FST 202
Botany of Economic Crops for Food Scientist

(2 Units)

O.A BABARINSA *Ph.D*

Course requirements

- Number of units: 2 units
- Lecture period: 2 hour /week(30 hours/semester)
- 75% attendance is required to qualify to sit final examination
- Grading

take home assignment	10%
A short quiz in class	20%
Final Examination	70%

Course Learning Objectives

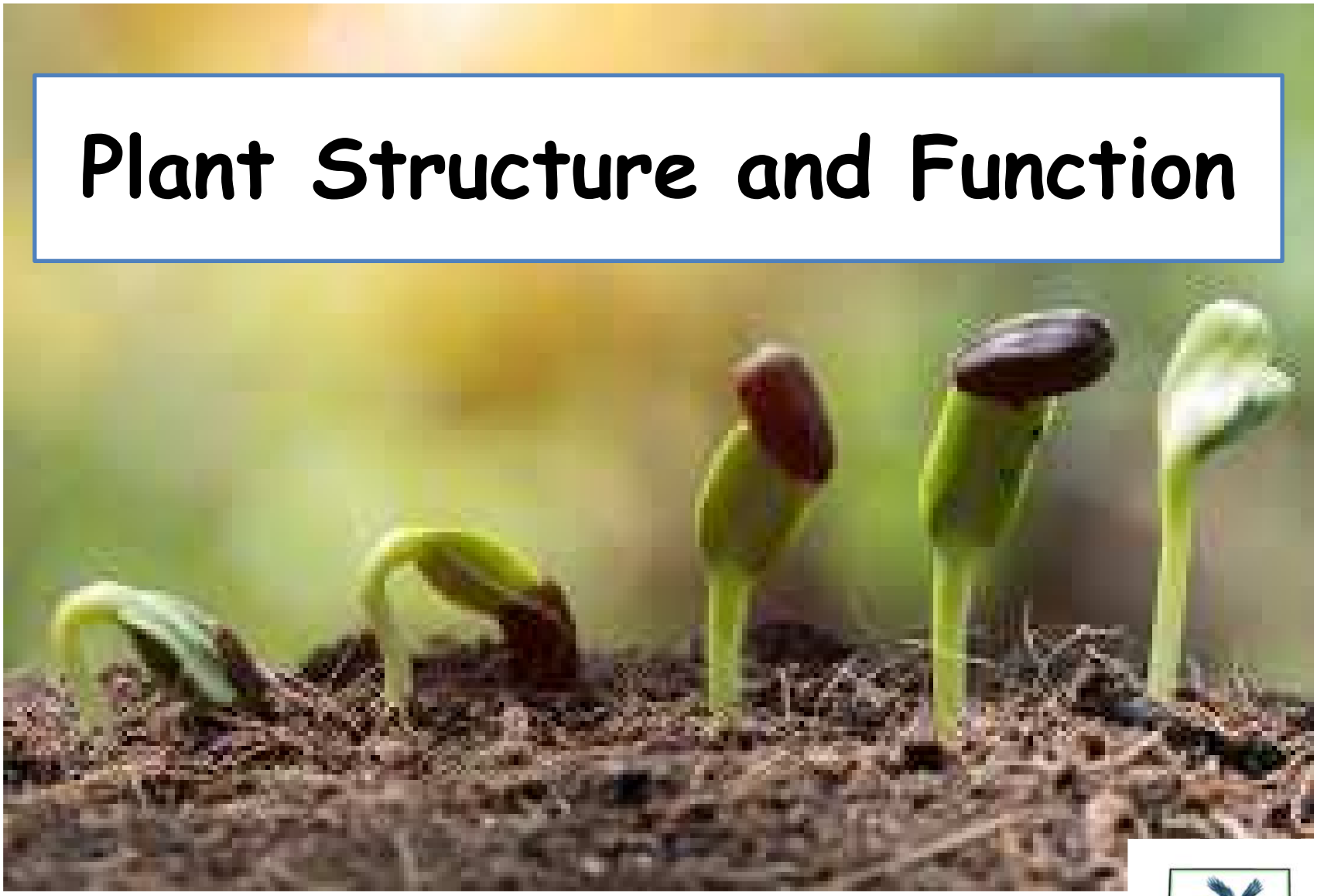
Upon successful completion of the course students should:

- explain the various cell structures and their functions;
- understand the plant tissue systems and their functions;
- understand the make-up of the organs of both dicot and monocot plants; and
- explain the various processes of plant metabolism;

Course Outline

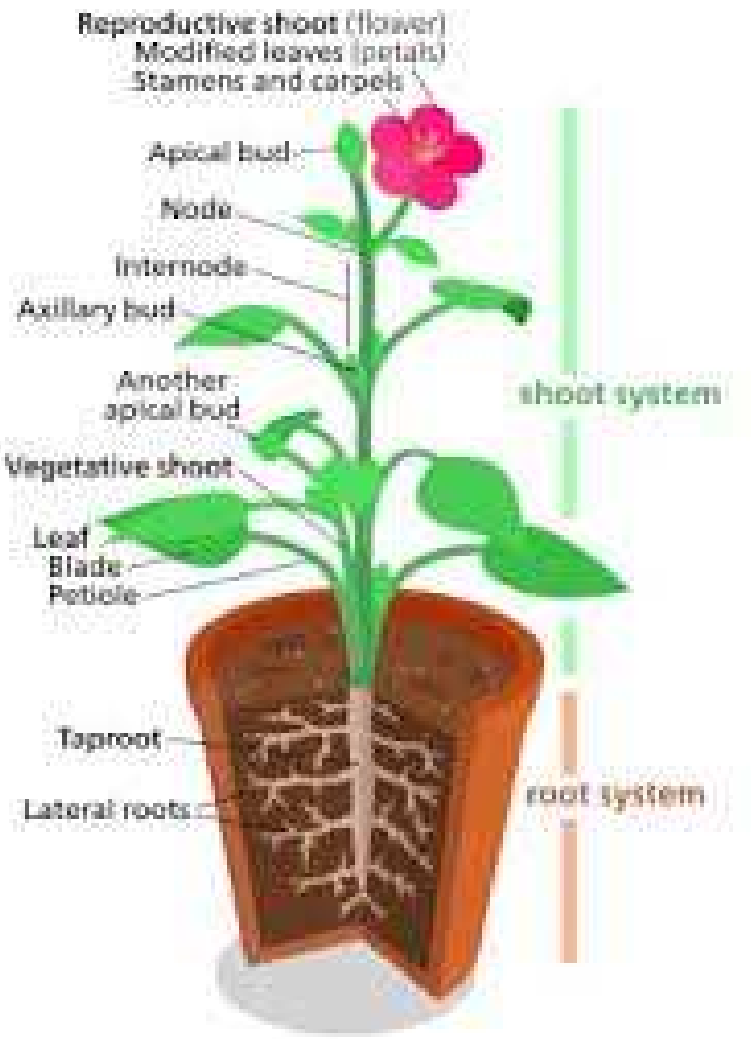
- Plant structure and function including the cell, tissue and organs, the stem, roots, leaves, flowers, fruits and seeds.
- Processes in plant such as photosynthesis, respiration, translocation of materials.
- Plant growth and development.
- Classification of economically important plant families

Plant Structure and Function



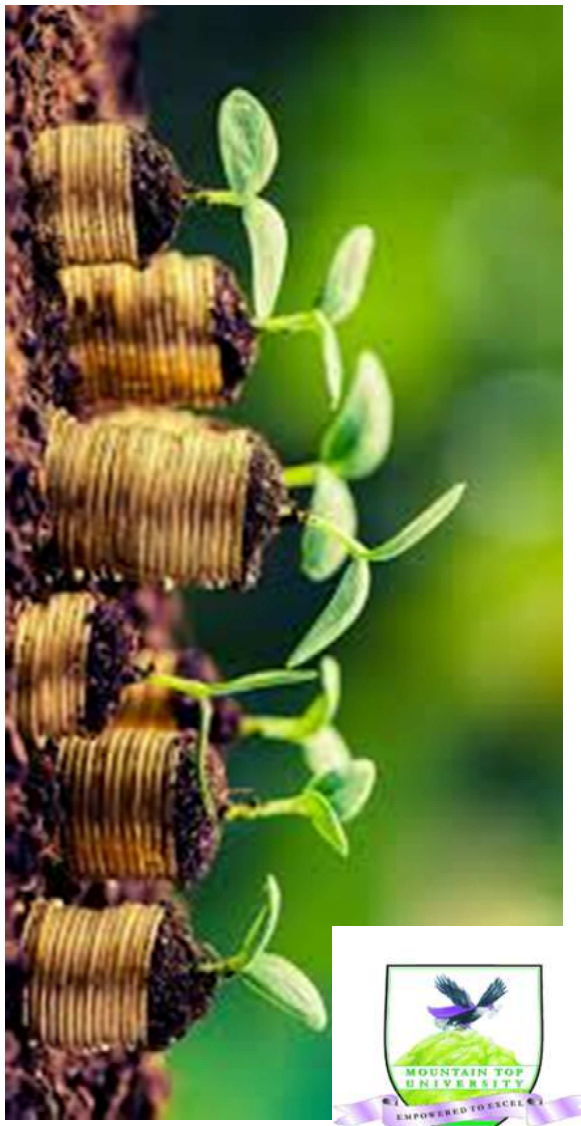
Introduction

- **Botany** is the field of basic science dealing with the study and inquiry into the form, function, development, diversity, reproduction, evolution, and uses of plants and their interactions within the biosphere.
- **Plants** are defined as multicellular organisms living on land that carry out photosynthesis.
- **Agricultural botany** is a branch of biology concerned with the study of plants (kingdom Plantae).



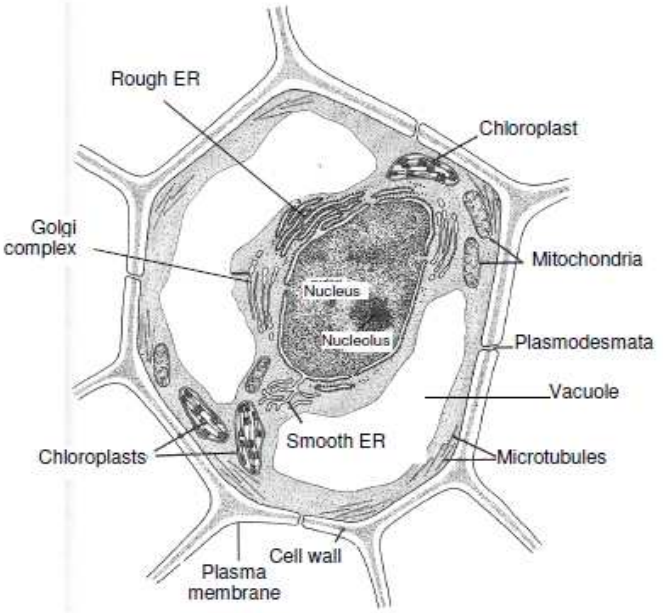
Introduction

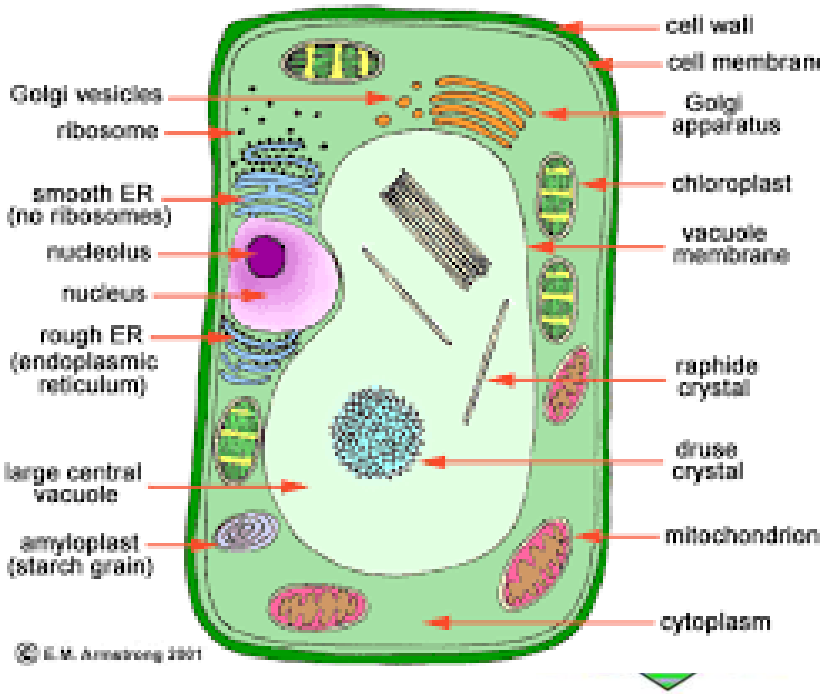
- **Economic Botany** would therefore, be the study of plants of economic value.
- A plant is considered to be of economic value either by virtue of its usefulness in whatever form, or by its negative attributes militating against other factors affecting man or the ecosystem generally.
- For instance, a plant which constitutes some nuisance poses some economic hazard from the point of view of the cost of keeping such plants under control!
- Simply put, Economic Botany is the interaction of people with plants.



Plant Cell

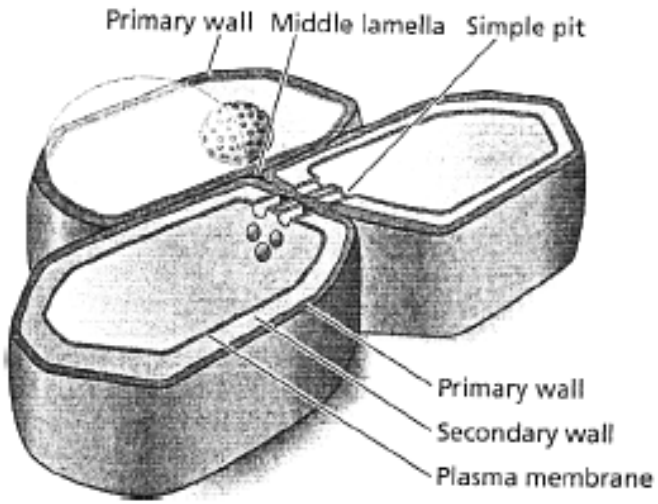
- The plant cell is the basic structural and functional unit for all living organisms. Plant cell structure is very similar to that of the animal cell.
- The term cell is derived from the Latin ‘cella’ means storeroom or chamber.
- The term cell was first used by the English botanist Robert Hooke in 1665, to describe the individual units of the honeycomb-like structure in cork under compound microscope.
- Plants are multicellular organisms composed of millions of cells with specialized function.





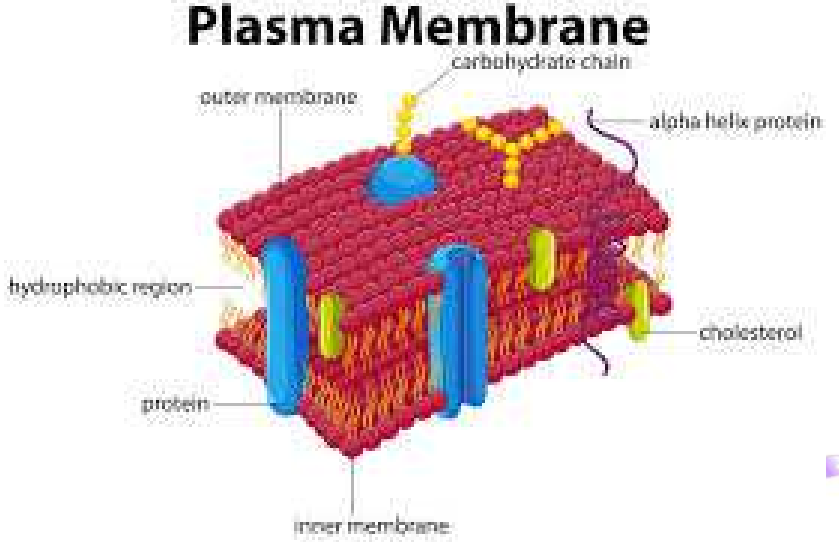
Cell Wall

- A fundamental difference between plant and animal cells is that the plant cell is surrounded by a rigid cell wall, mostly made of polysaccharides (cellulose, hemicellulose, pectin) and lignin.
- Plants have two types of cell walls, primary and secondary.
- Primary cell walls are thin and characteristic of young, growing cells.
- Secondary cell walls are thicker and stronger, and they are deposited when most cell enlargement has ended.
- Secondary cell walls have their strength and toughness due to lignin; a glue like material.
- In plants, the neighboring cells are cemented together by a middle lamella (intercellular layer).



Plasma Membrane (Plasmalemma)

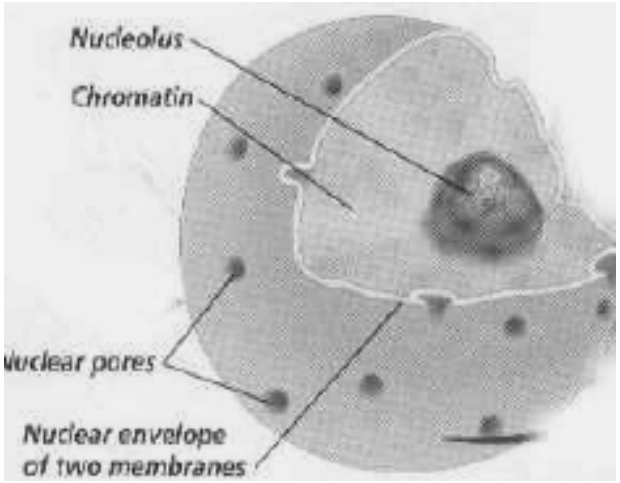
- All cells are enclosed in a membrane that serves as their outer boundary, separating the cytoplasm from the external environment.
- This plasma membrane allows the cells to take up and retain certain substances while excluding others. Thus, plasmalemma accounts for selective traffic of solutes across membrane.
- All biological membranes consist of a double layer (bilayer) of phospholipids in which proteins are embedded.
- The membrane is not a static structure, but it is a dynamic structure. Both lipid and protein molecules are free to move and are usually in a constant motion.



Nucleus

- Nucleus is the site of storage and replication of chromosomes, composed of DNA and its associated proteins (histones). The DNA-protein complex is known as chromatin.

- Nucleus contains a densely granular region called the nucleolus, which is the site of ribosome (ribosomal RNA) synthesis.

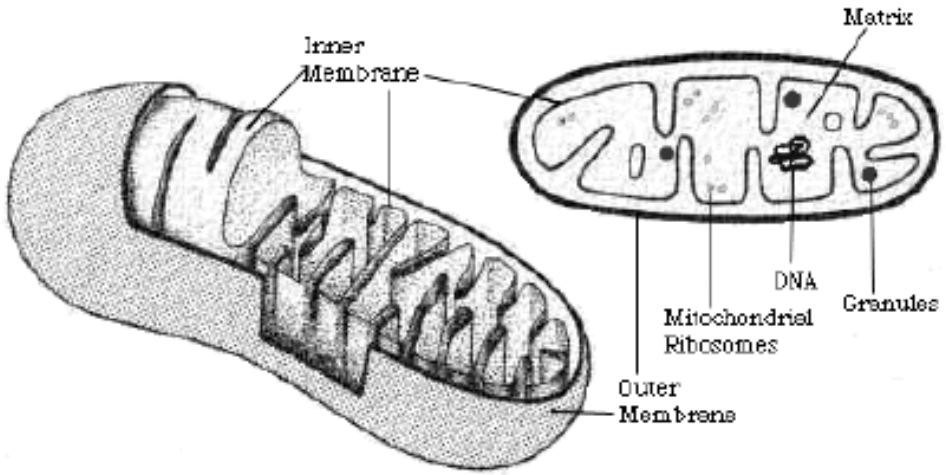


- The genes are transcribed in nucleus to form mRNA, tRNA and rRNA. mRNA and tRNA pass from nucleus to cytosol where they are used for protein synthesis.

