Program	**:**	**B. Pharmacy**
Semester	**:**	**1st**
Subject /Course	**:**	**Remedial Biology**
Subject/Course ID	**:**	**BP106RBT**
Module No.	**:**	**01**
Module Title	**:**	**Living World and Morphology of Flowering Plants**
Maximum Hours to Complete	**:**	**10**
Course coordinator	**:**	**Dr. Richa Gupta**
Mobile No.	**:**	**9041393001**
Email id	**:**	**rgcognosy@gmail.com**

Learning Outcome of Module

LO	Particular
1.	Learn about basic features and nomenclature of living organism
2.	Taxonomy of living organism
3.	Plant parts structure and function
4.	Anatomy of plant root, stem and leaf

Module Content Table

No.	Topic
1.	Diversity and Living Organism characters
2.	Binomial Nomenclature
3.	Taxonomy and Five Kingdom Classification
4.	Morphology of various plant parts- Root, Stem, Leaf, Flower, Inflorescence, Fruit & Seed
5.	Anatomy of Root, Stem and Leaf

LIVING WORLD

Biodiversity or biological diversity means the variety of living organisms present on a particular region. There are about 20 lac organisms known on the Earth which differ from one another in external form, internal structure, mode of nutrition, habitat, etc.

The warm and humid tropical regions of the Earth between the tropic of Cancer and the tropic of Capricorn have a rich diversity of life, i.e. plants, animals, and microorganisms and are called the region of mega biodiversity. India is one of the 12 countries which consist of more than half of the biodiversity ofthe Earth.

These are the general characteristics of living organisms-

Life process	**Explanation**
Movement	All living things move in some way. This may be obvious, such as animals that are able to walk, or less obvious, such as plants that have parts that move to track the movement of the sun.
Respiration	Respiration is a chemical reaction that happens within cells to release energy from food.
Sensitivity	The ability to detect changes in the surrounding environment.
Growth	All living things grow.
Reproduction	The ability to reproduce and pass genetic information onto their offspring.
Excretion	Getting rid of waste.
Nutrition	The intake and use of nutrients. This occurs in very different ways in different kinds of living things.

Nomenclature - An organism can have different names in different languages. This creates confusion in naming organism. So, a scientific name is needed which is same in all languages. Binomial nomenclaturesystem given by Carolus Linnaeus is used for naming different organisms.

Binomial Nomenclature-

"Binomial nomenclature is the biological system of naming the organisms in which the name is composed of two terms, where, the first term indicates the genus and the second term indicates the species of the organism."

What is Binomial Nomenclature?

The system of binomial nomenclature was introduced by Carl Linnaeus. Multiple local

names make itextremely difficult to identify an organism globally and keep a track of the number of species. Thus, it creates a lot of confusion. To get rid of this confusion, a standard protocol came up. According to it, eachand every organism would have one scientific name which would be used by everyone to identify an organism. This process of standardized naming is called as Binomial Nomenclature.

All living species including plants, animals, birds and also some microbes have their own scientific names. For eg.,

- The scientific name of the tiger is presented as *Panthera tigris*. '*Panthera'* represents the genus and'*Tigris'* represents a particular species or specific epithet.

- The scientific name of humans is presented as *Homo sapiens*. '*Homo'* represents the genus and'*sapiens'* represents a particular species.

- The Indian bullfrog is scientifically written as *Rana tigrina. 'Rana'* is the name of the genus and'*tigrina'* is the name of the specific species.

Rules of Binomial Nomenclature

A Biologist from all over the world follows a uniform set of principles for naming the organisms. Thereare two international codes which are agreed upon by all the biologists over the entire world for thenaming protocol. They are:

- International Code of Botanical Nomenclature (ICBN) – Deals with the biological nomenclaturefor plants.

- International Code of Zoological Nomenclature (ICZN) – Deals with the biological nomenclatureof animals.

These codes make sure that each organism gets a specific name and that name is

globally identified.The naming follows certain conventions. Each scientific name

has two parts:

- Generic name

- Specific epithet

The rest of the **binomial nomenclature rules** for writing the scientific names of organisms include the following:

1. All the scientific names of organisms are usually Latin. Hence, they are written in italics.

2. There exist two parts of a name. The first word identifies the genus and the second word identifiesthe species.

3. When the names are handwritten, they are underlined or italicized if typed. This is done to specifyits Latin origin.

4. The name of the genus starts with a capital letter and the name of the species starts with a small
letter.

Why is Binomial Nomenclature Important?

As stated previously, there are millions of species of organisms distributed throughout the world. Furthermore, the same organisms are known by different names around the world and this can cause confusion when trying to identify or classify. Hence, binomial nomenclature was seen as a viable solutionto this problem.

Drawbacks of Binomial Nomenclature

Some of the basic drawbacks of binomial nomenclature are:

- If two or more names are currently in use, according to the law of priority, the correct name will be the one used first and the others end up being synonyms as validity is the senior synonym. Providing stability in the naming and classification of organisms must be emphasized.

- Also, the names used prior to those included in the "Systema Naturae", by Linnaeus are notrecognized.

Taxonomy - It is a branch of biology which deals with identification, nomenclature, and classification of organisms. Carolus Linnaeus is called the father of taxonomy.

Classification

The method of arranging organisms into groups or sets on the basis of similarities and differences is called classification.

Importance of classification:

- It makes the study of wide variety of organisms easy and in systematic manner.

- It helps to understand how the different organisms have evolved with time.

- It helps to understand the inter-relationships among different groups of organisms.

- It forms a base for the study of other biological sciences, like biogeography.

Basis of classification:

- There are the certain features or properties used for the classification of living organisms which are known as **characteristics**. Organisms with same characteristics are placed in same groups.

Classification can be carried out based on many characteristics such as:

- Presence of nucleus
- Body design – make up of cells(Single-celled or Multicellular organisms)
- Production of food
- Level of the organization in bodies of organisms carrying out photosynthesis
- In animals – an organization of one's body parts, development of body, specialized organs fordifferent functions

These features can differ in both plants and animals as they differ in their body design. Hence, theseprominent designs and characteristic features can be used to make subgroups.

Hierarchy of classification

Linnaeus proposed a classification system by arranging organisms into taxonomic groups at differentlevels according to the characteristics they have. The groups or the levels from top to bottom are:

1. Kingdom
2. Phylum(Animals) / Division(Plants)
3. Class
4. Order
5. Family
6. Genius
7. Species

Species: A species is a group of living beings which can reproduce among themselves and keep theirpopulation alive.

Classification system

Two Kingdom Classification

Carolus Linnaeus gave the 2-kingdom system of classification and divided all the organisms into two groups as Plantae and Animalia. This kind of classification brought all the organisms which had a cell wall together within their cell in one group called the Plantae and rest all were placed in the other group known as Animalia. Plantae got comprised of bacteria, fungi with plants. All were very different from each other but still were kept together under two-kingdom classification. There was no distinction between the prokaryotes as well as eukaryotes. Thus this system of classification was not right but surely helped in evolving a better classification system.

Five Kingdom Classification

R.H Whittaker proposed a five-kingdom classification. This classification is accepted and corrects worldwide. A number of criteria were considered for making this model like the cell type, cell number,cell organization, nutrition, etc.

The main five kingdoms are following-

- Monera
- Protista
- Fungi
- Plantae
- Animalia

The major characteristics considered for classifying all organisms into five major kingdoms are:

1. Type of cellular organization -

a) Prokaryotic cells: These are primitive and incomplete cells without well – defined nucleus.

b) Eukaryotic cells: These are advanced and complete cells with well – defined nucleus.

2. Body organization -

a) Unicellular organisms: These are organisms made up of single cell with all activities performed by thesingle cell.

b) Multicellular organisms: These are organisms made up of large number of cells with different functionsperformed by different cells.

3. Mode of obtaining food -

a) Autotrophs: These are the organisms that make their own food by photosynthesis.

b) Heterotrophs: These are the organisms which depend on other organisms for food.

Characteristic of Five Kingdoms

Kingdom

Monera

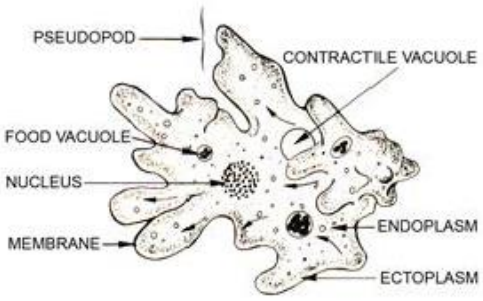
- These are unicellular prokaryotes.
- They lack a true nucleus.
- They may or may not contain a cell wall.
- They may be heterotrophic or autotrophic.
- Examples- Bacteria (heterotrophic), Cyano-bacteria or Blue green algaeAnabaena and (autotrophic).

BACTERIA

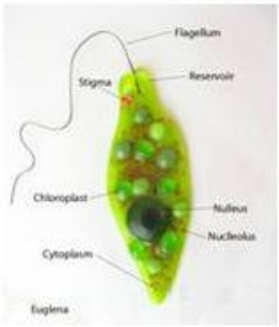
ANABAENA

Kingdom Protista

- These contain karyotic organisms unicellular, eu
- They exhibit an autotrophic or heterotrophic mode of nutrition.
- They possess pseudopodia, cilia, flagella for locomotion.
- Examples: plants like- Unicellular algae, Diatoms; animals like- protozoans (Amoeba,Paramecium, Euglena); fungi like- slime molds and water molds.



AMOEBA



EUGLENA

Fungi

- These are multicellular, eukaryotic organisms.
- Source of food:

  a) Mostly **saprophytes** - these organisms use decaying material for food.

  b) Some **parasitic** - these organisms live inside body of other living n to have food and organisbe disease causing.

  c) Symbiotic relation - these are relations between two organisms in which they live together forbenefit of one or both. Lichens are a symbiotic relation between fungi and cyanobacteria. Here fungi gets food from cyanobacteria and in return cyanobacteria gets water and protection from sunlight through fungi.
- Cell wall is made of chitin
- Examples-mushrooms(Agaricus), green mold(Penicillium), smut(Aspergilus)

PENICILIUM

AGARICUS

Kingdom Plantae

- These are multicellular, eukaryotic organisms.
- The cell wall is made up of cellulose.
- They prepare their own food by means of photosynthesis.
- Kingdom Plantae is sub-divided into- Thallophyta, Bryophyta, Pteridophyta, Gymnosperms,Angiosperms.
- For eg., Pines, ferns, Mango tree

Basis of division in Kingdom Plantae

1. Differentiated body parts: Body is differentiated into leaves, stems, roots, flower, etc.

2. Presence of vascular tissue: There are two types of vascular tissues present in the plants:

- Xylem: helps in transport of water.
- Phloem: helps in transport of food.

3. Reproduction through seeds or spores:

- Phanerogamae: Plants with seeds are called phanerogamae. They contains embryo with stored foodand are multicellular.
- Cryptogamae: Plants with spores are called cryptogamae. They contains only naked embryo andare generally unicellular.

4. Seeds are inside the fruit or naked:

- Angiospermae - these are plants with seeds inside the fruit and bears flowers.
- Gymnospermae - these are plants with naked seeds and do not bear flowers.

Note - If xylem and phloem are absent the plants would be small as transport of food and water will bedifficult.

Division 1: Thallophta

Following are its basic features:

- Basic and elementary plants with undifferentiated body parts.
- Generally called algae.
- No vascular tissue present.
- Reproduce through spores.
- Mainly found in water.
- Example- Ulva, Spirogyra, Ulothrix, Cladophora, Chara.

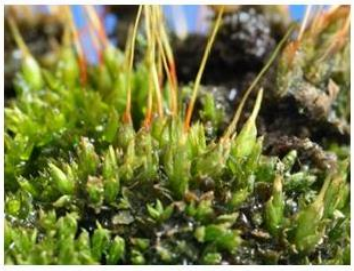
SPIROPGYRA

ULVA

Division 2: Bryophyte

Following are its basic features:

- Body structure differentiated but not fully developed.
- No vascular tissues present.
- Reproduce through spores.
- Found on both land and water therefore known as **'Amphibians of Plantae kingdom'.**
- Example - liverwort(Marchantia, Riccia), mosses(Funaria), hornwort (dendrocerous).



FUNARIA

RICCIA

Division 3: Pteridophyta

Following are its basic features:

- Differentiated body structure- leaves, stems, roots,etc.
- Vascular tissues present.
- Reproduce through spores
- Examples- Marsilea, fern, horsetails

MARSILEA

FERN

Division 4: Gymnosperms

Following are its basic features:

- Differentiated body parts
- Vascular tissues
- Naked seeds without fruits or flowers
- Perennial, evergreen and woody
- Examples- Pines(deodar), Cycus, Ginkgo.

PINUS

CYCUS

Division 5: Angiosperms

Following are its basic features:

- Also known as Flower - bearing plants.
- Later on flower becomes fruit.
- Seeds are inside the fruit.
- Embryos in seeds have structure called They are also called seed leaves because in many plantsthey emerge and become green when they germinate.

Angiosperms are further divided on the basis of number of cotyledons into two parts:

S.No.	Features	Monocots	Dicots
1.	Seed	One cotyledon	Two cotyledons
2.	Root	Fibrous root	Prominent primary root
3.	Stem	False or hollow	Strong
4.	Leaf	Parallel venation	Reticulate venation
5.	Flower(petals)	Five or multiple of five	Three or multiple of three
6.	Example	Potato, Sunflower, Banyan, wheat etc.	Peanuts, Beans, Mango etc.

Kingdom Animalia

Basis of classification of Animalia kingdom:

1. Symmetry:

i) Bilateral symmetry: it is when an organism can be divided into right and left halves, identical but mirrorimages, by a single vertical plane.

ii) Radial symmetry: it is when an organism is equally spaced around a central point, like spokes on abicycle wheel.

2. Germ layers : in embryonic stages there are different layers of cells called germ cells. The threedifferent types of germ cells are -

- Ectoderm – It is the outermost layer which forms nail, hair, epidermis, etc.
- Endoderm - It is the innermost layer which forms stomach, colon, urinary bladd
- Mesoderm – It is the middle layer between ectoderm and endoderm which forms bones, cartilage,etc.

So, according to the number of germ layers present in embryonic stage, animal could be:

i) Diploblastic - organisms which derived from two embryonic germ layers (ecto and endo).

ii) Triploblastic - organisms which d rived from all the three embryonic germ layers.

3. Coelom: Body cavity or coelom is important for proper functioning of various organs. For example, heart which has to contract and expand needs some cavity or empty space, which is provided by the coelom.

On the basis of presence or absence of coelom, organisms are divided into:

i) Acoelomates - these are the simple organisms having no body cavity.

ii) Coelomates - these are complex organisms having true cavity lined by mesoderm from all sides.These are further sub- divided into **schizocoelomates or protostomes**(coelom formed due to splitting of mesoderm) and **enterocoelomates or dueterostomes**(coelom formed from pouches pinched off from endoderm)

iii) Pseudo coelomate - these are organisms having false coelom. They have pouches of mesoderm scattered between endoderm and ectoderm.

4. Notochord: it is a long rod like structure, which runs along the body between nervous tissues and gutand provides place for muscle to attach for ease of movement.

Organisms could be:

- Without notochord
- With Notochord
- With Notochord in initial embryonic stages and vertebral column in adult phase.

Phylum 1: Porifera or sponges

Following are its basic features:

- Cellular level of organization.
- Non motile animals.
- Holes on body which led to a canal system for circulation of water and food.
- Hard outside layer called as skeletons.
- Examples - Sycon, Spongilla, Euplectelia.

Phylum 2: Coelenterata

Following are its basic features:

- Tissue level of organization
- No coelom
- Radial symmetry, Diploblastic
- Hollow gut
- Can move from one place to another.
- Examples: hydra, sea anemone, jelly fish(solitary) ; corals (colonies)

Phylum 3: Ctenophores

Following are its basic features:

- Tissue level of organization
- No coelom present
- Radial symmetry, Diploblastic
- Have Comb plates for locomotion
- Aquatic
- Examples- Pleurobrachia

Phylum 4: Platyhelminthes

Following are its basic features:

- Also called **flat worms.**
- No coelom present
- Bilateral symmetry, Triploblastic
- Free living or parasite
- Digestive cavity has one opening for both ingestion and egestion.
- Example - Planaria (free living), Liver fluke (parasitic).

Phylum 5: Nematode

Following are its basic features:

- False coelom
- Bilateral symmetry, Triploblastic
- Cylindrical
- Many are parasitic worms living inside human body, and can cause various diseases, like Filarialworm causes elephantiasis, Round worms and Pin worms live in human intestine.
- Example - Ascaris, Wulchereria.

Phylum 6: Mollusca

Following are its basic features:

- Coelom present
- Triploblastic, bilateral symmetry
- Soft bodies sometimes covered with shell
- Generally not segmented
- No appendages present
- Muscular foot for movement
- Shell is present
- Kidney like organ for excretion
- Examples - Chiton, Octopus, Pila, Unio.

Phylum 7: Annelida

Following are its basic features:

- Second largest phylum
- Coelom present
- Bilateral, triploblastic
- Segmented (segments specialized for different functions)
- Water or land
- Extensive Organ differentiation
- Examples - Earthworm, Leech, Nereis

Phylum 8: Arthropoda

Following are the basic features:

- Largest phylum (consist of 80%of species)
- Generally known as insects.
- Coelom present
- Bilateral, triploblastic
- Segmented, sometimes fused
- Tough exo-skeleton of chitin
- Joint appendages like feet, antenna
- Example- Prawn, Scorpio, Cockroach, Housefly, Butterfly, Spider,

Phylum 9: Echinodermata

Following are its basic features:

- Spiny skin, Marine
- No notochord
- Coelom present , bilateral symmetry, triploblastic
- Endoskeleton of calcium carbonate.
- Water vascular system for locomotion.
- Bilateral symmetry before birth and radial symmetry after birth.
- Example- Antedon, Sea cucumber, Star fish, Echinus.

Phylum 10: Hemichordata

Following are its basic features:

- Small group of marine animals
- Cylindrical, Bilateral symmetry, triploblastic
- Coelom present
- Gills for respiration
- Examp

les -

Balanoglossus

Phylum

11:

Chordata

Following

are its

basic

features:

- Bilateral symmetry, Triploblastic
- Coelom present
- Notochord
- Gills present at some phase of life.
- Dorsal nerve chord
- Post anal tail present at some stage of life, For example, present in humans in embryonic stages.
- Subdivided into two

(a) Prochordata –

- Notochord at some stage of life
- Marine
- Example- Herdemania, Amphioxus,

(b) Vertebrata -

- Notochord converted to vertebral column
- 2,3,4 chambered heart
- Organs like kidney for excretion
- Pair appendages
- Example- humans(4 chambered), frog(3 chambered), fishes(2 chambered)

Vertebrates are divided into five classes namely Pisces, Amphibia, Reptillia, Aves and Mammalia.

Following are some common features of the five classes of vertebrates:

S. no	Features	Pisces	Amphibian	Reptilia	Aves	Mammalia
1.	Inhabit	Water	Water and land	Water and land	Water land and air	Land or water
2.	Respiratory organs	Gills	Gills, lungs	lungs	lungs	lungs
3.	Heart	2 chambered	3 chambered	3 chambered	4 chambered	4 chambered
4.	Maintenance of Body temperature	Cold-blooded	Cold- blooded	Cold-blooded	Warm-blooded	Warm-blooded
5.	Young ones	Eggs	Eggs in water	Eggs with tough coating on land	Eggs	Young babies except platypus and echidna.
6.	Skin	Skin covered with scales	Mucus glands in skin	Skins covered with scales	Skin covered with feathers	Hair, oil and sweat glands are present on the skin
7.	Special features	Streamlined body				Mammary glands which produces milk for children.
8.	examples	Anabas, Dog fish, Angler fish, Mandarin fish, Electric ray, String fish, Sea horse, Flying fish.	Salamander, common frog, Toad, Hyla (tree frog).	Turtle, Snakes, Lizard, Flying lizard, Crocodile, Chameleon.	Ostrich, Sparrow, Crow, Pigeon, Tufted Duck, White Stork.	Humans, Lion, Tiger, Cat, Bat, Whale.

