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class 11

Biology

SHORT NOTES 2025-2026

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Class XI (2025 - 2026)

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UNIT-I (DIVERSITY IN THE LIVING WORLD)

CHAPTER-I

The Living World

➡ DIVERSITY IN THE LIVING WORLD :-

The convention on Biological Diversity defines biodiversity as "**The variability among living organisms form all sources including**, interalia terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems."

➡ BIOLOGICAL NOMENCLATURE :-

It is the universally accepted principals to provide scientific name to known organisms. Each name has two components - generic name (genus) and specific epithet (species). This system of nomenclature was provided by Carlous Linnaeus.

Mango - Mangifera indica. Human beings - Home sapience

Universal rules of nomenclature :-

- Biological names are generally in latina and written in Italics.
- The first word in a biological name represents the genus while the second component denotes the specific epithet.
- Both the words in a biological name, when handwritten, are separately underlined or printed in italics.
- The first word denoting the genus starts with a capital letter while the specific epithet starts with small letter.

➡ TAXONOMIC CATEGORIES :-

A taxonomic category is a rank or level in the hierarchical classification of organism. There are seven obligate categories and some intermediate categories. Since the category is a part of overall taxonomic arrangement, it is called taxonomic category and all categories together constitute the taxonomic hierarchy.

(a) **Species** :- Species are the natural population of individuals or a group of population which resemble one another in all essential morphological and reproductive characters so that they are able to inter breed freely and produce fertile off spring. For mango tree **indica** is species of genus Mangifera (Mangifera indica).

(b) **Genus** :- It is a group of related species which resemble one another in certain correlated characters. All species of genus presumed to have evolved from a common ancestor. lion, tiger, leopard are closely related species and placed in same genus Panther.

(c) **Family** :- It is a taxonomic category which contains one or more related genera. All genera of a family have some common features or correlated characters. Family Solanaceae contains a number of genera like Solanum, Withania, Datura etc.

(d) **Order** :- This category includes one or more related families. Families felidae and canidae are included in same order carnivore.

(e) **Class** :- A class is made of one or more related orders. The class dicotyledoneae of flowering plants contains all dicots which are grouped into several orders like roales, polemoniales, renales etc.

KINGDOM
↑
PHYLUM or DIVISION
↑
CLASS
↑
ORDER
↑
FAMILY
↑
GENUS
↑
SPECIES

(f) **Phylum** :- The term phylum is used for animals while division is used for plants. They are formed of one or more class. The phylum chordate of animals contains not only the mammals but also aves, reptiles, amphibians, etc.

(g) **Kingdom** :- It is the highest taxonomic category. All plants are included in the Kingdom Plantae while all animals belong to kingdom Animalia.

UNIT-I (DIVERSITY IN THE LIVING WORLD)

CHAPTER-2

Biological Classification

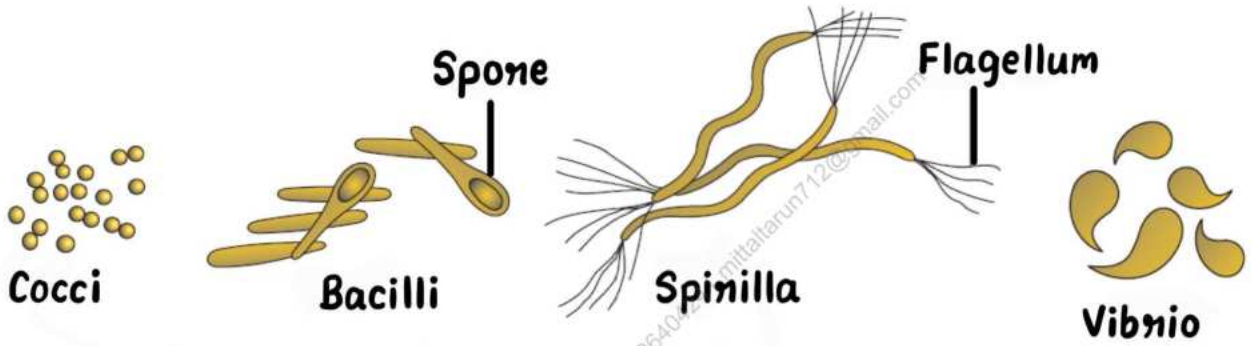
Characters	Five Kingdoms				
	Monera	Protista	Fungi	Plantae	Animalia
Cell Type	Prokaryotic	Eukaryotic	Eukaryotic	Eukaryotic	Eukaryotic
Cell Wall	Noncellulosic (Polysaccharide + amino acid)	Present in Some	Present with chitin	Present (cellulose)	Absent
Nuclear Membrane	Absent	Present	Present	Present	Present
Body Organisation	Cellular	Cellular	Multicellular	Tissue / Organ	Tissue/ Organ/ Organ System
Mode Of Nutrition	Autotrophic (chemosynthetic and photosynthetic and Heterotrophic (saprophytic/parasitic	Autotrophic (photosynthetic) and Heterotrophic	Heterotrophic (saprophytic /parasitic)	Autotrophic (photosynth-	Heterotrophic (Holozoic/Saprophytic etc.)

➡ KINGDOM MONERA :-

- Has bacteria as sole members.
- Bacteria can have shapes like : Coccus (spherical), Bacillus (rod-shaped), Vibrium (comma shaped) and spirillum (spiral shaped).
- Bacteria found almost everywhere and can be Photosynthetic autotrophs, Chemosynthetic autotrophs or Heterotrophs.

Bacteria → Archaebacteria
Bacteria → Eubacteria

- Halophiles (salt - loving)
- Thermoacidophiles (in hot springs)
- Methanogens (in marsh and in gut of ruminant animals. Produce methane gas.)
- Photosynthetic autotrophs like Cyanobacteria (Blue - green algae BGA). Some like *Anabaena* and *Nostos* have specialized cells called heterocysts for nitrogen fixation.
- *Algae bloom* is rich growth of blue green algae over the surface of polluted water bodies.
- Algae bloom release neurotoxins, deplete oxygen and makes water unfit for use.



Bacteria of different Shapes

- **Chemosynthetic autotrophs :** Oxidise various inorganic substances like nitrates/nitrites, ammonia and use released energy for their ATP production. They helps in nutrients recycling of N, P, Fe and S.
- **Heterotophic bacteria :** Decomposers help in making curd, production of antibiotic, N_2 fixation, casuse disease like cholera, typhoid, tetanus and citrus canker.
- **Mycoplasmas :** Completely lack cell wall. Smallest living cells. Can survive without oxygen. Pathogenic in animals and plants.

➡ KINGDOM PROTISTA :-

(Comprise of all single celled eukaryotes)

- Forms a link between plants, animals and fungi.

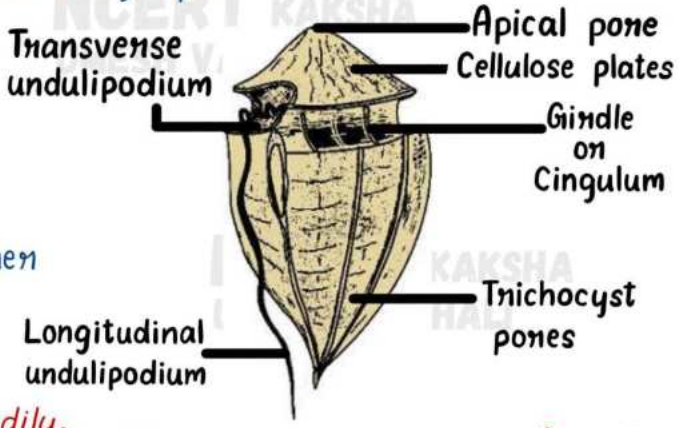
CHRYSOPHYTES - (Has diatoms and golden algae/desmids)

Fresh water/marine, photosynthetic, microscopic plankton

- Chief producers in Ocean.
- Cell walls have silica which makes it indestructible and cell walls overlap to fit together like a soap box.
- Their accumulation forms 'Diatomaceous Earth' (gritty soil)
- Used in polishing, filtration of oils and syrups.

DINOFLAGELLATES -

- Marine, photosynthetic, cell wall has stiff cellulose plates.
- Two flagella - one longitudinal and other transverse in a furrow between wall plates.
- **Example ~** *Gonyaulax multiplies rapdily, make sea appear red (red tides) and produce toxins to kill marine animals.*



Dinoflagellates

EUGLENOIDS -

- Found in stagnant fresh water.
- Have protein rich layer 'pellicle' which makes body flexible.
- Photosynthetic in presence of sunlight but become heterotrophs if they do not get sunlight.(Mixotrophic nutrition)
- **Example ~** *Euglena*

SLIME MOULDS -

- Saprophytic protists
- Under suitable conditions form an aggregates called plasmodium, grows on decaying twigs and leaves.
- During unfavourable conditions, plasmodium differentiates and forms fruiting bodies bearing spores at their tips
- Spores have true walls which are extremely resistant and survive for many years and dispensed by air currents.

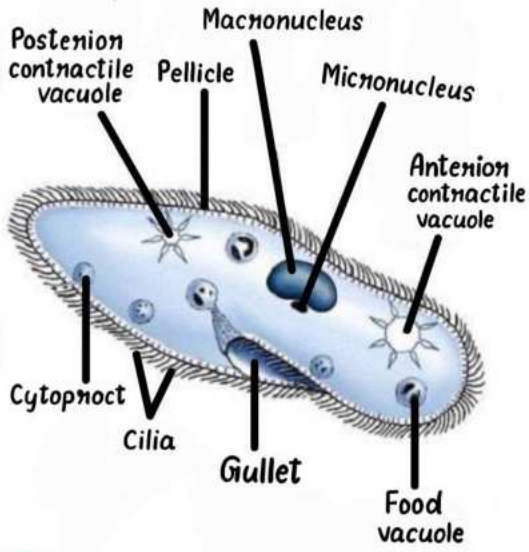
PROTOZOANS - Are heterotrops and live as parasites. Have four major groups.

Amoeboid ~ Catch prey using pseudopodia, e.g., *Amoeba*, *Entamoeba* are parasite.

Flagellated ~ Have one or more flagella. Cause disease like sleeping sickness e.g., *trypanosoma*.

Ciliated ~ Have clili to move food into gullet and help in locomotion. e.g., *Paramoecium*.

Sporozoans ~ Have infective spore like stage in life cycle, e.g., Plasmodium which causes malaria.



Paramoecium

KINGDOM FUNGI :-

1) They are achlorophyllous, heterotrophic, spore forming, non-vesicular eukaryotic organisms.
2) Cell wall is made up of chitin or fungal cellulose.
3) Reserved food is glycogen.
4) Mode of nutrition is saprophytic, parasitic or symbiotic
5) Reproduction may be vegatative (fragmentation, fission or budding), asexual conidia, sporangiospores or zoospores) or sexual reproduction by oospores, ascospore and basidiospores.
6) Sexual cycles involves the following steps :

PHYCOMYCETES :-

- Found in aquatic habitate and on decaying wood in moist and damp places.
- Mycelium is aseptate and coenocytic.
- Asexual reproduction by zoospores (motile) or aplanospores (non-motile).
- **Example** ~ *Mucor*, *Rhizopus*, *Albugo* etc.

ASCOMYCETES (The sac fungi) :-

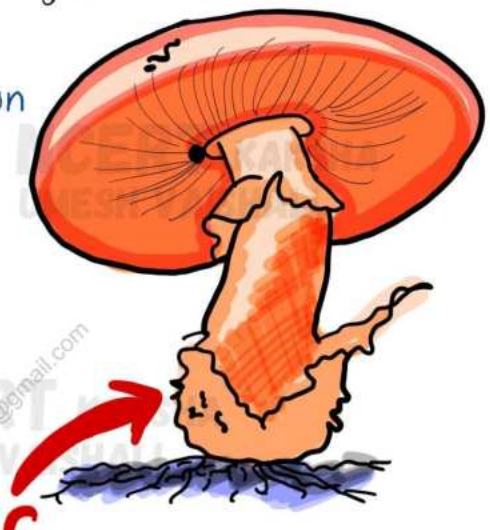
- Saprophytic, decomposers, parasitic or coprophilous (growing on dung).

- Mycelium and branched and septate and asexual spores are conidia.
- Sexual spores are called ascospores produced inside the fruiting body called ascocarps.

Example ~ *Neurospora, Aspergillus, Claviceps* etc.

BASIDIOMYCETES (The club fungi) :-

- Mycelium is branched and septate.
- Vegetative reproduction is by fragmentation Asexual spores are not found. Sexual reproduction is by two vegetative or somatic cells forming basidium.
- Basidiospores are produced in basidium by developing a fruiting body called basidiocarps.
- **Example ~** *Agaricus, Ustilago, Puccinia.*



Agaricus

DEUTEROMYCETES (The fungi imperfect) :-

- Only vegetative and asexual phase is known.
- Mycelium is septate and branched. Some members are saprophytes or parasites.
- **Example ~** *Alternaria, Trichoderma, Colletotrichu.*

KINGDOM PLANTAE :-

1) Eukaryotic, chlorophyll bearing organism.
2) Life cycle is divided into diploid saprophytic and haploid gametophytic which alternate with each other.
3) Kingdom Plantae includes Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms.

KINGDOM ANIMALIA :-

1) Heterotrophic, eukaryotic organisms that are multicellular and cell wall is absent in the cell.
2) Mode of nutrition is holozoic and reserve food is glycogen or fats.

3) Sexual reproduction is by copulation between male and female followed by embryological development.

➡ VIRUSES :-

- Find a place in biological classification.
- Not truly living.
- Non-cellular organisms which take over the machinery of host cell on entering it and become living but as such they have inert crystalline structure appear non-living. So, difficult to call them living or non-living.
- Virus means venom or poisonous fluid. Pasteur gave the term 'virus'.
- **D.J. Inanowsky** found out that certain microbes caused Tobacco Mosaic Disease in tobacco plant.
- **M.W. Beijerinek** called fluid as **Contagium vivum fluidum** as extracts of infected plants of tobacco could cause infection in healthy plants.
- **W.M. Stanely** showed viruses could be crystallized to form crystals of protien which are inert outside their specific host.
- Viruses are obligate parasites.

➡ VIROIDS :-

- Infectious agent, free RNA (lack protein coat)
- RNA has low molecular weight.
- Causes potato spindle tuber disease.
- Discovered by **T.O. Diener**.

➡ PRIONS :-

In modern medicine certain infectious neurological diseases were found to be transmitted by an agent consisting of abnormally folded protien. The agent was similar in size to viruses. These agents were called prions. The most notable diseases caused by prions are bovine spongiform encephalopathy (BSE) commonly called mad cow disease in cattle and its analogous variant Cr-Jacob disease (CJD) in humans.

➡ LICHENS :-

- Symbiotic association between algal component (Phycobiont) and fungal component (mycobiont). Algae provides food. Fungi provides shelter and absorb nutrients and water for alga.
- Good pollution indicators as they do not grow in polluted areas.

UNIT-I (DIVERSITY IN THE LIVING WORLD)

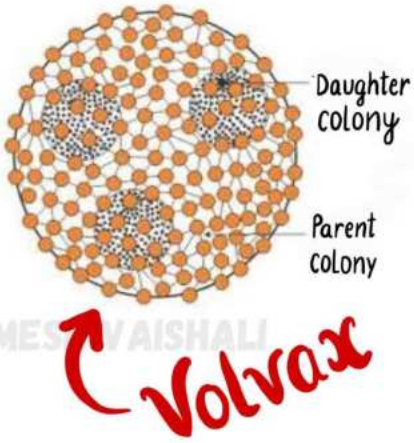
CHAPTER-3

Plant Kingdom

➡ **Algae** : Chlorophyll bearing, simple, thalloid, autotrophic and largely aquatic organisms.

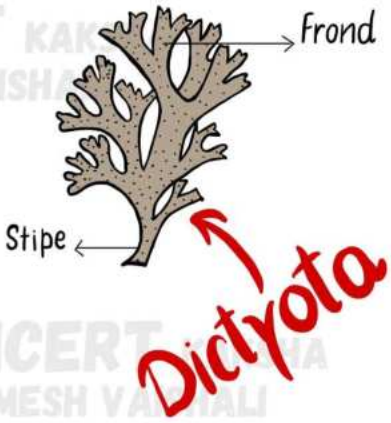
Chlorophyceae –

- Green algae, Main pigment is chlorophyll 'a' and 'b'.
- Cell wall has inner layer of cellulose and outer layer of pectose.
- Has pyrenoids made up of starch and proteins.
- Pigment and pyrenoids are located in **Chloroplast**.
  e.g; **Chlamydomonas, Volvax, Spirogyra, Ulothrix, Chara**.



Phaeophyceae –

- Brown algae are brown coloured due to main pigments chlorophyll 'a', 'c' and fucoxanthin (xanthophyll).
- Cell wall has cellulose with gelantionous coating of algin
- Has mannitol and laminarin (complex carbohydrate) as reserve food material.
- Body divisible into holdfast, stipe and frond.
  e.g. **Ectocarpus, Fucus, Laminaria, Dictyota, Sargassum**.



Rhodophyceae –

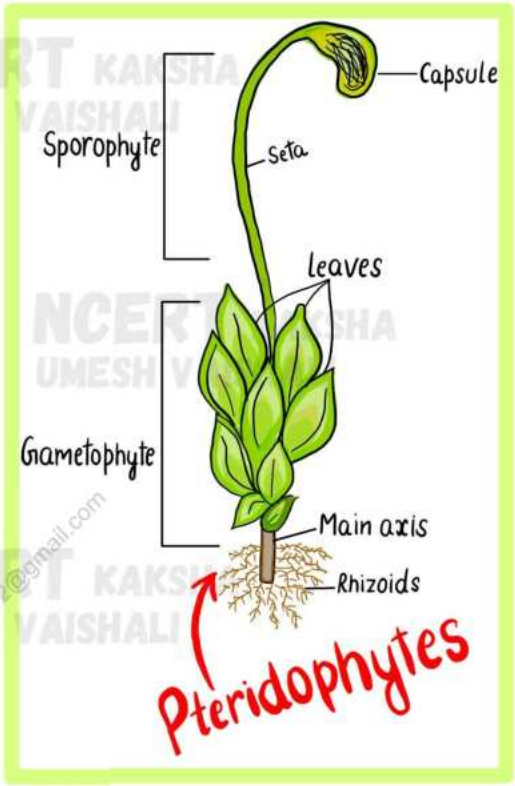
- Red algae are red coloured due to pigments chlorophyll 'a', 'd' and r-phycoerythrin.
- Found on surface as well great depths in oceans.
- Cell wall has cellulose.
- Reserve food material is floridean starch.
  e.g. **Polysiphonia, Porphyra, Gelidium, Gracilaria**.

➡ Bryophytes :

★ 'Amphibians of plant kingdom'
★ Occur in damp, humid and shaded places.
★ Lack true roots, stem or leaves.
★ Main plant body is haploid and thallus like (prostrate or erect).
★ **Economic Importance**: food for herbaceous animals.
Sphagnum is from of peat is used as fuel and also used as packing material for trans-shipment of living material, as it has water holding capacity, Prevents soil erosion, along with lichens are first colonizers on barren rock.

★ Is divided into two classes **Liverworts** (thalloid body, dorsiventral, e.g. **Marchantia**) and **Mosses** (have two stages in gametophyte – creeping, green, branched, filamentous **protenema stage** and the **leafy stage** having spirally arranged leaves. e.g., **Funaria, Polytrichum and Sphagnum**).

➡ Pteridophytes :—



★ They are seedless vascular plants that have sporophytic plant body and inconspicuos gametophyte. Sporophytic plant body is differentiated into true stem, roots and leaves.

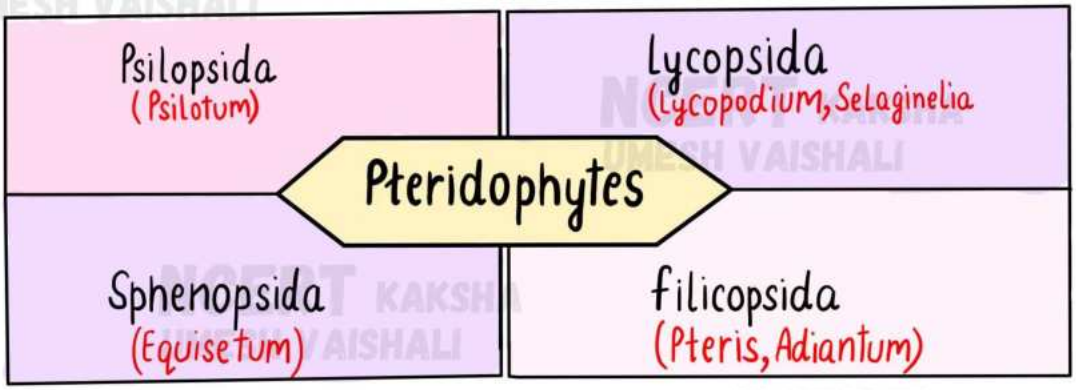
★ Vascular tissue are present but vessels are absent from xylem and companion cells and sieve tube are absent.

★ Sporophytes bear sporangia that are subtend by leaf like appendages called **sporophylls**. In some plants the compact structure called strobili or cone is formed.

★ Sporangia produce spores by meiosis in spore mother cells, spores germinate to produce multicellular thalloid **prothallus.**

★ Gametophyte bears male and female sex organ called antheridia and archaegonia. Water is required for fertilisation of male and female gametes.

★ Most of pteridophytes produce spores of similar kind (homosporus) but in Selginella and Salvinia, spores are of two kinds (**heterosporous**) larger called megaspore that produce female gametophyte and smaller microspore that produce male gametes. Water is required for fertilization of male and female gametes.



➡ Gymnosperms :

★ Gymnosperms are those plants in which the ovules are not enclosed inside the ovary wall and remain exposed before and after fertilisation.

★ They are perennial and woody, forming either bushes or trees. Some are very large (Sequoia sempervirens) and others are very small (Zamia Pygmia).

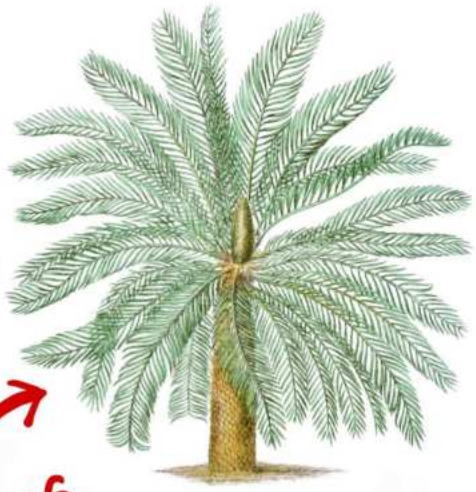
★ Stem may be unbranched (Cycas) or branched (Pinus). Root is taproot. leaves may be simple or compound.

★ They are heterosporous, produce haploid microspore and megaspore in male and female strobili respectively.

★ Male and female gametophytes do not have independent free-living existence.

Pollination occurs through air and zygote develops into embryo and ovules into seeds. These seeds are naked.

Examples – Pines, Cycus, Cedrus, Ginkgo etc.



Cycas

➡ Angiosperms :

★ Called flowering plants and have seeds enclosed in fruits.

★ Divided into two classes – Dicotyledons (have two cotyledons) and Monocotyledons (have one cotyledon).

★ **Smallest Angiosperm:** Wolfia.

★ **Large Tree :** Eucalyptus (Over 100 meters)

★ Stamen has filament and anther. Anthers bear pollen grains. Pollen grains have two male gametes.

★ Pistil has stigma, style and ovary. Ovary has ovule in which female gametophyt (embryo sac) develops.

★ Embryo sac has 7 cells and 8 nuclei. One egg cell 2 synergids, 3 antipodals and two polar nuclei which fuse to form secondary nucleus.

★ Pollen grain is carried by wind, water insects and other agents reaches to stigma and produces pollen tube which enters embryo.

★ **Double fertilisation :** One male gemate fuses with egg cell (Syngamy) to form zygote which develops into embryo.

★ Ovules develop into seeds and ovaries into fruits.

You Are Never Alone when You have A Good book

UNIT-I (DIVERSITY IN THE LIVING WORLD)

CHAPTER-4

Animal Kingdom

➡ Basis of Classification :-

(a) Levels of Organisation :

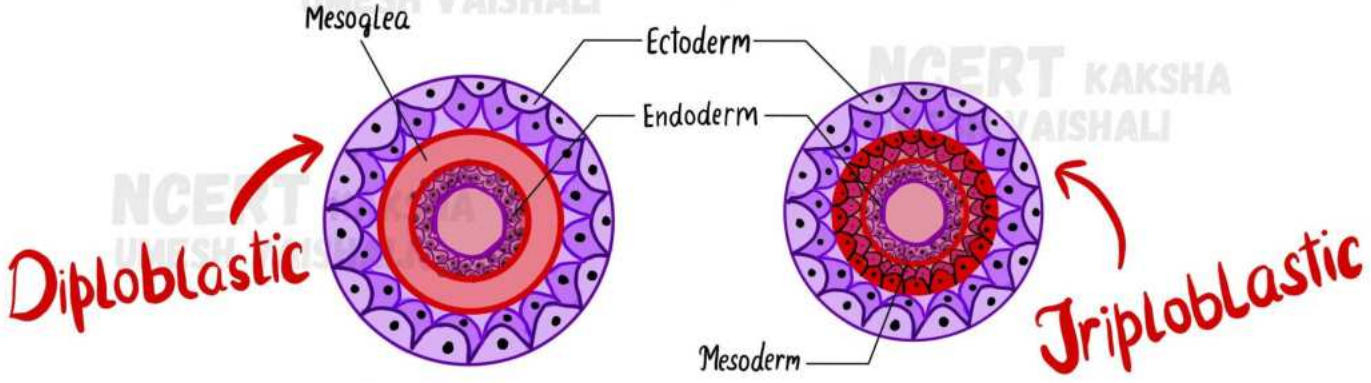
- Cellular level : Cells are arranged as loose cell aggregates, e.g., sponges.
- Tissue level : The cells performing the same function are arranged into tissues. e.g., Coelenterates.
- Organ level : Tissues are grouped together to form organs, each specialised for a particular function. e.g., platyhelminthes.
- Organ System level : Organs are associated to form functional systems e.g., Annelids, Arthropods, Molluses, Echinoderms and Chordates.
  Example : Circulatory System.

(b) Symmetry :

Asymmetrical	Radial Symmetry	Bilateral Symmetry
Cannot be divided into equal halves through median plane. e.g., Sponges.	Any plane passing through central axis can divide organism into identical halves. e.g., coelentrates, Ctenophores and echinoderms.	Only one plane can divide the organism into two identical left and right halves. e.g., Annelids and Arthropods.

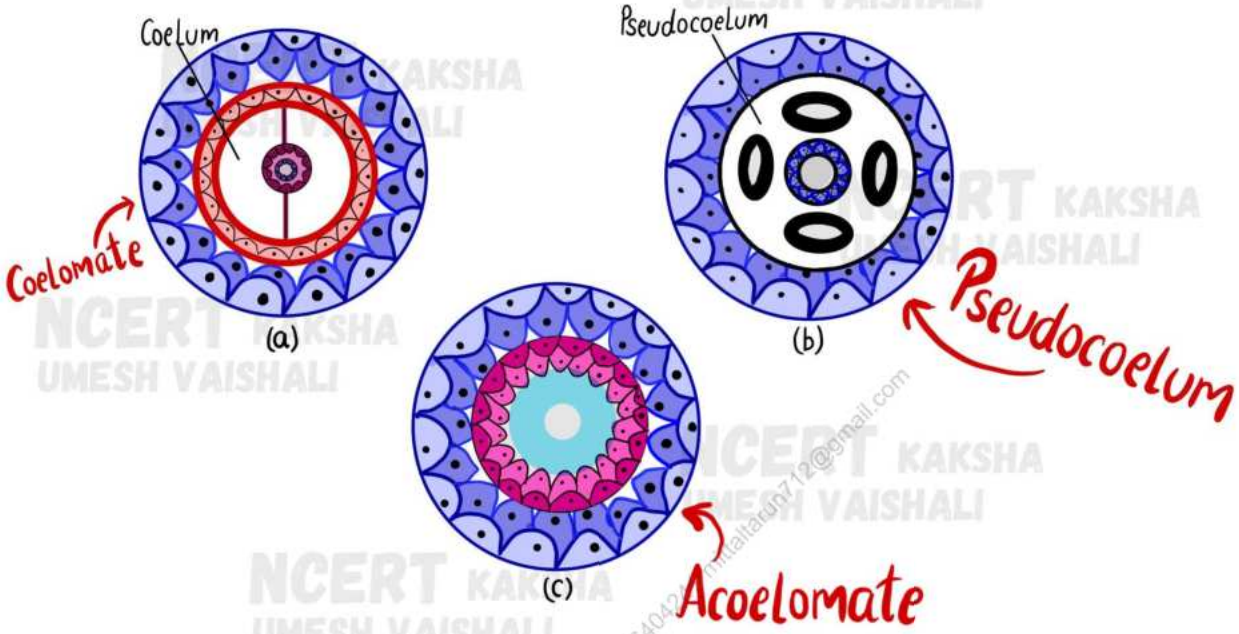
(c) Germination :

- Diploblastic :- Cells arranged in two embryonic layers i.e external ectoderm and internal endoderm. (Misoglea may be present in between ectoderm and endoderm) e.g., porifers and Coelent-rates. (Cnidarians).
- Triploblastic :- Three Layers present in developing embryo i.e, ectoderm, mesoderm and endoderm. e.g., Platyhelminthes to chordates.



(d) **Coelom**: (Body cavity which is lined by mesoderm)

- **Coelomates**:- Have coelom e.g. Annelids, Arthropods, molluses, Echinoderms, Chordates .
- **Pseudocoelomates**:- No true coelem as mesoderm is present in scattered pouches between ectoderm and endoderm. e.g., Aschelminthes.
- **Acoelomates**:- Body cavity is absent. e.g., Platyhelminthes .



(e) **Segmentation**: (A) True Metmarism: found Annelida, Arthropoda, Chordata:

- Segmentation is external as well as a internal in Annelids.
- Segmentation is external in Arthropods.
- Segmentation is internal chordates.

(f) **Notochord**:

- Rod like structure formed during embryonic development on the dorsal side .
- Non-chordates do not have notochord. e.g., porifera to echinoderms.

➡ Classification Of Animals :-

(a) Phylum-Porifera :-

- Members of this phylum are commonly known as sponges. Mostly marine, asymmetrical and have cellular level of organization.
- They have water transport or canal system. Water enters through minute pores, **Ostia**, into central cavity **Spongocoel**, from where it goes out through **Osculum**.
- Nutrition, respiration and excreation is performed by pathway of water transport system.

- Skeleton made up of spicules or spongin fibres.
- Egg and sperms are produced by same organism (hermaphrodite). Asexual reproduction by fragmentation and sexual reproducation by gametes formation.
- Fertilisation internal and development is indirect.
- Example- Sycon, spongilla.

(b) Phylum – Cnidaria (Coelenterate) :-

- They are aquatic, mostly marine, sessile, free swimming, radially symmetrical animals.
- They exhibit tissue level of organization, diploblastic, coelomate with single opening.
- They show two types of body called polyp and medusa.
- Polyp is sessile, fixed and cylindrical, without gonads. Example- Hydra, Adamsia.
- Some cnidarians exhibits both forms (Obelia). Polyp produce medusa asexually and medusa produce polyp sexually.

(c) Phylum – Ctenophora:

- Also called as sea walnuts or comb jellies.
- Are exclusively marine, radially symmetrical.
- Have tissue level organisation are diploblastic.
- Digestion both extra and intracellular.
- Body has eight external rows of ciliated comb plates for locomotion.
- Show Bioluminescene (Property of living Organism to emit light)
- Hermaphrodite (sexes are not seprate).
- Only sexual reproduction occurs External fertilization. Indirect development.
  e.g., **Ctenoplana, Pleurobrachia.**

(d) Phylum – Plathyhelminthes :-

- Also called as **'Flat worms'**.
- Have dorsoventrally flattened body. Are mostly endoparasites in animals.
- Are bilaterally symmetrical, tripoblastic, acoelomate with organ level of organisation.
- Absorbs nutrients through body surface.
- Parasitic forms have hooks and suckers.

(e) Phylum- Aschelminthes (The Round Worm) :-

- They may be free-living, aquatic, terrestrial or parasitic in plants or animals

- Bilaterally symmetrical, triploblastic, pseudo coelomate
- Alimentary canal is complete with well developed muscular pharynx.
- They are Dioecious. Females are longer than male.
- Example – Ascaris (round worm), Wucheriria (filarial worm), Ancyclostoma.

(f) Phylum-Annelida :-

- Aquatic or terrestrial, bilaterally symmetrical, segmented with organ system level of organization.
- Aquatic Annelids like Nereis possesses lateral appendages parapodia, for swimming. Nephridia help in osmoregulation and excreation.
- Neural system consists of paired ganglia connected by lateral nerves to a double ventral nerve cod.
- Dioecious (Nereis) or monocious (earthworm, Leech).
- Example :- Pheretima (earthworm), Hirunidaria (Blood sucking leech).

(g) Phylum-Arthropoda :-

- Largest phylum of animals which includes insects. They have organ system of organization. They are triploblastic, coelomate, bilaterally symmetrical with chitinous exoskeleton.
- Body consists of head, thorax and abdomen, jointed appendages (jointed feet) Respiratory organs are gills, book lungs or tracheal system with open circulatory system.
- Excreation through malpighian tubules, sense organs antenna or eyes. Fertilisation internal, mostly oviparous.
- Example – Apis (honey bee), Bombyx (silk worm).

(h) Phylum- Mollusca :-

- Terrestrial or aquatic, organ level of organization, bilaterally symmetrical, triploblastic and coelomate.
- Body divided into head, muscular foot and visceral hump . Unsegmented and covered with calcareous shell.
- Feather like gills are present between hump and mantle.
- Mouth contains file like rasping organ for feeding called radulla. • Example- Pila, Octopus.

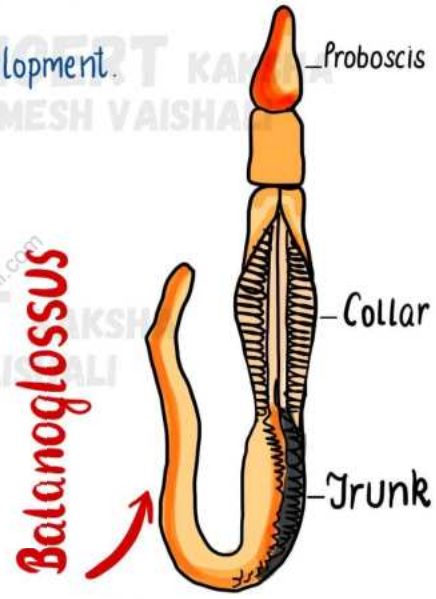
(i) Phylum – Echinodermata :-

- Endoskeleton of calcareous ossicles, marine with organ system of organization.
- Triploblastic, coelomate, presence of water vascular system help in locomotion, capture of food and respiration.

- Sexes are separate, fertilisation is external and development is indirect.
- Example - Asterias (star fish), Cucumaria (Sea cucumber), Antedon (sea lily).

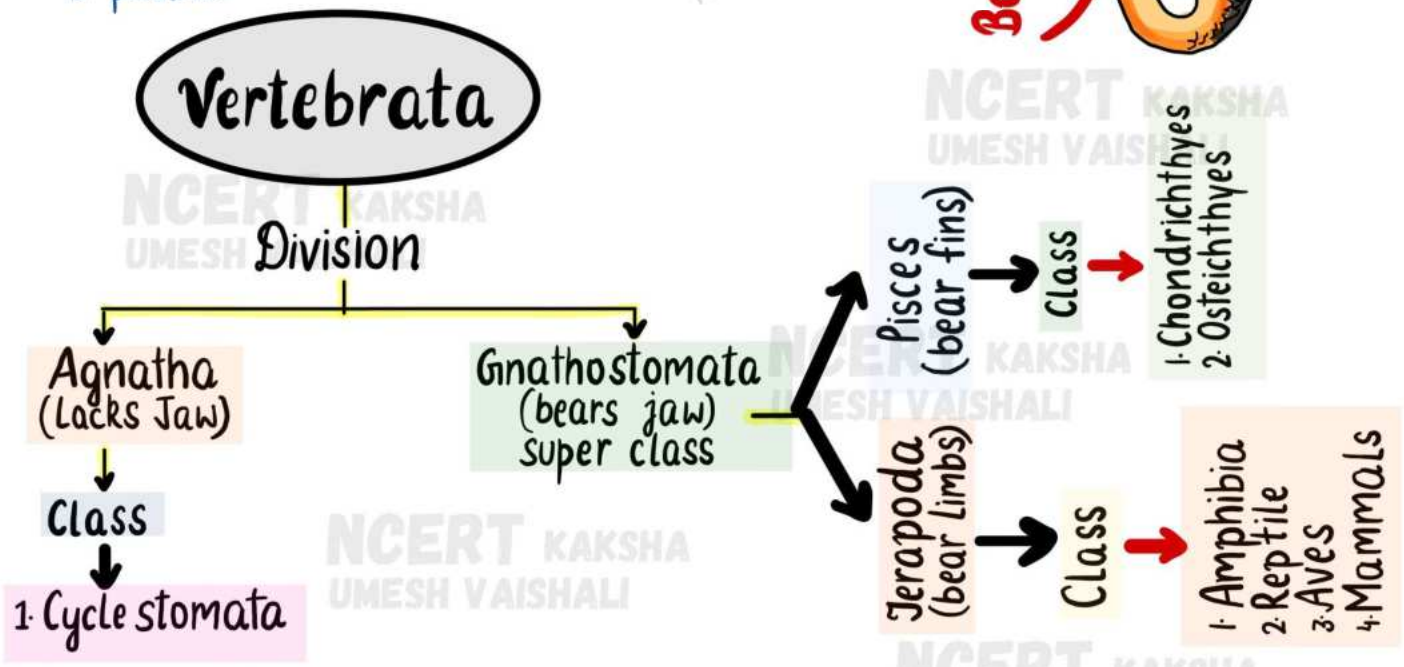
(j) Phylum - Hemichordata :-

- Worm-like marine animals with organ system of organization, bilaterally symmetrical, tripoblastic and coelomate animals.
- Body is cylendrical, composed of anterior proboscis, a collar and a long trunk.
- Open circulatory system, respiration by gills, excreatory organ is proboscis glands
- Sexes are separate, fertilisation extenal, indirect development.
- Example - Balanoglossus



(K) Phylum - Chordata :-

- Presence of Notochord, have dorsal hollow nerve chord and paired pharyngeal gill slits.
- Bilaterally symmetrical, triploblastic, coelomate with organ system levels of organization.
- Closed Circulatory system, ventral heart, post-anal tail is present.



