General Biology

Component: Botany
Module Code: BSC 1223
Course Credit: 15 Units

Course Outlines

- The Cell,
- Living Cell -Contents (The protoplast),
- The differentiated part of Protoplast
- The Tissue System
- Morphology and Anatomy of leaves
- Organography of Angiosperms (External Structure)
  Vegetative System: Stem. Root and Leaf
  Flowers and Structural Variations
  Female Reproductive System- Gynoecium
  Male Reproductive System- Androecium
  Fruit and Seeds

Course requirement

The course is compulsory for all year one students of CAVM. Students are expected to attend and participate fully in all the theory and practical classes.

Attendance

Attendance is mandatory and It is necessary for students to attend all lectures and practical classes. Unexcused absences during CAT and Exams will not be welcomed

WEEK ONE

THE CELL

A cell may be defined as a unit of protoplasm bounded by a plasma or cell membrane and possessing a nucleus. Protoplasm is the life giving substance and includes the cytoplasm and the nucleus. The cytoplasm has organelles such as ribosomes, mitochondria, golgi bodies plastids, lysosomes and endoplasmic reticulum. Plant cells have in their cytoplasm large vacuoles containing non-living inclusions like crystals, pigments etc. The bacteria have neither organelles nor a well formed nucleus. But every cell has three major components

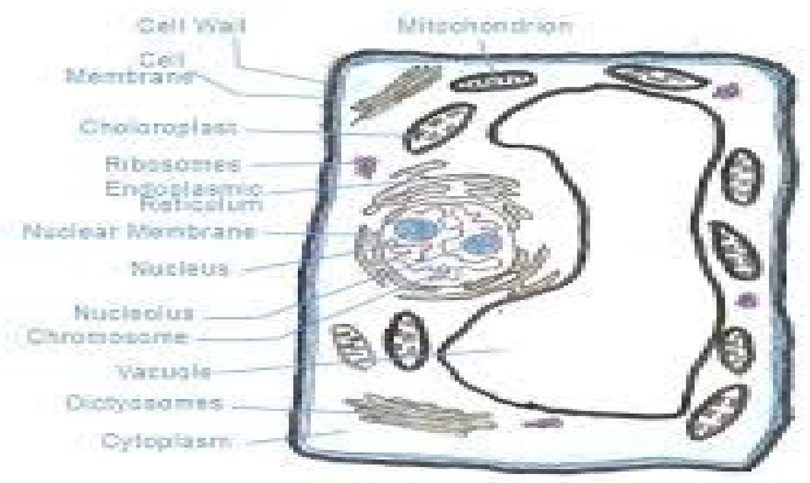
- Plasma membrane
- Cytoplasm
- DNA (naked in bacteria and covered by a membrane in all other organisms

Two basic types of cells Cytologists recognize two basic types of cells which are the:
- Eukaryotic cells
- Prokaryotic cell

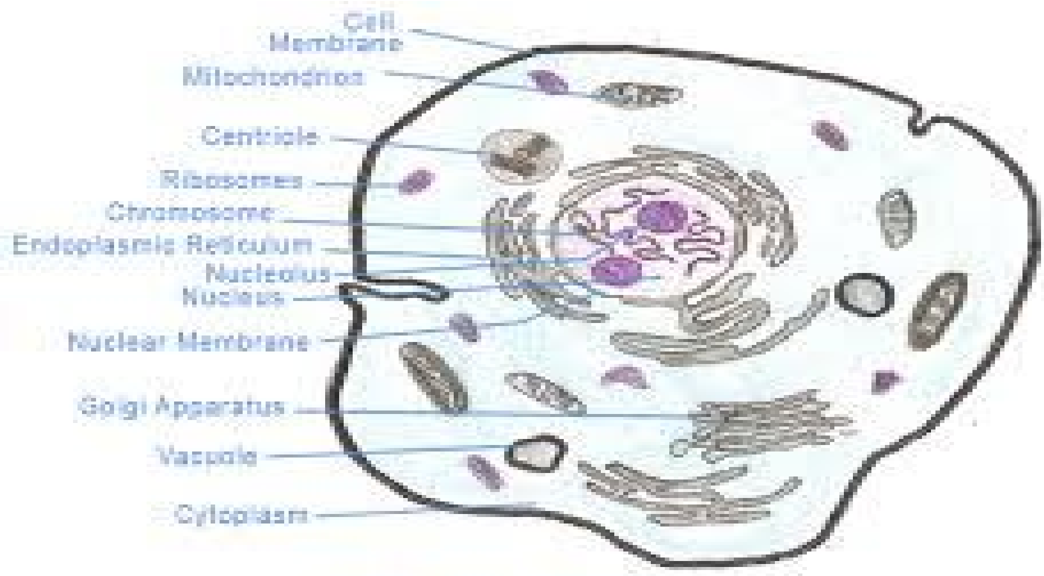
Organisms which do not possess a well formed nucleus are **prokaryotes** such as the bacteria. All others possess a well defined nucleus, covered by a nuclear membrane. They are eukaryotes.

Differences between Eukaryotic and Prokaryotic cells

Eukaryotic cell	**Prokaryotic cell**
1. Plants, animals, fungi, protist, algae	1. Bacteria, Archaea
2. Nucleus distinct, with well formed nuclear membrane.	2. Nucleus is not distinct, it is in the form of the nuclear membrane of the nuclear zone 'nucleoid'. Nuclear membrane absent.
3. Cell membrane and membrane-bound organelles	3. Cell membrane
4. highly structured by endomembranes and a cytoskeleton	4. Very few cytoplasmic structures
5. Double-membraned cell organelles (Chloroplasts, mitochondria nucleus) and single membraned (Golgi apparatus, lysosomes vacuole endoplasmic reticulum) are present.	5. Single-membraned cell bodies like mesosomes present. Endoplasmic reticulum and Golgi body absent.
6. Distinct compartments in the cell i.e. the cytoplasm and the nucleus	6. No compartments



A well-labelled diagram of Plant Cell



A well-labelled diagram of Animal Cell

COMPONENTS OF THE CELL

The major components of the cell are (1) cell membrane, (2) cytoplasm, and (3) nucleus.

1. ***Cell membrane (Plasma membrane)***

Each cell has a limiting boundary, the cell membrane, plasma membrane or plasmalemma. It is a living membrane, outermost in animal cells but next to cell wall in plant cells.

It is flexible and can fold in (as in food vacuoles of Amoeba) or fold out (as in the formation of pseudopodia of Amoeba)

The plasma membrane is made of proteins and lipids and several models were proposed regarding the arrangement of proteins and lipids. The **fluid mosaic model** proposed by Singer and Nicholson (1972) is widely accepted.