Note -

- **Warm blooded organism:** these are organisms which maintain mperature same body t e irrespective of outside temperature. Example – humans. Human's body temperature isapproximately 37^0.
- **Cold blooded organisms:** these are organisms which changes their body temperature as persurrounding temperature. Example – frog
- Fishes are divided into two o the basis of skeleton:

i) Fishes with bony skeleton called **bony fishes**. Example- Tuna.

ii) Fishes with cartilage skeleton called **Cartilaginous fishes**. Example – Shark

Characters	Five Kingdoms				
	Monera	**Protista**	**Fungi**	**Plantae**	**Animalia**
Type of nucleus	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Number of cells	Unicellular	Unicellular	Multicellular	Multicellular	Multicellular
Cell wall	If present then noncellulosic.	Present in some	Present made of Chitin	Present of cellulose	Absent
Mode of nutrition	Autotrophic and heterotrophic	Autotrophic and heterotrophic	Heterotrophic (Saprophytic)	Autotrophic	Heterotrophic
Level of organisation	Cellular	Cellular	Multicellular/ Loose tissue	Tissue level	Organ level
Examples	Bacteria, Cynobacteria	Amoeba, Paramaecium	Penicillium, Aspergillus	All plants	All animals

There are some acellular organisms and lichens that do not come in any kingdom.They have some different properties. These are described below-

Virus

The viruses are non-cellular organisms that are characterised by having an inert crystalline structure outside the living cell. A virus is nucleoprotein and its genetic material is infectious. When they infect acell, they take over the machinery of that host cell to replicate themselves.

The name virus that means venom or poisonous fluid was given by Ivanowsky (1892). Viruses are smaller than bacteria and were called as 'infectious living fluid' by Beijerinek (1898). They are inert outside thehost cell but become active when infected a cell and replicate fast.

In addition to protein coat, they contain genetic material either RNA or DNA. In general, the virus which infect plants, have single stranded RNA and which infect animals, have either single or double stranded DNA.

Examples- Tobacco Mosaic virus, Corona virus

Viroids

These infectious agents are smaller than Virus. It constitutes a free RNA and does not contain protein coat.

Lichens

These are symbiotic associations between algae and fungi. The algal component is known as Phycobiont, itis autotrophic and Fungi component is known as Mycobiont, it is heterotrophic. Algae prepare food for fungi and fungi provide shelter and absorb mineral nutrients and water for algae. These are very good pollution indicators because these do not grow in polluted areas.

Classification and Evolution

Classification of organisms is closely related to evolution. Evolution is the changes that have accumulated over the years in the body design of organisms for better survival. In 1859, Charles Darwin first described the idea of evolution in his book 'The Origin of Species'.

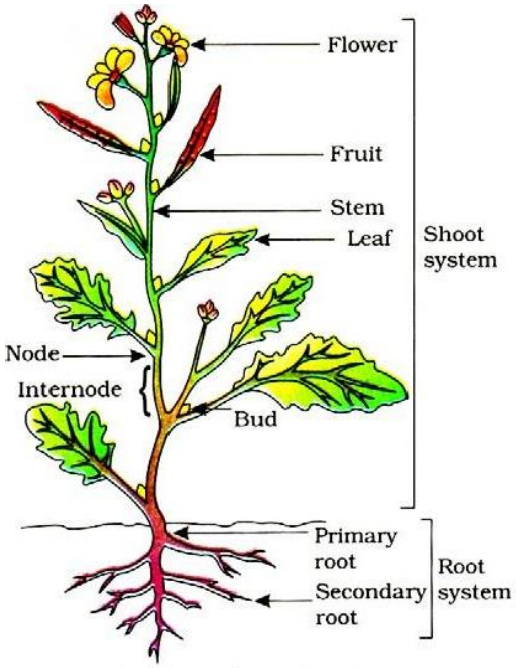
Listed below are inferences drawn when evolution is connected to classification:

- 'Lower' or 'primitive' organisms are the organisms having the ancient body type and seem to havenot changed over the years.
- 'Higher' or 'advanced' organisms are those who are relatively recent and have acquired theirparticular body designs.

But these terms cannot used be used in classifying organisms, hence we use terms like 'younger' and 'older' organisms as there is a possibility of witnessing changes with passing time due to increase in the complexity of body designs. Hence, we can simply say, older organisms are simpler compared to youngerorganisms.

PLANT MORPHOLOGY

INTRODUCTION



Parts of a flowering plant

Morphology – (Morphe = form + logos = study). It deals with the **study of forms and features** of different plant organs like roots, stems, leaves, flowers, seeds, fruits etc.

The body of a typical angiospermic plant is differentiated into:

1. An underground root system
2. An aerial shoot system.

The shoot system consists of stem (including branches), leaves, flowers and fruits.

The roots, stems and leaves are **vegetative parts**, while flowers constitute the **reproductive part**.

Classification of Plants

Depending upon their life span, plants are classified as –

1. **Annuals –** Complete their life cycle in **one year** or **single growing season** or few weeks to a few months. They pass the unfavourable period in the form of **seeds** eg. Mustard, Pea.
2. **Biennials –** Complete their life cycle in two years-**growing, vegetative** and storing food **in the first year, flowering and fruiting in the second year**. They die off after producing flowers and fruits eg. Radish, turnip, carrot are **biennial** in **colder** areas. They become **annual** in **warmer** places.
3. **Perennials – Survives for several years**. These plants usually bear flowers and fruits every year and do not die after producing flowers. eg. Mango, Banana, Guava

ROOT

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

General Characters :

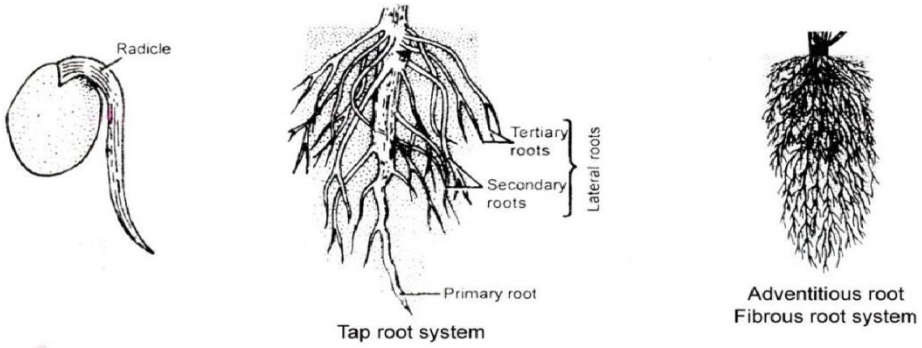
1. Roots are **non green**, **underground**, (+) geotropic, (–) phototropic and (+) hydrotropic.
2. Roots do not bear buds.
3. Buds present for vegetative propagation in sweet potato (***Ipomea***) and Indian red wood (***Dalbergia***)
4. Roots do not bear **nodes** and **internodes**.
5. Roots have **unicellular** root hairs.

TYPES OF ROOTS

Roots are of two types:

A) Tap root B) Adventitious root

Tap root: It develops from radicle and made up of one main branch and other sub branches. The primary roots and its branches constitute tap root system. e.g. Dicot roots.



Adventitious roots: In some plants, after sometime of the growth of tap root which arises from radicle, stops and then roots, develop from other part of plant, which are branched or unbranched, fibrous or storage, are known as adventitious roots and constitute fibrous root system. e.g. Monocot roots.

REGIONS OF ROOTS

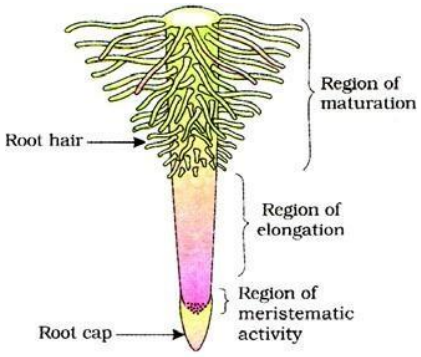
Morphologically four distinct regions are present in roots.

A) **Root cap:** It is terminal structure. It protects tender apex of root.

B) **Meristematic zone:** Cells of this region are very small and thin walled. They divide repeatedlyand increase cell number

C) **Elongation region:** The cells proximal to meristematic zone undergoenlargement and are responsible for rapid growth of rapid elongation and roots.

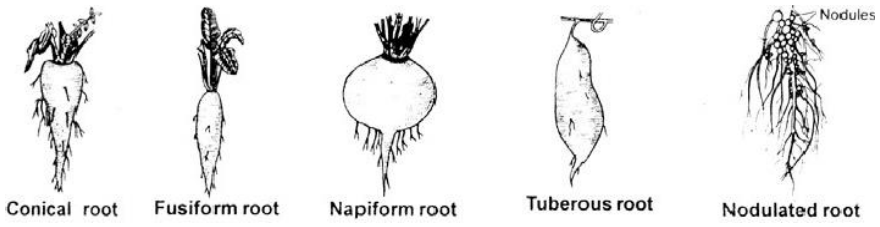
D) **Maturation region:** Cells proximal to region of elongation gradually differentiate and mature.Root hairs are present in maturation zone.



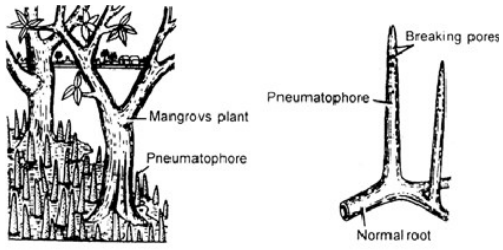
The regions of the root-tip

MODIFICATION OF ROOTS

1. **Modified tap root for storage:**
   - **Fusiform roots:** These root are thicker in the middle and tappered on both ends. In this type ofroots both hypocotyl and root help in storage of food. **eg. Radish**.
   - **Conical roots:** These roots are thicker at their upper side and tapering at basal end. **eg. Carrot.**
   - **Napiform:** These roots become swollen and spherical at upper end and tappered like a thread attheir lower end. **eg. Turnip (*Brassica rapa*), Sugarbeet**
   - **Tuberous root:** Such roots do not have regular shape and get swollen & fleshy at any portion ofroots. eg. Mirabilis.
2. **Nodulated root:** Nodules are formed on branches of roots by nitrogen fixing bacteria, (*Rhizobium*). eg. Plants of leguminosae family (Papilionatae) – **Pea.**



3. **Respiratory roots:** Halophyte or mangrove grow in oxygen deficient marshy area. Some branches of tap root in these plant grow vertically & comes out from soil. These roots are called pneumatophores throughwhich air entered inside the plant. **eg. *Rhizophora, Heritiera, Sonaratia* and other mangrove plant.**

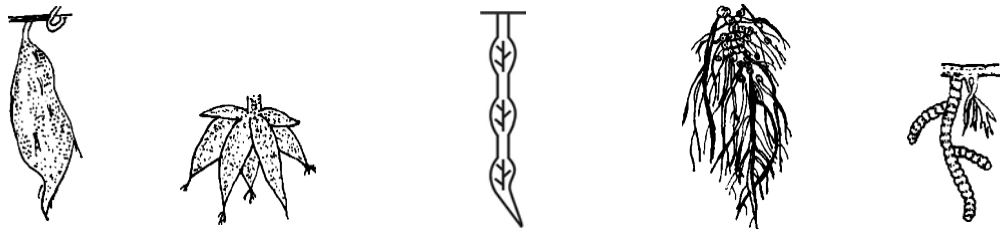


Respiratory roots (Pneumatophores) of Rhizophora

Modification of adventitious roots :

1. **Storage adventitious roots**

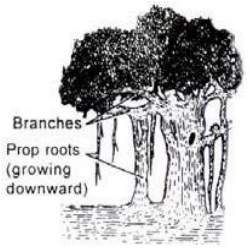
   - **Tuberous root :** When food is stored in these roots, they become swollen and form abunch. eg. **Sweet potato (*Ipomea batata*)**
   - **Fasciculated –** Roots arise in **bunch** (cluster) from lower node of the stem and becomefleshy eg. Dahlia, Asparagus.
   - **Nodulose :** In this type, tips of roots swell up. **eg. *Melilotus, Curcuma amoda.***
   - **Beaded or moniliform :** When root swells up like a bead at different places after a regularinterval. Eg. ***Vitis, Momordica* (Bitter gourd), Portulaca.**
   - **Annulated :** Roots having series of ring like swellings **eg. *Psychrotia***



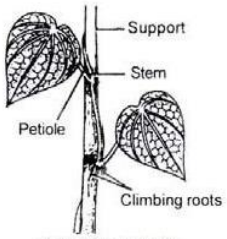
Tuberous **Fasciculated roots** **Moniliform** **Nodulose** **Annulated roots**

2. **Stilt roots or brace roots :** When root arises from lower nodes and enter in soil obliquely, known as stiltroots **eg. Maize, Sugarcane, *Pandanus* (screwpine)**
3. **Prop root or pillar roots :** when root arises from branches of plant and grows downward towards soil. Itfunction as supporting stem for the plant. **eg. Banyan**.
4. **Climbing roots –** These roots arise from nodes and helps the plant in climbing. **eg. Money plant (*Pothos*),Betel, Black pepper, *Techoma*.**
5. **Foliar roots or Epiphyllous roots –** When roots arise from leaf they are called as foliar roots. **eg. *Bryophyllum, Bignonia*.**

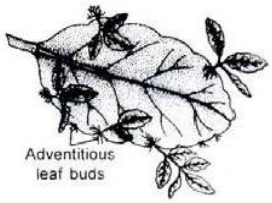
6. **Sucking or haustorial roots or Parasitic roots :** In parasitic plant roots enter in the stem of host plant toabsorbed nutrition from host. **eg. *Dendrophthoe, Cuscuta, Viscum*.**



Prop root



Climbing root



Foliar root

7. **Assimilatory roots:** The aerial roots of ***Tinospora*** and submerged roots of ***Trapa*** (Water chestnut) becomegreen and synthesize food. ***Podostemon*** also has green assimilatory roots.

8. **Hygroscopic roots:** These are found in epiphytes, specially in orchids and help in absorption of moisturefrom the atmosphere using special tissue called **velamen**. **eg. *Orchids, Banda***

9. **Contractile roots:** They shrink 60 – 70% of the original length and bring underground organ at properdepth in the soil e.g., corm of ***Crocus*** (saffron), ***Fresia***.

10. **Root thorns:** These are hard, thick and pointed thorns e.g. ***Pothos armatus***.

11. **Reproductive roots:** These are fleshy, adventitious roots used for vegetative reproduction e.g., sweet potato(*Ipomea batata*), Dahlia.

12. **Leaf roots:** In Salvinia, one leaf of each node modifies into root like structure for balancing the plant inwater.

FUNCTIONS OF ROOT

a. Fixation (Primary function)

b. Absorption of water and minerals

c. Storage of food

d. Conduction of water

e. Photosynthesis and respiration

STEM

Stem is a part of plant which lies above from surface of soil i.e. it shows negative geotropic growth. It hasnodes and internodes. Branches, leaf, flower bud and bracts are developed from nodes. Stem arises from plumule.

FORMS OF STEM

- **Caudex :** It is unbranched, erect, cylindrical stout stem and marked with scars of fallen leaves.
  Crown of leaves are present at the top of plant. eg.: Palm
- **Culm :** Stem is jointed with solid nodes & hollow internodes. eg. Bamboo (Graminae)
- **Excurrent :** The branches arise from the main stem in acropetal succession and the tree assumesa cone like appearance e.g. ***Pinus, Eucalyptus, Casuarina,*** etc.
- **Decurrent (Deliquescent) :** The lateral branches grow more vigorously and outcompetes the
  main trunk, giving a dome-shaped appearance, e.g., mango (***Mangifera indica***), shishem
  (***Dalbergia sissoo***) and banyan (***Ficus bengalensis***).

TYPES & MODIFICATION OF STEM

Aerial stems (Epiterranean stem) :

It may be reduced, erect and weak.

Reduced – Stem reduced to a disc. eg., Radish, Carrot, Turnip.

Erect stem - It is strong and upright e.g., maize, wheat, mango.

Weak stems – These are thin, soft and weak and need support. They can be upright or prostrate.

1. **Creepers –** The stem creeps on earth and the roots arise at the nodes, e.g., Grasses, Strawberry,Oxalis.
2. **Trailers-** The stem creeps on the ground, but the roots do not arise at the nodes. They may beof two types-

- **Prostrate or procumbent** – The stem creeps on ground totally, e.g., *Evolvulus*, *Tribulus*.
- **Decumbent** – When prostrate stem projects its tip, e.g., *Portulaca*, *Linderbergia*.

3. **Lianas (Stem climber).** Woody perennial climbers found in tropical rain forests are lianas.They twin themselves around tall trees to secure sunlight, e.g., ***Hiptage***, ***Bauhinia vahlii*** (Phanera).
4. **Climbers –** Plants are with long weak stem and have organs of attachment to climb the object.They may be of following type .

i. **Rootlet climbers** – Roots produced at nodes help in climbing e.g., ***Tecoma, Pothos, Piperbetal*** (pan).

ii. **Hook climbers** – In *Bougainvillea, Duranta* and *Carrisa*, the thron is modification of axillary vegetative bud which helps in climbing. In *Bignonia*, terminal leaflet is converted into hook.

iii. **Tendril climbers** – Tendrils are thread like structure which help the plants in climbing.Tendrils are modifications of :

1. Entire leaf e.g. ***Lathyrus sativus.***

2. Leaflet e.g. ***Pisum sativum***

3. Petiole e.g. ***Clematis, Nepenthes***.

4. Stipule e.g. ***Smilex***.

5. Leaf apex e.g. ***Gloriosa***

6. Inflorescence e.g. ***Antigonon.***

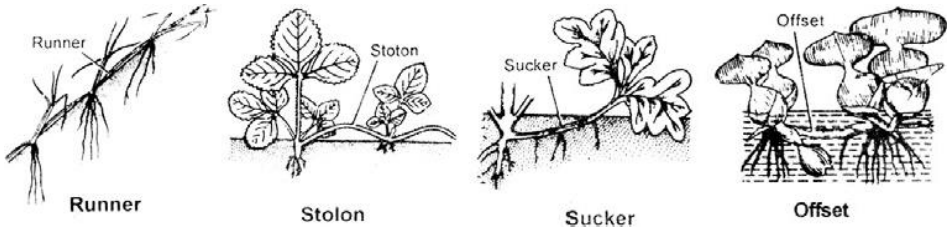
7. Stem e.g., ***Vitis*** (grapevines), gourds, ***Passiflora*** (modified axillary bud).

5. Twiners – The stem body twines around the support without any special organ of attachment. e.g., *Cuscuta, Dolichos*.

Sub-aerial modification:

1. **Runner –** When stem grows and spread on the surface of soil. Roots are developed at lower sideand leaves from upper side from node eg. ***Cynodon dactylon*** **(Doob grass),** ***Oxalis.***
2. **Stolon –** In it branches are small and stem condensed and grow in all direction. After sometime, ofgrowing, their apical region comes out from the soil. eg. **Wild strawberry), Jasmine Peppermint.**
3. **Sucker** – In it the main stem grow in the soil horizontally and branches develop obliquely from nodesabove the soil, eg. **Mint, Pineapple,** ***Chrysanthemum*****.**
4. **Offset** – A lateral branch with short internode and each node bearing a rossette of leaves and tuft ofroots at base. eg. ***Pistia, Eichhornea.***

These modification are also involved in vegetative reproduction.