(a) Class - Cyclostomata (Circular mouthed fishes) :-

- They are ectoparasites on some fishes. They have sucking and circular mouth without jaws.
- Body devoid of scales, gill slits for respiration, cranium and vertebral column is cartilaginous.

- Circulation is closed type. They are marine but migrate to fresh water for spawning and die after few days. Larva return to seas after metamorphosis.
- Example - Petromyzon (Lamprey), Maxine (Hag fish).

(b) Class - Chondrichthyes (The Cartilaginous Fish) :-

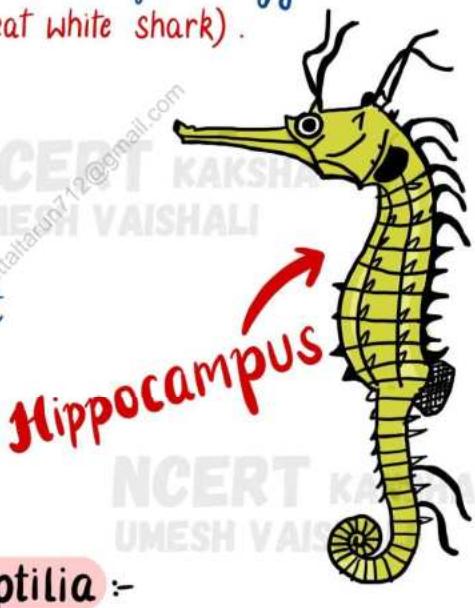
- They are marine, steamlined body, have cartilaginous endoskeleton, cold Blooded, tough skin with minute placoid scales.
- Gill slits are separate without operculum.
- They have powerful jaw and are predators.
- Air bladder is absent, hence to avoid sinking swims constantly. Heart is two chambered, cold blooded (Poikilothermous).
- Sexes separate. Males have pelvic fins which bear claspers. Internal fertilisation, many are viviparous.
- Electric Organ is present in **torpedo** and poison sting in **trygon**.

Example - Scoliodon (Dog fish), Carcharodron (great white shark).

(c) Class - Ostechthyes (The body fish) :-

- Marine and fresh water both have bony endoskeleton. Steamlined body with four pair of gills covered by operculum.
- Skin is covered with scales, air bladder is present and heart is two chambered, cold blooded.
- Sexes are separate, fertilisation external, oviparous and development direct.

Example - Marine - Hippocampus (sea horse), Exocoetus (Flying fish).



(d) Class - Amphibia :-

- Can live in aquatic as well as terrestrial habitat.
- Two pair of limbs.
- Moist skin without scales.
- Respiration by gills, lungs or skin.
- Heart three chambered, cold blooded.
- Oviparous
- **Rana** (frogi), Salamander, Hyla.

f) Aves :-

- Presence of feathers for flying.
- forlimb is modified into wings.
- skin is dry without glands. long bones are hollow with air cavities.
- Respiration by lungs.
- Heart is 4 chambered, warm blooded.
- Oviparous.
- Columba, Pavo, Ostrich.

(e) Reptilia :-

- Mostly terrestrial animals.
- Limp two pair if present.
- Dry and cornified skin having scale or scute.
- Respiration by lungs.
- Heart three chambered crocodile 4 chambered
- Oviparous
- Chamelion, Crocodilus, Naja.

(g) Mammalia :-

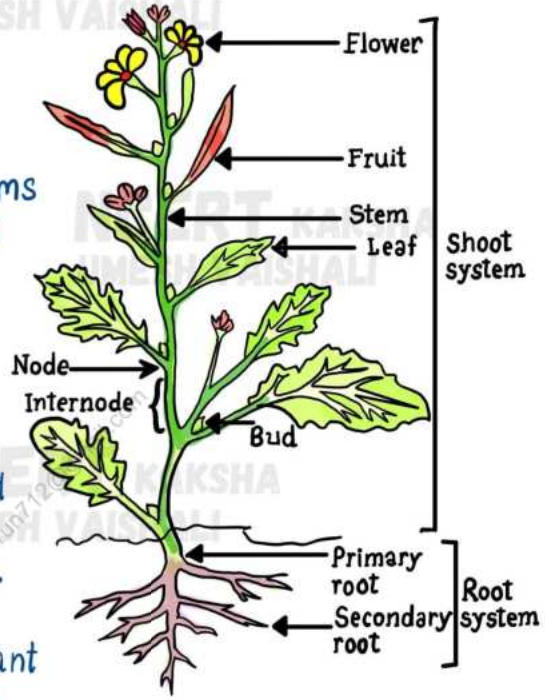
- Mostly terrestrial, a few can fly and live in water.
- Two pair of limbs.
- Skin possesses hairs. Mammary gland is present to produce milk.
- Viviparous or Oviparous.
- Platypus (oviparous), camel, dog, Blue Whale

Morphology Of Flowering Plants

➡ Parts Of Flowering Plants :-

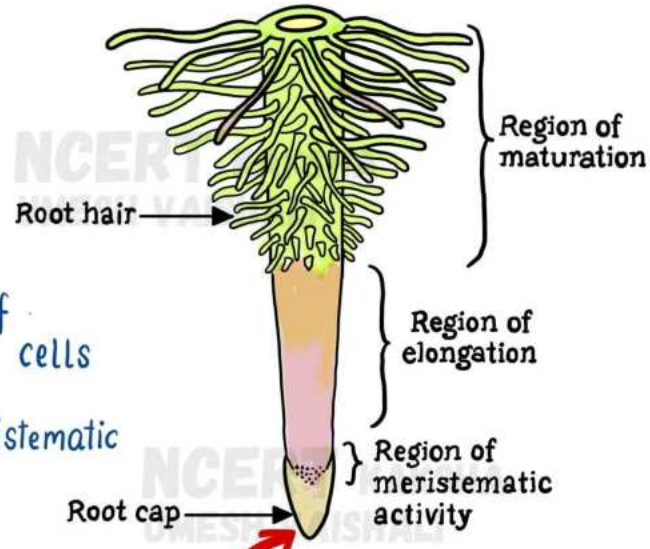
➡ The Root :-

- In Dicotyledons, elongation of radicle forms the primary roots which bears lateral roots of several orders called secondry roots, tertiary roots etc.
  Primary roots along with lateral roots forms the **tap root system**. Example; Mustard, Gram etc.
- In monocotyledons, primary root is replaced by large number of roots at its base of stem to constitute the **fibrous root system**. Wheat, rice etc.
- The roots that arise from other parts of plant beside radicle are called **adventitious roots.**
  Example - Grass, Banyan tree, Maize etc.
- The main function of root system are the absorption of water and minerals from the soil, providing proper anchorage to the plant parts and storing reserve food materials.



✱ Regions Of The Root ⇐

- The apex of root is covered by a thimble like structure called **root cap**, it protect the tender apex of root while making way through soil.
- Above the root cap is **region of meristematic activity** having small cells with dense cytoplasm.
- The part above the region of meristematic activity is **region of elongation** where cells under go elongation and enlargement to increase the length of root.
- **Region of maturation** contain root hairs that help in absorption of water and minerals.



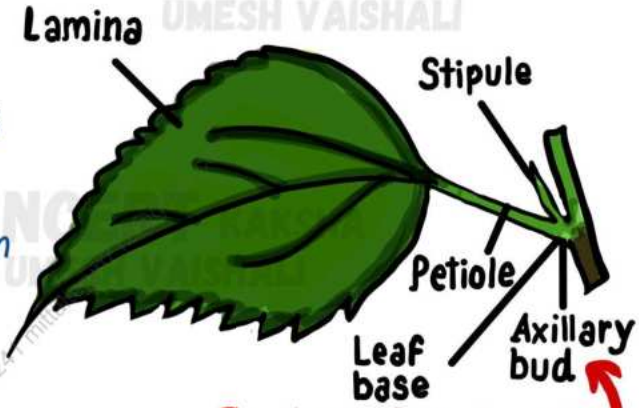
Regions Of The Root-Tip

The Stem :-

- It is the ascending part of axis bearing branches, leaves, flowers and fruits. It develops from Plumule of the embryo.
- Stem bears nodes and internodes. The region of stem where leaves are born called nodes and portion between two nodes are called internodes.
- The main function of stem is spreading branches, bearing leaves, flowers and fruits. It also conducts water and minerals from root to leaves and product of photosynthesis.
- Some stem perform special functions like storage of food, support, protection and vegetative propagation.

The Leaf :-

- leaf is a green, dissimilar exogenous lateral flattened out growth which is borne on the node of a stem or its branches is specialised to perform photosynthesis.
- Leaves originate from shoot apical meristem and are arranged in an acropetal order.
- A typical leaf consists of three parts - **leaf base** **Petiole, lamina.** leaf is attached with stem by leaf base which may bear two small leaf like structure called stipule.
- Middle prominent vein is called mid vein. Veins provide rigidity to the leaf blade and act as channel for transport of water and minerals.



Parts Of A Leaf

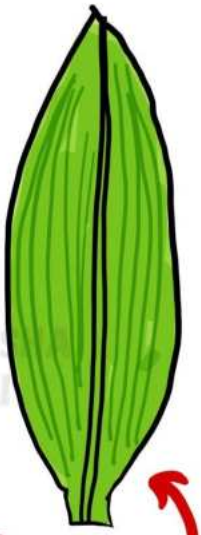
TYPES OF LEAVES

1) Simple leaves
2) Compound leaves
   (i) Pinnately Compound leaves
   (ii) Palmately Compound leaves

Venation

The arrangement of veins and the veinlets in the lamina of leaf is termed as **veination**. When the veinlets form a network the venation is termed as **reticulate**. When the veins run parallel to each other with in a lamina, the venation is termed as **parallel** leaves of dicotyledonous plants generally possess reticulate venation, while parallel venation is the characteristic of most monocotyledons.


Reticulate Venation


Parallel Venation

Phyllotaxy

- The pattern of arrangement of leaves on the stem or branch is called **Phyllotaxy.**
- In **alternate type of phyllotaxy** single leaf arise at each nodes as in china rose.
- In **opposite types of phyllotaxy** a pair of leaves arise from each node opposite to each other as in Guava.
- If more than two leaves arise at a node and form a whorl is called **whorled type** of phyllotaxy as in Alstonia.
- leaves are modified to perform other functions like converted to tendril for climbing as in Peas and spines for defence in cactus.

The Inflorescence :-

The arrangement of flowers on the floral axis is termed as inflorescence. Two main types of inflorescence are racemose and Cymose.

Racemose

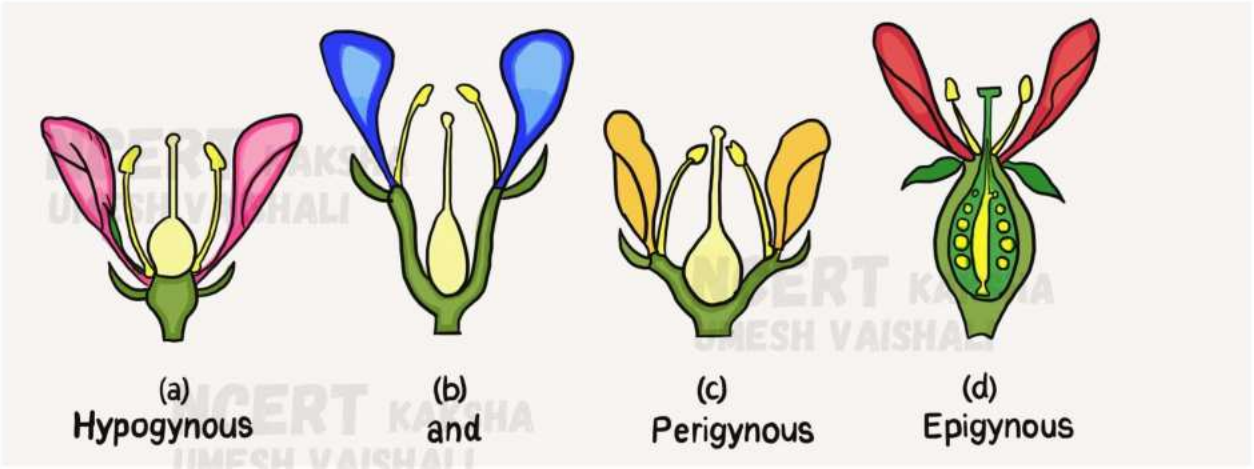
- The main axis continuous to grow. Flowers are borne laterally in an
- acropetal succession.
- Example – Radish, Mustard.

Cymose

- Main axis terminates in flower having limited Growth.
- Flowers are borne in a basipetal succession.
- Example – Jasmine, Bougainvillea.

The Flower :

- Flower is the reproductive part of angiospermic plants for sexual means of reproduction.
- A typical flower has four whorls arranged on a swollen end of stalk or pedicel called **thalamus**. They are **Calyx, Corolla, Androecium and Gynoecium.**
- When a flower has both androecium and gynoecium, the flower is called bisexual and flower having either androecium and gynoecium only is called unisexual.
- When flower can be divided into two equal radial halves in any radii passing through center the symmetry of flower is called **actinomorphic** (radial symmetry) as in Mustard, Datura and Chili.
- When flower can be divided into two similar parts only in one vertical plane it is **zygomorphic** as in Pea, Cassia etc.
- When floral appendages are in multiple of 3,4 or 5 they are called **trimerous, tetramerous** and **pentamerous** respectively. Flower with bracts are called **bracteates** and without it **ebracteate.**
- Based on the position of ovary with respect to other floral part on that amus, flowers are of following types :

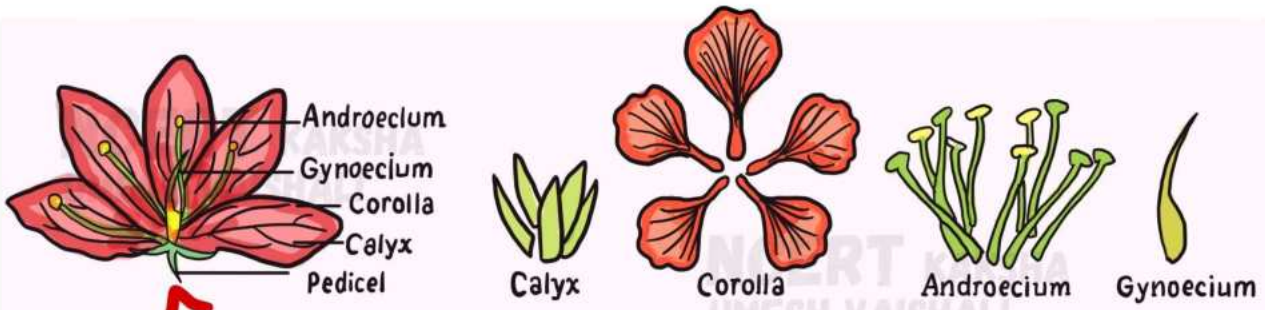


- Hypogynous Flower ~ Ovary occupies the highest position. The ovary in such case is called superior. Eg. Mustard, brinjal and china rose.
- Perigynous Flowers ~ If the gynoecium is situated at the centre and other parts are on the rim at same height. Ovary is called half-inferior.
- Epigynous Flowers ~ The margin of thalamus grows to completely cover the ovary. Ovary is said to be inferior.

Parts Of A Flower

- **Calyx** is the outermost whorl of the flower; its members are called sepals. They are generally green and leafy; protect the flower in bud stage. It may be **gamosepalous** (sepals united) or **polysepalous** (sepals free).
- **Corolla** consist of petals, brightly coloured to attract the insects for pollination. They may be gamopetalous or polypetalous.

- The mode of arrangement of sepals or petals in floral bud with respect to the other members of same whorl is called aestivation. In **valvate**, the whorls of sepals or petals touch each other as in Calotropis. In **Twisted** aestivation, the whorls overlap each other as in china rose.
- In **Imbricate** aestivation, margin overlap each other but not in particular fashion as in Gulmohar.
- In pea and bean flowers, there are 5 petals - the largest (standard) overlaps the two smallest anterior petals (keel). This type of aestivation is known as **vexillary** or **papilionaceous**.



Parts Of A Flower

The Androecium~

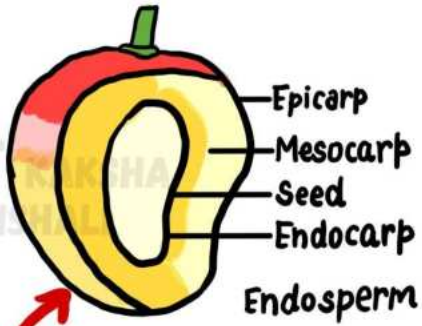
- Androecium represent the male reproductive parts of flower, consists of stamens. Each stamen consists of filament and anther. Pollen grains are produced in pollen sac. sterile stamen is called **stemenode.**
- When stamens are attached with petals it is called epipetalous (Brinjal). Stamen may be free (polyandrous), more than two (polyadelphous), two bundles (diadelphous), more than two (polyadelphous).

The Gynoecium~

- Female reproductive part of flower consists of one or more carpels. Each carpel is made up of stigma style and ovary.
- When more than one carpel is present, it may be free (apocarpous) as in lotus and rose or fused together (syncarpous) as in mustard and tomato.
- After fertilisation, ovules change into seeds and ovary mature into fruits.

The Fruit :-

- Mature and ripened ovary developed after fertilisation is fruit. If a fruit is formed without fertilisation of ovary it is called **parthenocarpic fruit**.
- Fruit consists of seeds and pericarp. Thick and fleshy pericarp is three layered called epicarp, mesocarp and endocarp.



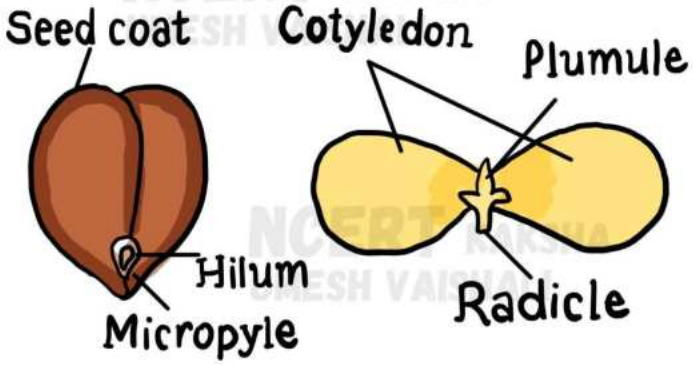
Mango

The Seed :-

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

✱ Structure Of A Dicotyledonous Seed ~

✱ Dicotyledonous Seed is made up of a seed coat and an embryo. Embryo is made up of embryonal axis, radicle and cotyledons.



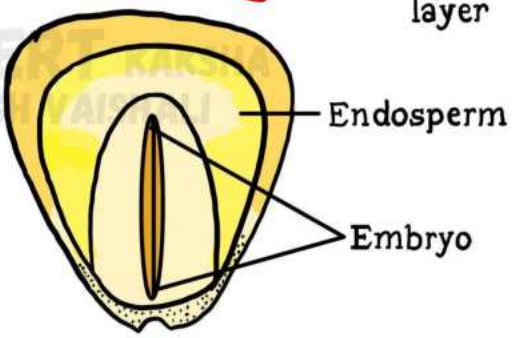
Structure Of Dicotyledonous Seed

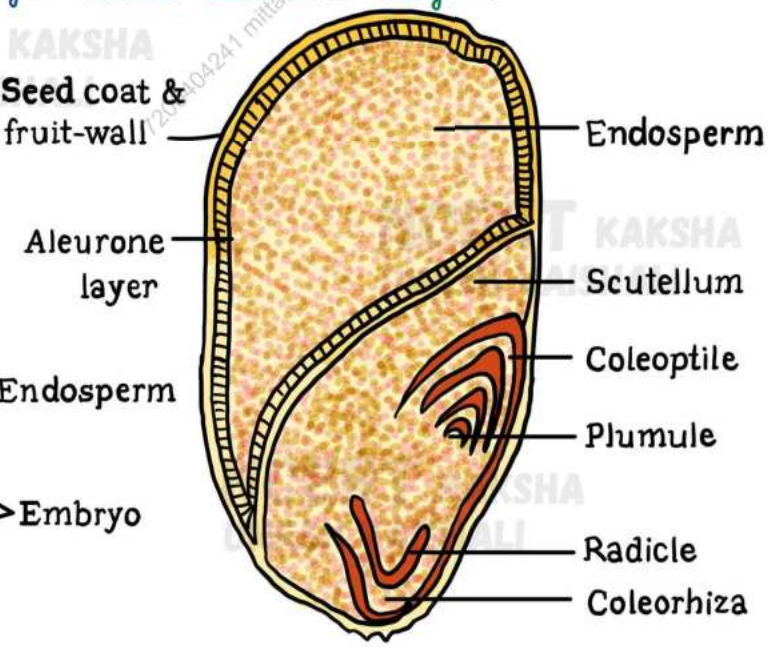
✱ Seed coat has two layers outer **testa** and inner **tegmen**. Hilum is scar through which seed is attached to the ovary. Small pore above the hilum is called **micropyle**.

✱ Structure Of Monocotyledonous Seed ~

✱ In monocotyledonous seed, outer covering of endosperm separate the embryo by a proteinous layer called **aleurone layer**.

Structure Of Monocotyledonous Seed





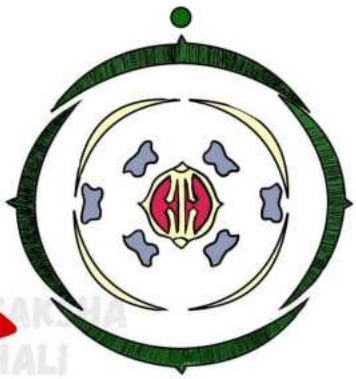
✱ Single cotyledon is called as scutellum having a short axis bearing Plumule and radicle.

✱ Plumule and radicle are closed inside sheaths called as coleoptile and coleorhiza respectively.

➡ Semi-Technical Description Of A Typical Flowering Plant :-

The plant is described beginning with its habitat, vegetative characters roots, stem and leaves and then floral characters inflorescence and flower parts.

The floral formula is represented by some symbols. In the floral formula, Br stands for bracteate K stands for calyx, C for corolla, P for perianth, A for androecium and G for Gynoecium. Fusion is indicated by enclosing the figure within bracket and adhesion by a line drawn above the symbols of the Floral Parts.



Floral Diagram With Floral Formula

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

Solanaceae :-

It is a large family, commonly called as the 'Potato Family'. It is widely distributed in tropics, subtropics and even temperate zones.

Vegetative Characters ~ Plants mostly herbs, shrubs and rarely small trees.

- **Stem** – herbaceous rarely woody, aerial; erect, cylindrical, branched solid or hollow, hairy or glabrous, underground stem in potato (Solanum tuberosum).
- **Leaves** – alternate, simple, rarely pinnately compound, exstipulate; venation reticulate.

Floral Characters –

- Inflorescence : Solitary, axillary or cymose as in Solanum.
- Flower : Bisexual, Actinomorphic
- Calyx : Sepals five, united; persistent valvate aestivation.
- Corolla : Petals five, united; valvate aestivation.
- Androecium : stamens five, epipetalous
- Gynoecium : Bicarpellary obligately placed, syncarpous; ovary superior, bilocular, placenta swollen with many ovules, axile.
- Fruits : Berry or Capsule • Seeds : many, endospermous
- Floral Formula : $\oplus \, ♀ \, K_{(5)} \, C_{(5)} \, A_5 \, \underline{G}_{(2)}$
- Economic Importance :-

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

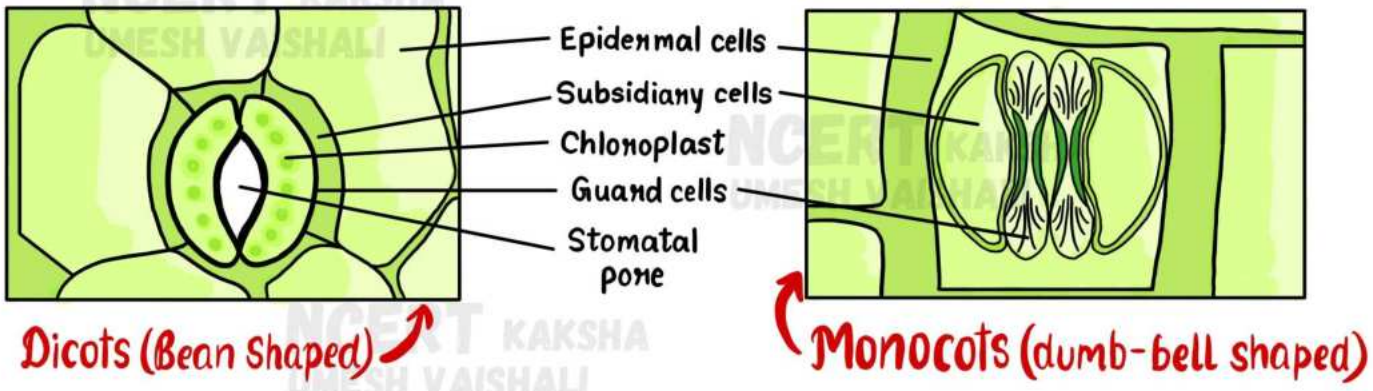
Anatomy Of Flowering Plants

➡ **Tissue :-** A group of cells performing essentialy the same function and commonly of similar structure is called a tissue.

➡ The Tissue System :-

Epidermal Tissue System~

- It forms the outermost covering of whole plant body, which consists of whole plant body, which consists of epidermal cells, stomata, epidermal appendages (trichomes and hairs).
- Epidermis is single layered, parenchymatous with waxy thick layers of cuticle to prevent water loss.
- Stomata is present in epidermis of leaves. It regulates the transpiration and gaseous exchange. In dicots, stomata are bean-shaped having two guard cells closing the stomatal pore. In monocots, stoma is dumb bell-shaped. Guard cells contain chloroplasts and help in opening and closing of stomata.



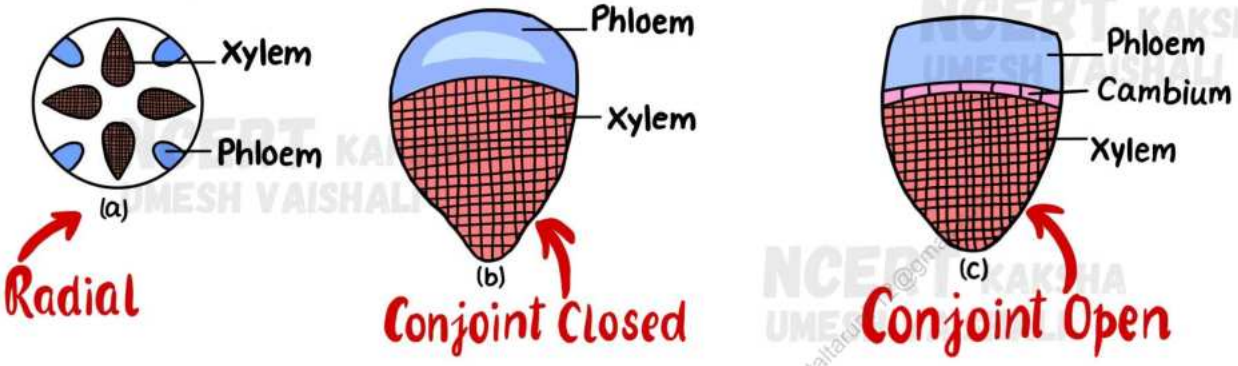
- Guard cells are surrounded by subsidiary cells. The stomatal aperture, guard cells and the surrounding subsidiary cells are together called **stomatal apparatus**.
- Epidermis also contains a number of hairs. Root hairs are unicellular elongation of epidermal cells. Trichomes are present on stems, which are multicellular branched or un-branched preventing water loss due to transpiration.

The Ground Tissue System~

All tissue except epidermis and vascular bundles constitute the **ground tissue**. It consists of simple tissues such as parenchyma, collenchyma and sclerenchyma. Parenchymatous cells are usually present in cortex, pericycle, pith and medullary rays, in the primary stems and roots. In leaves, the ground tissue consists of thin-walled chloroplasts containing cells and is called **mesophyll**.

The Vascular Tissue System~

- The vascular system consists of complex tissues, xylem and phloem that together form vascular bundles.

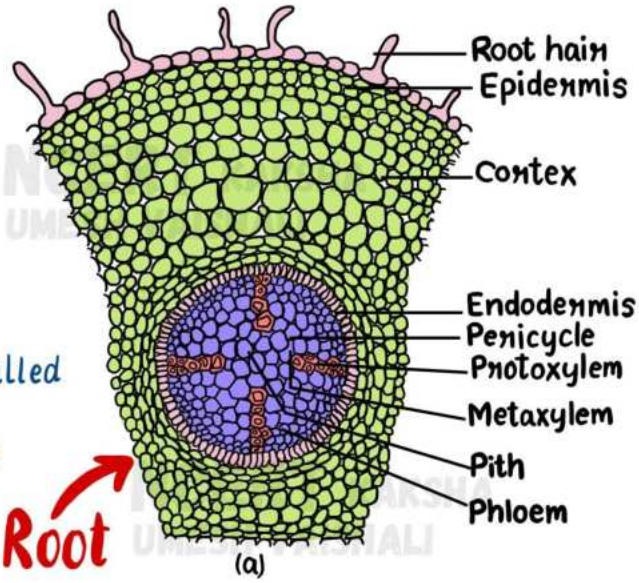


- When xylem and phloem within a vascular bundle are arranged in alternate manner on different radii, the arrangement are called **radial** as in roots. When xylem and phloem are situated at the same radius of vascular bundle, it is called **conjoint** as in stem and leaves.

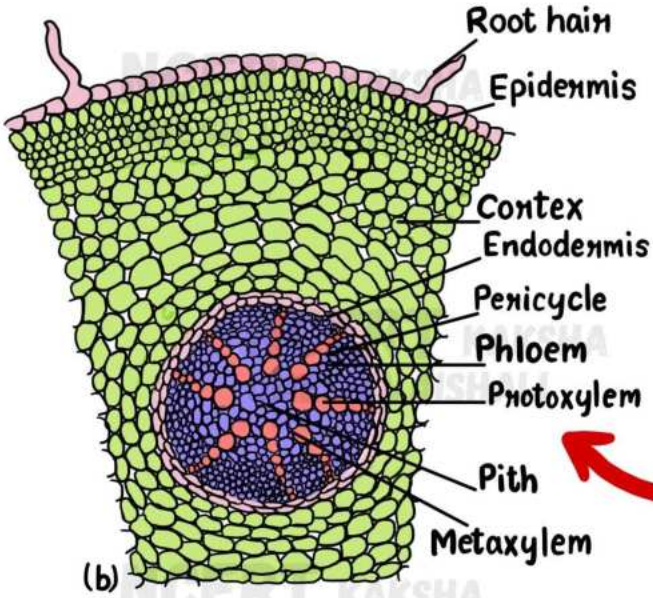
Anatomy Of Dicotyledonous And Monocotyledonous Plants:-

Dicotyledonous Root~

- The outermost layer of dicot root is **epidermis** containing unicellular root hairs.
- The **cortex** consists of several layers of thin walled parenchyma cells.
- The innermost layer of cortex is called **endodermis** having waxy material suberin as **casparian strips**, which is impermeable to water.



Monocotyledonous Root~

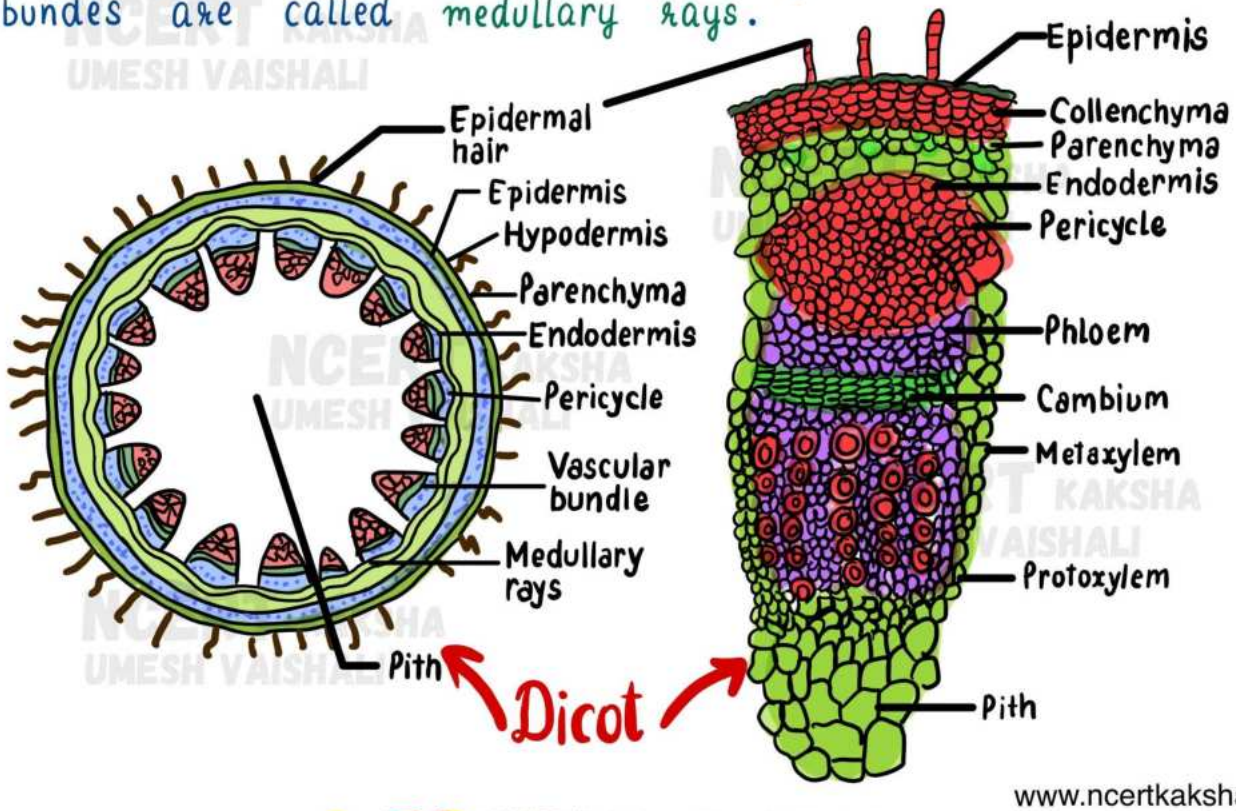


- The anatomy of the monocot root is similar to the dicot root in many respects.
- It has epidermis, cortex, endodermis, pericycle, vascular bundles and pith. As compared to the dicot root which have fewer xylem bundles.

Monocot Root

Dicotyledonous Stem~

- Epidermis is covered with a thin layer of cuticle and may have trichomes and stomata.
- Cortex: The cortex is made up of the multiple layers of cells including hypodermis, middle layer of parenchyma cells and innermost layer called endodermis.
- Endodermis cells are rich in starch grains and are called starch sheath. Pericycle is present on the inner side of endodermis. Layers of radially placed parenchyma between the vascular bundes are called medullary rays.

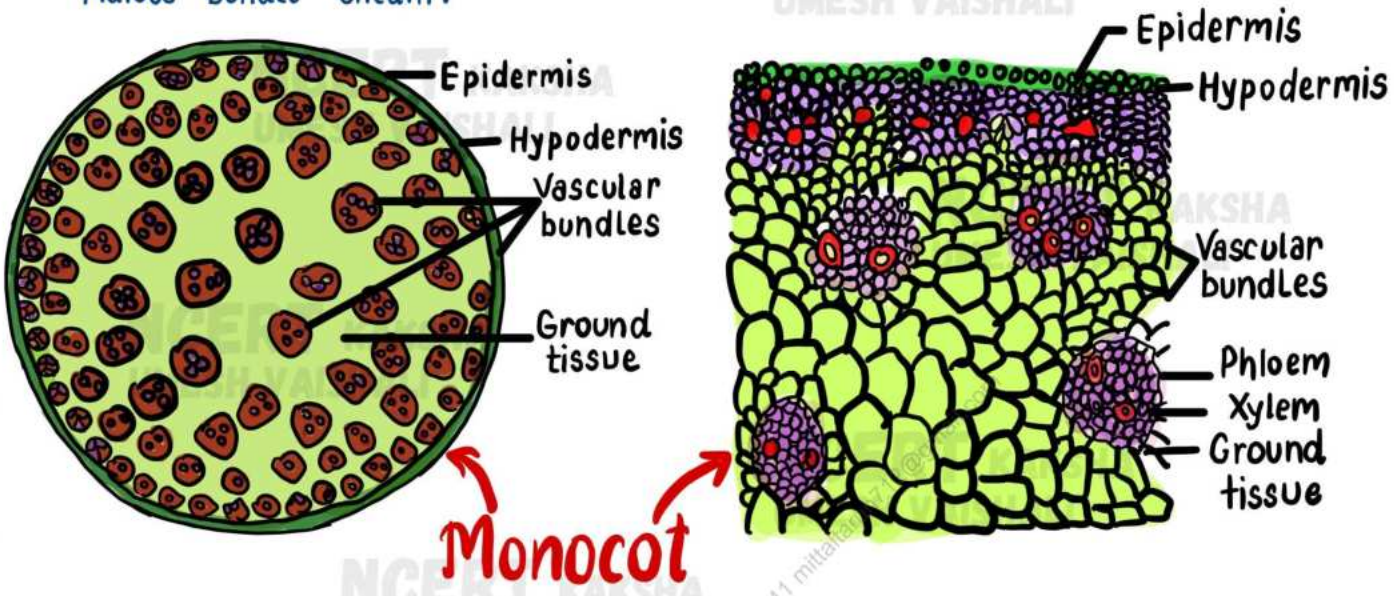


Dicot

- A large number of vascular bundles are arranged in a ring. Each vascular bundle is conjoint, open, Protoxylem is endarch.

