केन्द्रीय विद्यालय संगठन

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BIOLOGY

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CONTENTS

Chapter-1

The Living World

TERMS REVISION:

1- Biodiversity: Large variety of organisms.
2- **Nomenclature: Scientific naming of organisms**.
3- Identification : Correct description of organism prior to nomenclature.
4-Classification: Grouping of organisms in to categories on the basis of similarities & differences.
5-Taxon: Concrete biological object or category of classification.
6-Taxonomy: Study of Identification, nomenclature and classification of organisms.
7-Systematics: Branch of biology dealing with taxonomy along with evolutionary relationship between organisms.
8-Species :Group of Individual organisms with fundamental similarities (with capacity of interbreeding).

LEARNING TIPS:

1-Concentrate on minute points of the chapter keeping very short answer& short answer type questions in mind.
2- Emphasise on concepts.

LET US LEARN THE LESSON

What is Living?

-Objects having characteristics of cellular organisation, growth & development, reproduction, ability to sense environment & give response, metabolism etc.

All organisms grow:

-Increase in mass or number of cells characterise growth.
-Plants grow throughout life but Animals grow to certain age.
-Growth in Non living objects is external and in living beings its internal.

Reproduction:

-Characteristics of living beings to produce progenies possessing features of their own type.
-Reproduction is of sexual& asexual type.
-Fungi produce spores for asexual reproduction.
-Organism viz. *Planaria* reproduce by regeneration in which a fragment of body forms whole organism.
-Fungi, filamentous algae, protonema of moss reproduce by fragmentation also.
-In unicellular organisms growth & reproduction are synonymous.
- Certain organisms do not reproduce viz. mule,worker bees, infertile human couple.
-Hence reproduction **cannot be considered as defining property** of living beings. Reproduction is not essential for survival of an Individual but it is necessary for continuity of species over the time.

Metabolism:

Sum total of all Biochemical reactions in the Body of organisms are called Metabolism. It consists of Catabolism & Anabolism.
-**It is defining property of living beings.**

Cellular organisation:

-living organisms consist of cells & their products.
-It is **defining property of living beings. Exception: Virus**

***Consciousness**: Ability to sense environment & respond to environmental factors*

-It is defining property of organisms.

LIVING ORGANISMS CAN BE CONSIDERED AS SELF REPLICATING, EVOLVING& SELF-REGULATING INTERACTIVE SYSTEMS CAPABLE OF RESPONDING TO EXTERNAL STIMULI.

Diversity in the living world:

-Described number of species range 1.7-1.8 million.
-Scientific names are given to organisms after identification, acceptable at global level.
-Nomenclature is done as per criteria given in ICBN (International code for botanical nomenclature) & ICZN (International code for zoological nomenclature)
-Binomial nomenclature was given by CAROLUS LINNAEUS. Father of Indian Taxonomy= H.Santapau.
- Scientific names consist of Two words. First word is Generic name & second word is Specific epithet. -Names are in Latin or Latinised.
-Names, if hand written , separately underlined & if printed, are italicised.
-First word starts with capital letter & second word with small letter.
Example: *Mangifera indica* (Mango)
-Name of author in last as abbreviation.
-For ease of study organisms are classified into groups or categories known as taxa.
- eg. Taxon may be Dogs, Mammals, wheat, Rice etc.

Taxonomic categories:

-Each rank or category of classification is termed as taxonomic category.
-Arrangement of categories in sequence is termed as Taxonomic Hierarchy.

Taxonomical Hierarchy

Species: Group of organisms with fundamental similarities.
eg. **Mangifera indica**
In this species is **indica.**
Genus: Group of realated specieswith common characters.
eg. *Panthera* is a genus which includes lion(*Pantheraleo*),leopard(*Pantherapardus*) & Tiger (*Pantheratigris*).

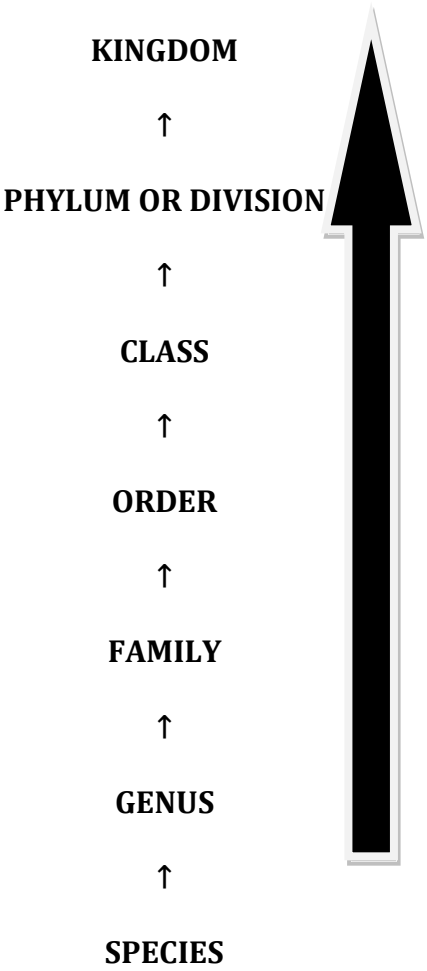
Family: Group of realated genera .
eg. Genus *Solanum,Petunia&Datura* belong to one family Solanaceae.

Order : Group of related families.
eg. FamaliesConvolvulaceae,Solanaceae belong to one order- Polymoniales.

Class : Group of related orders.
eg. Order Primata&Carnivora belong to one class Mammalia.

Phylum: Group of related classes.
eg. Class Mammalia, Pisces,Amphibia,Reptilia belong to one phylum -Chordata.

Kingdom: Group of all related Phyla.
eg. Kingdom Animalia-includes all animals.



Organisms with their Taxonomic Categories

Common Name	Biological Name	Genus	Family	Order	Class	Phylum/Division
Man	*Homo sapiens*	*Homo*	Hominidae	Primata	Mammalia	Chordata
Housefly	*Musca domestica*	*Musca domestica*	Muscidae	Diptera	Insecta	Arthropoda
Mango	*Mangifera indica*	*Mangifera*	Anacardiaceae	Sapindales	Dicotyledonae	Angiospermae
Wheat	*Triticuma estivum*	*Triticum*	Poaceae	Poales	Monocotyledonae	Angiospermae

Taxonomical Aids

-Articles helpful in correct identification & classification of organisms are called taxonomical aids.

1-Herbarium:

- Store house of collected plant specimens that are dried, pressed & preserved on sheets.
-Sheets are arranged according to universally accepted classification system.
-used as ready reference in scientific studies.

2-Botanical Gardens:

-Collection of various living plant species in form of garden for identification , conservation and study Example: Royal Botanical Garden at Kew, England, Indian Botanical Garden Howrah,
-National Botanical Research Institute, Lucknow , FRI Dehradun.

3-Museum:

-Collection of preserved plant &animal specimens.
-Specimens may be preserved in preservative solutions *viz*.Formalin (40%).
-Specimens may also be preserved as dry specimens eg. Insects and stuffed large animals.
-Skeleton of animals may be also as museum specimen.
-Used as actual material for study and identification.

Zoological Parks:

Place where wild animals are kept in protected environment under human care .
eg. Alipur zoo, Kolkata, West Bengal, National Zoological Park of New Delhi
- Used as aid to learn about food habits and behaviour, Life cycle for Incaptive Breeding.

Key:

Taxonomical aid based on contrasting characters called as couplet.
- Couplet has two opposite statements, each called lead.
- Separate keys for separate taxonomic categories needed.
- Used to classify organism.

***Flora*:**

Actual account of habitat & distribution of plant species in an area.
Flora: *All the animals species of a particular area.*

Manual:

- Have description of species in an area.
- Used for getting information foridentification of names.

Monograph:

- Has information of any one taxon.
- Used for classification purpose.

Some Important Questions:

1. **Explain binomial nomenclature by taking an example.**
2. **Explain taxonomic hierarchy by taking a suitable example from plants.**

Biological Classification

Terms Revision:

1-Thallus: Plant body without true stem, root & Leaf.
2-Halophiles: Organism living in salty areas.
3-Plankton: Plants floating passively in water current.
4-Chemosynthetic: Using chemical reactions as energy source. Eg Nitrosomonas Bacteria.
5-Heterotrophic: Unable to synthesise own food and dependent on others for food.
6-Pathogenic: Disease causing.
7-Plasmodium: Main body of slime mould.
8-Saprophyte: Organism feeding on dead & decaying organic matter.
9-Parasite: Organism which depend on living host for food.
10-Symbionts : Two organisms living together benefitting each other.
11- Plasmogamy : Fusion of cytoplasm.
12- Karyogamy : Fusion of nuclei.
13- Dikaryon : A cell with two nuclei.
14- Dikaryophase : Stage of fungus with dikaryotic cells.
15- Isogamous : Morphologically & physiologically identical gametes.
16- Anisogamous : Morphologically non identical Gametes.
17- Oogamous : Female gamete non motile , large and Male gamete motile,small.

LET US LEARN THE LESSON

Introduction:

- Aristotle classified organisms for the first time.
- Two kingdom system includes – Plantae &Animalia.

Demerits of Two Kingdom system

- No difference in Eukaryotes and Prokaryotes.
- Heterotrophic Fungi kept in Plantae.
- Five kingdom system is given by R.H Whittaker (1969) viz. Monera, Protista, Fungi, Plantae and Animalia.

Kingdom Monera –

- Prokaryotic unicellular organisms.
- Also live in extreme habitats viz. Hotsprings, Snow etc. as endoparasite etc.
- eg. *Bacteria*, archaebacteria.

Archaebacteria –

- Cell wall different from other bacteria.

- Live in excess salt habitats eg. Halophile. In high temp. acidic habitats: thermoacidophiles.

- Methanogens are found in the gut of ruminants and produce methane (CH_4) gas.

Eubacteria –

- True bacteria.

- Rigid cell wall with or without flagellum.

- Cyanobacteria (Blue green algae) are also included in this group.

- Cyanobacteria are Photosynthetic autotrophs, unicellular, colonial or filamentous, with gelatinous sheath.

- Have Heterocyst for N_2fixation eg. *Nostoc*, *Anabaena*, *Oscillatoria*, *Rivularia*, *Gloeotrichia* etc.

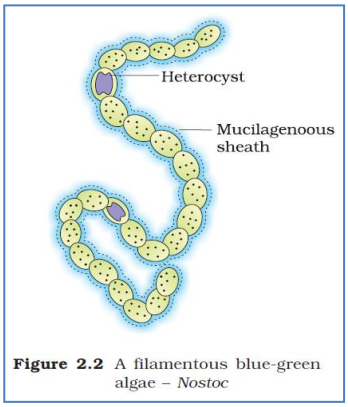


Figure 2.2 A filamentous blue-green algae – *Nostoc*

- Reproduction occurs by fission. Also by primitive type of sexual reproduction, by transferring DNA piece from one bacterial cell(+ strain) to other (- strain).

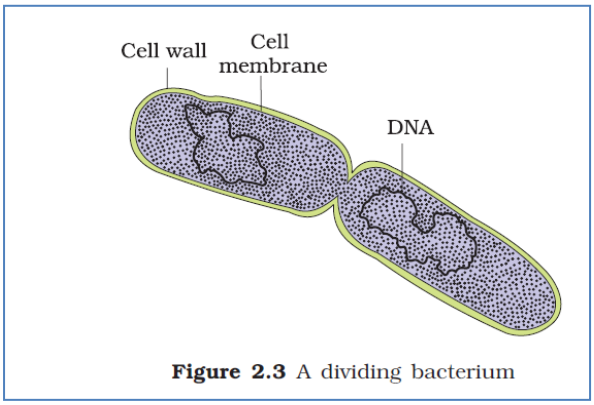


Figure 2.3 A dividing bacterium

Mycoplasma – PPLO

- Smallest unicellular anaerobic organisms having no cell wall.

- Pathogenic in plants and animals.

Kingdom Protista –

- Unicellular eukaryotes.

- Some have cilia and flagella.

- Reproduction sexual and asexual both.

Chrysophytes –

- Fresh water or marine microscopic Planktons.

- Mostly photosynthetic and chief producer in ocean eg. Diatoms and Golden algae (Desmids).
- Diatoms with cell walls in two halves having Silica (indestructible).

- Diatomaceous earth is formed by cell wall deposits of Diatoms and used in polishing, filtration of oils and syrups, fire bricks and explosives.

Dinofagellates –

- Marine.

- Photosynthetic yellow , green, blue, brown or red in colour.

- One longitudinal and other transverse two flagella.

- *Gonyaulax* causes Red tides.

Euglenoids –

- Fresh water forms.

- No cell wall, outer most layer pellicle.

- Two unequal flagella.

- Photosynthetic but also heterotrophic in absence of light (Myxotroph).

- eg. *Euglena*.

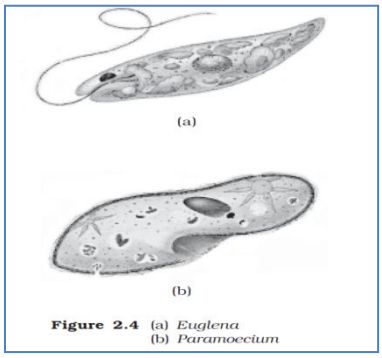


Figure 2.4 (a) *Euglena* (b) *Paramoecium*

Slime moulds –

- Saprophytes.

- Body is an aggregation called 'Plasmodium'(multinucleate, without cell wall, irregular in shape and can spread over several feet).

- Plasmodium produces fruiting body having spores with walls which are highly resistant and spread through wind.

Protozoans –

- Fresh water or marine unicellular heterotrophs.

- Primitive relative of animals.

(a) **Amoeboid Protozoans –**

- Free living or parasites.

- Pseudopodia (false feet) formed eg. *Amoeba* ,*Entamoeba*.

(b) **Flagellated Protozoans –**

- Free living or Parasitic with flagella eg.*Trypanosoma*(causes sleeping sickness).

(c) **Ciliated Protozoans –**

- With cilia eg. *Paramecium* (sleeper animalcule).

(d)**Sporozoans –**

- Spore like stage in life eg. *Plasmodium vivax*.(Malarial parasite)

Kingdom Fungi –

- Fungi are a group of achlorophyllous, heterotrophic organisms with cell wall without cellulose.

- Saprophyte or Parasite or Symbiotic.

- Prefer to grow in warm and humid places.

- Unicellular (eg. Yeast) to multicellular filamentous body called *mycelium*.

- One unit of *mycelium* called *hypha* .

- *Mycelia* maybe aseptate (no septum) or septate.

- **Lichens –** Symbiotic association of fungus(Mycobiont) and algae(phycobiont). Indicator of pollution specially for SO_2

- **Mycorrhiza –** Symbiotic association of fungi with root of higher plants (Mostly with trees)eg. *Pinus.*

- Reproduction –Vegetative : by fragmentation and by spores.

- Three steps in sexual reproduction

1) Plasmogamy – fusion of protoplasm.

2) Karyogamy – fusion of nuclei.

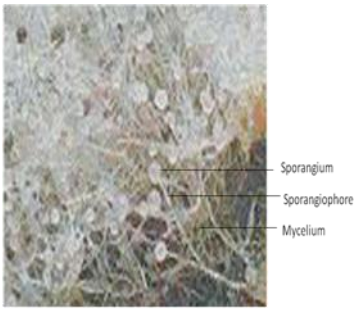
3) Meiosis of zygote.

Phycomycetes –

- Grow on aquatic places or decaying wood or damp places or obligate parasite.

- Mycelium aseptate, coenocytic.- **Reproduction –** asexual by zoospores or aplanospores.
Sexual by zygospores.