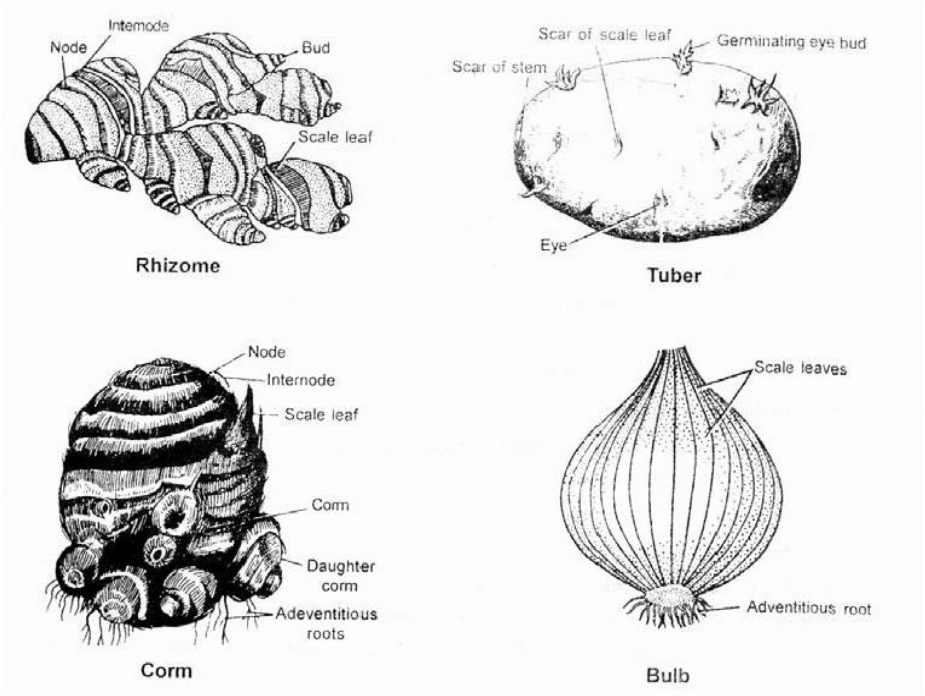
Underground modification:

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

1. **Tuber –** The tips of underground branches become swollen in the soil. Eyes are found on thenwhich are axillary buds and covered with scaly leaves.

eg. **Potato,** ***Helianthus tuberosus***

2. **Rhizome –** It is fleshy and horizontally stem found below in soil. Small nodes and internodes arefound which are covered by scaly leaves. eg. **Ginger, Turmeric, Canna, Water lily, Banana.**
3. **Corm** – It is condensed structure which grow vertically under the soil surface. They are having spherical node and inter node eg. ***Colocasia, Alocasia,*** **Saffron,** ***Gladiolus,*** **Zaminkand,** ***Colchicum***
4. **Bulb** – This stem is reduced and has disc like structure and surrounds with numerous fleshly scalyleaves. Many roots arise from its base. Food is stored in flashy leaves. They show apical growth eg.Onion, Garlic.

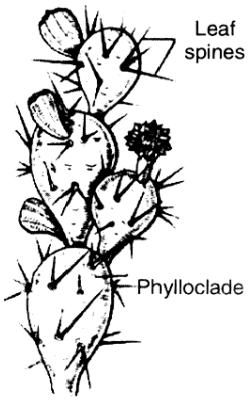


Special stem modification :

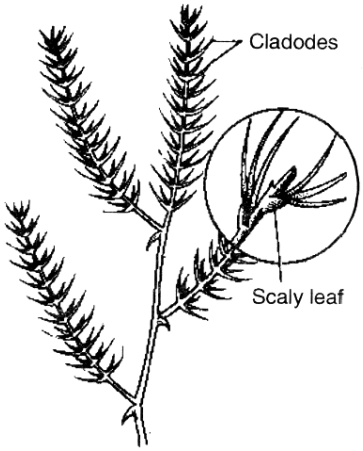
1. **Phylloclade –** It is green photosynthetic flattened or rounded succulent stem with leaves either feeblydeveloped or modified into spines e.g., ***Opuntia, Casuarina***, ***Euphorbia, Cactus***.

2. **Thorn –** It is modification of axillary bud, e.g., ***Bougainvillea, Duranta, Carissa.*** Thorns of ***Alhagi*** possess flowers, while thorns of ***Duranta*** bears leaves.

3. **Cladode** – Phylloclade usually having one or two internode long & succulent is called cladode, e.g., ***Asparagus***, ***Ruscus***.

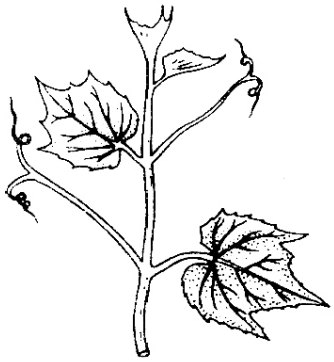


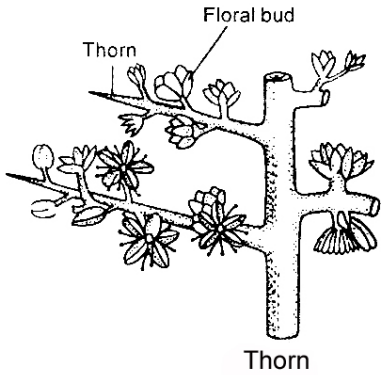
Phylloclade of *Opunita*



Cladode of *Asparagus*

4. **Stem tendrill** – it is a leafless, spirally coiled structure found in climbers. It may be a modification ofAxillary bud, e.g. ***Passiflora*** or terminal bud e.g., ***Vitis***.


Stem tendril



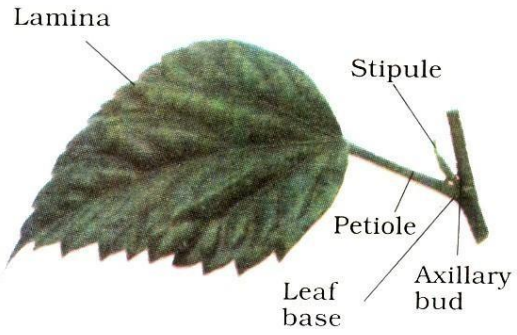
5. **Bulbils** – A condensed , axillary fleshy bud is called ***bulbils***. It helps in vegetative reproduction. eg., ***Dioscorea, Globba, Agave, Oxalis***.

FUNCTIONS OF STEM

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.

LEAF (PHYLLOPODIUM)

The leaf is a lateral generally flattened structure borne on the stem. The leaves develop from the nodes. Their main function is photosynthesis and food making, axillary buds are found in its axil. All the leaves of a plant is known as phyllome. Axillary bud later develops into a branch. Leaves originated from shoot apical meristem and are arranged in acropetal order.



Leaf is divided into 3 main parts:

1. **Leaf base (Hypopodium) –**
    - Leaves are attached to stem by leaf base.
    - In some plants, leaf base becomes swollen and is called **pulvinus** which is responsible forsleep movement e.g., Cassia, mimosa, bean.
    - In some plants, leaf base expands into **sheath** (**Sheathing leaf base**), e.g., grasses andbanana (monocots).
    - When the leaf base partially encloses the stem, it is called **semi amplexicaul** e.g., Pricklypoppy, ***Calotropis procera*** (Madar).
    - It completely encloses the stem, it is called **amplexicaul** e.g., ***Sonchus, Polygonum***.
2. **Petiole (Mesopodium)** –
    - The part of leaf connecting the lamina with the branch of stem.

      Petiole help to hold theblade to light. In ***Eichhornia*** petiole swell and in citrus it is winged.
    - Petiole is modified in tendrils in ***Nepenthes***.
    - In Australian acacia petiole is modified in phyllode.
    - Long thin flexible petiole allow leaf blade to flutter in air, thereby cooling the leaf andbringing fresh air to leaf.

3. **Lamina (Epipodium)** – It is a broad and flattened part of leaf. Its main functions are photosynthesisand transpiration. Shape of lamina are :

- **Acicular –** Lamina is long and pointed, like a needle. eg. ***Pinus***
- **Lanceolate –** In this type lamina is pointed or narrower at the ends while broader in themiddle. eg.
- **Bamboo, *Nerium***
- **Linear –** The lamina is long and narrow having parallel margins. eg. **Grass**
- **Ovate – L**amina is egg-shaped having broad base with slight narrow top. eg. ***Ocimum,***
- Banyan**, China rose.**
- **Cordate –** Its shape is like a heart. eg. Betel**.**
- **Oblong –** Long and broad lamina. eg. Banana
- **Sagittate –** The lamina is triangular in

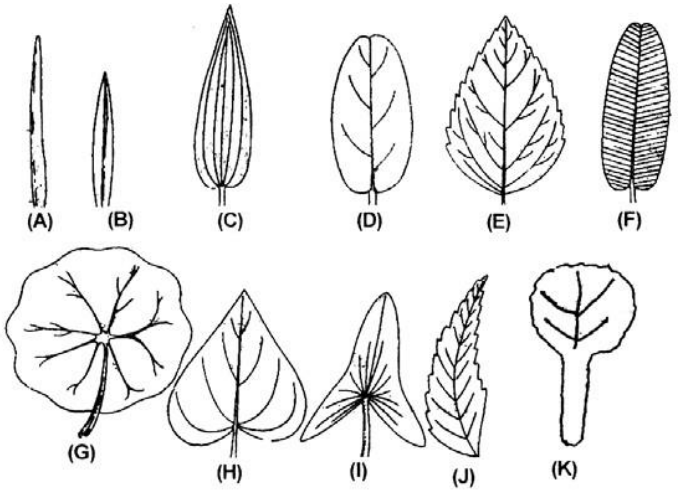
  shape. eg. ***Sagittaria*Spathulate –**

  The lamina is broad spoon shaped.

  eg. ***Calendula* Orbicular or Rotund**

  – In this types the laminais spherical.

  eg. **Lotus.**
- **Elliptical or Oval –** In this type the middle part of lamina is broad while the ends arenarrow and oval. eg. **Guava.**
- **Oblique –** In this types midrib divides, lamina into two unequal halves. eg. ***Bignonia*,Neem.**



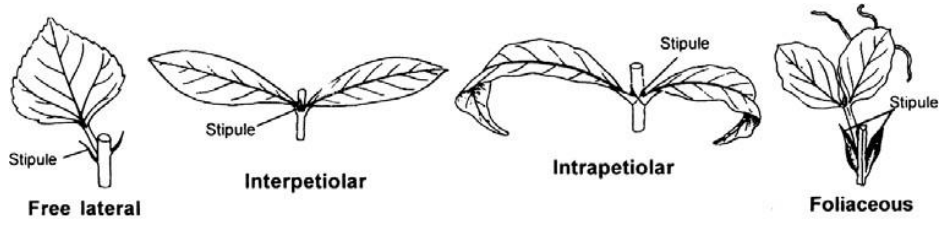
Shapes of lamina :
(A) Acicular, (B) Linear, (C) Lanceolate,
(D) Elliptical, (E) Ovate, (F) Oblong, (G) Rotund,
(H) Cordate, (I) Sagittate, (J) Oblique (K) Spathulate

Stipules:

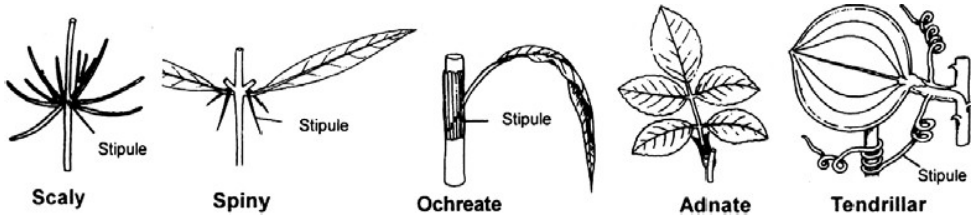
Leaves of some plants have lateral appendages on either side of leaf base, known as stipules. If stipules arepresent in leaf it is called stipulated leaf, if it is absent then leaf is called exstipulated.

Stipules are of various types –

1. **Free lateral –** They are independently present on both sides of leaf base. eg. ***Hibiscus rosasinensis***
   (China rose)
2. **Interpetioler –** When two leaves are meet oppositely at the node then nearest stipules of each leaf join with each other. In this way only two stipules of two leaves are found in place of four. eg. ***Ixora, Anthocephalus.***
3. **Intrapetioler –** In this type both stipules of a single leaf join with each other to form a single stipule. eg.
   Gardenia
4. **Foliaceous** – These type of stipules form a leaf like structure. eg. **Pea**



5. **Scaly –** Stipules are dry, small and paper like. eg. ***Desmodium***
6. **Spiny –** Stipules modified into spine. eg. ***Zizyphus*** (Beri), ***Acacia***.
7. **Ochreate –** When both stipules of leaf combine together and form a tube like structure, It is calledochreate. eg. **Polygonum**
8. **Adnate** – Both stipules are attached with petiole. eg. **Rose**
9. **Tendrillar –** Stipules are modified into tendrils like structure. eg. ***Smilax***
10. **Bud scale –** Protect the young Bud. e.g. **Ficus**

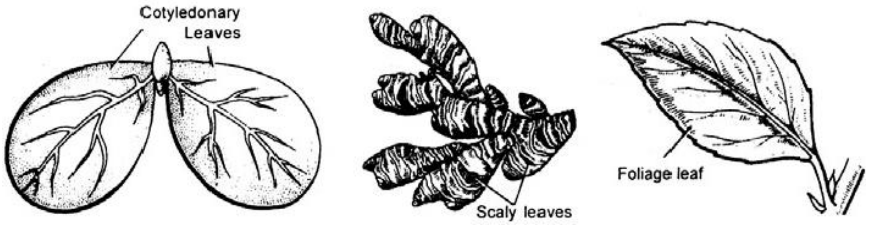


TYPES OF LEAVES

Foliage leaf – They are usually green coloured and their main function is photosynthesis.

Cotyledonary leaf – This leaf comes out during germination and helps in nutrition until the first leaf isnot formed.

Scaly leaf (Cataphylls) – Such leaves are usually dry membrane like and they can not performphotosynthesis

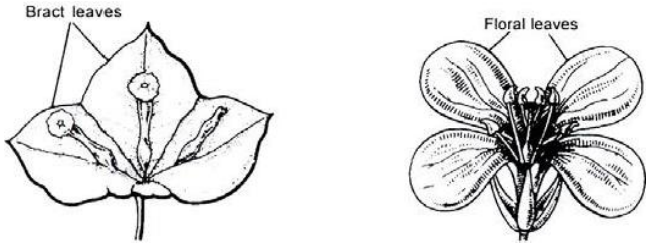


Bract (Hypsophyll) – Bract are the leaves which is present in flower axis.

Bracteole – These are leaf like structure found on pedical.

Floral leaf – Sepals, petals, stamen and carpel are found in flower which are included in this type of leaf.

Perianth – In some flowers, Calyx and Corolla are not distinct and are termed as Perianth and unit ofperianth is called tepal. eg. ***Lily***



Duration of leaf:

Persistent / Evergreen – Leaves of such plants are found in all season and do not (fall) shedcombindly. eg. ***Pinus, Saraca indica,*** **Datepalm.**

Deciduous – All leaves of such plants shed at the same time eg.

Azadirachta**. Caducous –** Leaves fall soon just after appearance or

after opening of bud. eg. **Rose**

Leaf insertion:

Cauline leaves – When the leaves are found on node of stem, then these are called cauline leaves. eg.
Maize, Hollyhock.

Ramal leaves – When leaves are found on branches, then these are called ramal leaves. eg. ***Delbergia,Zizypus*****.**

Radical leaves – During favourable season, leaves develop from the nodes of under ground stem and seem that they are developing from roots. This type of leaves are known as radical leaves. eg. **Radish,Turnip.**

VENATION OFLAMINA

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

1. **Reticulate:** It is found in dicots. Exception – ***Calophyllum***, ***Eryngium.*** It has parallel venation.
2. **Parallel:** It is found in monocots. Exception – ***Smilax***, ***Dioscorea, Alocasia, Colocasia***. It has reticulate venation.

Reticulate venation:

In it main vein divided into various branches (veinlets) and form a net like structure. Reticulate venation isof 2-types.

Unicostate or pinnate – In this type of venation leaf have only one principal vein or midrib that giveoff many lateral veins which proceed toward margin and apex of lamina of the leaf and form a network.eg. **Mango, guava, Peepal,**

Multicostate or palmate – In this type of venation many principal veins arising from the tip of petioleand proceed towards tip of lamina. This is again two types –

a. **Multicostate divergent –** Many principal veins arising from the tip of petiole, diverge from the another toward the margin of leaf blade eg. Cotton, Caster, Cucurbita, grape.

b. **Multicostate convergent –** Many principal veins arising from the tip of petiole. At the base ofleaf they are closely arranged but diverage from one another in middle part and converge towards the apex of leaf. eg. Camphor, ***Zizyphus***, Tejpat, Chinarose, plum.

Reticulate unicostate (Pinnate) | Multicostate (Palmate) Divergent | Multicostate (Palmate) Convergent

Parallel venation :

In this type of venation, all veins run parallel to each other and they do not from network. They are of 2 types.

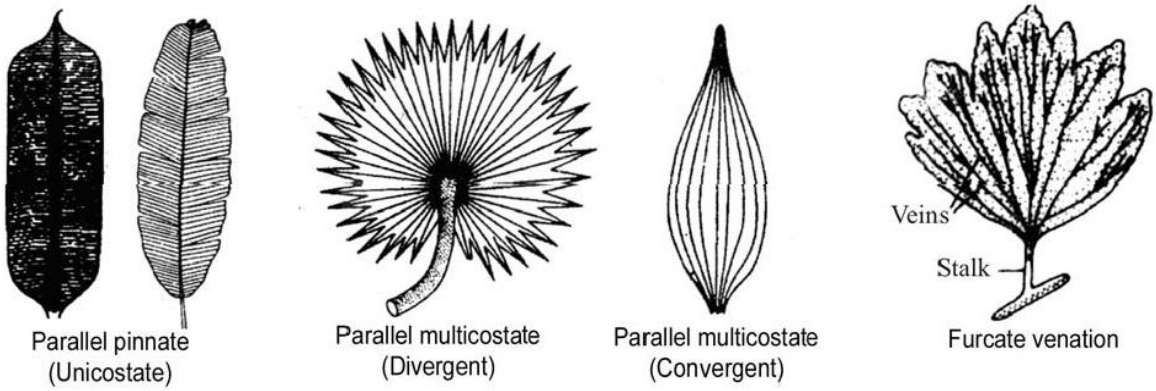
Unicostate or pinnate – This type of pattern having only one principal vein, that gives off many lateralveins, which proceed toward the margin of leaf blade in a parallel manner but they donot have veinlets.eg. **Banana, Ginger, Canna.**

Multicostate or palmate – Having many principal veins arising from the tip of the petiole and proceeding upwards.

a. **Multicostate divergent –** Many principal veins arising from the tip of petiole and diverge towardthe margin of leaf. They donot divide into veinlets and do not form network. eg. ***Coconut, Date palm***

b. Multicostate convergent – Many principal veins arising from the tip of petiole run in a curved manner in lamina and converge towards the apex of leaf blades. eg. – Wheat, Sugar-cane, Bamboo.

Furcate venation – The veins branch dichotomously but the reticulum is not formed by the finer branches. eg. ***Adiantum*** (fern).



TYPES OF LEAF

Simple and Compound Leaf :

Simple Leaf – A leaf which may be incised to any depth, but not down to the midrib or petiole, thenthis type of leaf called simple leaf. eg. **Mango, Chinarose, Ficus**, etc.

Compound leaf – A leaf in which the leaf blade is incised up to the midrib or petiole, thus dividing itinto several small parts, known as leaflets. This type of leaf is known as compound leaf.

It is of two types –

a. **Pinnately compound leaf –** In this type of leaf mid rib is known as rachis. Leaflets are arranged onboth sides of rachis. eg. **Neem**.

It is of following types -

Unipinnate – In this type of leaf, division occurs only once and leaflets are directly attached on bothsides of rachis.

If the number of leaflet is even, then leaf is known as paripinnate. eg. ***Cassia fistula, Sesbania***

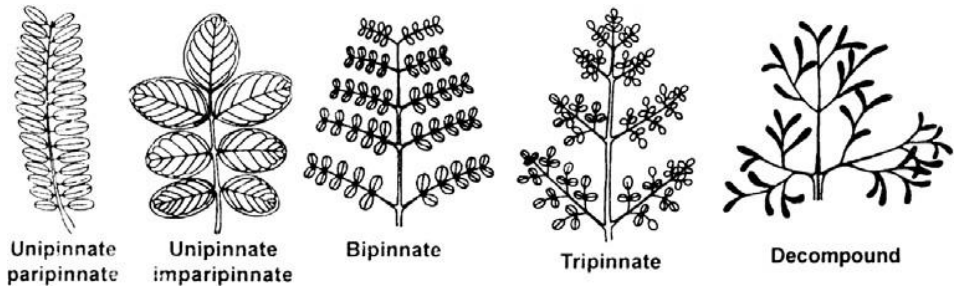
If the number of leaflet is odd, it is known as imparipinnate. eg.

Rose, Neem. Bipinnate – A twice pinnate compound leaf eg.

***Acacia,* Gulmohar, *Mimosa*.Tripinnate –** A thrice pinnate

compound leaf eg. ***Moringa*.**

Decompound – A compound leaf, which is more than thrice pinnate. eg. **Carrot, Coriander.**



b. **Palmate compound leaf –** In this type incision of leaf are directed from leaf margin to apex ofpetiole and all leaflets are attached on the upper end of petiole.