- The nucleotide sequence of mRNA is translated into amino acid sequence of proteins by ribosomes. tRNA assists by transferring amino acids to mRNA codons.

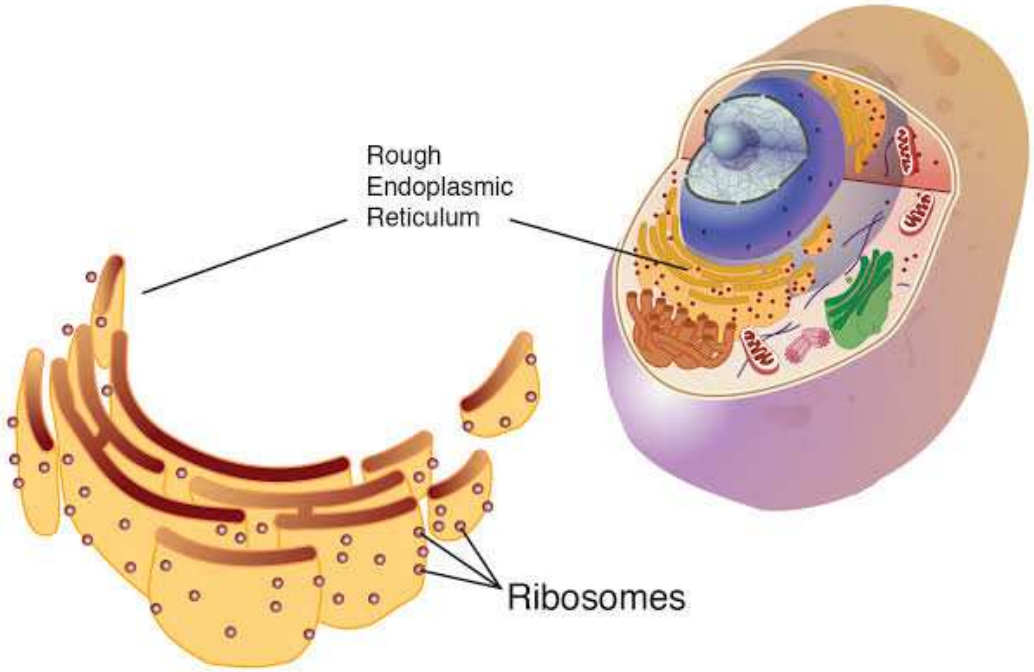
Mitochondria

- Mitochondria major function is to converts energy from organic compounds to energy for cellular activities
- Mitochondria are the sites of oxidative phosphorylation (ATP synthesis).
- Mitochondria are surrounded by two membranes. The outer membrane is smooth and the inner membrane is highly convoluted.
- Mitochondria contain their own protein synthesizing machinery (ribosomes, tRNA etc.).



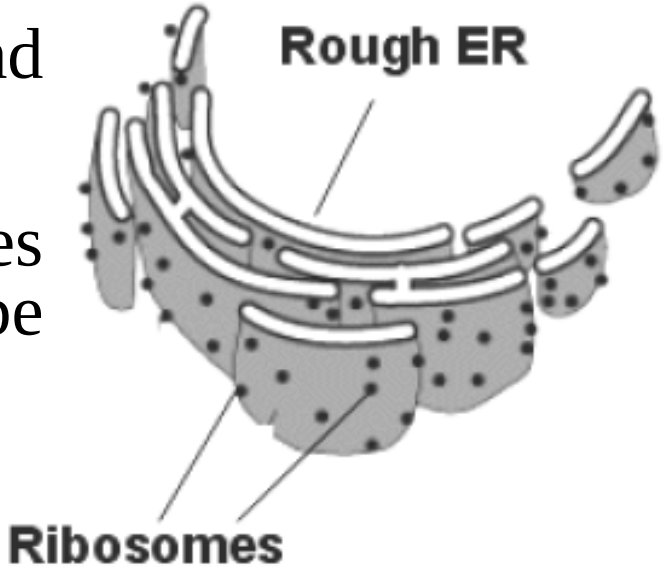
Ribosome

- Ribosomes are composed of rRNA and protein.
- Ribosomes play an important role in protein synthesis.
- Plant cells contain 3 distinct types of ribosomes, which occur in cytoplasm, mitochondria and Chloroplast



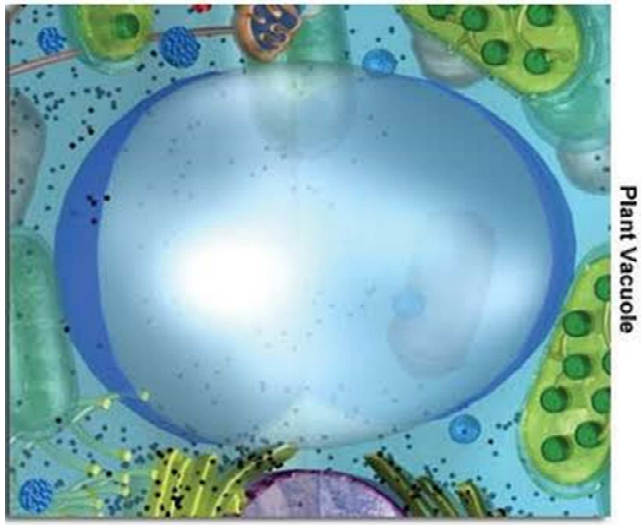
Endoplasmic Reticulum

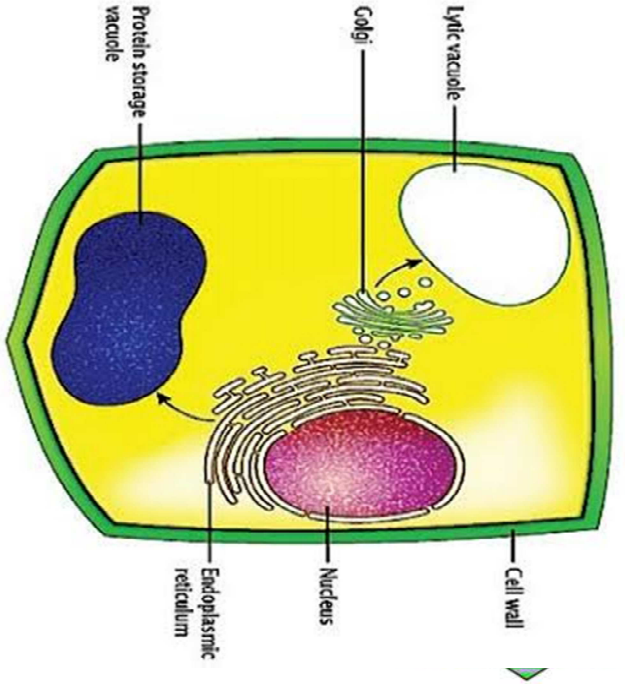
- Cells have an elaborate network of internal membranes called endoplasmic reticulum (ER).
- There are 2 types of ER, smooth and rough, which are interconnected.
- Rough ER is covered with ribosomes which synthesize proteins to be delivered to lumen of ER.
- Smooth ER lacks ribosomes.
- Smooth ER is the site of lipid synthesis and membrane assembly.
- Both types of ER are involved in secretion.



Vacuoles

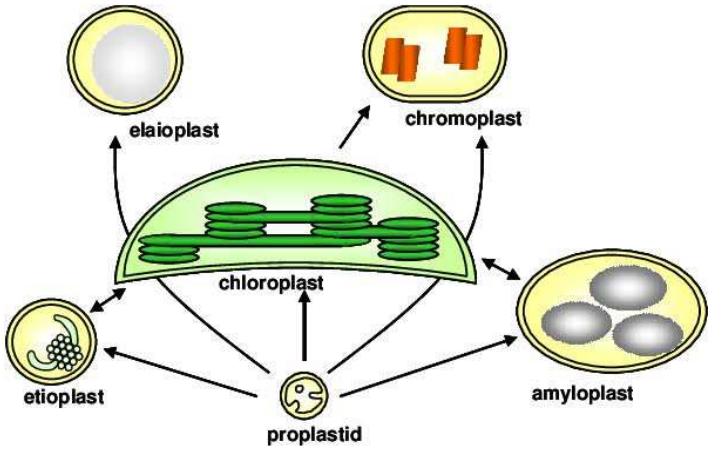
- Vacuoles are fluid filled organelles that store metabolic waste.
- Although some of the stored wastes are very toxic and must be kept away from the rest of the cell, they can be used to benefit the plant.
- Some of these wastes can be used as a defense against plant-eating insects and animals.
- Vacuoles are often very large, occupying as much as 90% of the cell's volume.





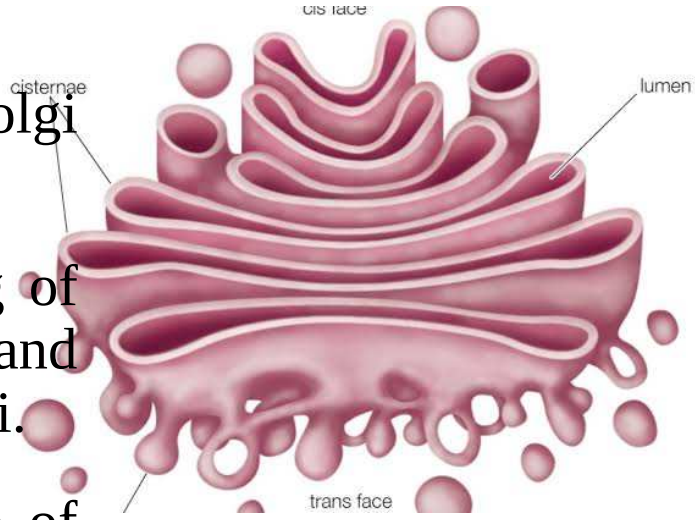
Plastids

- Another distinguishing characteristic of the plant cell is the presence of plastids.
- Plastids are DNA containing organelles surrounded by two membranes. Plastids store starch and fats.
- In some cases, they contain pigments that absorb light.
- Chloroplasts are an example of a pigmented plastid. These green organelles convert light energy into chemical energy during photosynthesis. The green pigment gives leaves and stems their green color.
- Other types of plastids are responsible for the colors of fruits and flowers.



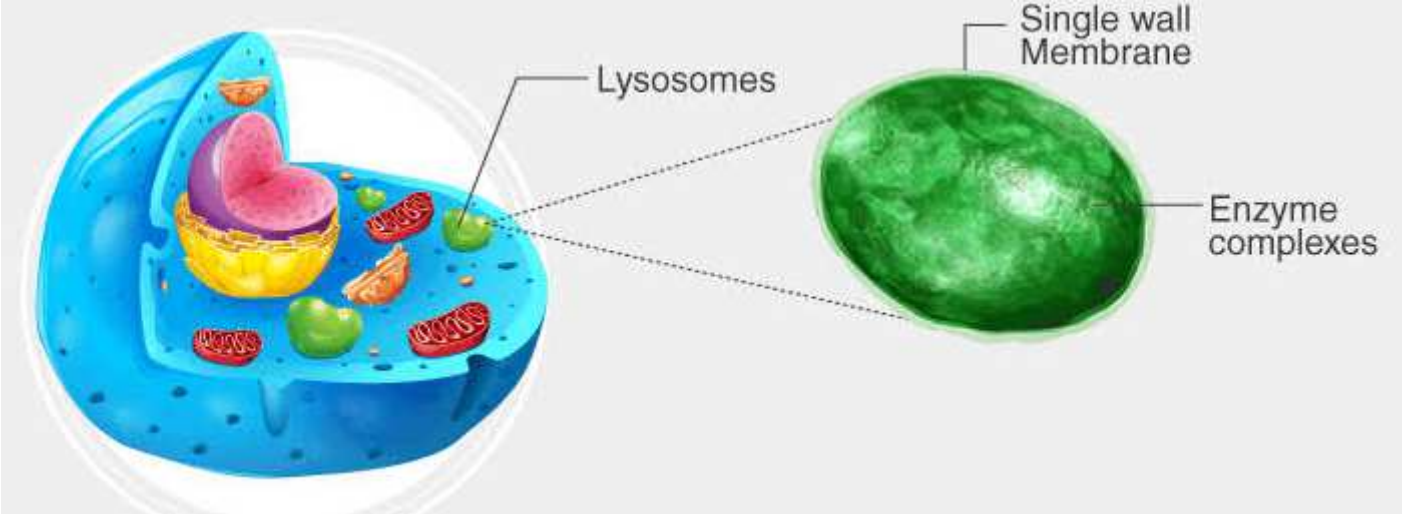
Golgi Apparatus

- Golgi apparatus (or Golgi complex) is made of one or more dictysomes (or Golgi bodies) which are stacks of 3-10 flattened sacs (cisternae) and vesicles.
- Plant cells contain up to several hundred Golgi bodies dispersed in cytoplasm.
- It is involved in the transport and processing of many substances that are produced in ER and eventually discharged outside the cell via Golgi.
- It plays a key role in synthesis and secretion of complex polysaccharides and in processing of glycoproteins.
- Various proteins (including enzymes) are first synthesized in rough ER then they reach to Golgi via vesicles that bud off from ER and fuse with Golgi.



Lysosomes

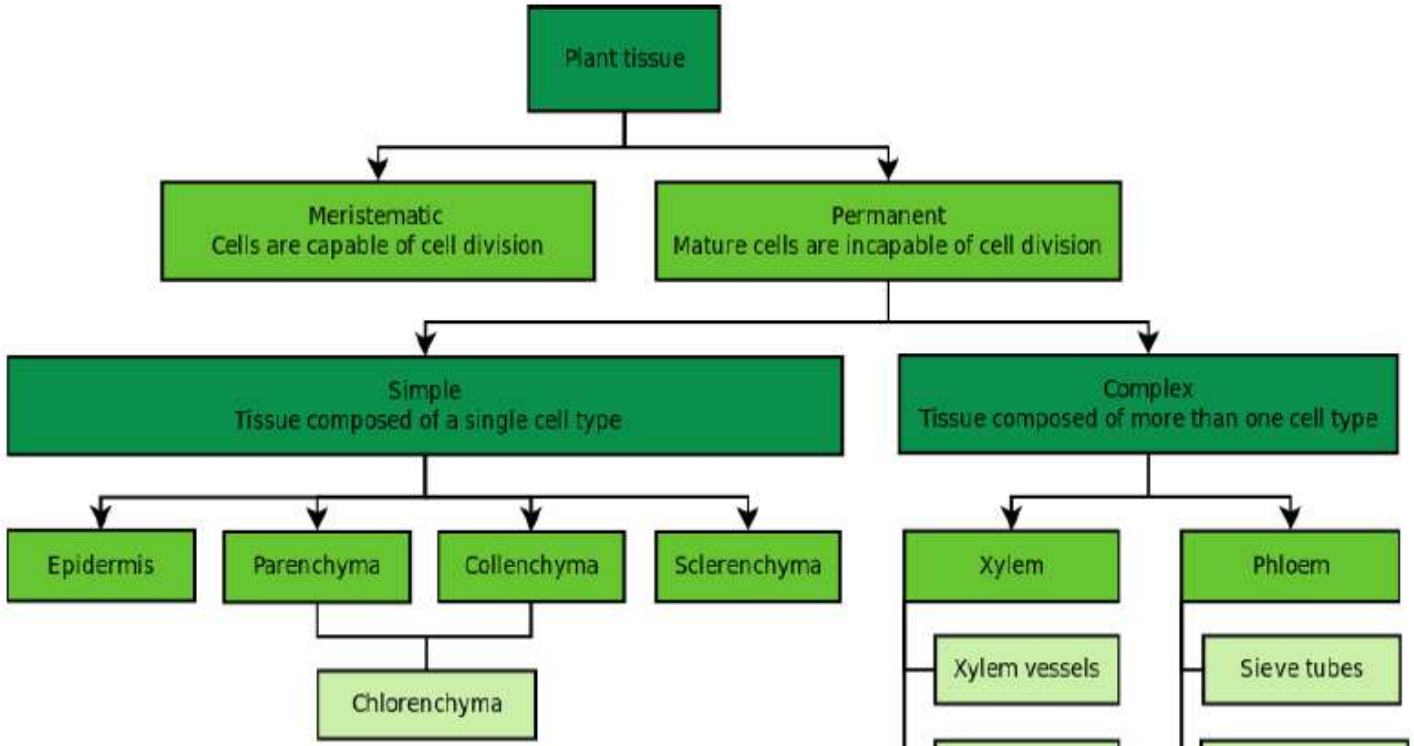
- Lysosomes are organelles bounded by a single membrane and contain enzymes capable of digesting various cellular components such as proteins and lipids.
- Their exact functions are unclear, but they are believed to be important in the development of those cells which are hollow at maturity.
- They may also be a defensive mechanism against invasion by pathogens.



Organelle	Function
Nucleus	Stores DNA, synthesizes ribosomes and RNA
Endoplasmic Reticulum (ER)	Rough ER prepares protein for export; Smooth ER synthesizes steroids, regulates calcium levels, breaks down toxins
Mitochondrion	Converts energy from organic compounds to energy for cellular activities
Ribosomes	Organize the production of protein
Microtubules	Contribute to the support and division of the cell
Golgi Complex	Processes and packages substances made by the cell
Cell Membrane	Semi-permeable membrane separating cell content from the outside
Lysosomes	Digest old organelles and foreign substances

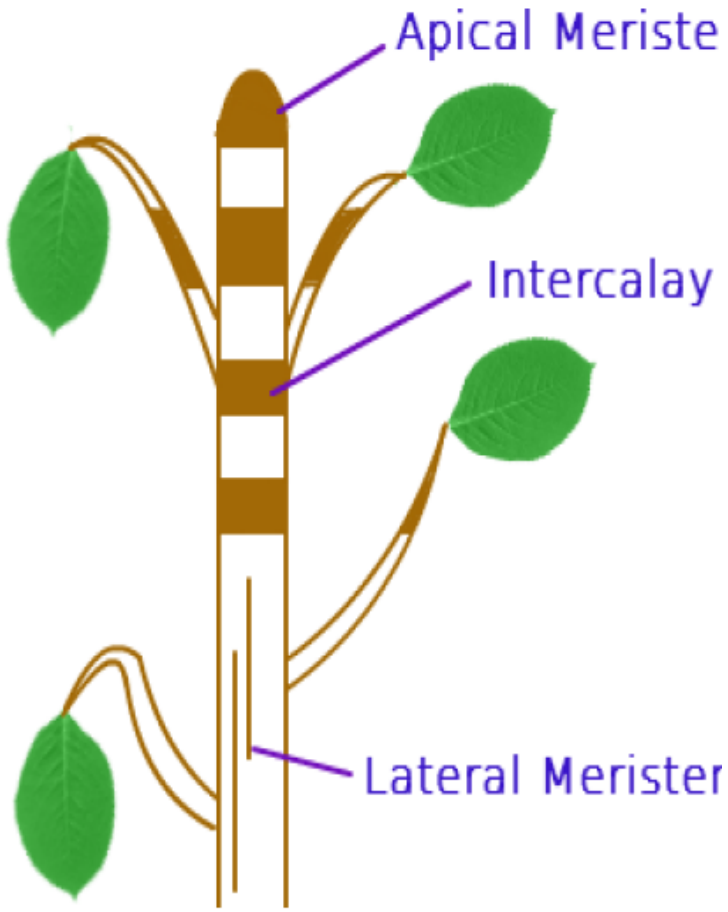
Plant Tissue

- A tissue is a group of cells, similar in structure that work together to perform specific function.
- Different types of plant tissues include permanent and meristematic tissues.