Monocotyledonous Stem ~

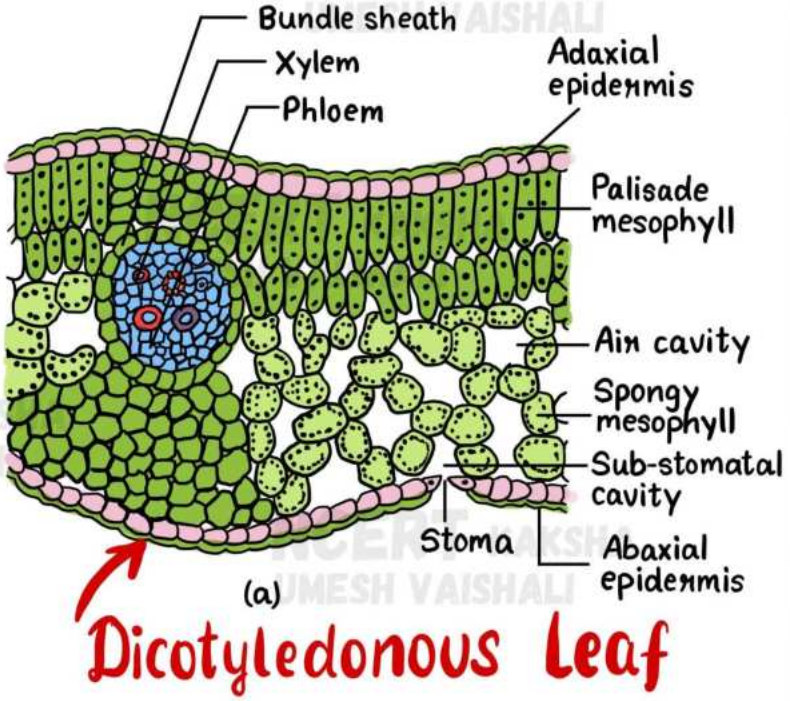
- The hypodermis is made up of sclerenchyma. Vascular bundles are conjoint, closed and scattered. Each vascular bundle is surrounded by a sclerenchymatous bundle sheath.



- Phloem parenchyma is absent. Water-containing cavities are present within the vascular bundles.

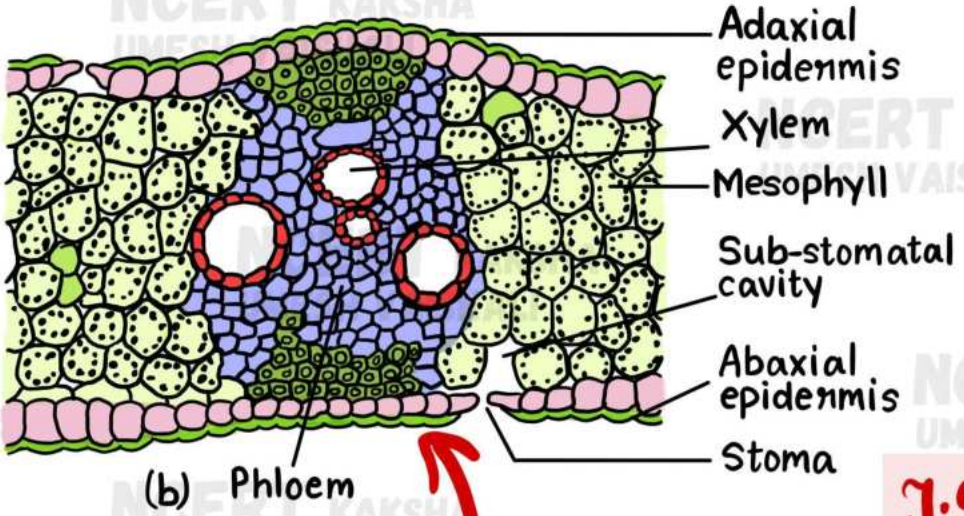
Dorsiventral (Dicotyledonous) Leaf ~

- The leaf lamina of a dorsiventral leaf has 3 parts: epidermis, mesophyll and vascular system.
- The upper epidermis is called adaxial epidermis and lower one is called abaxial epidermis. More number of stomata are present on the abaxial epidermis.
- There are two types of cells in the mesophyll: palisade parenchyma and spongy parenchyma. The palisade parenchyma is placed adaxially.



- The spongy parenchyma is situated below the palisade parenchyma and extends to the lower epidermis. There are numerous large spaces and air cavities between the cells of spongy parenchyma.

Isobilateral (Monocotyledonous) leaf ~



T.S. of leaf

Monocotyledonous leaf

- Stomata are present on both the surfaces of an isobilateral leaf. The mesophyll is not differentiated into palisade and spongy parenchyma.
- Some adaxial epidermal cells in grasses are modified into large, empty cells called bulliform cells. When the bulliform cells absorb water, they become turgid. So the leaf surface is exposed. During water stress, when the bulliform cells become flaccid, the leaves curl inwards to minimize water loss.

Studying Means
10% Reading
And 90% Complaining
So Your Friend that
You have to study

Structural Organisation In Animals

ANIMAL TISSUES ➡ 1) Epithelial 2) Connective 3) Muscular 4) Neural

➡ Epithelial Tissue :-

This tissue provides covering or lining for some part of the body. Cells are compactly packet without intercellular space.

★ Simple epithelium is composed of single layer of cell and function as lining of body cavities, ducts and tubes.

★ The compound epithelium consists of two or more than two layers of cells and has protective function.

★ The squamous epithelium is made up of single layer of flattened cells with irregular boundaries. They are present in lining of blood vessels, air sacs of lungs.

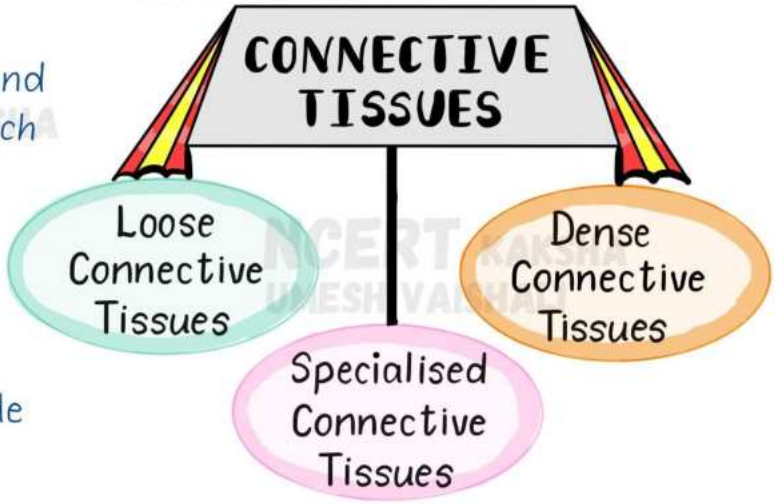
★ Cuboidal epithelium is made up of single layered cube-like cells and found in ducts of glands and tubular part of nephron of kidney for absorption and secretion.

★ Columnar epitheliums are made up of tall and slender cells. The nuclei are located at the base. Free surface may have microvilli found in lining at stomach and intestine. The ciliated one are calle as ciliated epithelium.

★ Columnar and cuboidal epithelium specialized for secretion are known as glandular epithelium, which may be unicellular as in goblet cells of alimentary canal or multicellular as in salivary gland.

➡ Connective Tissue :-

They are most abundant and widely distributed tissue which link and support the other tissues. All connective tissue except blood cells, secrete fibres of structural protein called collagen or elastin to provide elasticity and flexibility.



Muscle Tissue :- Each muscle is made up of long cylindrical fibres arranged parallel to each other. Fiber are composed of fine fibrils called myofibrils. Muscle fibres contract and relax in response to stimulation.

SKELETAL	SMOOTH	CARDIAC
* They are also known as striated, voluntary muscles.	* They are known as unstriated or involuntary muscles.	* They are known as heart muscles and involuntary in nature.
* Multinucleated with light and dark bands.	* They are uninucleated without bands.	* Uninucleate with faint light and dark bands
* They are attached with bones.	* They are present in vessels, oesophagus.	* They are present in wall of heart
* They are fibrous and unbranched, cylindrical in shape.	* They are fibrous and unbranched, spindle shaped.	* They are fibrous and cylindrical in shape.

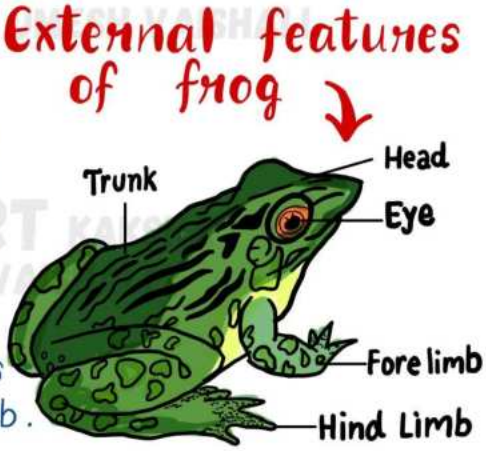
Neural Tissue :-

- The unit of neural system is neuron. Neuroglial cell protects and supports the neuron.
- When neuron get stimulated, electrical impulses are generated that travel along the plasma membrane (axon).

The tissues organize to form organs which in turn associate to form organ system in multicellular organisms.

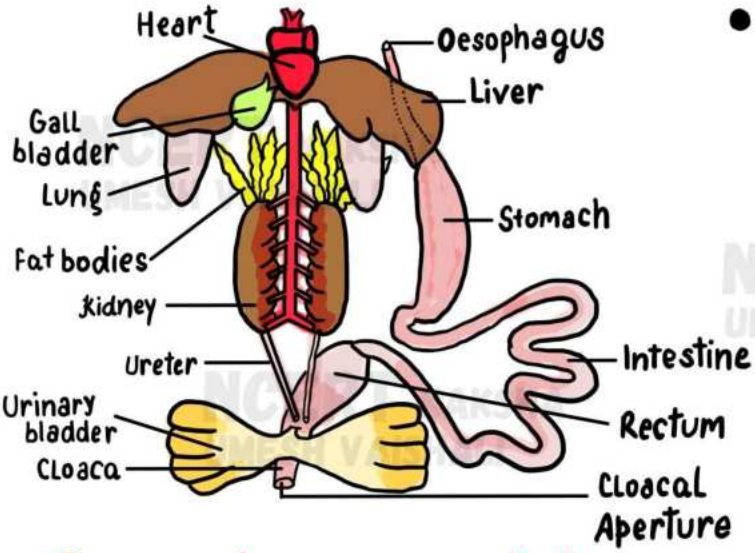
Frogs :-

Morphology :- Frogs are cold-blooded organism having ability to change colours to hide from enemies. Body is divisible into head and trunk, bulged eyes covered by nictitating membrane. Male frog is different from female having vocal sacs and copulatory pad on first digit of forelimb.



Anatomy :-

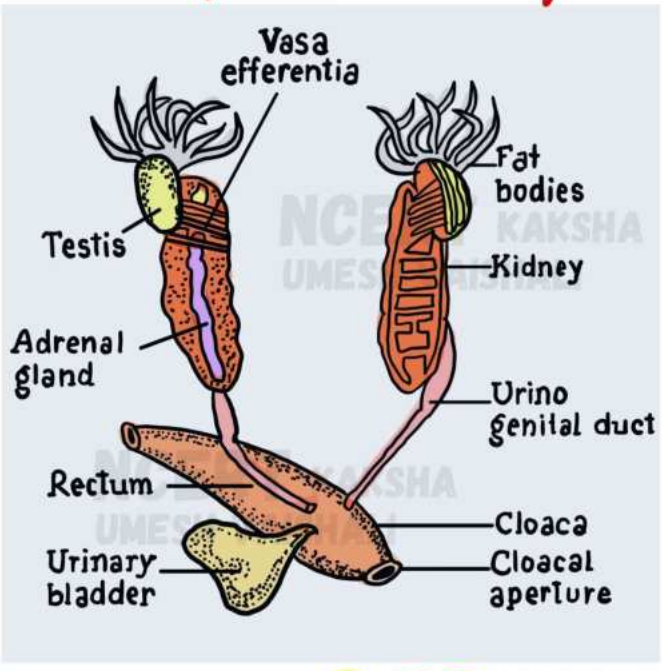
- Digestive system consists of alimentary canal and digestive glands.
- Digestion starts in stomach and final digestive occurs in small intestine. Digested food is absorbed by villi and microvilli present in the inner wall of small intestine.
- Skin acts as aquatic respiratory organs (cutaneous respiration). On lands skin, buccal cavity and lungs acts as respiratory organs.



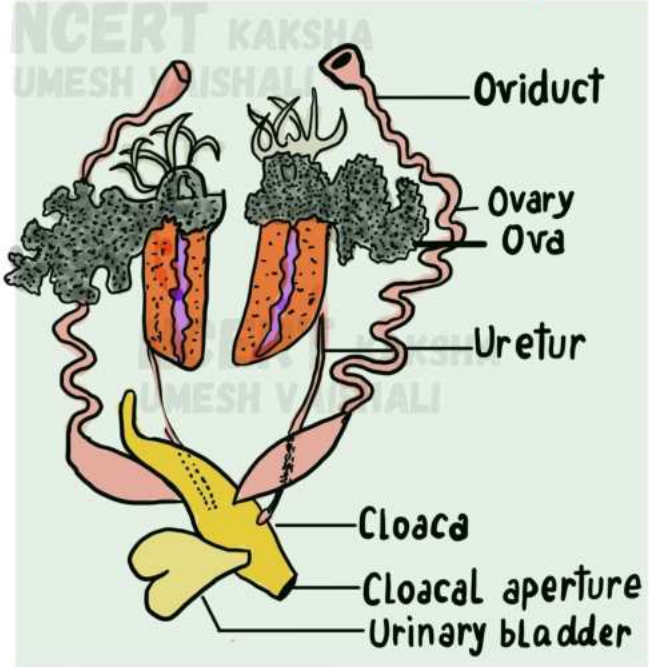
Internal organs of frog showing complete digestive system

- The vascular system of frog is well-developed closed type. Heart is 3-chambered Blood consist of plasma, RBC, WBC and Platelets.
- Frog have a lymphatic system consisting of lymph, lymph channels and lymph nodes.
- The elimination of nitrogenous wastes is carried out by a well developed excretory system. The excretory system consists of a pair of kidneys, ureters, cloaca and urinary bladder. The frog excretes urea and thus is a **ureotelic** animal.
- The system for control and coordination is highly evolved in the frog. It includes both neural system and endocrine glands.
- Frogs have well organised male and female reproductive systems. Male reproductive organs consists of a pair of yellowish ovoid testes, which are found adhered to the upper part of kidneys by mesorchium. The female reproductive organs include a pair of ovaries which are situated near kidneys.
- Fertilisation is external and takes place in water. Development involves a larval stage called tadpole. Tadpole undergoes metamorphosis to form the adult.

Male Reproductive System



Female Reproductive System



UNIT-3 (CELL: STRUCTURE AND FUNCTIONS)

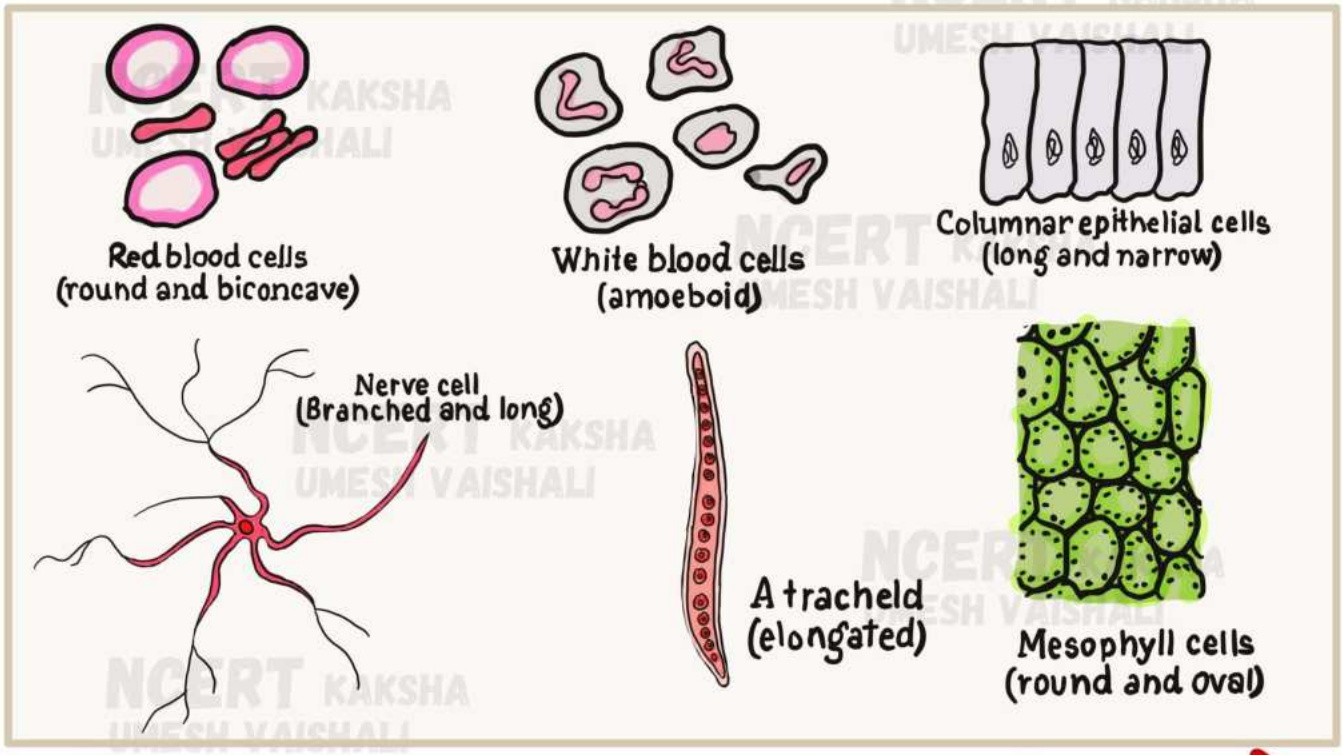
CHAPTER-8

Cell: The Unit Of Life

➡ **Cell** :- Cell is the structural and functional unit of organisms which may be unicellular or multicellular.

➡ **Cell Theory** :- Important postulates of cell theory are :

- All the living organisms are made up of cells i.e., they are **morphological and structural units** of living organisms and life exists only in cells.
- The cells contain **hereditary material** i.e. they are responsible for transmission of characters.
- **New cells are formed** de novo i.e., afresh from abiotic materials analogous to crystal formation.
- Cells are responsible for all the metabolic activities within the living organisms i.e. they are **physiological units** of living organisms.
- A cell is a small **mass of protoplasm** usually containing a nucleus or nuclear material along with some organelles and is bounded by plasma membrane. A cell organelle cannot survive alone.



Different Shapes Of the Cells

Prokaryotic Cells :-

- Prokaryotic cells are represented by bacteria, Blue green algae, Mycoplasma and PPLO. They multiply rapidly and vary in size greatly.
- Bacteria cells may be Bacillus (rod shaped), Coccus (spherical), Vibrio (comma-shaped) and spirillum (spiral).
- All prokaryotic cells have cell wall surrounding the cell membrane except in mycoplasma. Genetic material is naked.
- The plasmid DNA, in some bacteria provides some special features like resistance to antibiotics.
- Cell organelles like Mitochondria, Golgi bodies etc. are absent in prokaryotes A specialized differentiated cell membrane called Mesosome is the characterstic of prokaryotes.

Cell Envelope And Its Modifications :-

Gram Positive (retain gram stain) ← **BACTERIA** → Gram Negative (do not take up gram stain)

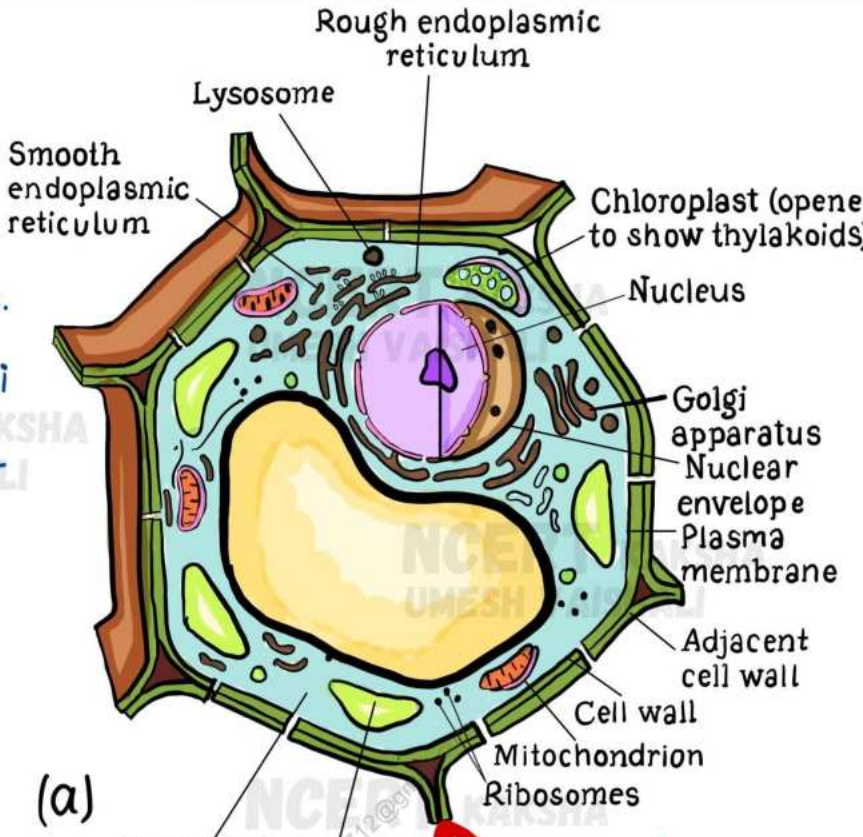
- In bacterial cell a chemically complex cell envelop is present, which consist of three layers. The outermost is Glycocalyx, middle one cell wall and inner innermost is the cell membrane.
- Glycocalyax may be as loose sheath in some bacteria called slime layer. In some other bacteria Glycocalyx may be thick and tough called capsule.
- Plasma Membrane is semi-permeable having mesosome in the form of vesicles, tubules and lamellae. They help in cell wall formation, DNA replication and distribution to daughter cells.
- Motile bacterial cell contain Flagella, which is composed of filament, hook and basal body. Pili and fimbriae are the other surface structures that help the bacteria to attach with host and other substances.

Ribosomes and Inclusion Bodies :-

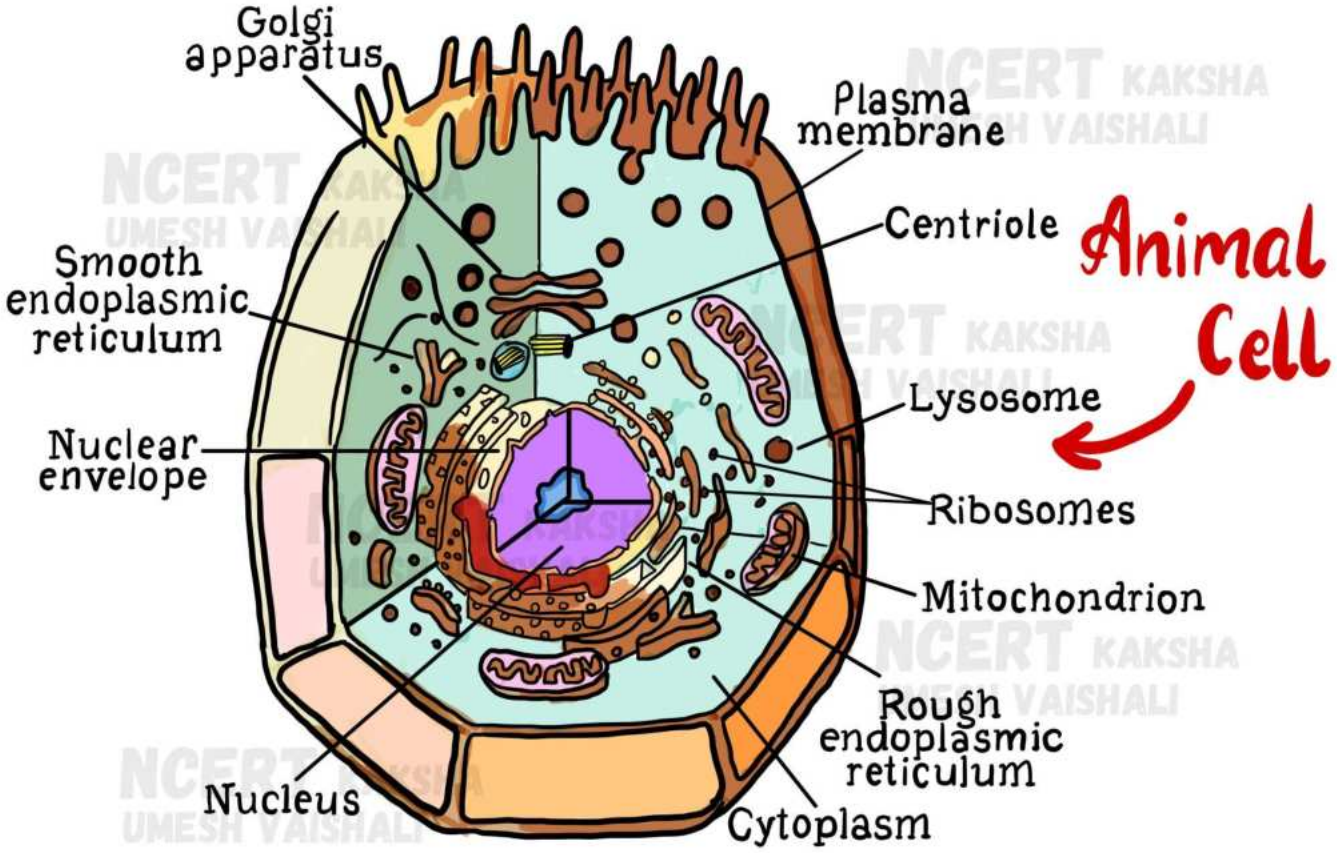
- In Prokaryotes, ribosome are attached with cell membrane having two subunits - 50S and 30S to form together 70S prokaryotic ribosomes.
- Ribosomes are site of protein synthesis. Ribosomes attached with mRNA to form a chain are called polyribosomes.
- Reserved materials in Prokaryotic cells are present in Cytoplasm as cell inclusion bodies, which may contain phosphate, granules, glycogen granules etc.
- Gas vacuoles are found in blue green algae and purple and green photosynthetic bacteria.

Eukaryotic Cell :-

- Eukaryotic cells are present in Protista, Plants, Animals and fungi. Cytoplasm is divided into comparments due to presence of membrane bounded organelles.
- The cells contain well organised nucleus with nuclear membrane. The genetic materials are arranged in chromosomes.
- Plants cells differ in having cell wall, plastids and large central vacuole as compared to animal cells. Animal cells have centrioles, which are absent in plant cells.



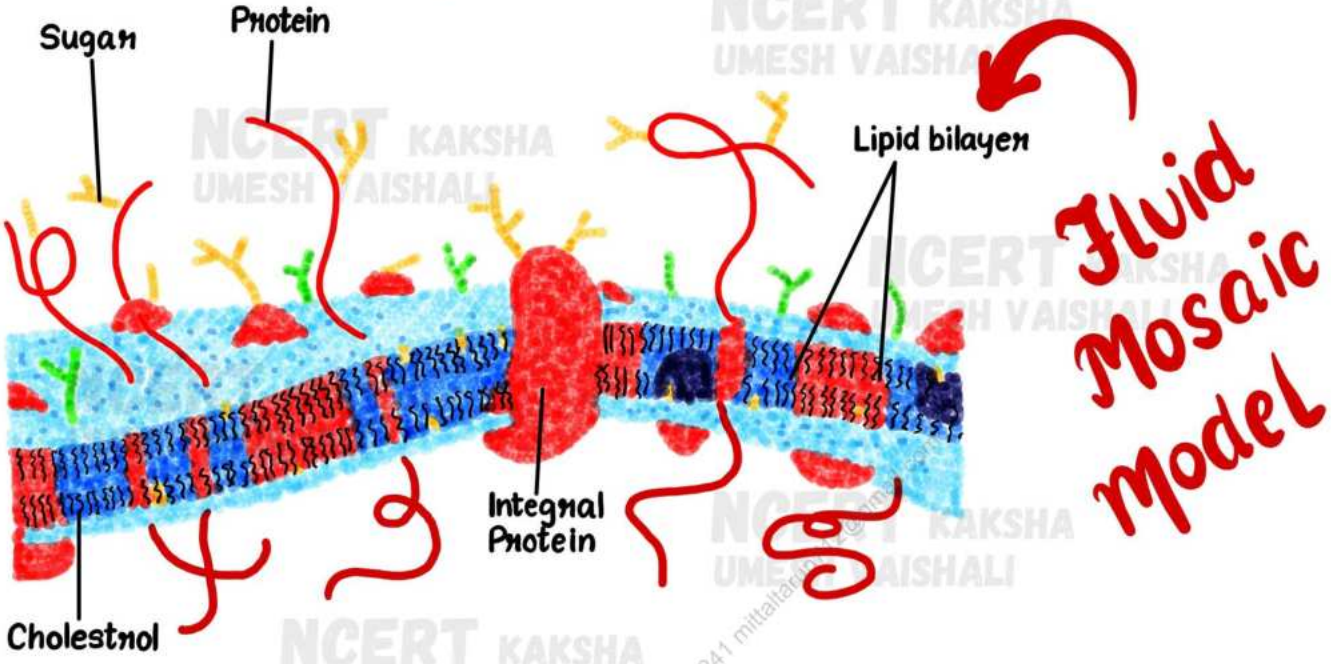
(a) Plant Cell



(b) Animal Cell

Cell Membrane ~

- Cell membrane is composed of lipids that are arranged in bilayer. The lipid Component is mainly composed of phosphoglycerides. Later it was found that protein is also present in cell membrane. Ratio of protein and lipids varies in different cells.



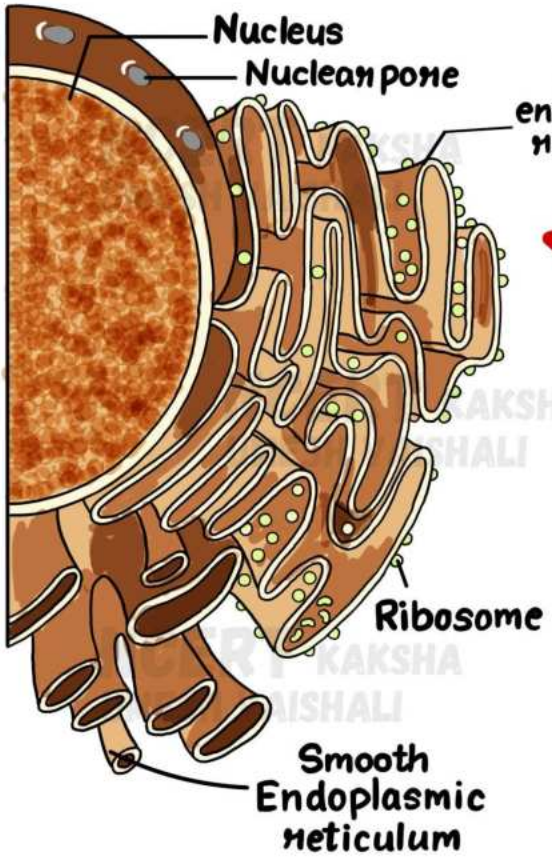
- Membrane protein may be integral or peripheral. Integral protein remains buried in membrane but peripheral protein lies on the surface.
- Singer and Nicholson (1972) proposed **fluid mosaic model**. According to this model the quasi-fluid nature of lipid enables lateral movement of protein within the bilayer of lipids.

Cell Wall ~ It is present outside cell membrane in all the plant cells, bacteria, cynobacteria, fungi and some protists. In plant cells, it is formed of primary cell wall of cellulose, hemicellulose and pectin, and secondary cell wall of cellulose microfibrils further strengthened by suberin or liginin or cutin. Middle lamella of calcium and magnesium pectates lies between cell walls of adjoining plant cells. Cell wall is protective and supportive in function.

Endomembrane System ~

- **Endoplasmic Reticulum:** It is a well developed network of interconnected cisternae, tubules and vesicles throughout the cytoplasm of cell. It is of 2 types: SER (without ribosomes) and RER (with ribosomes). ER helps in cell circulatory system, a part of cytoskeleton, storage, cell plate and nuclear membrane formation, lipid synthesis (SER), protein synthesis (RER) etc.

Endoplasmic Reticulum.



- **Golgi Complex :** It is formed of flat and curved cisternae, vacuoles and vesicles. It has two specific faces: Cis (formative) and trans (maturation) face. It is involved in cellular secretion, condensation of secretion, cell plate formation, acrosome formation and glycosylation of lipids and proteins.

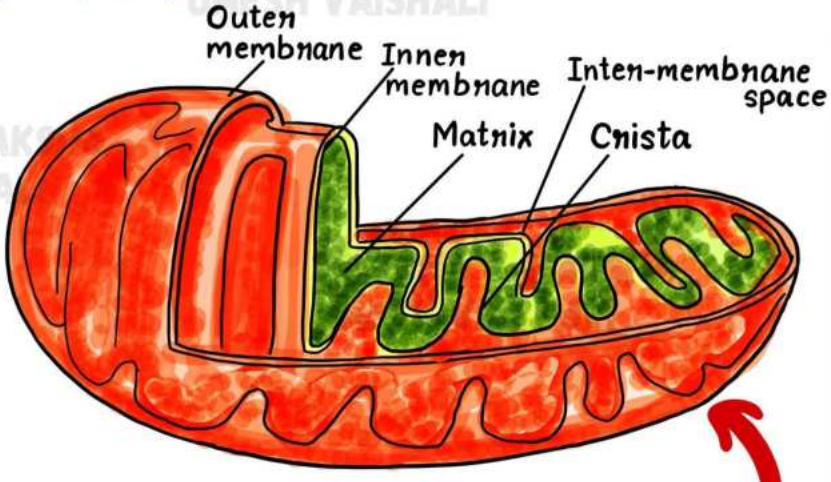
- **lysosomes :** These were discovered by de Duve (1995) and are electron microscopic, vesicullar structures having acid hydrolases (with pH5) which help in heterophagy, autophagy, autolysis, extracellular digestion, seed germination, scavenging, defence, etc. These show polymorphism.

- **Vacuoles :** The vacuole is the membrane-bound space found in the cytoplasm. It contains water, sap, excretory product and other materials not useful for the cell. The vacuole is bound by a single membrane called tonoplast. In plant cells the vacuoles can occupy upto 90 percent of the volume of the cell.

In Amoeba the contractile vacuole is important for osmoregulation and excretion. In many cells, as in protists, food vacuoles are formed by engulfing the food particles.

- **Mitochondria :**

It was first discovered by Kolliker (1880) and show great variations in shape, size and number. It is formed of two mitochondrial membranes and two chamberes. Inner mitochondrial membrane is infolded to form cristae which are studied with oxysomes. Inner chamber is filled with



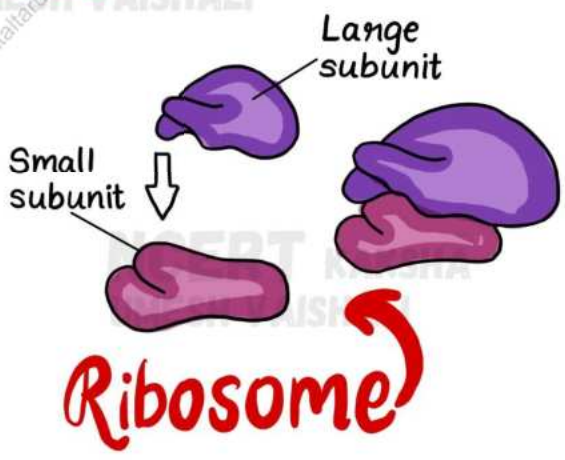
Structure Of Mitochondrion

matrix which has 70S ribosomes, enzymes of Kreb's cycle, rings of DNA molecules etc.

Mitochondria are of semiautonomous nature. These act as Power houses (as are the sites of ATP synthesis).

- **Plastids :** They are found in all the plant cells and some protisits. These are of 2 types :- Leucoplasts (colourless and food storage) and chromoplasts (with coloured pigments). Most common type of plastids are chloroplasts. These vary in shape, size and number. A chloroplasts has two limiting membranes, ground substance stroma or matrix and grana. Stroma is with 70S ribosomes, enzymes for CO_2 fixation and protein synthesis, naked and circular DNA molecules etc. Each granum is formed of superimposed thylakoids which contain photosynthetic units called quantasomes. Light phase of photosynthesis occurs in quantasomes of the thylakoids, while dark phase of photosynthesis occurs in stroma of chloroplast and involves CO_2 fixation. Chloroplasts are also semiautonomous in nature. Chloroplasts are sites of photosynthesis so are called **Kitchens of the cell.**

- **Ribosomes :** These were discovered by Palade and are electron microscopic, naked, ribonucleoprotein particles attached on RER or lying freely in the cytoplasm. These are of 70S type (50S and 30S subunits) in prokaryotes and of 80S type (60S+40S subunits) in eukaryotes. These are sites of protein synthesis so are called protein factories.



- **Cytoskeleton :** It is formed of microtubules, microfilaments and intermediate filaments. A microtubule is hollow and cylindrical structure formed of spirally-arranged 13 rows of α, β-dimeric tubulin protein. Micro tubules form astral rays and spindle fibres which help in cell division. Microfilaments are solid and contractile structures which are present in myofilaments of muscle fibres and also in microvilli of intestinal cells.

- **Cilia And Flagella :** Cilia (sing : cilium) and Flagella (sing.: flagellum) are hair like outgrowths of the cell membrane. Cilia are small structures which work like oars, causing the movement of either the cell or the surrounding fluid. Flagella are comparatively longer and responsible for cell movement. They both have similar ultrastructure. Each is formed of 11 microtubules with 9+2 arrangement. Each peripheral microtubule is doublet and are interlinked by interdoublet linkers. Both help in locomotion and Nutrition.