It is of following types -

Unifoliate – When single leaflet is found. eg. **Lemon**

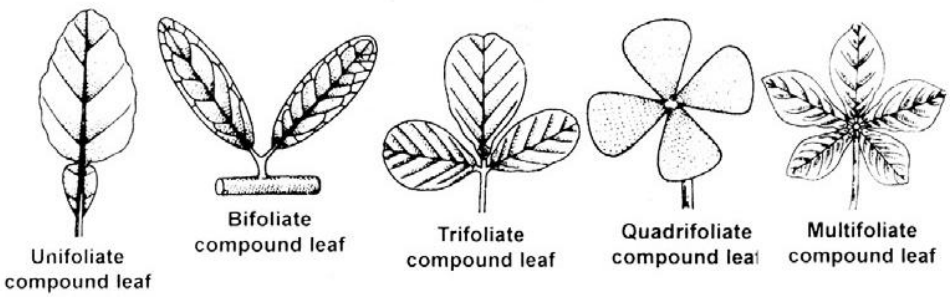
Bifoliate – When two leaflets are present. eg. ***Bauhinia,***

Regnelidium, ***Bignonia***.**Trifoliate –** When three leaflets are

attached. eg. ***Oxalis, Aegle, Trifolium*** **Tetrafoliate –** When

four leaflets are attached to the petiole. eg. ***Marsilea*.**

Multifoliate – when more than four leaflet are found, then leaf is called multifoliate palmatecompound leaf. eg. **Silkcotton.**



Phyllotaxy : Arrangement of leaves

on stem or branches.It is of

following type –

Alternate or spiral – Single leaf arising at each node. eg. ***Cyprus rotandus,*** Chinarose, mustard &Sunflower,.

Opposite – Leaves occuring in pairs at the node, they may be –

Decussate : Leaves that stands at right angle to next upper or lower pair eg. ***Calotropis, Mussaenda***.

Superposed : Successive pairs of leaves stand directly over a pair in the same plane eg. ***Psidium***

(guava), ***Ixora***.

Whorled – More than two leaves at each node eg. ***Nerium, Alstonia***.

Spiral **Alternate** **Opposite** **decussate** **Opposite**

superposed Whorled Heterophylly – It is the occurrence of more than one type of leaves on the same plant. It is of three types –

Developmental Heterophylly : Leaves of different forms and shape occur at different period or placeson the same plant eg. Mustard, Sonchus, Eucalyptus.

Environmental Heterophylly : It is aquatic adaptation which is commonly found in rooted emergenthydrophytes. In this, submerged leaves differ from the floating and aerial leaves. eg. ***Limnophila***, ***Heterophylla, Ranunculus aquatiles, Sagittaria***.

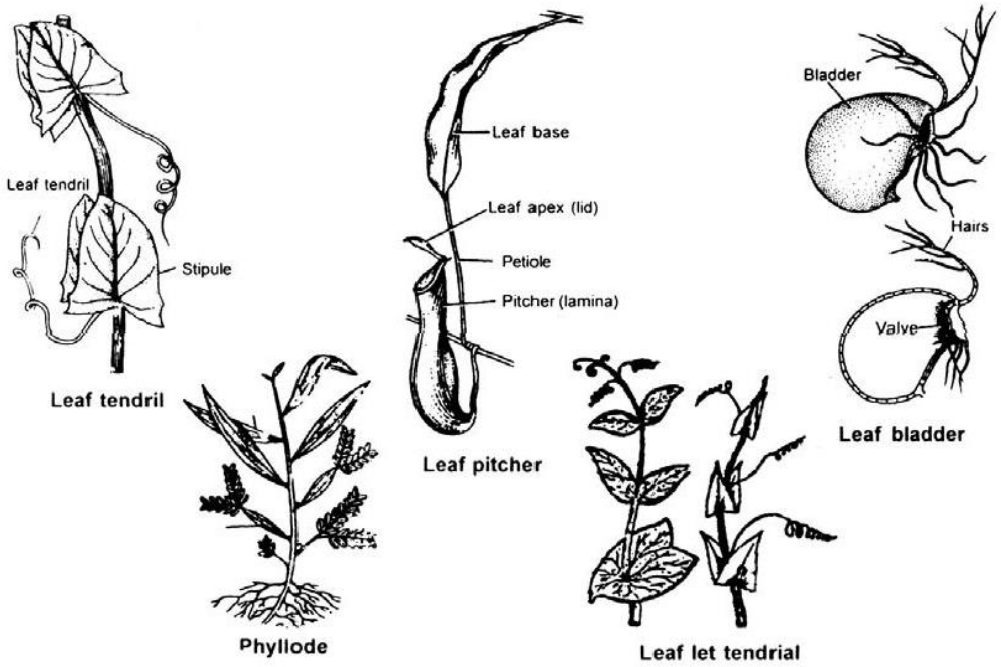
Habitual Heterophylly : Due to habit mature leaves differ in their shape and incissions eg. *Artocarpus*

(Jack fruit).

MODIFICATIONOFLEAVES

1. **Leaf tendril –** In it, whole leaf is modified into thin thread like structure which is called leaftendril. eg. ***Lathyrus aphaca* (wild pea).**
2. **Leaflet tendril –** When leaflet is modified into tendril like structure than it is called leaflet tendril. eg. ***Pisum sativum*** (Garden pea), ***Lathyrus odoratus*** (sweet pea)
3. **Leaf spine** – Leaves or any part of leaflet are modified into pointed spine. eg. ***Asparagus, Opuntia,Aloe, Argemone.***
4. **Leaf scale –** In it, leaves become thin, dry and form a membrane or paper like structure and serve toprotect axillary buds as in ***Ficus*** and ***Tamarix, Ruscus***, ***Casurina***.
5. **Leaf pitcher –** Leaves of some plants are modified to pitcher shape. eg. ***Nepenthes, Dischidia.***
6. **Leaf bladder –** In some plan , leaves are modified into bladder like structure eg. ***Utricularia.***

1. **Leaf Hooks –** In some plants terminal leaflets are modified into curved hooks for helping the plant inclimbing. eg. ***Argemone, Opuntia, Aloe*, Cat's nail (*Bignonia unguis – cati*)**
2. **Phyllode –** In its, petiole becomes flat structure and function as normal leaf. eg. ***Australian acacia*.**
3. **Flashy leaves –** In onion and garlic food storing flashy leaves are present.



INFLORESCENCE

Arrangement of flower on floral axis is called inflorescence. Two main types- **Racemose & Cymose**

Racemose – In this type of inflorescence the main axis continues to grow and does not terminate in a flower and give off flower laterally in acropetal manner where old flowers are arranged toward base and young flowers are at tip. When peduncle is broad then flowers are centripetally arranged.

This is of following different types:

1. **Raceme –** When peduncle (main axis) is elongated and flowers are pedicellate. eg. **Radish,** characteristic feature of cruciferae family. When peduncle is branched and each branch bear pedicellated flowers like racemose and are arranged in acropetal manner known as compound raceme or panicle. eg. Gulmohar, Neem.

2. **Spike –** In it peduncle is elongated but flowers are bisexual and sessile. eg. ***Achyranthes***

When peduncle is branched and each branch bear spike, like inflorescence then the small branch having flower is called spikelet and this arrangement is called as spike of spikelet. Characteristic inflorescenceof family gramineae.

3. **Catkin –** In it peduncle is thin, long and weak, and flowers are sessile and unisexual. Peduncle ispendulus. eg. mulberry, betula, oak.

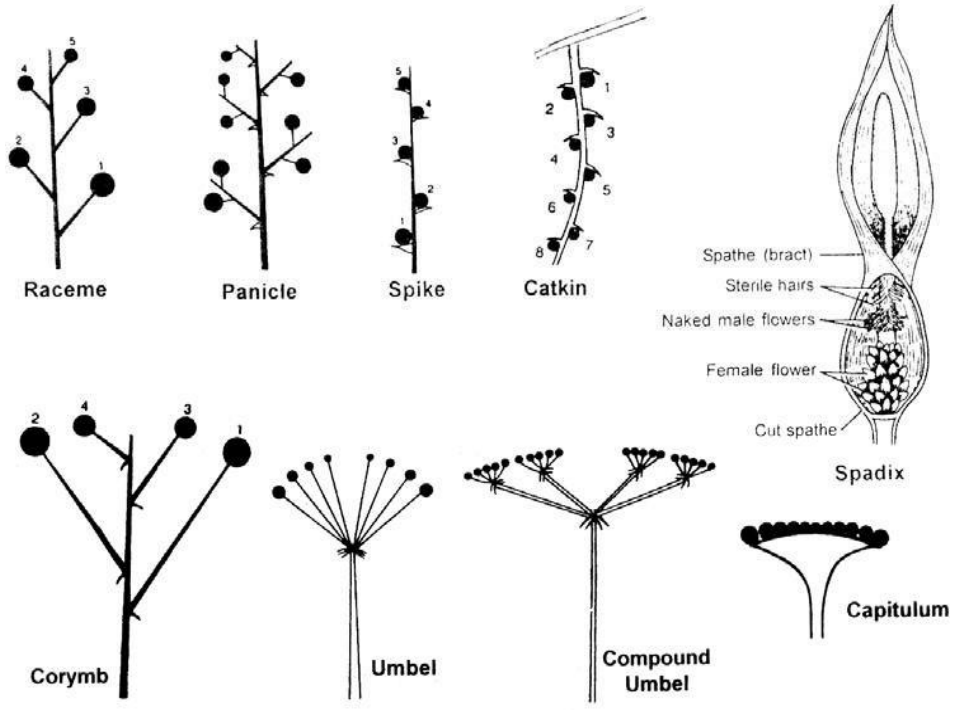
4. **Spadix –** In it peduncle is thick, long and fleshy and have small sessile and unisexual male and femaleflowers covered with one or more green or colourfull bracts known as spathe. eg. Colocasia, Maize, Aroids, Palms.

5. **Corymb –** In it peduncle is short and all flowers are present at same level because the lower flowerhas much long pedicel than the upper one eg. Candytuft **(*Iberis amara*)**. If in this type of inflorescenepeduncle is branched, then each branch has flower cluster then this type of inflorescence is called compound corymb. eg. **Cauliflower.** * In mustard corymbose raceme type of inflorescence is present.

6. **Umbel –** An inflorescence in which the flower stalks of different flowers are of more or less equal length,arise from the same point. At the base of flowers stalks, there is whorl of bracts forming the involucre. eg.***Centella.*** If in this type of inflorescence, peduncle is branched then each branch has flower cluster then this type of inflorescence is called compound umbel. eg. ***Coriander, Foeniculum, Cuminum***. Characteristic feature of umbelliferae.

7. . **Capitulum / Racemose head –** In it the growth of peduncle is retarded and it become broad, flattened concave or convex. On it small flowers are found. These flowers are called floret. Ifall the flower of capitulum are same , then it is called homogamous. If two different type of floret, ray floret and disc floret are present in same inflorescence than it is known as heterogamous. In this type of inflorescence florets may be unisexual, bisexual and sterile. This inflorescence is surrounded by one or more involucre. It is most advanced type of inflorescence. eg. **Sunflower, Zinnia, Marigold**, **Cosmos**.

Characteristic feature of asteraceae family.



CYMOSE

In this type of inflorescence, the peduncle terminate in a flower. In it the older flowers are present at tip andyoung buds are arranged towards base. This arrangement is called basipetal succession.

It is of following types.

1. **Uniparous cyme / Monochasial cyme -** The peduncle ending in a flower producing lateral branch at atime of ending in flower. It is of two types -

   Helicoid cyme – When all lateral branches developed on the same side on peduncle then it is called
   helicoid cyme. eg. ***Heliotropi m, Saraca, Atropa*, *Datura.***

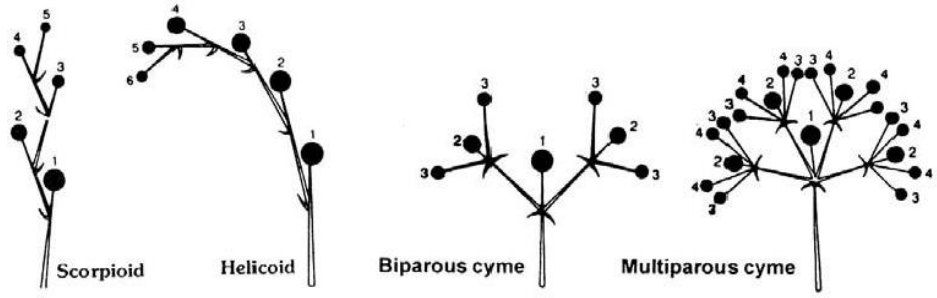
   Scorpioid cyme – In it the lateral branch is alternately develop on left and right side. eg. ***Bignonia*,**

   Riphidium – In monochasial cyme all flowers are borne on same plane. eg. ***Solanum nigrum***

2. **Dichasial or biparous cyme –** In it peduncle ends in a flower, from the basal part of peduncle two lateral branches arise, which also end in a flower, now this same arrangement occur on these lateral branches.

eg. ***Bougainvillea,* Jasmine, Teak*, Mirabilis, Dianthus, Nyctanthes*.**

3. **Multiparous cyme / polychasial –** In it peduncle ends in a flower and from the base of it many lateral branches arise which also terminates in flower, this arrangement now also occur on these lateral branches. eg. ***Calotropis*** (Madar)**,** ***Nerium, Asclepias, Hamelia***.



SPECIAL TYPE OF INFLORESCENCE

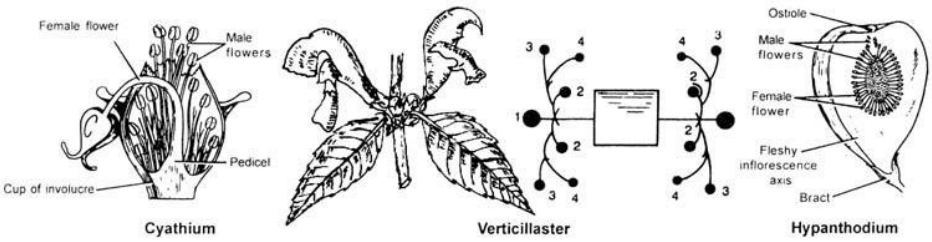
Cyathium – The bracts or the involucre become fused to form a cup shaped structure on the margin. Inthe central part of cup shaped structure a single female flowers is found, which mature earlier. Due to the growth of pedicel this come out from the cup shaped structure. Female flower are surrounded by large no. of small male flowers. The male flower, which lie toward centre mature earlier than the flower which are towards periphery. This inflorescence is found in Euphorbiaceae family like ***Euphorbia, Poinsettia, Pedilanthus***.

Verticillaster - A cluster of subsessile or sessile 3-9 flowers born on a dichasial cyme ending in monochasial cyme (scorpioid) in the form of condensed whorl on either side of the node. The opposite clusters give the appearance of whorl or verticel due tp overcrowding. The verticels are further arranged in a racemose manner eg. ***Ocimum*** (Tulsi), ***Salvi.***

Characteristic inflorescence of labiateae family.

Hypanthodium – In it peduncle is modified in narrow cup like structure. At the base of cup female flowers develop while towards mouth male flower develops. All three types of flowers are present in this inflorescence. eg. **Banyan, Peepal, Ficus species**.

Coenanthium : In Dorsitenia, the receptacle becomes saucer shaped and its margins are slightlycurved. Arrangement of florets are similar to hypanthodium.



Mixed inflorescence – Some times flowers are arranged in both racemose and cymose manner on samepeduncle called mixed inflorescence.

Mixed spadix – Banana **Cymose raceme or thyrsus** – Grapes.

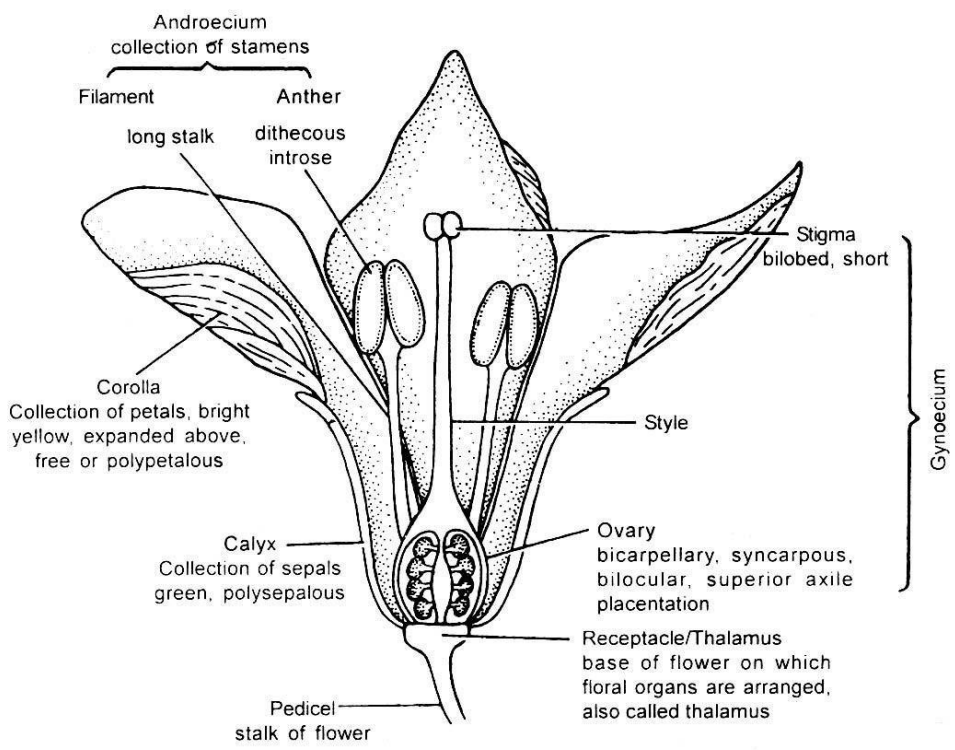
FLOWER

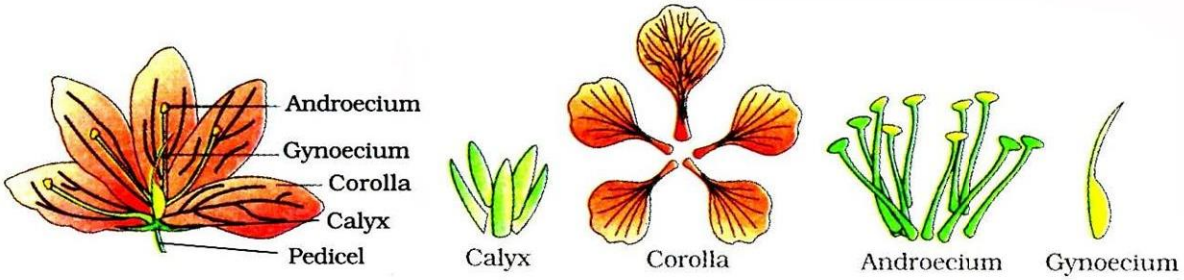
Flower is defined as highly condensed and modified reproductive shoot. The part from where flower arise is called bract. Flower has short or long flower stalk which is called pedicel. The upper part of pedicel is swollen, spherical shaped or conical which is called thalamus / Receptacle.

Floral leaves are present on it.

In a flower there are 4 type of floral leaves are found.

Sepal Petal Stamen Carpel





Parts of a flower

SOME WORDS RELATE TO FLOWER

Complete Flower – When calyx, corolla, androecium and gynoecium are present.

Incomplete Flower – Flower with one of the four whorl missing.

Bisexual Flower – Both gynoecium and androecium present in the same flower.

Unisexual Flower – Androecium (staminate flower) or gynoecium (Pistillate flower) any one of themare present in the flower.

Monoecious Plant – When both male and female flowers are present on the same plant. eg. ***Cocos*,*Ricinus, Colocasia, Zea, Acalypha***.

Dioecious Plant – When male and female flowers are present on separate plant eg. Mulberry, Papaya.

Polygamous Plant – When unisexual (male or female), bisexual and neuter flowers are present on thesame plant eg. Mango, Polygonum.

Monocarpic Plant – The plant which produces flowers and fruits only once in life eg. Pea, Mustard,Bamboo, Agave.

Polycarpic Plant – The plants which produces flowers and fruits many times in life, eg. Pear, Mango,

Achlamydeous Flower – Flowers are naked without sepals and petals eg. piperaceae. **Monochlamydeous Flower :** Only one accessory whorl is present (Perianth) eg. Polygonaceae, Liliaceae.**Dichlamydeous Flower:** Both accessory whorls present in flower.