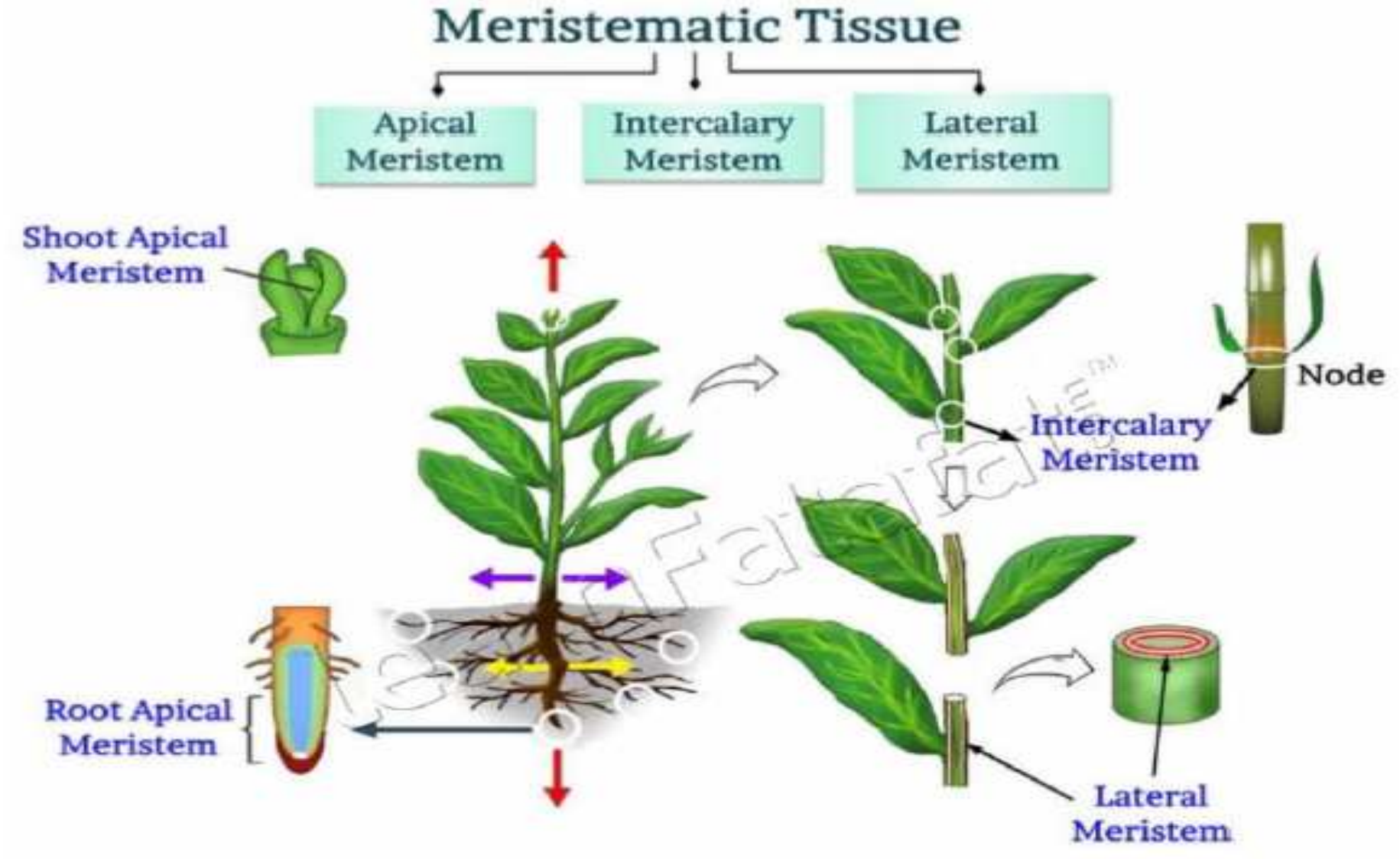
Meristematic tissue

- These tissues have the capability to develop by active division. They assist in the major growth of the vegetation. Growth in length and growth in diameter of the plant are carried about by these cells.
- Meristem cells are mainly located in the apical and axillary buds in all plants and in the cambium of perennial (woody) plants.
- The two principal meristerms are the “apical meristerms located at the apex of the shoot and root. The apical meristems are responsible for adding to the length of the shoot and root axis, called **primary growth**
- Many plants undergo an increase in girth or thickening of the stems and roots by adding new vascular tissues to the primary body. This lateral growth is called secondary growth and is produced by a lateral meristem called the vascular cambium



Meristematic tissue

- Many plants undergo an increase in girth or thickening of the stems and roots by adding new vascular tissues to the primary body. This lateral growth is called secondary growth and is produced by a lateral meristem called the vascular cambium
- Meristem can be subdivided into
  - Apical meristem is existent at the growing tips or apical of stems and roots. Apical meristem brings about elongation of the stem and root.
  - Lateral meristem is existent in the radial portion of the stem or root. Lateral meristem increases the diameter of the plant organs.
  - Intercalary meristem is found at the internodes or at the base of the leaves. Intercalary meristem increases length of the plant organs.
- Old meristematic cells lose the capability to distribute and convert into permanent tissues. This procedure of capturing up a permanent function, size, and shape is termed as differentiation.


Meristematic Tissue
Apical Meristem
Intercalary Meristem
Lateral Meristem
Shoot Apical Meristem
Node
Intercalary Meristem
Root Apical Meristem
Lateral Meristem

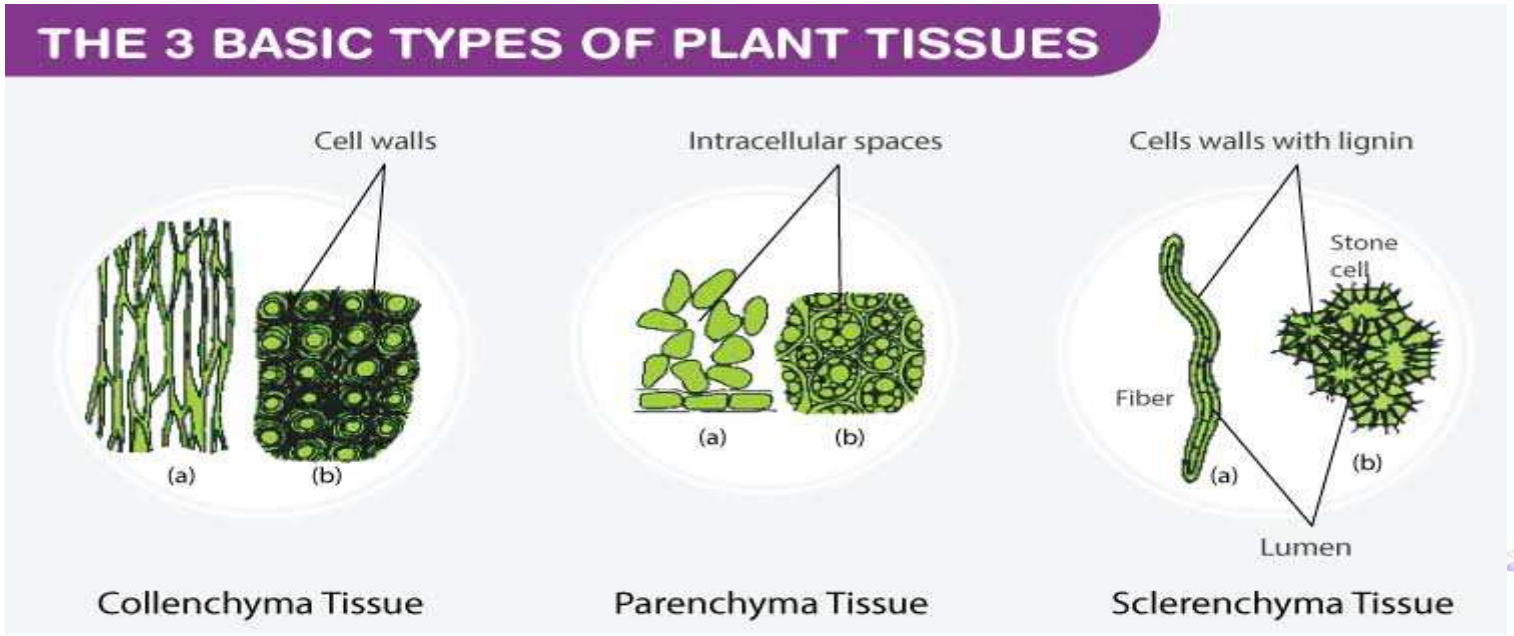
Permanent Tissue

- The tissues that are completely grown and has lost the ability of division are known as permanent tissues. The meristematic tissues divide and differentiate to form the permanent tissues.

Types of Permanent Tissue

Simple Permanent Tissue:

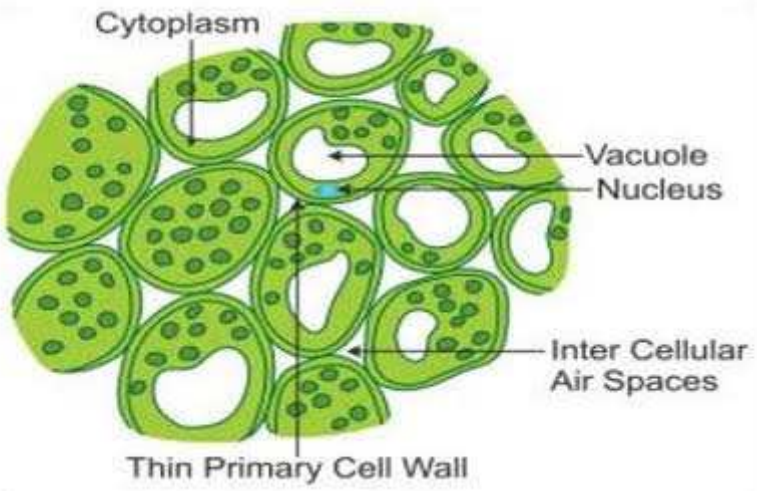
- These are also known as homogenous tissues. They are made up of a single cell type, usually with the same origin, structure, and function. Simple permanent tissue is further classified into three types



Permanent tissue

Parenchyma

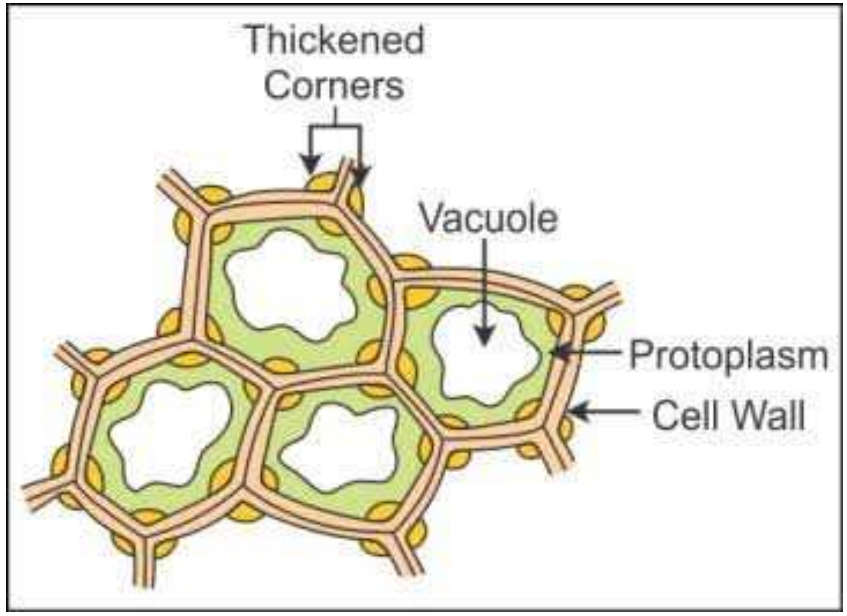
- The most common kind of cell found in plants.
- Parenchyma cells are found throughout the plant body in the cortical regions of stems and roots and in the mesophyll of leaves and are scattered throughout the vascular tissues.
- They perform most of the metabolic functions of the plant, ie. photosynthesusm gas exchange, food storage and transport of nutrients and hormones, and wound healing.



Permanent tissue

Collenchyma

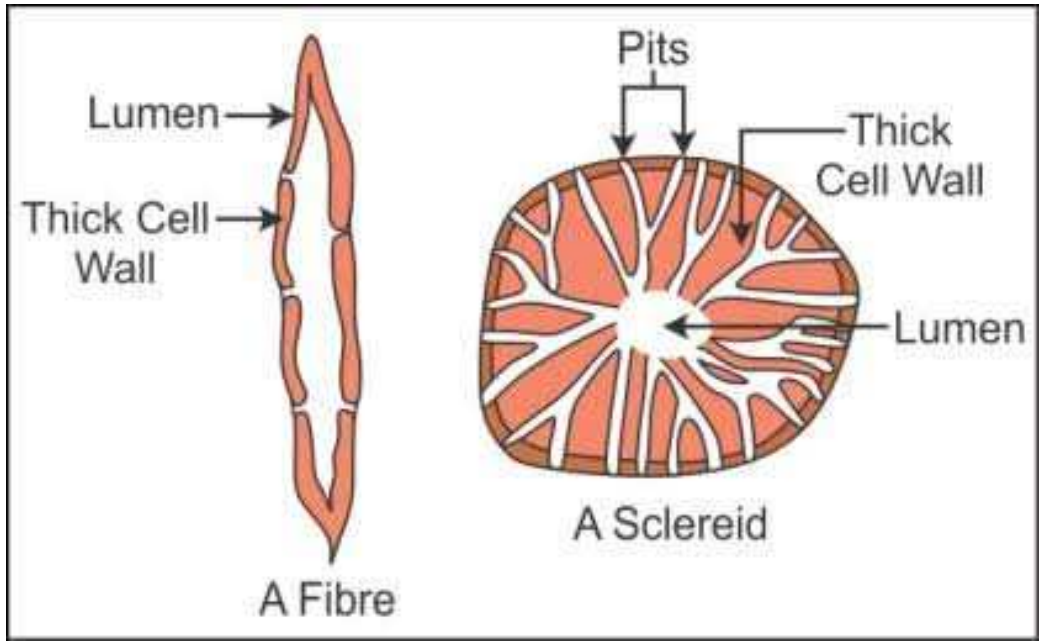
- Uncommon cells with unevenly thicker cell walls that tend to be grouped into strands and cylinders especially near the stem surface and along leaf veins.
- They mainly help to support herbaceous (annual or biennial) plants or new plant growth.
- They are commonly found in the cortex of stems and petioles or along the veins in leaves and are characterized by thickened primary walls



Permanent tissue

Sclerenchyma

- Cells with extremely thick cell walls of cellulose and often lignin that are dead at maturity.
- They are found especially in parts of the plant that have stopped growing and make up the bulk of the wood of perennial plants and the protective covering of seeds where they provide structural support and conduction of water and minerals from the roots to the leaves.

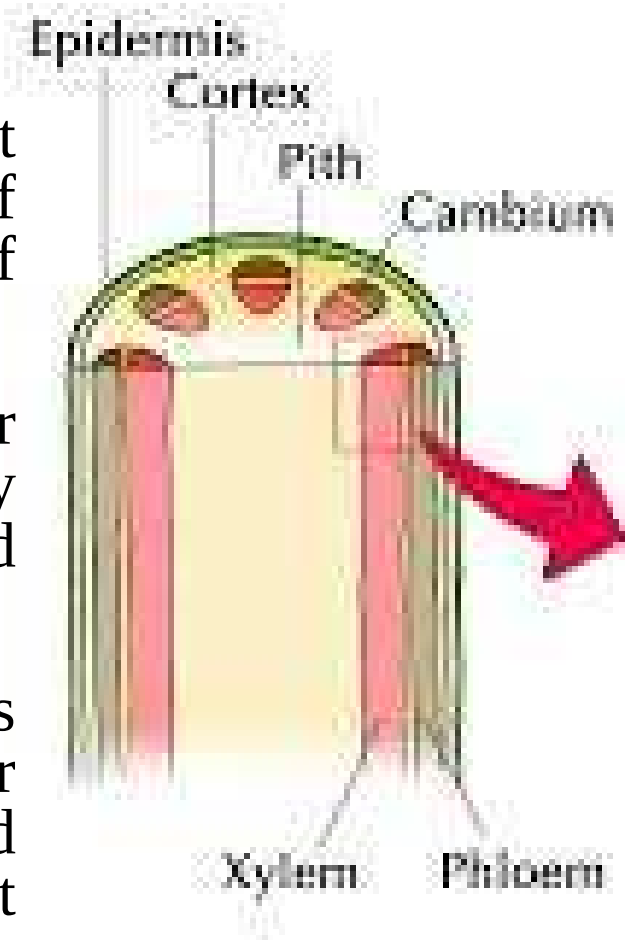


Permanent Tissue

Complex tissues:

Epidermis

- The epidermis is a superficial tissue that forms a continous layer over the surface of the primary plant body (outer covering of plants).
- Cells of the epidermis are usually regular in shape, they are appressed very tightly together and their outer walls are covered with a waxy curtical.
- In leaves the integrity of the epidermis is interrupted with pores, which allow for exchange of carbon-dioxide, water and oxygen between the leaf and the ambient air.
- The principal function of the epidermis is to provide mechanical protection and to restrict water loss.

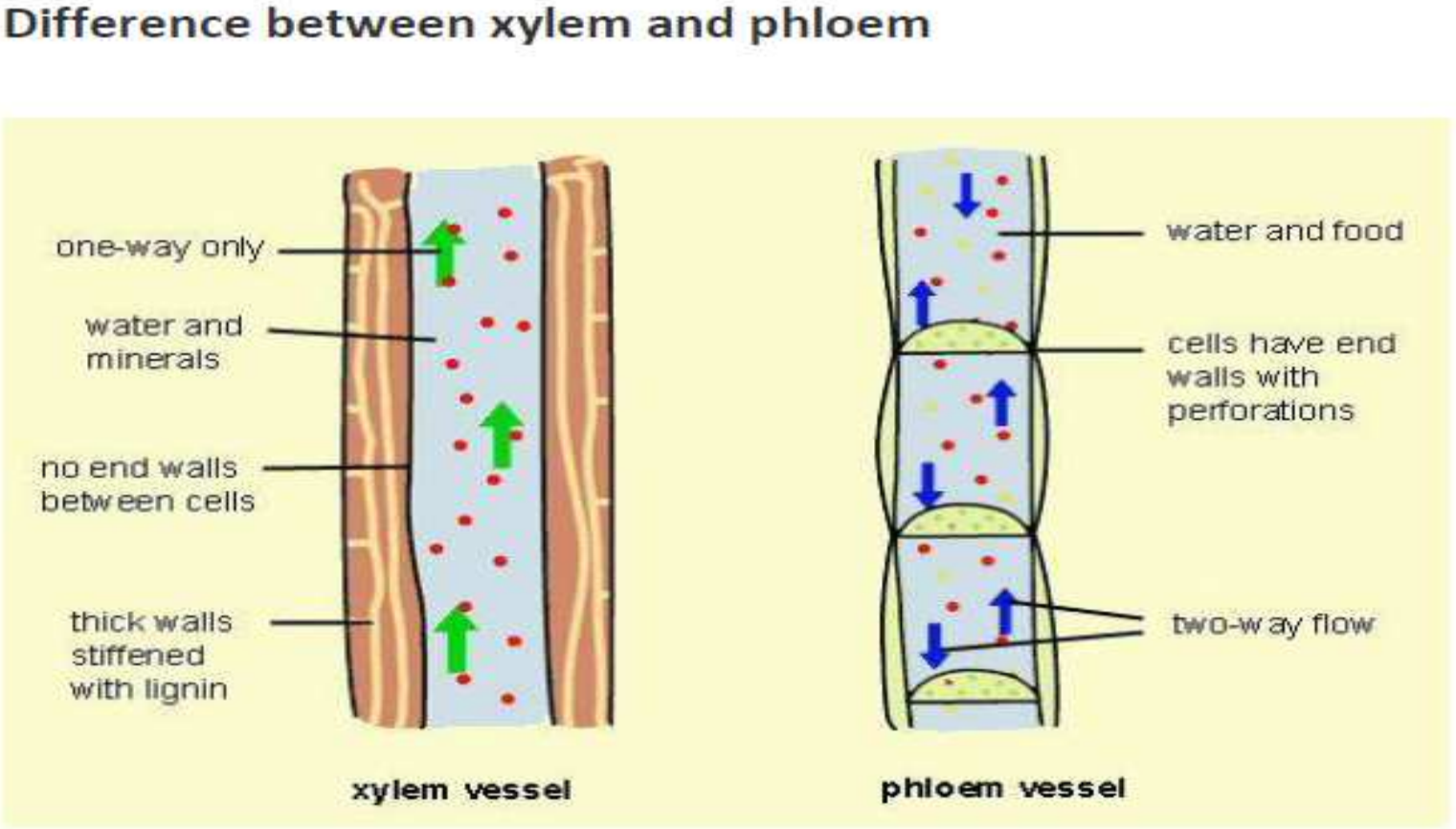


Permanent Tissue

Complex tissues:

Vascular tissue

- The vascular tissues are concerned primarily with the movement of water, minerals, nutrients and hormone throughout the plant. There are two types of vascular tissues: Xylem and Phloem.