Functions

(i) The plasma membrane encloses the cell contents.

(ii) It provides cell shape (in animal cells) e.g. the characteristic shape of red blood cells, nerve cells, bone cells, etc

(iii) It allows transport of certain substances into and out of the cell but not all substance, so it is termed selectively permeable.

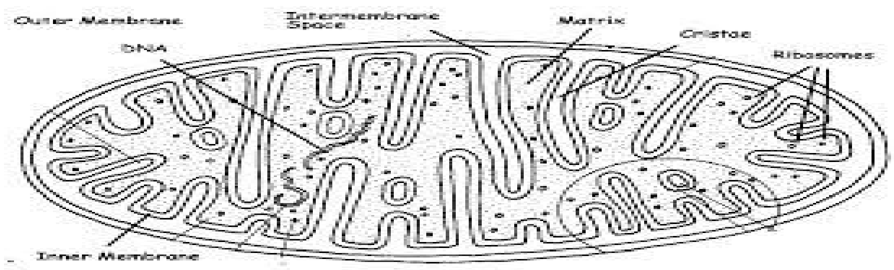
Transport of small molecules (such as glucose, amino acids, water, mineral ions etc). Small molecules can be transported across the plasma membrane by any one of the following three methods:

(i) **Diffusion**: molecules of substances move from their region of higher concentration to their region of lower concentration. This does not require energy. Example : absorption of glucose in a cell.
(ii) **Osmosis**: movement of water molecules from the region of their higher concentration to the region of their lower concentration through a semipermeable membrane. There is no expenditure of energy in osmosis. This kind of movement is along concentration gradient.
(iii) **Active Transport**: When the direction of movement of a certain molecules is opposite that of diffusion i.e. from the region of their lower concentration towards the region of their higher concentration, it would require an "active effort" by the cell for which energy is needed. This energy is provided by ATP (adenosine triphosphate). The active transport may also be through a carrier molecule.

2. The Cytoplasm

The cytoplasm contains many cell organelles, which include:

a. **Mitochondria and chloroplast - the energy transformers**
   Mitochondria (found in plant and animal cells) are the energy releasers and the chloroplasts (found only in green plant cells) are the energy trappers.



Structure of a Mitochondrion

Function: Oxidises pyruvic acid (breakdown product of glucose) to release energy which gets stored in the form of ATP for ready use. This process is also called cellular respiration.

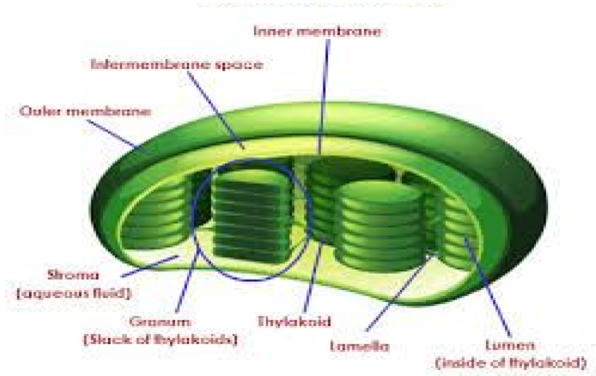
b. Plastids

Plastids are found only in a plant cell. They may be colourless or with colour. Based on this fact, there are three types of plastids. (i) Leucoplast-white or colourless (ii) Chromoplast – blue, red, yellow etc. (iii) Chloroplast – green

c. Chloroplast

- Found in all green plant cells in the cytoplasm.

- Number 1 to 1008
- Shape: Usually disc-shaped or spherical as in most plants around you. In some ribbon-shaped as in an alga spirogyra or cup-shaped as in another alga Chlamydomonas.



Structure of a chloroplast

3. The Nucleus (The Hereditary Organelle)

Its functions include maintaining the cell in a working order, coordination of the activities of organelles, reparation of the cells and the organelles, participation in cell division to produce genetically identical daughter cells called mitosis and production of gametes through another type of cell division called meiosis.

The part of a nucleus are given as:
- Nuclear membrane
- Chromatin
- Nucleolus

VEGETATIVE SYSTEM OF ANGIOSPERM

Plants like animals have organs composed of different tissues which in turn are composed of cells of different types. A tissue is a group of cells with a common function, structure or both. An organ consists of several types of tissues that together carry out particular functions.

- **The Plant Organs**

There are three basic plant organs, they are;
1. Roots
2. Stems
3. Leaves

These organs form root and shoot systems. The shoot system consists of the stem and the leaves while the root system consists of the root.

1. **Roots**

A root is a multicellular organ that anchors a vascular plant in the soil which absorbs minerals, water and often stores carbohydrates. Most eudicot and gymnosperms have a tap root that develop from an embryonic root. The tap root gives rise to lateral roots which are also called **branch roots**. In many angiosperms, the tap root stores sugars and starches that the plant will consume during flowering and fruit production. For this reason, root crops such as carrots, turnips and beets are harvested before they flower. Tap root systems generally penetrate deeply and are therefore well adapted to deep soils where the groundwater is not close to the surface.

In seedless vascular plants and in most monocots, such as grasses, the embryonic root dies and does not give rise to a main root. Instead, many roots grow from the stem. Such roots are said to be **adventitious** (a term describing a plant organ that grows in an unusual location, such as roots arising from stems or leaves). Each small root forms its own lateral root which results in a fibrous root system (a mat of generally thin roots spreading out below the soil surface with no root functioning as the main one). Fibrous root systems usually do not penetrate deeply and are therefore best adapted to shallow soils or regions where rainfall is light and does not moisten the soil much below the surface layer.

The entire root system helps anchor a plant, in most plants the absorption of water and minerals occurs primarily near the tips of roots where vast numbers of tiny root hairs increase the surface area of the root enormously. Root hair are short-lived and constantly replaced. A root hair is a thin, tubular extension of a root epidermal cell. Despite their great surface area, root hairs unlike lateral roots, contribute little to plant anchorage, their main function is absorption.

2. Stems

A stem is an organ consisting of an alternating system of nodes (the points at which leaves are attached) and internodes (the segment between the nodes). In the upper angle (axis) formed by each leaf and the stem is an axillary bud, a structure that can form a lateral shoot, commonly called a branch. Most axillary buds of a young shoot are dormant i.e not growing. Thus elongation of a young shoot is usually concentrated near the shoot tip, which consists of an apical bud or terminal bud with developing leaves and a compact series of nodes and internodes.

The proximity of the axillary buds to the apical bud is partly responsible for their dormancy. The inhibition of axillary buds by an apical bud is called Apical dominance. A growing axillary bud gives rise to a lateral shoot, complete with its own apical bud, leaves and axillary buds resulting in more lateral shoots.