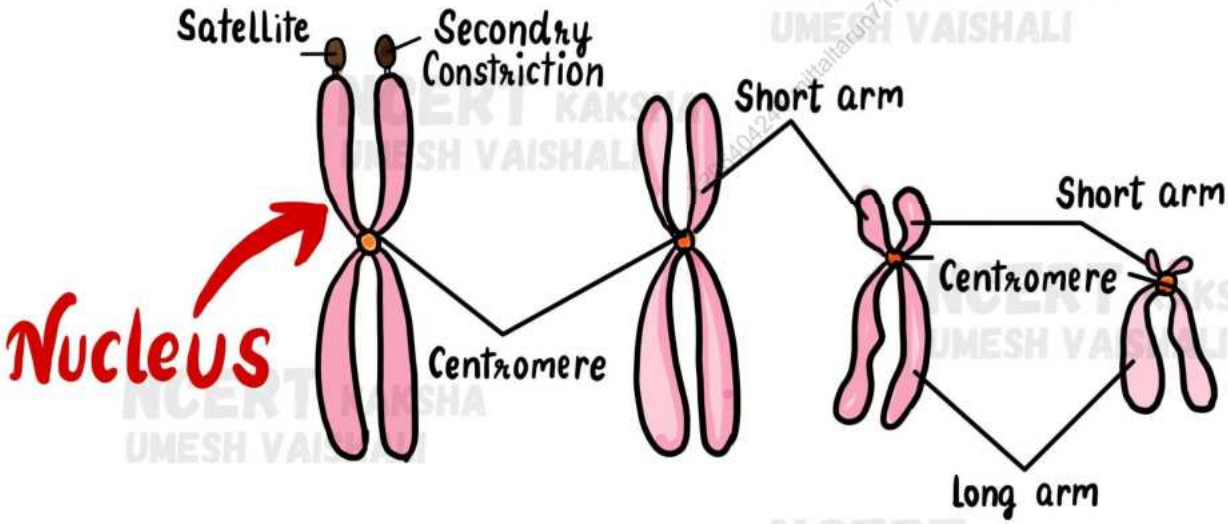
• Centrosome and Centrioles :

Centrosome is an organelle usually containing two cylindrical structures called centrioles. They are surrounded by amorphous percentriolar materials. Both the centrioles in a centrosome lie perpendicular to each other in which each has an organisation like the cartwheel.

Centrioles were discovered by Van Benden. It is light microscopic microtubular structure formed of 9 microtubules in 9+0 arrangement. Each microtubule is triplet in nature.

• Nucleus :

- Nucleus has highly extended, elaborate and nucleoprotein fibres called chromatin, nuclear matrix and nucleoli. The outer membrane is continuous with endoplasmic reticulum and bears ribosomes.
- The chromatin materials change into chromosome during active cell division. It consists of DNA and histone proteins.



- Every chromosome has a primary constriction or the centromere, on the sides of which disc shaped Kinetochores are present.
- Some chromosomes have non-staining secondry constriction at certain location. This gives a small fragment called satellite

• **Microbodies :** Many membrane bound minute vesicles called microbodies that contain various enzymes, are present in both plant and animal cells.

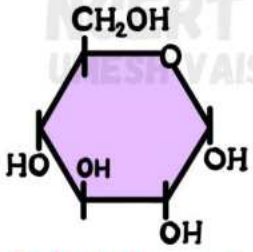
UNIT-3 (CELL: STRUCTURE AND FUNCTIONS)

CHAPTER-9

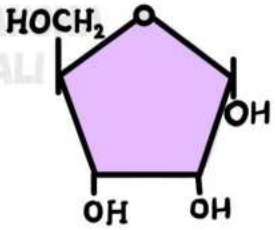
Biomolecules

Primary Metabolities :-

A primary metabolite is a kind of metabolite that is directly involved in normal growth, development and reproduction. It usually performs a physiological function in the organism (i.e. an intrinsic function). A primary metabolite is typically present in many organisms or cells. Example- Carbohydrates, proteins, lipids and vitamins.

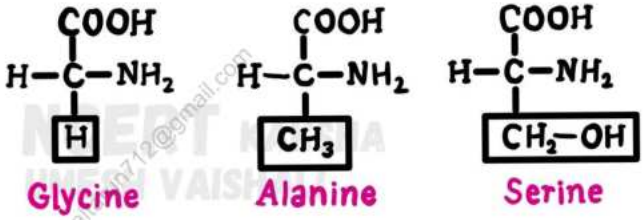


$C_6H_{12}O_6$ (Glucose)



$C_5H_{10}O_5$ (Ribose)

Sugars (Carbohydrates)



Amino acids

Secondary Metabolites :-

Alkaloids, flavonoids, rubber essential oils, antibiotics, coloured pigments, scents, gums, spices. These are called secondary metabolites.

Biomacromolecules :-

Those which have molecules weights less than one thousand dalton and are usually referred to as micromolecules or simply biomolecules while those which are found in the acid insoluble fraction are called macromolecules or biomacromolecules.

Proteins :-

Proteins are polypeptide chains made up of amino acids. There are 20 types of amino acids joined together by peptide bond between amino and carboxylic group. There are two kinds of amino acids.

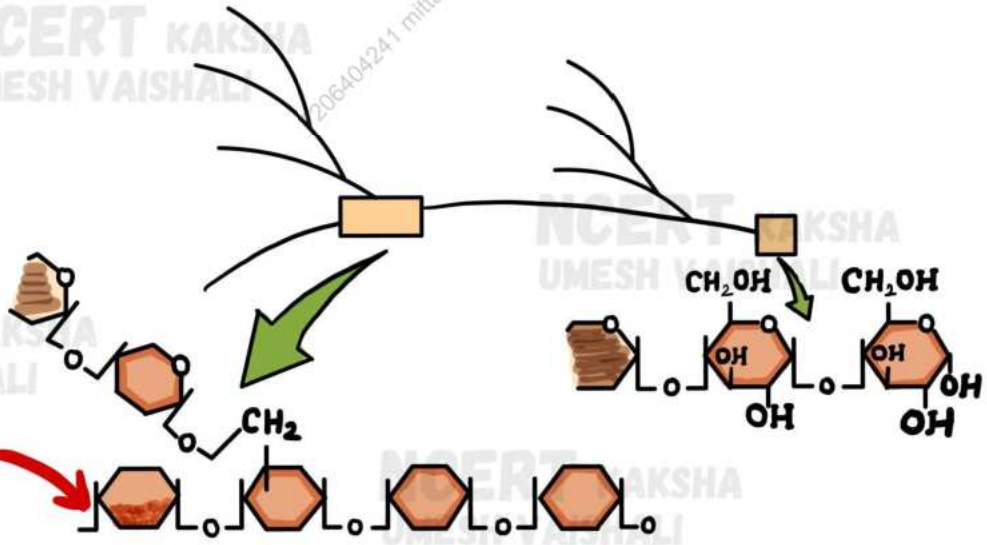
- **Essential Amino Acids** are obtained by living organism along with food.
- **Non-Essential Amino Acids** can be prepared by our body from raw materials.

- The main functions of protein in living cells are :-
- Transport or nutrient across the membrane.
- Fight infectious organisms.
- Produce enzyme and proteins.

➡ Polysaccharides (Carbohydrates) :-

- Polysaccharides are long chain of sugar containing different monosaccharaides as a building block.
- Starch is present in plants as store house of energy. It forms helical secondry structure. It can hold the I_2 molecules in the helical structure.
- Cellulose molecules contain glucose molecules joined together by 1-4 β linkage. It is the most abundant organic molecules on earth.
- Glycen is called animal starch as it is the reserve food materials for animals, bacteria and fungi. In this, glucose molecules are arranged in highly branched brush like chain having two types of linkage 1-4 α in straight chain and 1-6 linkage in branching.

Portion of Glycogen



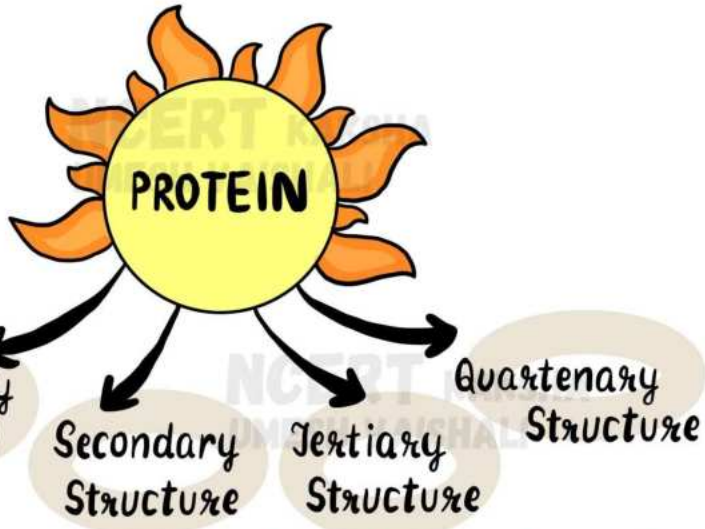
➡ Nucleic Acid :-

Nucleic acids are polynucleotides. A nucleic acid has three chemically distinct components - heterocyclic compound (nitrogenous base), polysaccharides (ribose/deoxyribose sugar) and phosphate or phosphoric acid.

- The sugar found in nucleic acid is either ribose or deoxyribose. Nucleic acid containing deoxyribose sugar is called DNA (Deoxyribonucleic Acid) and those containing ribose sugars are called RNA (Ribonucleic acid).
- Biomolecules are constantly being changed into some other biomolecules and also made from other biomolecules. This breaking and making is through chemical process called metabolism.

- In living organism, all the metabolic reactions are enzyme catalyzed. Catalysts are those substances that alter the rate of reaction. The protein with catalytic power is called enzyme .

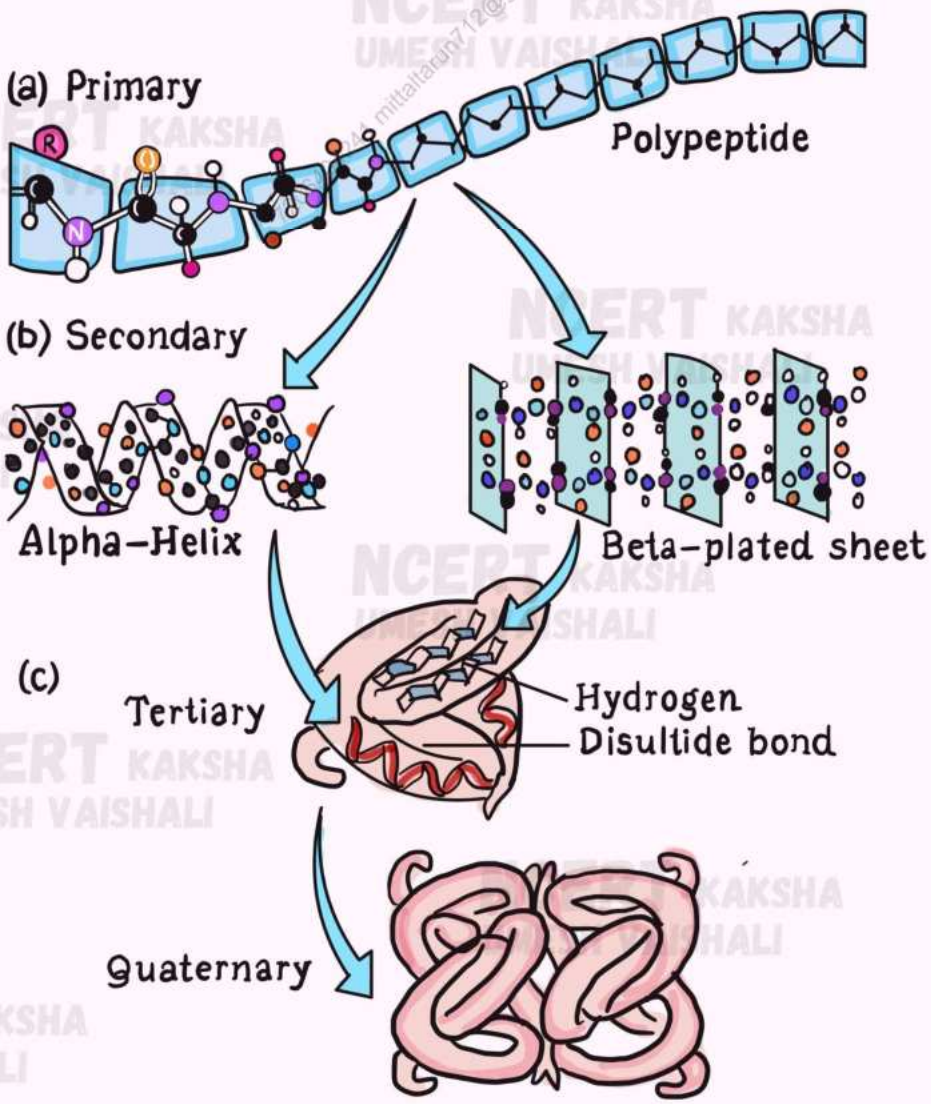
Structure Of Proteins :-



Primary Structure

It is the basic structure of protein in which a number of polypeptides are involved having sequence of amino acids. The first amino acid of sequence is called N-terminal amino acid and last amino acid of peptide chain is called C-terminal amino acid.

Various levels of Protein Structure



- **Secondary structure Protein** → It threads forms helix. There are three types of secondary structure - α helix, β pleated and collagen. In α helix, the polypeptide chain is coiled spirally in right handed manner.

- In β pleated secondary proteins two or more polypeptide chains are inter connected by hydrogen bonds. In collagen there are three strands or polypeptides coiled around one another by hydrogen bonds.

- In Tertiary structure long protein chain is folded upon itself like a hollow woollen ball to give three dimensional view of protein.

- **In Quaternary structure** - each polypeptide develops it own tertiary structure and function as sub unit of protein. Eg. Hemoglobin. In adult human hemoglobin 4 sub units are involved. The two subunits are of α type and two sub units of β types.

Enzymes :-

Enzymes a e water soluble, colloidal organic macrobiomolecules which are wholly or partially proteinous in nature, biological in origin, produced in microamounts and capable of catalyzing specific bio-chemical reactions under specific conditions of temperature and pH.

- **Chemical Reactions** ~ When bonds are broken and new bonds are formed during transformation, this will be called a chemical reaction. For example:

$$Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2H_2O$$

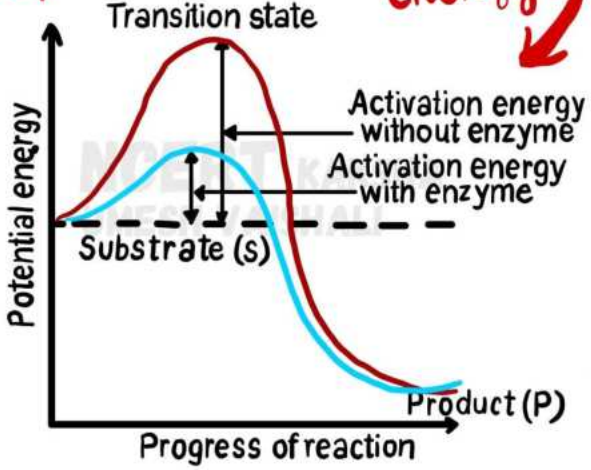
Is an inorganic chemical reaction. Similarly, hydrolysis of starch into glucose is an organic chemical reaction. Rate of a physical or chemical process refers to the amount of product formed per unit time. It can be expressed as:

$$\text{rate} = \frac{\delta P}{\delta t}$$

- **How Do Enzymes Bring About Such High Rates Of Chemical Conversions?**

The chemical which is converted into a product is called a substrate. Hence enzymes, i.e. proteins with three dimensional structures including an 'active site', convert a substrate (S) into a product (P). Symbolically, this can be depicted as: $S \rightarrow P$

Concept of Activation Energy.



It is now understood that the substrate 'S' has to bind the enzyme at its 'active site' within a given cleft or pocket. The substrate has to diffuse towards the 'active site'. There is thus, an obligatory formation of an 'ES' complex. E stands for enzyme. This complex formation is a transient phenomenon.

Nature Of Enzyme Action~ The formation of the ES complex is essential for Catalysts.

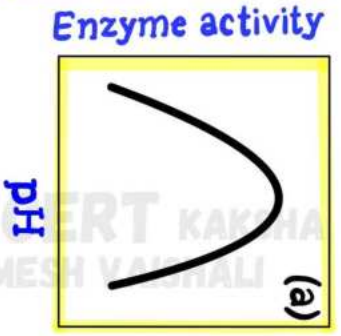
$$E + S \quad ES \longrightarrow EP \longrightarrow E + P$$

The catalytic cycle of an enzyme action can be described in the following steps :

- First the substrate binds to the active site of the enzyme, fitting into the active site.
- The binding of the substrate induces the enzyme to alter its shape, fitting more tightly around the substrate.
- The active site of the enzyme, now in close proximity of the substrate breaks the chemical bonds of the substrate and the new enzyme-product complex is formed.
- The enzyme releases the products of the reaction and the free enzyme is ready to bind to another molecule of the substrate and run through the catalytic cycle once again.

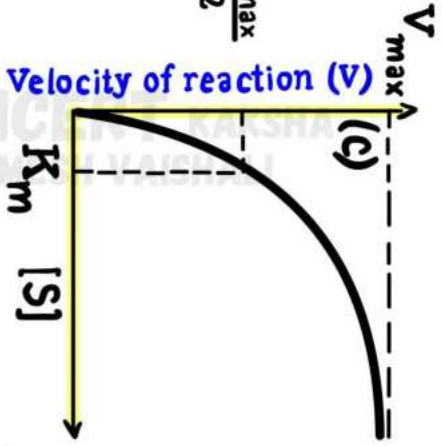
Factors Affecting Enzyme Activity~

- Temperature – An enzyme is active within a narrow range of temp. Temperature ate which enzyme is most active is called optimum temperature. The enzyme activity decreases above and below this temp.



- pH – Every enzymes has an optimum pH at which it is maximum active. Most of the intracellular enzymes work at neutral pH.

- Concentration Of Substrate ~ Increase in substrate concentration increases the rate of reaction due to occupation of more active sites by substrate.



* Competitive Inhibitor~ when the molecular structure of inhibitor resembles the substrate, it inhibits the function of enzymes.

Classification And Nomenclature of Enzymes ~

- **Oxidoreductases / dehydrogenases:**

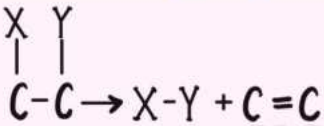
Enzymes which catalyse oxidoreduction between two substrates S and S' e.g.,

$$S \text{ reduced} + S' \text{ oxidised} \longrightarrow S \text{ oxidised} + S' \text{ reduced}$$

- **Transferases:** Enzymes catalysing a transfer of a group, G (other than hydrogen) between a pair of substrate S and S' e.g.,

$$S\text{-}G + S' \longrightarrow S + S'\text{-}G$$

- **Lyases:** Enzymes that catalyse removal of groups from substrates by mechanisms other than hydrolysis leaving double bonds.



- **Isomerases:** Includes all enzymes catalysing inter-conversion of optical, geometric or positional isomers.
- **Ligases:** Enzymes catalysing the linking together of 2 compounds, e.g., enzymes which catalyse joining of C-O, C-S, C-N, P-O etc. bonds.

Co-factors ~ Co-fa are the non-protein constituent of an enzyme which ma enzyme more catalytically active. The protein portions of enzyme are called apoenzyme.

Prosthetic groups are organic compounds and are tightly bound to the apoenzyme. For example, in peroxidase and catalase, which catalyze the break down of hydrogen peroxide, haem is the prosthetic group.

The essential chemical components of any coenzymes are vitamins. Example - coenzyme NAD and NADP contain the vitamin niacin.

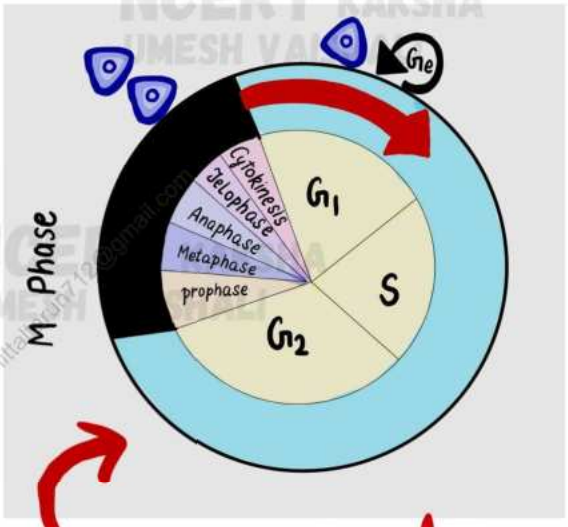
CHAPTER-10

Cell Cycle And Cell Division

Cell Cycle :-

- The sequence of events by which a cell duplicates its genome, synthesizes the other constituents of cells and eventually divides into two daughter cells is called cell cycle.
- DNA synthesis occurs in one specific stage of cell division but distribution of chromosome in cells occurs in complex series of events during cell division.

Phase of Cell Cycle Diagram :-



Cell Cycle

(a) Interphase :-

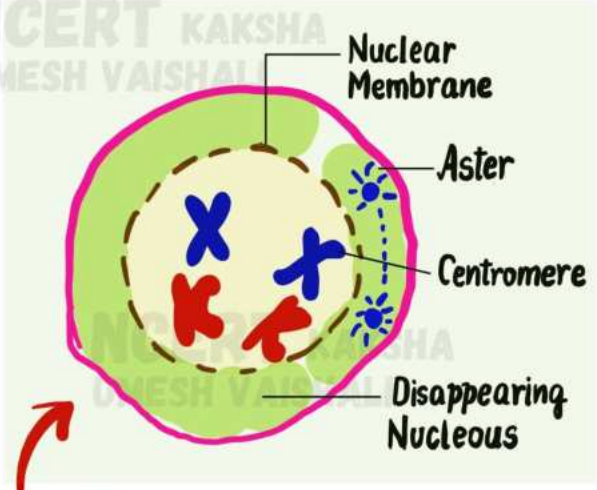
- G_1 Phase : Cell metabolically active and grows continuously but does not replicate DNA.
- S Phase : DNA synthesis occurs, DNA content increases from 2C to 4C, but the number of chromosomes remains same i.e. 2n
- G_2 Phase : Proteins are synthesised in preparation for mitosis while cell growth continues.

(b) M-Phase (Mitosis Phase) :-

- Starts with nuclear division, corresponding to separation of daughter chromosomes (karyokinesis) and usually ends with division of cytoplasm. (cytokinesis).

(i) Prophase :-

- Replicated chromosomes, each consisting of 2 chromatids, condense and become visible.
- Microtubules are assembled into mitotic spindle.
- Nucleous and nuclear envelope disappear.
- Centriole moves to opposite poles.

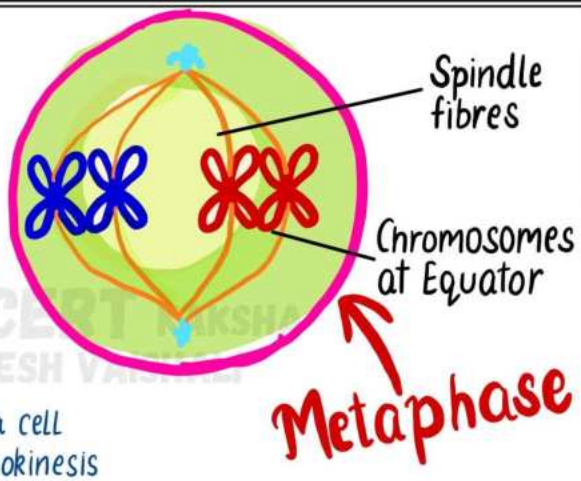


Prophase

(ii) Metaphase :-

- Spindle fibres attached to kinetochores (small disc-shaped structures at the surface of centromore) of chromosomes.

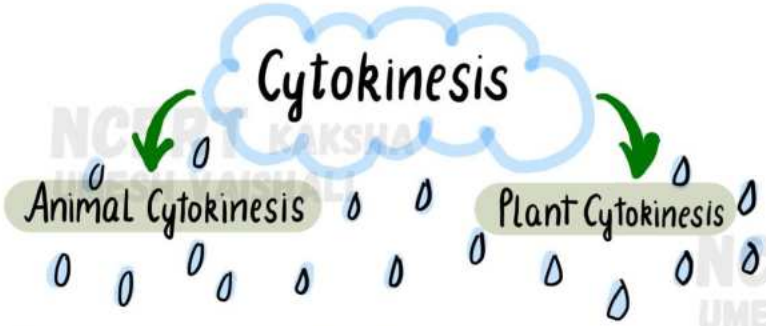
- Chromosomes line up at the equator of the spindle to form metaphase plate.

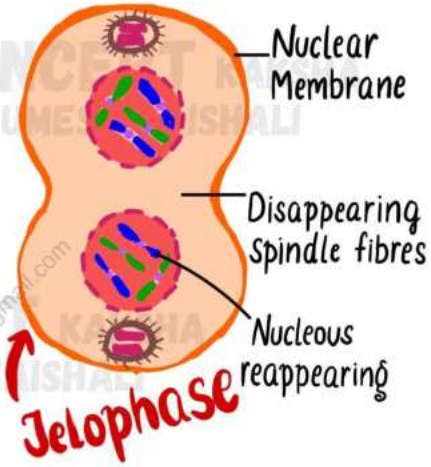


(iii) Telophase :-

- Chromosome cluster at opposite poles.
- Nuclear envelope assembles around chromosomes clusters.
- Nucleous, Golgi Complex. E.R. reforms.

(iv) Cytokinesis :- Is the division of protoplast of a cell into two daughter cells after karyokinesis (nuclear division).



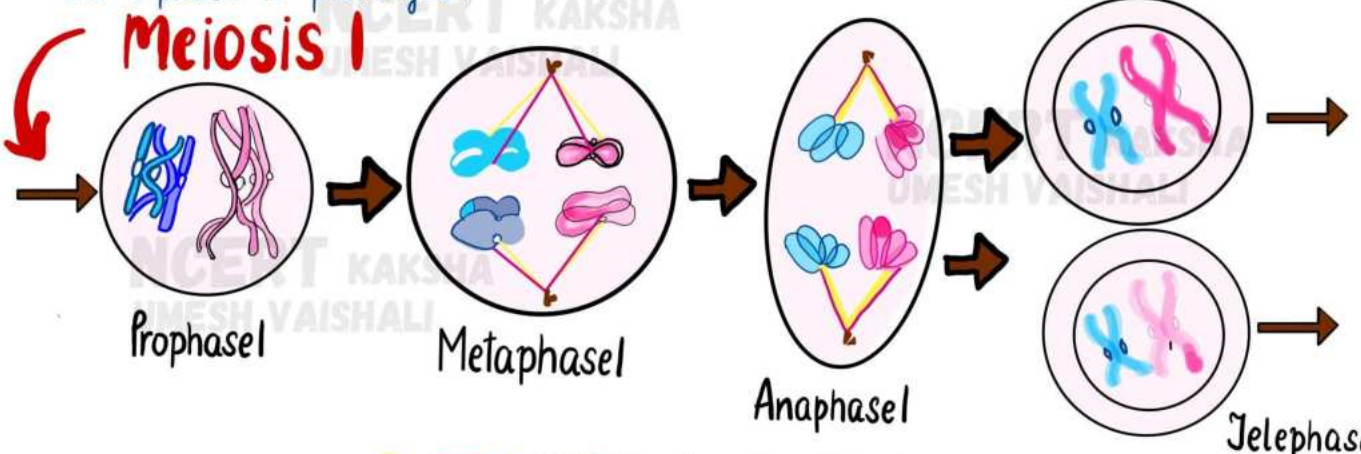


➡ Significance of Mitosis :-

- Mitosis produces diploid daughter cells with identical genetic complement.
- It helps in repair of cells, especially in lining of gut and blood cells.
- Meristematic division in apical and lateral cambium results in continous growth of plants.

➡ Meiosis :-

- Specialised kind of cell division that reduces the chromosomes number by half. Hence it is called reductional division.
- Occurs during gametogenesis in plants and animals.
- Involves two sequential cycles of nuclear and cell division called Meiosis I and Meiosis II.
- It results in 4 haploid daughter cells.
- Interphase occurs prior to meiosis which is similar to interphase of mitosis except the S phase is prolonged.

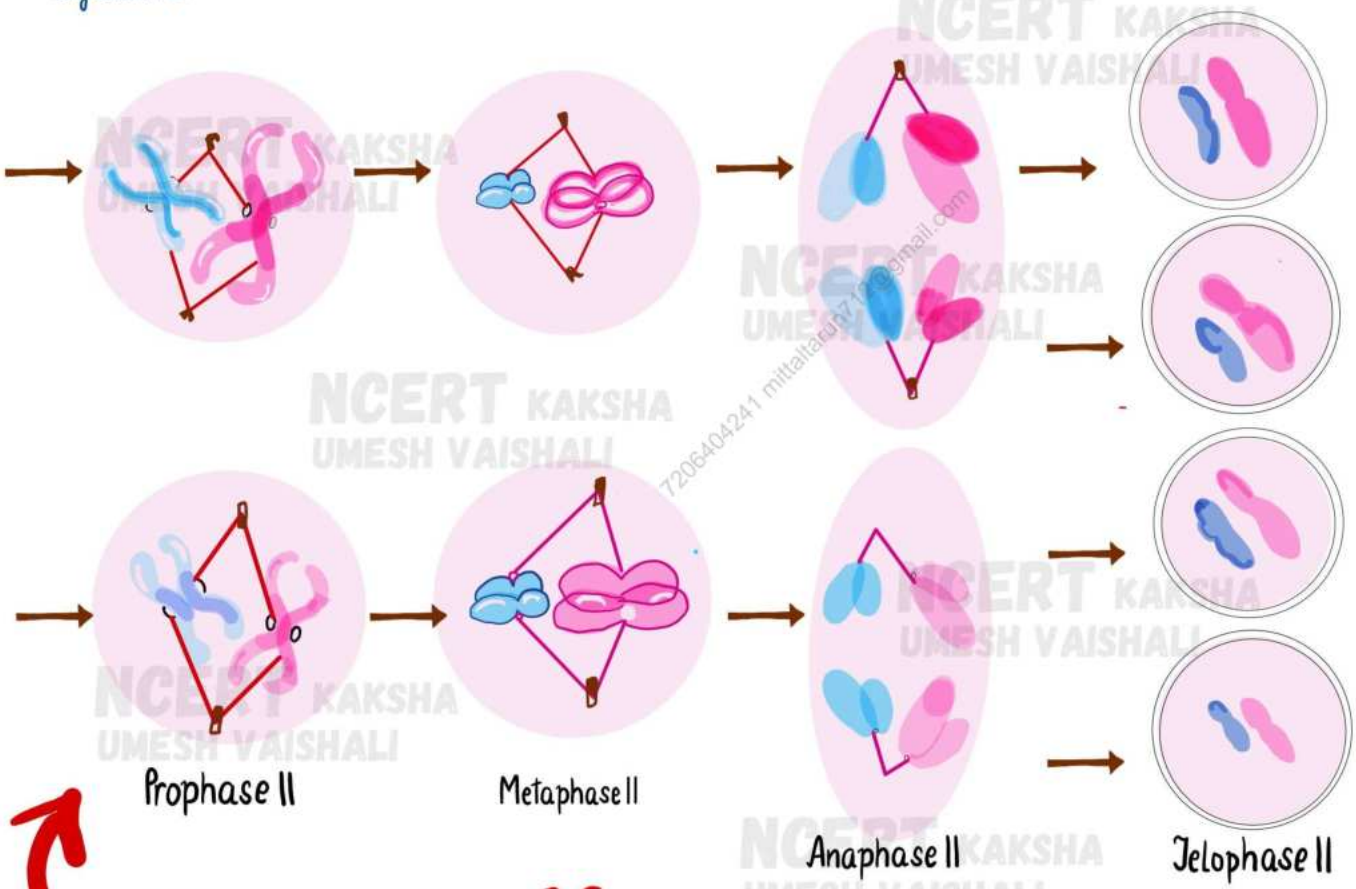


Meiosis I :-

Significance Of Meiosis :-

- Meiosis forms the gametes that are essential for sexual reproduction.
- Crossing over introduces new recombination of traits.
- Helps in maintenance of chromosome number of sexually reproducing organism.
- Provides evidence of basic relationship of organisms.

Meiosis I	Meiosis II
Prophase I	Prophase II
Metaphase I	Metaphase II
Anaphase I	Anaphase II
Telophase I	Telophase II



Meiosis II

Focus Is More Important Than Intelligence

Photosynthesis In Higher Plants

Photosynthesis :-

Photosynthesis is the absorption of light energy and its conversion into stable chemical potential.

It is best approac ed as a three phase process :-

- The absorption of light and retention of light energy.
- The conversion of light energy into chemical potential.
- The stabilization and storage of chemical potential.

$$6CO_2 + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

Early Experiments :-

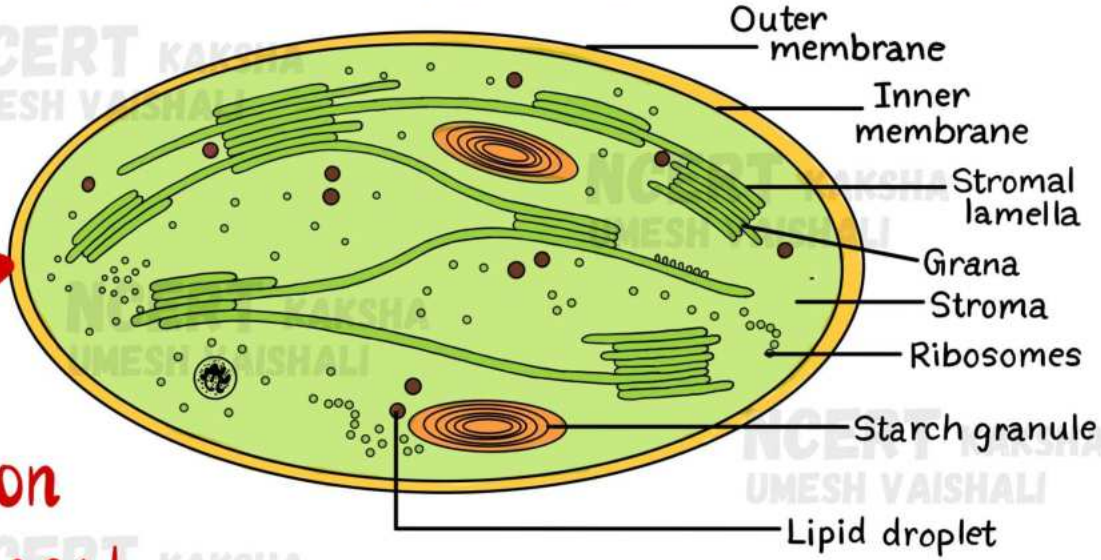
- **Joseph Priestley** in 1770, on the basis of his experiments showed the essential role of air in growth of green plants. A mouse kept in closed space could get suffocated and die but if a mint plant is kept in bell jar neither candle will extinguish nor will the mouse die. He concluded that foul air produced by animal is converted into pure air by plants. Priestley discovered oxygen gas in 1774.

Priestley's Experiment

Where Does Photosynthesis Takes Place :-

- Chloroplasts are **green plastids** which function as the site of photosynthesis in eukaryotic photoautotrophs. Inside the leaves, chloroplast is generally present in mesophyll cells along their walls.

- Within the chloroplast there is a membranous system consisting of grana, the stroma lamellae and the fluid stroma.

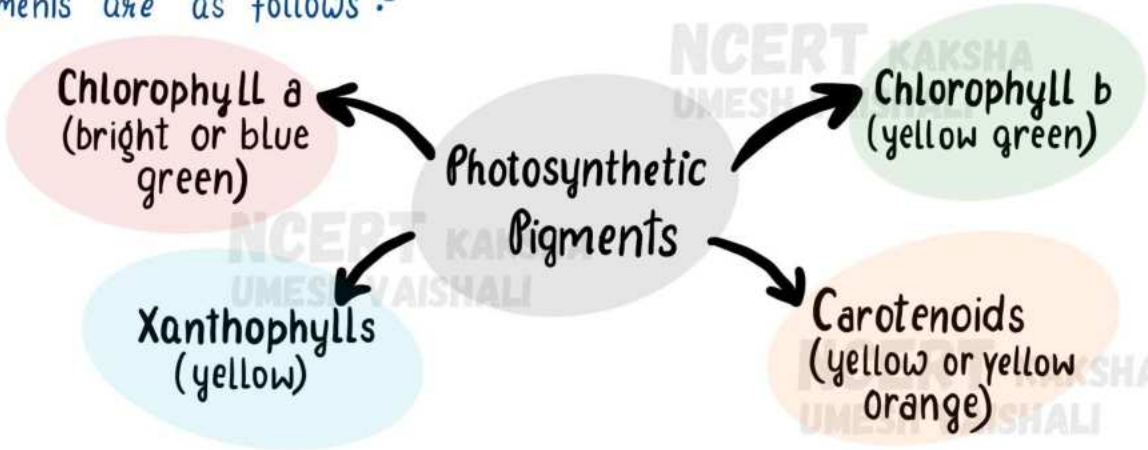


An Electron Micrograph of A Section of Chloroplast

- The membrane system is responsible for synthesizing light energy for the synthesis of ATP and NADPH. In stroma enzymatic reactions incorporate CO_2 in plants leading to synthesis of sugar.
- The reaction in which light energy is absorbed by grana to synthesis ATP and NADPH is called **light reaction**. The later part of photosynthesis in which CO_2 is reduced to sugar, light is not necessary and is called **dark reaction**.