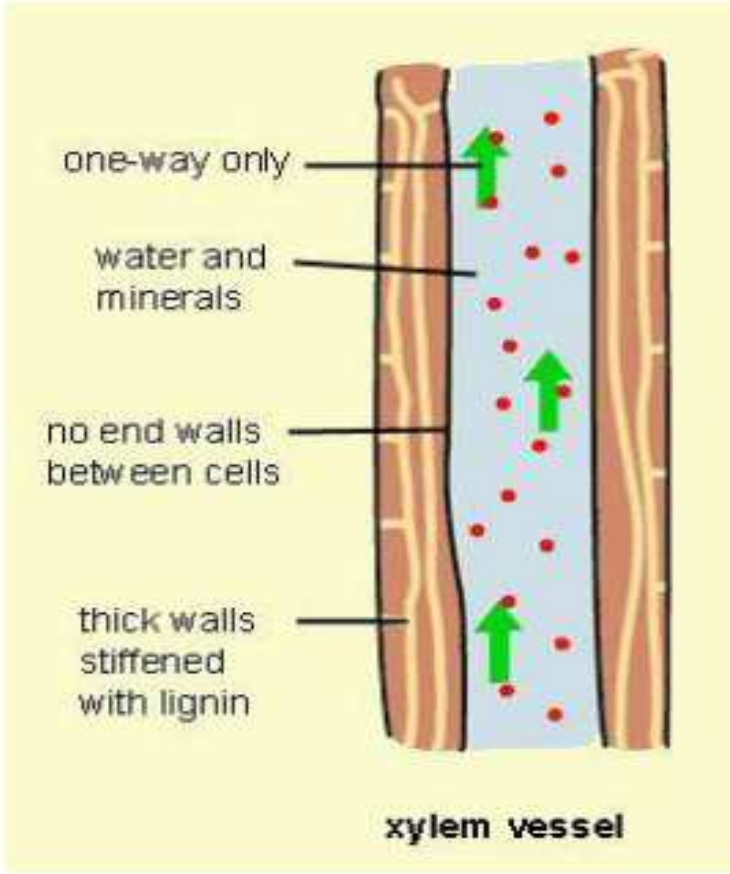
Permanent Tissue

Vascular tissue

Xylem

- Xylem is a structurally and functionally complex tissue concerned primarily with water conduction, storage and support. The cells most characteristics of xylem are the principal water conducting elements; tracheids and vessel elements. Xylem tissues also contain parenchyma cells, which function primarily as storage, and mechanical cells (sclerids and fibers) which provide support.

- Specifically, xylem
  - transports water and nutrients from the roots to the leaves of the plant.
  - provides support to the plants.
  - is divided into-tracheids, vessels, xylem fiber, and xylem parenchyma.

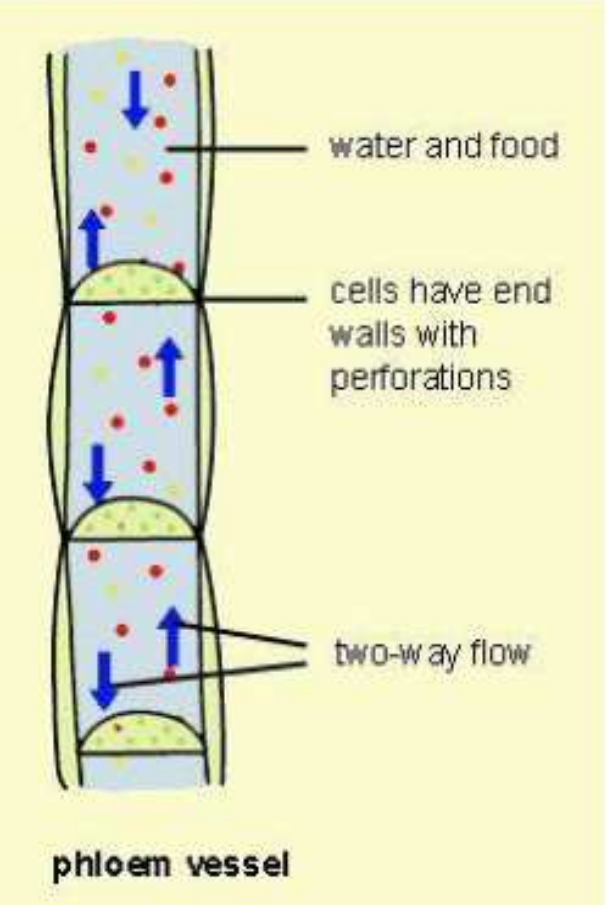


Permanent Tissue

Vascular tissue

Phloem

- This tissue also is both structurally and functionally complex. Phloem is concerned primary with the distribution of organic molecules between “source” that is photosynthetic or storage tissues, and “sinks” or regions of active growth and metabolism. The principal conducting elements are sieve cells on sieve tubes phloem also contain parenchyma cells. Some of which are specialized companion cells or transfer cells as well as sclerids and fibers.



- Specifically, Phloem
  - translocates the prepared organic food from the leaves to different parts of the plant.
  - is also known as bast.
  - is composed of sieve tubes, companion
- Vascular tissues are of two origin: primary (Apical meristem) and secondary (Vascular cambium).

Plant Organ

- Just as cells are grouped together to form tissues with distinct structures are functions, tissues are also grouped together to form Organs.
- The following are known as plant organs: Roots, stems, leaves, flowers and fruits.
- Plants produce two kinds of organs; vegetative and reproductive.
  - **Vegetative organs:** (eg. roots, stems, leaves) generally exist for the life of the plant.
  - **Reproductive organs:** (eg. sori, capsules, antheridia, archegonia, male & female cones, flowers & fruits) are temporary structures that facilitate asexual or sexual reproduction.

Plant Root

- The root is the first plant structure to emerge from a seed during germination.
- Roots are mostly found below the soil surface. They represent about 50% of a plant's weight.
- The primary functions of roots are to absorb water and nutrients from the soil and to support the plant in an upright position.
- Roots also distribute the food energy produced in the leaves to the rapidly growing areas found at the root tips. Some plants also use their roots as specialized food storage reserves.

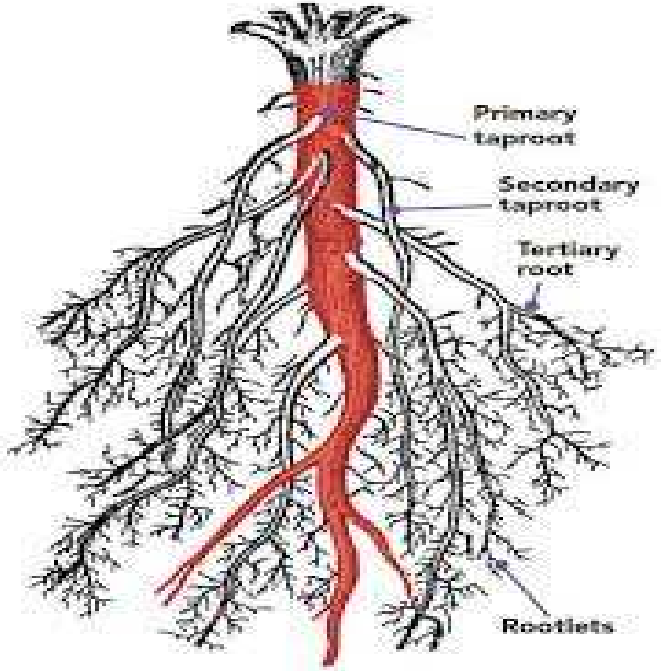
Plant Root

Types of root

- The first root to emerge from a seed is the primary root, or radicle. Plant root systems are classified based on the relative sizes of their primary and secondary roots.

Tap Root

- Plants such as carrots and most trees have a taproot.
- In taproot systems, the primary root thickens and becomes the dominant root. Secondary roots are present but are much smaller in diameter.
- Although most plant roots do not spread more than two to three feet into the ground, the taproots of many trees grow deeply into the soil and can often reach water far below the soil surface.



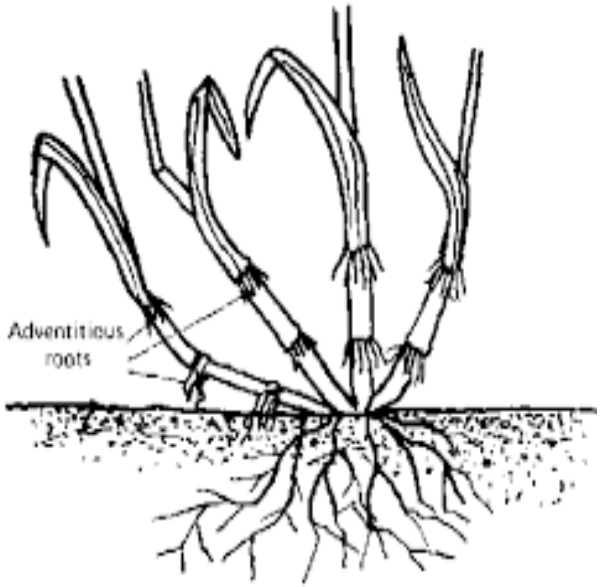
Plant Root

Fibrous Root

- In fibrous root systems, the primary and secondary roots are of similar diameter. They remain fairly close to the soil surface. Plants with fibrous root systems are very important because their roots prevent the erosion of topsoil during heavy rainstorms. Plants such as grasses, corn, and onions have fibrous root systems

Adventitious Root

- Adventitious roots are roots that originate from stems or leaves, rather than branching directly off the primary root. Brace, or prop, roots produced from the stems of corn plants are examples of adventitious roots. The brace roots help to support the tall plant in addition to its shallow fibrous root system



Plant Root

Root structure

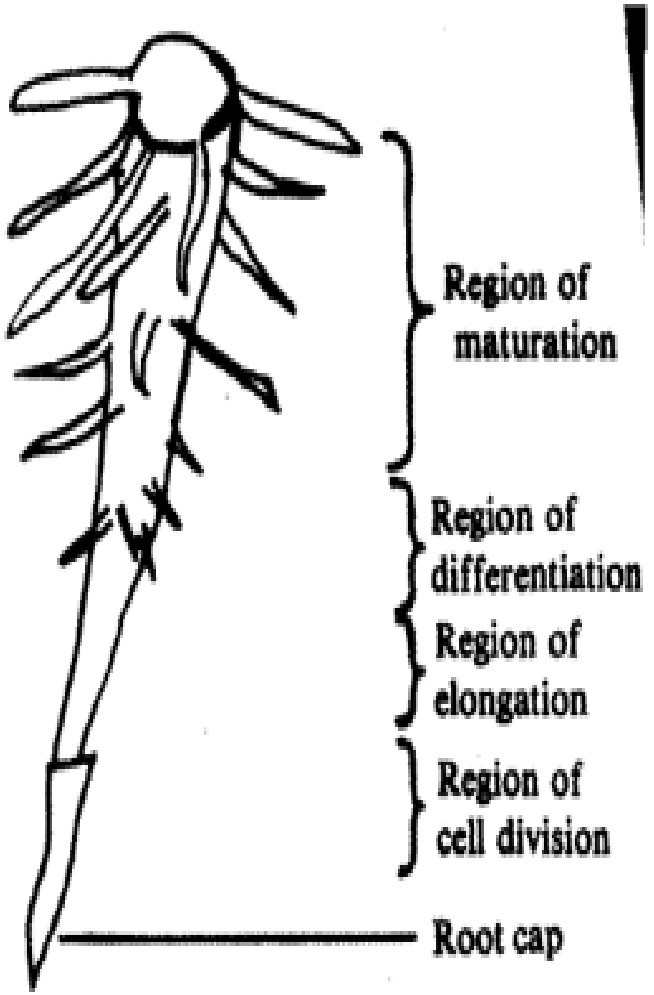
It's made up of the following structures:

Root-cap

Each root is covered over at the apex by sort of cap or thimble known as the root cap, which protects the tender apex of the root as it makes its way through the soil.

Due to the impact of the hard soil particles the outer part of the root-cap wears away and newer cells formed by these underlying growing tissues are added to it.

The root-cap is usually absent in some aquatic plant.



Plant Root

Region of cell division

- This is the growing apex of the root lying within and a little beyond the root - cap and extends to a length of one to a few millimeters.

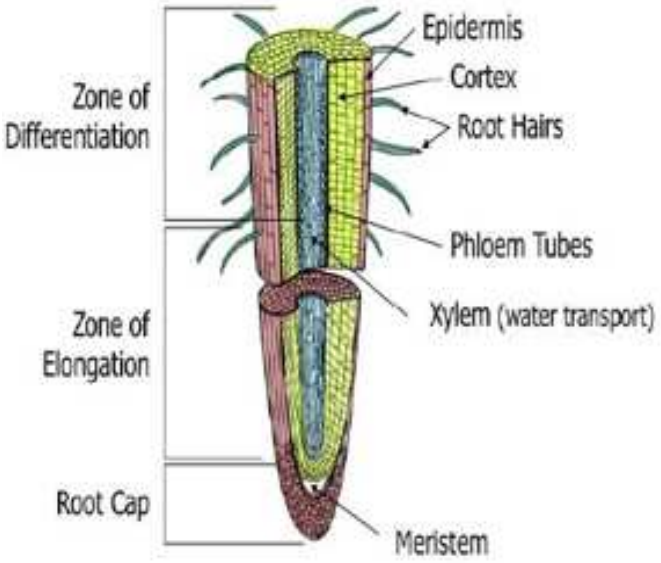
Region of elongation

- This lies above the meristematic region and extends to a length of a few millimeters

Region of maturation

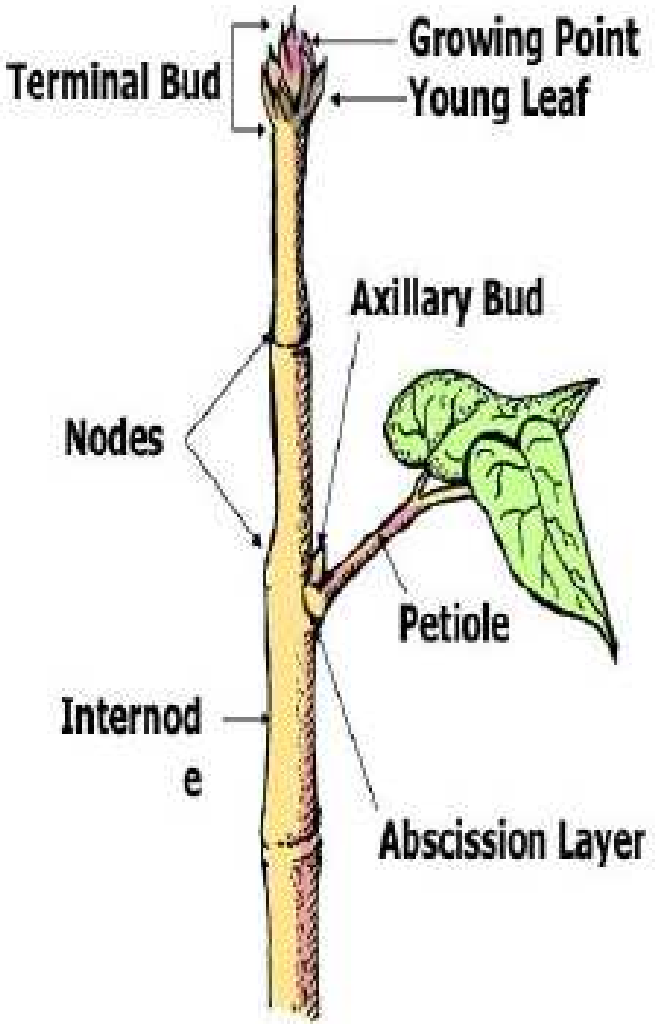
- This region lies above the region of elongation and extends upwards.

- The root hairs and root cap are two important external features of a root.
- Root hairs, found along the main root, perform much of the actual work of water and nutrient absorption. These root hairs develop as an outgrowth of the epidermal cells (epidermis).
- Most plants produce root hairs that live only a few days or a few weeks.



Plant Stem

- This is ascending portion of the axis of the plant, developing directly from the plumule, and bears leaves, branches and flowers. Plant stems connect the roots with the leaves.
- Plant stems are important because they transport water and nutrients from the roots to the leaves. They also transport food energy from the leaves to the roots.
- Stems function as supportive structures. They hold a plant's leaves up toward the sun so they can capture energy from sunlight. Tall, strong stems give a plant a competitive advantage by holding the leaves above those of other plants, increasing their exposure to sunlight.
- Young, green stems help leaves collect sunlight for photosynthesis. Stems also support flowers and reproductive structures that allow for the perpetuation of the plant species



Forms of stems

Varieties of stem structure adapted to perform diverse functions, they may be aerial or underground.

