil.

Roots are modified for various functions like storage of food, mechanical support, climbing, photosynthesis, respiration, absorption of moisture, parasitism and symbiosis and reproduction.

The shoot system is developed from plumule. It is negatively geotropic, positively phototropic and negatively hydrotropic. The shoot system is diffentiated into stem, leaves, flowers and fruits. Stem possesses nodes, internodes, leaves, hairs and axillary and apical

buds. Under specific condition the stem performs diverse functions such as storage of food, reproduction, protection, climbing, and photosynthesis.

A leaf is a flat, green and broad lateral appendage developing from the node of stem or its branches. A typical leaf possesses three parts namely leaf base, petiole and lamina. The arrangement of veins and veinlets in lamina is called venation. Two main types of venations are found – reticulate and parallel. Leaves are also divided into simple and compound leaf. The compound leaf may be of two types: pinnately compound and palmately compound. The arrangement of leaves on stem is called phyllotaxy. This is usually of three types: alternate, opposite and whorled. Leaves are often modified to perform various functions like storage of food, support, climbing and protection.

Exercise

1. Put a dark colour in a given circle for correct answer :

(1) Root is....

(A) Positively phototropic ◯ (B) Positively geotropic ◯

(C) Negatively hydrotropic ◯ (D) None of this ◯

(2) Root pocket is found in which of the following plants ?

(A) Pandanus ◯ (B) Pistia ◯

(C) Maize ◯ (D) Radish ◯

(3) Example of fusiform tap root is.....

(A) Radish ◯ (B) Beet ◯

(C) Carrot ◯ (D) Sweet potato ◯

(4) Fasciculated tuberous root is found in.....

(A) Dahlia ◯ (B) Beet ◯

(C) Sweet potato ◯ (D) Maize ◯

(5) Function of prop root is.....

(A) Reproduction ◯ (B) Climbing ◯

(C) Support ◯ (D) Food storage ◯

(6) Which of the following plants is an incomplete parasite ?

(A) Rhizophora ◯ (B) Tinospora ◯

(C) Loranthus ◯ (D) Cuscuta ◯

(7) In which type of branching, apical bud becomes inactive after sometimes ?

(A) Racemose ◯ (B) Cymose ◯

(C) Monopodial ◯ (D) Sympodial ◯

(8) Function of turmeric is .....

(A) Protection ◯ (B) Reproduction ◯

(C) Food storage ◯ (D) Climbing ◯

(9) Which of the following plants possesses *Rhizobium* bacteria ?

(A) Orchid ◯ (B) Bean ◯

(C) Tinospora ◯ (D) Cuscuta ◯

(10) Which of the following plants possesses photosynthetic root ?

(A) Banyan ◯ (B) Rhizophora ◯

(C) Tinospora ◯ (D) Pandanus ◯

2. Answer in short :

(1) Which parts produce root system and shoot system ?

(2) Mention the regions of root.

(3) What are Mangroves ? Give examples.

(4) Give the examples of insectivorous plants.

3. Define with suitable example :

Tuberous root, Adventitious root, Epiphytic root, Rhizome, Tuber, Runner, Offset, Stolon, Stem tendril, Bulbil, Stipule.

4. Describe the special modifications of root, stem and leaf with examples for following functions :

(1) Storage of food (2) Climbing

(3) Photosynthesis

5. Explain the following terms :

Root pocket, Epiphyte, Symbiosis, Branching, Thorn, Spine, Prickle, Stolon, Bulbil, Phylloclade, Stipules, Compound leaf, Phyllotaxy, Phyllode.

6. Write short notes on :

Normal functions of Root, Symbiotic Root, Stilt roots, Normal functions of Stem, Clinging roots, Venation, Photosynthetic roots, Phyllotaxy, Pneumatophores, Normal functions of leaf, Parasitic root, Insectivory, Typical leaf

7. Draw labelled diagrams of :

(1) Various regions of root. (2) Typical Leaf

(3) Typical angiosperm plant

8. Distinguish between :

(1) Tap root system - Fibrous root system

(2) Roots of Cuscuta and Orchid OR Parasitic root and Hygroscopic root.