Some plants have stems with additional functions such as food storage and asexual reproduction. These modified stems which include rhizomes, bulbs, stolons and tubers are often mistaken for roots.

3. Leaves

In most vascular plants, the leaf is the main photosynthetic organ, although green stems also perform photosynthesis. Leaves vary extensively in form but generally consist of a flattened blade, a stalk and the petiole (joins the leaf to the stem at a node). Grasses and many other monocots lack petiole but instead, the base of the leaf forms a sheath that envelops the stem.

Monocots and eudicots differ in the arrangement of veins, which are the vascular tissue of leaves. Most monocots have parallel major veins that run the length of the blade. Eudicots generally have a branched network of major veins.

In identifying angiosperms according to structure, taxonomists rely mainly on floral morphology, but they also use variation in leaf morphology; such as leaf shape, the branching pattern of veins, and the spatial arrangement of leaves.

Many of the very large leaves are compound or doubly compound. This structure adaptation may enable large leaves to withstand strong wind with less tearing. It may also confine some pathogens (disease causing organisms and viruses) that invade the leaf to a single leaflet rather than allowing them to spread to the entire leaf. Almost all the leaves are specialized for photosynthesis. However, some species have leaves with adaptations that enable them to perform additional functions such as support, protection, storage and reproduction.

PLANT TISSUE SYSTEM

Each plant organ, that is, root, stem or leaf has dermal, vascular and ground tissues. Each of these three categories forms a tissue system (a functional unit connecting all of the plant organs). Each tissue system is continuous throughout the plant, specific characterisation of the tissue and their spatial relationships to one another vary in different organs.

1. The Dermal Tissue System

The dermal tissue system is the plant’s outer protective covering. It forms the first line of defense against physical damage and pathogens. In non woody plants, it is usually a single tissue called the **Epidermis** (a layer of tightly packed cells). In leaves and stems, the cuticle (a waxy coating on the epidermal surface) helps to prevent water loss. In woody plants, protective tissue called **Periderm** replaces the epidermis in older regions of stems and roots. In addition to protecting the plant from water loss and disease, the epidermis has specialized characteristics in each organ. For example, a root hair is an extension of an epidermal cell near the tip of a root. Trichomes (hairlike outgrowths of the shoot epidermis) reduce water loss and reflect excess light. They can also provide a defense against insects by forming a barrier or by secreting sticky fluids and toxic compounds. For instance, the trichomes on aromatic leaves such as mints, secrete oils that protect the plants from herbivores and diseases.

2. The Vascular Tissue System

The vascular tissues of a root or stem is collectively called the **Stele** (the greek word for **'Pillar'**). The arrangement of stele varies depending on the species and organ. In angiosperms, for example, the root stele is a solid central vascular cylinder of xylem and phloem, whereas the stele of stems and leaves consists of vascular bundles, separate strands containing xylem and phloem. Both xylem and phloem are composed of a variety of cell types, including cells that are highly specialized for transport or support.

3. The Ground Tissue System

Tissues that are neither dermal or vascular are part of the ground tissue system. Ground tissue that is internal to the vascular tissue is known as **Pith**, and ground tissue that is external to the vascular tissue is known as **Cortex**. It includes various cells specialized for functions such as storage, photosynthesis and support.

- **Plant Cells**

There are 5 major types of plant cells;

1. Parenchyma cell
2. Collenchyma cell
3. Sclerenchyma cell
4. Water- conducting cells of the Xylem
5. Sugar- conducting cells of the phloem

Parenchyma Cells

The parenchyma cells perform most of the metabolic functions of the plant, synthesizing and storing various organic products. For example, photosynthesis occurs within the chloroplasts of parenchyma cells in the leaf. Some are found in stems and roots, and have colorless plastids that store starch. Most of them retain the ability to divide and differentiate into other types of plant cells under particular conditions e.g wound repair.

Collenchyma Cells

The collenchyma cells help to support young parts of the plant shoot. They have thicker primary walls when compared to parenchyma cells, though the walls are unevenly thickened. Young stems and petioles often have strands of collenchyma cells just below their epidermis. They lack secondary walls and the hardening agent lignin is absent from their primary walls.

Sclerenchyma cells

There are two types of sclerenchyma cells known as sclereids and fibres. These are specialized entirely for support and strengthening. Sclereids impart the hardness to nutshells and seed coat and the gritty texture to pear fruits. Fibres are usually arranged in threads, which are long , slender and tapered. Some are used commercially, such as hemp fibres for making rope and flax fibres for weaving into linen.

Water-conducting cells of the xylem

There are two types of water-conducting cells which are the tracheids and vessels elements. These are tubular, elongated cells that are dead at functional maturity. Tracheids are found in the xylem of nearly all vascular plants. They are long, thin cells with tapered ends while the vessel elements are generally wider, shorter, thinner-walled and less tapered than tracheid.

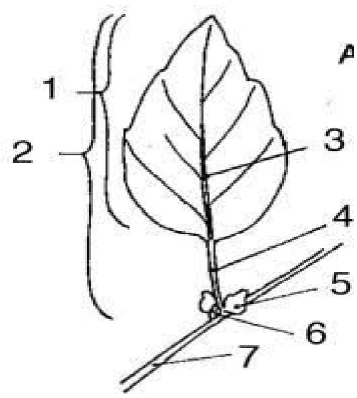
Sugar-conducting cells of the phloem

Unlike the water-conducting cells of the xylem, the sugar-conducting cells of the phloem are alive at functional maturity. In seedless vascular plants and gymnosperm, sugar and other organic nutrients are transported through long, narrow cells called sieve cells, In the phloem of angiosperm these nutrients are transported through sieve tube, which consist of chains of cell called sieve-tube elements or sieve-tube members.

MORPHOLOGY AND ANATOMY OF LEAVES

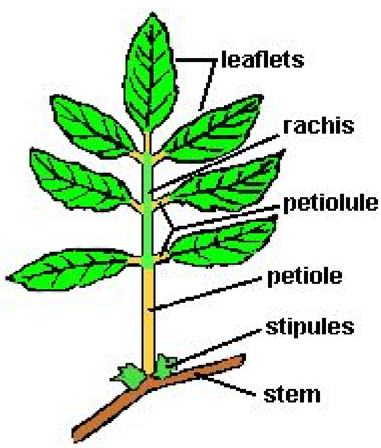
Morphology of Leaves

To successfully identify plants, it is necessary to have a keen awareness of taxonomic terminology and concise mental picture of leaf, bud. Stem, flower and fruit morphology.