- **Erect or strong stems**: They are unbranched erect, cylindrical and stout stems marked with scars of fallen leaves, this is called caudex e.g. Palms

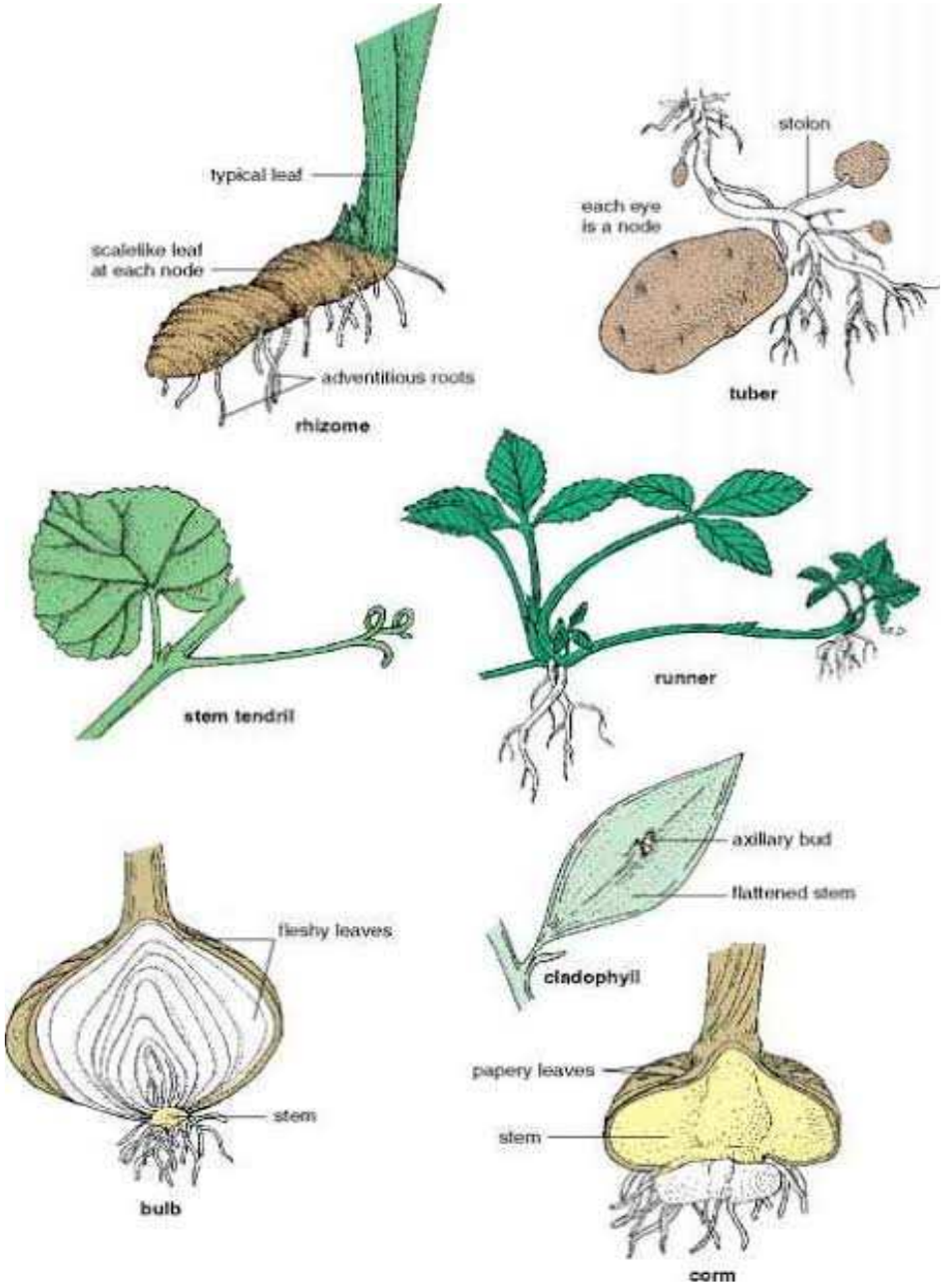
- 2. **Weak stems** – They are of three kinds
  - **Trailers** - those plant whose thin and long or short branches trail on the ground with or without rooting at the nodes e.g. oralis, tridax, boerhaavia
  - **Creepers** – weak-stemmed plants with their long or short branches creeping along the ground and rooting at the nodes. e.g. runner, stolon, offset sucker
  - **Climbers** - those plant that attach themselves to any neighbouring object, often by means of some special devices and climb it to a long or short distance. e.g. pea, passion-flower, Vine.

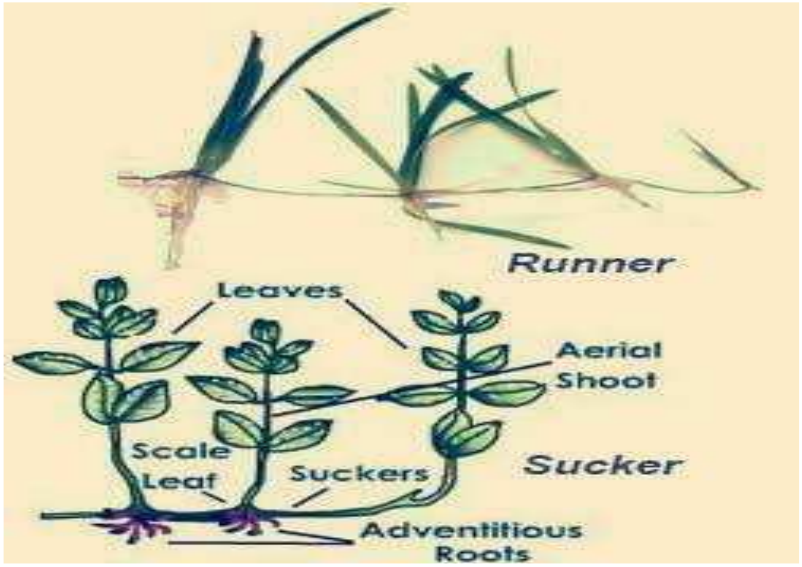
Modification of stem

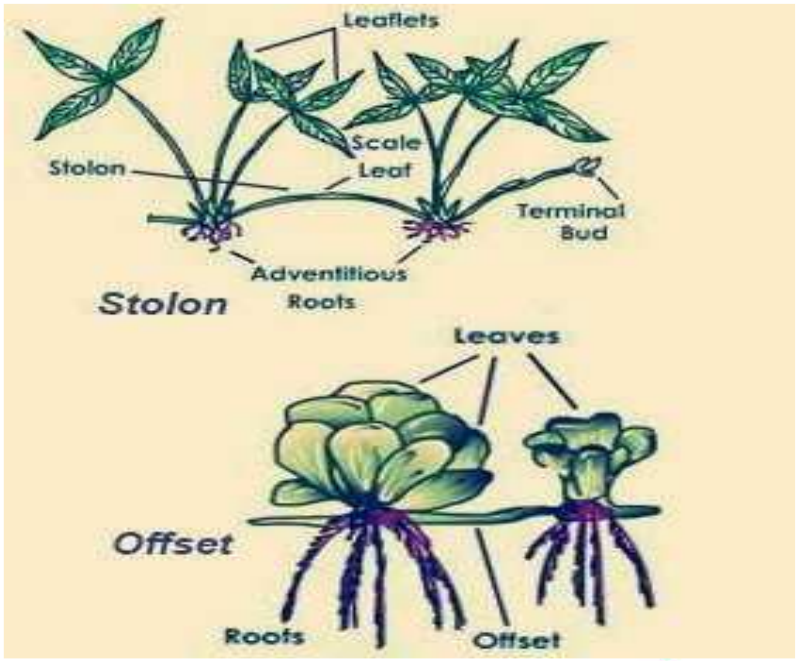
Modified stems in plant perform mainly the following functions:

- **Perennation** - surviving from year to year through bad seasons by certain underground stems e.g.
  - rhizome (ginger, water lily, lotus)
  - tuber (potato, artichoke)
  - bulb (onion)
  - corn (cocoyam, meadow saffron)
- **Vegetative propagation** - by certain horizontal sub-aerial branches spreading out in different direction e.g.
  - runner (strawberry)
  - stolon (peppermint)
  - offset(water lettuce)
  - sucker (banana, bamboo, raspberry)
- **Specialized functions** - by certain metamorphosed aerial organs. e.g.
  - stem-tendril (vine, passion-flower),
  - thorn (lemon),
  - phylloclade (cacti, cocoloba),
  - cladode (butcher's broom),
  - bulbil (oxalis repens, onion)

Modification of stem







Leaf

- This is flattened, lateral outgrowth of the stem or branch, developing exogenously (From superficial tissues) from a node and having a bud in its axil. This is the most important vegetative organ of the plant since food material is prepared in it.

Function of the Leaf

1. Manufacture of food by chloroplast in the presence of sunlight out of carbon dioxide and water obtained from the air and the soil respectively.

2. Interchange of gases, carbon dioxide and oxygen between the atmosphere and the plant body, the former for manufacture of food by green cells,

3. Evaporation of water mainly through the lower surface of the leaf.

Leaf

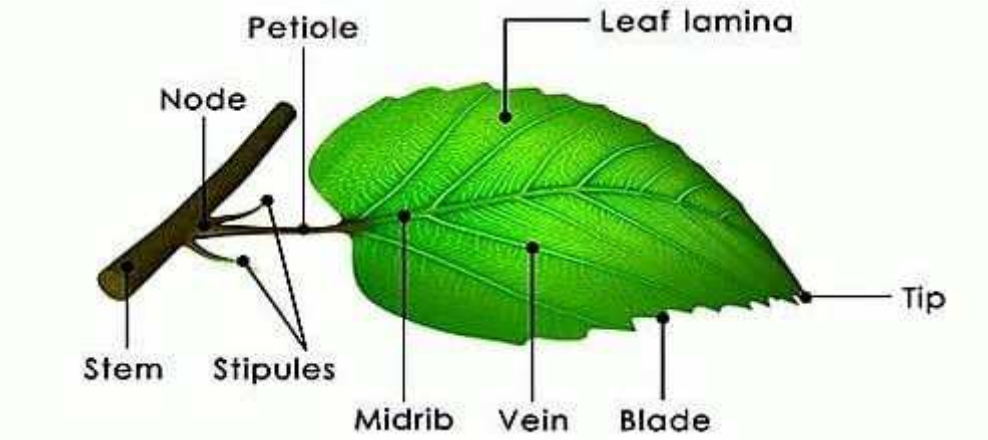
Parts of a Leaf

A typical leaf consists of the following parts each with its function:

Leaf-base – This is the part attached to the stem

Petiole – It is the stalk of the leaf. A long petiole pushes out the leafblade and thus helps it to secure more sunlight.

Leaf-blade/Lamina – Is the green, expanded portion. A strong vein, known as the mid-rib, runs centrally through the leaf-blade from its base to the apex. Lamina is the seat of food-manufacture for the entire plant.



Leaf

Type of Leaves

1. **Foliage leaves** – these are ordinary green, flat, lateral appendages of the stem or the branch borne at the node.

2. **Cotyledone leaves** – are attached to the axis of the embryo of the seed.

3. **Cataphylls or scale leaves** – are reduced forms of leaves, stalkness and often brownish.

4. **Stipules** – are the lateral appendages of the leaf born at its base.

5. **Ligules** – are minute, scaly fewer outgrowths born at the upper end of the leaf sheath, as in Gramineae.

6. **Hypsophylls or bract leaves**

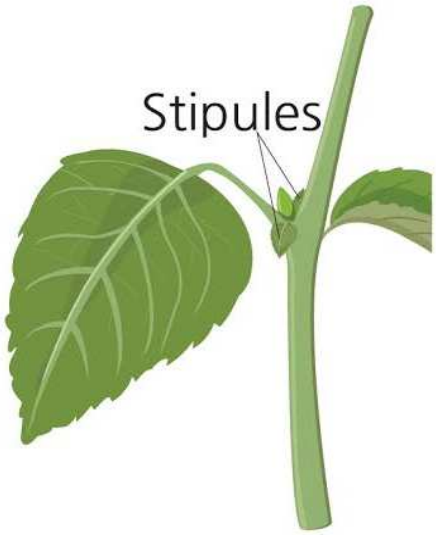
7. **Floral leaves** – are members of a flower, forming into two accessory whorls (calyx and corolla) and two essential whorls (androcium and gynacium)

8. **Sporophylls** – are the spore-bearing leaves concerned in asexual reproduction of plants

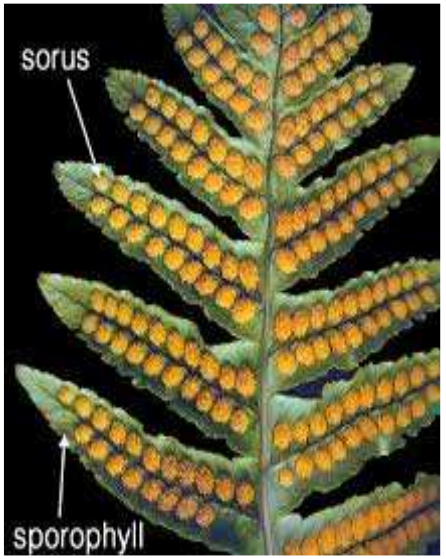
Leaf

Cotyledone

Ligules

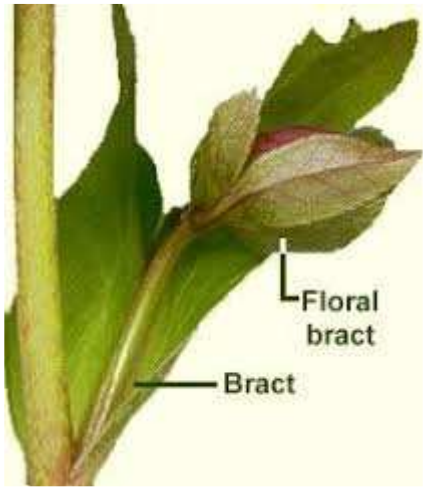


Stipules



Sporophylls

Cataphylls



Hypsophylls or bract

Foliage

Floral

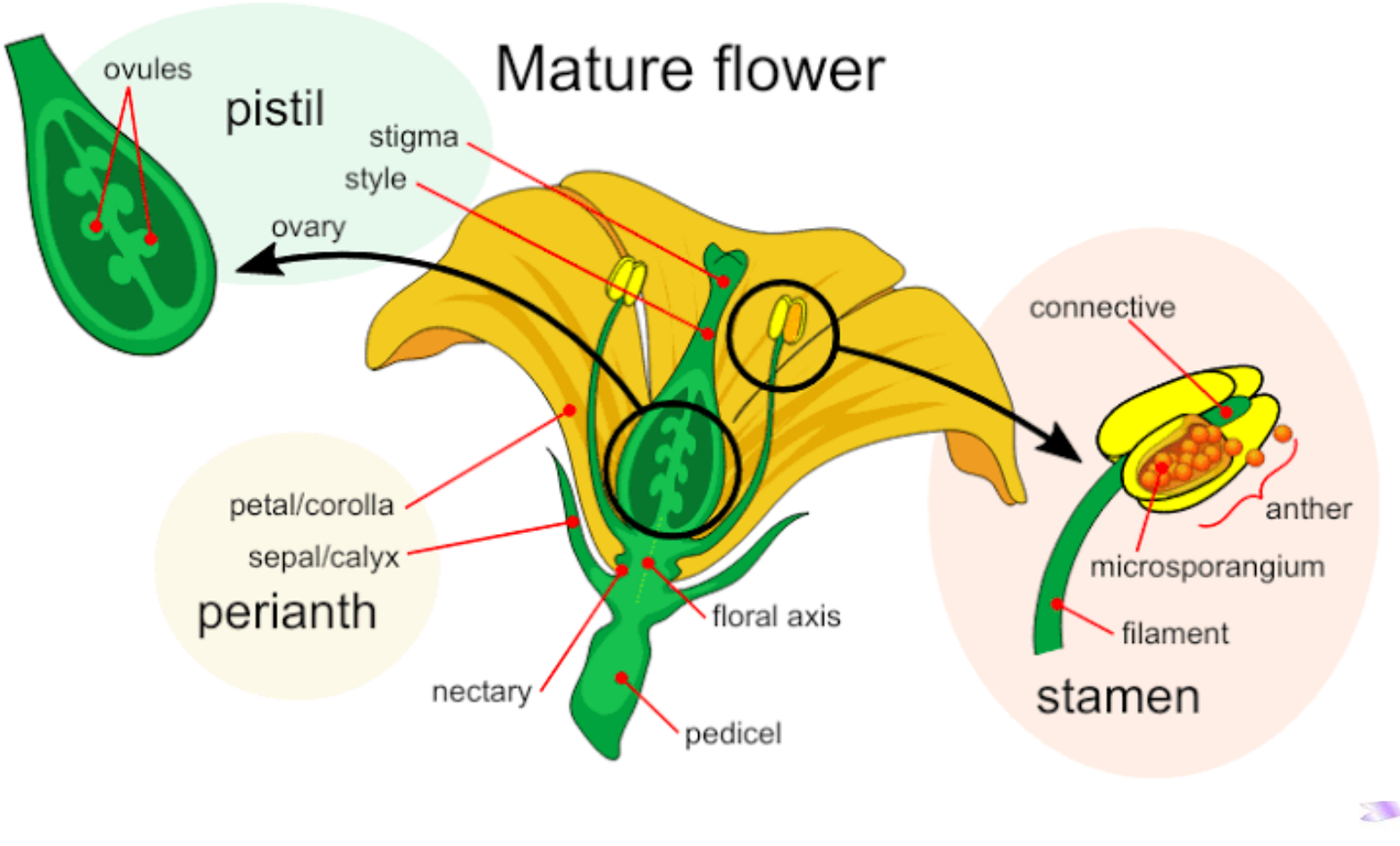
The Plant Flower

- Flowers are the reproductive structures of angiosperms (flowering plants).
- Reproductive structures play an important part in the life cycle of plants because they promote sexual reproduction and produce seeds and fruits that aid the dispersal of the plant species.
- Flowers develop from buds, as do shoots. Therefore, they are considered to be specialized branches of a plant.
- The flower is supported and connected to the stem by an elongated and specialized stem called the pedicel.
- The enlarged part of the pedicel where it joins the flower is the receptacle

The Plant Flower

Parts of a Complete Flower

Complete flowers have four basic parts: petals, pistil, sepals, and stamens.



Parts of Flower

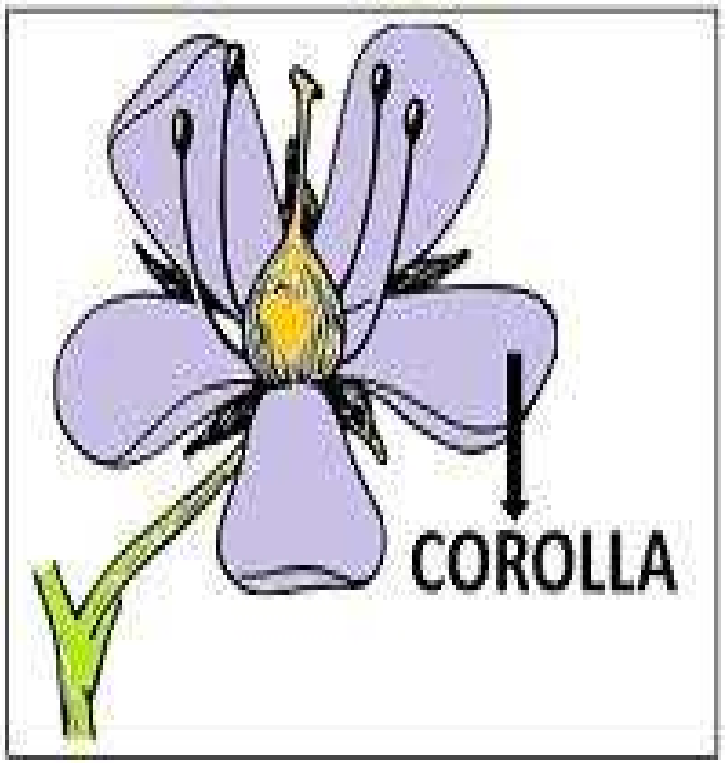
Sepals

- Sepals are leaf-like structures that form an outer ring around the base of the flower.
- Sepals enclose and protect the flower bud before it opens.
- Sepals are often small, green structures. However, in some flowers they are large and colorful.
- The complete ring of sepals is called the calyx.