Hemicyclic or Spirocyclic Flower: Some of the floral parts are in circles and some are spirally arranged. eg. Ranunculaceae.

Cauliflory: Production of flowers on old stem from dormant buds eg. ***Artrocarpus, Ficus***.

Symmetry of flower – If the floral leaves are cyclic arranged in a flower, then it is called cyclic flower.If floral leaves are spirally arranged then it is called spiral flower. Floral symmetry is of three type -

Actinomorphic / Radial / Regular – When flower is divided by any vertical plane into two equalhalves, then it is called actinomorphic flower eg. Mustard, China rose, Datura, Chilli.

Zygomorphic / Bilateral – When the flower is divided into two equal halves only by one verticalplane, then it is called zygomorphic flower eg. Pea, Bean, Gulmohur, Cassia.

If it is divided into two equal halves, from median plane, then it is called medianly zygomorphic, eg.
Ocimum (Tulsi)

But if it is divided into two equal halves, by lateral plane then it is called laterally zygomorphic.

Asymmetrical / irregular – When the flower cannot be divided into two equal halves from any plane,then it is called asymmetrical flower. eg. Canna.

Note : - Part of flower which lies near to mother axis is posterior part while the part which is far frommother axis is anterior part of flower.

INSERTION OF FLORAL LEAVES

Hypogynous condition – When petals, sepals and stamens are situated below the ovary, the flower is called hypogynous and in this condition ovary will be superior.

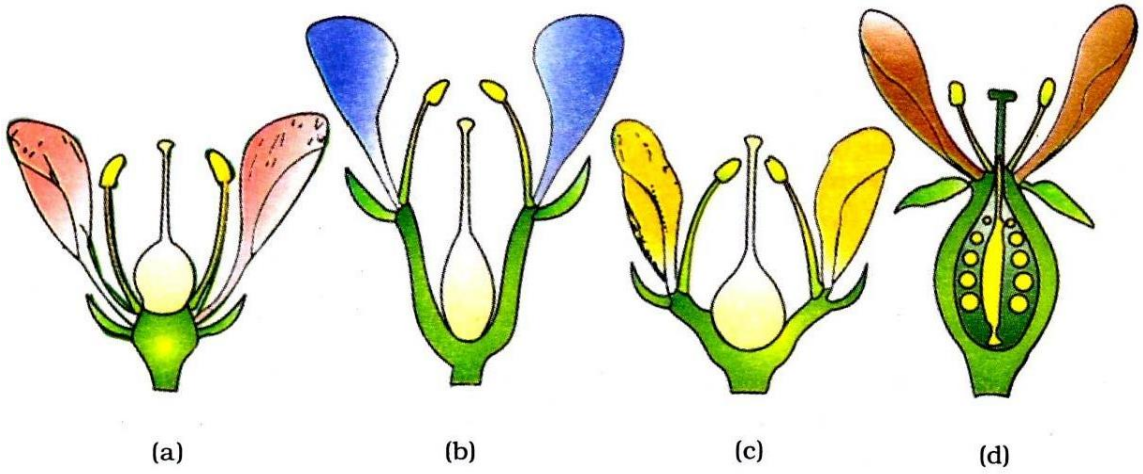
Eg. mustard, Chinarose, Brinjal.

Perigynous condition – In it thalamus grow upwardly and form a cup shaped structure. Gynoecium issituated in the centre and other parts of flower are located on the rim of the thalamus almost at the samelevel. It is called perigynous. The ovary here is said to be half inferior.

Eg. plum, peach, rose.

Epigynous condition – The margin of thalamus grows upward enclosing the ovary completely and getting fused with it, the other parts of flower arises above the ovary, the ovary is said to be inferior and this condition is known as epigynous.

eg. Guava, Cucumber and ray florets of sun flower



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

Notes :

Bracts : Bracts are specialized leaves present in axis of flower. **Bracteate –** The flower which have bract is called bracteate flower. **Involucre –** The whorl of bract surrounding peduncle is called involucre.

Involucel – Group of bracteole is called involucel.

Spathe – In flowers when large bract completely encloses whole inflorescence, then it is called spathe.eg. Banana, Maize.

Petaloid bract – When the size of bract of flower is greater than size of flower and these are of variouscoloured then it is called petaloid bract. eg. ***Bougainvillea.***

Glumes – Small, dry, scaly bracts are called Glumes. eg. Wheat, Grass.

CALYX

The outermost whorl of flower is called calyx. Each member of this whorl is called sepal when all the sepals are free from each other, then it is called poly-sepalous condition eg. Mustard, Radish. When the sepals are fused each other, then it is called gamosepalous condition eg. Cotton, Datura, Brinjal.

DURATION OF SEPALS

Caducous – Sepals fall just at the time of opening of flower bud. eg. Poppy.

Deciduous – Sepals fall after pollination eg. Mustard

Persistant – If sepals do not fall and remain attached to fruit. eg. Tomato, Capsicum, Brinjal, Cotton, Datura.

* Sometime below calyx, a whorl similar to sepals is found which is called epicalyx. eg. Malvaceaefamily

COROLLA

The second whorl of flower is called corolla and each member of it is called Petals. When the shape and size of petals are similar then it is called symmetrical while when they are not similar then they are asymmetrical. When all the petals are free, then it is called polypetalous while when petals are fused, then it is called gamopetalous.

Forms of

Corolla -

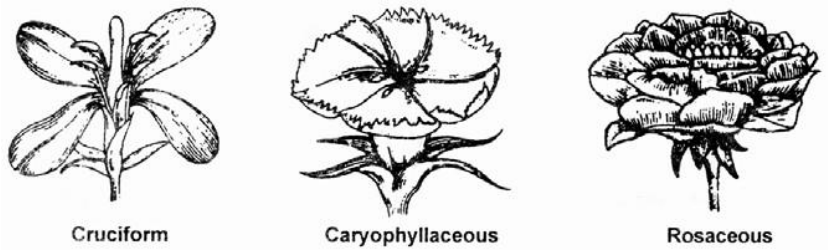
POLYPET

ALOUS

Cruciform – 4 petals are present in it. The lower narrow part of petal is called claw while the outerbroad part is called limb. These petals are arranged crosswise. eg. **Radish, Mustard**.

Caryophyllaceous – It consists of 5 petals the claw of petals are short and the limb of petals from rightangle to the claw eg. **Dianthus.**

Rosaceous – It consist of 5 or more petals. Claws are absent in it and limbs are spread regularlyoutwards. eg. Rose, Coconut.

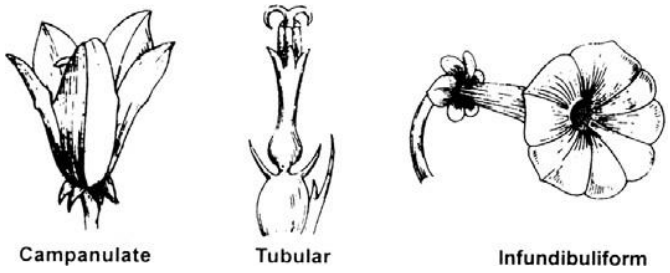


GAMOPETALOUS

Campanulate – Five petals are arranged like bell. eg. **Tobacco, Raspberry, Campanula**.

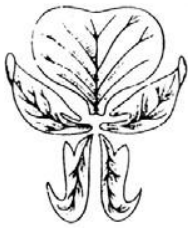
Funnel shaped or infundibuliform – Funnel like petals arrangement eg. **Datura,**

Railway creeper.**Tubular –** Petals are like tube eg. **Disc florets of sunflower**.



ZYGOMORPHIC POLYPETALOUS COROLLA -

Papilionaceous – Five petals are present. It's posterior petal is largest and is known as standard or vexillum. Vexillum covers two lateral petals which are called as wings and the innermost basal petals are united to form a keel or carina. Both lateral parts



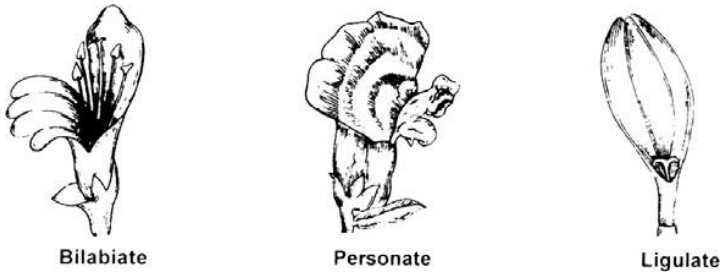
covers the keel. eg. **Pea, Gram, Arher**

ZYGOMORPHIC GAMOPETALOUS COROLLA -

Bilabiate – The petal of gamopetalous corolla is divided into two lips. The place between two lips iscalled corolla mouth. eg. ***Ocimum, Salvia.***

Personate – In this case the corolla is bilabiate but the two lips are near to each other eg. ***Antirrhinum***

Ligulate – The upper part of corolla is long, flattened which is attached with short narrow tube. eg. **Rayflorets of sunflower**.



AESTIVATION -

The mode of arrangement of sepals or petals in floral bud with respect to the other members of the semewhorl is known as aestivation. It is of following types -

Valvate – When the petal of a whorl lie adjacent to each other petal and just touches it. eg. ***Calotropis*,Custard-apple, Mustard.**

Twisted – In it one part of a petal covers adjacent petals and the other part is covered by posterior petal. One margin of the petal overlaps that of the next one, and the other margin is overlapped by the third one. eg. Cotton, Ladyfinger, Chinarose

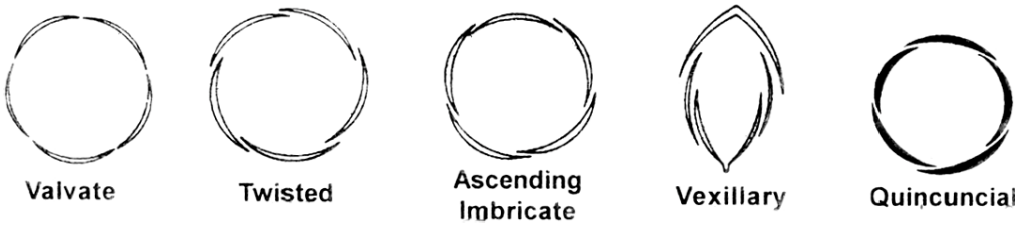
Imbricate – When both margin of the one petal are covered by the others two petals and both margin of another one, covers other, Rest are arranged in twisted manner.

It is of two types -

Ascending imbricate – The posterior petal is innermost i.e., its both margins are overlapped. eg.
Cassia, Bauhinia, Gulmohur etc.

Vexillary or Descending imbricate – The anterior petal is innermost and posterior petal isoutermost & largest. eg. Pea, Bean.

Quincuncial – It is a modification of imbricate type. Out of the five petals, two are completely internal, two completely external and in the remaining petal, one margin is internal and the other margin is external. eg. ***Murraya, Ranunculus***.



PERIANTH

When there is no distinction between calyx and corolla the whorl is described as perianth.

Individual perianth segments are called **Tepals**. Green tepals are called **sepaloid** and

coloured tepals are called **petaloid**. Tepals are free (polytepalous) or fused (gamotepalous). eg. ***Liliaceae*** and ***Graminae***family

ANDROECIUM

It constitutes the third whorl of the flower and is made up of one or more stamens. Each stamen consist of
filament, anther and connective. Each anther is usually bilobed and each lobe has two chambers the
pollensac. The pollen grains are produced in pollensac.

Attachment of filament to anther lobe :

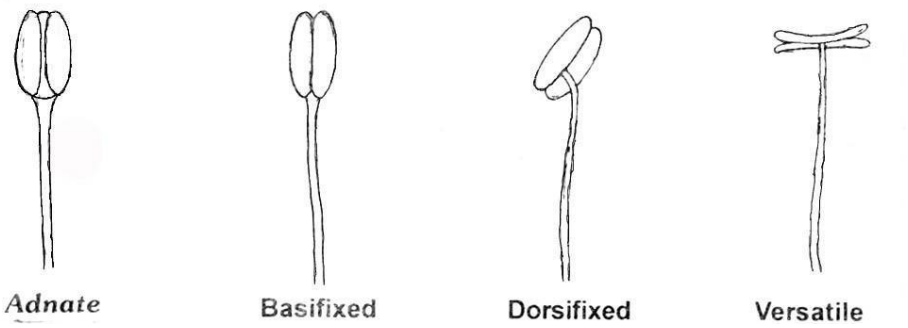
The attachment of filament to another lobe is of 4 type -

Adnate – Filament runs through the whole length of the anther from the base to the apex. eg. ***Michelia***

(Champa)***, Magnolia***

Basifixed – Filament is attached to anther by its base. eg. **Datura, Radish, Mustard. Dorsifixed –** The filament is attached at the centre to the back of the anther. eg. **Passion flower**

Versatile – Filament attached to the back of the anther at a point only, thus the anther can swing freely.eg. Wheat, grass, maize.



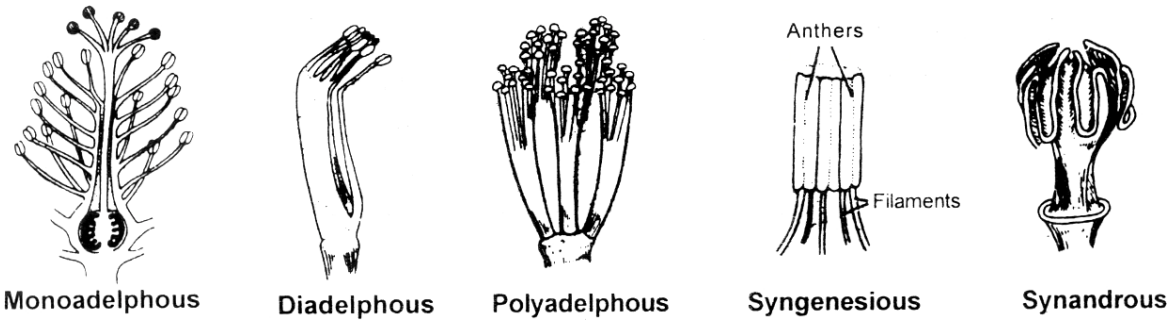
Cohesion of stamens :

When the floral parts of similar whorl are fused, then it is called cohesion. When the stamens of an androecium are free from one another, it is called polyandrous condition.

1. **Adelphous** : when stamens are united by their filament only, it is called adelphous. It is of following types –
    - **Monoadelphous** – When all the filaments are united into a single bundle but anthers arefree from each other. In this type of cohesion a tube is formed around the gynoecium which is called staminal tube eg. Cotton, Hollyhock, Ladyfinger.
    - **Diadelphous –** When the filaments are united in two bundles but the anther remains free eg. Gram, Pea, Bean. In these plants from 10 stamens, 9 stamens are arranged in bundlewhile 1 remains free.

- **Polyadelphous –** When filaments are united into more then two bundles. eg. Citrus, Castor.

2. **Synandrous –** When anthers as well as filaments of stamens are united through their whole length. eg.
Colocasia, Alocasia, Momordica, Cucurbitaceae family
3. **Syngenesious** – In it only anthers are united in bundle but filaments remain free eg. Compositaefamily



Adhesion of stamens:

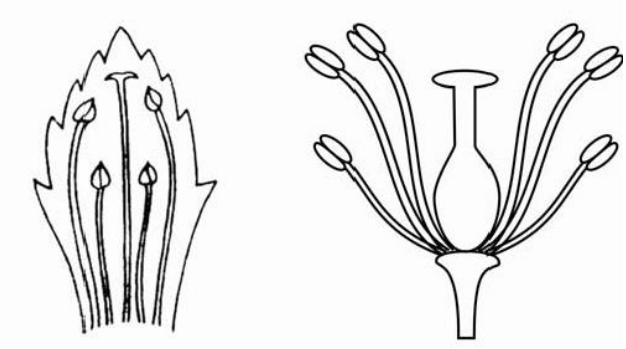
When the stamens are attached to other parts of flower, then it is called adhesion of stamens.

1. **Epipetalous –** When stamens are attached to petals. eg. Brinjal, Datura, Tobacco, Sunflower, Potato.
2. **Epiphyllous –** When stamens are attached to tepals. eg. Onion, Lily.
3. Gynandrous – When stamens are attached to gynonecium either throughout their whole length orby their anther eg. *Calotropis*

Length of stamens:

Didynamous – When four st mens are present, out of them two are long and two are short, then it is called didynamous. eg. Labiatae family.

Tetradynamous – When there are six stamens and they are arranged in two whorls. In outer whorl, there are two short stamens while in inner whorl, there are four long stamens, this condition is called tetradynamous. eg. Cruciferae family.



Didynamous **Tetradynamous**

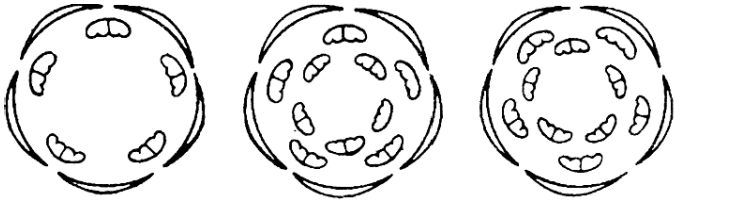
Note -

Inserted – When the stamens are smaller than corolla. eg. Datura

Exserted – Stamens are longer than corolla and are radially outward. eg. Gulmohar.

Diplostemonous – The stamens are double the number of petals and present in two whorls. The outer whorl of stamens is alternating with petals (alternipetalous), while inner whorl is opposite to petals (antipetalous). eg. **Liliaceae family.**

Obdiplostemonous – It is reverse of diplostemonous. The outer whorl of stamen is opposite to petals, while inner whorl of stamen is alternating with petals. eg. **Caryophyllaceae.**



Isostemonous or Haplostemonous – In such type of condition stamens are present in single whorls. No. of stamens is equal to no. of sepals and petals and generally whorl of stam ns is alternating with petals.

Heterostemonous – Stamens are of different length in some flowers.

Staminodes – When stamens are without pollen grains & remain sterile through out life are called staminodes e.g. ***Salvia verbascum***.

GYNOECIUM (PISTIL)

It is the fourth and second essential whorl of the flower. It is female part of the flower comprising of the inner whorl of megasporophylls in the form of carpels bearing ovules. It consists of ovary, style and stigma. 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 receptive surface for pollengrains. The gynoecium may be monocarpellary or multicarpellary.

If only one carpel is present in gynoecium this condition is called monocarpellary.

If more than one carpel is present in gynoecium this condition is called polycarpellary.

If all the carpels in polycarpellary / multicarpellary condition are free, then condition is calledapocarpous.

If all the carpels are fused together, then condition is called syncarpous.

COHESION OF CARPEL

In syncarpous gynoecium four types of cohesion are found

When ovaries are fused, but stigma and style are separated with each other, eg. **Dianthus,**

Plumbago

Ovary and style are fused, but stigma are not fused. Malvaceae family. ***Hibiscus rosasinensis,***cotton.

When stigma are fused but the ovary and style are free. eg. ***Calotropis, Cassia fistula, Nerium*.**

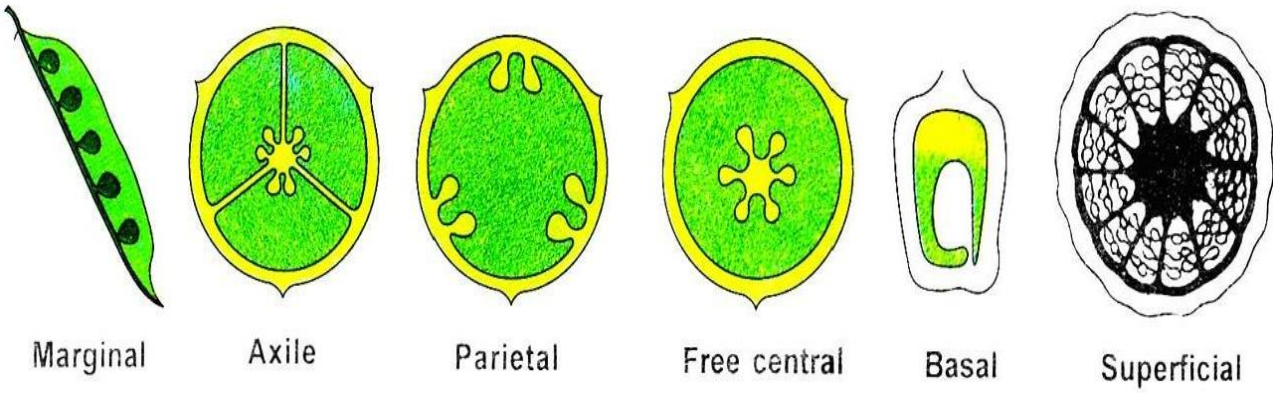
Carpels are completely fused. This condition is found in max. flowers, eg. **Mustard, Radish, Tomato**.