1= Leaf Blade 2= Leaf 3= Midrib 4= Petiole 5= Stipule 6=Bud 7= Stem

Simple Leaf



Compound Leaf

The position of the bud determines whether the leaf is simple or compound. In the case of the single leaf the bud is found in the axil of the leaf and stem. If the bud is located in the axil of a structure containing more than one leaf it is termed compound.

Types of compound leaves include:

1. Palmately compound e.g *Berberis thunbergii* (Barberry),
2. Old pinnate (Imparipinnate)e.g *Murraya*
3. Even pinnate (Paripinnate) e.g *Tamarindus indica*

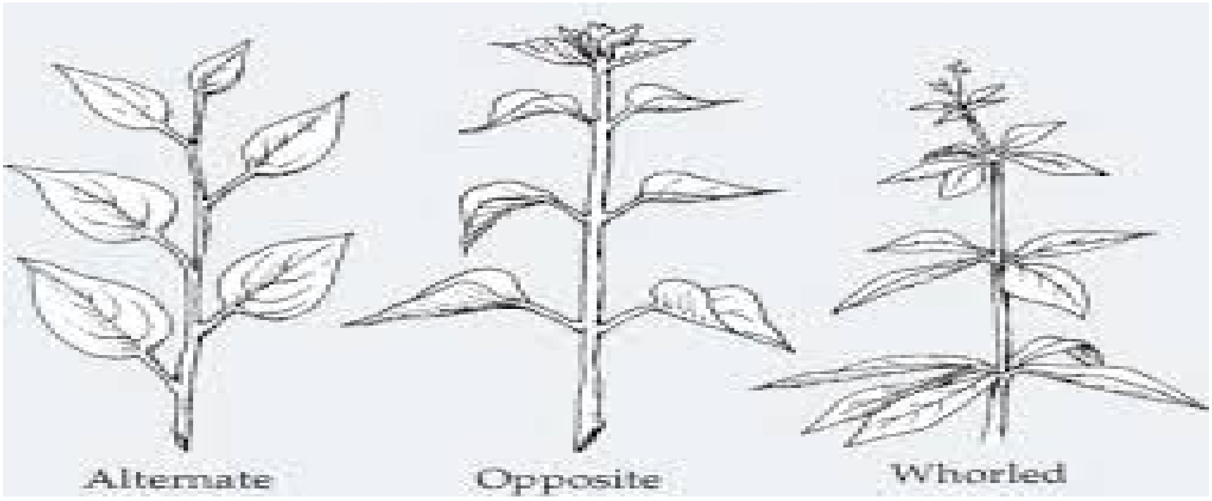
Others Examples of compound leaves include:

Palmately compound leaf

Odd Pinnately compound leaf

Even Pinnately compound leaf

Arrangement of Leaves

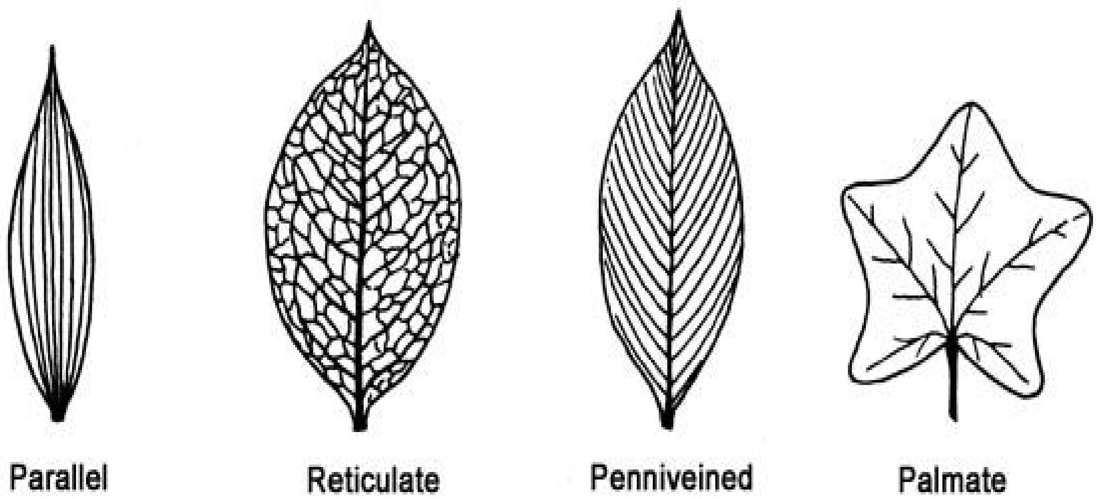


Alternate – Leaves or stems borne singly at each node (1 per node) e.g *Liquidambar styraciflua (Sweetgum), Berberis thunbergii* (Barberry).

Opposite – Leaves or stems borne across from one another at a node (2 per node) e.g *Olea* spp. (Olive tree), *Acer* spp. (Maple tree)

Whorled – Three or more leaves or stems arising at a node (3+ per node) e.g *Alstonia scholaris* (Blackboard tree), *Pittosporum eugenioides* (Lemonwood)

Types of Leaf Venation



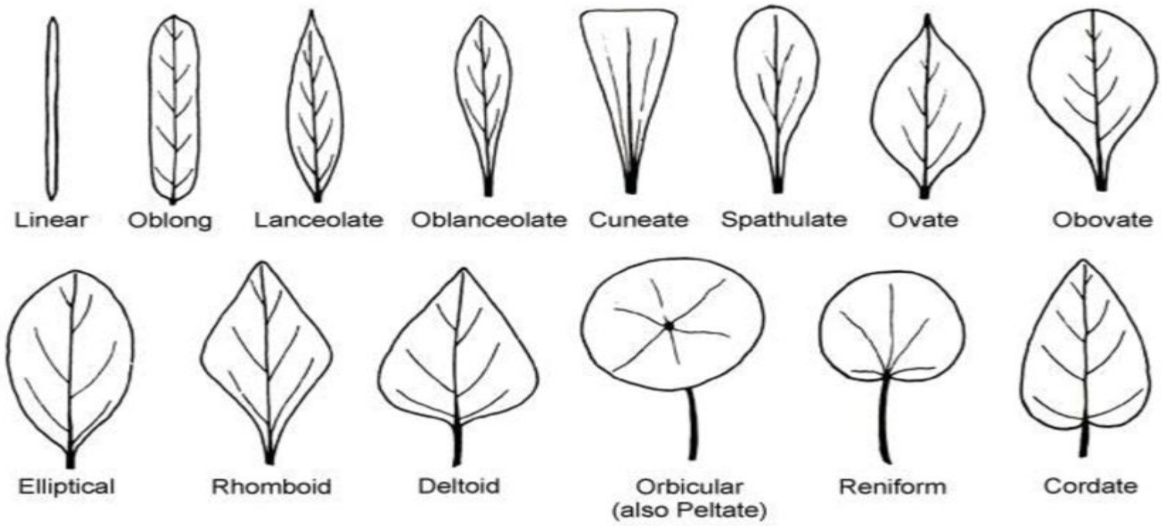
Reticulate Venation:
When the veins are irregularly distributed to form a channel, it is known as Reticulate Venation. It is a common feature in dicots. There are two types
1. Pinnate Reticulate e.g *Hibiscus*, *Magnifera indica*
2. Palmate Reticulate e.g *Papaya, Cucurbita*