Parts of Flower

Corolla

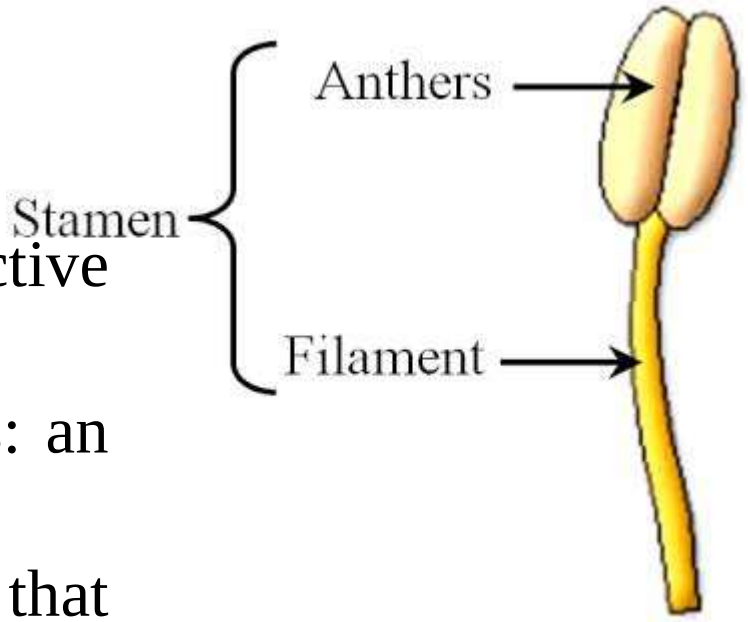
- The corolla consists of individual petals.
- Petals are the bright and colorful part of the flower.
- Petal colors and scents attract specific pollinators. Flowers that rely on birds such as hummingbirds for pollination usually have red or orange petals. This is because hummingbirds can see these colors best and are attracted preferentially to these flowers.
- Bees are most attracted to blue, yellow, and white flowers. So, flowers that are mainly pollinated by bees use these colors to attract their pollinators.
- Other flowers, such as jasmine, do not have colored petals. They have powerful scents to attract pollinators such as night-flying moths.

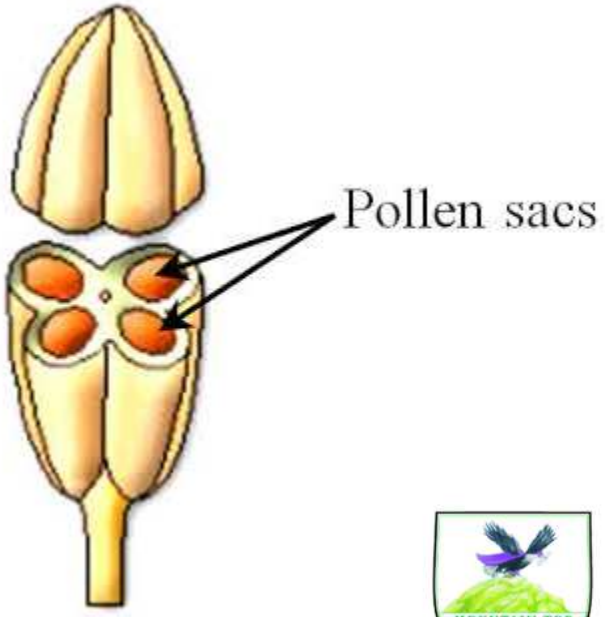


Parts of Flower

Stamens

- The stamens are the male reproductive organs.
- A stamen is comprised of two parts: an anther and a filament.
- The filament is a stalk-like structure that holds the anther.
- The anthers are located at the tip of the filament. They are sac-like structures that contain pollen grains.
- Pollen grains contain the male sex cell and are modified to be sticky or easily carried by the wind, depending on the mode of pollination for the particular plant. A single flower usually has several stamens.

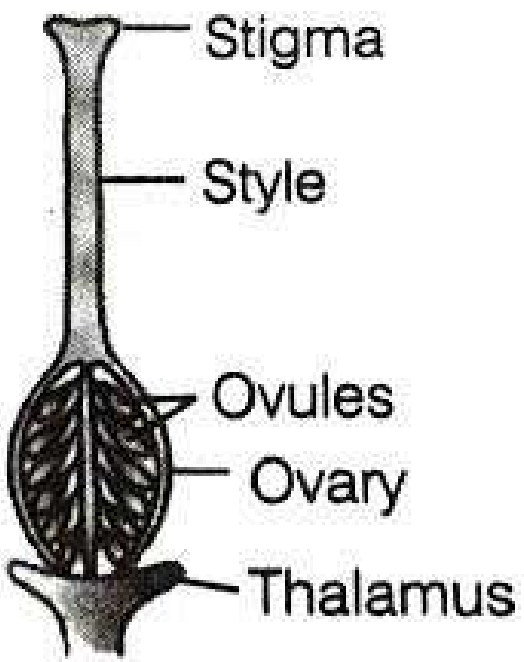




Parts of Flower

Pistil

- The pistil is located at the center of the flower. The pistil has three parts: stigma, style, and ovary.
- The stigma is a sticky, flattened surface that projects upwards towards the pollinator.
- As an insect or bird pollinator collects nectar, the pollen from previous plants it visited is brushed against the sticky surface of the stigma. The pollen sticks on the stigma and is triggered to germinate like a seed.
- The pollen produces a root-like structure called a pollen tube that grows down into the stigma, through the style and into the ovary.



Parts of a pistil

Parts of Flower

Pistil

- The style is a supportive structure equivalent to the filament in the stamen.
- The style holds the stigma in a position to maximize the chances of pollination. At the base of the style is the ovary
- The ovary is an enlarged structure that contains the female sex cells, or ovules.
- The pollen tube grows through the ovary and into an ovule. When the male and female sex cells merge, fertilization occurs.
- At this point, the ovary begins to develop and change into a fruit.

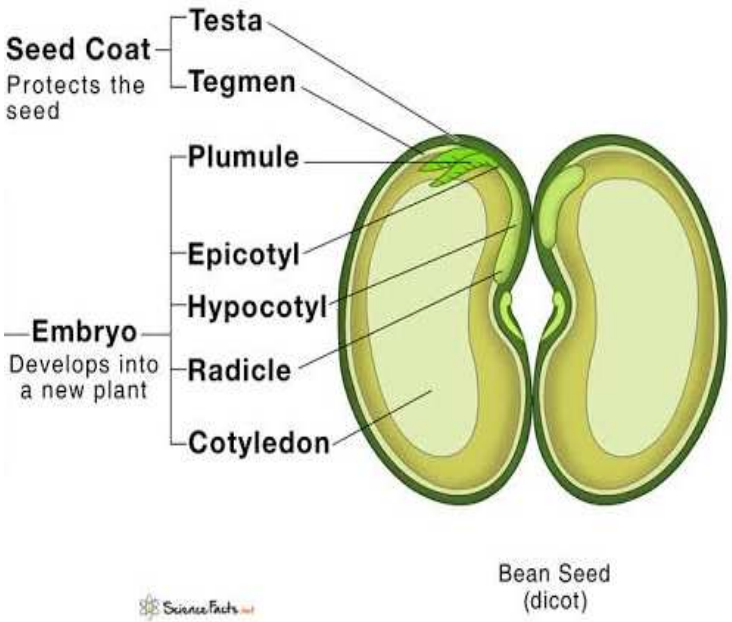
The Plant Flower

Incomplete Flower

- Not all flowers have a corolla, calyx, pistil, and stamen. Those missing at least one of these components are incomplete.
- Pistillate flowers have a pistil but no stamens while staminate flowers have stamens but no pistils. Both pistillate and staminate flowers are imperfect incomplete flowers because they are missing reproductive organs.
- Sterile flowers are missing both pistils and stamens.
- A monoecious plant is one that has both staminate and pistillate flowers on the same plant e.g Corn
- Dioecious plants have male and female flowers on completely separate plants. Staminate flowers occur only on male plants while pistillate flowers occur only on female plants. Kiwi, asparagus,

The Plant Seed

- Seed is matured developed fertilized ovule. Which undergo series of changes as a result the seed is formed.
- The fertilized egg cell or ovum grows and gives rise to the embryo, and the definitive nucleus to the endosperm. Other changes also take place in the ovule. Seed is made up of the following:



Bean Seed (dicot)

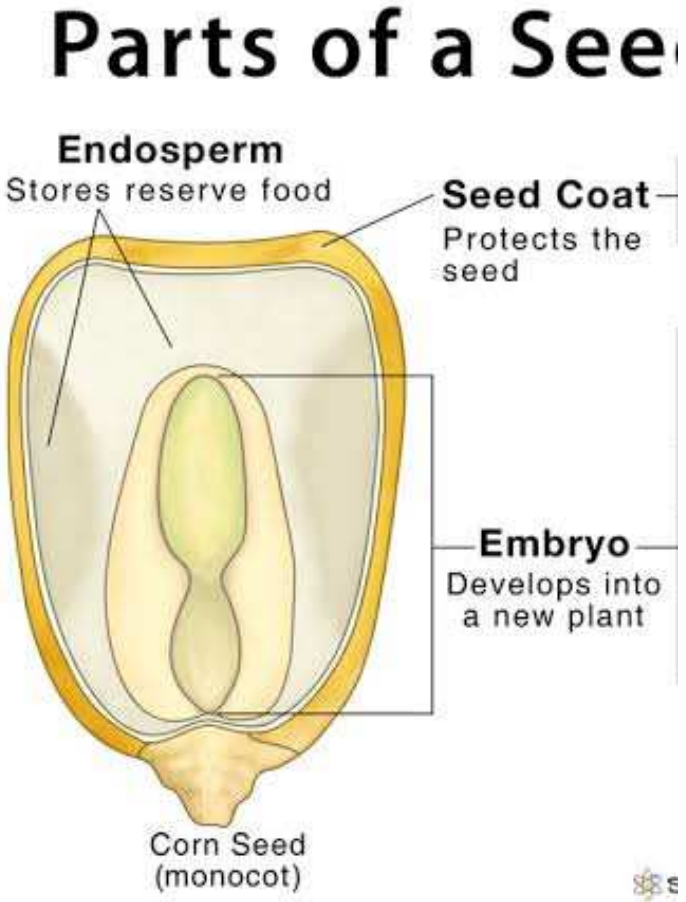
Embryo:

- After fertilization, the egg cell secretes a cellulose wall around itself and becomes the oospore, which finally gives rise to the embryo.

The Plant Seed

Endosperm:

- This is the definitive nucleus which tends to grow into a food storage tissue, usually triploid (3n) and sometimes tetraploid (4n). There are two main type of endosperm development:
  - · Nuclear type. It immediately after double fertilization, endosperm nucleus divides repeatedly without corresponding wall formation.
  - · Cellular type. As the endosperm nucleus divides there is corresponding formation of a cell wall around each nucleus.



Seed-coat

- The two integuments develop into two seed coats, of which the outer one is called the testa and the inner one the tegmen.

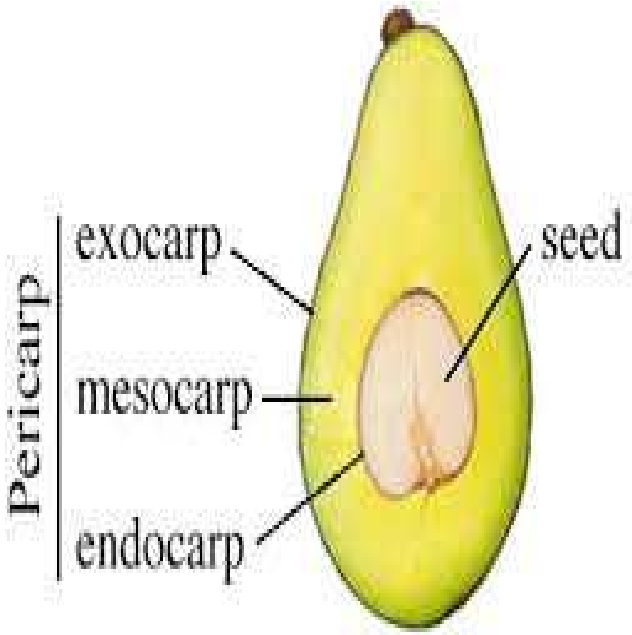
The Plant Fruit

- This is a matured ripened ovary, and a fruit consist of two portions viz.

1. Pericarp (developed from the wall of ovary and the pericarp may be thick or thin, thus consisting of epicarp, mesocarp and endocarp when thick). Fruit can be of two types as follows:

- · True fruit - When only ovary of the flower grows into the fruit
- · False fruit - when other floral parts such as the thalamus, receptacle or calyx may grow and form a part of the fruit (cashew)

2. Seed (developed from the ovule).



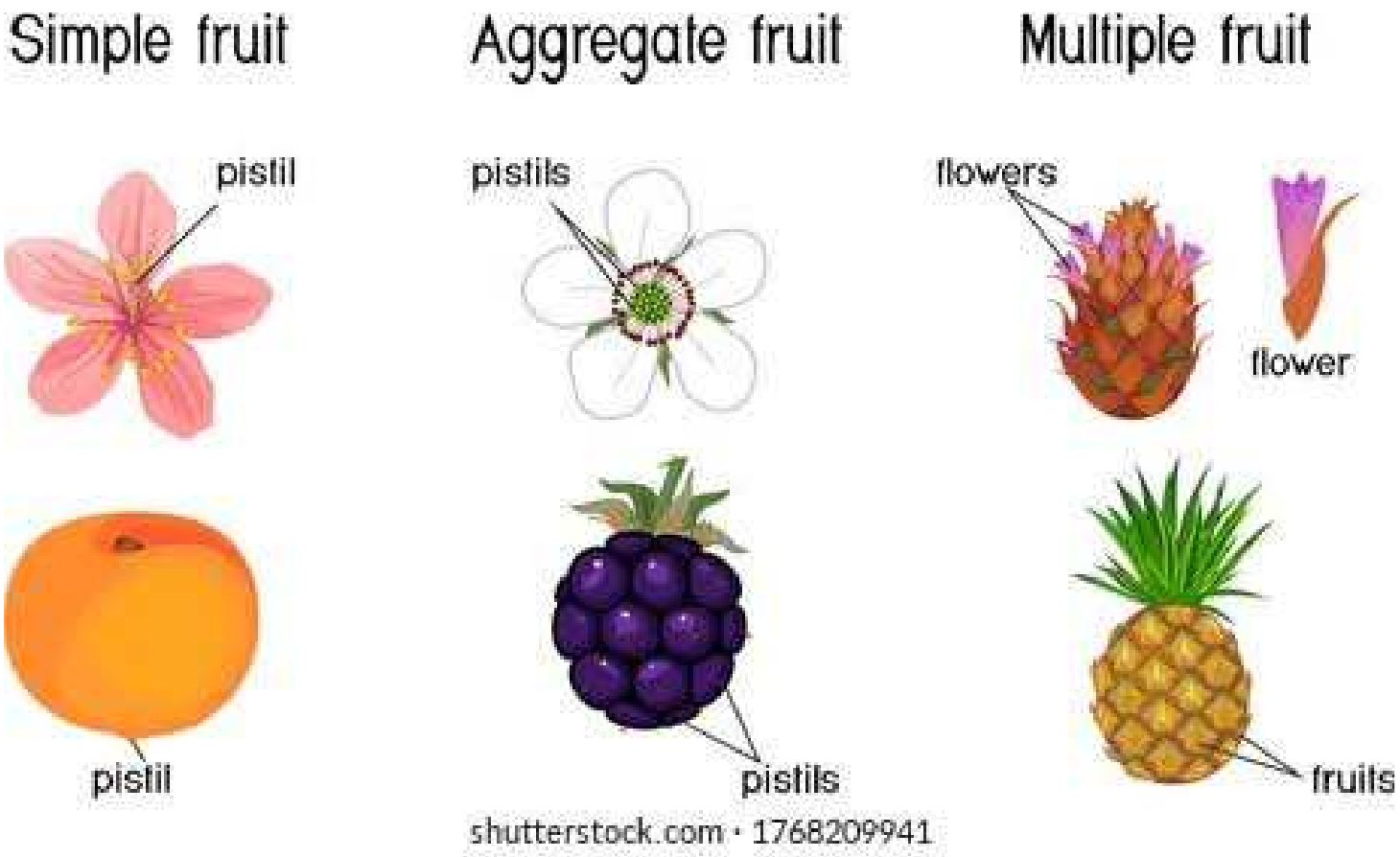
Classification of Fruits

- Fruits whether true or spurious, may be broadly classified into three groups

1. Simple- when the fruit develops from the single ovary (either of simple pistil or of syncarpous pistil) of a flower, with or without accessory parts. It can be:

- · Dry – Dehiscent (Legume or Pod, Follicle, Siliqua, Capsule)
- - Indehiscent (Caryopsis, Achene, Cypsela, Samra, Nut)
- - Schizocarpic (Lomentum, Cremocarp, Double Samara, Regma,
- Carcerule)
- · Fleshy – Drupe (mango, peach, coconut palm)
- - Bacca or Berry (tomato, guava, grapes, banana, pawpaw)
- - Pepo (gourd, cucumber, melon, squash)
- - Pome (apple, pear)
- - Hesperidium (orange, lemon)
- - Balausta (Pomegranate)

Classification of Fruits



Classification of Fruits

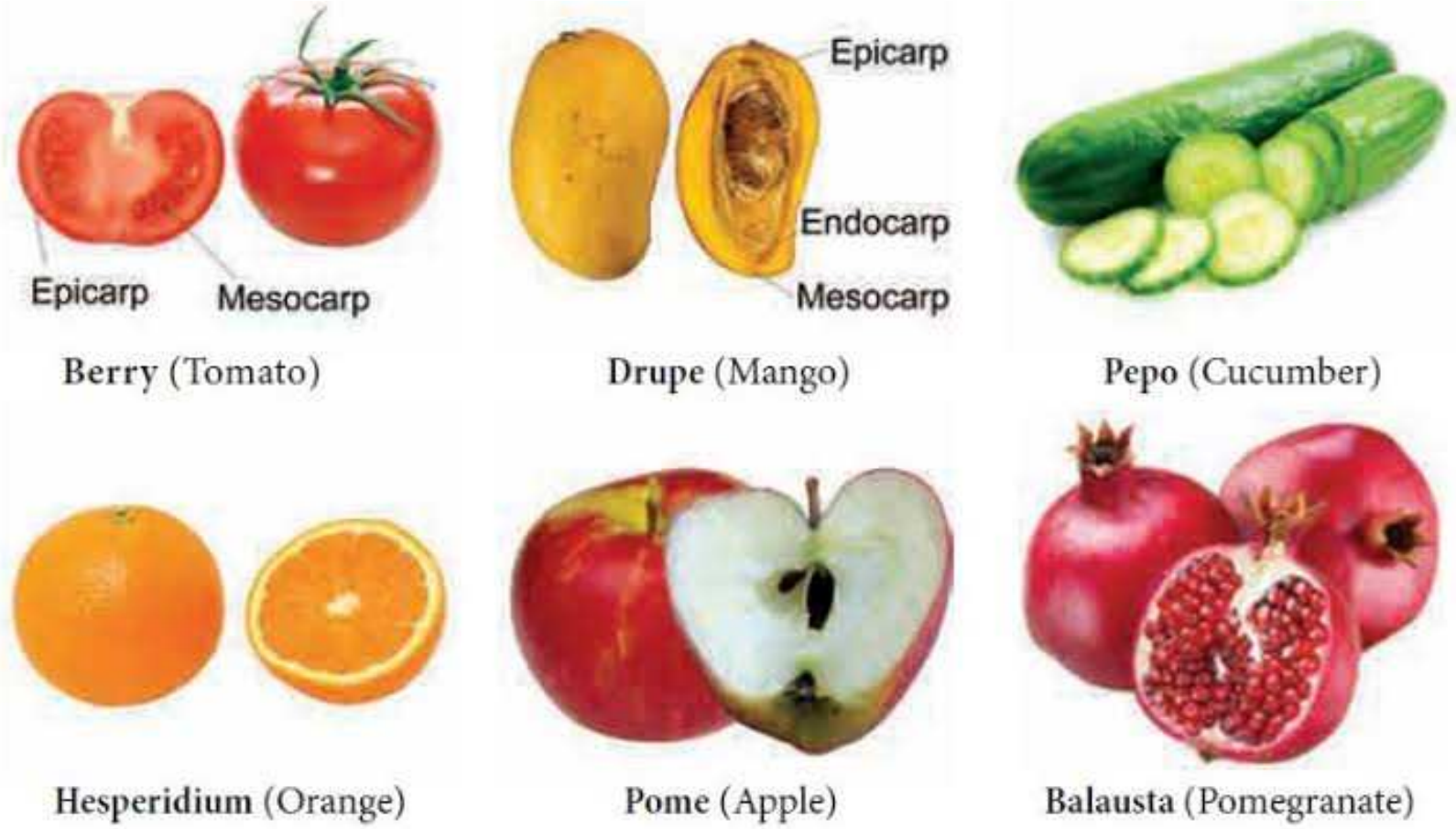
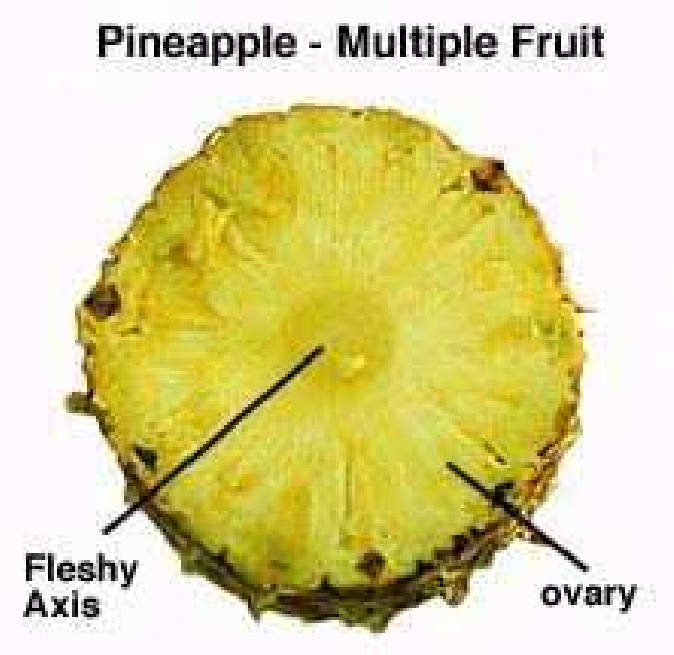