PLACENTATION

The ovules are attached on ovary walls on one or more cushion called placenta. The arrangement of ovulewithin ovary wall is known as placentation. It is of following types–

- **Marginal :** Marginal placentation is found in unilocular ovary. The placenta forms a ridge alongthe ventral suture of the ovary and the ovules are borne on this ridge forming two rows. eg. Leguminosae.
- **Parietal :** This type of placentation is found in unilocular syncarpus ovary. In it the ovule develops on the innerwall of the ovary or on peripheral part. Ovary become bi or multilocular due to formation a false septum eg. ***Cucurbita, Argemone*,** and Cruciferae family (Mustard)
- **Axile :** It is found in multicarpellary syncarpous gynoecium. The fusion margin of carpels grown inward and meet in the centre of the ovary. Thus an axis forms in the centre of ovary, thus ovary becomes multichambered. The ovules are born at the central axis. Number of these chambers areequal to the number of carpel **eg. Potato, China rose, Onion, Lemon, Orange, Tomato**.
  - **Free central :** This type of placentation is found in syncarpous gynoecium. In it, the ovary is unilocular and the ovules are borne on the axis in the centre of the ovary. septum are absent in ovary. Placentation is axile in beginning. After sometimes walls of chamber destroy and only

    ovulated central axis left. eg. **Primrose, Dianthus (Caryophyllaceae)**
- **Superficial –** This type of placentation is found in multicarpellary syncarpous gynoecium. The ovules are attached on the walls of locule eg. **Nymphea** (Water lily)



- **Basal :** The ovary is unilocular and a single ovule is borne at the base of ovary. eg. Marigold,Sunflower (Asteraceae family).

FRUIT

Fertilized and ripened ovary is fruit. A Fruit consist of (i) Pericarp (fruit wall), (ii) seed.

The seeds are protected inside fruit. But in some fruits. seeds are not found like in grapes, banana and suchtype of fruits are seedless fruit.

If a fruit is formed without fertilization of the ovary it is known as parthenocarpic fruit.

Pericarp : After ripening, the ovary wall change into pericarp. This pericarp may by thick and fleshy or thick and hard or thin and soft.

Pericarp is differentiated in 3 layers

Epicarp :- It is the outermost layer, which is also called rind

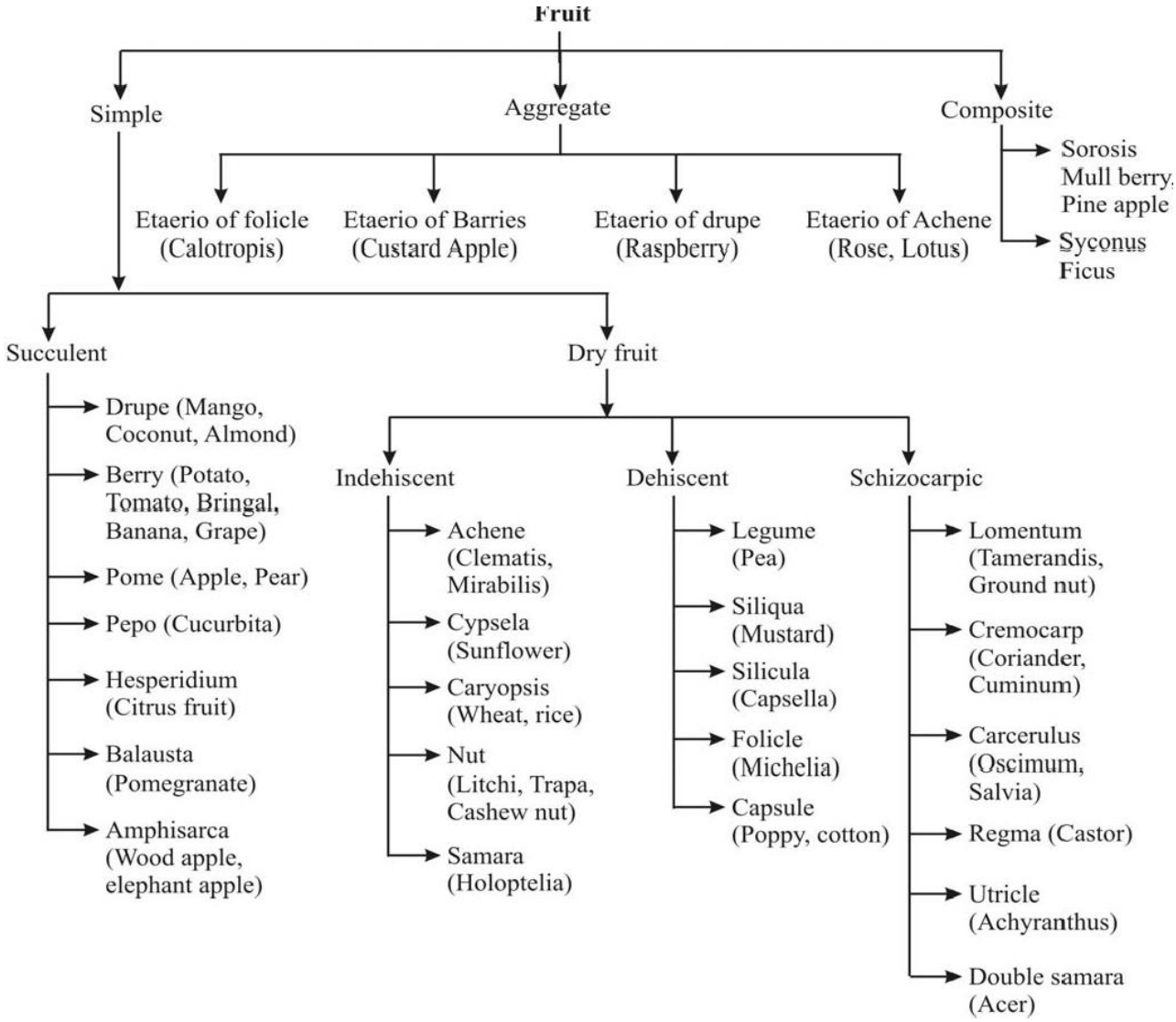
Mesocarp :- It is the middle layer.

Endocarp : It forms the innermost layer.

TRUE FRUIT: When the fruit is developed only from the ovary, the fruit is called as true fruit. eg. Mango,Coconut, ***Zizyphus***

FALSE FRUIT OR PSEUDOCARP: In some fruits, in place of ovary, some other parts of flower like thalamus, inflorescence, calyx are modified to form a part of fruit. These types of fruit are called false fruits.eg. Apple, Strawberry, Pear.

CLASSIFICATION OF FRUIT



Fruits are divided in three groups Simple, Aggregate AND composite

SIMPLE FRUIT :

These fruit develop from monocarpellary ovary or multicarpellary syncarpous ovary. Only one fruit isformed by the gynoecium. Simple fruits are of two types –

Fleshy fruit Dry fruit

A **Fleshy Fruit:-** These fruit develop from superior or inferior syncarpous gynoecium. These may be unilocular or multilocular. These fruits are indehiscent. Dispersal of seeds occur after pericarp is destroyed.

Fleshy fruits are of following types :

- **Drupe fruit:-** These fruit develops from mono or multicarpellary, syncarpous, superior ovary. In these fruits endocarp is hard and stony so these fruits are also called stony fruits. eg. Mango, coconut almond, Peach walnut, plum. Brachysclereids are present in endocarp.

  In mango edible fleshy part is mesocarp and the part where seed is protected is called as endocarp. In ber, epicarp and mesocarp both are edible part.

  The rind of Almond and walnut are endocarp and their edible part is seed.

  In coconut epicarp is hard and thin while mesocarp is thick and consist of hard fibers The endocarpis hard and seed is protected in it. Endosperm is edible in coconut.

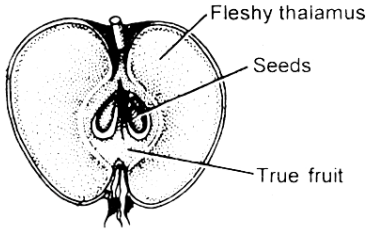
- **Berry:** These fruits develop from mono or multicarpellary syncarpous ovary. Ovary may be superior or inferior, Placentation is axile or parietal. In these epicarp is thin and seeds are embeddedin fleshy part. Initially seeds are attached with placenta of fruit but after maturation these seeds are deteched with placenta and are spread randomly in fleshy part.
  - Plants with superior ovary = Tomato, Grapes, Brinjal.
  - Plants with inferior ovary = Guava, Banana

  Date palm is one seeded berry. In it pericarp is divided into epicarp, mesocarp and endocarp. Epicarp is thin and soft while mesocarp is thick and fleshy and endocarp is thin like a membrane.Which is attached with seed.

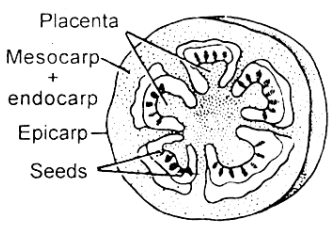
  Arecanut is one seeded fibrous fruit berry. When its thick fibrous layer is removed then seed comes out which is hard.

- **Pepo -** These fruit develops from tricarpellary, syncarpous and inferior ovary. This fruit is unilocular and have parietal placentation. These fruits are fleshy and spongy. sometime fruits are bitter in taste due to presence of tetracyclic triterpine in flashy pulp. eg. fruits of cucurbitaceae family.

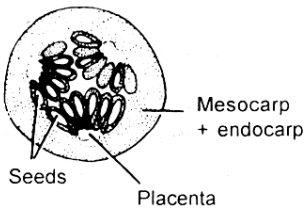
- **Pome -** This fruit develops from bi or multicarpellary syncarpous inferior ovary. The rind and fleshy pulp are made up of thalamus. The main part of ovary is hard and dry and remain inside the fruit. Seeds are present in it. eg. Apple, Pear.



L.s. of Apple



L.s. of Tomato



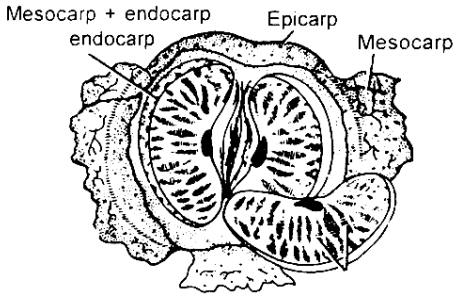
T.s. of Cucumber

- **Hesperidium :** This fruit develops from multicarpellary, syncarpous, superior ovary. This fruit isspecialy found in plants of Rutaceae family. eg. Orange, Lemon, Citrus fruit.

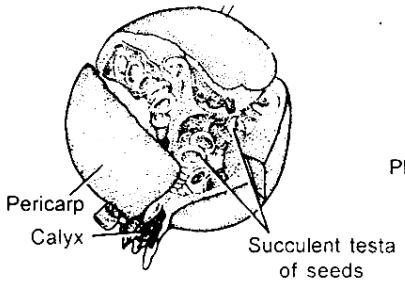
  Epicarp of these is made up of thick rind which is leathery and many oil glands are found in it. Mesocarp is white fibrous structure which is attached with epicarp. Membranous endocarp projects inward and form many chambers. Many glandular hairs are present on the inner side of endocarp. These glandular hairs are only edible parts.

- **Balausta :** It is a multilocular multiseeded fruit, which develops from inferior ovary. Its pericarp is hard. Persistent calyx is arranged in the form of crown. Seeds are irregularly arranged on placenta. Endocarp is hard. Testa is fleshy. This is the edible part of fruit. eg. Pomegranate **(*Punica granatum*).**

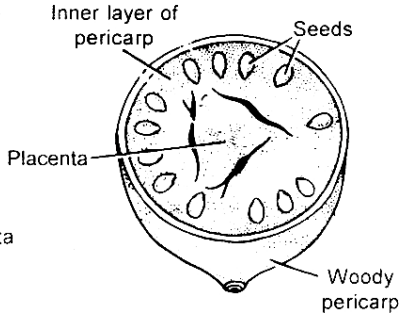
- **Amphisarca :** This fruit is multicarpellary and multichambered which develops from superior ovary. Pericarp is hard and fleshy placenta is found in them. The inner part of pericarp and placenta is edible part of fruit. Testa of seed is mucilegenous eg. wood apple **(*Aegle marmelos*),** elephant apple.



Hesperidium of orange



Balausta of pomegranate



Amphisarca of wood apple

Simple Dry Fruit - Pericarp of simple dry fruit is hard and dry and not differentiated into epicarp,mesocarp and endocarp. Such fruits are called dry fruit.

Simple dry fruits can be divided into

following three groups :Indehiscent Dehiscent Schizocarpic

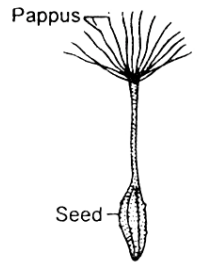
1. **Indehiscent fruits :** These simple dry fruits are generally of small size and single seeded pericarpdoes not rupture even after maturity.

   - **Cypsela :** It is a small, single seeded dry fruit which develops

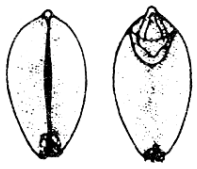
from bicarpellary, syncarpous inferior ovary. Pericarp and seed coat are free from each other. In these fruits a bunch of hair is attached with the fruit which is known as Pappus. Pappus helps in fruitdispersal. eg. Compositae family Plants.

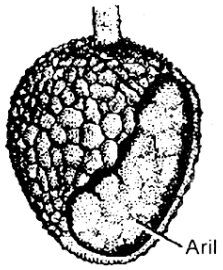
- **Caryopsis :** These are small, single seeded dry fruits. It develop from monocarpellary, superior ovary. Pericarp of these fruits is fused with the seed coat and form a joint surface. These fruits are present in family gramineae. Wheat grain or rice grain is a fruit.
- **Achene :** These are single seeded fruit which develops from monocarpellary superior ovary. In it, pericarp is free from the seed coat eg. ***Clematis, Mirabilis, Boerhaavia***
- **Nut :** This is a single seeded fruit which develop from monocarpellary syncarpous superior ovary. In it pericarp is hard eg. ***Quercus*** (oak), ***Anacardium occidentale*** (Cashewnut) ***Trapa***, (Water chest-nut), Litchi.
- In Litchi epicarp and mesocarp is fused and give leathery apperence. Endocarp is membrane like thin. Outer seed coat grows forward and forms an additional coat aroundthe seed which is called as aril. In mature fruit, this aril is fleshy and is only edible part.
- **Samara :** These are dry indehiscent one seeded feathery fruit. It develops from bi or tri carpellary, syncarpous and superior ovary. The main character of these fruits is wing like structure develops from its pericarp which helps in dispersal. eg. ***Holoptelia***.

In ***Shorea robusta*** wing develops from calyx instead pericarp and these fruit are called samaroid.

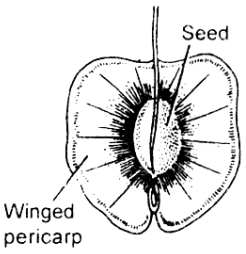


Cypsela of sunflower


Caryopsis of wheat

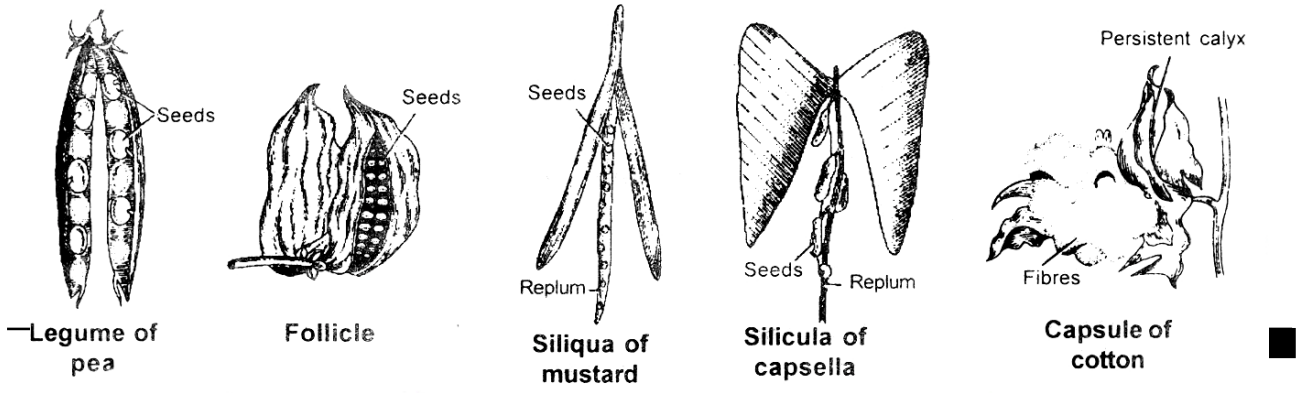


Nut of Litchi



Samara of Holoptelia

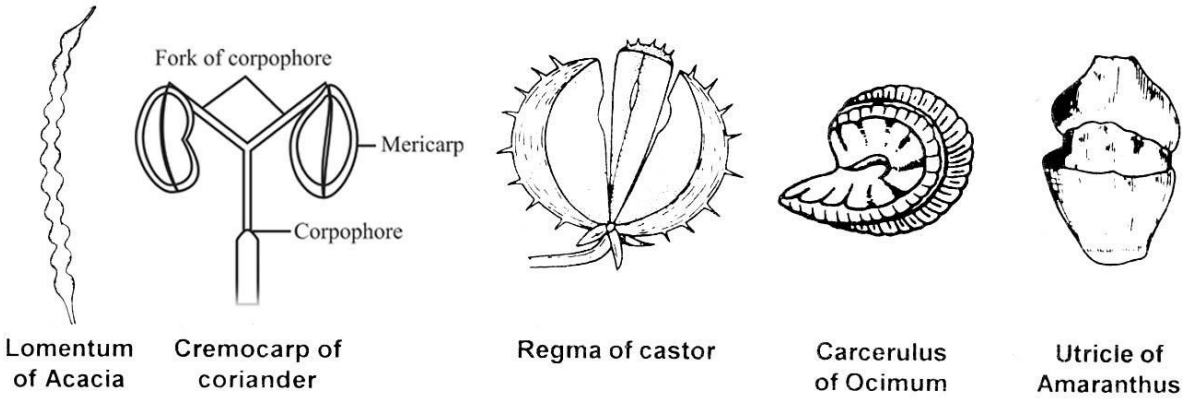
2. **Dehiscent Fruits :** After ripening pericarp are ruptured and seeds are dispersed outside.
    - **Legume or pods :** These fruits develop from monocarpellary, unilocular, superior ovary. It is generally long and multiseeded fruit. Dehiscense of fruit occurs at both sutures i.e. Dorsal and ventral side. Dehiscence start from apex and reaches to basal part. eg. Pea, Beans.
    - When only one or two seeds are present in fruit, then it is also called as pod.
    - **Follicle :** It is also multiseeded fruit which develops from superior unilocular, monocarpellary ovary but the dehiscence of it occur only at ventral suture. eg. ***Asclepias, Rauwolfia, Vinca, Michelia*** (Champa), ***Delphinium***.
    - **Siliqua :** This fruit develops from bicarpellary, syncarpous superior ovary with parietal placentation. Dehiscence occurs at both dorsal and ventral suture and starts from lower part and proceeds upward. Due to formation of false septum ovary become bilocular. Onfalse septum, seeds are attached, This type of fruit is found in Cruciferae family. eg. Mustard.
    - **Silicula :** A short broad siliqua is known as Silicula. It is also found in Cruciferae family.eg. Candytuft (***Iberis amara***), Capsella,
    - **Capsule :** This is dry multichambered and multiseeded fruit and develop from multicarpellary syncarpus, superior ovary. In it, Axile placentation is found and dehiscence occurs by various methods. Poricidal (Poppy), loculicidal (cotton), septifragal (Datura), septicidal (Lineseed).