Parallel Venation:
Veins are parallel and do not form a network. There are of two types
1. Pinnate Parallel e.g *Musa sapientum* (Banana)
2. Palmate Parallel e.g *Bambusa vulgaris* (Bamboo)

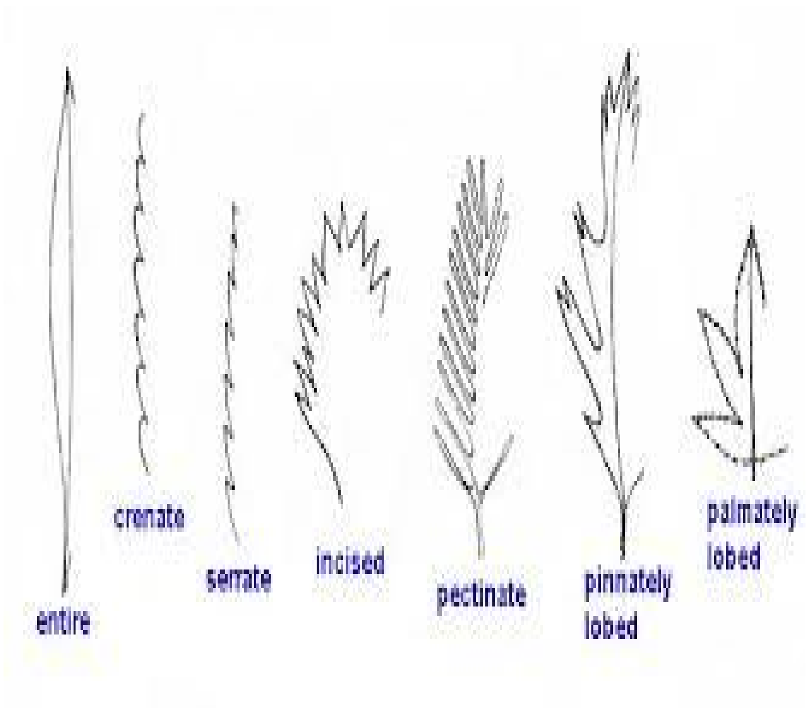
Penniveined Venation; the leaf has usually one main vein (called the **mid-vein**), with **veinlets**, smaller veins branching off laterally, usually somewhat parallel to each other; e.g. *Malus* (apples).

Palmate Venation: The veins radiate in a fan shape from the leaf petiole. Examples **include** *Acer* spp. (maple) and *Liquidambar styraciflua* (sweetgum leaves).

Leaf Shapes


Linear
Oblong
Lanceolate
Oblanceolate
Cuneate
Spathulate
Ovate
Obovate
Elliptical
Rhomboid
Deltoid
Orbicular
(also Peltate)
Reniform
Cordate

Leaf Margin



Anatomy of Leaves

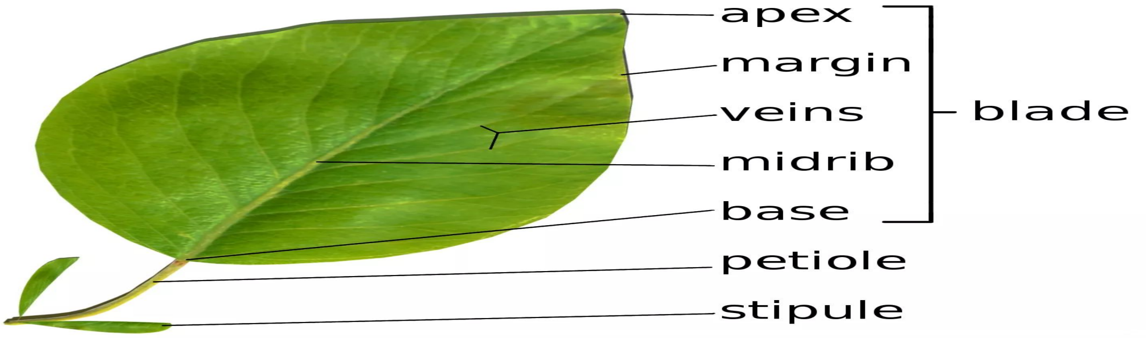
Leaves can be found in a variety of shapes and sizes. Most leaves are broad, flat and typically green in color. Some plants, such as conifers, have leaves that are shaped like needles or scales. Leaf shape is adapted to best suit the plant's habitat and maximize photosynthesis.

Basic leaf features in angiosperms (flowering plants) include the leaf blade, petiole, and stipules.

Blade - broad portion of a leaf
Apex - leaf tip.

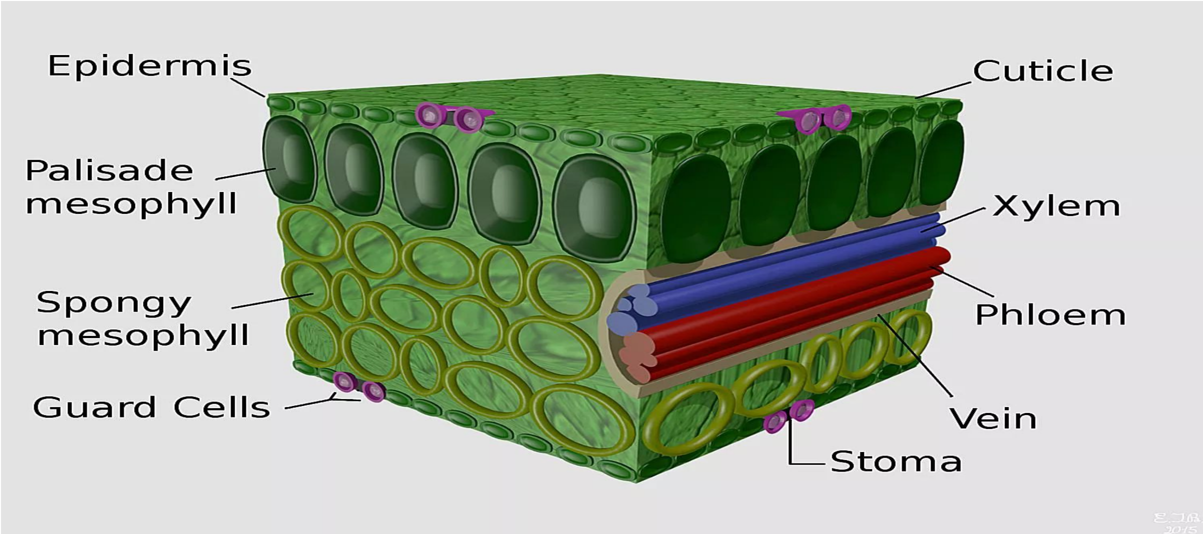
Margin - leaf edge boundary area. Margins can be smooth, jagged (toothed), lobed, or parted.
Veins - vascular tissue bundles that support the leaf and transport nutrients.
Midrib - central main vein arising from secondary veins.
Base - area of the leaf that connects the blade to the petiole.