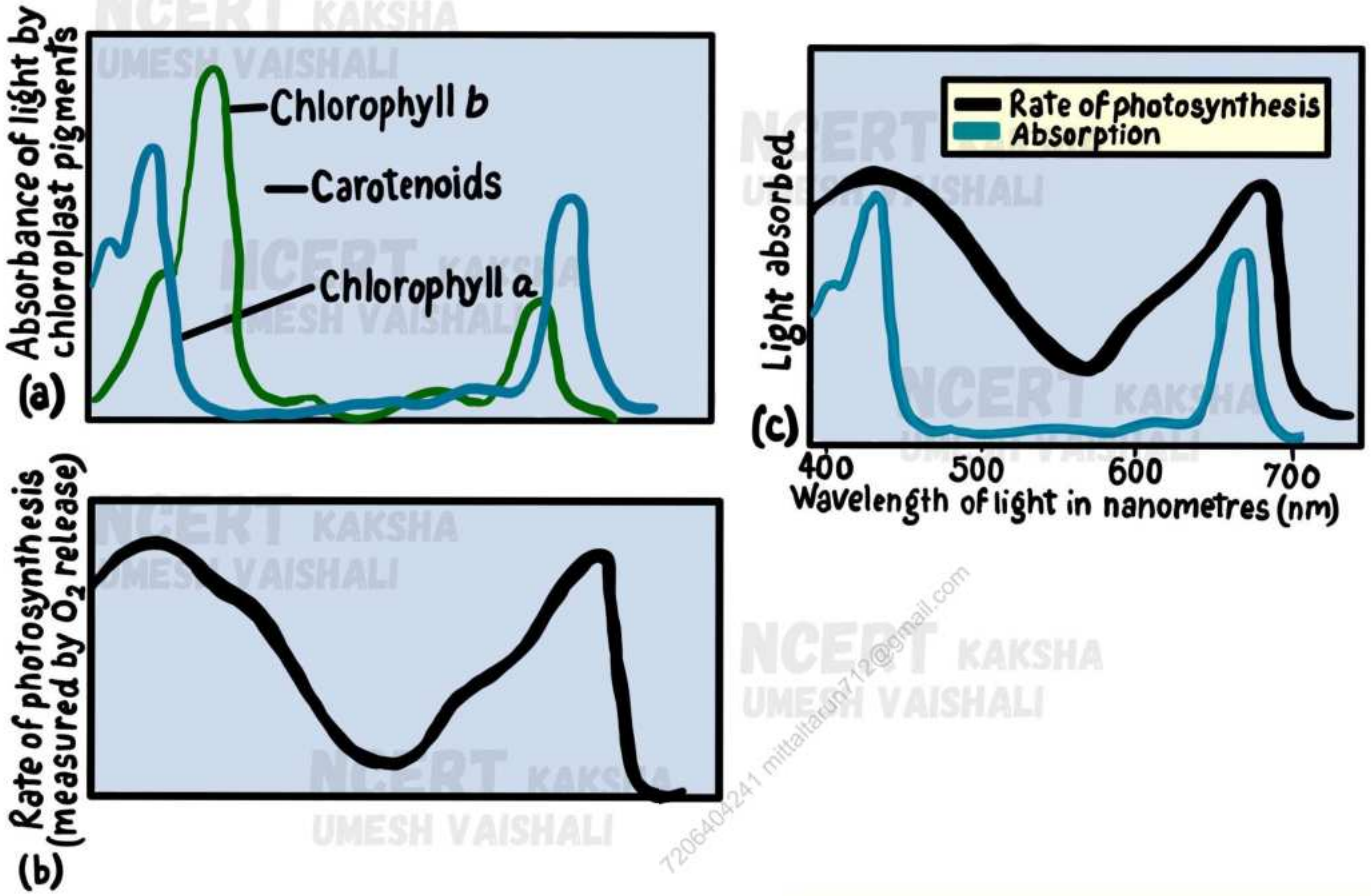
How many types of Pigments are involved in Photosynthesis:-

Pigments involved in Photosynthesis – Chromatographic separation of leaf pigments are as follows :-



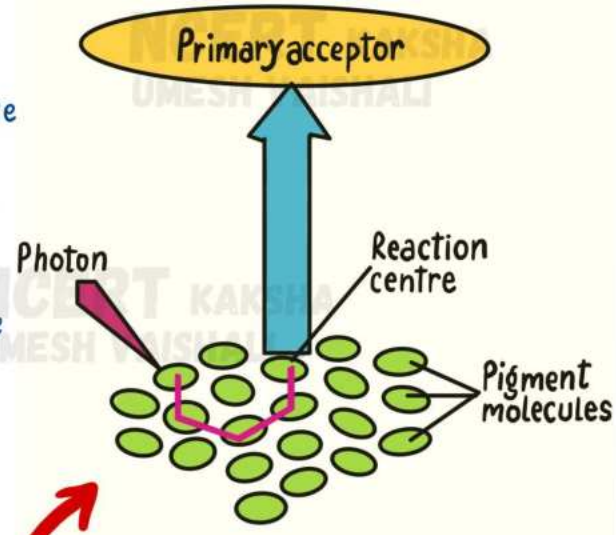
Maximum absorption by chlorophyll a occurs in blue and red regions having higher rate of photosynthesis. So **chlorophyll a** is the chief pigment.

- Other thylakoid pigments like chlorophyll b, xanthophyll and carotenoids are called **accessary pigments** that absorb light and transfer energy to chlorophyll a and protect them from photo-oxidation.



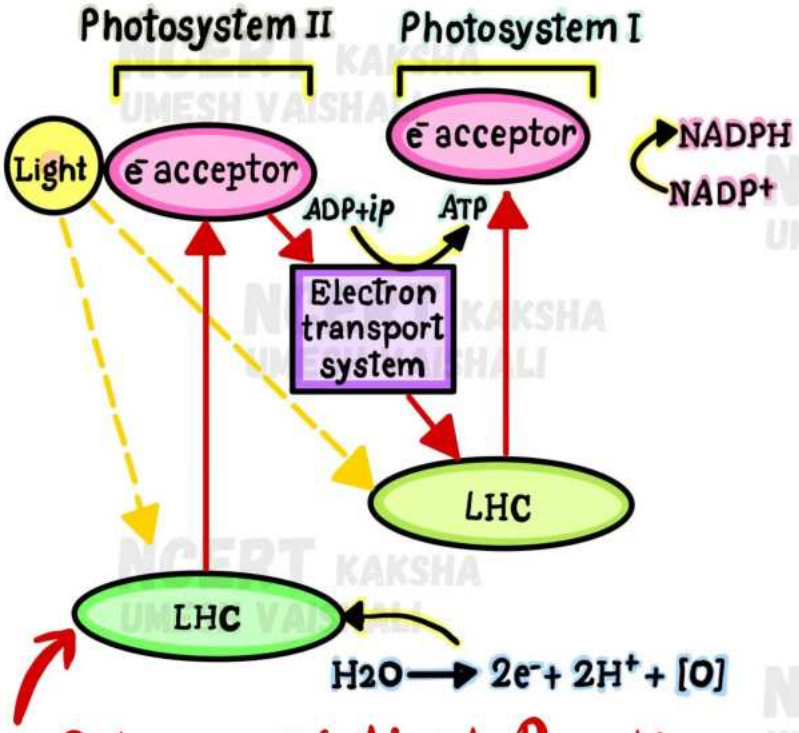
What Is light Reaction :-

- Light reactions or the 'Photochemical' phase include light absorption, watter splitting, oxygen release, and the formation of high energy chemical intermediates, ATP and NADPH.
- The pigments are organised into two discrete photochemical **light harvesting complexes (LHC)** within the **Photosystem I (PSI)** and **Photosystem II (PS II)**.
- The LHC are made up of hundreds of pigment molecules bound to proteins. Each photosystem has all the pigments (except one molecule of chlorophyll a) forming a light harvesting system also called **antennae**.
- In PS I the reaction centre chlorophyll a has an absorption peak at 700 nm, hence is called **P700**, while in PS II it has absorption maxima at 680 nm, and is called **P680**.



The Light Harvesting Complex

The Electron Transport System :-



Z Scheme Of Light Reaction

- Reaction centre of photosystem II absorbs light of 680 nm in red region and causing electron to become excited. These electrons are picked by an electron acceptor which passes to electron transport system consisting of **cytochromes**.
- **Electrons** are passed down the electron transport chain and then to the pigment of PSI.
- Electron in the PSI also get excited due to light of wave length 700 nm and are transferred to another acceptor molecule having a greator redox potential.
- When electron passes in down hill direction, energy is released. This is used to reduce the ADP to ATP and NADP + to NADPH. The whole scheme of transfer of electron is called **Z-scheme** due to its shape.
- Photolysis of water release electrons that provide electron to PS II. Oxygen is also released during this process.

$$2H_2O \rightarrow 4H^+ + O_2 + 4e^-$$

Splitting Of Water :-

The electrons that were moved from photosystem II must be replaced. This is achieved by electrons available due to splitting of water. The splitting of water is associated with the PSII; water is split into $2H^+$, [O] and electrons. This creates oxygen, one of the net products of photosynthesis. The electrons needed to replace those removed from photosystem I are provided by photosystem II.

$$2H_2O \longrightarrow 4H^+ + O_2 + 4e^-$$

Cyclic and Non-cyclic photophosphorylation

Cyclic Photophosphorylation

- It is performed by photosystem I independently.
- An external source of electron is not required.
- It synthesizes only ATP.
- It occurs only in stromal or integranal thylakoids.

Non-Cyclic Photophosphorylation

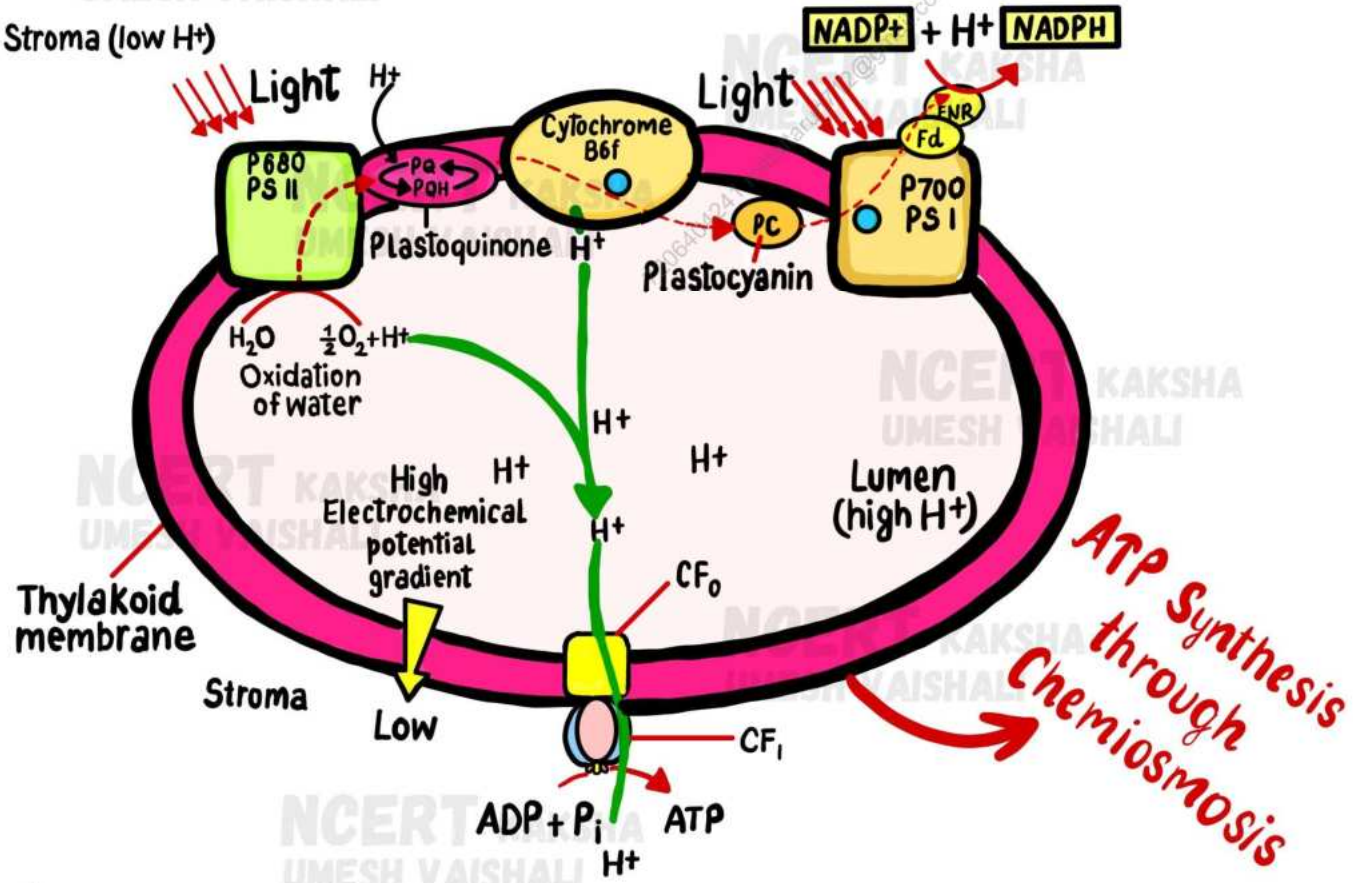
- It is performed by collaboration of both PS I and PSII.
- The process requires an external electron donor.
- It synthesizes ATP and NADH both.
- It occurs in the granal thylakoids only.

Chemiosmotic Hypothesis of ATP formation:-

This hypothesis was proposed by Mitchell in 1961. ATP synthesis is linked to development of proton gradient across the membrane of thylakoid and mitochondria.

The process that causes development of proton gradient across the membrane is:

- Splitting of water molecules occurs inside the thylakoid to produce hydrogen ion or proton.
- As electron passes through the photosystems, protons are transported across the membrane because primary acceptor of electron is located towards the outer side the membrane.
- The **NADP reductase** enzyme is located in the stroma side of membrane. Electrons come out from the acceptor of electron of PSI, protons are necessary for reduction of NADP+ to NADP + H+. These protons are also removed from the stroma. This creates proton gradient across the thylakoids membrane along with pH in the lumen.



- Gradient is broken down due to movement of proton across the membrane to the stroma through trans-membrane channel of **F0** of **ATPase**. One part of this enzyme is embedded in membrane to form trans-membrane channel. The other portion is called F1 that protrudes on the outer surface of thylakoid membrane which makes the energy packed ATP.
- ATP and NADPH produced due to movement of electron is used immediately to fix CO_2 to form sugar.

- The product of light reaction used to drive the process leading to synthesis of sugar are called **biosynthetic phase** of photosynthesis.

Where are the ATP and NADPH used :-

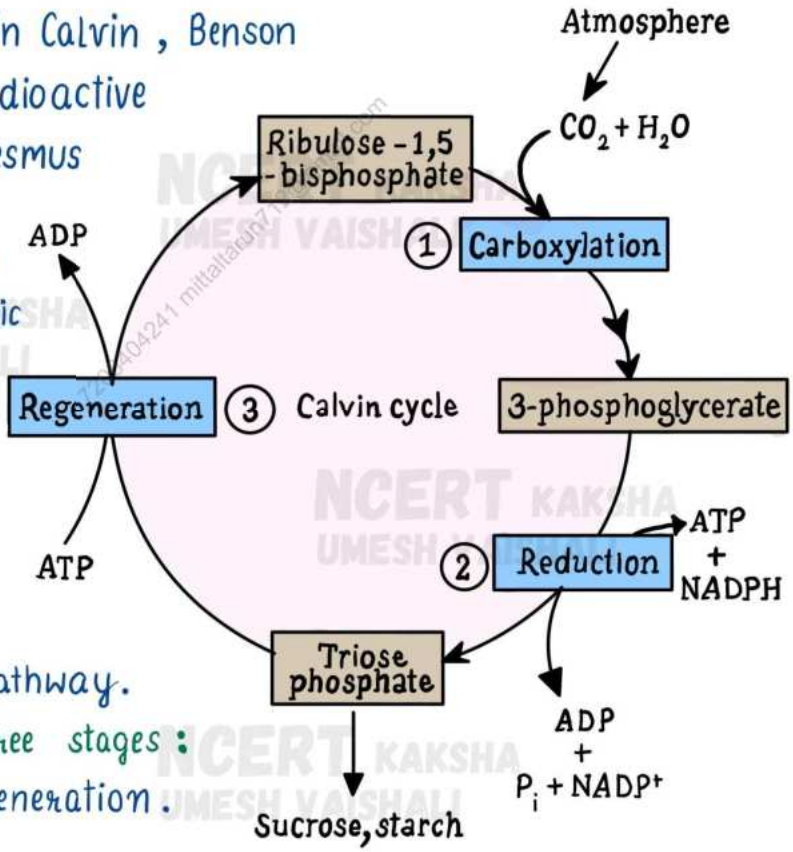
The products of light reaction are ATP, NADPH and O_2 of these O_2 diffuses out of the chloroplast while ATP and NADPH are used to drive the processes leading to the synthesis of food, more accurately, sugars. This is the **biosynthetic phase** of photosynthesis.

The Primary Acceptor of CO_2 :- ribulose biosphate (RuBP).

The first product was a C_3 acid, the primary acceptor would be a 2-carbon compound; they spent many years trying to identify a 2-carbon compound before they discovered the 5-carbon RuBP.

The Calvin Cycle :-

Malvin Calvin, Benson and their colleagues used radioactive 14C and Chlorealla and scenedesmus algae to discover that first CO_2 fixation product is 3-carbon organic compound (3-phosphoglyceric acid) or PGA. Later on a new compound was discovered which contain 4-carbon called Oxaloacetic Acid (AAO). On the basis of number of carbon atoms in first stable product they are named C3 and C4 pathway.

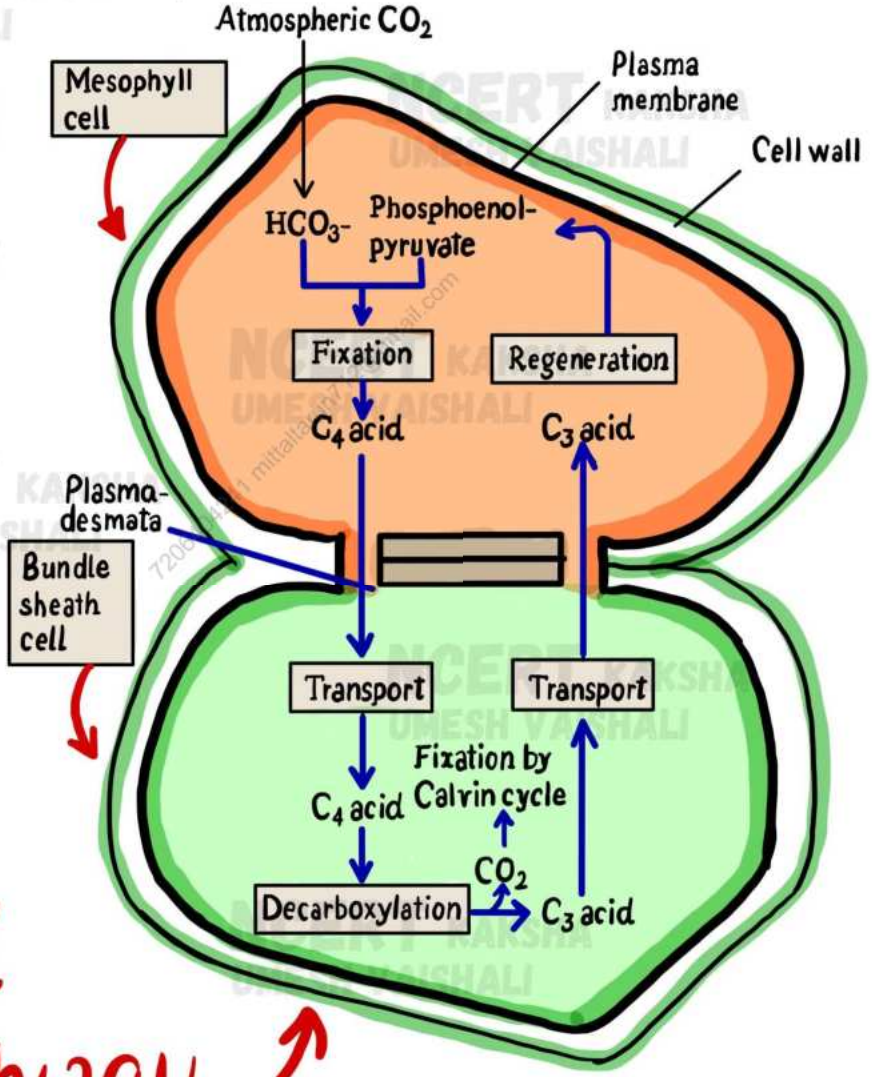


Cycle can be described under three stages: Carboxylation, reduction and regeneration.

- **Carboxylation** is the fixation of CO_2 into 3-phosphoglyceric acid (3-PGA). carboxylation of RuBP occurs in presence of enzyme **RuBP carboxylase (RuBisCO)** which results in the formation of two molecules of 3-PGA.
- **Reduction** is series of reaction that leads to formation of glucose. Two molecules of ATP and two molecules of NADPH are required for reduction of one molecules of CO_2. six turn of this cycle are required for removal of one molecule of Glucose molecules from pathway.
- **Regeneration** is the generation of RuBP molecules for the continuation of cycle. This process require one molecules of ATP.

The C4 Pathway/Hatch Slack Pathway :-

- This pathway was worked out by Hatch and Slack (1965, 1967), mainly operational in plants growing in dry tropical region like maize, sugarcane, sorghum etc.
- In this pathway first stable product is a 4-carbon compound **Oxaloacetic acid** (AAO) so called as C_4 pathway. C_4 plants have Kranz Anatomy (vascular bundles are surrounded by bundle sheath cells arranged in wreath like manner), characterized by large no of chloroplast, thick wall impervious to gases and absence of intercellular spaces.
- The primary CO_2 acceptor is a 3-carbon molecule **Phosphoenol Pyruvate** present in mesophyll cells and enzyme involved is PEP carboxylase.
- OAA formed in mesophyll cell forms 4-carbon compound like malic acid or aspartic acid which is transported to bundle sheath cells.
- In bundle sheath cell, it is broken into CO_2 and a 3-carbon molecule. The 3-carbon molecule is returned back to mesophyll cells to form PEP.
- The CO_2 molecules released in bundle sheath cells enters the Calvin Cycle, where enzyme RuBisCO is present that forms sugar.



Hatch And Slack Pathway

Photorespiration :-

- It is a light dependent process of **oxygenation of RuBP** and release of carbon dioxide by photosynthetic organ of plants.
- Photorespiration decreases the rate of photosynthesis when oxygen concentration is increased from 2-3% to 21%.
- Presence of light and higher concentration of Oxygen results in the binding of RuBisCO enzyme with O2 to form.

$$RuBisCO + O_2 \rightarrow PGA + \text{phosphoglycolate}$$

Factors Affecting Photosynthesis :-

- **Light** – as light intensity increases, the rate of photosynthesis also increases until light saturation point.
- **Carbon dioxide concentration** – with increase in concentration of CO_2 rate of photosynthesis increase till the compensation point.
- **Temperature** – It does not influence the rate of photosynthesis directly but at higher temperature enzyme activity is inhibited due to denaturation of enzymes which affect the dark reaction.
- **Water** – due to increase in amount of water, rate of photosynthesis does not increase proportionally as after saturation no more water is required during photosynthesis.

Today Is Your Opportunity To Build The Tomorrow You Want....

Respiration In Plants

Respiration :- It is an **excergonic** and **catabolic-physico-chemical process** which involves the exchange of environmental oxygen and body carbon dioxide through a liquid medium and the oxidation of glucose inside the mitochondria to produce energy which is partly stored in the **high energy bond** (~) of **ATP molecules as biologically useful energy**.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + Energy$$

THREE PHASES OF RESPIRATION

(A) Internal (tissue) Respiration
(B) External Respiration
(C) Cell Respiration

Do Plants Breath :- During respiration, plants need oxygen and release carbon dioxide. Plants bear stomata and lenticels for gaseous exchange. Animals bear specialised organs for this purpose.

Plants donot bear specialised organs for respiration due to following reasons :

- Every plant part has its own gas exchange requirements. Due to this, little transport of gases is needed from one part to another.
- Plants donot have great demands for gaseous exchange.
- Parts like roots, stems and leaves respire at lower rate, when compared with animals. However, during photosynthesis, gaseous exchange is vigorous. For this, leaves are well adapted. Oxygen is made avaible for respiration by photosynthesizing cells in plants.
- Oxygen deffusion into plants is no problem due to location of living cells near to atmospheric oxyge (through **stomata** on leaves).
- In stems, diffusion of gases may take place through lenticels.
- Loosely arranged parenchymotous cells present in root, stem and leaves further facilitate this process.
- All liberated energy during respiration is not converted into heat. It is stepped breakdown of food.

➡ Glycolysis :-

★ The scheme of glycolysis is given by Gustav Embden, Otto Meyerhof, and J. Parnas. It is also called as **EMP pathway**.

★ Glycolysis is the partial oxidation of glucose or similar hexose sugar in to two molecules of pyruvic acid through a series of enzyme mediated reaction releasing some ATP and NADH2. It occurs in cytoplasm.

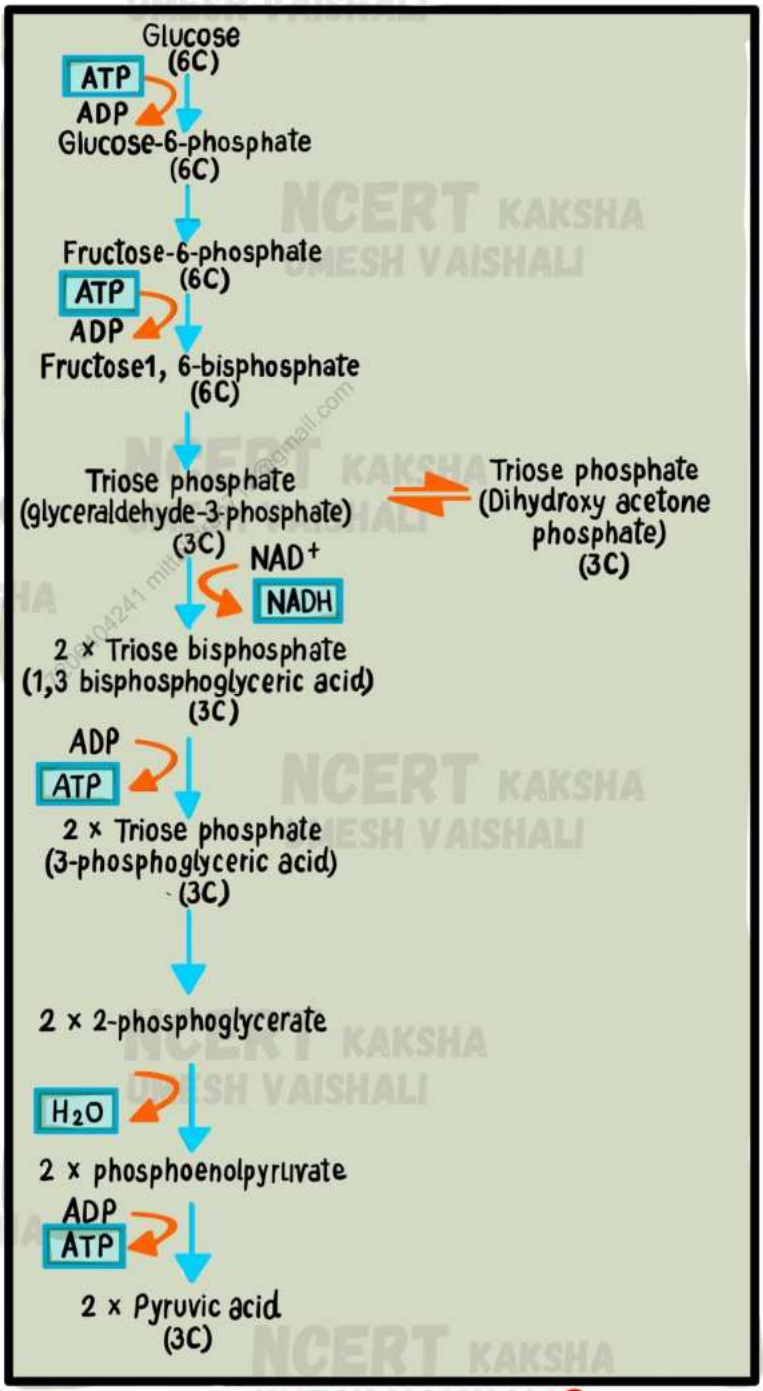
★ In plants glucose is derived from sucrose or from storage carbohydrates. Sucrose is converted into glucose and fructose by enzyme *invertase*.

★ Glycolysis starts with phosphorylation of glucose in presence of enzyme *hexokinase* to form Glucose-6-phosphate. One molecules of ATP is used in this process.

★ In next steps Glucose-6-phosphate is converted into fructose-6-phosphate, catalysed by enzyme *phosphohexose isomerase*.

★ Fructose-6-phosphate uses another molecule of ATP to form Fructose-1-6 biphospahte in presence of enzyme *phosphfructokinase*.

★ In glycolysis two molecules of ATP are consumed during double phosphorylation of glucose to fructose 1.6 biphosphate. Two molecules of NADPH2 are formed at the time of oxidation of glyceraldehyde 3-phosphate to 1.3 biphosphoglycerate. Each NADH is equivalent to 3ATP, so that **net gain in glycolysis is 8ATP**



Steps of glycolysis

★ Pyruvic acid is the key product of glycolysis, further breakdown of pyruvic acid depends upon the need of the cell.

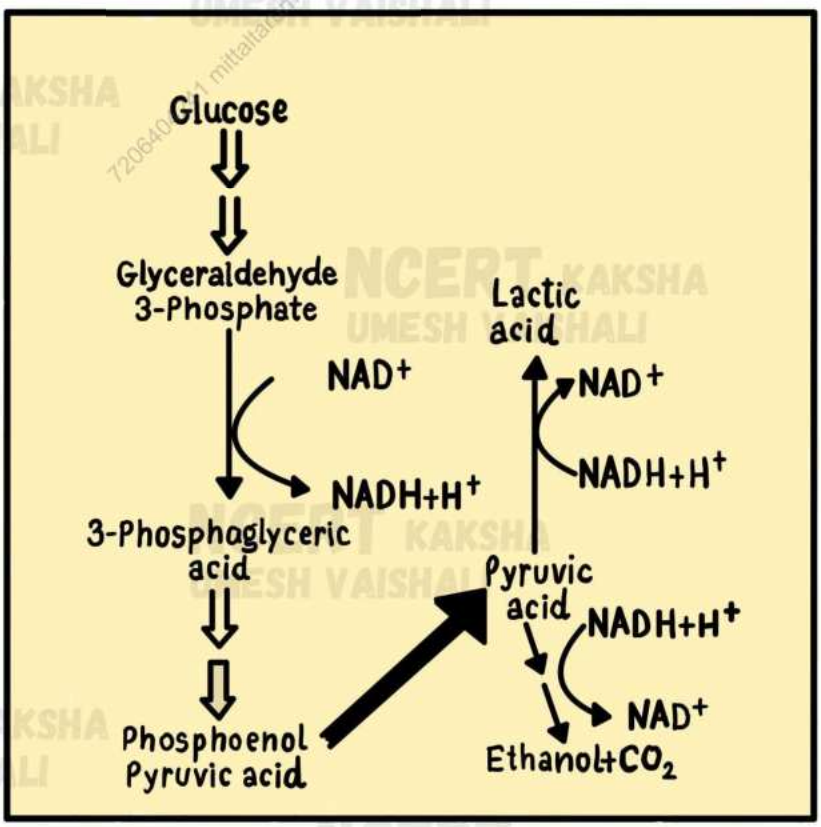
★ In animal cells, like muscles during exercise, when oxygen is insufficient for aerobic respiration, pyruvic acid is reduced to **Lactic acid** by enzyme lactate dehydrogenase due to reduction by NADH2.

➡ Fermentation :-

- In fermentation by yeast, pyruvic acid is convented to ethanol and CO2. The enzyme involved is pyruvic acid decarboxylase and alcohol dehydrogenase catalyse this reaction.
- In both lactic acid fermentation and alcohol fermentation very less amount of energy is released.
- Yeasts poison themselves to death if concentration of alcohol reaches above 13%.
- Final product of glycolysis, pyruvate is transported from the cytoplasm into mitochondria for further breakdown.
- Oxidation of Pyruvate to Acetyl-CoA is done to produce CO2 and NADH. The reaction catalyzed by pyruvic dehydrogenase requires the participation of several Coenzymes including NAD+.

$$\text{Pyruvic acid} + \text{CoA} + NAD^+ \xrightarrow[\text{Pyruvate dehydrogenase}]{Mg^{2+}} \text{Acetyl CoA} + CO_2 + NADH + H^+$$

- The Acetyl CoA enters a cyclic pathway called TCA cycle or **Kreb's cycle**.



Major pathways of anaerobic respiration

➡ Aerobic Respiration :-

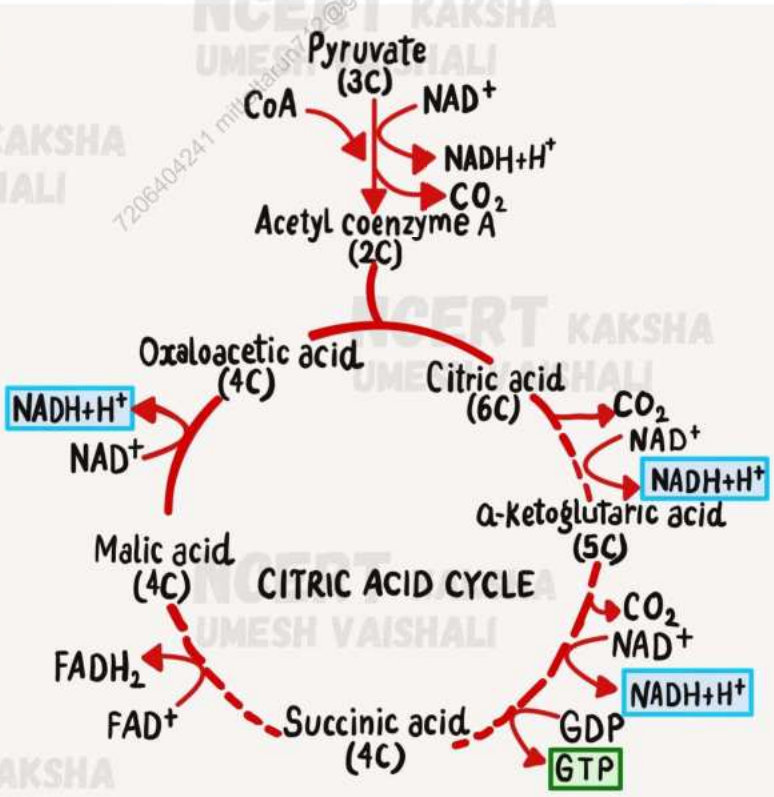
Aerobic Respiration is an enzymatically controlled release of energy in a stepwise

catabolic process of complete oxidation of organic food into carbon dioxide and water with oxygen acting as terminal oxidant.
The crucial events in aerobic respiration are :

- The complete oxidation of pyruvate by the stepwise removal of all the hydrogen atoms, leaving three molecules of CO_2.
- The passing on of the electrons removed as part of the hydrogen atoms to molecules O_2 with simultaneous synthesis of ATP.

➡ Tricarboxylic Acid Cycle :-

- TCA cycle was discovered by Hans Krebs in 1940. This cycle is called TCA cycle because initial product is citric acid.
- Acetyl CoA combine with OAA (Oxaloacetic acid) and water to yield **citric acid** in presence of enzyme citrate synthase to release CoA.
- Citrate is then isomerised to **isocitrate**. It is followed by two successive steps of decarboxylation, leading to the formation of **α-ketoglutaric acid** and then **succinyl - CoA**.
- In the remaining steps, succinyl - CoA is oxidised to OAA allowing the cycle to continue.
- There are three points in the cycle where NAD+ is reduced to NADH2 and one point where FAD+ is reduced to FADH2.
- A molecule of glucose produces two molecules of $NADH_2$, 2ATP and two pyruvate while undergoing glycolysis. The two molecules of pyruvate are completely degarded in krebs cycle to form two molecules of ATP, $8NADH_2$ and $2FADH_2$.

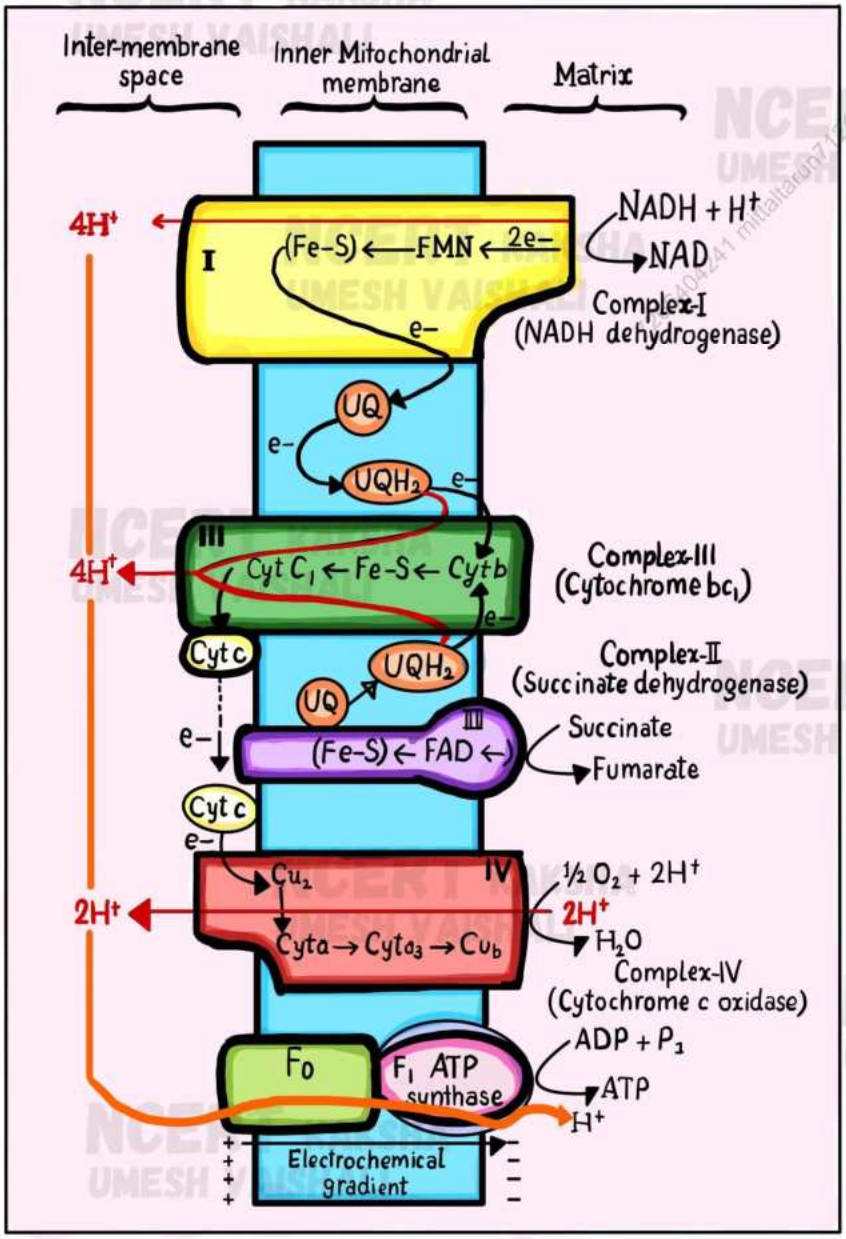


The Citric acid cycle

$$\text{Pyruvic} + 4NAD^+ + FAD^+ + 2H_2O + ADP + Pi \xrightarrow[\text{Mitochondrial Matrix}]{} 3CO_2 + 4NADH + FADH_2 + 4H^+ + ATP$$

➡ Electron Transport System (ETS) and Oxidative Phosphorylation :-

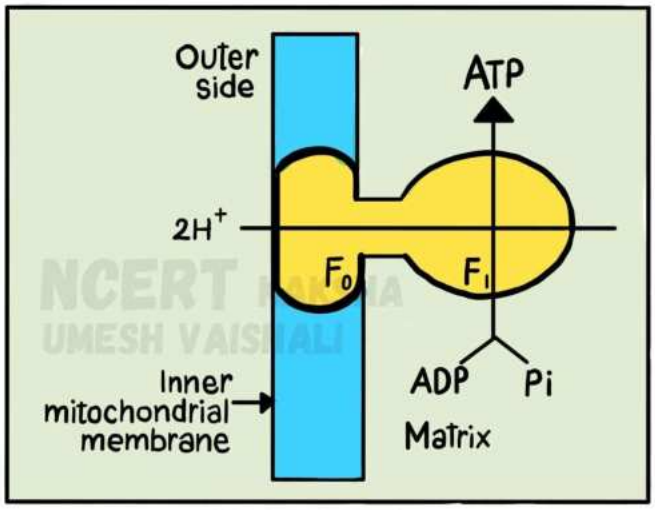
- The metabolic pathway through which the electron passes from one carrier to another inside the inner mitochondrial membrane is called **ETC or mitochondrial respiratory chain.**



- Electrons from NADH produced during citric acid cycle are oxidized by NADH dehydrogenase and electrons are transferred to ubiquinone located within the inner membrane. Ubiquinone also receives electrons from FADH2 which is transferred to cytochrome c viva cytochrome bc_1 complex.
- When the electrons pass from one carrier to another via electron transport chain, they produce ATP from ADP and inorganic phosphate. The number of ATP molecules synthesized upon electron donor.