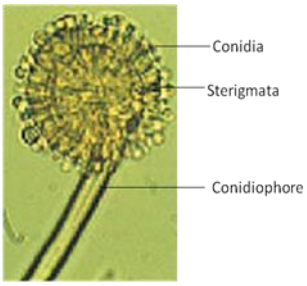
- eg. *Rhizopus*(bread mould) and *Albugo candida or Cystopus* (causing white rust of crucifers).



Mucor

Ascomycets (sac fungi)-

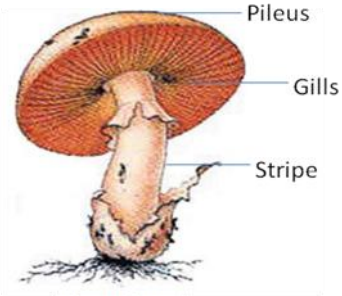
- Unicellular (eg. Yeast) or multicellular
- Saprophytic or parasitic.
- Maybe coprophillus (growing on dung) eg. Peziza, pilobolus.
- Mycelium septate and branched.
- Reproduction – asexual by exogenously produced conidia.
-Sexually by Ascospares produced (endogenously) in asci present in fruiting body called Ascocarp.
- eg*Aspergillus, Claviceps, Neurospora, Saccharomyces* (yeast) etc.



Aspergillus

Basidiomycetes (club fungi) –

- Grow on soil , logs or parasites (rusts and smuts).
- Mycelium septate and branched and of two types 1) Uninucleate 2) Dikaryophase.
- Reproduction – vegetative by fragmentation sexual by two somatic cells giving rise to Dikaryophase.
- Dikaryophase makes fruiting body Basidiocarp having Basidia.
-Inside basidia (singular basidium) – Karyogamy and meiosis occours.
-Meiosis results in formation of four basidiopores.



Agaricus

- eg. *Agaricus* (mushroom), *Ustilago* (smut fungi), *Puccinia* (rust fungus).

Deuteromycetes (Fungi- imperfectii) –

- It is formed class – Group of Fungi whose complete life cycle is not known.-Saprophyte/parasite , mostly decomposers.- eg. *Alternaria, Colletotrichum, Trichoderma*.

Kingdom Plantae –

- Eukaryotic, chlorophyll bearing autotrophic organisms.

- Only few members partial heterotrophs eg. Insectivorus plants (Bladder wort and Venus flytrap).

- Few parasites eg. *Cuscuta*

- **Reproduction –** vegetative, asexual and sexual.

- Life cycle shows alternation of generation.

- eg. Algae, Bryophytes, Pteridophyte, Gymnosperms and Angiosperms.

Kingdom Animalia –

- Eukaryotic, Heterotrophic organisms.

- No chloroplast and no cell wall.

-Holozoic mode of Nutrition .

- Definite shape and size and capable of locomotion.

- **Reproduction** – Sexual in general

- eg. frog, cockroach, cow, man etc.

Viruses, Viroids and Lichens –

Viruses – Connecting link between living and non living.

- Non cellular structure consisting of protein coat and Nucleic acid

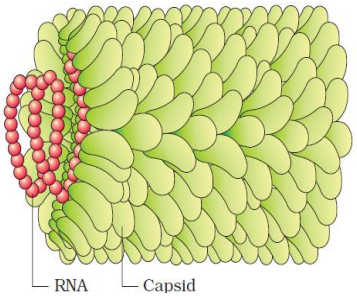
- Can reproduce within a host cell.

- Viruses which infect bacteria are called Bacteriophage.

- **Tobacco Mosaic Virus (TMV)-**

- Protein coat: - capsid consists of 2130 capsomers. It is an RNA Virus.

- Viruses can cause diseases viz. Mumps, Small pox, Herpes, Influenza, AIDS etc.



Tobacco Mosaic Virus (TMV)

Viroids –- Free RNA without protein coat.

RNA with Low molecular weight.

<u>SOME IMPORTANT QUESTIONS</u>:

1. **Write the criteria used by R.H.Whittaker for V kingdom classification.**
2. **Distinguish between virus and viroids.**
3. **Give a comparative account of various classes of fungi.**
4. **Write short note- Lichen**

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Plant Kingdom

***Terms Revision* –**

1- Phylogeny - Evolutionary history of organism .

2- Zoospores - Motile spores with flagella .

3- Gametophyte - Haploid stage of plant, producing gametes.

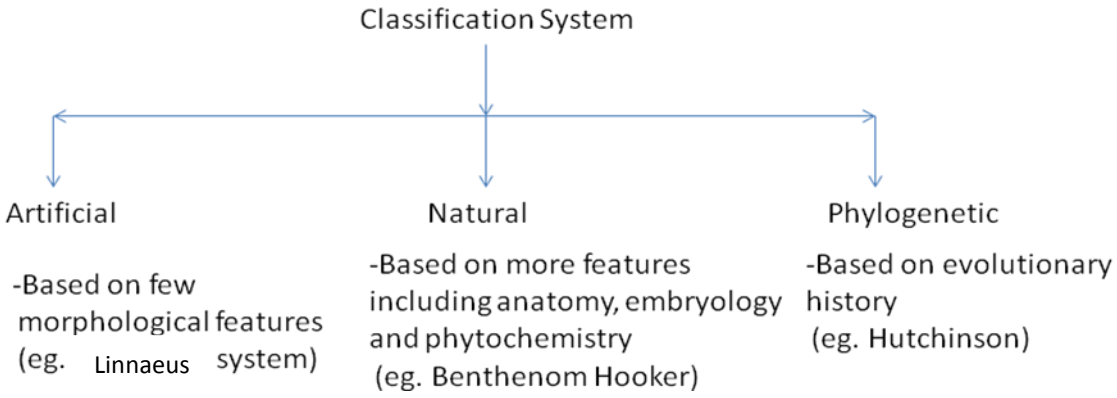
4- Sporophyte - Diploid stage of plants producing spores.

5- Archegonium - Female reproductive structure.

6- Antheridium - Male reproductive structure.

7- Megasporangium – The structure which bears megaspores.

8-Sporophyll- Leaf bearing sporangia producing spores.



- Numerical taxonomy - based on several features compared collectively by computer.

- Cytotaxonomy- based on cytological features.

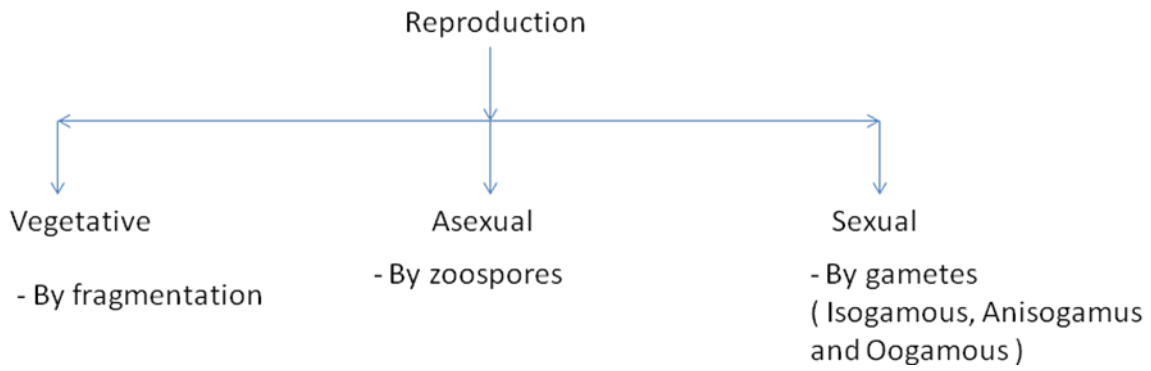
- Chemotaxonomy- based on chemical constituent.

***Algae* –**

- Group of chlorophyllous, simple, thalloid plants.

- Largely aquatic, grow on soil, stone, wood etc or symbiotic.

- Unicellular to large filamentous.



- Economically useful as-

a) Large photo synthesiser, release 0_2 .

b) Food for aquatic animals, humans.

c) Produce Algin (Brown algae), carrageen (red algae), agar (*Gelidium*, *Gracilaria*).

- *Chlorella*- in space travel as protein rich food.

Chlorophyceae	**Phaeophyceae**	**Rhodophyceae**
- Green algae chlorophyll a&b dominant. - Unicellular to filamentous. - Chloroplast of different shape(cup, spiral, ribbon) with pyrenoids . - Stored food starch. - Reproduction – vegetative-fragmentation Asexual- by zoospores Sexual- by gametes(iso, aniso and oogamus). - eg*Volvox, Ulothrix, Spirogyra, Chara* etc.	- Brown algae. - Xanthophyl, Fucoxanthin dominant others are chl. a, c cartenoid. - Simple branched filamentous to profusely branched large body. - Gelatinous coating on cell wall. - Stored food Mannitol and Laminarin. - Reproduction – Vegetative by fragmentation Asexual By biflagellate (lateral) zoospores. Sexual by gametes(Iso, Aniso and Oogamy). - eg. *Laminaria,Sargassum.*	- Red algae. - r- phycoerythrin (dominant) and others chlorophyll a and d. - Marine on surface or in great depths, multi cellular. - Stored food – Floridean starch. - Reproduction – Vegetative by fragmentation Asexual by non motile spores Sexual by oogamy. - eg. *Gracilaria, Gelidium*.

Bryophytes (Amphibians of plant Kingdom) –

- Group of autotrophic plants with thallus having rhizoids in place of roots.

- Occurs on damp, humid and shaded soil.

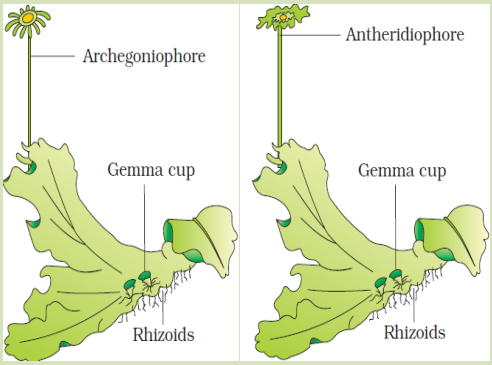
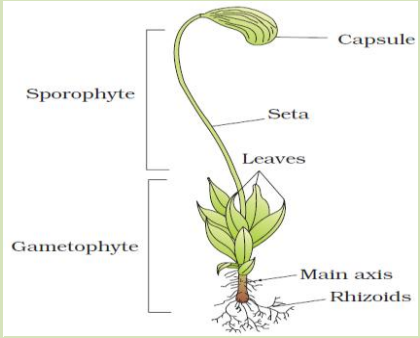
- Main plant body gametophyte bears Antheridia and Archegonia.

- Biflagellate antherozoids produced from Antheridium and reach through water to egg in Archegonium.

- Zygote forms sporophyte which produces haploid spores to give rise to new plants.

Types of Bryophytes

Liverworts	**Mosses**

- Thallus dorsoventrally flattened (Liver shaped), leafy members with leaf like appendages. - Asexual reproduction by fragmentation , gemmae formation. - Sexual reproduction - antheridia and archegonia produced. - Antherozoids fuse with egg to form zygote which give rise to Sporophyte. - Sporophyte - with foot, seta & capsule. - Spores give rise to new plant (gametophyte). eg. *Riccia, Marchantia* etc.	- Thallus : Two stages (gametophyte) – (a) Thread like Protonema(b)erect Leafy stage. - Reproduction : Vegetative by Fragmentation of protonema& Sexual by antherozoids &egg. - Zygote forms Sporophyte with foot, seta &capsule. -Sporophyte forms spores which germinate to form protonema. eg. *Funaria, Polytrichum* etc.
 *Marchantia*	 *Funaria*

Pteridophyte:

- Group of first terrestrial plants having vascular tissue viz. Xylem & Phloem.
- True stem, root & leaf.
- Found on damp, shady places.
- Sporophyte makes main plant body.
-Sporophylls of Sporophyte bear sporangia (sori) on ventral side producing haploid spores.
-spores give rise to Prothallus which is leafy & autotrophic.
- Prothallus bears sex organs – male – Antheridium and female- Archegonium.
- Fertilisation leads into zygote formation which produces diploid Sporophyte.

Heterospory and Seed habit:

- Two types of spores Microspore and Megaspore are produced in some members viz. *Selaginella, Salvinia.*
- called Heterospory.
- Heterospory is considered as beginning of seed habit in terrestrial plants.
- eg. *Pteris, Dryopteris* etc.

GYMNOSPERMS

- Medium sized trees and shrubs.

- Main plant body Sporophyte.

- In some members roots may have fungal association called Mycorrhiza.

- In some (Cycas) coralloid roots present having algal zone with N_2-fixing symbiotic algae.

Root – taproot and leaves of two types - 1)Foliage 2)Sporophylls.

- Microsporophyll bears sporangia where microspores are formed.

- Megasporophyll bears **ovules. Ovules are naked.**

- Compact arrangement of Sporophylls is called **Cone** and loose one is called **Strobilus.**

- Microspore i.e. pollens reaches to ovules. Wind Pollination.

- Pollen tubes help to transfer male gametes up to egg of archegonia present in female gametophyte of ovule. (Siphonogamy)

- Zygote develops in an embryo inside seed

-e.g. *Cycas, Pinus ,Cedrus*etc.

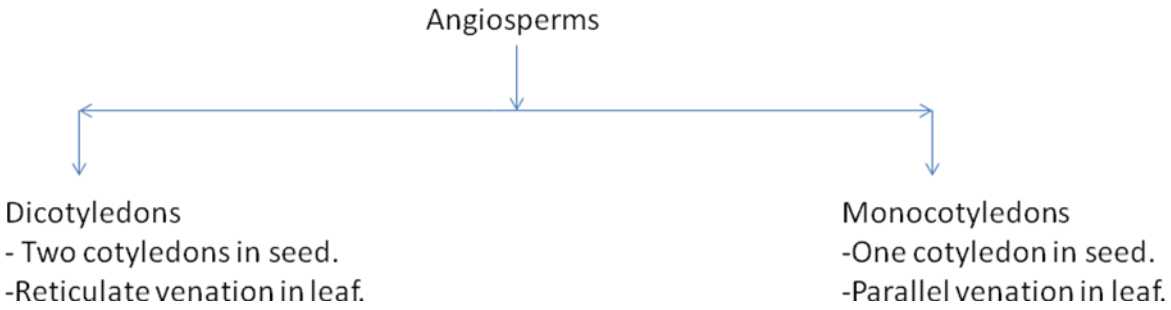
ANGIOSPERMS

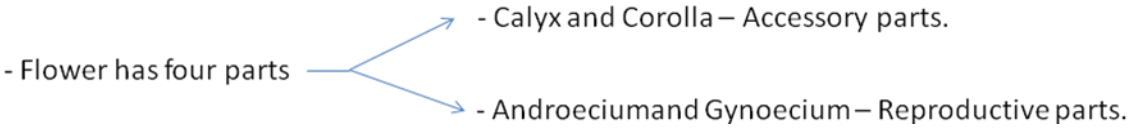
- Group of plants having covered seeds in fruits.

- Produce **flowers** having reproductive organs.

- Most evolved plants.

- Large no. of plants in varied habitats, small microscopic plants (*Wolfia*) to large trees(Eucalyptus).





- Androecium is male part and one unit is stamen.

- Gynoecium is female part and one unit is carpel and has ovules.

- Ovule bears embryo sac.

- Embryo sac is seven celled and has 8 nucleus

- Reproduction by vegetative and sexual methods.