Petiole - thin stalk that attaches the leaf to a stem.
Stipules - leaf-like structures at the leaf base.
Leaf shape, margin, and venation (vein formation) are the main features used in plant identification.



Source: https://www.thoughtco.com/plant-leaves-and-leaf-anatomy-373618

Anatomically, leaves consist of epidermis with stomata, mesophyll (kind of parenchyma) and vascular bundles, or veins. The mesophyll, in turn, has palisade and spongy variants. Palisade mesophyll is located in the upper layer and serves to decrease the intensity of sunlight for the spongy mesophyll, and also catches slanted sun rays. The palisade mesophyll consists of long, thin, tightly arranged cells with chloroplasts mostly along the sides. The spongy mesophyll cells are roughly packed, they are rounded and have multiple chloroplasts



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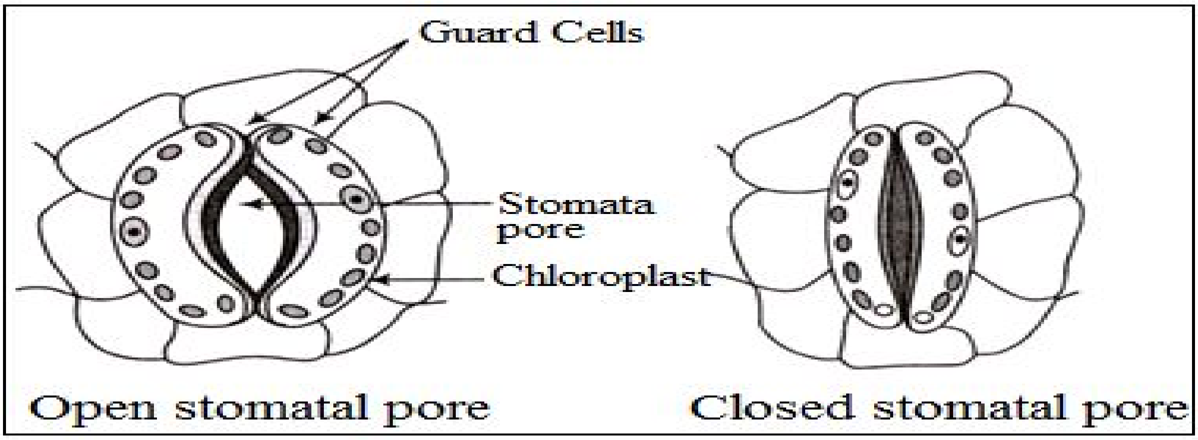
The epidermis includes typical epidermal cells, stomata surrounded with guard cells (also optionally with subsidiary cells), and trichomes. Almost all epidermal cells are covered with waterproof cuticle, rich of lignin and waxes.

The stomata assists in gas exchange, cooling and water transpiration. There are two guard cells paired together on each side of the stoma. These guard cells are kidney beans shaped and have a thicker cell wall in the middle.



The opening of the stoma starts from K+ accumulation, then osmosis inflates guard cells, and finally the uneven cell wall facilitates the opening of the stoma. The stoma closes when the potassium ions exit the cell and water amount decreases in its vacuoles.

In most cases, the lower epidermis contains more stomata than the upper epidermis because the bottom of the leaf is cooler and transpiration there is safer. A similar logic is applicable to trichomes (hairs): they are also more frequent on the lower side of the leaf.

FLOWER

Sporophyte and Gametophyte Generations Alternate in the life Cycles of Plants

The life cycles of angiosperms and other plants are characterized by an alternation of generations, in which haploid (n) and diploid (2n) generations take turns producing each other. The diploid plant, the sporophyte, produces haploid spores by meiosis. These spores divide by mitosis, giving rise to multicellular male and female haploid plants—the gametophytes. The gametophytes produce gametes—sperm and eggs. **Fertilization** results in diploid zygotes, which divide by mitosis to form new sporophytes.

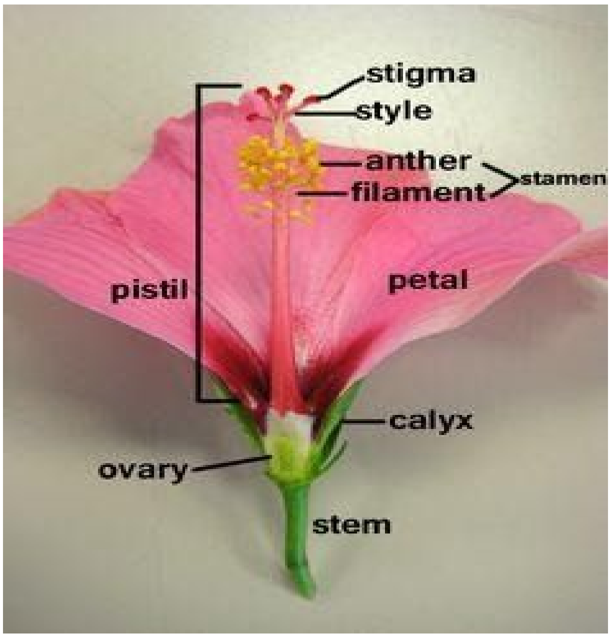
In angiosperms, the sporophyte is the dominant generation, the conspicuous plant we see. Over the course of seed plant evolution, gametophytes became reduced in size and dependent on their sporophyte parents. Angiosperm gametophytes are the most reduced of all plants, consisting of only a few cells. In angiosperms, the sporophyte produces a unique reproductive structure, the flower. Male and female gametophytes develop within the anthers and ovules, respectively, of a sporophyte flower. Pollination by wind, water, or animals brings a male gametophyte (pollen grain) to a female gametophyte contained in an ovule embedded in the ovary of a flower. Union of gametes (fertilization) takes place within the ovary. Ovules develop into seeds, while the ovary itself develops into the fruit around the seed.