Electron Transport System (ETS)

- Oxidation of one molecule of NADH gives rise to 3 molecules of ATP, while oxidation of one molecule of FAD_2 produce two molecule of ATP.
- The energy released during ETC is used to make ATP with the help of ATP synthesis of ATP from ADP and inorganic phosphate. FO is integral membrane protein that form channel for proton.
- For each ATP produced 2H+ passes through FO from the intermembrane space to the matrix down the electrochemical proton gradient.



ATP synthesis in mitochondria

➡ The Respiratory Balance Sheet :-

★ There is a sequential, orderly pathway functioning, with one substrate forming the next and with glycolysis, TCA cycle and ETS pathway following one after another.

★ The NADH synthesised in glycolysis is transferred into the mitochondria and undergoes oxidative phosphorylation.

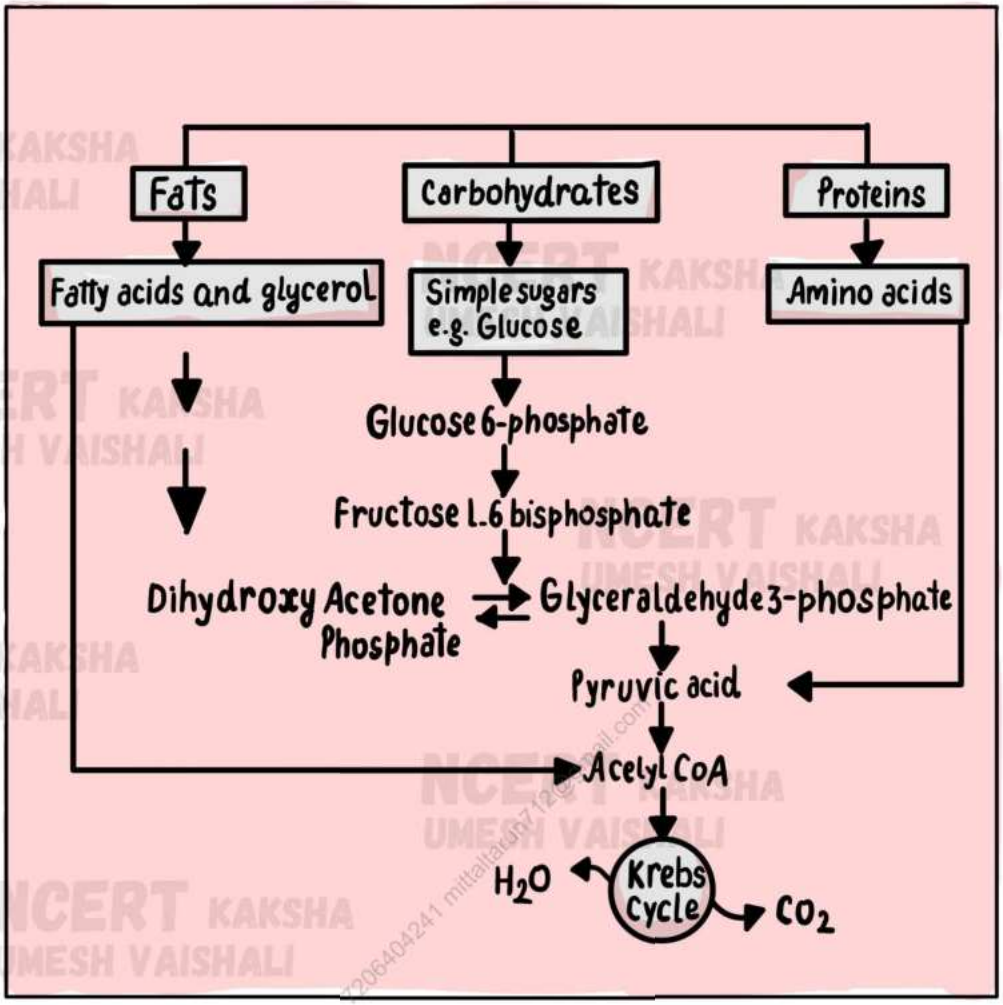
★ None of the intermediates in the pathway are utilised to synthesise any other compound.

★ Only glucose is being respired - no other alternative substrate are entering in the pathway at any of the intermediary stages.

➡ Amphibolic Pathway :-

- Glucose is the favored substrate for respiration. All carbohydrates are usually converted into glucose before used for respiration.
- Fats needs to be broken down into glycerol and fatty acid, which is further broken converted into Acetyl CoA and enter the respiratory pathway.
- Proteins are broken into amino acids and further enter into **knebs cycle**.
- Breaking down process within living organism is called catabolism and synthesis process is called anabolism process. So, respiration is an **Amphibolic pathway**.

Intemelationship among metabolic pathways showing nespination mediated breakdown of different organic molecules to Co_2 and H_2O



➡ **Respinatony Quotient** :- Respinatony Quotient is the natio of the volume of canbon dioxide produced to the volume of oxygen consumed in nespination oven a peniod of time. RQ is equal to one fon canbohydnate and less than one fon pnotein and peptones.

$$RQ = \frac{\text{volume of } CO_2 \text{ evolved}}{\text{volume of } O_2 \text{ consumed}}$$

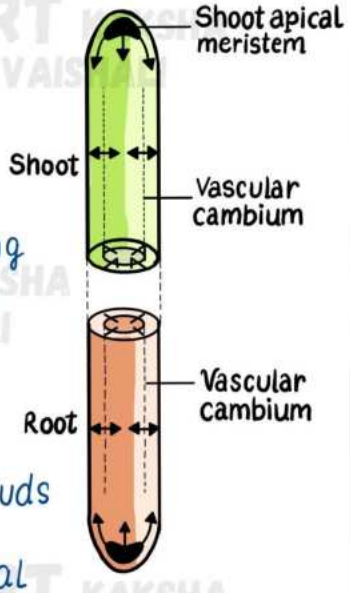
UNIT-4 (PLANT PHYSIOLOGY)

CHAPTER-13

Plant Growth & Development

Growth :- Growth can be defined as a vital process which brings about permanent change in any plant or its part with respect to its size, form, weight and volume.

Plant Growth Generally is Intermediate~

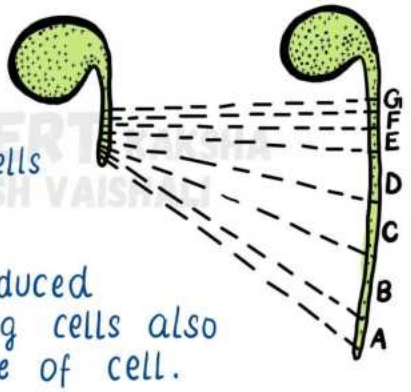


- **Plant growth is generally indeterminate** due to capacity of unlimited growth throughout the life. Meristem tissues are present at the certain locality of plant body.
- The plant growth in which new cells are always being added to plant body due to meristem is called **open form of growth**.
- **Root apical meristem and shoot apical** meristem are responsible for primary growth and elongation of plant body along the axis.
- **Intercalary meristem** located at nodes produce buds and new branches in plants.
- Secondary growth in plants is the function of lateral meristem that is vascular cambium and cork cambium.

Growth is measurable ~

- At cellular level, growth is the increase in amount of protoplasm. It is difficult to measure the increase in amount of protoplasm but increase in cell, cell number and cell size can be measured.
- The parameter used to measure growth is increase in fresh weight, dry weight, length, area and volume and cell number. All parameters are not used for every kind of growth.

Formative Phase is also called as the phase of cell formation or cell division. It occurs at root apex, shoot apex and other region having meristematic tissue. The rate of respiration is very high in the cells undergoing mitosis division in formative phase.



Phase of Enlargement newly formed cells produced in formative phase undergo enlargement. Enlarging cells also develops vacuoles that further increase the volume of cell.

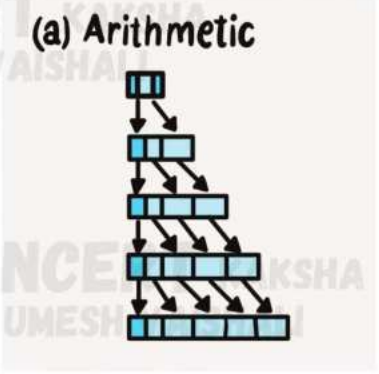
Phase of maturation - the enlarged cells develops into special or particular type of cells by undergoing structural and physiological differentiation.

Growth rate~ Increase in growth per unit time is called growth rate. Growth rate may be arithmetic or geometrical.

Arithmetic Growth > In arithmetic growth, following mitotic cell division, only one daughter cell continues to divide while the other differentiates and matures. The simplest expression of arithmetic growth is exemplified by a root elongating at a constant rate,

$L_t = L_0 + rt$

L_t = length at time 't'
L_0 = length at time 'zero'
r = growth rate / elongation per unit time.



Geometric Growth >

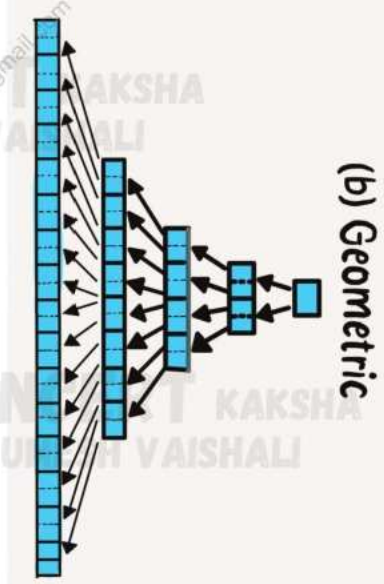
Here initial growth is slow and increase rapidly there after. Every cell divides. The daughter cells grow and divide and the granddaughter cells that result into exponential growth.

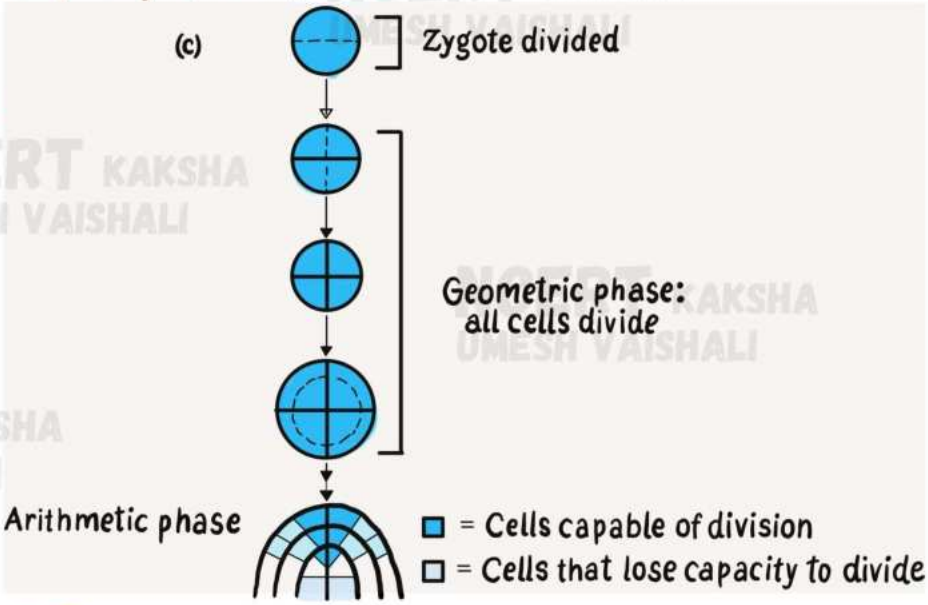
Geometrical growth is common in unicellular organisms when growing in nutrient rich medium.

The exponential growth can be expressed as:

$W_1 = W_0 e^{rt}$

W_1 = final size (weight, height, number etc.)
W_0 = initial size at the beginning of the period.
r = growth rate
t = time of growth
e = base of natural logarithms.





Condition for Growth~

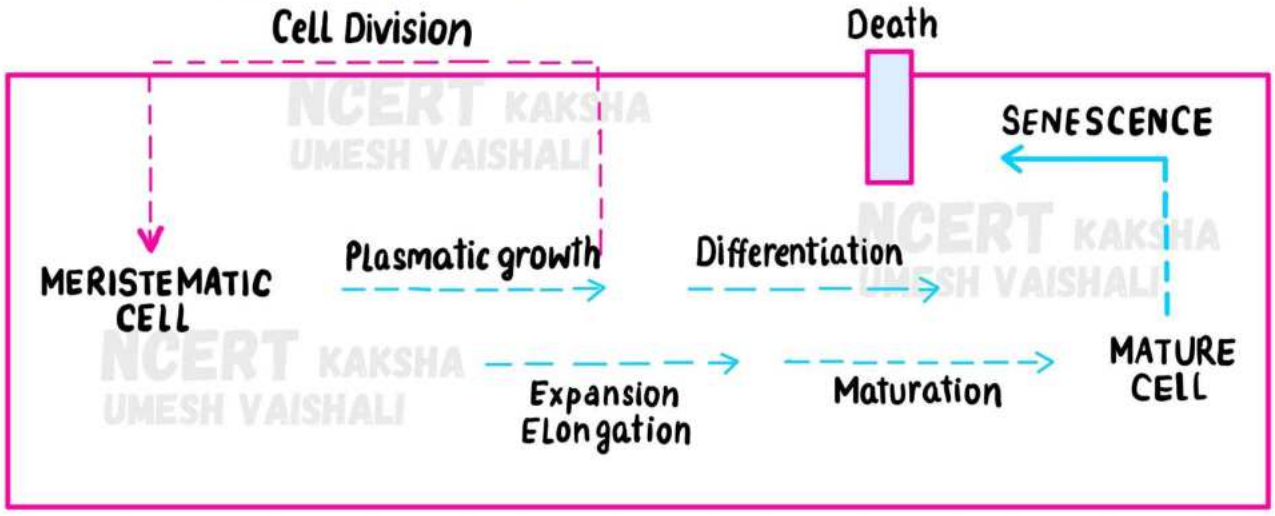
- Necessary condition for growth includes water, oxygen and essential elements. Water is required for cell enlargement and maintaining turgidity. Water also provide medium for enzymatic conditions.
- Protoplasm formation requires water and micro and macronutrients and act as source on energy.
- Optimal temperature and other environmental conditions are also essential for growth of the plant.
- Cells produced by apical meristem become specialized to perform specific function. This act of maturation is called **differentiation**.
- The living differentiated cells that have lost ability of division can regain the capacity of division. This phenomenon is called **dedifferentiation**. For example interfascicular cambium and cork cambium.
- Dedifferentiated cells mature and lose the capacity of cell division again to perform specific functions. This process is called **redifferentiation**.

Differentiation, Dedifferentiation And Redifferentiation :-

- The cells derived from root apical and shoot apical meristems and cambium differentiate and mature to perform specific functions. This act leading to maturation is termed as **differentiation**.
- Plants show another interesting phenomenon. The living differentiated cells, that by now have lost the capacity to divide can regain the capacity of division under certain conditions. This phenomenon is termed as **dedifferentiation**.
- such meristems/tissues are able to divide and produce cells that once again lose the capacity to divide but mature to perform specific functions, i.e., get **redifferentiated**.

Development :-

- It is the sequence of events that occur in the life history of cell, organ or organism which includes seed germination, growth, differentiation, maturation, flowering, seed formation and senescence.

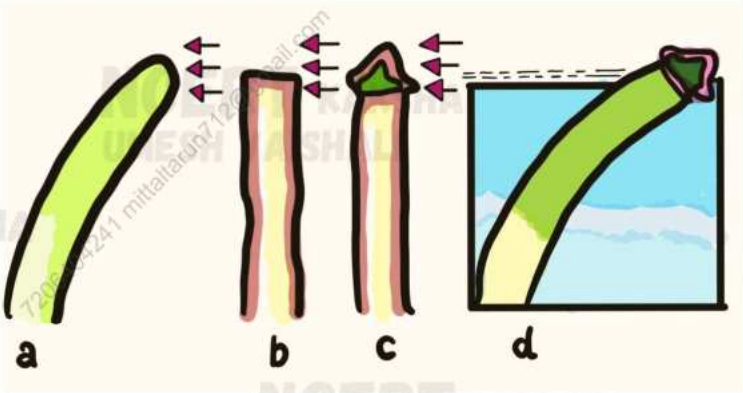


Different structures develop in different phases of growth as well as in response to environment. The ability to change under the influence of internal or external stimuli is called **plasticity**. Heterophylly in cotton plant is the example of plasticity.

➡ Plant Growth Regulators :-

Characteristics~ The plant growth regulators (PGRs) are small, simple molecules of diverse chemical composition. They could be indole compounds (indole-3 acetic acid, IAA); adenine derivatives (N^6-furfary lamino purine, kinetin), derivatives of carotenoids (abscisic acid, ABA); terpenes (gibberellic acid, GA_3) or gases (ethylene, C_2H_4). Plant growth regulators are variously described as plant growth substances, plant hormones or phytohormones in literature.

The Discovery Of Plant Growth Regulators~



The discovery of each of the five major groups of PGRs have been accidental. All this started with observation of Charles Darwin and his son Francis Darwin when they observed that the coleoptiles of canary grass responded to unilateral illumination by growing towards the light source (phototropism). After a series of experiments, It was concluded that the tip of coleoptile was the site of transmittable influence that caused the bending of the entire coleoptile. Auxin was isolated by F.W. went from tips of coleoptiles of oat seedlings.

Physiological Effects of Plant Growth Regulators~

Auxin ⇒ Auxin was first isolated from human urine. It is commonly indole-3 acetic acid (IAA). It is generally produced at stem and root apex and migrate to site of action.

Functions :-
- Cell enlargement
- Inhibition of abscission
- Apical dominance
- Cell division
- Induce Partheno carpy

Gibberllins ⇒ Gibberllins are promotery PGR found in more than 100 forms named as GA_1, GA_2, GA_3 ..... GA_{100}. The most common one is GA_3 (Gibberllic acid).

Functions :-
- Cell Elongation
- Early maturity
- Breaking of dormancy
- Seed Germination

Cytokinins ⇒ The plant growth hormone is basic in nature. Most common forms include kinetin, zeatin, etc. They are mainly synthesized in roots.

Functions :-

- Cell division and cell differentiation
- Essential for tissue culture.
- Overcome apical dominance
- Promote nutrient mobolisation

Ethylene ⇒ It is a gaseous hormone which stimulates transverse or isodiametric growth but retards the longitudinal one.

Functions :-

- Inhibition of longitudinal growth
- Fruit ripening
- Senescence
- Promote apical dominance

Abscisic Acid ⇒ It is also called stress hormone or dormin. It acts as a general plant growth inhibitor. Abscisic acid is produced in the roots of the plant and terminal buds at the top of plant.

Functions :-

- Bud dormancy
- leaf senescence
- Induce Parthenocarpy
- Seed development and maturation.

UNIT-5 (HUMAN PHYSIOLOGY)

CHAPTER-14

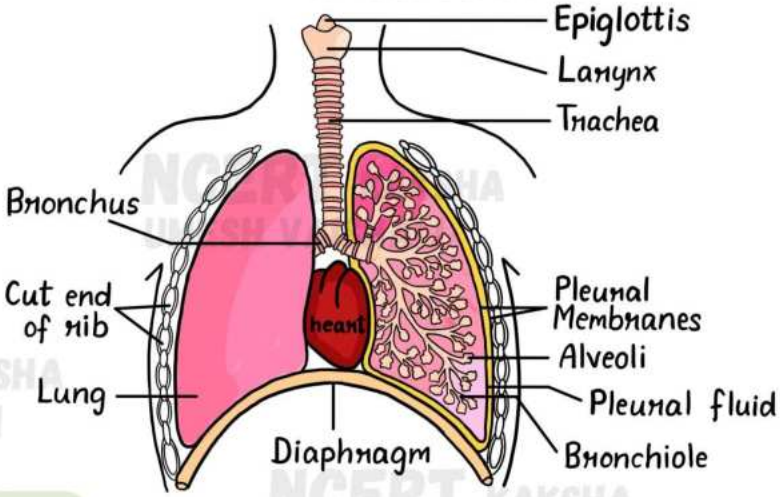
Breathing And Exchange Of Gases

➡ **Respiration** :- It process of exchange of O_2 from the atmosphere with CO_2 produced by the cells is called **breathing**, commonly known as **respiration**.

➡ **Respiratory Orangs** :- Mechanism of breathing varies in different organism according to their body structure and habitat.

➡ Human Respiratory System :-

- Human respiratory system consists of a pair of nostrills, pharynx, larynx, bronchi and bronchioles that finally terminates into alveoli
- **Nasal chamber** open into pharynx that leads to **larynx**. Larynx contains voice box (sound box) that help in sound production.
- The trachea, primary, secondary and tertiary bronchi and initial bronchioles are supported by **incomplete cartilaginous rings** to prevent collapsing in absence of air.
- Each bronchiol terminates into an irregular walled, vascularized bag like structure called **alveoli**.
- The branching network of bronchi, bronchioles and alveoli collectively from the lungs.
- Two lungs are covered with double layered **pleura** having pleural fluid between them to reduce the friction on lung surface.

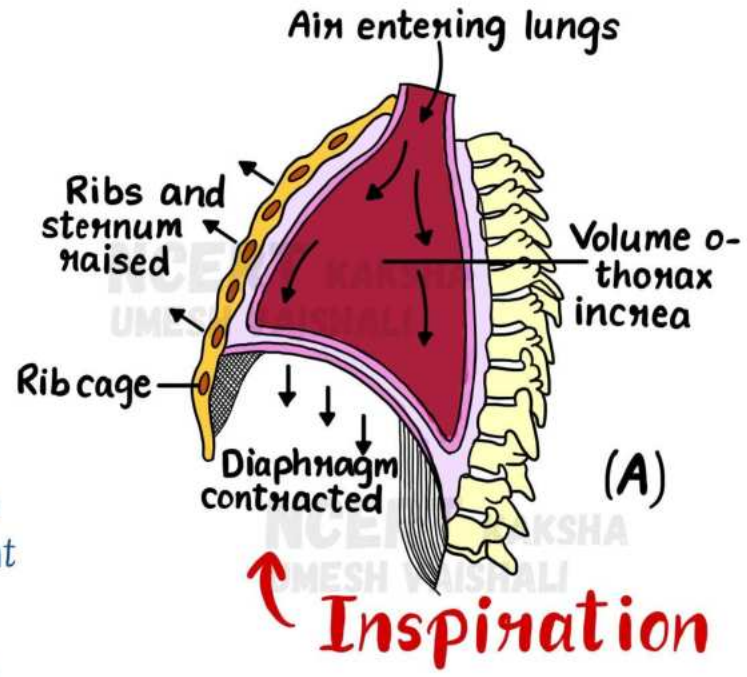


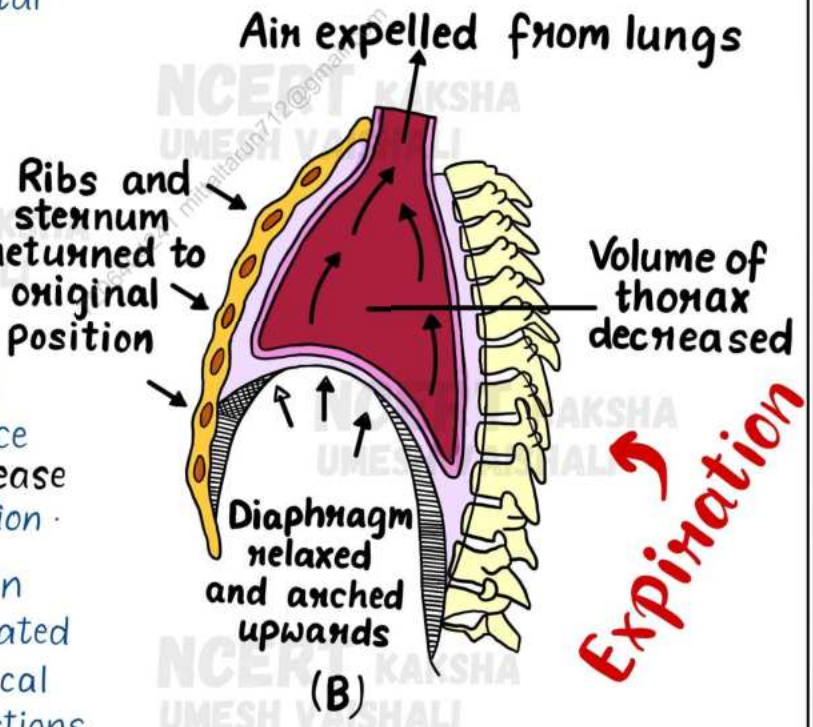
human Respiratory system

➡ Mechanism of Breathing :-

- Breathing involves inspiration and expiration. During inspiration atmospheric air is drawn in and during expiration, alveolar air is released out

- Movement of air in and out takes place due to difference in **pressure gradient**.
- Inspiration occurs when pressure inside the lung is less and expiration occurs when pressure is more in lungs than outside.
- The diaphragm and external and internal **intercostal muscles** between the ribs help in developing pressure gradient due to change in volume.
- The contraction of intercostal muscles lifts the ribs and sternum causing an increase in volume of thoracic cavity that results in **decrease in pressure** than the atmospheric pressure. This causes inspiration.
- Relaxation of the diaphragm and intercostal muscles reduce the thoracic volume and **increase the pressure** causing expiration.
- The volume of air involved in breathing movements is estimated by using **spirometer** for clinical assessment of pulmonary functions.





➡ Respiratory Volumes and Capacities :-

Tidal Volume (TV) : Volume of air inspired or expired during a normal respiration. It is approx. 500 mL., i.e., a healthy man can inspire or expire approximately 600 to 800 mL of air per minute.

Inspiratory Reserve Volume (IRV) : Additional volume of air, a person can inspire by a forcible inspiration. This averages 2500 mL to 3000 mL.

Expiratory Reserve Volume (ERV) : Additional volume of air, a person can expire by a forcible expiration. This averages 1000 mL to 1100 mL.

Residual Volume (RV) : Volume of air remaining in the lungs even after a forcible expiration. This averages 1000 mL to 1200 mL.

By adding up a few respiratory volumes described above, one can derive various pulmonary capacities, which can be used in clinical diagnosis.

Inspiratory Capacity (IC) : Total volume of air a person can inspire after a normal expiration. This includes tidal volume and inspiratory reserve volume (TV + IRV).

Expiratory Capacity (EC) : Total volume of air a person can expire after a normal inspiration. This includes tidal volume and expiratory reserve volume (TV + ERV).

Functional Residual Capacity (FRC) : Volume of air that will remain in the lungs after a normal expiration. This includes ERV + RV.

Vital Capacity (VC) : The maximum volume of air a person can breathe in after a forced expiration. This includes ERV, TV and IRV or the maximum volume of air a person can breathe out after a forced inspiration.

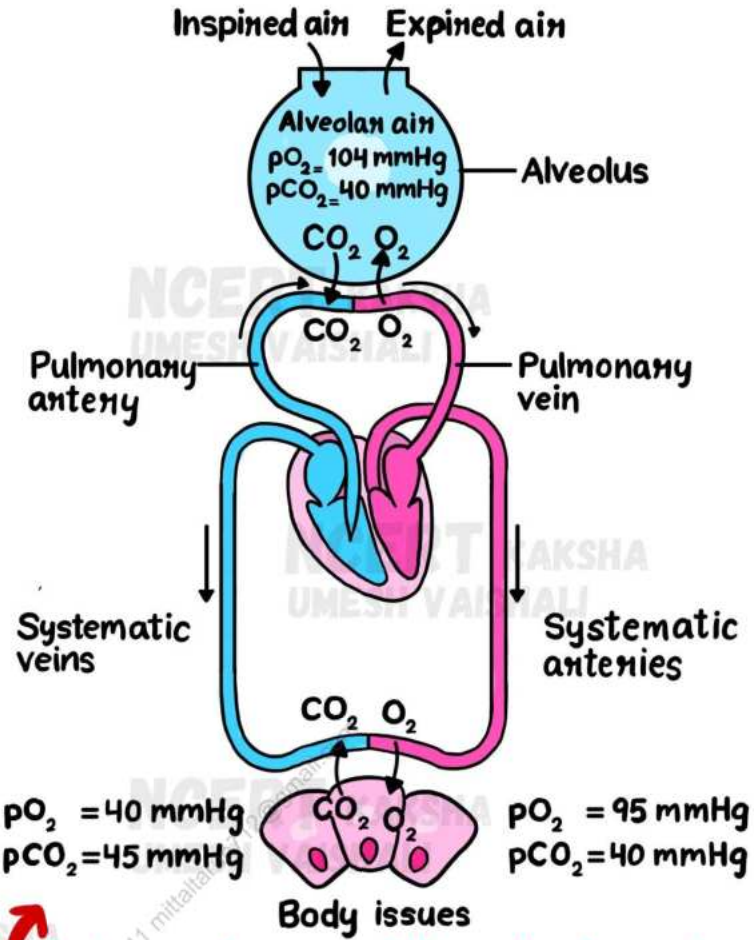
Total Lung Capacity (TLC) : Total volume of air accommodated in the lungs at the end of a forced inspiration. This includes RV, ERV, TV and IRV or vital capacity + residual volume.

➡ Exchange of Gases :-

- Exchange of gases takes place at **two sites**.
  - Alveoli to blood
  - Between blood and tissues
- Exchange of gases occurs by simple diffusion due to pressure / concentration gradient, solubility of the gases and thickness of membrane
- Pressure contributed by individual gas in a mixture of gas in called partial pressure represented by pCO_2 and pO_2.

Partial pressure of Oxygen and carbon dioxide at different part involved in diffusion varies from one part to another and moves from higher partial pressure to lower partial pressure.

- Solubility of CO_2 is 20 - 25 times more than solubility of O_2, so CO_2 diffuse much fasten through membrane.
- Diffusion membrane is three layered thick, that is alveolar squamous epithelium, endothelium of alveolar capillaries and basement substance between them.



Exchange of gases at the alveolus and the body tissues with blood transport of oxygen and cabon dioxide

➡ Transport of Gases :-

Blood is the medium of transport for O_2 and CO_2. About 97 per cent of O_2 is transported by RBCs in the blood. The remaining 3 percent of O_2 is carried in a issolved state through the plasma Nearly 20 - 25 percent CO_2 is transported by RBCs whereas 70 percent of it is carried as bicarbonate. About 7 per cent of CO_2 is carried in a dissolved state through plasma.

➡ Transport of Oxygen :-

- Haemoglobin in RBC combines with O_2 to from **Oxyhaemoglobin**. Each haemoglobin combine with four oxygen molecules.
- Binding of O_2 is related with partial pressure of O_2 and CO_2, hydrogenion concentration and temperature.
- Percentage saturation of haemoglobin and partial pressure of oxygen forms sigmoid curve (oxygen dissociation curve)
- In the alveoli, pO_2 is more and pCO_2 is less, less **H +** ions concentration and lower temperature favour the binding of O_2 with hemoglobin. Where opposite condition in tissues favour the dissociation of Oxyhaemoglobin.

➡ Transport of Carbon dioxide :-

- Carbon dioxide is transported by haemoglobin as **carbamino-haemoglobin**. In tissues pCO_2 is high and pO_2 is less that favour the binding of carbon dioxide with haemoglobin. Opposite condition

help in dissociation of carbamino - haemoglobin in alveoli.

- Enzyme **carbonic anhydrase** help in formation of carbonate ions to transport carbon dioxide.

$$CO_2 + H_2O \xrightleftharpoons{\text{Carbonic anhydrase}} H_2CO_3 \xrightleftharpoons{\text{Carbonic anhydrase}} HCO_3^- + H^+$$

➡ Regulation :-

- Human beings have ability to maintain and moderate the rate of respiration to fulfill the demand of body tissues by neural system.
- Respiratory rhythm centre is located in **medulla** region of hind brain. **Pneumotaxic centre** in pons moderate the function of respiratory rhythm centre.
- **Chemo - sensitive area** near rhythm centre is highly sensitive to CO_2 and **H +** ions that ultimately control the respiratory rate. Oxygen do not play major role in controlling rate of respiration.

➡ Disorder Respiratory System :-

▶ **Asthma** - it is due to allergic reaction to foreign particles that affect the respiratory tract. The symptoms include coughing, wheezing and difficulty in breathing. This is due to excess of mucus in wall of respiratory tract.

▶ **Emphysema** - is the inflation or abnormal distension of the bronchioles or alveolar sacs of lungs. This occurs due to destroying of septa between alveoli because of smoking and inhalation of other smokes. The exhalation becomes difficult and lung remains inflated.

▶ **Occupational Respiratory Disorders** - occurs due to occupation of individual. This is caused by inhalation of gas, fumes or dust present in surrounding of work place. This includes silicosis, Asbestoses due to exposer of silica and asbestos. The sympton includes proliferation of fibrous connective tissue of upper part of lung causing inflammation.

▶ **Pneumonia** - it is acute infection or inflammation of the alveoli of the lungs due to bacterium *streptococcus pneumoniae*. Alveoli become acutely inflamed and most of air space of the alveoli is filled with fluid and dead white blood corpuscles limiting gaseous exchange.

UNIT-5 (HUMAN PHYSIOLOGY)

CHAPTER-15

Body Fluids And Circulation

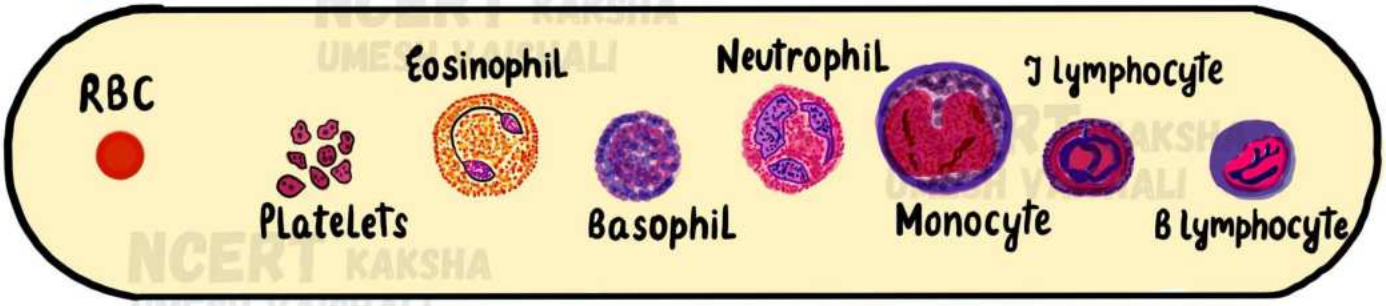
➡ **Body Fluids :-** Body fluids are the medium of transports of nutrients, oxygen and other important substances in the bod. Blood is the most commonly used body fluid in most of the higher organisms. lymph also transports certain substances like protein and fats.

➡ **Blood :-** Blood is a fluid connective tissue composed of a fluid matrix, plasma and the blood corpuscles. It forms about 30-35% of the extracellular fluid. It is slightly alkaline fluid having pH 7.4.

✱ **Plasma ~** Plasma is straw coloured viscous fluid that constitutes 55% of blood volume. It consists of 90-92% water, 6-8% protein (fibrinogens, albumins and globulins), glucose, amino acids and small amount of minerals like Na^+, Ca^{++}, Cl^- etc.

✱ **Formed Elements ~**

- Erythrocytes, leucocytes and platelets are collectively called **formed Elements.**
- **Erythrocytes** are most abundant cells in human body. Total blood count of RBCs is 55.5 million, which is slightly less in females due to mensuration. It is formed in bone marrow. Nucleus is absent in mammalian RBCs having biconave shape.
- Every 100 ml of blood contain 12-16 gm of haemoglobin. They have life span of 120 days. They are destroyed in spleen (graveyard of RBCs).
- **Leucocytes** or WBCs are colourless due to absence of haemoglobin. 6000-8000 of WBCs are present in each ml of blood.
- Neurophils are most abundant and bosophils are least abundant WBCs. Monocytes are neutrophils are **phagocytic cells** which destroy foreign organisms.



Formed Elements In Blood

- Basophils secrete histamine, serotonin and heparin that are involved in inflammatory reactions.
- Eosinophils resist infection and allergic reactions. B and T lymphocytes are responsible for immune response of the body.
- **Thrombocytes** or platelets are cell fragments produced from mega-karyocytes in bone marrow. 150000 - 350000 platelets are present in each ml of blood. Platelets are involved in clotting or coagulation of blood in case of injuries.

* **Blood Groups ~** Blood of human beings differ in certain aspects although it appear same in all individuals. Two main types of grouping are ABO and RH.

- **ABO Grouping ~** ABO grouping is based on presence or absence of two surface antigens RBC, antigen A and antigen B. The plasma of an individual also contains two antibodies produced in response of antigens.

Blood Group	Antigen	Antibody	Can give blood to	Can receive blood from	Genotype
A	A	b	A, AB	A, O	AA or AO
B	B	a	B, AB	B, O	BB or BO
AB	A, B (both)	None	AB	All (Universal recipient)	AB
O	None	a, b (Both)	All (Universal donor)	O	OO

- During blood transfusion, blood of donor has to be matched with blood of recipients to avoid clumping of RBCs.
- Group 'O' blood can be donated to any individual with any blood group, so it is called **universal donor**.
- Person with 'AB' blood group can receive blood from any person of any group, so it is called **universal recipient**.