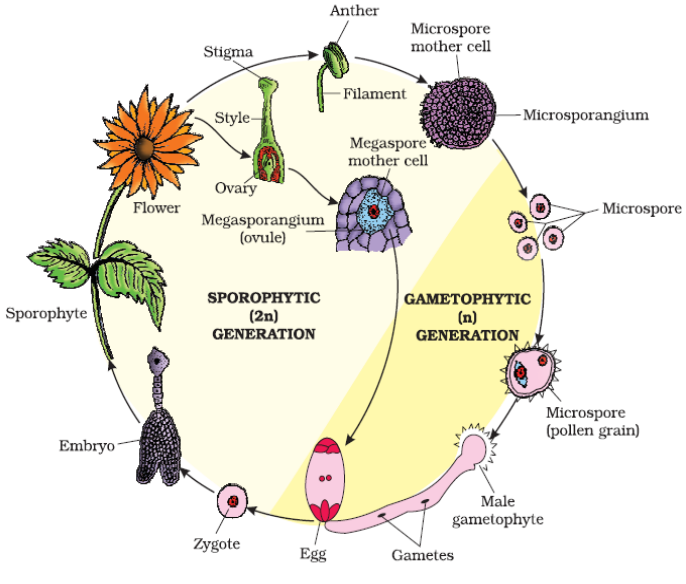


Figure 3.6 Life cycle of an angiosperm

- In sexual reproduction pollens shed off and reach to stigma of Gynoecium by pollination.

- Pollen germinates to form pollen tube with two male gametes and one tube nucleus.

- One gamete fuses with egg (Syngamy) and other with secondary nucleus to form PEN (primary endosperm nucleus). The whole process is called Double fertilization.

- Zygote forms embryo and PEN forms Endosperm in ovule which changes into seed inside fruit.

- Ovary wall changes into Pericarp (fruit wall).

- Alternation of generation occurs.

Plant life cycle and alternation of Generation –

- Alternate stages of haploid (n) and Diploid (2n) phase in life cycle of plants.

- Three Patterns -

Haplontic	**Diplontic**	**Haplodiplontic**
- Dominating phase haploid (n). -only zygote diploid (2n). -Haploid spores form the main plant body eg. *Algae viz. Ulothrix, Spirogyra* etc.	-Dominating phase diploid (2n). -Haploid phase only in single cell or few celled gametophyte. -Zygote forms embryo which forms Sporophyte (main plant body). eg. Gymnosperms& Angiosperms	-Intermediate i.e.haploid& diploid stages equal. -Gametophyte & Sporophyte stages both may be free living. eg. Bryophytes &Pteridophyte.

SOME IMPORTANT QUESTIONS:

1. Explain haplo-diplontic life cycle pattern.
2. Both Gymnosperms and Angiosperms produces seeds then why are they classified separately?

Chapter – 4

Animal Kingdom

1- Symmetry: Distribution of body parts around a hypothetical axis.

2- Ostia: Minute pores on body of sponge.

3- Osculum: Large outlet in body of sponge.

4- Hermaphrodite: Bisexual.

5- Polyp: Sessile cylindrical form of coelenterate (Asexual).

5- Medusa: Umbrella shaped free swimming sexual stage of coelenterate.

7- Acoelomate: No coelom.

8- Pseudocoelom: With false coelom (cavity not underlined by mesoderm). Eg Ascaris.

9- Dioecious: Unisexual.

10- Operculum: Cover over gills in fish.

11- Notochord: Dorsal rod like bone

12- Homoiotherms: Warm blooded.

13- Bioluminescence- Emit light. Eg Ctenophora.

- Levels of organisation

i) Cellular level- loose cell aggregates, small division of labour eg. Sponges.

ii) Tissue level- Groups of cells performing same functions. eg.

Coelenterate.

iii) Organ level- Tissues grouped into organs eg. Higher animals.

- Circulatory system - a) Open type- No blood vessels, blood flows in sinuses.

b) Close type- Blood flows in closed vessels.

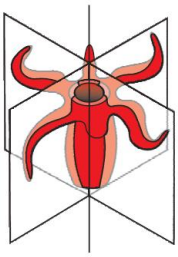


Figure 4.1 (a) Radial symmetry

Symmetry

- Asymmetrical – No symmetry eg. Sponges.

- Radial Symmetry – Any plane passing through central axis divides body in two equal halves.Coelenterate.

- Bilateral Symmetry – Body can be divided into two equal halves through one plane only. Eg Annelids.

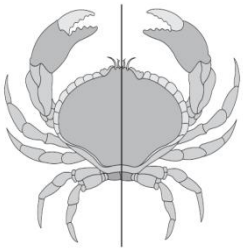


Figure 4.1 (b) Bilateral symmetry

Diploblastic and Triploblastic organisation –

- Two embryonic layers – Ectoderm and Endoderm – Diploblastic.

- Three embryonic layers- Ectoderm, Mesoderm and endoderm- Triploblastic.

Coelom –

- Body cavity lined by mesoderm- True Coelom.

- Body cavity not lined by mesoderm – Pseudo Coelom.

- No body cavity – Acoelomate.

Segmentation –

- True segments- Metameres (Body divided internally and externally).Eg Annelids.

Notochord –

- With notochord – Chordates.

- Without notochord – Non-Chordates.

Classification of Animals –

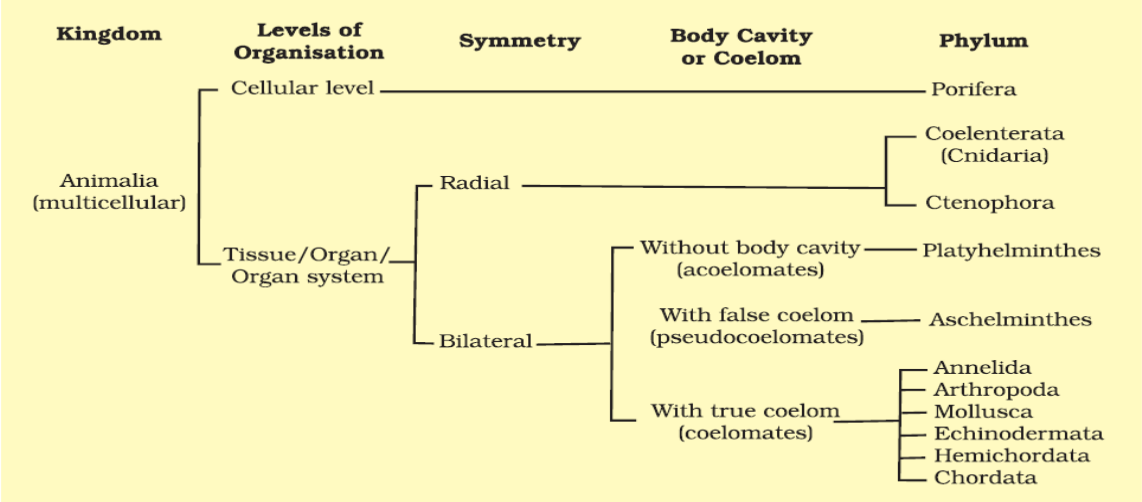


Figure 4.4 Broad classification of Kingdom Animalia based on common fundamental features

Phylum Porifera –

- Marine , few species fresh water.

- Multicellular, cellular grade body.

- Asymmetrical.

- Water canal system for food, respiration and excretion.

- Body wall with many pores – Ostia.

- Diploblastic.

- Water enters through Ostia and goes out through Osculum.

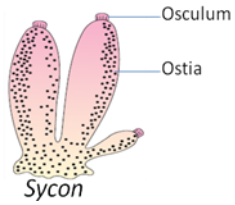
- Skeleton of spicules or spongin fibres.

- Hermaphrodite.

- Reproduction asexual by fragmentation and sexual by gametes.

- Fertilisation is internal, development indirect.

- eg. *Sycon, Spongilla, Euspongia*etc.



Phylum Coelenterata (Cnidaria) –

- Aquatic (marine), Sessile or free living.

- Presence of Cnidoblasts or Cnidocytes – Stinging cells.

- Cnidoblasts are for defence, anchorage or predation.

- Tissue level body organisation.

- Diploblastic.

- Central gastro vascular cavity, single opening mouth.

- Two body forms – Polyp (Asexual), Medusa (Sexual) stage.

-eg Hydra, *Physalia, Obelia, Aurelia* etc.

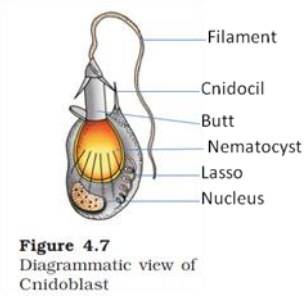


Figure 4.7
Diagrammatic view of Cnidoblast

Phylum Ctenophora (sea walnuts or comb jellies) –

- Marine, radial symmetry, Diploblastic, tissue grade.

- Eight external rows of Comb Plates.

- Bioluminescence.

- Reproduction sexual.

- eg. *Ctenoplana, Pleurobrachia* etc.

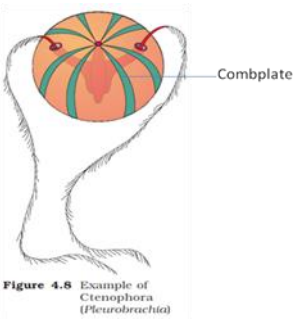


Figure 4.8 Example of Ctenophora (*Pleurobrachia*)

Phylum Platehelminthes (Flat worms) –

- Body dorso ventrally flattened.

- Endoparasite.

- Triploblastic, bilateral symmetry.

- Acoelomate.

- Organ level organisation.

-Flame cells- for excretion & osmoregulation.

- Hermaphrodite.

- Reproduction – Sexual - Fertilisation internal.

- eg. *Taeniasolium*(Tape worm), *Fasciola hepatica* (liver fluke).

Phylum Aschelminthes (Round Worm) –

- Free living or parasitic, aquatic and terrestrial.

- Bilateral symmetry and Triploblastic.

- Pseudocoelomate.

- Muscular pharynx.

- Male smaller and thinner than female.

- Fertilisation internal, development direct or indirect.

- eg. *Ascarislumbricoides, Wucherariabancroftii*etc.

Phylum Annelida –

- Aquatic or terrestrial.

- Free living or parasitic.

- Organ system level body bilateral symmetry and Triploblastic, coelomate.

- Metameric segmentation.
- Nephridia for excretion.

- Ventral double Nerve cord.

- Monoecious or Dioecious.

- Reproduction – Sexual.

- eg. Earthworm(*Pheretima*),*Nereis* etc.

Phylum Arthropoda(Jointed Legs) –

- Largest phylum.

- Bilateral symmetry, Triploblastic, segmented coelomate.

- Body - Head, Thorax and Abdomen(three parts).

- Respiration by gills, book lungs and trachea.

- Blood without haemoglobin and circulatory system open.

- Excretion by malpighian tubules.

- Fertilisation internal – development direct or indirect.

- eg. Cockroach, *Apis*, *Anopheles* etc.

Phylum Mollusca –

- Soft body animals.

- Second largest phylum.

- Aquatic, bilateral symmetry, triploblastic, coelomate.

- Body unsegmented divided into head, muscular foot and visceral hump.

- Soft mantle over visceral hump.

- Respiration and excretion through gills.

- Unisexual.

- Sensory tentacles on head and Radula in mouth as rasping organs

- Oviparous.

-eg.*Pila*, Octopus etc.

PHYLUM ECHINODERMATA

-Body surface spiny, (due to calcareous ossicles)
-Marine , organ system level, adult radially symmetrical, triploblastic coelomate.
-Mouth ventral

1. Water vascular system present for locomotion, capture and transport of food and respiration.
2. Sexes separate fertilization external, development indirect
   e.g. *Asterias* (Starfish), *Sea urchin* (Echinus), etc.

PHYLUM HEMICHORDATA

1. Marine
2. Bilateral symmetry, triploblastic, coelomate
3. Body--- i) Proboscis
   ii)Collar
   iii) Trunk

4. Circulatory system open
5. Gills for respiration
6. Proboscis gland for ***excretion***
7. Sexes separate fertilization external, development indirect, e.g. *Balanoglossus*.

PHYLUM- CHORDATA

Distinguishing features----

1. Presence of Notochord
2. Dorsal hollow nerve cord
3. Paired pharyngeal gills slits
4. Post anal tail present
5. Heart is ventral

SUB PHYLA –

1. **Urochordata** or **Tunicata**, Notochord only in larval tail e.g. *Ascidia*
2. **Cephalochordata** notochord head to tail in all stage e.g. *Branchiostoma*

3.**Vertebrata**: Notochord replaced by a vertebral column.

SUB PHYLUM- VERTEBRATA

AGNATHA-without jaw

CLASS- Cyclostomata- Ectoparasite on fish

- Circular mouth
-No scales and paired fins
-Marine but go in fresh water for spawning and die. Larva returns to ocean.
-Eg. *Petromyzon, Myxine*.

Gnathostomata – with jaws

Class – Chondrichthyes: Cartilagenous Endoskeleton

Class- Osteichthyes: Bony Endoskeleton

Class Amphibia –

- Aquatic and terrestrial both.

- Two pairs of limbs.

- No neck.

- Body has head and trunk only.

- No external ear, tympanum on surface.

- Heart three chambered.

- Cloaca present as common opening for digestive, reproductive and urinary system.

- Respiration by gills, skin and lungs.

- Sexes separate.

- Fertilisation external, development direct/

- eg. *Ranatigrina, Bufo, Hyla* etc.

Class Reptilia –

- Creeping or crawling mode of locomotion.

- Skin with scales/scutes.

- Tympanum on surface.

- Heart three chambered (Four chambered in crocodile).

- Fertilisation internal, development direct.

- eg. *Chelone, Testudo, Naja, Hemidactylus etc*.

Class Aves –

- presence of feather, beak and forelimb modified into wing.

- Hind limb adapted to clasping, walking and swimming.

- No glands on skin (only oil gland at tail base).

- Hollow bones (pneumatic).

- Air sacs connected to lungs to supplement respiration.

- Crop and gizzard are additional chambers in digestive system.

- Warm blooded.

- Heart four chambered.

- Sexes separate.

- Fertilisation internal and development direct.

- eg. *Columba*, *Psittacula* etc.

Class Mammalia –

- Aquatic, terrestrial and aerial.

- Mammary glands present for milk production.

- Two pairs of limbs.

- Skin with hair.

- Ear with pinna.

- Homoiothermic.

- Heart four chambered.

- Excretion by kidneys.

- Respiration by lungs.

- Sexes separate.

- Internal fertilisation, vivipary (exception *Platypus*).

- eg. Whale, Rat , Man, Tiger etc.

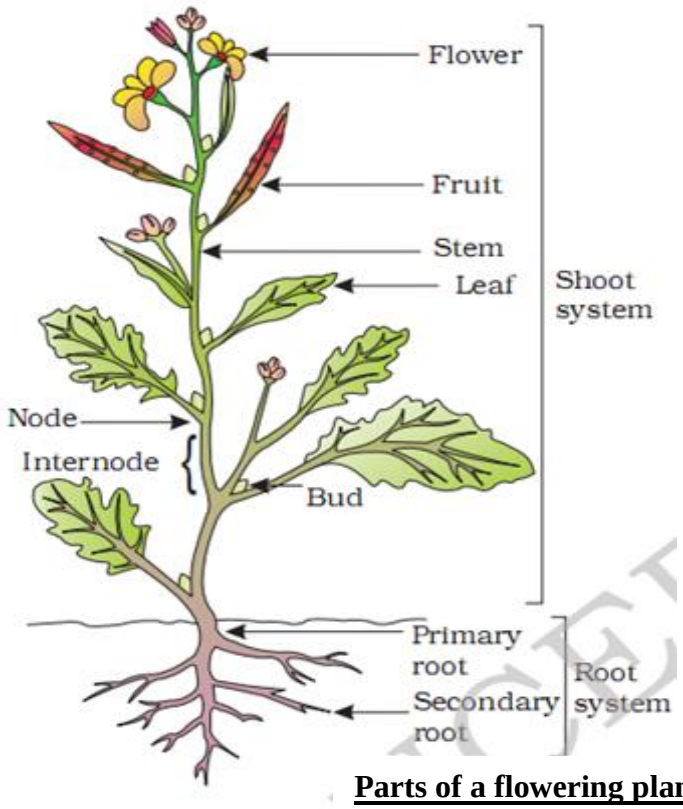
SOME IMPORTANT QUESTIONS:

1. What are the reasons that one can think of for the Arthropods to constitute the largest group of animal kingdom?
2. Distinguish between chordates and non chordates.
3. Mention the significance of presence of Air Bladder in fishes.
4. Write short note on: water vascular system, nephridia.