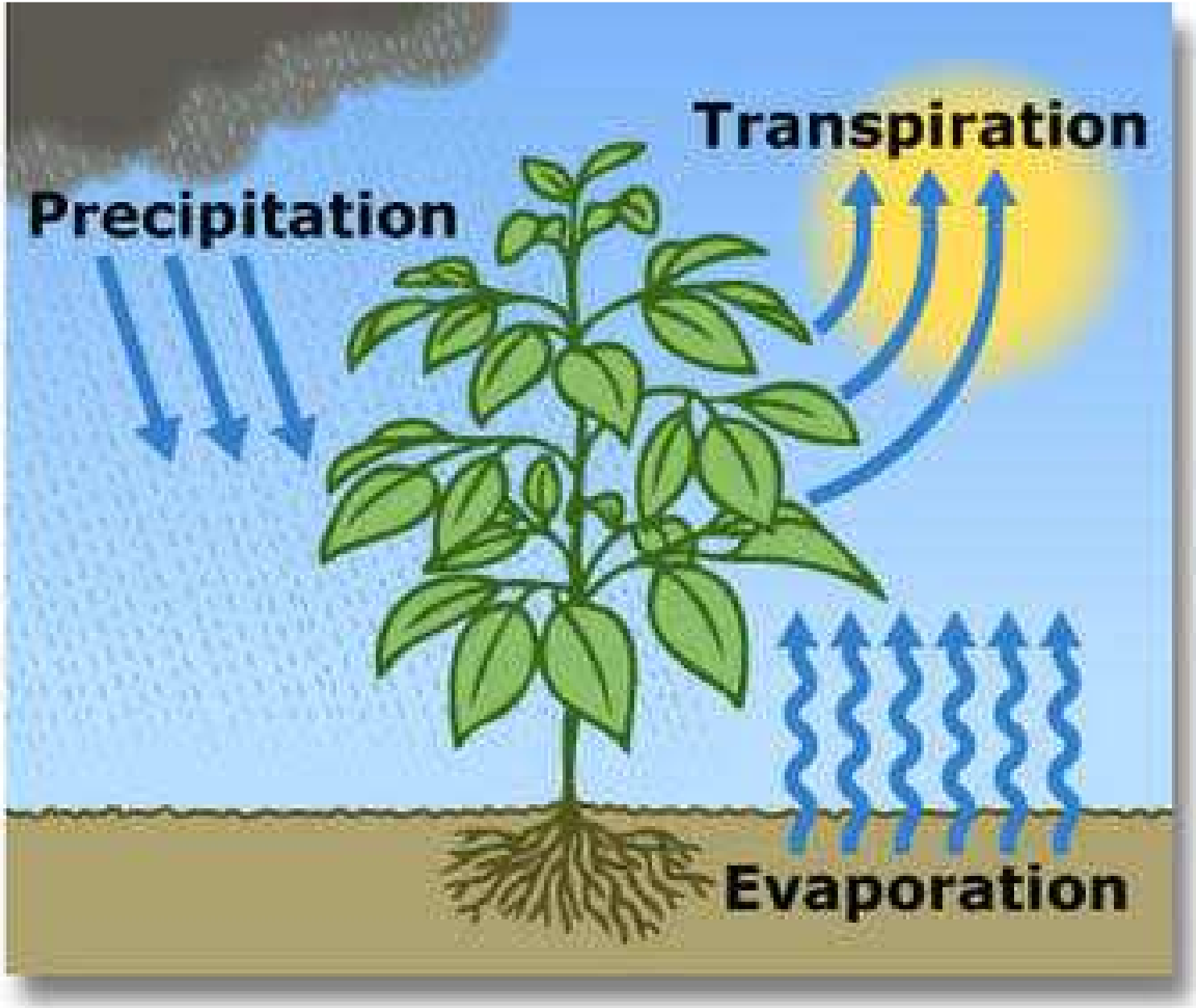
Figure 4.40: Simple fleshy fruits

Classification of Fruits

2. Aggregate – Is collection of simpe fruits developing from the apocarpous pistil or flower. An aggregate of simple fruits born by a single flower is otherwise known as an entaerio

3. **Multiple** – A is that which develops from a number of flowers juxtaposed together, or in other words, from an inflorescence. Such a fruits is otherwise known as an infructescence e.g Pineapple, jack-fruit




Transpiration
Precipitation
Evaporation

Transpiration

- This is an evaporation process which refers to the loss of water vapour by plants. It occurs mainly from leaves and differs from simple evaporation in that it takes place from the living tissues of plant.
- Transpiration takes place chiefly through the stomata and to a much less extent through the cuticle and lenticel as stomatal, cuticular and lenticular transpiration respectively.

Factors affecting transpiration:

- Water
- Light and
- Humidity of air
- Air temperature
- Wind

Importance of Transpiration

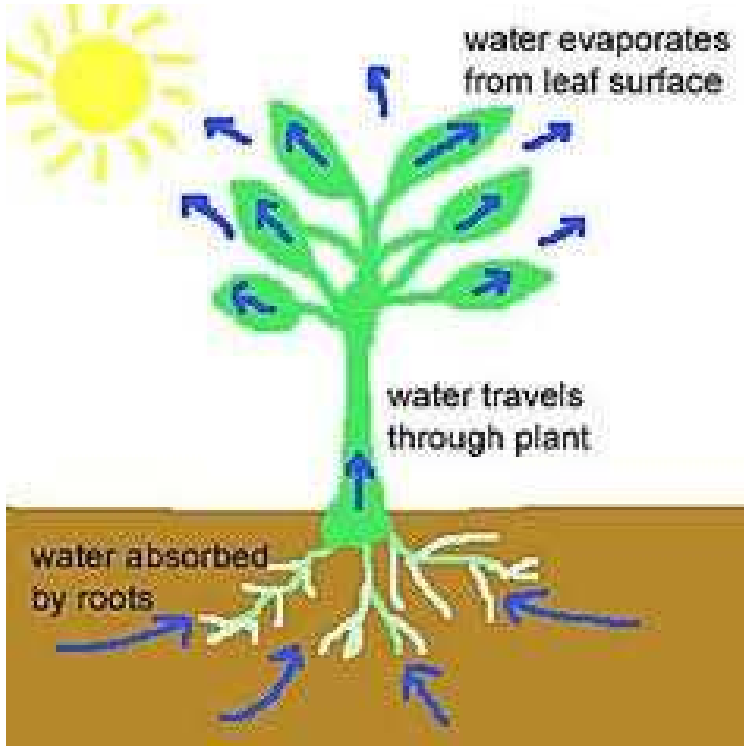
- In spite of its possible harmfulness to the plant when excessive, resulting in wilting, transpiration has some advantages to plants.
  - An upward moving current of water transpiration stream is affected and this facilitates water absorption by roots.
  - It facilitates upward transport of solute in the xylem/translocation whence reach the leaf cells.
  - Evaporation of water from the transpiring surfaces helps to prevent excessive heating and at the same time leave the salts in the cells for use by the plants.
  - It aids the plants in getting rid of excess water.
  - It may help in salt absorption.

Photosynthesis

- All living organisms are composed, among other things of organic compounds. These organic compounds are derived from simple inorganic substances present in the physical environment of living things.

- Only plant out of all the living things that which have a green pigment called chlorophyll, are capable of carrying out this transformation of inorganic substances (Carbon dioxide and water into organic compound) e.g. carbohydrates.

- Carbon dioxide which is present in the air, and in water in dissolved form, diffuses into the cells of land and water plants and where these cells contain chlorophyll the CO2 is transformed to carbohydrates. This transformation occurs in the presence of and with the participation of water and light.



$CO_2 + 2H_2O$ ----------$(CH_2O) + O_2 + H_2O$

Carbon dioxide + water---------- Carbohydrate + Oxygen + Water

Photosynthesis

- In green plants, the pigments that serve for the absorption of light for photosynthetic purposes are the chlorophylls.
- The physical radiant energy that is trapped by the chlorophylls is converted to chemical energy, and stored in the organic compounds synthesized.
- Chlorophylls are of three types a, b and c. Chlorophylls is coloured bluish green while chlorophyll b is olive/yellow green. These pigments are contained in specialized structures called chloroplasts in algae and higher plants.
- Also present in the photosynthetic apparatus is another group of pigments called caratenoids which include carotenes and anthophylls and are brightly coloured. The carotene is coloured orange while the xanthophylls are yellow in colour.
- Pigments may absorb light energy but this has to be passed to chlorophyll a before it can be used in photosynthesis and so these pigments are called – accessory pigments
- The process of photosynthesis consist of two phases.
  - a) a light dependent phase or light reaction
  - b) the light independent phase or dark reaction

True respiration

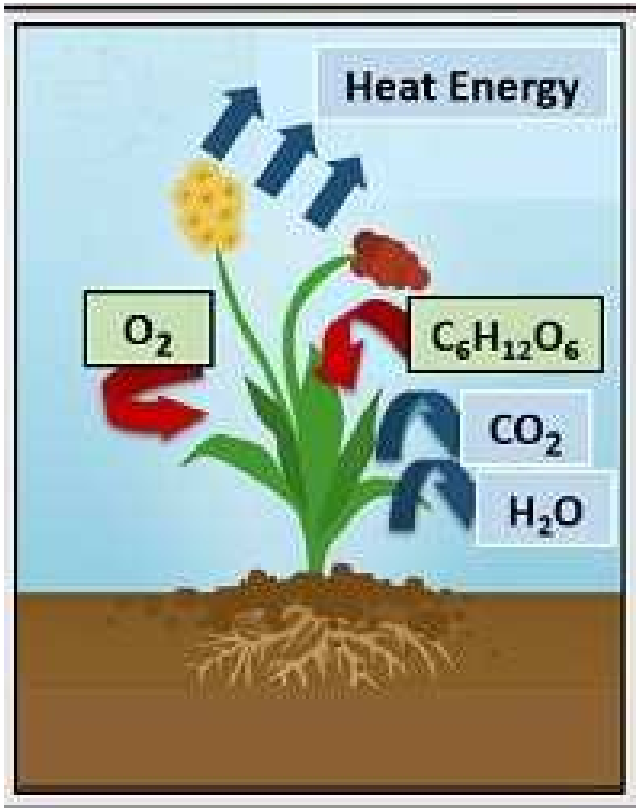
- The common misconception about plants is that their only energy-related metabolic process is photosynthesis:

CO2 + H2O + energy carbohydrates + O2

- However, as most eukaryotes, plants have mitochondria in cells and use aerobic (oxygen-related) respiration to obtain energy:

Carbohydrates + O2 CO2 + H2O + energy

- Typically, plants spend much less oxygen in respiration than they make in photosynthesis.
- However, at nights plants do exactly the same as animals, and make only carbon dioxide!



Water translocation

- In terrestrial rooted plants practically all of the water which enters a plant is absorbed from the soil by the roots. The water thus absorbed is translocated to all parts of the plant. The upward movement of water in plants occurs in the xylem, which, in the larger roots, trunks, and branches of trees and shrubs, is identical with the wood. In the trunks or larger branches of most kinds of trees, however, sap movement is restricted to a few of the outermost annual layers of wood.

- Root pressure is generally considered to be one of the mechanisms of upward transport of water in plants. While it is undoubtedly true that root pressure does account for some upward movement of water in certain species of plants at some seasons, various considerations indicate that it can be only a secondary mechanism of water transport.

- Upward translocation of water (actually a very dilute sap) is engendered by an increase in the negativity of water potential in the cells of apical organs of plants. Such increases in the negativity of water potentials occur most commonly in the mesophyll cells of leaves as a result of transpiration.

Growth and Development in Plants

Introduction

- **Growth** in living organisms may be defined as an irreversible increase in the number and size of a cell, organ or whole organism.
- Growth in living organisms is not uniform throughout the life span. Growth takes Heredity place at a faster rate till the plants or animals attain maturity. Then it slows down and at a particular time it stops. Later in life death occurs.
- All these changes that occur in an organism starting from its beginning till its death may collectively be termed as development.
- **Development** is the whole series of qualitative and quantitative changes such as growth, differentiation and maturation, which an organism undergoes throughout its life cycle.
- Development is associated with morphogenesis and differentiation. **Morphogenesis** is the process of development of shape and structure of an organism; and differentiation is the process of change in cells, tissues or organs to carry out different functions.

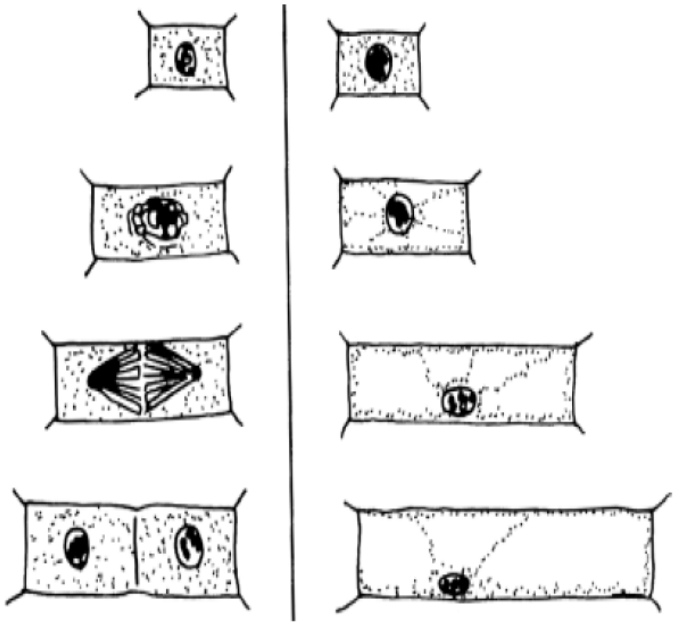
Stages of Cellular Growth

The growth of an organ or an organism occurs in three successive stages. They are

Cell division: The number of cells increases due to mitosis.

Cell enlargement: The size of individual cell increases after cell division due to increase in the volume of its protoplasm.

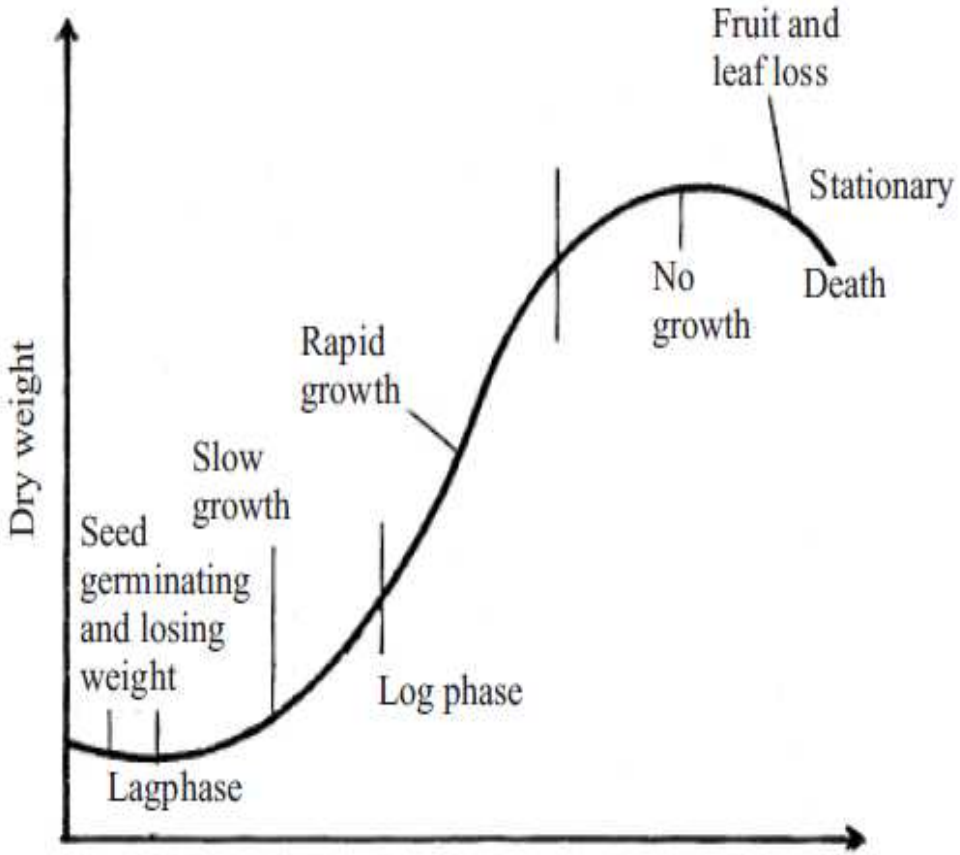
Cell differentiation: In this stage, structure of the cells changes to perform specific functions. And similar type of cells having same functions form a group, which is known as tissue.



- In lower organisms such as bacteria and algae the entire body grows. But in higher organisms like ferns, pine and flowering plants, growth is restricted to the cells present only in the growing regions, like shoot apex and root tip and close to the lateral sides of the stem and root.
- Growth at the tips leads to elongation of body parts and lateral (side ways) growth leads to increase in the thickness of stem and root.

Growth Curve

The rate of growth of a plant or plant part is not always the same during its life span. Sometimes it is slow and at other times rapid. If we plot the increase in cell number (growth rate) against time, a typical S-shaped curve is obtained. This is called growth curve or sigmoid growth curve.



This curve has three phases of growth.

Lag Phase – This is the initial phase of growth when the rate of growth is very slow.