- **RH Grouping ~** RH antigen (similar to Rhesus monkey) are observed on surface of RBCs of majority of individuals (about 80%). Such people are called RH positive (Rh^+) and those in whom this antigen is absent are called Rh negative (Rh^-).

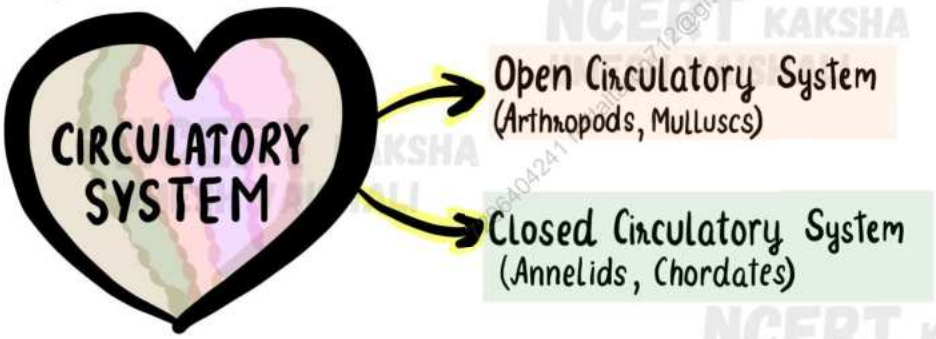
- **Erythroblastosis Foetalis ~** If father blood is Rh^+ and mother blood is Rh^-, the foetus blood is Rh^+. During the delivery of first child there is possibility of exposure of mother blood with foetus blood to develop antibodies in mother blood. In subsequent pregnancy the mother's blood can leak into foetus blood and destroy the foetus RBC. This case is called erythroblastosis foetalis.

Coagulation Of Blood (Blood Clotting)~ It is a defensive mechanism to prevent excess bleeding from the injuries as blood changes into gel state. It is **cascade mechanism** and involves 13 factors. It involves conversion of prothrombin to thrombin, activation of fibrinogen to fibrin and polymerization of fibrin to form blood clot. The yellow fluid released after clot retraction is called **serum** which is blood plasma minus blood clotting proteins.

Lymph (tissue fluid) :- During flow of blood through capillaries, some water soluble substances move out in the space between cells of tissues. This fluid released out is called interstitial fluid or tissue fluid. It is similar to the blood but has fewer blood proteins, less calcium and phosphorus and high glucose concentration.

- It is a colourless fluid containing specialized lymphocytes that provide immune response to body.
- Main function of lymph is to provide immunity, carry proteins and fats molecules and transport oxygen, food materials, hormones etc..

Circulatory Pathways :-

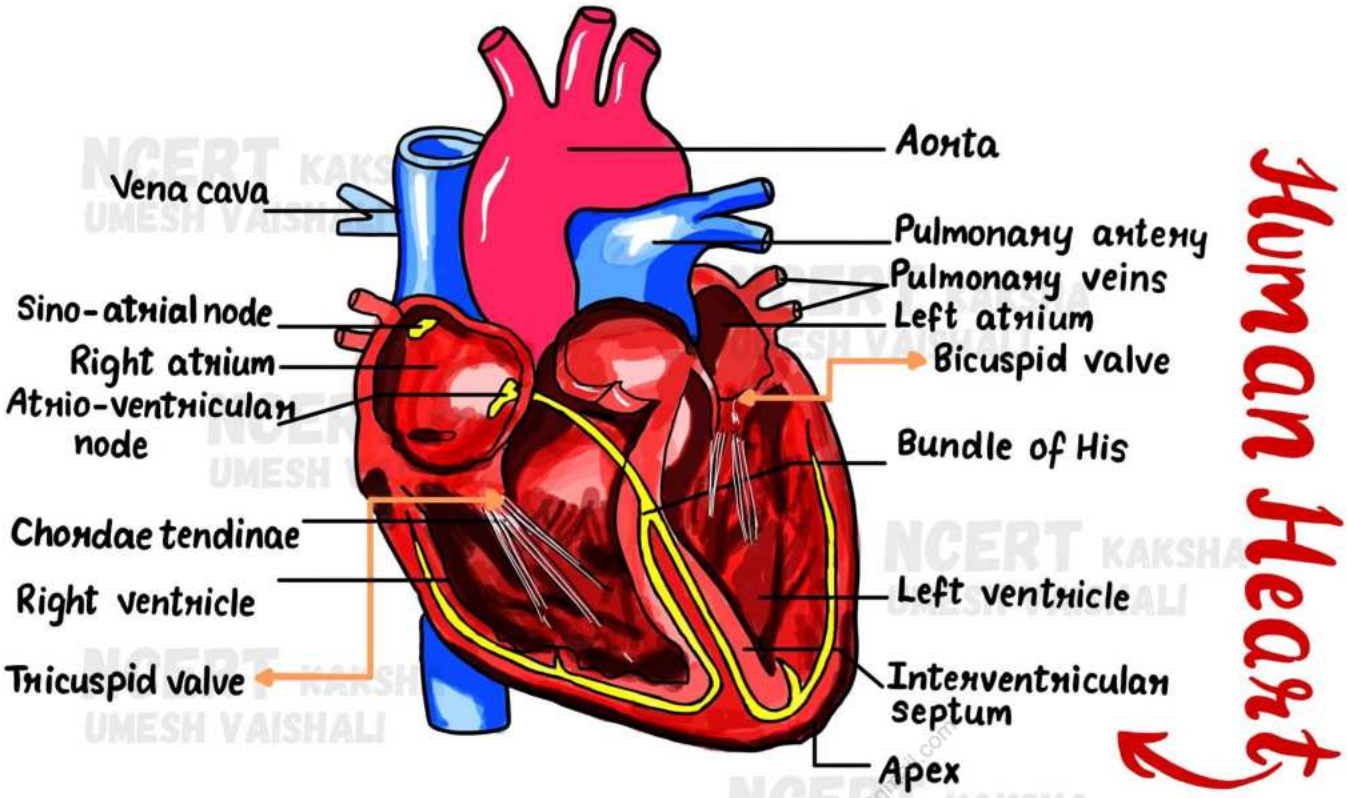


- All vertebrates have a muscular chambered heart.
  Fish - 2 chambered heart
  Amphibian and Reptiles (except crocodile) - 3 chambered heart.
  Crocodiles, Birds and Mammals - 4 chambered heart.

Human Circulatory System~ Human circulatory system, also called the blood vascular system consists of a muscular chambered heart, a network of closed branching blood vessels and blood, the fluid which is circulated.

Human Heart :- **Heart** is the mesodermally derived muscular organ, present in thoracic cavity between the two lungs protected by double membrane of pericardium.

- The upper two chamber is called **atria** and lower two chambers are called **ventricles**. Interatrial septum separate the right and left atrium and thick walled inter ventricle septum separate the ventricles.
- The opening between right atrium and right ventricle is guarded by a three muscular flaps called **tricuspid valve, Bicuspid** or **mitral valve** guards left atrium and ventricle.



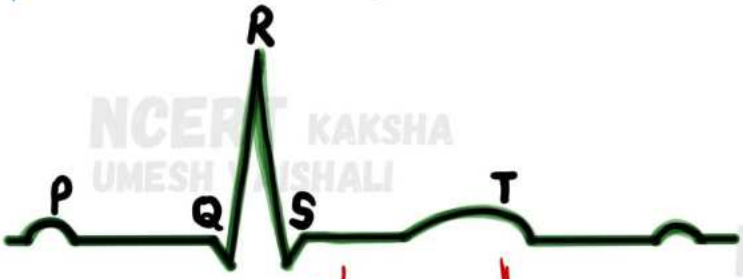
- The opening of right and left ventricle to pulmonary artery and aorta respectively is controlled by **semilunar valve**.
- The nodal tissue present on upper right corner of right atrium is called **SAN (sinoatrial node)** and those on lower left corner of right atrium is called **AVN (atrioventricular node)**.
- The purkinje fibres along with right and left bundles from the **bundle of HIS**. The nodal musculature has ability to generate action potential.
- SAN generate maximum number of action potential and is responsible for rhythmic contraction of heart. Therefore it is called **pace maker**.

* Cardiac Cycle ~

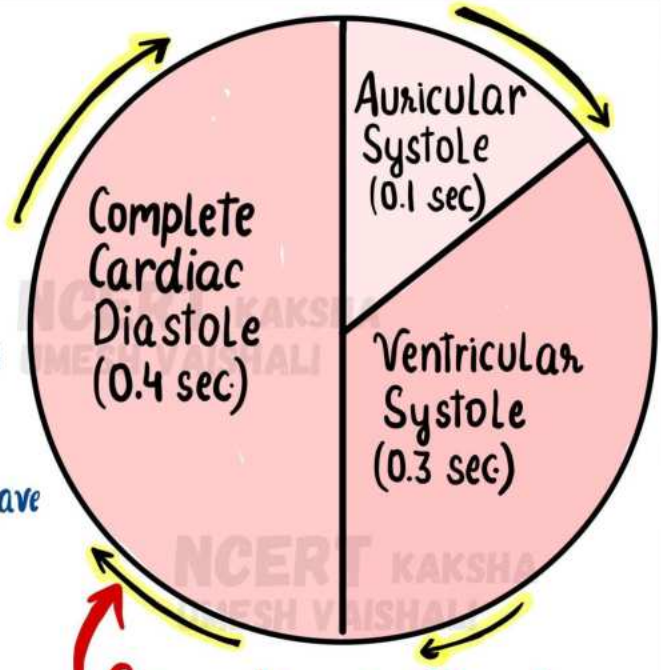
- To begin with, all four chambers are in relaxed state called **joint diastole**. As the bicuspid and tricuspid valves are open, blood from pulmonary vein and vena cave flows to left and right ventricle respectively. Semilunar valves are closed at this stage.
- SA node generates action potential that contracts both atria **(atrial systole)**. The action potential passes to AV node and bundle of HIS transmit it to ventricular musculature to cause **ventricular systole**. At the same time atria undergoes relaxation diastole to close the bicuspid and tricuspid valve.
- Semilunar valves open into circulatory system that relax the ventricle and close the valves to prevent back flow of blood.
- As the pressure inside ventricle decreases the bicuspid and tricuspid valve open to repeat the process of cardiac cycle.

- During each cardiac cycle two sounds are produced. The first sound (lub) is due to closure of bicuspid and tricuspid valve and second heart sound (dub) is due to closure of semilunar valve.

Electrocardiography ~ ECG is record of electrical disturbances in cardiac muscles fibre during the heart beat. Its **P-wave** represents atrial depolarization, **QRS-wave** represents ventricular depolarization while **T-wave** represents ventricular repolarization.



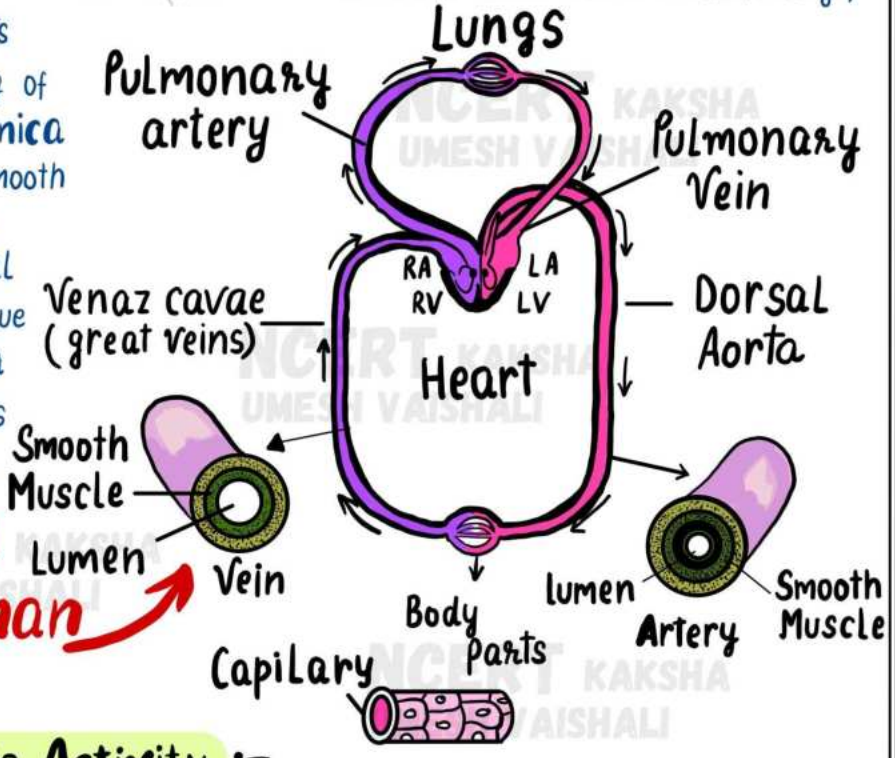
Standard ECG



Cardiac Cycle

Double Circulation :-

The blood flows strictly by a fixed route through **Blood vessels** — the arteries and veins. Basically, each artery and vein consists of three layers: an inner lining of squamous endothelium, the **tunica intima**, a middle layer of smooth muscle and elastic fibres, the tunica media, and an external layer of fibrous connective tissue with collagen fibres, the **tunica externa**. The tunica media is comparatively thin in the veins.



Blood Circulation In Human

Regulation of Cardio Activity :-

- Normal activities of heart are regulated by nodal tissue (SA and AV node), so the heart is myogenic.

- A special neural centre in medulla oblongata moderates the cardiac function by ANS. Sympathetic nerve can increase the rate of heart beat and parasympathetic nerve of ANS decrease the rate of heart beat.
- Adrenal medullary hormone also increases the cardiac output.

Disorder of Circulatory System :-

* **Hypertension (high blood pressure)** ~ Blood pressure higher than (120/80). 120 mm Hg is the systolic that is pumping pressure and 80 mm Hg is the diastole, resting pressure. It leads to heart disease and affect vital organs like brain and kidney.

* **Coronary Artery Disease (CAD)** – commonly called artherosclerosis that affects the blood vessels that supply blood to heart muscles due to deposition of fat, calcium, Cholestrol that makes the arteries lumen narrower.

* **Angina** ~ also called angina pectoris, acute chest pain due to less supply of oxygen to heart muscles. It may occur in elderly male and female. It occurs due to restricted blood flow.

* **Heart Failure** ~ heart does not pump enough blood to meet the requirement of body. It is also known as congestive heart failure because congestion of lung is one of its causes. Heart failure is different from heart attack (heart muscle is damaged by inadequate blood supply) and cardiac arrest (when hearts stop beating).

* **Coronary Thrombosis** ~ formation of clot in the coronary artery is coronary thrombosis. It occurs most frequently in the left anterior descending coronary artery.

UNIT-5 (HUMAN PHYSIOLOGY)

CHAPTER-16

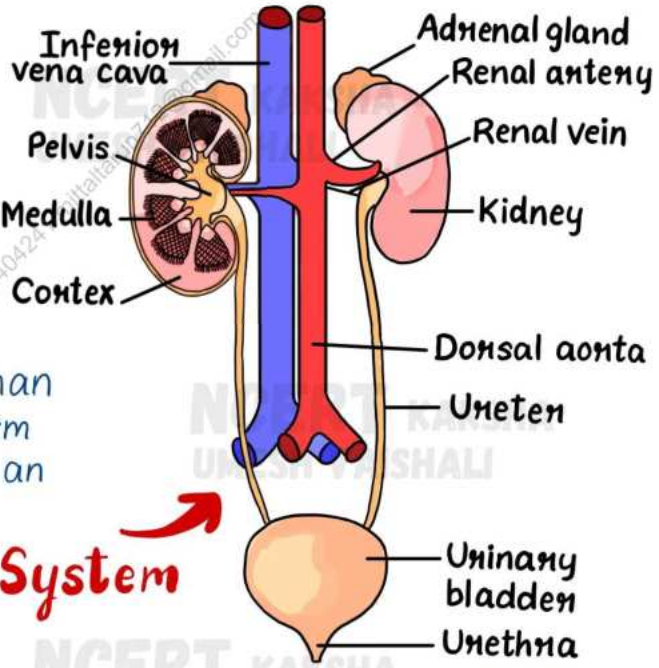
Excretory Products And Their Elimination

Excretion :- The process of expelling of non-gaseous nitrogenous wastes like ammonia, urea, uric acid etc. alongwith excess of water, salts and pigments out of body, is called **excretion**. Main aim of excretion is to keep a constant internal chemical composition called **homeostasis**.

TYPES OF EXCRETION ~ Ammonotelism , Ureolelism , Unicotelism

Human Excretory System :-

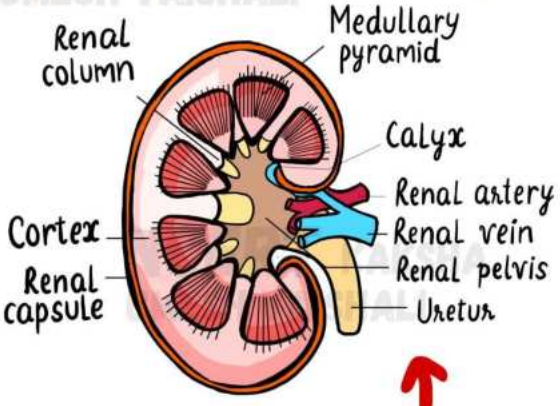
Kidney :- Kidneys are reddish brown bean shaped structure situated between last thoracic and lumber vertebra. Each kidney has a notch on its inner side called **hilum** through which ureter, blood vessels and nerves enter. Each kidney of an adult human measures 10-12 cm in length, 5-7 cm in width. 2-3 cm in thickness with an average weight of 120-170 g.



Human Urinary System

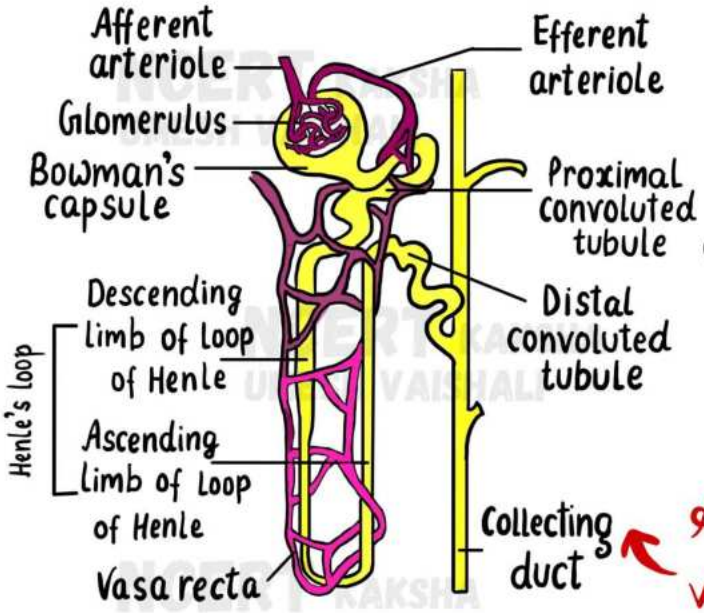
Utetens :-

- Inside the hilum has broad funnel shapped space called renal pelvis with projection called calyces.
- Inside the kidney are two zone - outer cortex and inner medulla. Medulla is divided into medullary pyramids projecting into calyx.
- Cortex extends between medullary pyramids as renal column called **Columns of Bertini**.
- The functional unit of kidney is nephron. Each kidney contains about one million nephrons.



Longitudinal section of kidney

✦ Urinary Bladder :-



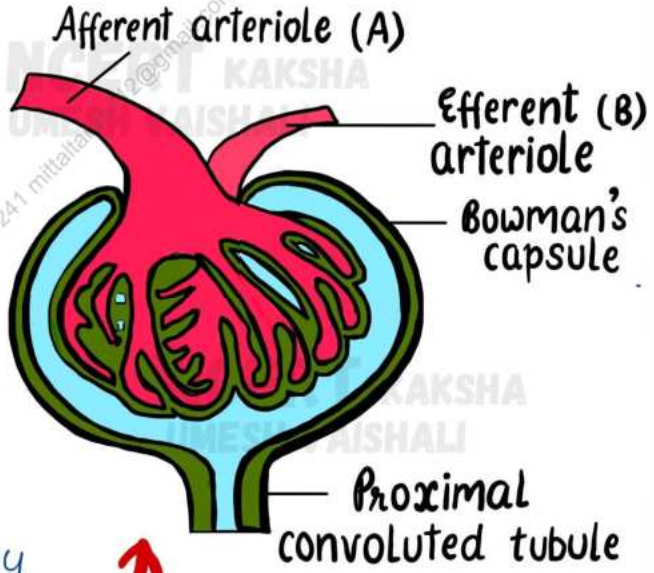
A Nephron showing blood vessels, duct and tubule

- Each nephron has two parts - the **glomerulus** and **renal tubules**. Glomerulus is that tuft of capillaries formed by **affent arteriole**. Blood form glomerulus is carried away by **effenent arteriole**.
- Renal tubules starts with **Bowman's capsule** continue with tubular parts divided into **Proximal Convoluted tubules**, **Henle's loop** and **Distal Convoluted tubule**

✦ Urethna :-

A hairpin shaped **Henle's loop** is the next part of the tubule which has a descending and an ascending limb.

- The ascending limb continues as another highly coiled tubular region called **distal convoluted tubule** (DCT).
- The Malpighian corpuscle. PCT and DCT of the nephron are situated in the corticle region of the kidney whereas the loop of Henle dips in to the medulla. In majority of nephrons, the loop of Henle.



Malpighian body (renal corpuscle)

➡ Urine formation :-

1st step
- **Glomerular filtration**
- Filtration of blood by glomerules

2nd step
- **Reabsorption**
- Reabsorption by renal tubules

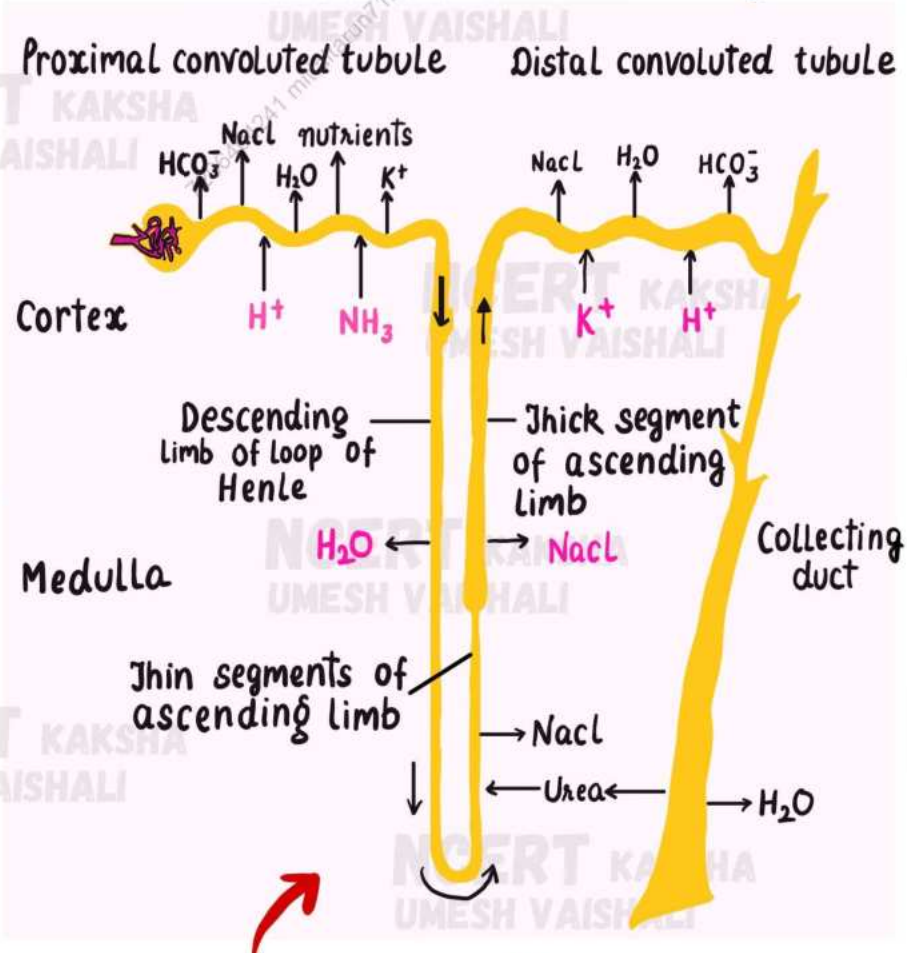
3rd step
- **Secretion**
- Tubular cells secretes H + K + ammonai into filtrate

Function of the Tubules :-

Proximal Convoluted Tubule (PCT): PCT is lined by simple cuboidal brush border epithelium which increases the surface area for reabsorption. Nearly all of the essential nutrients, and 70-80 per cent of electrolytes and water are reabsorbed by this segment. PCT also helps to maintained the pH and ionic balance of the body fluids by selective secretion of hydrogen ions and ammonia into the filtrate and by absorption of HCO_3^- from it.

Henle's Loop: Reabsorption is minimum in its ascending limb However, this region plays a significant role in the maintenance of high osmolarity of medullary interstitial fluid. The descending limb of loop of Henle is permeable to water but almost impermeable to electrolytes. This concentrates the filtrate as it moves down. The ascending limb is impermeable to water but allows transport of electrolytes actively or passively. Therefore, as the concentrated fitrate pass upward, it get diluted due to the passage of electrolytes to the medullary fluid.

Distal Convoluted Tubule (DCT): Conditional reabsorption Na^+ and water takes of place in this segment. DCT is also capable of reabsorption of HCO_3^- and selective secretion of hydrogen and potassium ions and NH_3 to maintain the pH and sodium potassium balance in blood.

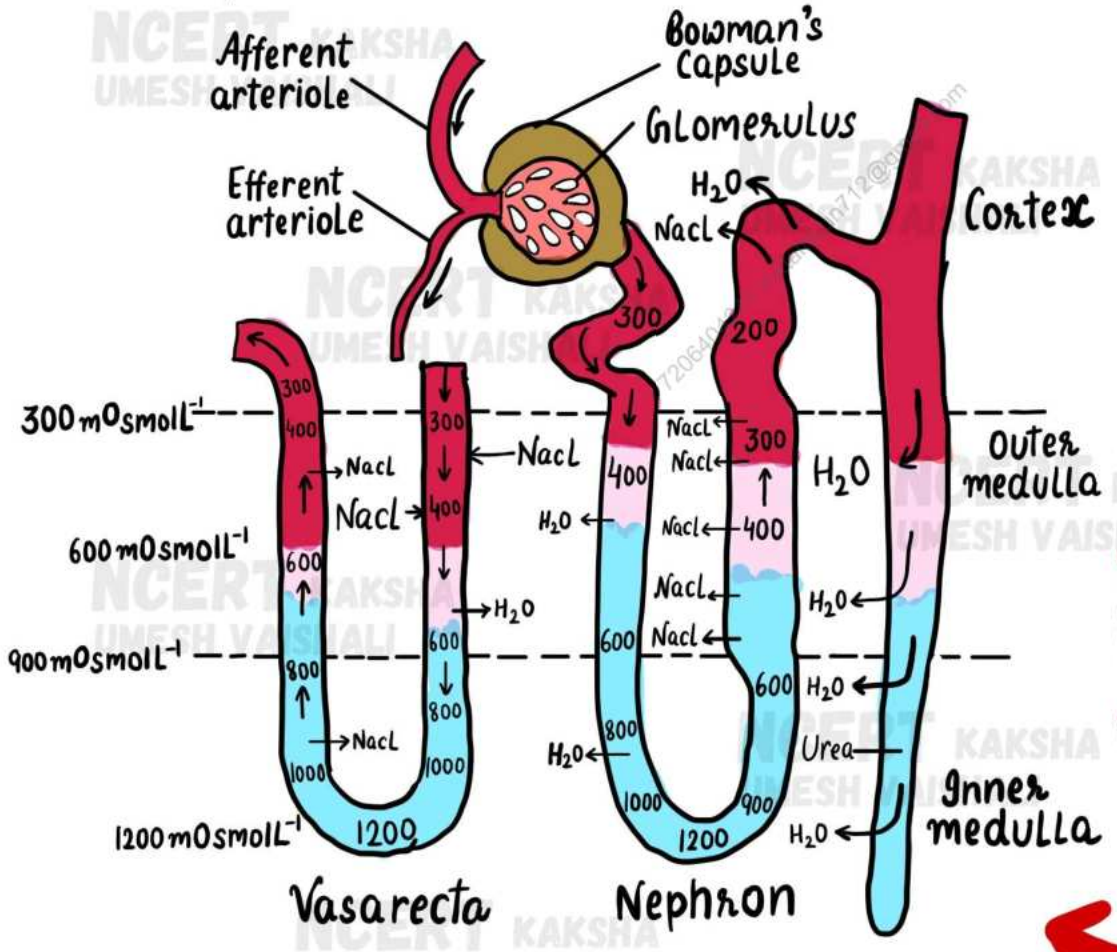


The Nephron (Arrow indicate direction of movement of materials)

Collecting Duct: This long duct extends from the cortex of the kidney to the inner

parts of the medulla. Large amounts of water could be reabsorbed from this region to produce a concentrated urin. This segment allow passage of small amounts of urea into the medullary interstitium to keep up the osmolarity. It also plays a role in the maintenance of pH and ionic balance of blood by the selective secretion of H^+ and K^+ ions.

➡ **Mechanism of Concentration of the filtrate** :- This flow of filtrate in two limbs of Henle's loop is in opposite direction to form counter current. The flow of blood in two limbs of vasa recta increase the osmolarit towards the inner medullary interstitium in the inner medulla. The transport of substance facilitated by special arrangment of Henle's loop and vasa recta is called **counter current mechanism**.



A Nephron and vasa recta showing counter current mechanisms

➡ **Regulation of Kidney function** :-

- Functioning of kidney is monitored by hormonal feedback mechanism of hypothalamus and JGA. Change in blood volume, body fluid and ion concentration activates the osmoreceptores in the body that stimulate the hypothalamus to release ADH or vasopressin hormones. The ADH facilitates water absorption in tubules.

- Decrease in glomerular blood pressure activate JG cells to release renin which converts angiotensinogen to angiotensim I and II that increase the glomerular blood pressure and release of aldosterone that increase absorption of Na^+ ions and water.

➡ **Micturition** :- The process of expulsion of urine from the urinary bladder is called micturition. The neural mechanism that causes it is called micturition reflex. Urine formed in nephron is stored in uninary bladder till a voluntary signal is given by CNS. This initiates the contraction of smooth muscles of the bladder and simultaneous relaxation of the urethral sphincter causing the release of urine.

➡ **Role of other organs in Excretion** :-

- Lungs, liver and skin also play important role in process of excretion. Lungs remove CO_2 and water, liver eliminates bile containing substances like bilirubin, bilivendin.
- Sweat glands remove NaCl, small amount of urea and lactic acid. Sebaceous glands excrete sterol, hydrocarbons and waxes.

➡ **Disorders of Excretory System** :-

- **Uremia** - there is high concentration of non-protein nitrogen (urea, uric acid, creatinine). Urea can be removed by hemodialysis.
- **Renal failure** - also known as kidney failure where glomerular filtration is ceased and both kidney stops working. Kidney transplant is the ultimate method in connection of acute kidney failure.
- **Renal Calculi** - formation of stone or insoluble mass of crystallized salts formed within the kidney.
- **Glomerulonephritis (Bright's Disease)** - inflammation of glomeruli of kidney due to entry of protein or red blood corpuscles into filtrate due to injury.

SUCCESS is a journey not a Destination.....

UNIT-5 (HUMAN PHYSIOLOGY)

CHAPTER-17

Locomotion And Movement

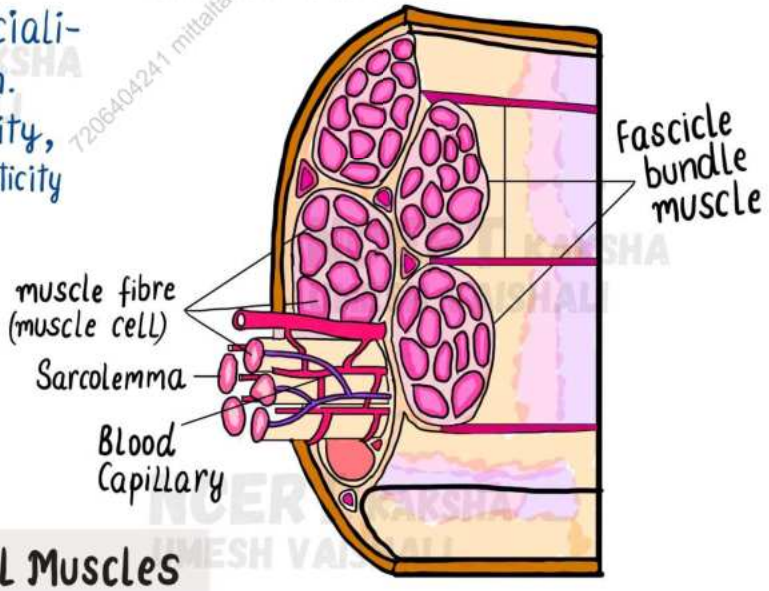
➡ **Locomotion :-** Locomotion is the voluntary movement of an individual from one place to another. Walking, running, climbing, swimming are the examples of locomotion. ALL locomotion are movement but all movements are not locomotion.

➡ **Types of Movement :-**

There are three types of cellular movement in humans:-

- Amoeboid Movements ~ Amoeboid movements with pseudopodia in leucocytes, phagocytes and macrophages.
- Ciliary Movements ~ Ciliary movements of ciliated epithelial cells of trachea, oviducts and vasa efferentia.
- Muscular Movements ~ Muscular movements of body parts and locomotion.

➡ **Muscles :-** Muscles are specialized tissues of mesodermal origin. They have property like excitability, contractility, extensibility and elasticity



Based on their location, three types of muscles are identified :-

Skeletal Muscles

Associated with skeletal system, alternate light and dark bands, voluntary and locomotory and change in body posture function.

Visceral Muscles

Form inner wall of internal visceral organs involuntary muscle, assists in movement of food through digestive tract and gametes.

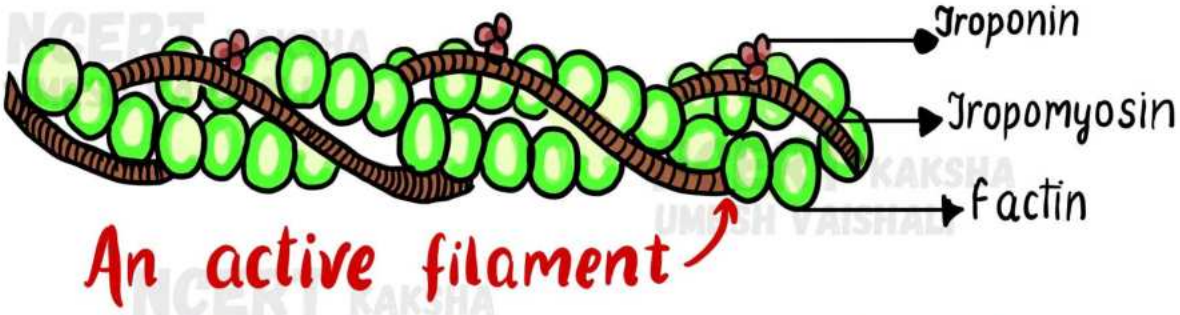
Cardiac Muscle

Muscles of heart, having branching pattern, alternate light and dark bands, involuntary in action.

◆ **Structure Of Contractile Proteins :-**

Each thin filament (actin) is made of two 'F' actins helically wounded to each other. Two

filaments of another protein, **tropomyosin** runs close to it. A complex protein **troponin** is disturbed at regular intervals on the tropomyosin.

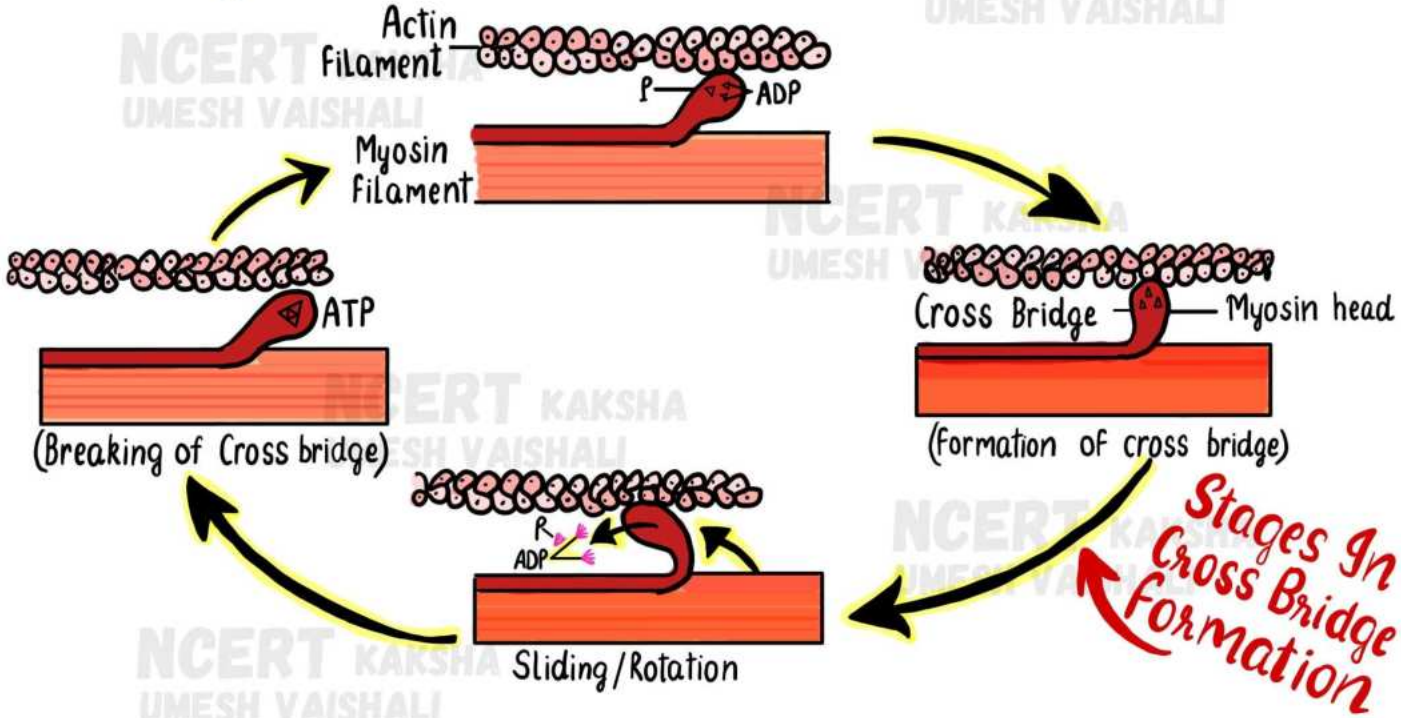


An active filament

Each myosin filament is made of many monomeric proteins called **Meromyosins**. Each meromyosin has globular head with short arm and tails. Globular head has ATP binding sites.