Chapter-5

Morphology of Flowering Plants

Morphology: The study of various external features of the organism is knownas morphology. The angiosperms are characterized by presence of roots, stems, leaves, flowers and fruits.



Parts of a flowering plant

The Root: The root is underground part of the plant and develops from elongationof radicle of the embryo.

Various types of root

1. Tap root: Originates from radicle. Dicotyledonous plants *e.g.*, mustard,gram, mango.

2. Fibrous root: Originates from base of the stem. Monocotyledonous plants *e.g.*, wheat, paddy.

3. Adventitious root: Originates from parts of the plant other than radicle. Banyan tree (Prop roots)Maize (Stilt roots)

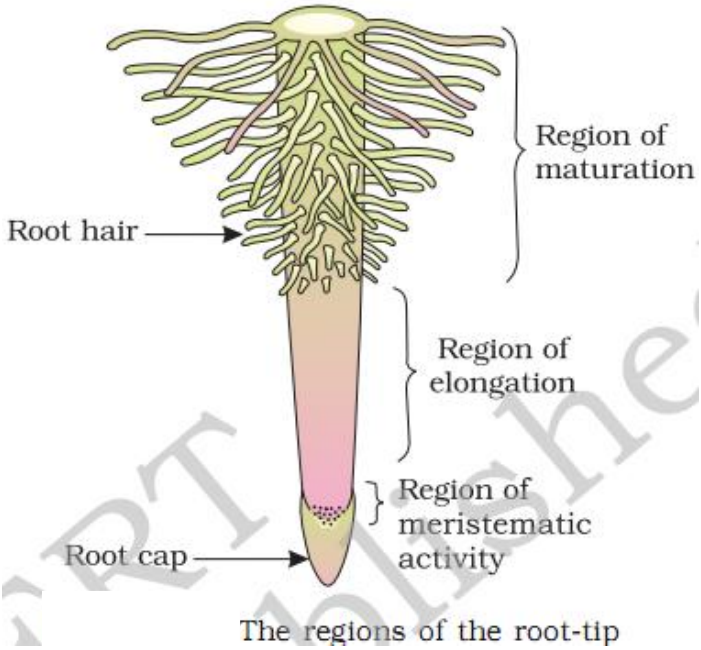
Root Cap: The root is covered at the apex by the thimble-like structure which protects the tender apical part of the root. It is positively Geotropic, hydrotropic and negatively phototropic.

Regions of the root:

1. Region of meristematicactivity: Cells of this region have the capabilityto divide.

2. Region of elongation: Cells of this region are elongated and enlarged, responsible for root growth.

3. Region of Maturation: This region has differentiated and matured cells. Some of the epidermal cells of this region form thread-like **root hairs** for absorption of water and minerals.

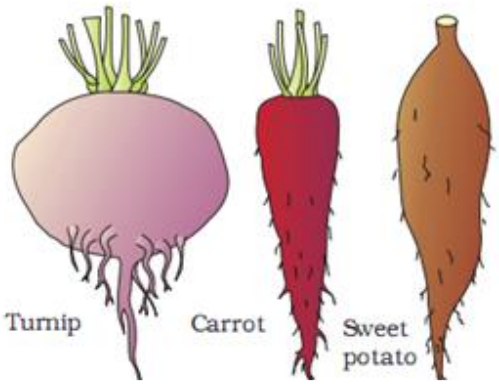


The regions of the root-tip

Modifications of Root:

Roots are modified for support, storage of food, respiration.

Asparagus



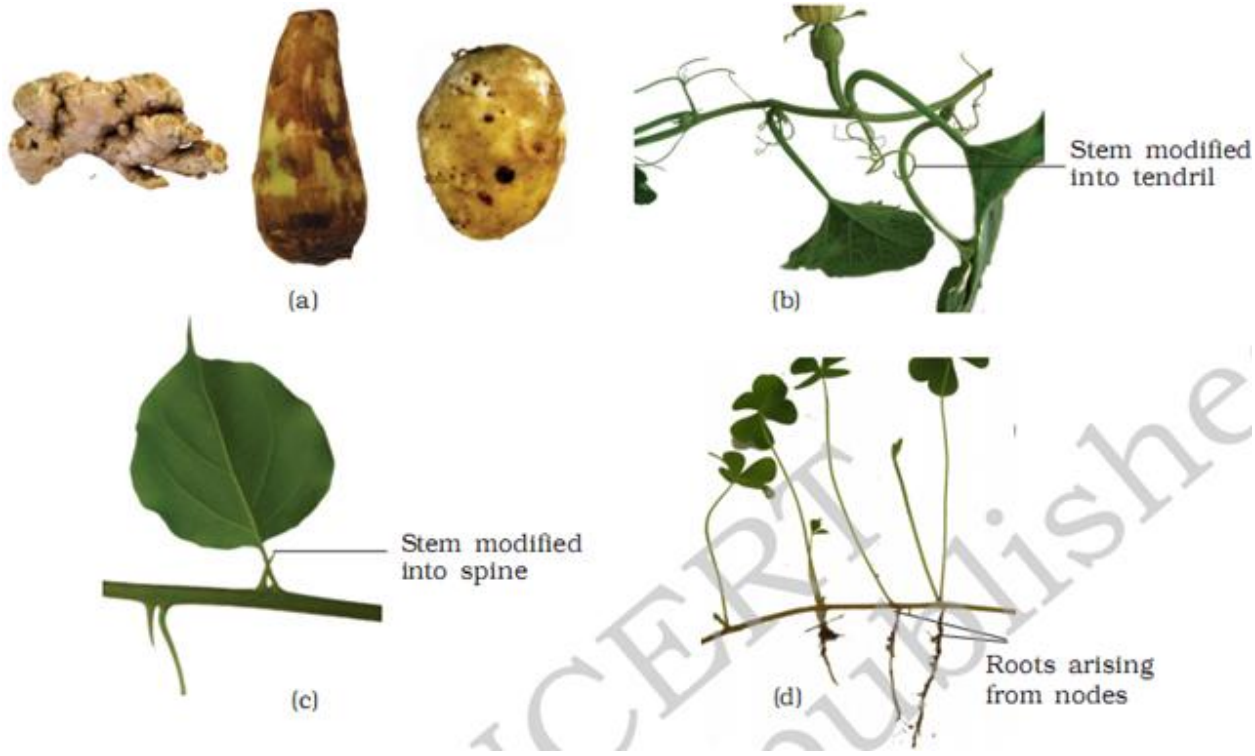
Modifications of Root

- **For support**:**Prop** roots in Banyan tree, **stilt** roots in maize andsugarcane.
- **For respiration:Pneumatophores** in *Rhizophora*(Mangrove).
- **For storage of food:**Fusiform (radish), Napiform (turnip), Conical (carrot).

The Stem:Stem is the aerial part of the plant and develops from plumule of theembryo.It bears **nodes and internodes**.

Modifications of Stem:

In some plants the stems are modified to perform the function of storage of food, support, protection and vegetative propagation.



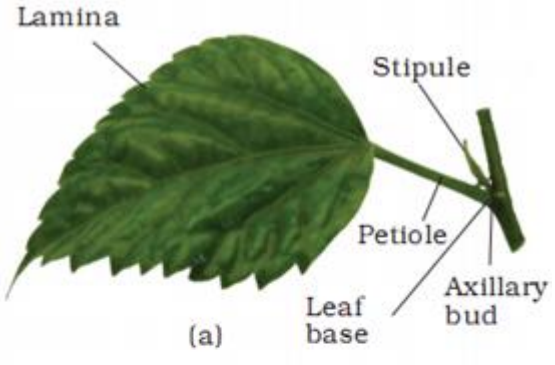
Modifications of Stem

- **For food storage:Rhizome** (ginger), **Tuber** (potato), **Bulb** (onion), and **Corm**(*colocasia*).
- **For support:**Stem **tendrils** of watermelon, pumpkin, cucumber.
- **For protection:**Axillary buds of stem of *Citrus*, *Bougainvillea* get modified into pointed **thorns**.
- **For vegetative propagation:**Underground stems of grass, strawberry, lateral branches of mint and jasmine.

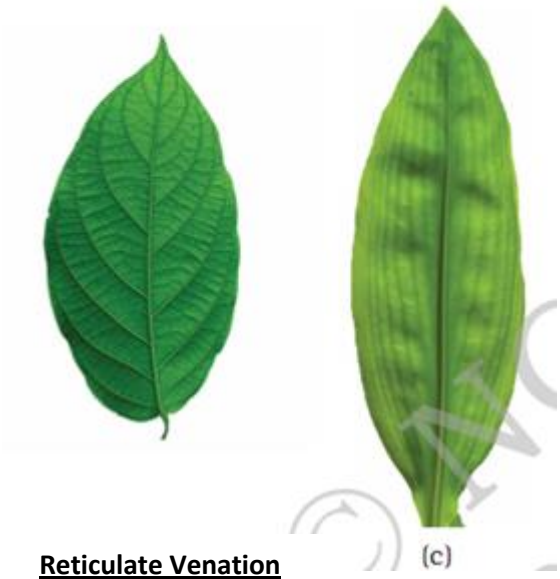
• **For assimilation of food:** Flattened stem of *Opuntia* contains chlorophyll and performs photosynthesis.

The Leaf: Develops from shoot apical meristem, flattened, green structure, manufacture the food by photosynthesis. It has bud in axil. A typical leaf has **leaf base, petiole** and **lamina**.

Venation: The arrangement of veins and veinlets in the lamina of leaf.



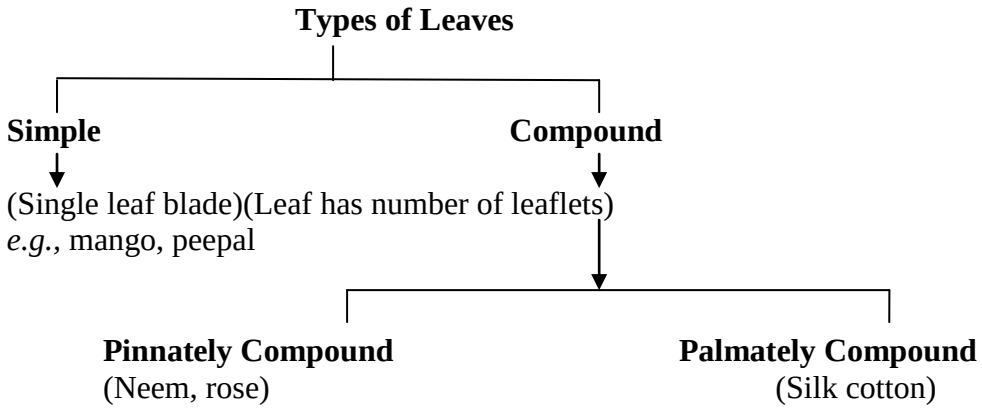
Parts of a leaf



Reticulate Venation **Parallel Venation**

Types of Venation:

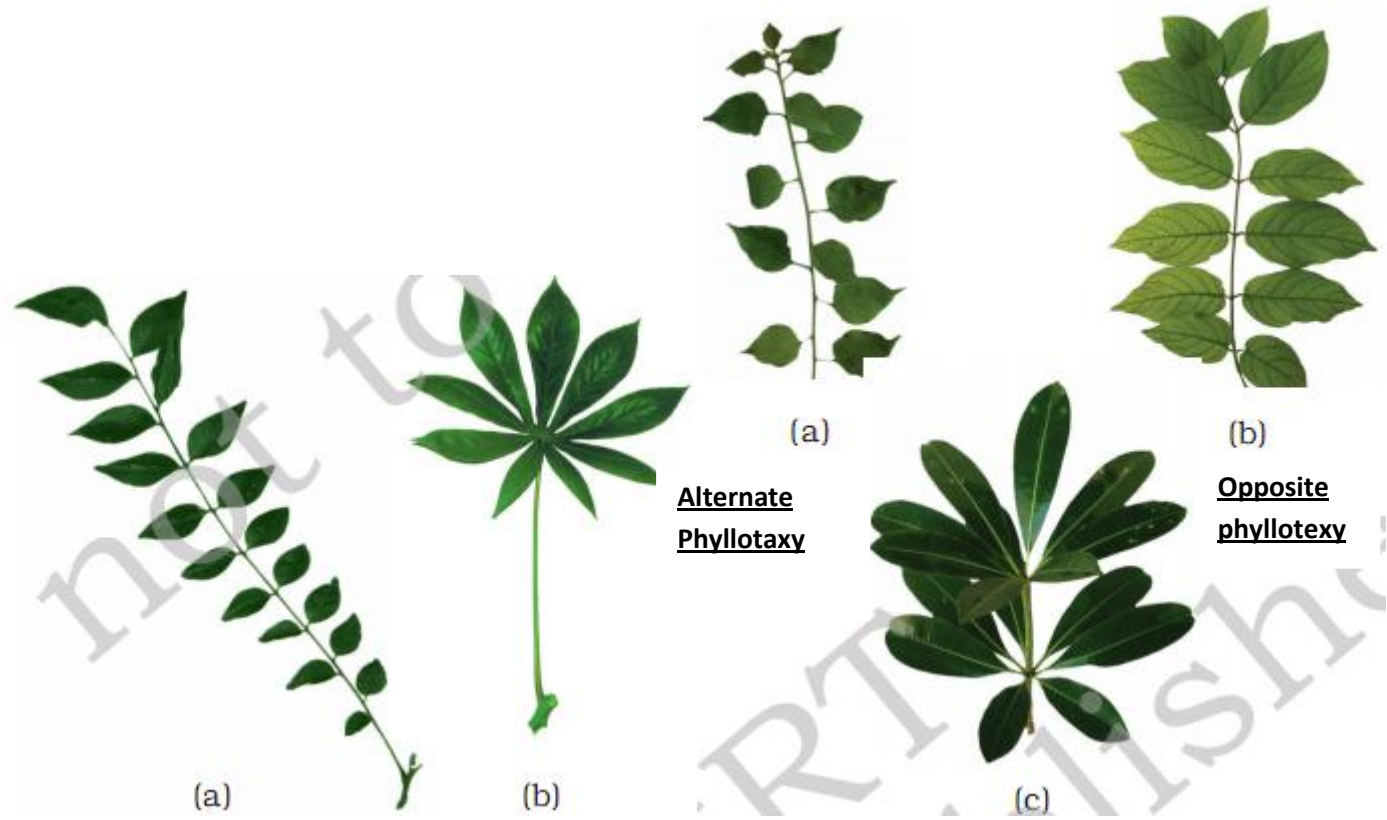
1. **Reticulate:** Veinlets form a network as in leaves of dicotyledonous plants(China rose, Peepal).
2. **Parallel:** Veins run parallel to each other as in leaves of monocotyledonous plants (grass, maize).



Phyllotaxy: The pattern of arrangement of leaves on the stem or branch.