Log Phase – It shows rapid growth and is maximum during the entire life span.

Stationary Phase – Here the rate of growth starts decreasing and finally it stops

The total time period during which the festest growth of the organ or organism occurs is called **grand period of growth**.

Factors Affecting Plant Growth

Generally plant growth is influenced by a number of factors both external and internal.

External growth factors

External factors are those factors present in the environment that affect the growth of the plants directly or indirectly. These factors are

(i) Light (ii) Temperature (iii) Water (iv) Mineral nutrients

Light: Besides photosynthesis, light is also essential for seed germination, growth of seedling, differentiation of various tissues and organs, and reproduction.

Temperature: Some plants grow in cold climate and some in hot climate. The optimum temperature required for growth of plants ranges between 28-30°C, but it may occur in the temperature range of 4-45°C. All metabolic activities of plants are directly affected by variation of temperature. A very low temperature causes injuries to the plant due to chilling and freezing, and very high temperature stops its growth.

Water: For proper growth of plants a particular quantity of water is required. Both deficiency and excess of water retards the growth of plants.

Mineral Nutrients: All metabolic processes require inorganic nutrients. Plant growth is adversely affected by the deficiency of nutrients.

Factors Affecting Plant Growth

Internal Growth Factors

- In addition to the external factors as discussed above, there are some substances produced in the plant body itself, which affects the growth of the plant.

- These are called plant hormones or phytohormones or growth hormones. A **phytohormone** is an organic substance produced in a small quantity in one part of plant body and capable of moving to other parts to influence the growth of that part.

- The growth of the plants can also be influenced by certain synthetic chemicals resembling plant hormones both in structure and functions. These are called **growth regulators**. They **are not** produced by plants naturally.

- Growth regulators are chemical substances, other than naturally produced hormones, which promote, inhibit or modify growth and development in plants.

- The naturally produced growth hormones are broadly grouped under five major classes. They are (i)Auxin (ii) Gibberellins (iii) Cytokinins (iv) Ethylene (v) Abscissic acid

Factors Affecting Plant Growth

Auxin

- Auxin is a growth promoter, generally produced by the growing apex of stem and root of the plants. It helps in the elongation of shoot and root tips behind apical meristem.

- The naturally produced auxins is ***Indole-3-Acetic Acid (IAA).***

Functions of Auxin

(a) It promotes cell elongation;

(b) It suppresses the growth of lateral bud. If the tip of a plant is removed, the lateral branches begin to grow; In most of the plants apical bud suppresses the development of lateral buds. This is called apical dominance.

(c) It delays fall of leaves. (leaf abscission)

(d) NAA (Naphthalene acetic acid) is used for preventing fruit drop in apples before they are ripe.

(e) 2, 4-D (2, 4-dichlorophenoxy acetic acid) acts as a dicot weedicide.

Factors Affecting Plant Growth

Gibberellin

- Gibberellin or Gibberellic Acid (GA) was initially isolated from a fungus *Gibberella fujikuroi.*
- In plants, it is produced in embryos, roots, and young leaves and it enhances growth.

Functions of Gibberellins

(a) It helps in elongation of stems in genetically dwarf plants. By using gibberellin he height of the dwarf plants can be increased.

(b) It breaks dormancy of seeds and buds.

(c) It induces parthenocarpy. (Formation of seedless fruits without fertilization) or provides stimulus received by pollination.

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Cytokinins

- Cytokinins are synthesized in root apex, endosperm of seeds, and young fruits where cell division takes place continuously.
- **Functions of Cytokinins**

(a) They stimulate cell division, cell enlargement and cell differentiation.

(b) They prevent aging of plant parts.

(c) They inhibit apical dominance and help in growth of lateral buds into branches.

Factors Affecting Plant Growth

Ethylene

Ethylene is a gaseous hormone. It is found in ripening fruits, young flowers and young leaves.

Functions of Ethylene

(a) It induces ripening of fruits.
(b) It promotes senescence and abscission of leaf, and flowers.
(c) In cells it only increases the width not the length.

Abscissic acid

Abscissic acid also known as **Dormin** is a naturally occurring growth inhibitor found in wide variety of plants. It is synthesised in leaves.

Functions of Abscissic acid

(a) It induces dormancy of buds and seeds as opposed to Gibberellin, which breaks dormancy.
(b) It promotes the senescence of leaf, i.e., fall of leaves happen due to abscissicacid.
(c) It inhibits seed germination and development.
(d) It causes closing of Stomata.

SEED GERMINATION

- Seed germination is the return of metabolic activities and growth by the seed tissue to give rise to a new plant by the development of the embryo.
- Some seeds do not germinate immediately after dispersal even if suitable conditions of growth are provided. In this period growth of the seeds remains suspended and it is said to be in the rest or dormant stage. This phenomenon is called **dormancy of seeds**.

PHOTOPERIODISM

- Photoperiodism is the response in growth, transpiration, photosynthesis, and reproduction (flowering) of a plant to the specific duration of light, which falls on it per day.

- On the basis of day-length required by the plants for flowering, the plants are classified into the following three categories:

  (i) **Short-day Plants (SDP)** : Some plants produce flowers when exposed to a light period shorter than a required day-length. These are called Short-day Plants. Chrysanthemum, Cosmos, Dahlia, Soyabean, are short-day plants.

  (ii) **Long-day Plants (LDP)** : They produce flowers when exposed to a light period longer than a fixed day-length. Gulmohar, radish, spinach, are long-day plants.

  (iii) **Day-neutral Plants (DNP)** : In these plants flowering is not affected by length of light period i.e. they produce flower in almost all photoperiods. Cucumber, Tomato, and Sunflower, are day-neutral plants.

- Though flowering is the best known example of photoperiodism, many other plant processes are also controlled by duration of light. Bud dormancy, bulb formation in onion, and tuber formation in potato are affected by period of light

ABSCISSION – SHEDDING OFF

- You might have noticed whenever a leaf becomes old it separates from the plant body and falls down.
- Again ripe fruits and older flowers also become separated from plants. This detachment of older plant parts or organs from the main plant body is called **abscission**.
- In plants, a layer of tissue generally forms an abscission zone at the base of the petiole of a leaf or flower or fruit.
- The cells of this layer become soft and weak due to destruction of middle lamella and cell wall. So the organ is easily detached by wind or rain fall.

Factors Affecting Plant Growth

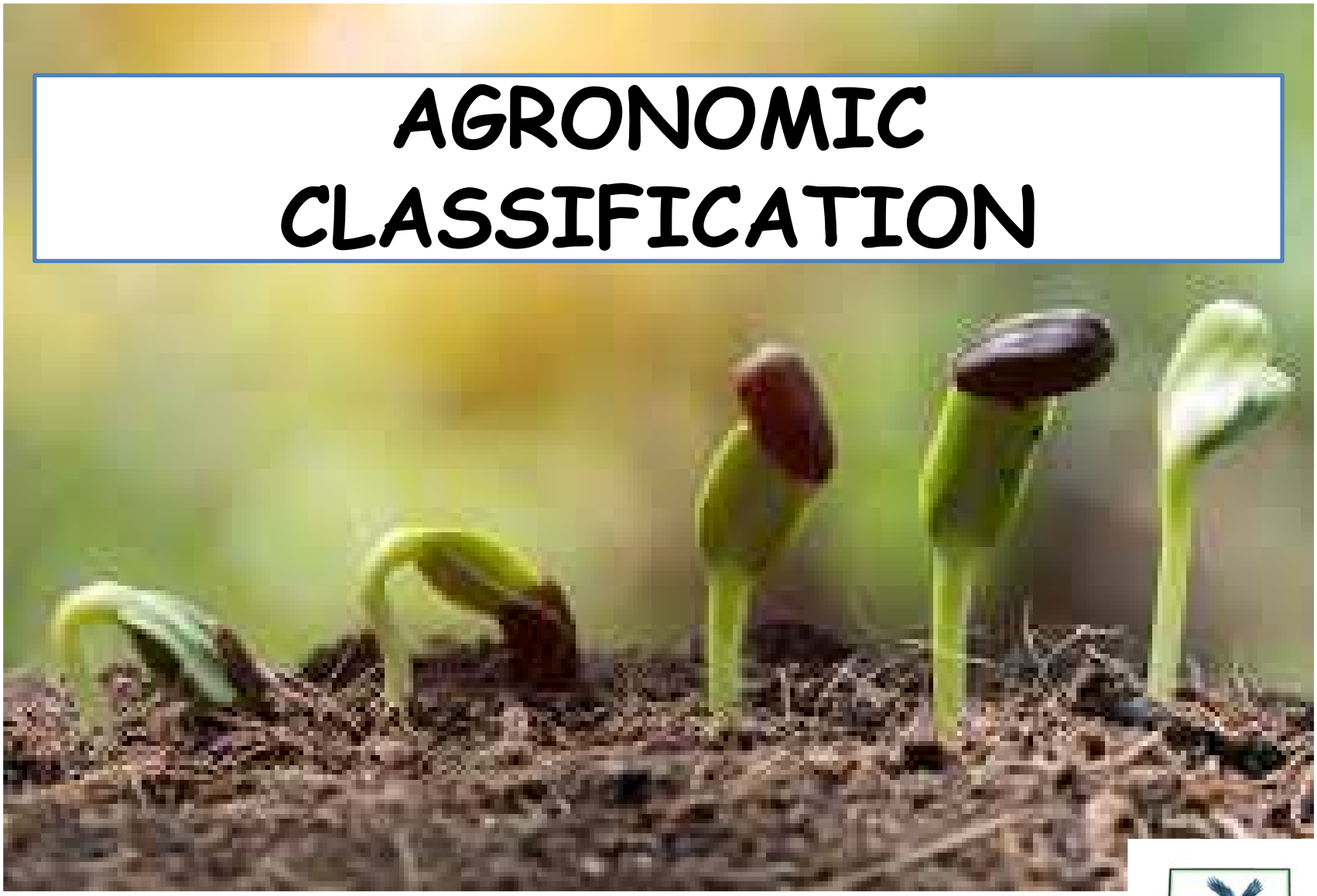
Nastic Movement

- The nastic (nastein : bending) movements are the growth movements resulting due to difference in the rate of growth on opposite sides of an organ e.g., opening of petals, coiling of leaves, etc.
- When upper side of an organ grows faster than the lower side, the movement is called **epinasty**. (e.g., downward curling of leaf, opening of sepals of goldmohur flower. When the lower side grows more rapidly than upper side, it is called as **hyponasty**. (e.g. upward curling of leaf blade)

Turgor Movements

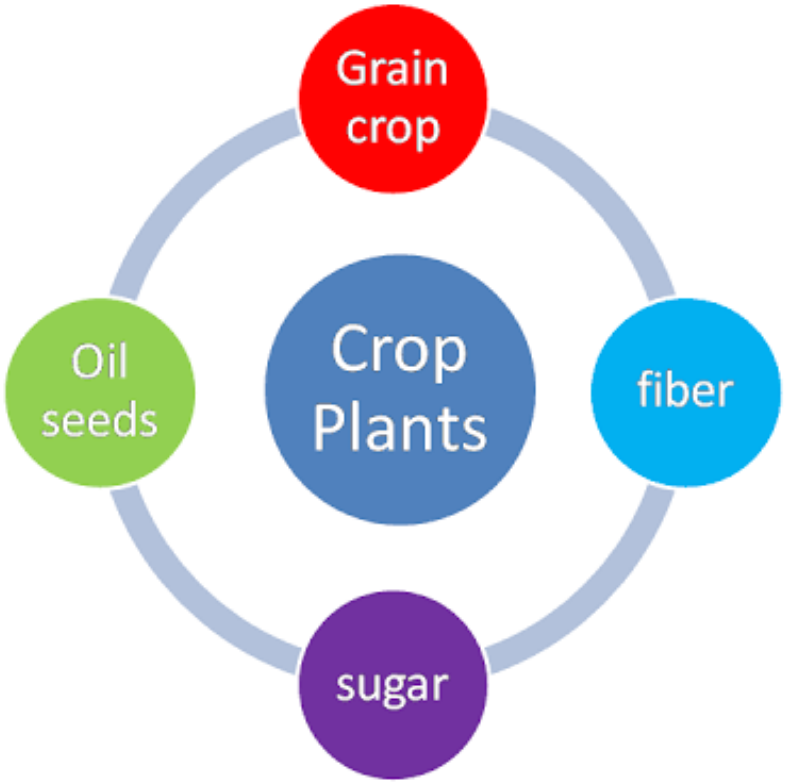
- These movements are due to change in the volume of water inside the cell. When more water is present in the cell it is fully expanded and becomes rigid or hard. Such a condition is called turgidity and the cell is said to be turgid. When less water is present inside the cell, it is not fully expanded and remains soft. This is called flaccid condition.
- The leaves bend in hot summer due to excessive transpiration on account of loss of turgidity of cells of the leaf.
- Some examples of turgor movements are :
  - (i) Leaves or leaflets of some plants close on the fall of darkness (sleep movement). Example - Portulaca, Acacia.
  - (ii) Closing of leaflets and drooping of leaves in response to a strong stimulus of blowing wind or of touch. Example - Sensitive plant (Mimosa pudica)
  - (iii) Closing of leaves of Venus Flytrap to catch a landing insect.
  - (iv) Seed pods of some plants open on maturity, vigorously expelling their seed. Example - Balsam (Gulmehandi).

AGRONOMIC CLASSIFICATION



Introduction

- Plants are classified according to the products from the plant and or their use, rather than any form of character similarity.
- There are Cereal crops, Roots, Tuber, Grain legumes, Vegetables, Sugar crops, Forage, Fruit crops, Oil crops, Nut crops, Rubber, Timber or Tree crops, Fibre crops, Spices and stimulants.
- A broader classification contract the groups as Food crops, Tree crops, Fibre, Forage, Cereals, Medicinal and Timber crops. A particular crop may recur under more than one of these broad groups.
- Crops are generally used as food or raw materials for the industries which provide processed foods of different kinds. In recent times, awareness is gaining ground on the medicinal import of some plants.

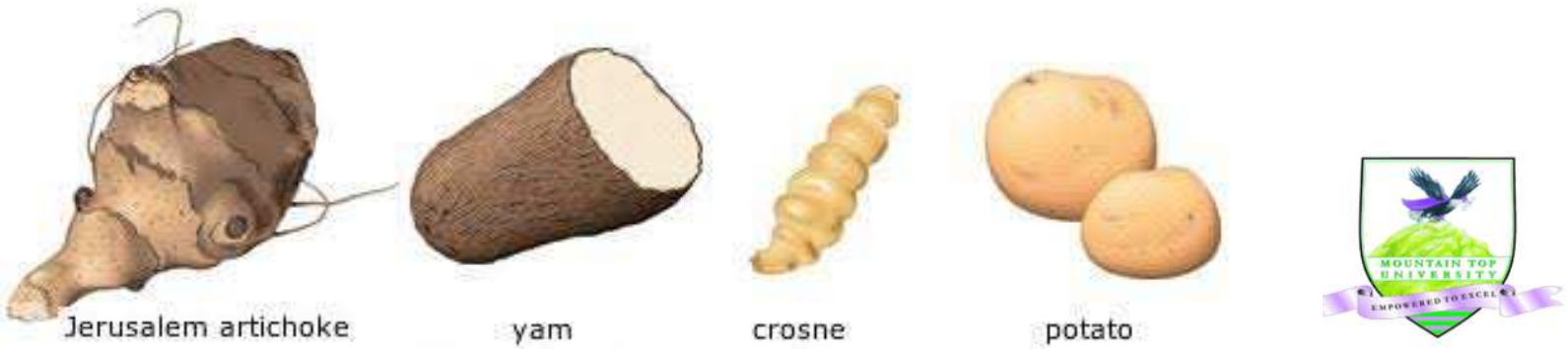


CEREALS

- Cereals are the edible seeds or grains of the grass family.
- Cereals have been part of the human diet since prehistoric times. There are many different types of cereal grains, each having unique properties.
- Most cereals are processed to form other foods or ingredients. Cereals and cereal products are an important source of energy, carbohydrate, protein and fibre. They also contain a range of micronutrients such as vitamin E, some of the B vitamins, sodium, magnesium and zinc.
- Wheat and rice are the most important cereal crops world-wide as they account for over 50% of the world's cereal production.
- Each cereal has unique properties which make it suitable for a variety of food products. Cereals require different conditions to grow. For example, rice is grown in damp tropical climates and oats in cold temperate climates, e.g. Scotland.
- Cereals are also known as 'staple foods' as they often make up the bulk of the diet since they are relatively cheap to produce.

ROOTS AND TUBERS

- Roots are plant materials which edible portions grows under the soil but the stem serve as planting materials, while tubers are thick parts or swollen parts of an underground stem bearing small buds from which new plants can be formed.
- Roots and tubers belong to the class of foods that basically provide energy in the human diet in the form of carbohydrates.
- The principal root and tuber crops of the tropics are cassava (Manihot esculenta Crantz), yam (Dioscorea spp.), sweet potato (Ipomoea batatas L.), potato (Solanum spp.) and edible aroids (Colocasia spp. and Xanthosoma sagittifolium).
- They are widely grown and consumed as subsistence staples in many parts of Africa, Latin America, the Pacific Islands and Asia.



ROOTS AND TUBERS

- The increased use of major roots and tubers – cassava, potato, sweet potato, and yam, for food and livestock feed in developing countries will have wide-ranging effects on global public- and private-sector policies and investments.

- Roots and tubers will continue to play a significant role in developing-country food systems because they:

  - a. contribute to the energy and nutrition requirements of more than 2 billion people;
  - b. are produced and consumed by many of the world's poorest households;
  - c. are an important source of employment and income in rural, and often marginal, areas, especially for women, and
  - d. adapt to a wide range of uses, from food-security crops to cash crops, raw material for industrial uses, and from fresh to high-end processed products.

OIL CROPS

- Vegetable Fats and oil are located in the form of small insoluble droplets within the plants' cells.
- They occur predominantly in seeds' endosperms and cotyledons.
- There are many plants yielding oils that are edible and used for industrial purpose in high percentages. Examples of oil-yielding plants are oil-palm tree, coconut palm tree, groundnut plant, mustard oil, castor oil and gingerly plants.

VEGETABLE CROPS

- These are the groups of economic plants that have attracted least attention even though they are used on daily basis. They are classified into the following:

- **Vegetable fruits plants**: okro, tomato, cucumber etc
- **Leafy plant** e.g: lotus, Amaranths, fluted pumpkin leave

FIBRE CROP

- Fibre may be defined as the unit of matter that has hair like dimension and length may be 200 times greater than the width.
- Fibres botanically consist of very long narrow cells that are many times longer than they are broad. The long cells can be between 1-3 mm and can be up to 55 mm in Rammie. These sheets of tissues occurring either singly or in groups can be overlapping lignified or elastic substances in plants which are potential sources of raw materials to industries.
- There are many schemes for classifying fibres. They can be classified based on structural properties, functions and sources and morphology: Bast or soft fibres eg: fibres from flax, jute and hemp.

BEVERAGES AND STIMULANT CROPS

- These are plant for refreshing and stimulating, they are mild, agreeable and stimulating liquors meant for drinking. The tea, coffee and cocoa plants are few examples of non-alcoholic beverages

MEDICINAL PLANTS

- These are plant used for curing various human ailments.
- In the last two decades there had been more interest to obtain active ingredients from vegetable sources than at any time in the history of mankind and plants.
- The active ingredients of plants drugs are more commonly concentrated in storage organs. Such storage organs are the roots, seeds and fruits, bark and leaves. Flowers are less commonly used for drugs purposes. The roots and woody parts of herbaceous plants are usually relatively inert in nature. E.g: Bellodonia, cinchona