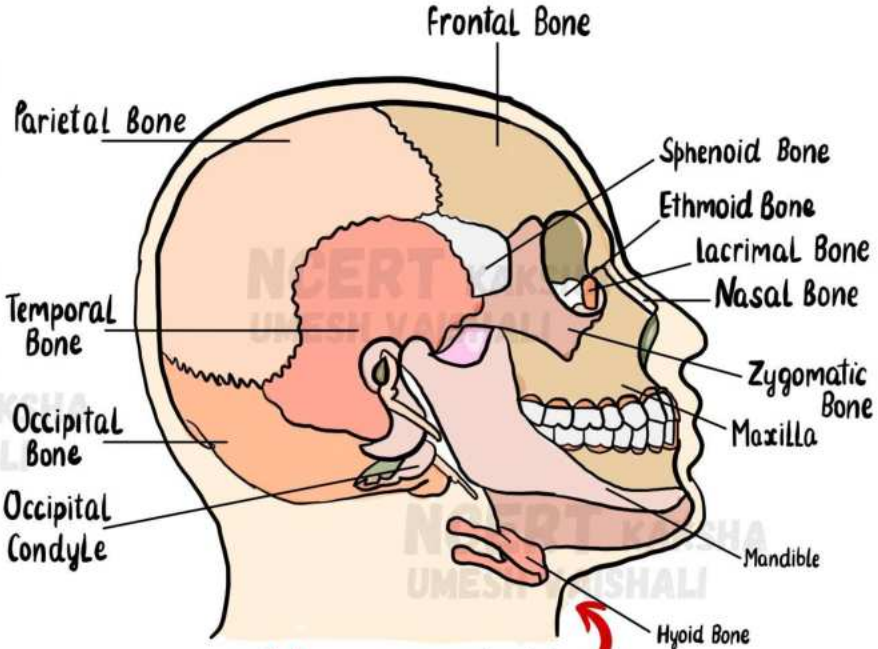
• Mechanism OF Muscle Contraction :-

- The mechanism of muscle contraction is explained by sliding mechanism theory in which thin filament slide over thick filament.
- Muscle contraction start with signal sent by CNS via motor neuron. Neural signal release neurotransmitter (Acetyl choline) to generate action potential in the sarcolemma.
- This causes the release of Ca^{++} from sarcoplasmic reticulum.
- Ca^{++} activates actin which binds to the myosin head to form a cross bridge.
- These cross bridges pull the actin filaments causing them to slide over the myosin filaments and thereby causing contraction.
- Ca^{++} are than returned to sarcoplasmic reticulum which inactive the actin. cross bridges are broken and the muscles relax.



Skull :-

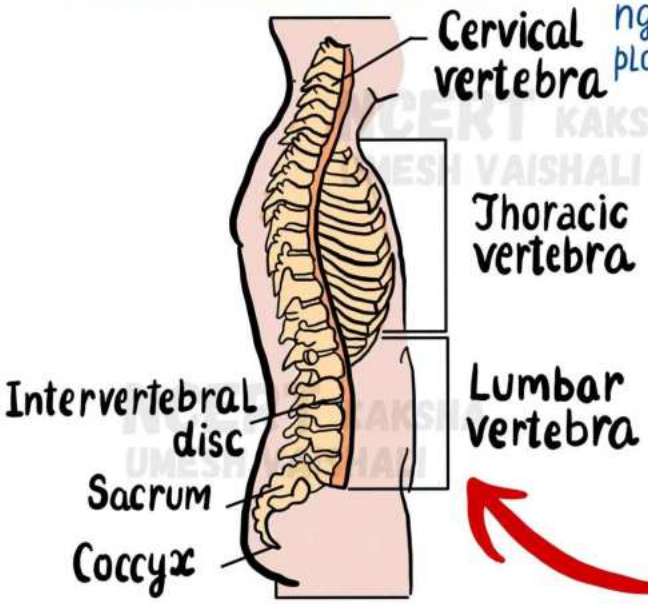
- The skull (22 bones) is composed of **cranial** and **facial bones**. Cranial (8 bones) forms protective covering for brain (cranium). The facial region consists of 14 skeletal systems that form front part of skull. Hyoid bone (U-shaped) forms the base of buccal cavity.
- The middle ear bone (Malleus, Incus and Stapes) collectively called Ear ossices. Skull joins with vertebral column with two occipital condyle.



Human skull

Vertebral column :-

- Vertebral column is formed by 26 serially arranged units called vertebrae and is dorsally placed.
- First vertebra is the atlas and its articulates with occipital condyles.
- The vertebral column is differentiated into cervical (7), thoracic (12), lumbar (5), sacral (1-fused) and coccygeal (1-fused) regions starting from the skull.
- **Sternum** is a flat bone on the ventral midline of thorax.

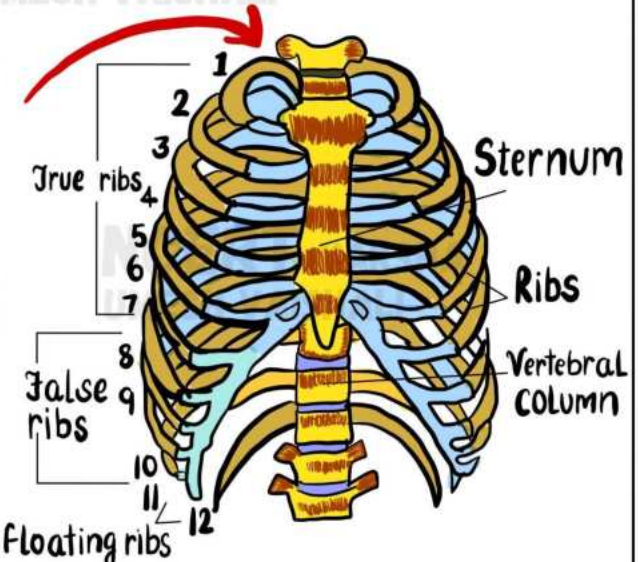


Vertebral Column (right lateral view)

Ribs and Rib cage :-

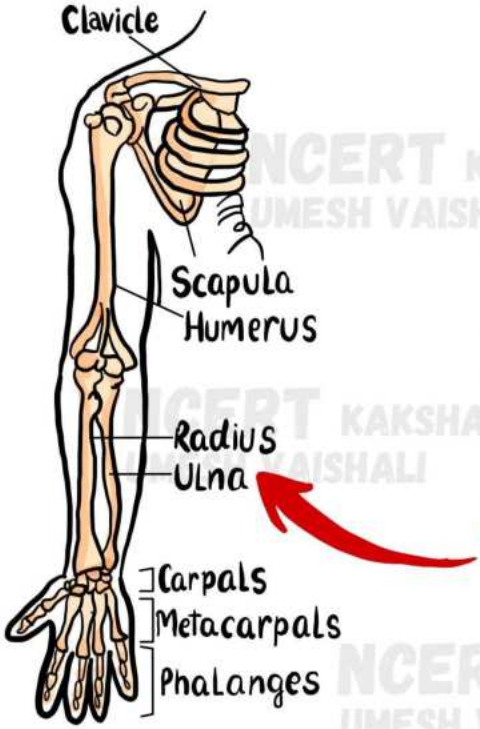
- There are 12 pairs of **ribs**.
- Each rib is a thin flat bone connected dorsally to the vertebral column and ventrally to the sternum.
- First seven pairs of ribs are called *true ribs*.
- 8th, 9th and 10th pairs of ribs do not articulate directly with the sternum but join the seventh rib with the help of hyaline cartilage.

Ribs and Rib cage



- These are called vertebrochondral (false) ribs.
- Last 2 pairs (11th and 12th) of ribs are not connected ventrally and are therefore, called floating ribs.

Pectoral Girdle :-

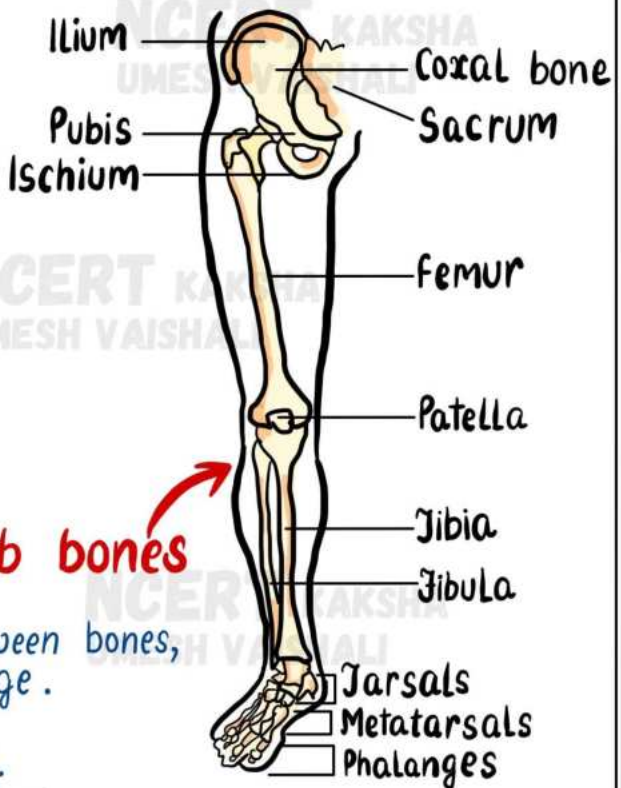


Right Pectoral Girdle And Upper Arm (Frontal view)

- Pectoral and Pelvic girdle bones help in the articulation of the upper and the lower limbs respectively with the axial skeleton.
- Each girdle is formed of two halves.
- Each half of pectoral girdle consists of a clavicle and a scapula.
- Scapula is a large triangular flat bone situated in the dorsal part of the thorax between the second and the seventh ribs.
- Each clavicle is a long slendor bone with two curvatures.
- This bone is commonly called the collar bone.

Pelvic Girdle :-

- Each clavicle is a long slender bone with two curvatures.
- This bone is commonly called the collar bone.
- Pelvic girdle consists of two coxal bones.
- Each coxal bone is formed by the fusion of three bones - ilium, ischium and pubis.
- The two halves of the pelvic girdle meet ventrally to form the public symphysis containing fibrous cartilage.



Right pelvic Girdle And lower limb bones

Joints :-

Joints are points of contract between bones, or between bones and cartilage.

- **Fibrous Joints** ~ do not allow any movements. Present in flat skull bones to form cranium.

- **Cartilaginous Joints** ~ bones are held together with the help of cartilage present in vertebrae, permits limited movements.
- **Synovial Joints** ~ fluid filled synovial cavity, provide considerable movements, ball and socket joint, hinge joints, pivot joints, gliding joins etc..

➡ Disorders Of Muscular And Skeletal System :-

- **Myasthenia Gravis** ~ auto immune disorder affecting neuromuscular junction causing fatigue, weakening and paralysis of skeletal system.
- **Muscular Dystrophy** ~ degeneration of skeletal muscles due to genetic disorder.
- **Osteoporosis** ~ decreased bone mass in old age leading to chance of fracture due to decreased estrogen.
- **Arthritis** ~ Inflammation of joints.
- **Gout** ~ Inflammation of joints due to accumulation of uric acid crystals.
- **Tetany** ~ Rapid spasms in muscle due to low Ca^{++} in body fluid.

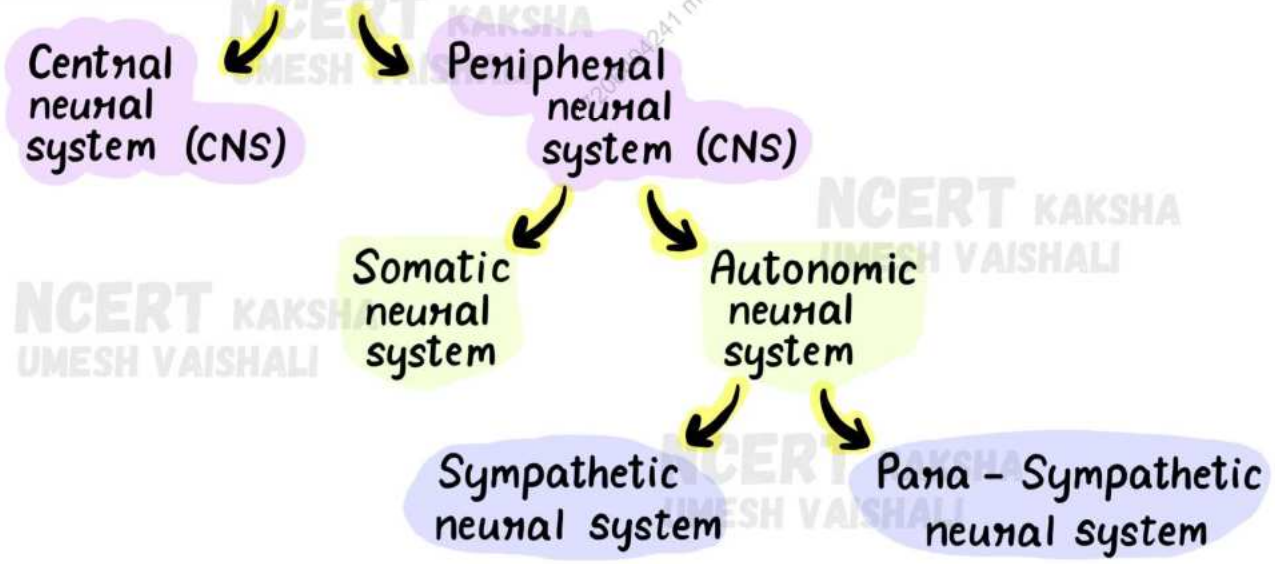
Neural Control And Coordination

➡ **Neural System** :- Neural system provides an organized network of point to point connection for quick coordination. **The endocrine** system provides chemical integration through hormones.

- **Neural system** of animal is composed of specialized cells called neuron, which can detect, receive and transmit different kinds of stimuli. In hydra neural system is composed of network of neuron. In insects it consists of brain and a number of ganglia. Vertebrates have highly developed neural system.

➡ **Coordination** :- Coordination is the process through which two or more organs interact and complement the function of each other.

* HUMAN NEURAL SYSTEM



➡ Neuron as Structural and Functional Unit of Neural System:-

Neuron is made up of three major parts **cell body**, **dendrite** and **axon**.

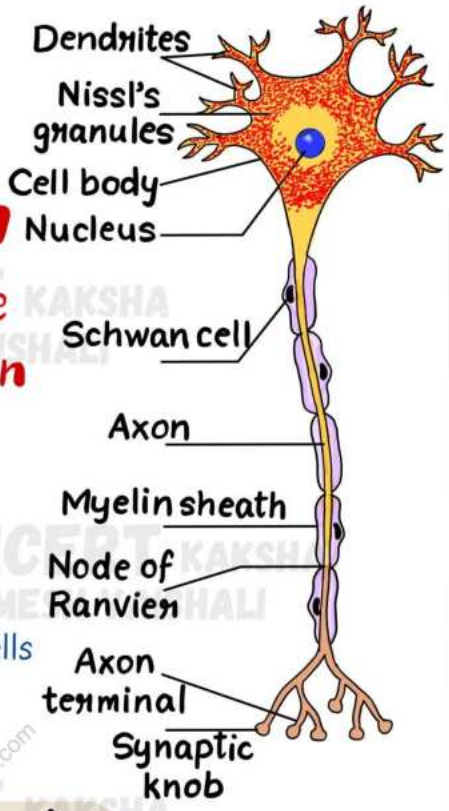
- Cell body contains cytoplasm, cell organelles and Nissl's granules. Short fibres projecting out from cell body is called dendrites. The axon is long fibre having branched structure at the end that terminates into knob like structure called **synaptic knob**.
- Based on number of axon and dendrites neuron are of three types -

★ **Multipolar** - one axon and two or more dendrite found in cerebral cortex.

★ **Bipolar** - one axon and one dendrite found in retina of eyes.

★ **Unipolar** - cell body with only one axon found in embryonic stage.

Structure of a Neuron



- There are two types of axon

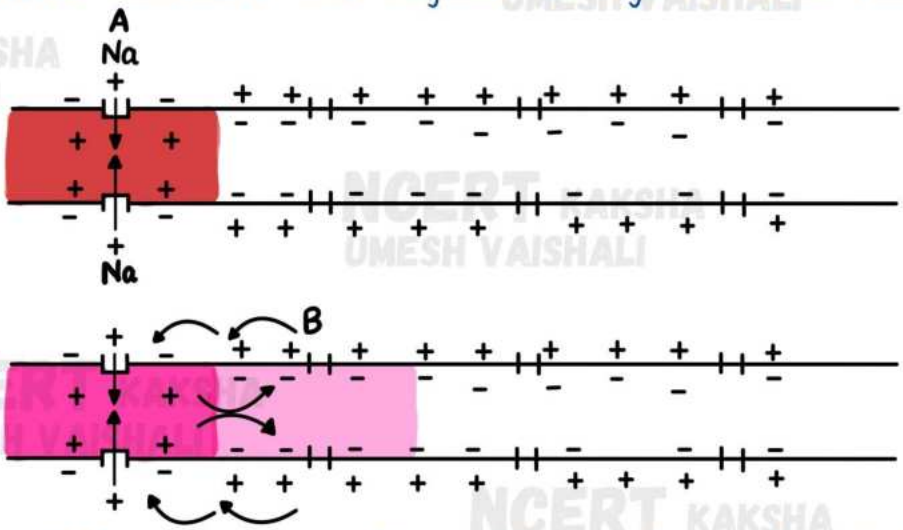
~ **Myelinated** - fibres are enveloped with **Schwann cells** to form myelin sheath around the axon. The gap between two myelin sheaths is called **nodes of Ranvier**. Found in spinal and cranial nerves.

~ **Unmyelinated** - fibre is enclosed by Schwann cells that do not form myelin sheath around the axon . Found in autonomous and somatic neural system.

Generation and Conduction of Nerve Impulse :-

- Ion channels are present in neural membrane which is selectively permeable to different ions. When neuron is not conducting impulse (resting), axonal membrane is more permeable to K^+ ions and impermeable to Na^+ ions.
- Ionic gradient across the resting membrane is maintained by active transport of ions by sodium - potassium pump. This will develop positive charge outside the axonal membrane and negative charge on inner side

Impulse conduction through an axon



- The electrial potential difference across the resting membrane is called **resting potential**.
- When stimulus is applied at site A, the membrane becomes permeable to Na^+ ions to make rapid influx of Na^+ ions to create outer surface negatively charged and inner membrane positively charged that create **Action Potential** or nerve impulse.

- The nerve impulse from A moves to B in inner surface and B to A on outer surface. This process is repeated several times to transmit the impulse.
- Nerve impulse is transmitted from one neuron to another neuron through synapse.

➡ Transmission of Impulses at Synapse:-

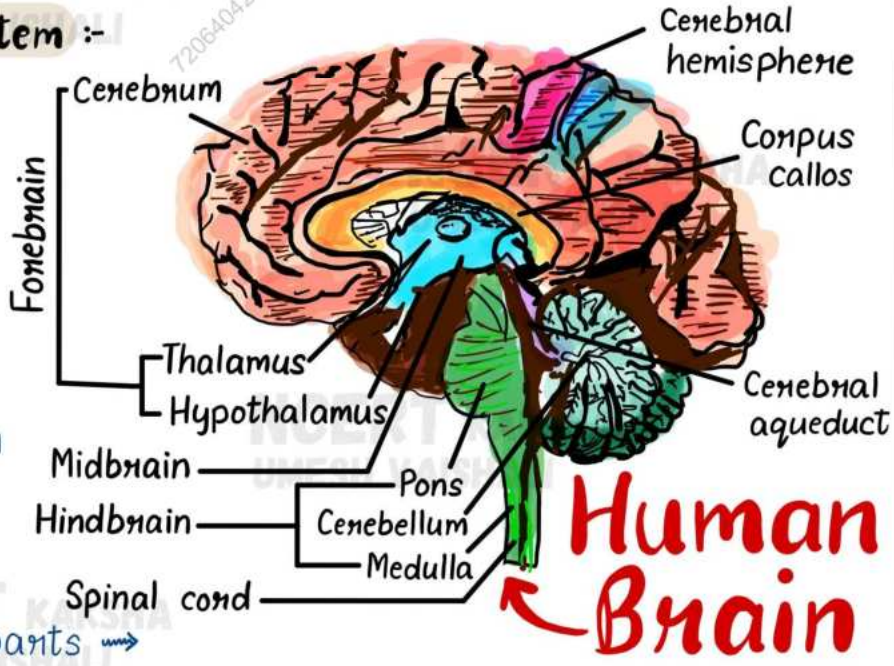
✱ **At electrical synapses :** Here the membrane of pre and post-synaptic neuron are in very closs proximity. Electric current can flow directly from one neuron into other across these synapses, like impulse conduction along a single axon.

✱ **At chemical synapses :** Here the membrane of pre and post-synaptic neuron are separated by fluid filled space called synaptic cleft. Neurotransmitter are involved here.

When an impulse arrives at the axon terminal, it stimulates the movement of the synaptic vesicles towards membrane and they fuse with the plasma membrane and release their neurotransmitter in the synaptic cleft. These chemicals bind to specific receptors, present on the post-synaptic membrane. Their binding opens ion channels and allow the entry of ion which generate new potential in post synaptic neuron.

➡ Central Neural System :-

Brain is the central information processing organ of our body and act as command and control centre. Human brain is proctected by skull (cranium) and three layers of cranial meninges - outer **dura mater**, middle **arachnoid** and inner **pia mater**.



Brain can be divided 3 parts ⟹

★ Forebrain :-

- **Cerebrum :-** Cerebrum is divided into left and right cerebral hemispheres which are covered by cerebral cortex (grey matter). Cerebral cortex contains sensory neuron, motor neuron and association area. Association area controls complex functions like intersensory associations, memory and communication.

- **Thalamus** :- Cerebrum wraps around a structure called thalamus. It is a major coordinating centre for sensory and motor signaling.
- **Hypothalamus** :- Controls the urge for eating, drinking and body temperature. They also release hypothalamic hormones. Limbic system is involved in controlling sexual behavior and expression of emotional reactions.

★ **Midbrain** :- Midbrain is located between hypothalamus and pons of hindbrain. Dorsal portion consists of four round lobes called **corpora quadrigemia**. They are involved in relay of impulses back and forth between cerebrum, cerebrum, and medulla.

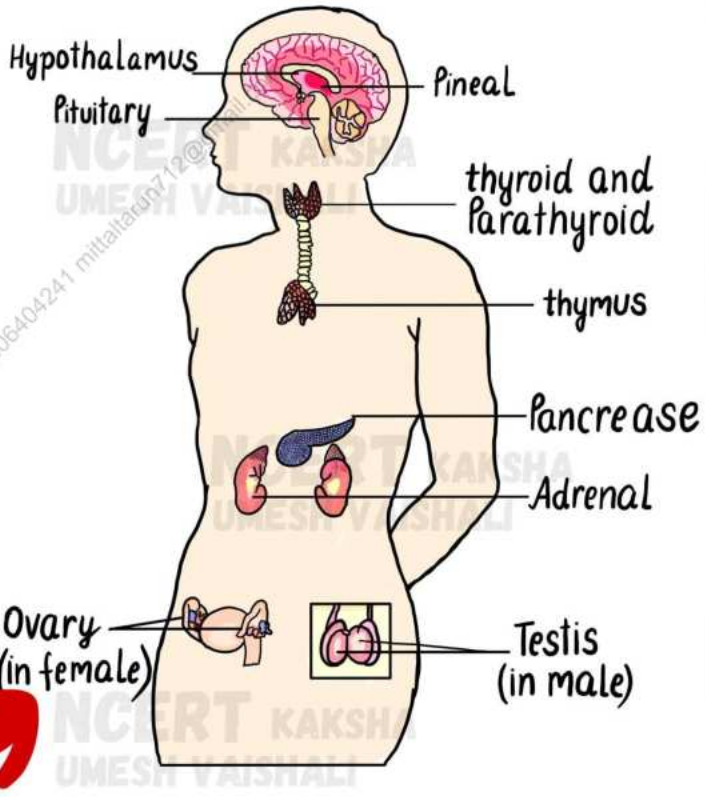
★ **Hindbrain** :- Hindbrain consists of **pons, medulla oblongata** and **cerebellum**.
Pons consists of fibre tracts that interconnect different regions of the brain. The medulla contains centres which control respiration, cardiovascular reflexes and gastric secretions. Cerebellum controls balance and posture.

Chemical Coordination And Integration

➡ **Endocrine Glands** :- Endocrine glands are endogenously located glands which release small amounts of **hormones** generally into the blood and have specific excitatory or inhibatory action on specific target organ of the body. These differ from the exocrine glands in being ductless.

➡ **Hormones** :- Hormones are chemical messengers of endocrine glands to the target organs having specific receptor proteins either on their plasma membrane or in their cytosol.

➡ **Human Endocrine System**:-



Human Endocrine System

◆ **The Hypothalamus** ~ Hypothalamus contains several groups of neurosecretory cells called nuclei which produce hormones. Hormones released by hypothalamus regulate the synthesis and secretion of pituitary hormones.

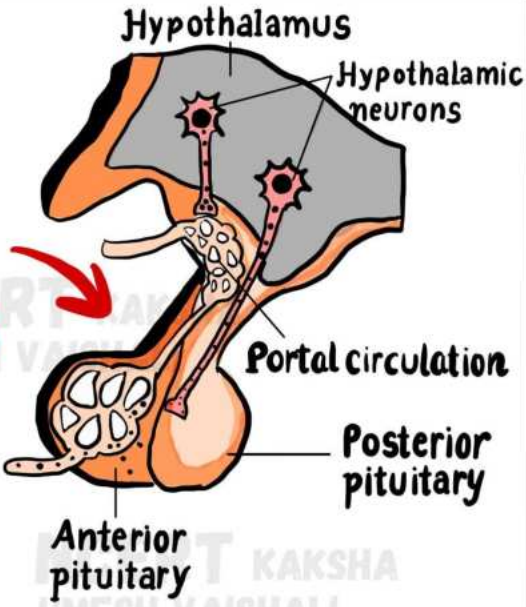
- The hormones released from hypothalamus reaches the anterior pituitary through portal circulatory system and regulate its function.
- The posterior pituitary is under direct control of hypothalamus.

◆ **The Pituitary Gland** ~ Pituitary Gland is located in sella tursica, a bony cavity. It is attached to the hypothalamus by a stalk.

- Excess secretion of growth hormone causes over growth of the body leading to gigantism and low secretion causes stunted growth called **dwarfism**.
- Prolactin stimulates growth of mammary gland and production of milk.
- TSH stimulates production and release of thyroid hormone.
- LH and FSH stimulate activity of the gonads. In male, LH stimulates synthesis and secretion of androgen hormone from testis. In female, LH induces ovulation of fully mature ovum from ovary.
- Oxytocin helps in contraction of uterus during child birth and milk ejection from mammary glands.

- Vasopressin stimulates absorption of water and electrolyte in kidney.
- MSH acts on the melanocytes and regulates skin pigmentation

Pituitary And its relationship with hypothalamus



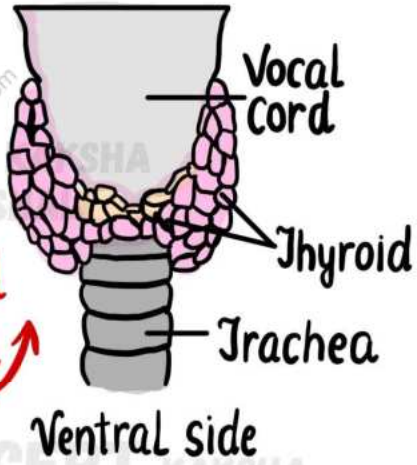
◆ The Pineal Gland~

The pineal gland is located on the dorsal side of forebrain. Pineal secretes a hormone called **melatonin**. Melatonin plays a very important role in the regulation of a 24-hour (diurnal) rhythm of our body.

◆ Thyroid Gland~

Thyroid gland composed of two lobes on either side of trachea connected by isthmus.

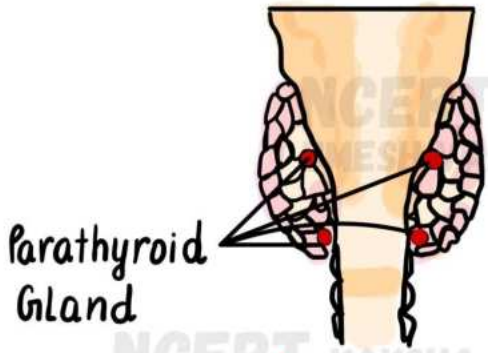
Thyroid gland is made of follicles and stromal tissues.



- Iodine is essential for synthesis of thyroid hormones. Deficiency of iodine leads to hypothyroidism (Goitre). During pregnancy, hypothyroidism may cause stunted growth of baby and mental retardation.
- Thyroid hormones regulate the basal metabolic rate. They support the process of red blood cell formation. They control the metabolism of carbohydrates, proteins and fats.

Thyrocalcitonin hormone regulates blood calcium levels.

◆ Parathyroid Gland~



Parathyroid Gland is located on the back side of thyroid gland, secretes peptide hormone called **parathyroid hormone** (PTH). PTH regulates the calcium ion concentration in the blood. It also helps in reabsorption of calcium from renal tubules and digestive tracts.

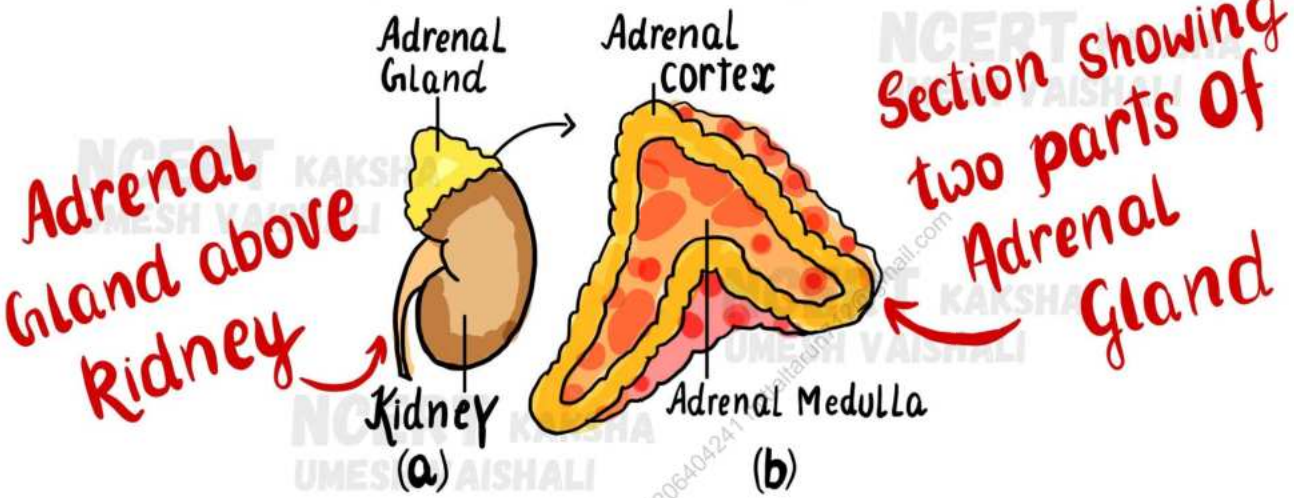
◆ Thymus~

Thymus is located on the dorsal side of heart and the aorta. This gland releases peptide harmone thymosins that help in differentiation of T-lymphocytes for cell-mediated immunity. It also promotes

production of antibodies to provide humeral immunity.

- **Adrenal Gland~** Adrenal Gland located on anterior part of each kidney composed of two types of tissues central adrenal medulla and outside adrenal cortex. Adrenal medulla secretes adrenaline and noradrenaline hormone commonly called as catecholamines. These hormones are also called as **emergency hormone**. These hormones increase alertness, pupilary dilation, sweating, heart beat, rate of respiration, glycogenolysis.

  The adrenal cortex secrets glucocorticoids and mineralocorticoids. glucocorticoids stimulate gluconeogenesis. Mineralocorticoids regulate water and electrolyte contents of the body.



- **Pancrease~** It acts as both endocrine and exocrine gland. Endocrine pancrease consists of "Islets of langerhans" which contain α-cells and β-cells. The α- cells secrete hormone glucagon and β-cells secrete insulin. Both hormones are involved in maintenance of blood sugar levels.
  - Glucagon is a peptide hormone that stimulates glycogenolysis resulting in increased blood sugar (hyperglycemia).
  - Insulin is a peptide hormone that play major role in regulation of glucose homeostasis. It triggers rapid movement of glucose from blood to hepatocytes and adipocytes resulting in decreased blood glucose levels (hypoglycemia).

- **Jestis~**

  Jestis perform dual functions as a primary sex organ as well as endocrine glands. leydig cells or interstitial cells produce androgen mainly testosterone which regulate maturation of primary sex organs and spermatogenesis.

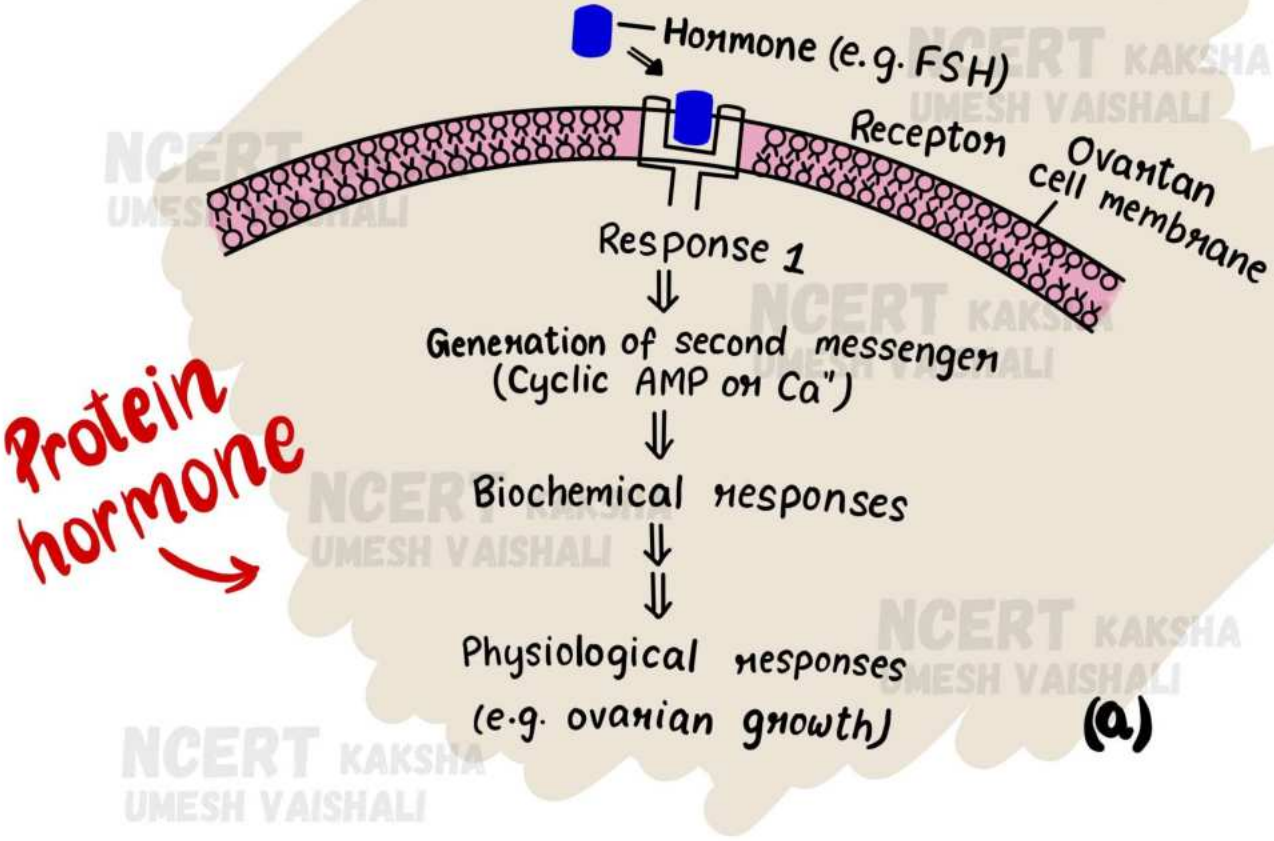
- **Ovary~**

  Ovary produce two groups of steroid hormones called estrogen and progesterone. Estrogen is synthesized and secreted by growing ovarian

follicles. After ovulation, ruptured ovum called corpus luteum, secretes progesterone.

➡ Hormones of Heart, Kidney And Gastrointestinal Tract :-

- Endocrine cells present in the atrial wall of heart secrete a polypeptide hormone called **Atrial natriuretic factor (ANF)** which causes vasodilation so decreases the blood pressure so is secreted in case of increased blood pressure.
- **Erythropoietin** ~ It is a glycoproteinous hormone secreted by juxtaglomerular cells of the afferent arteriole of the kidney in response to reduced RBC count i.e. anaemia. It stimulates **erythropoiesis** (RBC formation) in the bone marrow.
- Gastro-intestinal tract secrete four major peptide hormones:
  - Gastrin stimulates the secretion of hydrochloric acid and pepsinogen.
  - Secretin acts on the exocrine pancreas and stimulates secretion of water and bicarbonate ions.
  - Cholecystokinin (CCK) stimulates secretion of pancreatic enzymes and bile juice.
  - Gastric inhibitory peptide (GIP) inhibits gastric secretion and motility.
  - **Growth Factors** are secreted by several non-endocrine tissues and help in normal growth of tissues and their repair or regeneration.



Mechanism Of Hormone Action:-

Hormones produce their effects on target tissues by binding to specific proteins called **hormone receptors.**

On the basis of their chemical nature, hormones can be divided into groups :

- **peptide, polypeptide, protein hormones** (e.g; insulin, glucagon, pituitary hormones, hypothalamic hormones, etc.)
- **Steroids** (e.g., cortisol, teststerone, estradiol and progesterone).
- **iodothyronines** (thyroid hormones).
- **amino-acid derivatives** (e.g.; epinephrine.