Types of phyllotaxy

Alternate	**Opposite**	**Whorled**
(Single leaf at a node)	(Two leaves at a node)	(More than two leaves in a whorl at a node)
e.g., China rose, Mustard	*e.g.*, *Calotropis*, guava	*e.g.*, *Nerium,Alstonia*



Alternate Phyllotaxy

Opposite phyllotexy

Pinnately Compound leaf

Palmately Compound leaf

Whorled Phyllotaxy

Modifications of Leaves:

- **Tendrils:** (Climbing) −Sweet wild pea
- **Spines** (Protection) −*Aloe, Opuntia, Argemone*
- **Pitcher:** (Nitrogen Nutrition) −*Nepenthes*
- **Fleshy:** (Storage) −Onion

The Inflorescence: The arrangement of flowers on the floral axis.

Main types of Inflorescence:

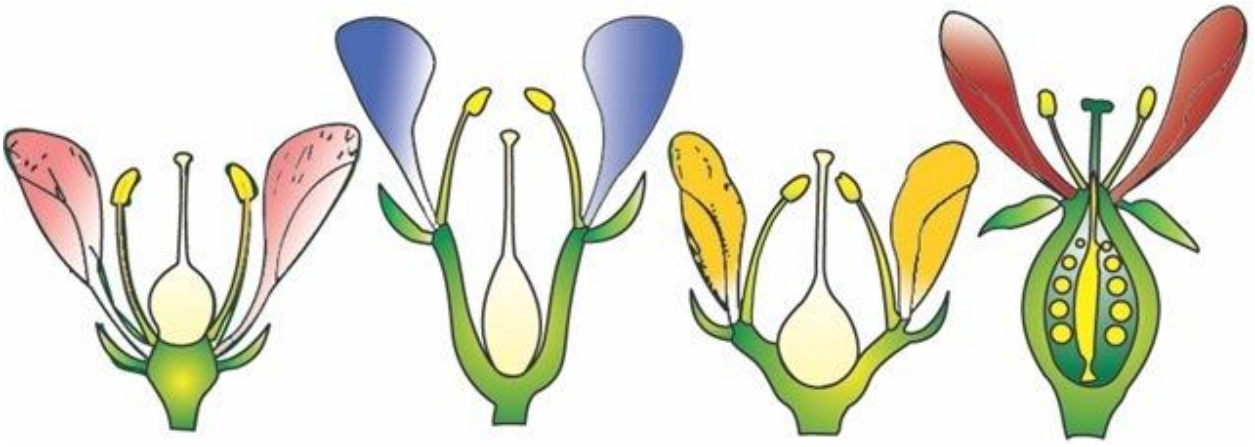
1. Racemose: Main axis is **unlimited** in growth-Radish, Mustard, *Amaranthus. Flowers in* Acropetal order.

2. Cymose: Main axis is **limited** in growth-Cotton, Jasmine, *Calotropis. Flowers in Basipetal order.*

3. Special type:*Ficus, Salvia, Euphorbia.*

The Flower:A flower is modified shoot and reproductive unit in angiosperms.

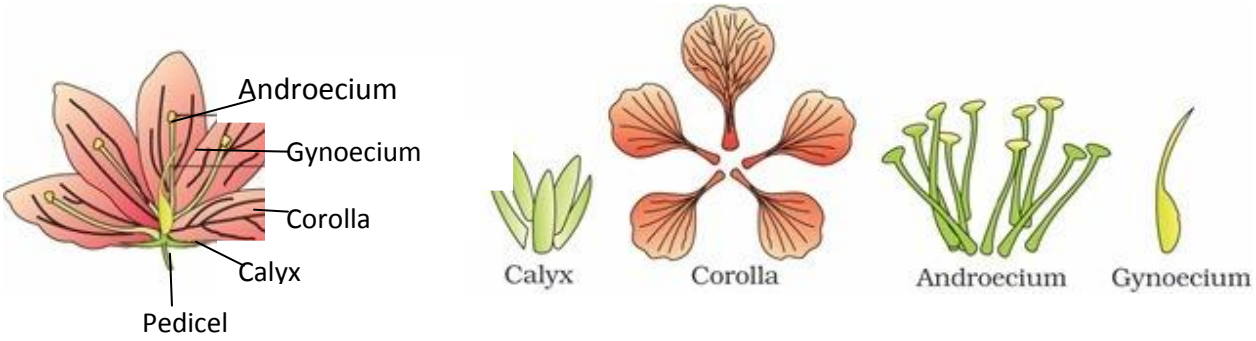
Flowers may be **unisexual** or **bisexual**, **bracteate** or **ebracteate**. Some features of flower are:



Hypogynous Flower Parigynous flowers Epigynous flower

Symmetry of flower	On the basis of no. of floral appendages	On the basis of position of calyx,corolla, androecium with respect to ovary
Actinomorphic (radial symmetry)	Trimerous	Hypogynous (superior ovary)
Zygomorphic (bilateral symmetry)	Tetramerous	Perigynous (half inferior ovary)
Asymmetric (irregular)	Pentamerous	Epigynous (inferior ovary)

Parts of aflower:

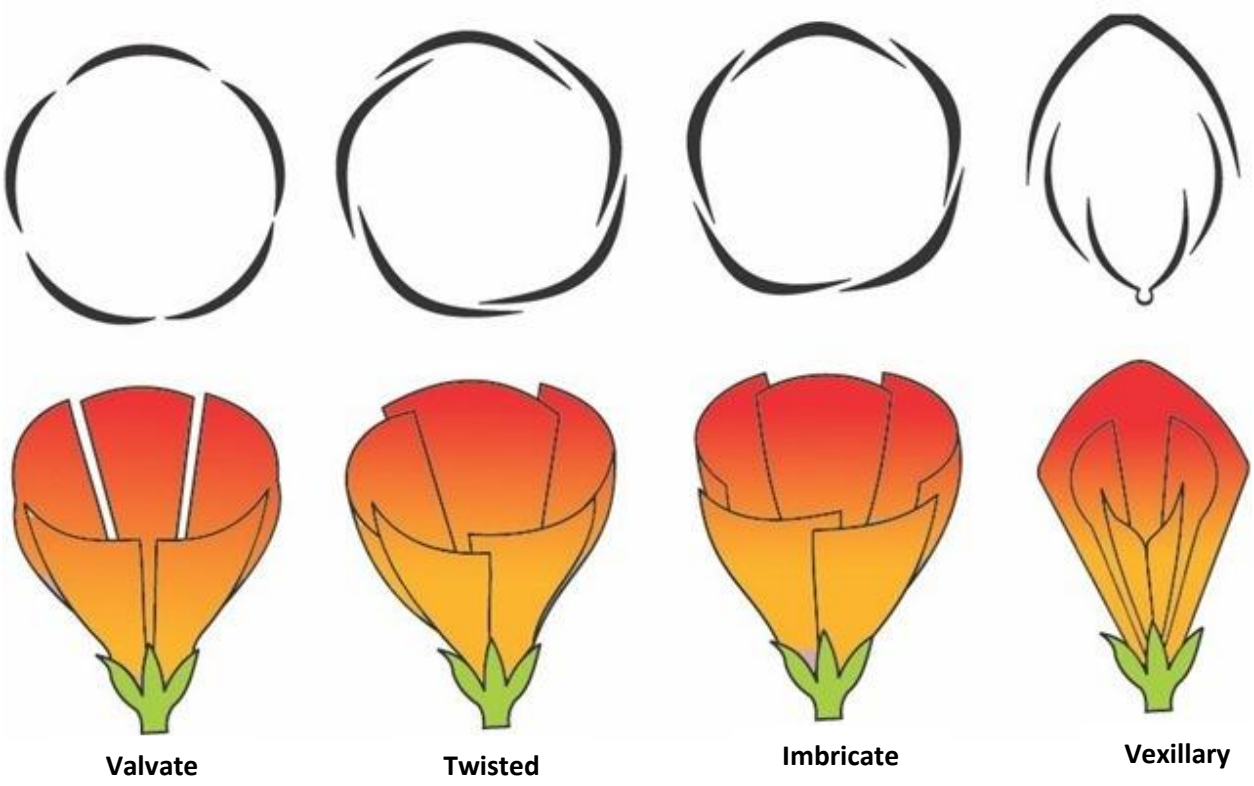


1. Calyx: Sepals, green in colour, leaf like.**Gamosepalous**− (Sepals united)**Polyseppalous**− (Sepals free)

2. Corolla: Petals, usually brightly coloured to attract insects forpollination**Gamopetalous**− (Petals united)**Polypetalous** − (Petals free)

Aestivation: The mode of arrangement of sepals or petals in floral bud with respect to other members of the same whore.

Types of aestivation:



1. Valvate: Sepals or petals do not overlap the sepal or petal at margins as in *Calotropis.*

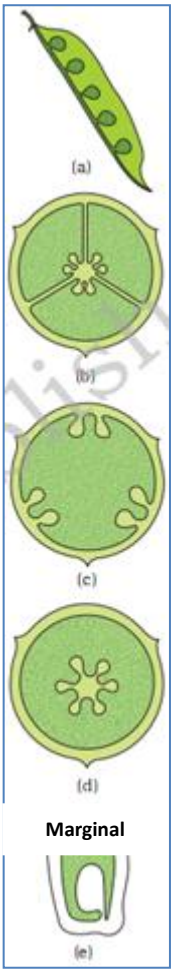
2. Twisted: Sepals or petals overlap the next sepal or petal as in China rose.

3. Imbricate: The margins of sepals or petals overlap one another but not in any definite direction as in Gulmohar.

4. Vexillary: The largest petal overlaps the two lateral petals which in turn overlap two smallest anterior petals as in Pea**. (Papilionaceous)**

Perianth: If calyx and corolla are not distinguishable (tepals), they are called perianth

3. Androecium: Stamens (filament, anther), **male reproductive organ** and produce pollengrains. Stamens may be **epipetalous** (attach to petals) or **epiphyllous** (attachto perianth). Stamens may be **monoadelphous** (united into one bundle-china rose), **diadelphous**(two bundles-pea) or **polyadelphous** (more than two bundles-citrus).



4. Gynoecium: Made up of one or more carpels, **female reproductive part**, consists of **stigma**, **style** and **ovary**, ovary bears one or more **ovules**. Carpels maybe **apocarpous** (free) or **syncarpous** (united). After fertilisation, ovules developinto seeds and ovary into fruit.

Placentation: The arrangement of ovules within the ovary.

Types of Placentation:

1. Marginal: Placenta forms a ridge along the ventral suture of ovary as in pea.

2. Axile: Margins of carpels fuse to form central axis as in China rose.

3. Parietal: Ovules develop on inner wall of ovary as in mustard.

4. Free central: Ovules borne on central axis, lacking septa as in *Dianthus*.

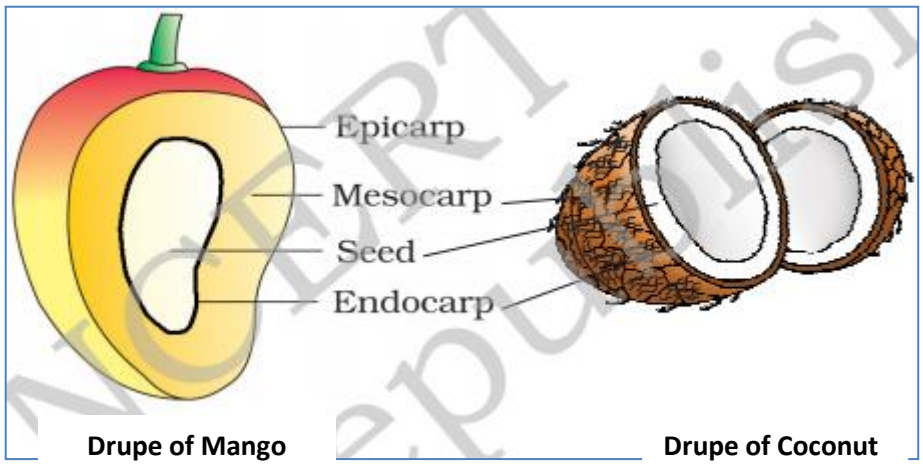
5. Basal: Placenta develops at the base of ovary as in sunflower.

Axile

The fruit:

After fertilization, the mature ovary develops into fruit. The**parthenocarpic** fruits are formed from ovary without fertilization.

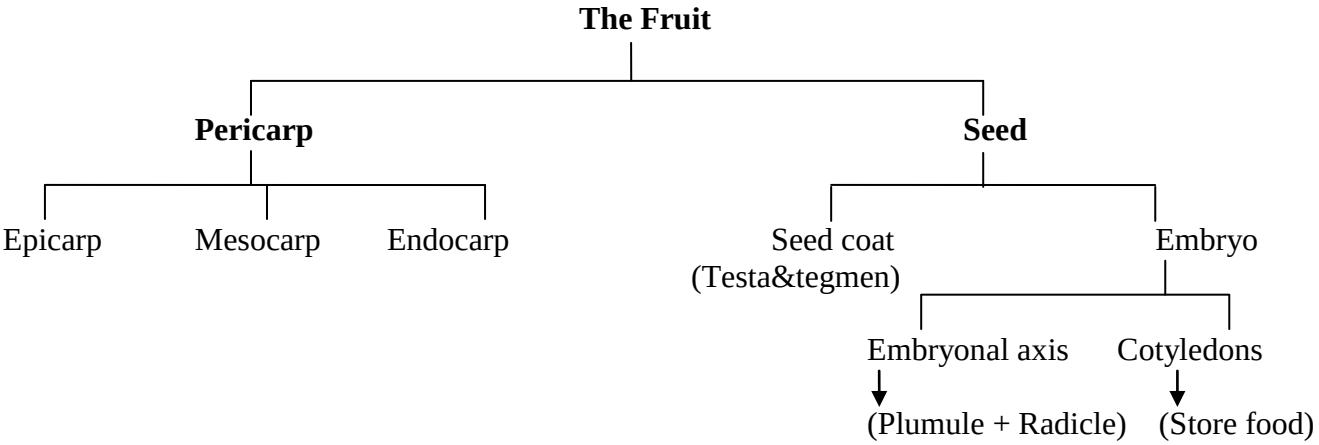
Parietal



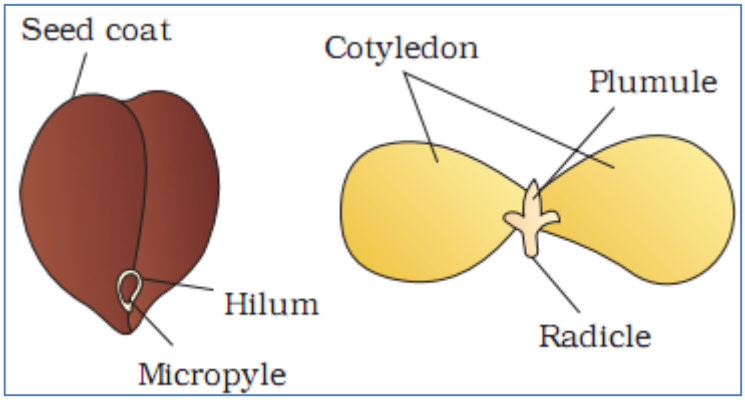
ree Central

Drupe of Mango Drupe of Coconut

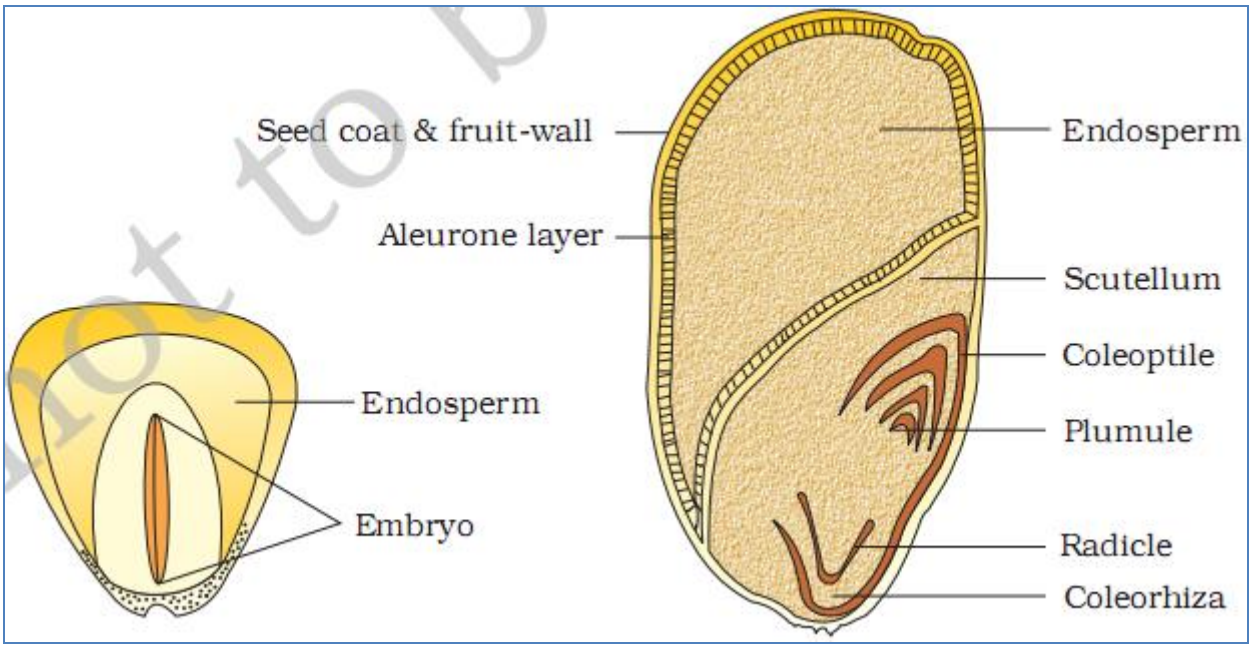
Basal



Structure of a Dicotyledonous Seed:

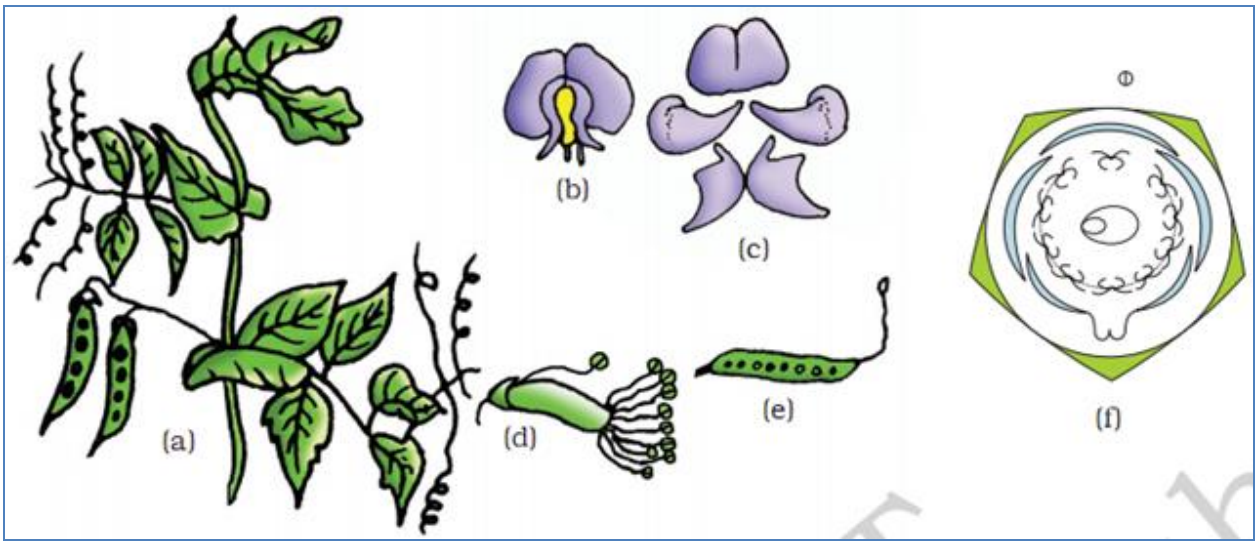


Structure of a Monocotyledonous Seed:



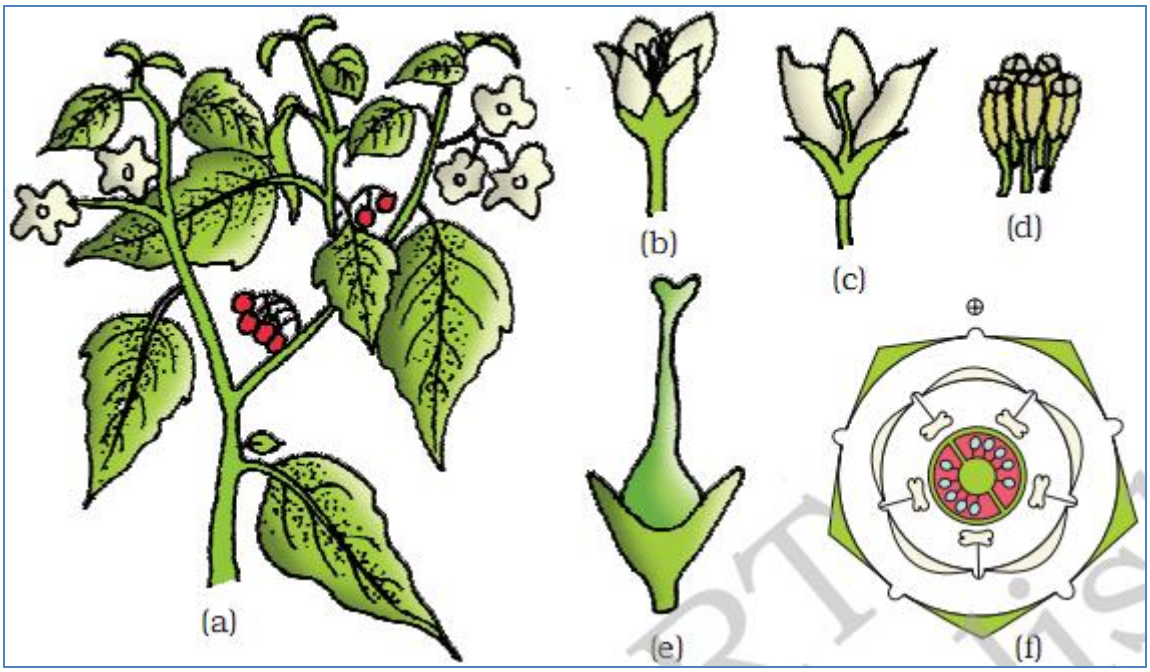
Description of Some Important Families:

1. **Fabaceae (Pulse Family)**



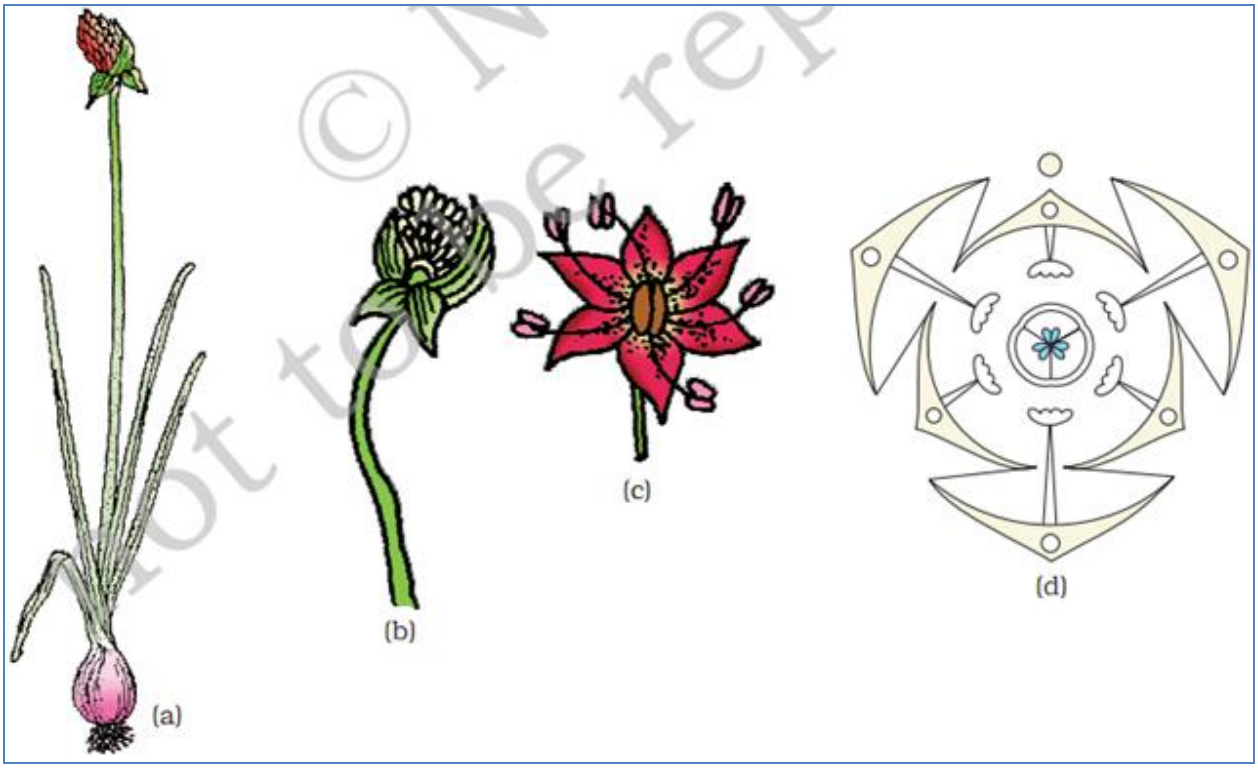
Floral formula: % ♀ $K_{(5)}\ C_{1\ +\ 2\ +\ (2)}\ A_{(9)\ +\ 1}\ G_{1}$

2. Solanaceae (Potato Family)



Floral formula: $\oplus$ ♂♀ $K_{(5)}\ C5\ \ A_5\ G_{(2)}$

2. Liliaceae (Lily Family)



Floral formula: $Br\ \oplus$ ♂♀ $P_{3+3}\ A_{3+3}\ G_{(3)}$

SOME IMPORTANT QUESTIONS:

1. **Define placentation. Describe various types of placentation.**
2. **Draw diagram to show arrangement of floral members in bud stage in relation to other members of their whorl.**

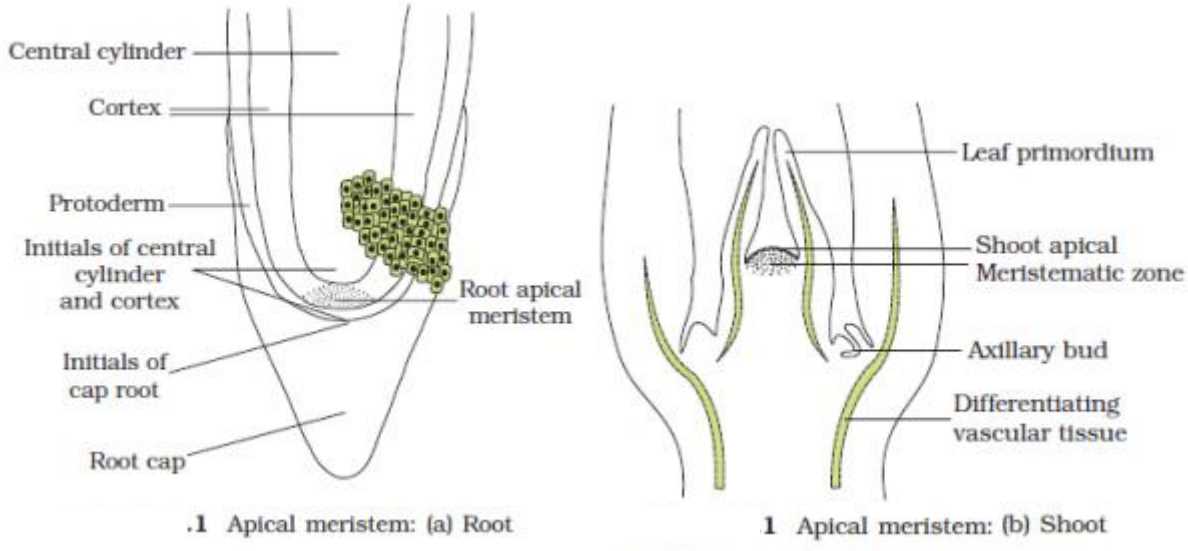
Chapter-6

Anatomy of Flowering Plants

Anatomy: Anatomy is the study of internal structure of organisms. Plant anatomy includes organization and structure of tissues.

Tissue:A group of cells having a common origin and function.

Meristematic tissues: The meristematic tissue is made up of the cells which have the capability to divide. **Meristems** in plants are restricted to specialized regions and responsible for the growth of plants. Thin cell wall, Prominent nucleus, dense cytoplasm are the characteristics of meristems.



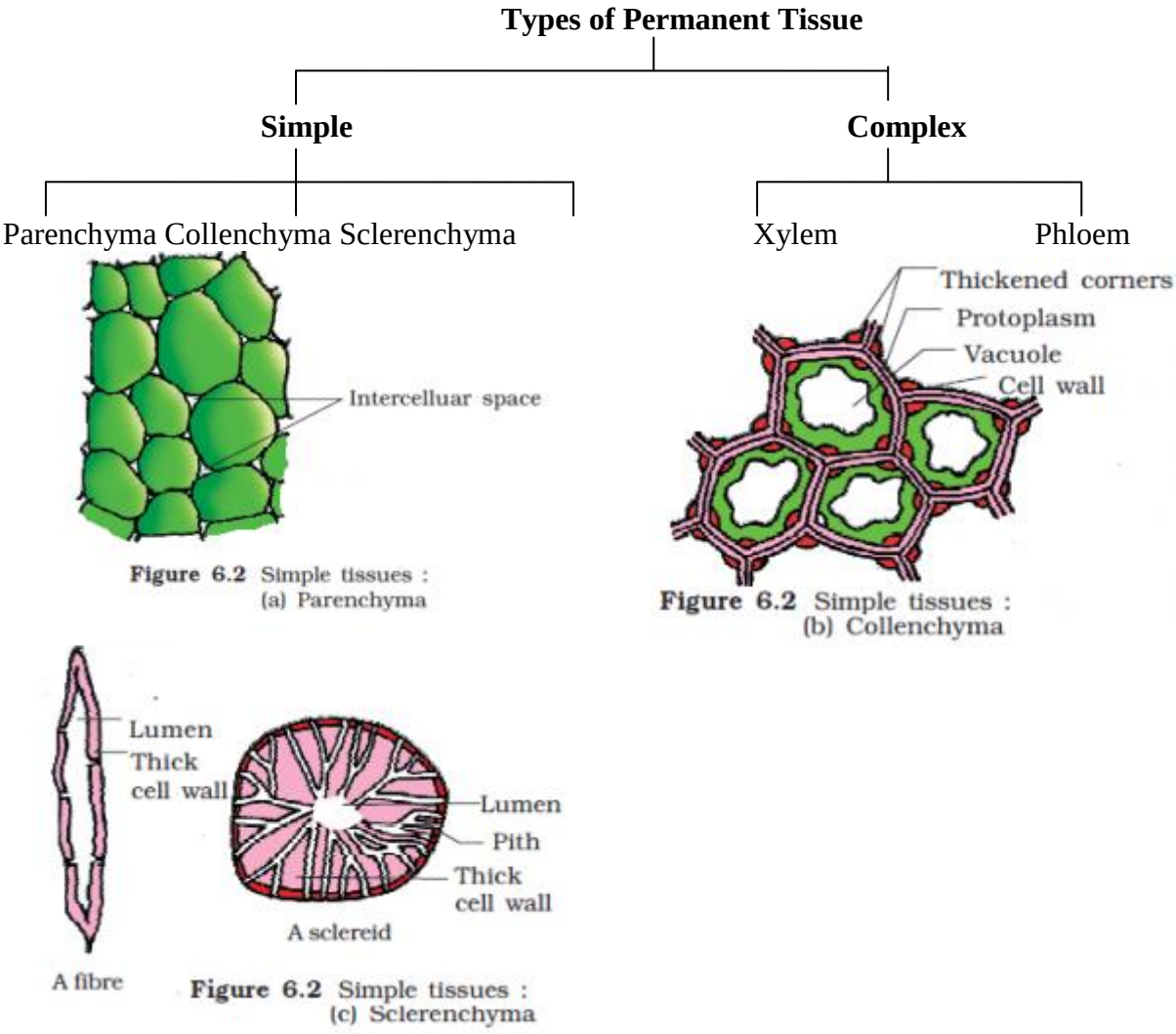
.1 Apical meristem: (a) Root

1 Apical meristem: (b) Shoot

Apical meristem	Intercalary meristem	Lateral meristem
• Occurs at the tips of roots and shoots	• Occurs between mature tissues.	•Occurs in the mature regions of roots and shoots
• Primary meristem	• Primary meristem	• Secondary meristem
• Increase the length of plant	• Capable of forming branch and flower	•Appears later than primary meristem and responsible for secondary growth

Axillary bud: The buds which are present in the axils of leaves and are responsible for forming branches or flowers.