Legume of pea | Follicle | Siliqua of mustard | Silicula of capsella | Capsule of cotton

3. **Schizocarpic fruit :** It is a multiseeded fruit. After ripening, it is devided into mericarp and seeds come out after destruction of pericarp. The fruits develop from mono or bi or multicarpellary superior or inferior ovary. The mericarp contains one or two seeds.

- **Lomentum :** It develops like legume. Fruits are constricted or divided in one seeded mericarp, after maturity these are separated with each other. Eg ***Tamarind, Cassia fistula, Mimosa pudica, Archis hypogea, Desmodium***.
- **Cremocarp :** It is a double seeded fruit and develops from bicarpellary, syncarpous, inferior ovary. On maturation, it dehisces from apex to base in such a way that two mericarp forms andeach contain one seed. These mericarp are attached with carpophore. Carpophore is the extended part of receptacle. eg. **Coriander, Cuminum, Foeniculum.**
- **Regma :** This fruit develops from tri to pentacarpellary, syncarpous superior ovary. In it three locules are present and its fruit is breaks into three one seeded part. Each part is known as coccus. At the outer end of pericarp, spines are found. eg. Euphorbiaceae family, Castor has three cocci Geranium has 5 cocci.
- **Carcerulus :** It is a dry fruit which develops from multi carpellary or bicarpellary, syncarpous, superior ovary. Number of mericarp is more than locules because of formation of false septum. It divides into four one seeded locules. eg. ***Ocimum*** (Basil), ***Salvia.***
- In hollyhock and abutilon (family malvaceae), the no. of locules is more than four
- **Utricle :** It is a single seeded fruit which has thin membrane. It dehiscence generally from cap. It develops from bicarpellary, unilocular, syncarpous, superior ovary. eg. ***Achyranthes, Amaranthus.***
- **Double Samara :** It develop from bicarpellary syncarpous superior ovary. Pericarp develops into two wings. On maturation it divides in two single seeded mericarp eg . samara , acer.



Lomentum of Acacia | Cremocarp of coriander | Regma of castor | Carcerulus of Ocimum | Utricle of Amaranthus

AGGREGATE FRUIT :-

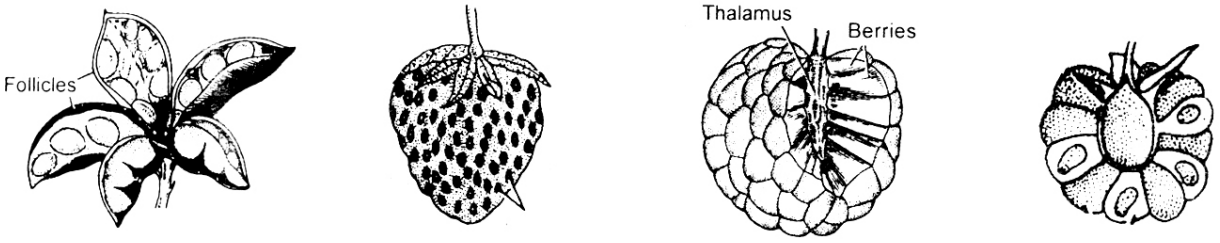
These fruits develop from multicarpellary apocarpous ovary. Because in apocarpous ovary, each carpel is separated from one another, therefore it forms a fruitlet. These fruits are made up of bunch of fruitlets whichis known as etaerio.

Etaerio of follicles : Each fruitlet is a follicle. eg. ***Calotropis, Catharanthus, Magnolia*.**

Etaerio of achenes : In this aggregate fruit, each fruitlet is an achene. eg. ***Rananculus***, Strawberry,Rose, Lotus

Etaerio of berries : It is an aggregate of small berries. eg. ***polyalthia, Annona squamosa*** (Custard-apple). In etaerio of Anona all the berries are arranged densly on thalamus.

Etaerio of drupes : In this type of fruit, many small drupes develop from different carpels. eg.Raspberry



Etaerio of Follicles | **Etaerio of Achenes** | **Etaerio of Berries** | **Etaerio of DrupesCOMPO**

All composite fruits are false fruits.

This type of fruit differ from aggregate fruit that in place of single ovary many ovaries and other floral parts combine together to form fruit. In composite fruits, generally whole inflorescence is modified into fruit. These are of two types.

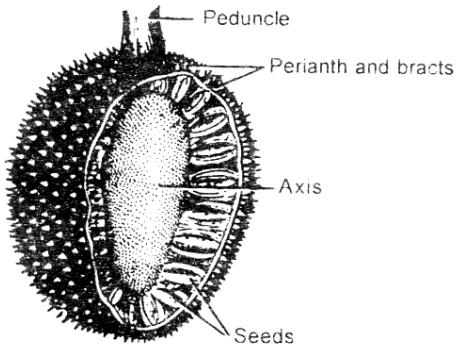
Sorosis : This fruit develops from spike, spadix or cartkin inflorescence. Peduncle become thick spongyand woody. eg. Jack fruit, ***Pandanus*** **(screwpine)**, Pineapple

In jack fruit (Kathal) pistillate flowers are developed around the peduncle. In fruit formation pericarpbecome spongy and fused.

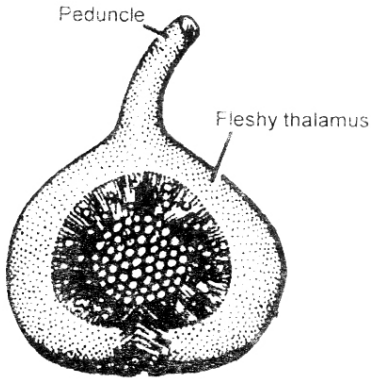
In Pine apple peduncle bracts and perianth become fleshy. Due to the fusion of perianths of flower acomposite fruit is formed.

In mulberry perianth become fleshy and calyx of every flower becomes thick, sweet and fleshy and are edible.

Syconus : This fruit develops from hypanthodium inflorescence. eg. **Ficus** species like fig, Peepal



Sorosis of jack fruit



Syconus of fig.

Geocarpic fruit : When fruit development occurs inside soil e.g. **ground nut**

SEED

Seed is a fertilized or ripened ovule. Seed is an "EMBRYO", a living tissue embedded in the supporting or the food storage tissue OR A seed is a small embryonic plant enclosed in a covering called the seed coat, usually with some stored food. The ovule after fertilization develops into seed.

A SEED IS MADE UP OF THREE STRUCTURES- 1. Seed coat. 2. Embryo. 3. Nutrient storage tissue.

1. **SEED COAT** Outer most covering of a seed is the seed coat. The seed coat is a protective covering that forms around the fertilized ovule. The seed coat is normally hard and water resistant. The seed coat has two layers, the outer TESTA and the inner TEGUMEN.

Testa is developed from the outer integument of the ovule. It is also known as EPISPERM or OUTER COAT. Testa varies in texture, being soft or fleshy and succulent, or more or less spongy or membranous or it may become woody and hard. Testa of some seeds bears numerous hairs on entire surface (cotton). Testa is externally marked by a scar indicating the HILUM . Hilum is the part by which it was attached to the funiculus or placenta.
MICROPYLE:- A minute opening above the Hilum is present on the testa. RAPHE:- A ridge around the seed formed by the funicule or stalk in many seeds.

TEGUMEN- Inner membrane or coat of the seed, which is completely adhere to the testa. It is also known as ENDOPLUERA or INTERNAL COAT. Generally, it is soft and delicate in nature, which is a whitish coloured and more or less transparent.

FUNCTIONS OF SEED COAT:-

1. Prevents the embryo from dehydration
2. Protects the embryo from physical/ mechanical damage
3. Protects the embryo from insects as well as bacterial and fungal infections
4. Protects the embryo during seed dispersal: e.g. protects against the damage of stomach acid whenseeds are eaten by animals.

2. EMBRYO- Embryo is the rudimentary (Primitive/ basic) plant. It is developed from the fertilized egg cell in the embryo sac . The embryo is made up of a 1. RADICLE. 2. PLUMULE. 3. HYPOCOTYL. 4. EPICOTYL. 5. COTYLEDONS.

RADICLE:- Radicle is considered as the embryonic root or primordial root. It is the lower portion of the embryo axis, from which the root is developed during later stage. It is normally the first organ to emerge from the testa on germination. The radicle may persist to form a taproot. Alternatively it may be replaced either by lateral or adventitious roots. Radicle is protected by root cap. Radicle(including root cap) is surrounded and protected by root sheath called “COLEORHIZA”.

PLUMULE Plumule is considered as the embryonic shoot or primordial shoot. It is the upper portion of embryonal axis, from which the shoot is developed during later stage. Plumule (growing point and foliage leaves) is surrounded by a protective sheath called “PLUMULE SHEATH” or “COLEOPTILE”. It emerges after the emergence of the radicle.

COTYLEDONS Leaf like appendages of the embryo is known as “COTYLEDONS”. Cotyledons are fleshy and laden (Having) with food materials In angiosperms the number of cotyledons is an important taxonomic character used to separate the two subclasses Monocotyledonae and Dicotyledonae. In dicotyledons they are fleshy due to storage of food materials. But in monocots they do not store food and hence remain thin. In endospermic seeds the cotyledons may be thin and membranous, as in the castor oil seed, but in non-endospermic seeds, e.g. pea, they take over the food-storing functions of the endosperm.

HYPOCOTYL The portion of the embryonal axis lying immediately below the cotyledons is known as “HYPOCOTYL”. Plays a important role in epigeal type of

germination. Eg:- Tamarind, Cotton, Castor, Cucumber. etc.

EPICOTYL The portion of the embryonal axis lying immediately above the cotyledons is known as "EPICOTYL". It plays an important role in hypogeal type of germination. Eg :- Grams, Pea, Mango, Groundnut.

3. NUTRIENT STORAGE TISSUES The term "ALBUMEN" is commonly applied for the storagetissue of the seed. But it is preferably designated as the perisperm or endosperm according to its origin. ENDOSPERM:- Endosperm is the nutritive tissue useful for developing embryos. Endosperm is a compacttissue, lacking intercellular spaces and stores starch, hemicelluloses, proteins, oils and fats. Based on thepresence and absence of the endosperm seeds are classified into two types

NON-ENDOSPERMIC SEED OR EX-ALBUMINOUS SEEDS:- In some plants, during the developmental stages the embryo takes food from the endosperm and completely utilized it by the time the ovule is converted into seed. At that time the ovule contains only the embryo without any endosperm. Such seeds are called non-endospermic seeds. Eg :- Dolichos , Cicer and Capsella.

ENDOSPERMIC SEEDS OR ALBUMINOUS SEEDS:- In some other plants as the embryo cannot utilize the endosperm completely, a little amount of endosperm is left out in the mature seed. Such seeds are called endospermic seeds or albuminous seeds. Eg :- Cocos , Ricinus and Datura .

PERISPERM:- The reminant (remaining part) of the nucellus in the seed and is nutririve in function like the endosperm is known as perisperm As the embryo and endosperm are developing in the embryosac, the embryo sac also grows by absorbing the nutrients from the nucellus . Hence this nucellus gets depleted when the seed reaches maturity. But in some seeds some amount of nucellus is left out and it is called "perisperm" It is specially developed in the non endospermic seeds. Eg:- Seeds of Piperaceae (Piper nigrum), and Nymphaeaceae. The edible part of the coffee seed is the perisperm.

OTHER IMPORTANT STRUCTURES ON THE SEED:-

1. ARIL:- An outgrowth of funicle which grows up around the ovule and more or less completely envelops the seed called "ARIL". Aril is regarded as third integument. Eg:- Water lily (Nymphaea), NUTMEG (Myristica fragrans) – Aril is bright red in colour, In Pithecolobium - aril is fleshly and as edible aril of pomegranate.
2. CARUNCLE :- Caruncle is a fleshy, whitish structure which is hygroscopic in nature, present on the micropyle or end of the seed. It arises due to the proliferation of cells at the tip of the outer integument, on the side of the funicle or all over the micropyle. Eg :- Common in Euphorbiaceae members like castor, ballon vine (Cardiospermum). FUNCTIONS:- Being sugary it is eaten by ants, which helps in seed dispersal. As it is hygroscopic it absorbs water from the soil and passes it on to the embryo during germination.

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 . There

is a scar called hilum on the seed coat through which the developing seeds were attached to the fruit. Near the Hilum is a small pore called the micropyle. Within the seed coat is the embryo, consisting of an embryonal axis called tigellum and two cotyledons. The cotyledons are often fleshy and full of reserve food materials. The cotyledons are hinged to the embryonal axis at the point called cotyledonary node . At the two ends of the embryonal axis are present the radicle (embryonic root) and the plumule (first apical bud of shoot). During germination, the radicle develops into a root system and Plumule into a shoot system.

The region of the embryonal axis between the radicle and the point of attachment of the cotyledons is called hypocotyl where as the portion between the Plumule and cotyledons is termed as epicotyl . In some seeds such as Ricinus the endosperm formed

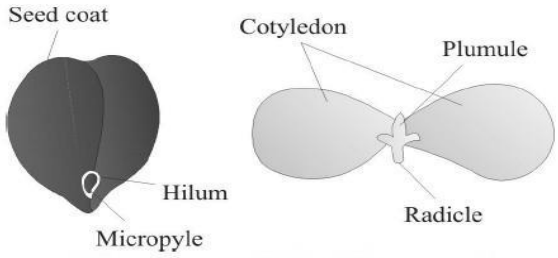


Fig. : Structure of dicotyledonous seed

as a result of triple fusion is a food storing tissue.

STRUCTURE OF A MONOCOTYLEDONOUS SEED:- Monocotyledonous seeds are generally endospermic but as in some 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 by sheaths which are called coleoptile and coleorhizae respectively. The region between cotyledonary node and base of coleoptiles is called mesocotyl .

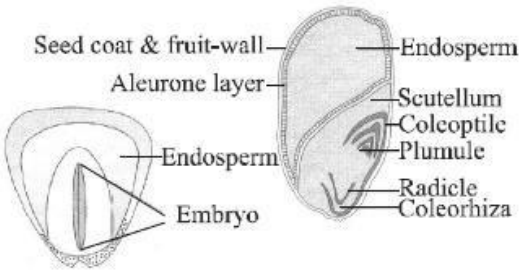
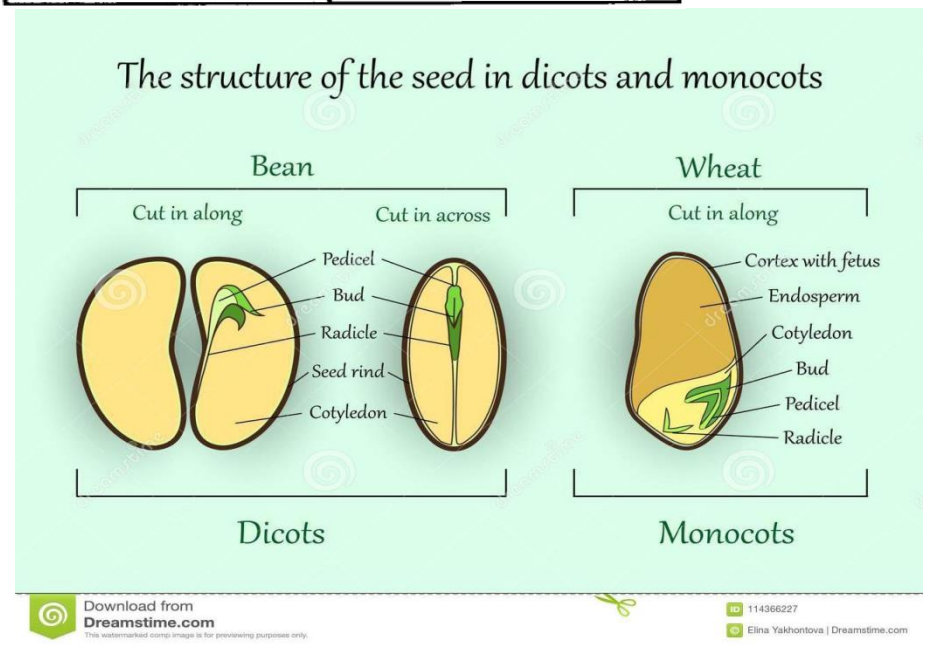


Fig. : Structure of a monocotylendous seed

DIFFERENCE BETWEEN MONOCOTS AND DICOTS- ?

Dicot Seed	Monocot Seed
The seed coat is distinct from the fruit wall.	The seed coat is completely fused with the pericrap.
There are two cotylendons in the seeds.	There is a single cotylendon in the seed.
Endosperm is absent.	Endosperm is present.
There is no protective sheath for the plumule and radicle.	The plumule is protected by coleoptile and radicle by coleorhiza.

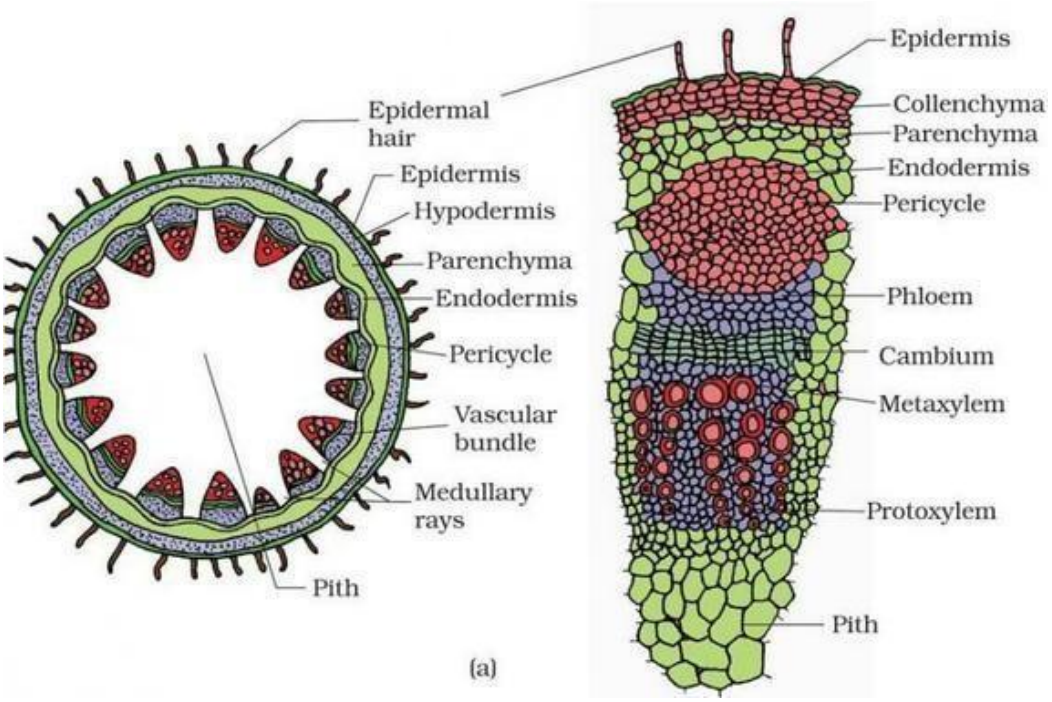


Parts of the ovule Changes occur after fertilization 1. Funiculus Stalk of the seed 2. outer integument Testa 3. Inner integument Tegmen 4. Micropyle Seed pore 5. Zygote Embryo 6. Synergids Degenerate 7. Antipodals Degenerate 8. Primary endosperm nucleus Endosperm 9. Hilum Scar of the seed

HISTOLOGY/ ANATOMY OF STEM, ROOT AND LEAF

Internal Structure of Dicot Stems

Internal structure of a typical dicot stem shows following features:



1. Epidermis:

- Epidermis is the outermost layer of the stem.
- It is single layerd and lack of chloroplast.
- Multicellular hairs (trichomes) and stomata are found on epidermis.
- Outer side of epidermis a layer is present which is made up of cutin is called cuticle.
- Epidermis plays a significant role in protection.

2. Cortex:

In dicotyledon stem cortex divided into three parts:

(a) Hypodermis: It is present just below the epidermis. It provides additional support to epidermis. It is thick multicellular layer. This layer is composed of collenchyma and their cells contain chloroplast. So hypodermis is green and photosynthetic.

(b) General Cortex: This part is composed 01 parenchyma. Storage of food is the main function of the cortex. Resin canal/ mucilage canal are present in it. These are schizogenous in origin. The innermost layer of the cortex is called endodermis.