Flower Structure and Function

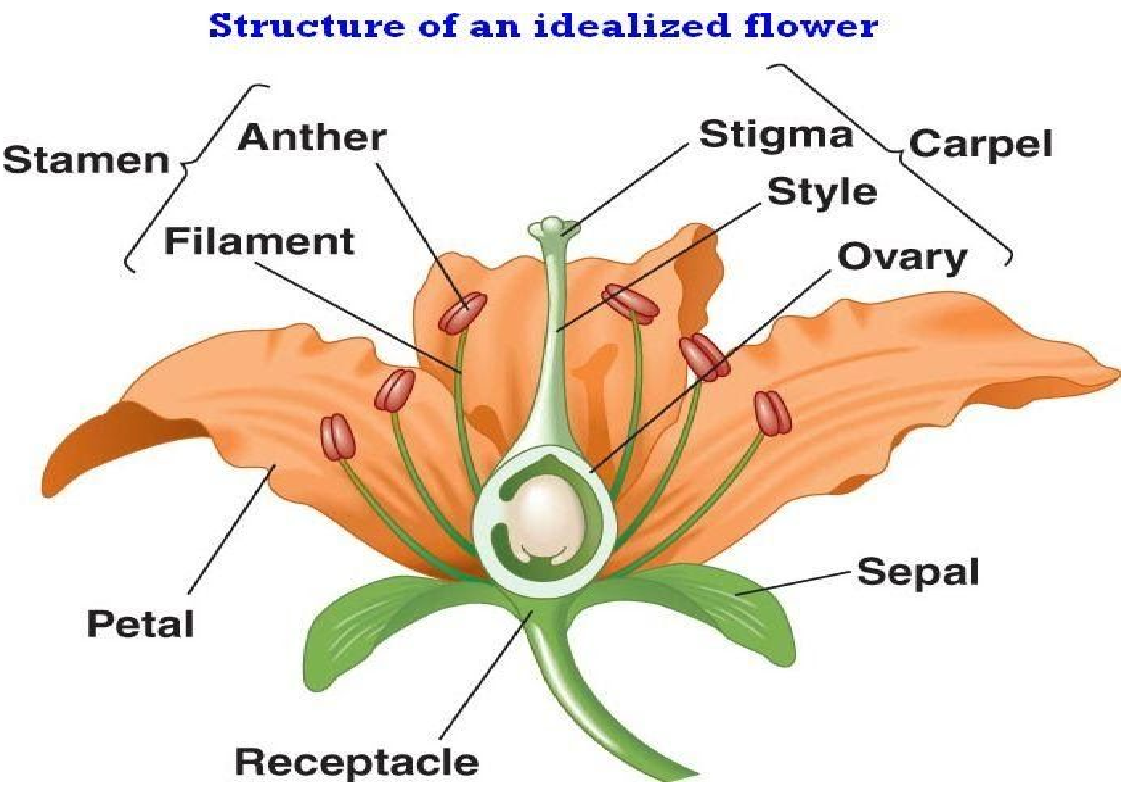
Flowers, the reproductive shoots of the angiosperm sporophyte, are typically composed of four whorls of highly modified leaves called floral organs, which are separated by very short internodes. Unlike the indeterminate growth of vegetative shoots, flowers are determinate shoots in that they cease growing once the flower and fruit are formed. The four kinds of floral organs are the sepals, petals, stamens, and carpels. Their site of attachment to the stem is the **receptacle**. Sepals and petals are sterile. Sepals, which enclose and protect the floral bud before it opens, are usually green and more leaflike in appearance than the other floral organs. In many angiosperms, the petals are brightly colored and advertise the flower to insects and other pollinators. Stamens and carpels are the male and female reproductive organs, respectively.

A stamen consists of a stalk (the filament) and a terminal anther containing chambers called pollen sacs that produce pollen. A carpel has an ovary at the base and a slender neck, the style. At the top of the style is a sticky structure called the **stigma** that serves as a landing platform for pollen. Within the ovary are one or more ovules, the number of ovules depends on the species. Some flowers have a single carpel, while in others, several carpels are fused into a single structure, producing an ovary with two or more chambers, each containing one or more ovules. The anthers and the ovules bear sporangia, where spores are produced by meiosis and where gametophytes later develop. The male gametophytes are sperm-producing structures called pollen grains, which form within the pollen sacs of anthers. The female gametophytes are egg-producing structures called embryo sacs, which form within the ovules in ovaries.

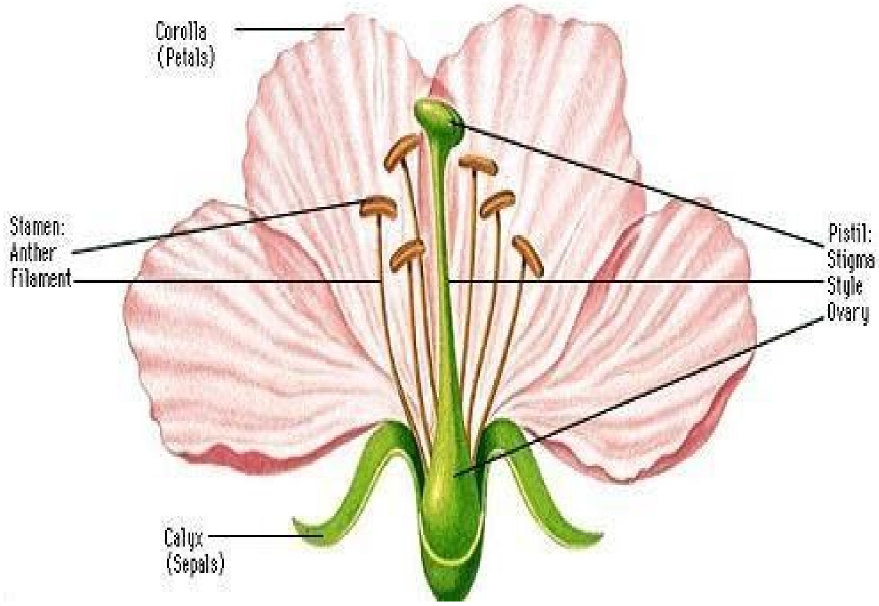
Numerous floral variations have evolved during the 130 million years of angiosperm history. Plant biologists distinguish between complete flowers, those having all four organs, and incomplete flowers, those lacking one or more of the four floral parts. A bisexual flower is equipped with both stamens and carpels. All complete and many incomplete flowers are bisexual. A unisexual flower is missing either stamens (therefore, a carpellate flower) or carpels (therefore, a staminate flower). A monoecious plant has staminate and carpellate flowers at separate locations on the same individual plant. For example, maize and other corn varieties have ears derived from clusters of carpellate flowers, while the tassels consist of staminate flowers.A dioecious species has staminate flowers and carpellate flowers on separate plants. For example, date palms have carpellate individuals that produce dates and staminate individuals that produce pollen. In addition to these differences based on the presence of floral organs, flowers vary in size, shape, and color. Much of this diversity represents adaptations of flowers to different animal pollinators. The presence of animals in the environment has been a key factor in angiosperm evolution.