Permanent tissues: The permanent tissues are derived from meristematic tissue and are composed of cells, which have lost the ability to divide.



1. Parenchyma: Thin walled cells, with intercellular spaces, cell wall is made up of cellulose. It performs the function like photosynthesis, storage, secretion.

2. Collenchyma: It is formed of living cellswithout intercellular spaces, closely packed isodiametric cells which are thickened at the corners due to deposition of cellulose, hemicelluloses and pectin. It provides elasticity to plant parts.

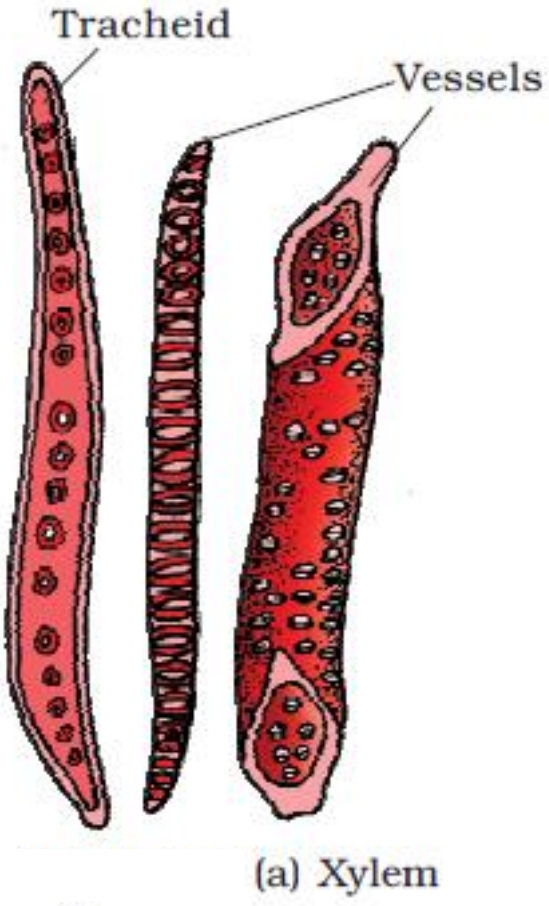
3. Sclerenchyma: It is formed of dead cells with thick and lignified cell walls with pits.They have two types of cells:**fibres** and **sclereids.**They provide mechanical support to organs.

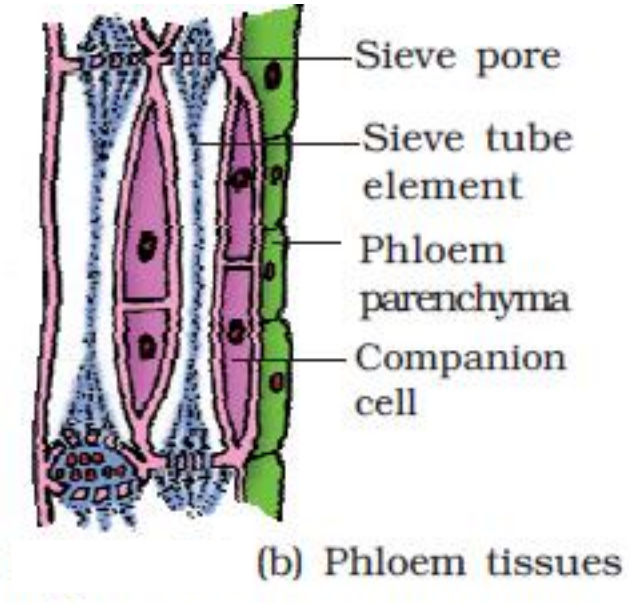
Xylem: Xylem consists of **tracheids, vessels, xylem fibres** and **xylem parenchyma.**

It conducts water and minerals from roots to other parts of plant.

Protoxylem: The first formed primary xylem elements.
Metaxylem: The later formed primary xylem.
Endarch: Protoxylem lies towards the centre and metaxylem towards the periphery of the stems.
Exarch: In roots,theprotoxylem lies towardsperiphery and metaxylem lies towardsthe centre.

Phloem: Phloem consists of **sieve tube elements, companion cells, phloem fibres** and **phloem parenchyma.** Phloem transports the food material from leaves to various parts of the plant.
Protophloem: First formed phloem with narrow sieve tubes.
Metaphloem: Later formed phloem with bigger sieve tubes.





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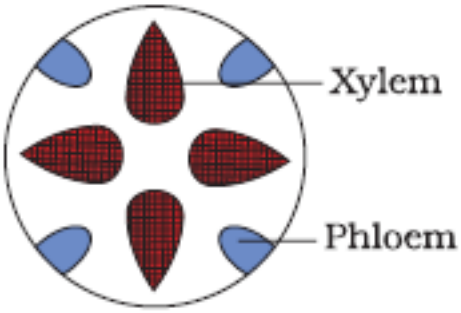
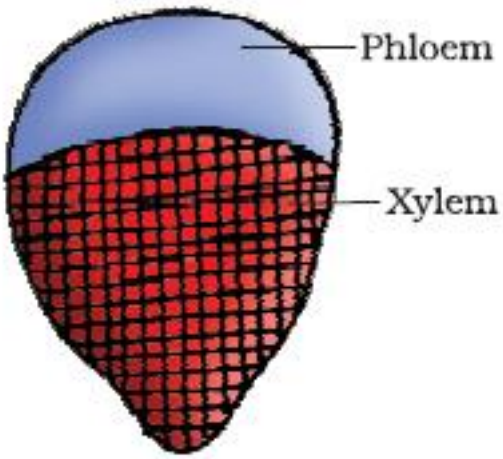
The Tissue System:

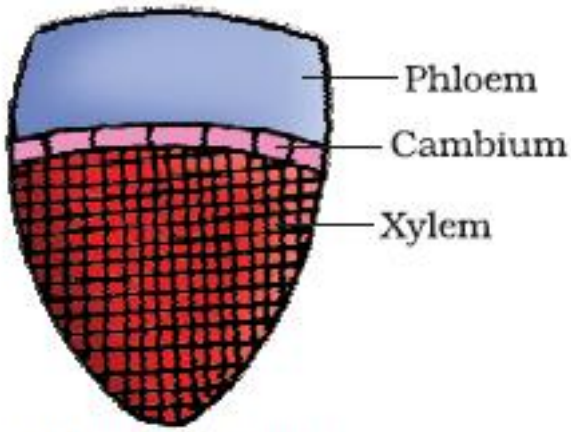
1. Epidermal tissue system: It includes **cuticle, epidermis, stomata**, epidermal appendages-**root hairs** and **trichomes.**
2. The ground tissue system: It is made up of parenchyma, collenchyma, sclerenchyma. In dicot stems and roots the ground tissue is divided into: hypodermis, cortex, endodermis, pericycle, medullary rays and pith. In leaves it is made up of **mesophyll cells.**
3. The vascular tissue system: It includes **vascular bundles** which are made up of xylem and phloem.



(a) radial



(b) conjoint closed



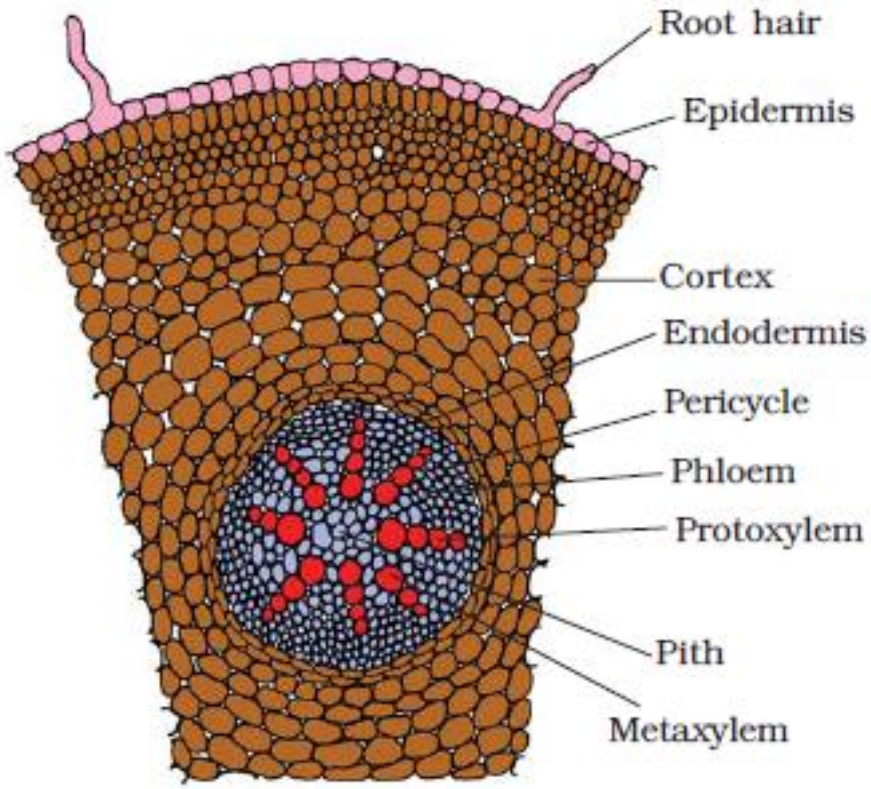
(c) conjoint open

Vascular Bundles

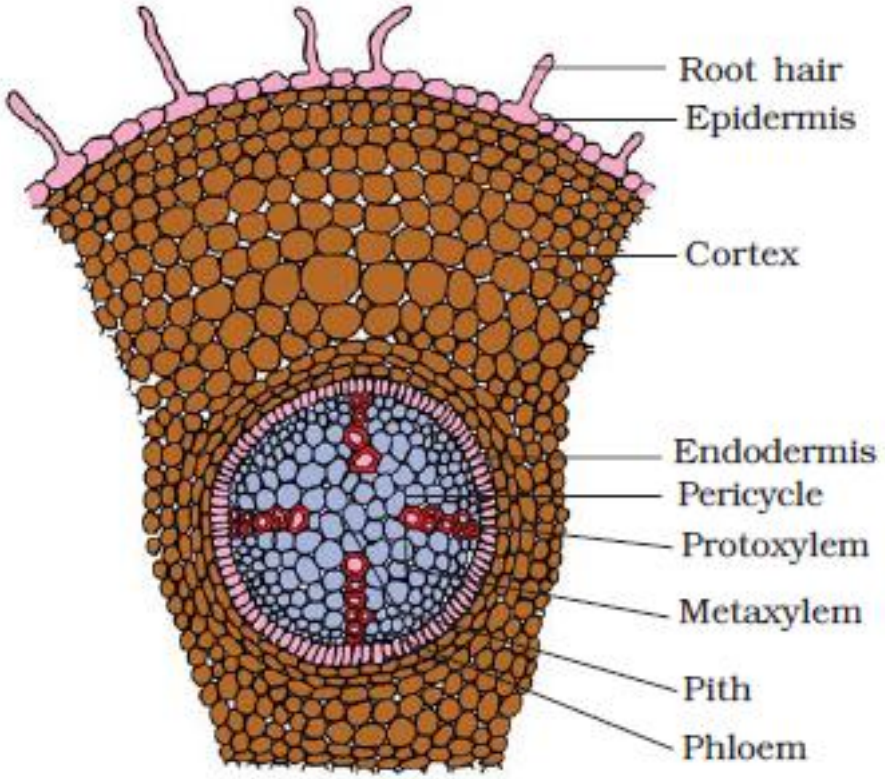
- **Radial bundles** (Xylem and phloem occur on different radii-root)
- **Conjoint bundles** (Xylem and phloem are situated at the same radius of vascular bundle-stem)
  - Collateral bundles
    - Open (With cambium-dicots)
    - Closed (Without cambium-monocots)
  - Bicollateral bundles
  - Concentric bundles

Anatomy of Root

Dicot Root	Monocot Root
1. Cortex is comparatively narrow.	1. Cortex is very wide.
2. Endodermis is less thickened. Casparian stripes are more prominent.	2. Endodermal cells are highly thickened. Casparian strips are visible only in young roots.
3. The xylem and phloem bundles vary from2 to 5.	3. Xylem and phloem are more than 6 (polyarch).
4. Pith is absent or very small.	4. Well developed pith is present.
5. Secondary growth takes place with the help of vascular cambium and cork cambium.	5. Secondary growth is absent.