(c) Endodermis: It is single celled thick layer. The cells of endodermis are barrel shaped. These cells accumulate more starch in stem of dicot. Thus it is known as "Starch sheath".

3. Pericycle:

This layer is situated in between the endodermis and vascular bundles. The perieycle of stem is multilayered and made up of sclerenchyma. Sclerencymatous perieyle is also

known as Hard bast.

4. Vascular Bundle:

The vascular bundles (wedge shaped) are arranged in a ring. Each vascular bund is conjoint, collateral and open. Each vascular bundle is made of phloem, cambium and xylem. Eustele is present in dicotyledonstems.

5. Pith:

This is well developed region, spreading from ring of vascular bundle to the centre. The cells of this regionmainly made up of parenchyma.

Function of pith: Storage of water and food.

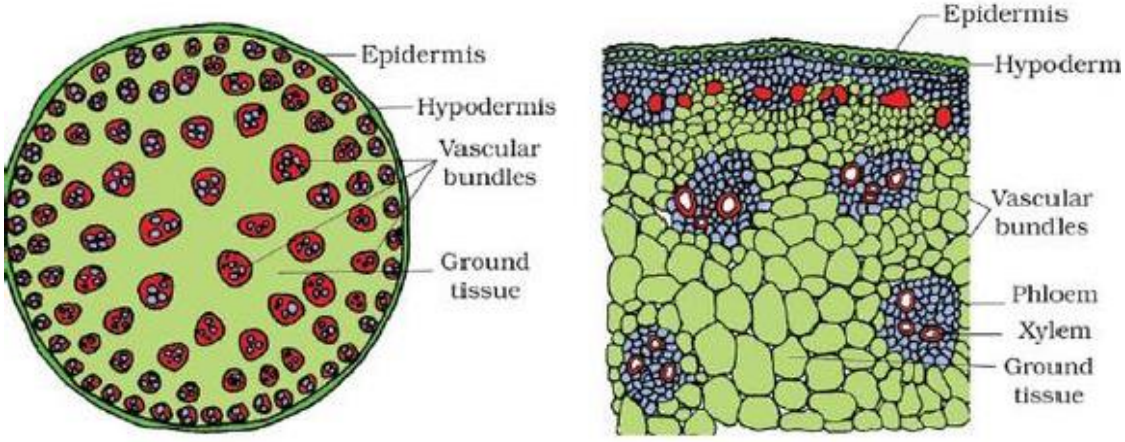
Internal Structure of Monocotyledon Stem

1. Epidermis: Epidermis is the outer most single celled thick layer. It is covered with thick cuticle.Multicellular hairs are absent & stomata are also less.

2. Hypodermis: Hypodermis of monocotyledor' stem is made up of sclerenchyma. It is 2-3 layered hypoderrrus where as in dieot stem elasticity is more. It provides more inmechanical support to plant.

3. Ground tissue: The entire mass of parenchyma cells next to hypodermis and extending to the centre is called ground tissue. There is no differentiation of ground tissue in monocotyledon stem. It means ground tissue is not differentiated into endodermis, cortex, Pericycle etc.

Note: Sometimes in some grasses,called Pith cavity. heat etc. the central portion of ground tissue becomes hollow and is



4. Vascular Bundle:

- Many vascular bundles are scattered in the ground tissue and V.B. are generally oval shape.
- Vascular bundles lies towards the centre are large insize and-less in number.

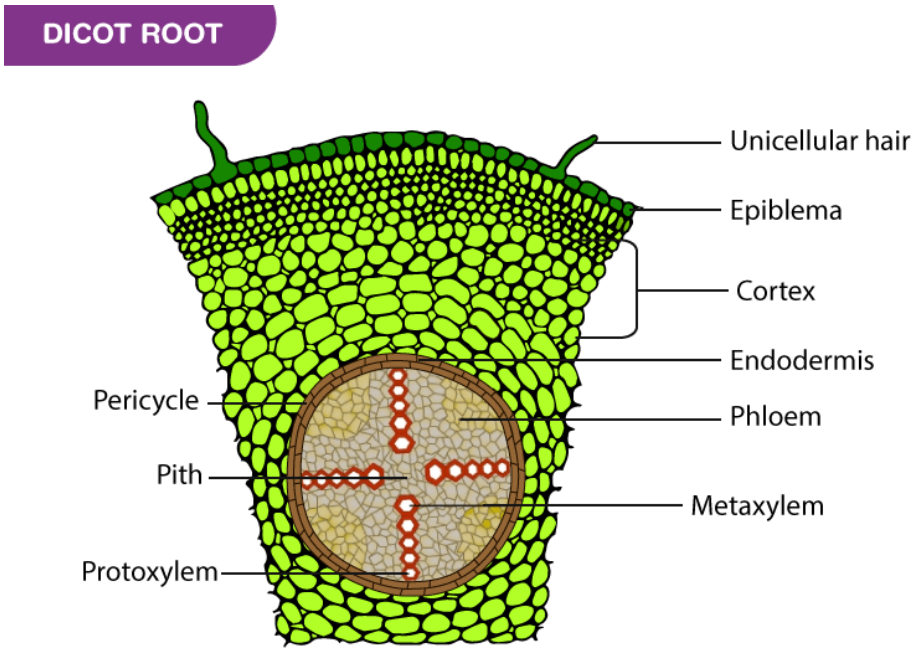
- Vascular bundles situated towards the periphery are small in size but more in nu

- Each vascular bundle are conjoint, collateral and closed.
- Vascular bundles surrounded by the layer of sclerenchymatous fibre are known a bundles sheath.
- So vascular bundles are called fibro vascular bundles.

(a) Xylem: In xylem number of vessels is less. In metaxylem there occur two large vessels while inprotoxylem there occur one or two small vessels. Vessels are arranged in V or Y shape. Just beneath
protoxylem vessels, there occur a water cavity which is schizolysigenous in origin but major part of water cavity is lysigenous. This cavity is formed by disintigration of the element present below the proto xylem and neighbouring parenchyma.
Exception: In Asparagus water cavity & bundle sheath are absent.
(b) Phloem: It consists of sieve tube elements and companion cells. Phloem parenchyma is absent.
5. Pith: Pith is undifferentiated in monocotyledon stems. Atactostele is found in monocotyledon. This is highly developed stele.

Internal Structure Of Typical Dicotyledon Root

Internal structure of a typical dicotyledon root shows following features:



1. Epiblema: It is uniseriate outermost layer. It comprising tubular living components. Cuticle and stomata are absent. Unicellular root hairs are formed due to elongation of some cells of epiblerna. Epiblema also known as Rhizoderrnis or Piliferous layer. Root

hair are present in maturation zone of root.
Note: Cells of epiblema which develop root hair called trichoblast.

2. Cortex: It is made up of parenchymatous cells.

Chloroplast is absent so they are nonphotosynthetic but chloroplast is present in roots of Tinospora andTrapa so they are photosynthetic.

Note: The cells of outer part of cortex -are suberized in old root. It is called exoderrnis. Exoderrnis is found in some dicotyledonae roots and most of the monocotyledonae roots'.

3 Endodermis: This layer is situated between the pericycle and cortex. Casparian strips are present on radial and tangential wall of endodermis. These strips are made up of ligno suberin (mainly suberin).

Casparian strips are discovered by Caspari.

The cells of endodermis which are situated in front of protoxylem cells lack of casparian strips.

These are called passage cells/ transfusion cells. The number of passage cells is equivalent to theprotoxylem cells. Passage cells provide path to absorbed water from cortex to pericycle.

Note:

- Root hairs are linearly arranged on root apex.
- Casparian bands and passage cells are well developed in monocot root.
- They are also present in stem but they are less developed.
- Endodermis acts as a watertight jacket.

4. **Pericycle:** It is single layered. It is composed prosenchyma.

Lateral roots are originated from the part of pericycle which is lying opposite to protoxylem. Thus lateral roots are endogenous in origin. A few mature cells of pericycle usually opposite to protoxylem, become meristernatic. These cells divide by periclinal divisions and form some layers of cells. These divisions are followed by anticlinal divisions forming a primordium which grows to form a lateral root.

Note:

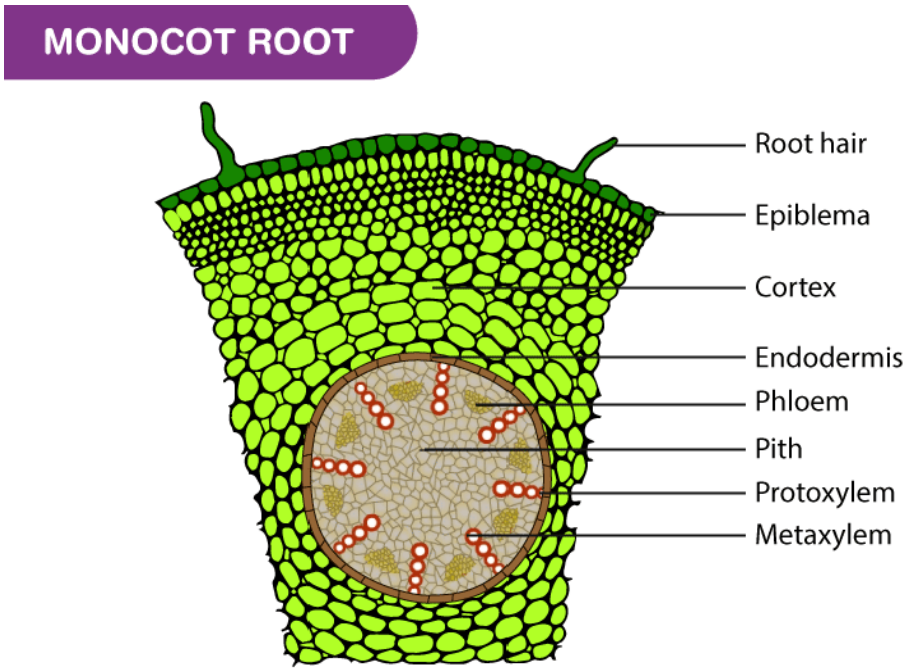
- The branches of stems are exogenous in origin because these are originates from the outer part of cortex.
- Adventitious root are also endogenous. It originates from phloem parenchyma or internal layer of endodermis or pericycle.

5. **Vascular Bundles:** Vascular bundles are radial and exarch, xylem and phloems are separate and equalin number. The numbers of xylem bundles are two to six (diarch to hexarch). But exceptionally, Ficus (Banyan tree) root is polyarch. Parenchyma which is

found between xylem and phloem is called conjunctive tissue.

6. **Pith:** In dicot root pith is less developed or absent.

Internal Structure of Monocotyledon Root



The internal structure of a typical monocotyledon root is similar to dicotyledon root:

(1) Number of xylem bundles are more than six (Polyarch) in monocotyledon root (exceptionally the
number of xylem bundles are two to six in onion).

(2) Pith is well developed in monocotyledon root.

LEAF

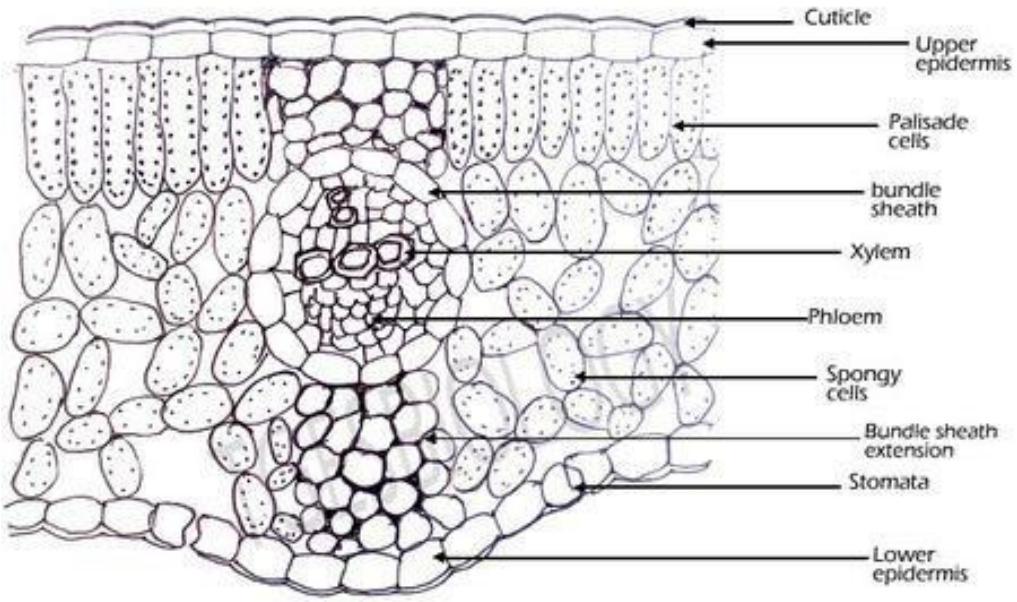
Anatomically the leaves are of following types-

1. **Dorsiventral (Bifacial)-** Distinct upper and lower epidermis, Mesophyll is differentiated in topalisade and spongy parenchyma, mainly these are dicot leaves.
2. **Isobilateral (Equifacial)-** Both leaf surfaces are equally exposed to sun, no difference in betweenupper and lower epidermis, mesophyll is not differentiated, miainly these are monocot leaves.
3. **Unifacial-** no upper and lower surface, leaves are cylindrical ex- Onion.

Histology of dorsiventral leaf-

Its upper surface is exposed to sun and is darker in colour. A vertical sectionthrough the lamina showfollowing tissue arrangements-

1. EPIDERMIS-
    - Upper epidermis= Adaxial, Lower epidermis= Abaxial. Epidermis is of single layer of cells, tightly packed, no intercellular spaces. The cells are polygonal, parenchymatous and appear rectangular in vertical section.
    - A thin and uniform layer of cutin is found, called cuticle on outermost side. Cuticleprevents excessive water loss and protects the epidermal cells.
    - Minute pores are found, called stomata, which allows exchange of gases and also causestranspiration. Stomata are more on lower epidermis.
    - Multicellular hairs are present on epidermal cells which are protective in action.
2. MESOPHYLL-
    - It occurs between lower and upper epidermis. It is divided in two parts- Palisadeparenchyma and spongy parenchyma
    - Palisade parenchyma- It occurs beneath the upper epidermis. It is of 1-3 layers of columnar,closely packed cells. Its cells are arranged at right angle to the upper epidermis. Its cells contain chloroplast, so it constitutes the principal photosynthetic tissue of plant.
    - Spongy parenchyma- It lies between palisade parenchyma and lower epidermis. Cells are rounded, oval or irregular shape with large intercellular spaces. It contains less chloroplastand allow free circulation of gases throughout the entire leaf.
3. VASCULAR SYSTEM-
    - Many vascular bundles are found and located about half way between the upper and lowerepidermis.
    - Each vascular bundle is Conjoint and Collateral. Xylem towards adaxial/ upper surface andphloem towards abaxial/ lower surface.
    - No cambium so it is closed.
    - Phloem fibers are absent and other parts of xylem and phloem are present.
    - Each vascular bundle is surrounded by a sheath of closely packed parenchyma cells, calledbundle sheath.



Transverse section of Dicot leaf

HISTOLOGY OF MONOCOT LEAF-

1. EPIDERMIS-
    - Both epidermis are uniseriate (Single layer). Cells are compactly arranged, almost ovalshape parenchyma. Cuticle present.
    - The upper epidermis show the presence of large, thin walled protruding cells called Bulliform/ Motor cells. These cells help in unrolling of the leaf during development.
    - Both upper and lower surface contains stomata.
    - Function of epidermis- Protection of inner tissue, Gaseous exchange & transpiration bystomata, unrolling of lamina with help of bulliform cells.
2. MESOPHYLL-
    - It is not differentiated. It consists of compactly, arranged, thin walled isodiametric cellswith intercellular spaces. These cells contain chlorenchyma so helps in photosynthesis.
3. VSCULAR BUNDLE-
    - Many in number and arranged in parallel series in mesophyll.
    - Vascular bundles are collateral and closed.
    - Bundle sheath is present, made of parenchymatous cells and contain chloroplast and starchgrain.
    - Bundle sheath extension is sclerenchymatous which provide mechanical strength to leaves.

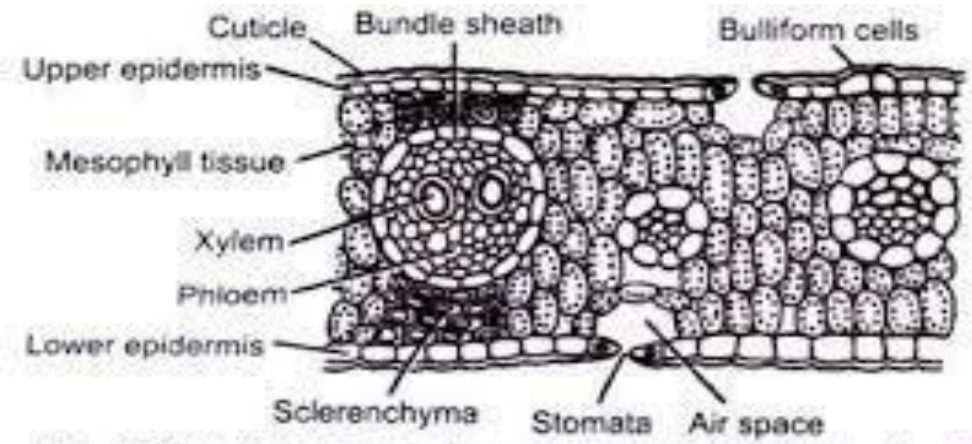


Fig. 4.13 (ii) Detailed structure of a part of I.S. of maize-leaf (Monocot leaf)

Difference between monocot and dicot leaf-

Dicot leaf	Monocot leaf
Upper and lower surface are different	Both are similar
Upper surface is dark green and lower is light green.	Both are equally green
Silica is not deposited in epidermal cells	Silica is present
Mainly stomata are on lower epidermis and absent or very less in upper epidermis	Stomata equal on both surface
Stomata guard cells are kidney shaped	Dumb bell shaped guard cells
No bulliform cells	Bulliform cells present
Mesophyll is differentiated in palisade and spongy parenchyma	Not differentiated
Reticulate venation is found	Parallel venation present
Mainly in dicot plants	Mainly in monocot plants

Important point to remember-

1. Definitions of- Diversity, Binomial Nomenclature, Taxonomy, Morphology, Root, Stem, Leaf,Flower, Fruit, Seed, Dicot, Monocot and other important terms.

2. Rules of Binomial Nomenclature
3. Taxonomy criteria
4. Five kingdoms characteristics with example
5. Various plant parts morphology
6. Modifications of Root, stem and leaf
7. Differences between Monocot and Dicot root, stem, seed and leaf
8. Various types of inflorescence
9. Functions of all plant parts
10. Basic differences between plants and animals.

Important questions-

Short questions- (1 or 2 marks)

1. Define the term living and diversity.
2. Give example of tap root modifications for food storage.
3. Give example of adventitious root modifications for food storage.
4. Give example of stem modifications for food storage.
5. What is inflorescence?
6. Enumerate various parts of a root.
7. How Monera can be differentiated from Protista kingdom?
8. What is Venation?
9. Give any two differences between Dicot and Monocot seed.
10. Give any two differences between Dicot and Monocot root.
11. Give any two differences between Dicot and Monocot stem.
12. Give any two differences between Dicot and Monocot leaf.
13. Why a flower is called as reproductive organ of plant?
14. What are aggregate fruits?
15. Give the fruit type for Apple and Mango.
16. Who has given Five kingdom classification?
17. Enumerate various shapes for leaf lamina.
18. What is the meaning of a vascular bundle?

19. Define Isobilateral leaf with example.
20. What are creepers and climbers?

Important Questions for 5 marks-

1. Explain rules of Binomial nomenclature.
2. Write a short comparative study for five kingdoms.
3. Differentiate root and stem with diagram.
4. Give the basis for further classification of plant kingdom.
5. Write a short note on leaf morphology.
6. Explain all whorls of a flower with floral diagram.
7. Write different types of Succulent fruits.
8. Compare anatomy of monocot and dicot leaf.
9. Write a note on various types of inflorescence.
10. Show various plant parts with their funmction in a labeled diagram.

Important Questions for 10 marks-

1. Write a detailed note on Five kingdom classification.
2. Describe various types of root modifications.
3. Describe various types of stem modifications.
4. Define a fruit and discuss its various types with example.
5. Write a detailed note on Seed morphology and compare monocot & dicot seed features withexample.