(3) Simple leaf and Compound leaf

(4) Pinnate compound leaf and Palmate compound leaf

2

Plant Morphology-2
(Flower, Fruit, Seed and Family)

We have so far discussed the vegetative organs of the plant in Chapter 1; now we study the reproductive parts of flowers in this chapter.

As the young plants grow and the vegetative parts mature, flowers make their appearances in order to produce seeds and thus, pave way for the next generation. The vegetative growth leads to the development of branches and foliages. Some of these mature shoots start bearing flowers and are known as reproductive shoots.

Inflorescence

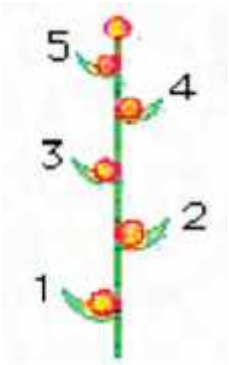
The axis of a plant which bears flowers is called peduncle or rachis. The arrangement of flowers on the rachis is called inflorescence. It is also termed as Anthotaxy. An inflorescence may be apical or axillary. There are two main types of inflorescence (A) Racemose and (B) Cymose.

(A) Racemose Inflorescence : In this type of inflorescence the apical bud is not transformed into a flower. It goes on producing new flowers in an acropetal succession on the rachis. The flowers towards the base develop earlier and are larger. Then the process gradually progresses towards the apex.

Raceme - Caesalpinia

Racemose Inflorescence is of different types. Some common types are as follow :

(1) Raceme : When peduncle or rachis is normally elongated and flowers are stalked, the inflorescence is called a raceme. e.g. Mustard, Caesalpinia



Spike - Achyranthus

(2) Spike : When peduncle or rachis is normally elongated but flowers are sessile, the inflorescence is called a spike e.g. *Achyranthus.*

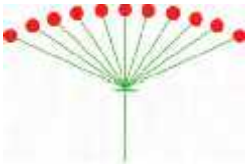
Spadix - Colocasia

(3) Spadix : In this type the peduncle is thick and fleshy and bears unisexual, sessile flowers at its lower end. The male flowers are borne above the female flowers. Sometimes sterile flowers are present between male and female flowers. The peduncle is protected by a large foliage bract known as spathe e.g. *Colocasia, Musa.*

(4) Catkin : If the axis of a spike is weak and does not stand erect but is pendulous and all the flowers in an inflorescence are unisexual, the inflorescence is called Catkin e.g. Mulberry, Acalypha.

Catkin - Acalypha

(5) Umbel : In an umbel type of inflorescence, the rachis becomes condensed and stalked, flowers are arranged on its tip like the spokes in an umbrella. The flowers are usually bracteate. Thus the bracts form a whorl or a cluster at the base of flowers. This group of bracts is called involucre e.g. Onion.



Umbel - Onion

(6) Capitulum : In a capitulum type of inflorescence, the peduncle becomes flat and disk like. It is called receptacle. Small, sessile flowers are arranged in a centripetal order. Peripheral flowers are called ray florets and central flowers are called disc florets. The receptacle is surrounded by a whorl of bracts known as an involucre e.g. Sunflower, Tagetes.

Capitulum - Sunflower


Hibiscus

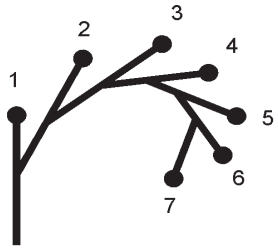
(B) Cymose inflorescence : In this type of inflorescence, the apical bud is transformed into a flower. Thus, the development of inflorescence axis becomes arrested. It may be divided into the following types:

(1) Cymose solitary : In this type only one pedicellate flower is borne terminally by the peduncle. A joint some where in the stalk demarcates the extent of peduncle and pedicel. e.g. *Hibiscus*, *Argemone*