Hibiscus flower L/S of Hibiscus flower showing parts of a flower



L/S of Complete Flower



L/S of An Incomplete Flower

Pollination

Pollination is the transfer of pollen from an anther to a stigma. It begins the process by which the male and female gametophytes are brought together so their gametes can unite. Pollination occurs when pollen released from anthers is carried by wind, water, or animals to land on a stigma. Each pollen grain produces a pollen tube, which grows down into the ovary via the style and discharges sperm into the embryo sac, fertilizing the egg. The zygote gives rise to an embryo and ovule develops into a seed, and the entire ovary develops into a fruit containing one or more seeds. Fruits carried by wind, water, or animals disperse seeds away from the source plant where the seed germinates. If pollination is successful, a pollen grain produces a pollen tube, which grows down the ovary through the style.

THE SEED

Seeds are mature, fertilized ovules. Ovules are structures of seed plants containing the female gametophyte with the egg cell, all being surrounded by the nucleus and 1-2 integuments. Seeds are the dispersal and propagation units of the spermatophyta (gymnosperms and angiosperms). The formation of the seed completes the process of reproduction in seed plants (started with the development of flowers and pollination), with the embryo developed from the zygote and the seed coat from the integuments of the ovule.

A typical seed includes two basic parts:

i. The Testa (Seed coat): The seed coat develops from the material tissue, the integuments surrounding the ovule. The seed coat in the mature seed can be a paper-thin layer (e.g. peanut) or something more substantial (e.g. thick and hard in coconut), or fleshy. The seed coat helps protect the embryo from mechanical injury, predators and drying out. Usually parts of the testa form a hard protective mechanical layer which may prevent water penetration and germination.
ii. The Embryo: is an immature plant inside a seed from which a new plant develops under proper conditions. The embryo in seeds has structures called cotyledons (seed leaf). A cotyledon is the central portion of a seed embryo to which the plumule (embryo shoots) and the radicle (embryo root) are attached.
Plants are classified according to the number of cotyledons present in the embryo. If the embryo has one cotyledon, it is referred to as a monocotyledonous plant (monocots) and if there are two cotyledons, it is termed a dicotyledonous plant (dicots).

Seeds can be subdivided into two based on the type and location of the storage materials (endosperm). The endosperm forms a supply of nutrients for the embryo.

i. Endospermic seeds: the seeds that have the endosperm present in the mature seed. It is fleshy, oily, surrounds the embryo and functions as the sole food storage organ. The amount of endosperm in mature seeds is highly species-dependent and varies from an abundant endosperm layer to a single layer. Monocot plants have endospermic seeds.
ii. Non-endospermic seeds: these are seeds that do not have an endosperm in the mature seed. The cotyledons are thick, fleshy and serve as sole food storage organs. The endosperm is almost degraded in the mature seed and the embryo is enclosed by the testa. Examples are seeds of Dicot plants.

Seed Germination

Seed germination is a process by which a seed embryo develops into a seedling. It involves the breaking apart of the seed after which the embryo inside begins to grow with the help of water and nutrients from the soil. Seed germination is the reactivation of the metabolic pathways that lead to growth and the emergence of the radicle (root) and plumule (shoot). For germination to occur, the seed must be viable i.e. the embryo must be alive and also there must be a proper environmental condition. During germination, the seeds absorb water either through the micropyle (pore-like opening) if present or through the testa (outer seed coat) when permeable.

FRUITS

Fruits are fertilized and matured ovaries after pollination. The fruits develop from fertilized ovaries and the ovules in the ovaries become the seeds. In some plants, fruits are formed without fertilization, such fruits are known as parthenocarpic fruits and are usually seedless e.g. banana, pineapple, etc. The fruit has two scars, one is the point of attachment to the receptacle and the other is the remains of style.

Fig. 1.15. A mango fruit

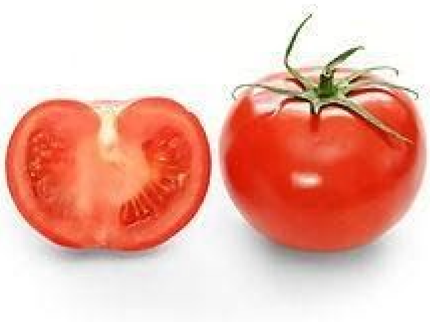
Parts of Fruits

Pericarp: The fruit wall is known as the pericarp. It is made up of three layers, an outerlayer called epicarp, a middle layer called mesocarp and an inner layer called endocarp. The pericarp encloses the seeds.

Types of Fruits

(1) Fruits are described based on the floral parts that formed the fruit.

- **True fruits:** Fruits formed solely from the ovary are known as true fruits e.g. tomato (*Solanum lycopersicum*), cowpea (*Vigna unguiculata*) e.t.c.



A whole tomato fruit

- **False fruits:** Fruits formed from the ovary and other floral parts such as calyx, corolla and receptacle are known as false fruits e.g. cashew (*Anarcadium occidentales*) and apple.

An Apple fruit.

Classification of True fruits

(a) Fruits are also classified on the basis of the number of flowers involved in the fruits formation.
(1) **Simple fruits:** They are formed from a single flower with a monocarpous or syncarpous pistils e.g. cowpea.
(2) **Aggregate fruits:** They are formed from a single flower with an apocarpous pistil with each carpel forming a fruitlet e.g. strawberry, raspberry e.t.c.

(3) **Compound/multiple fruits**: They are formed from whole inflorescence or from many flowers that are positioned very close to one another forming fruitless that fuse together to form a single large fruit e.g. pineapple, fig, etc.

(b) Simple fruits are broadly divided into two classes on the basis of the nature of the pericarp namely;

(i) Fleshy/succulent: Fleshy/succulent fruits have fleshy fruit walls. Fleshy fruits are usually juicy, they store water and carbohydrate in their tissues and they are indehiscent i.e. they do not split open to release their seeds e.g. tomato, mango e.t.c.

(ii) Dry fruits: while dry fruits have hard, dry, fibrous or woody fruit walls. Dry fruits may be dehiscent or indehiscent.