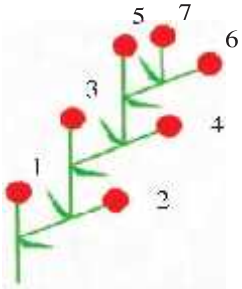
(2) Uniparous (Monochasial) : The main axis ends in a flower and the growth is continued by a single lateral branch. It may be:

(A) Helicoid : In monochasial cyme, the apical bud gives rise to a single lateral branch before being transformed into a flower. The apical bud of this branch also does the same. This order continues. If the new branches are formed sequentially on one side of the axis only. The inflorescence is called unilateral, monochasial cyme or helicoid. e.g. *Hamelia*


Hamelia



Helicoid




Scorpioid - Heliotropium

(B) Scorpioid : In this case the lateral branches arise alternately on left and right sides e.g. *Heliotropium*

Jasmine

(3) Biparous (Dichasial) : A determinate inflorescence in which the main axis ends in a flower after producing two daughter axis in flowers. e.g. *Jasmine, Nyctanthus*

(4) Multiparous (Polychasial) : A determinate inflorescence in which the main axis ends in a flower after producing more than two branches e.g. *Calotropis*, Red oleander


Calotropis

A typical flower

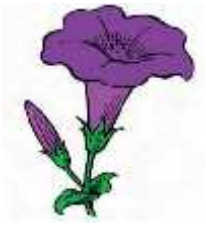
Flower : The flower is the reproductive unit in the angiosperms. It is meant for sexual reproduction. It consists of a middle axis, called as Floral axis. The expanded and swollen tip of the floral axis is called a thalamus or receptacle while stalk like lower portion is called Pedicel. A typical flower consists of four whorls – calyx, corolla, androecium and gynoecium. The components of all these whorls are concentrically arranged on a thalamus. The calyx and corolla are accessory organs, while androecium and gynoecium are reproductive organs.

(1) Calyx : The calyx is the outermost whorl of the flower and its individual unit is called sepal. Sepals are green, leaf-like and protect the flower in the bud stage. If the sepals are free from one another, the calyx is called polysepalous and if they are united through their margins to form a tube-like structure, the calyx is called gamosepalous

Polysepalous

Gamosepalous

Polypetalous



Gamopetalous

(2) Corolla : The next whorl is of corolla. Corolla is composed of petals. Petals are of various shapes and colors. Corolla may be tubular, bell-shaped, funnel-shaped, wheel-shaped or butterfly-shaped. Petals are usually brightly colored to attract insects for pollination. They protect the floral whorls arranged on their inside. They can also be of polypetalous and gamopetalous types.

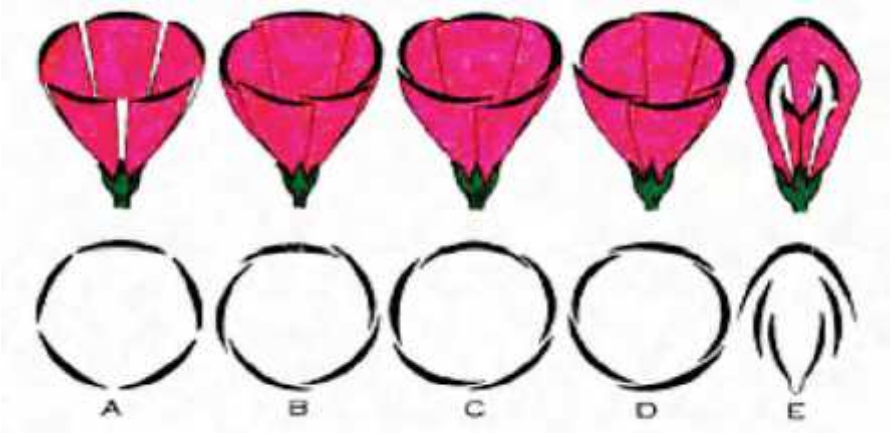
Sometimes, both these whorls appear similar, then, jointly they are called perianth, e.g. *Crinum*, *Bougainvillea*

Aestivation

Aestivation is the arrangements of sepals or petals in the bud condition of a flower. It may be of the following types.

(A) Valvate : If the sepals and petals touch only along their margins and do not overlap one another, then the aestivation is called valvate. e.g. *Calotropis*, Mustard

(B) Twisted : If the component members have their one margin overlapped by the margin of another component, and the other margin overlapping the margin of another component, the aestivation is called twisted. e.g. China Rose, Cotton



Types of Aestivation

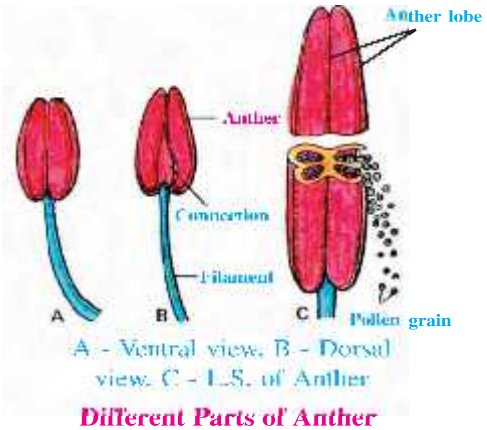
A – Valvate B – Twisted C – Imbricate D – Quincuncial E – Vexillary

(C) Imbricate : One member is completely outside and one member is completely inside. While other three members have one end outer and another one inner. This aestivation is called imbricate. e.g. Cassia, Delonix (Gulmoher).

(D) Quincuncial : It is a special type of imbricate aestivation where there are five components, two components are outer, two are inner and in one component one margin is inner and another margin is outer. e.g. Cucurbita, Melia

(E) Vexillary : This type of aestivation is seen in flowers having vexillary corolla. Out of the five petals, the largest (standard) overlaps the two lateral petals (alae) which in turn overlap the two smallest anterior petals (keel). This type of aestivation is known as vexillary. e.g. Pea and Bean

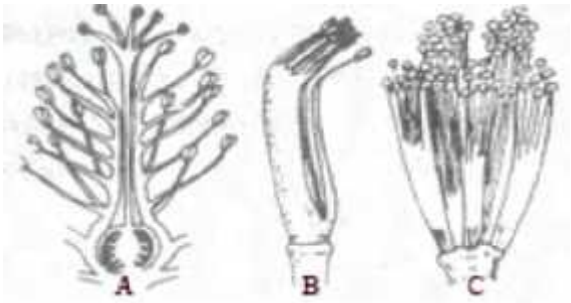
(3) Androecium : This whorl which is arranged inner to corolla is made up of stamens. Each stamen is made up of a filament, connective and anther. Pollen grains are produced within anther. Pollen grains can be smooth or spiny and of various shapes. A sterile stamen is called staminode. The mature anther is bilobed, hollow and sac-like. Anthers dehisce in various ways and liberate the pollen grains. The filament and the anther are joined through a connective. This union can be of various types.



A - Ventral view, B - Dorsal view, C - L.S. of Anther

Different Parts of Anther

The number of stamens varies. If all stamens are free from one another, they are called free. If all stamens are jointly through their filaments, they are called monodelphous e.g. China Rose. Sometimes, two groups are formed. They are called diadelphous. e.g. pea or when they are in more than two bundles, they are called polydelphous e.g. Citrus



Monodelphous Diadelphous Polydelphous

Cohesion of stamens

(4) Gynoecium : This whorl is arranged on the innermost side and it is made up of carpels. Each carpel possesses, at its base a hollow bag like ovary, from its tip a tubular style occurs. The tip of the style is called stigma and is the receptive surface for pollen grains. Each ovary bears one or more ovules attached to a flattened cushion-like placenta.

Apocarpous

If a singal carpel occurs in the gynoecium it is called monocarpellary. e.g. Pea. If more carpels occur, it is called polycarpellary. In a polycarpellary gynoecium, if all carpels remains free from one another it is called apocarpous. e.g. Rose, Lotus. If all carpel's are united with one another, it is called syncarpous. In such case only one ovary occurs. e.g. *Datura, Hibiscus*

Syncarpous