T.S Monocot root

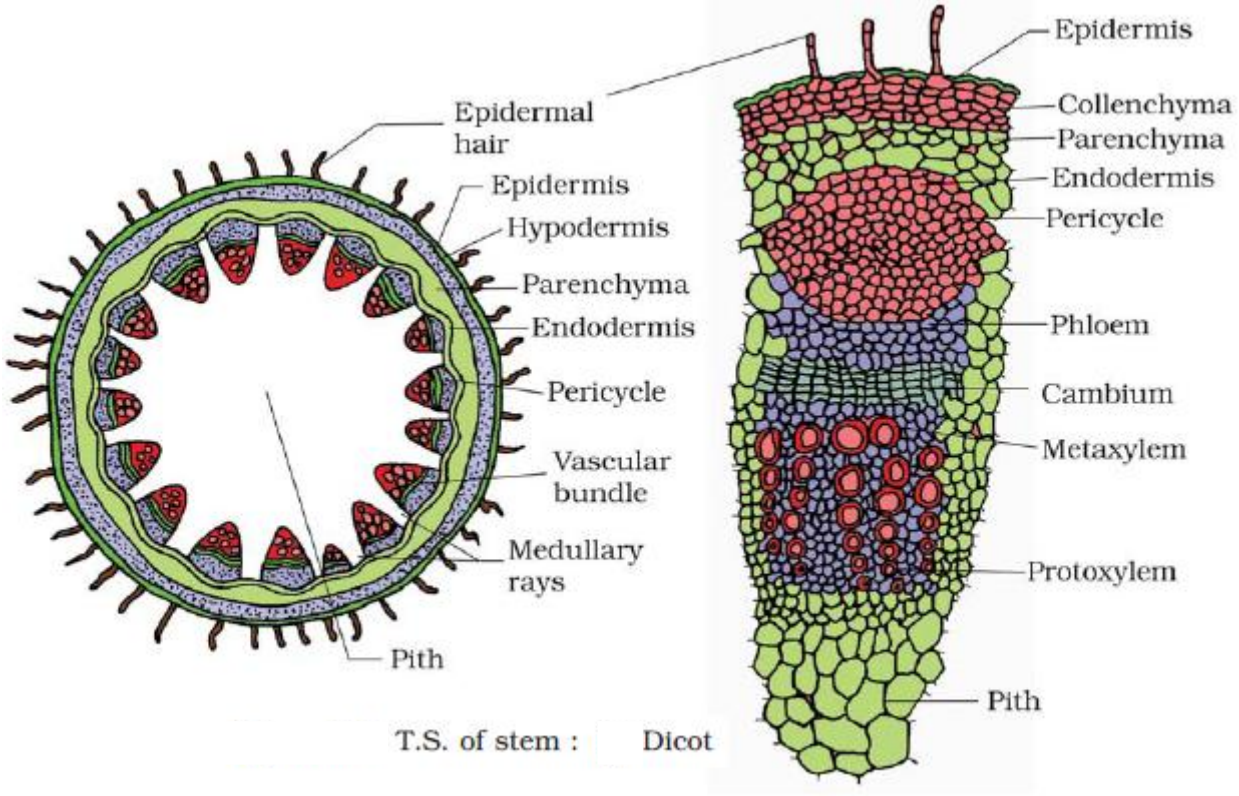


T.S Dicot root (Primary)

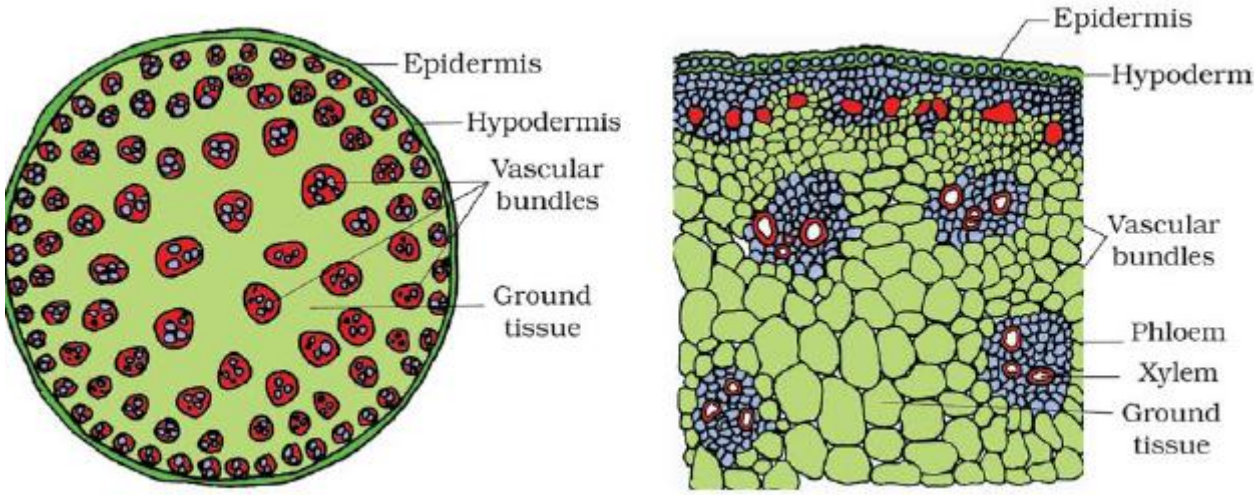
Anatomy of Stem

Dicot Stem	Monocot Stem
1. The ground tissue is differentiated into	1. The ground tissue is made up of similar

cortex, endodermis, pericycle and pith.	cells.
2. The vascular bundles are arranged in a ring.	2. The vascular bundles are scattered throughout the ground tissue.
3. Vascular bundles are open, without bundle sheath and wedge-shaped outline.	3. Vascular bundles are closed, surrounded by sclerenchymatous bundle sheath, oval or rounded in shape.
4. The stem shows secondary growth due to presence of cambium between xylem and phloem.	4. Secondary growth is absent
5. Stomata have kidney-shaped guard cells.	5. Stomata have dumb bell-shaped guard cells.



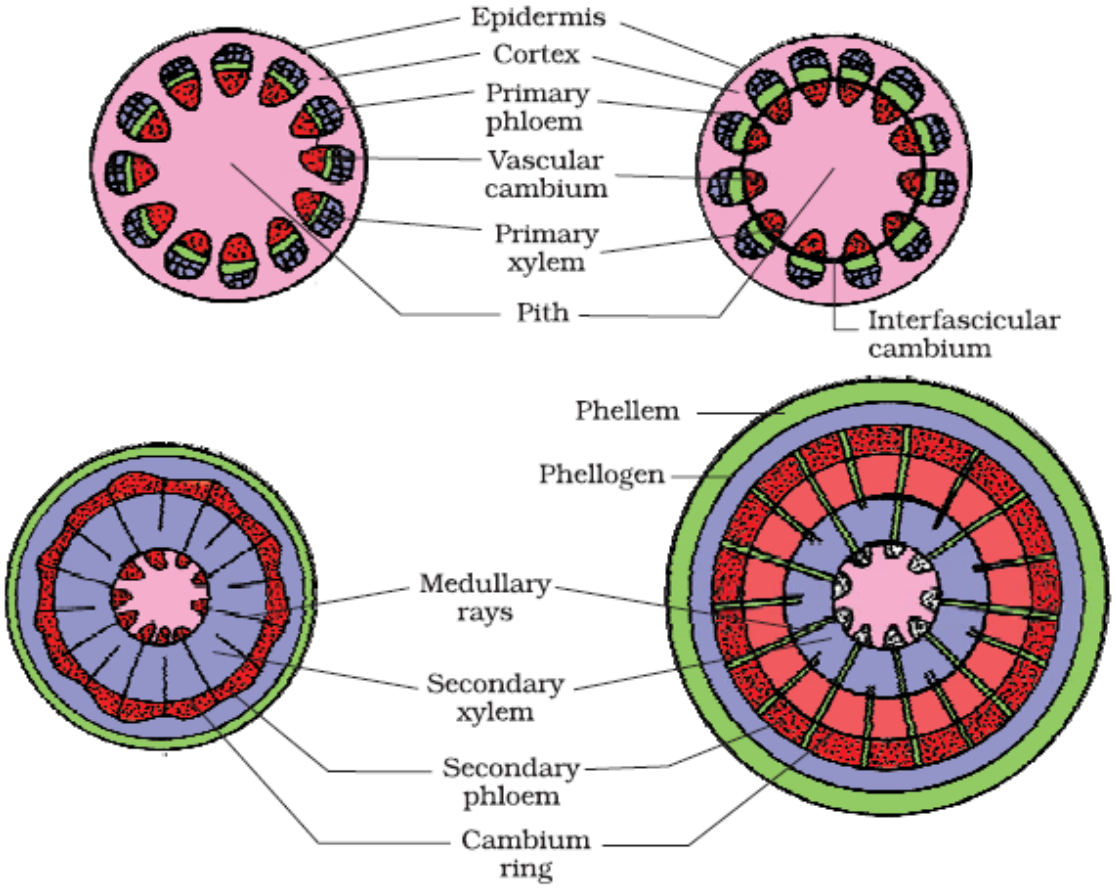
T.S. of stem : Dicot



T.S. of stem : Monocot

Secondary growth in dicot stem: An **increase in the girth** (diameter) in plants. **Vascular cambium** and **cork cambium (lateral meristems)** are involved in secondary growth.

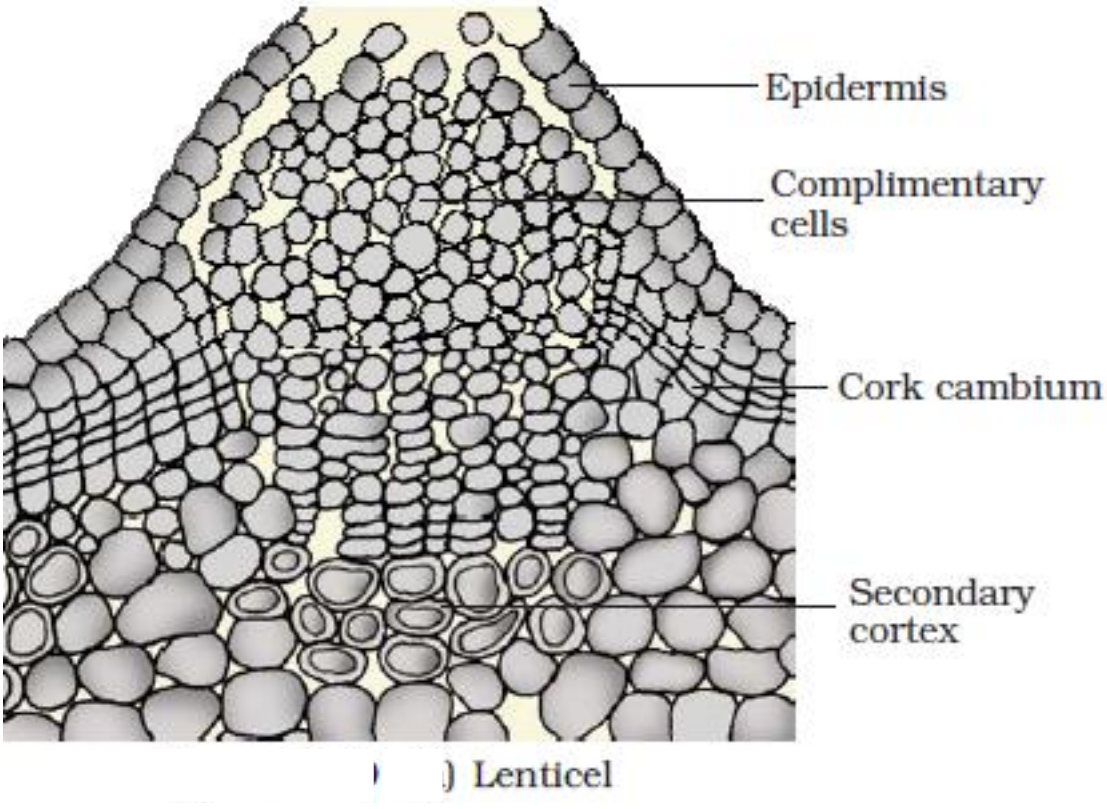
1. Formation of cambial ring: **Intrafascicular cambium + interfascicularcambium.**
2. Formation of **secondary xylem** (inner side) and **secondary phloem** (outer side) from cambial ring.
3. Formation of **spring (early) wood** and **autumn (late) wood** in the form of **annual rings.**
4. Development of **cork cambium (phellogen).**



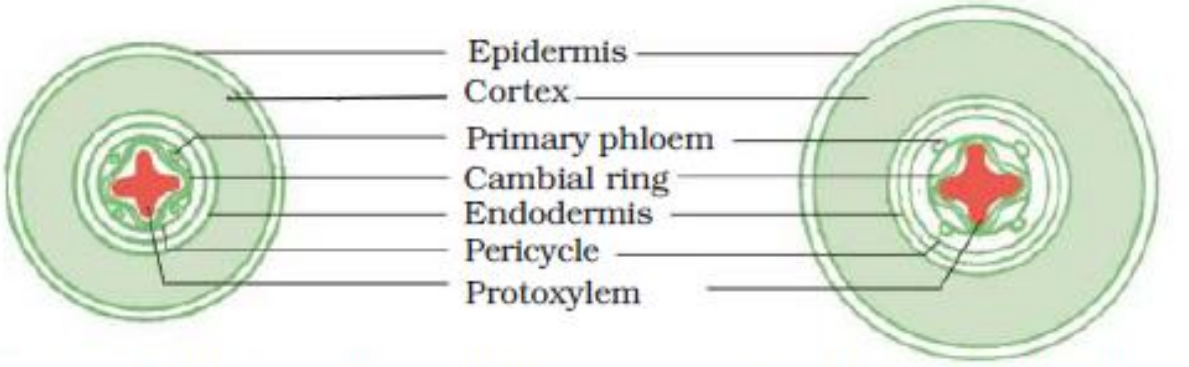
Secondary growth in a dicot stem (diagrammatic) – stages in transverse views

Cork (phellem) - From outer cells
Cork Cambium
Secondarycortex (phelloderm) - From inner cells
(Phellogen + Phellem + Phelloderm) = Periderm (Bark)

Dendrochronology: The branch of Botany in which age of tree is calculated by counting the annual rings.



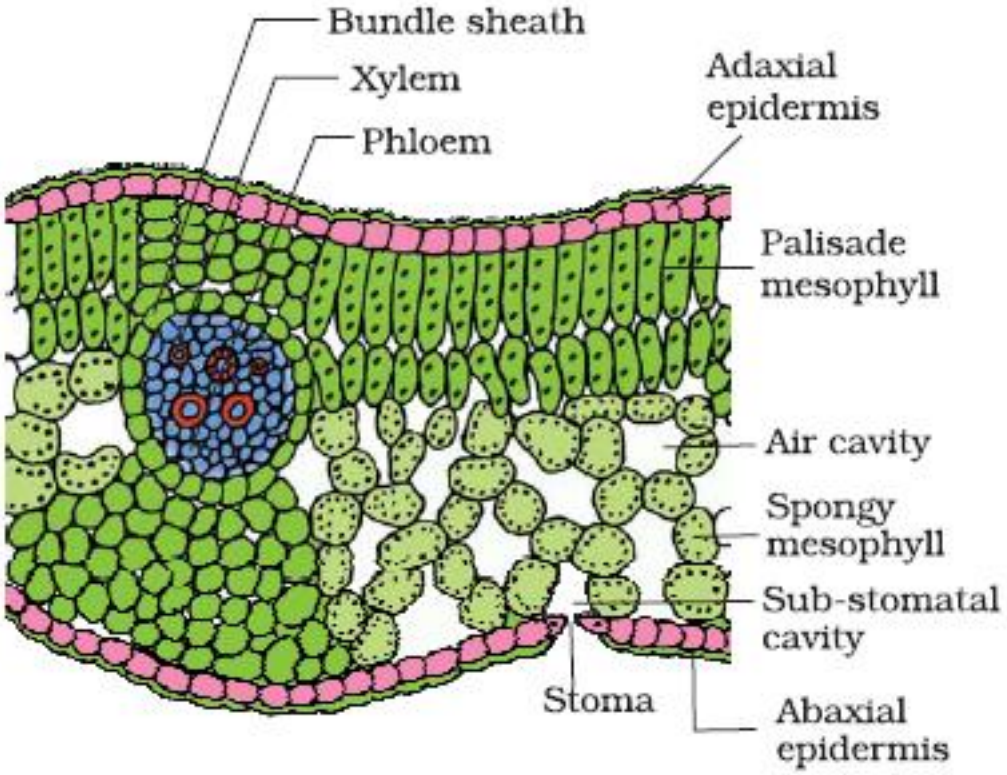
Secondary growth in dicot roots: Secondary growth in dicot root occurs with the activity of secondary meristems (vascular cambium). This cambium is produced in the stele and cortex, and results in increasing the girth of dicot roots.



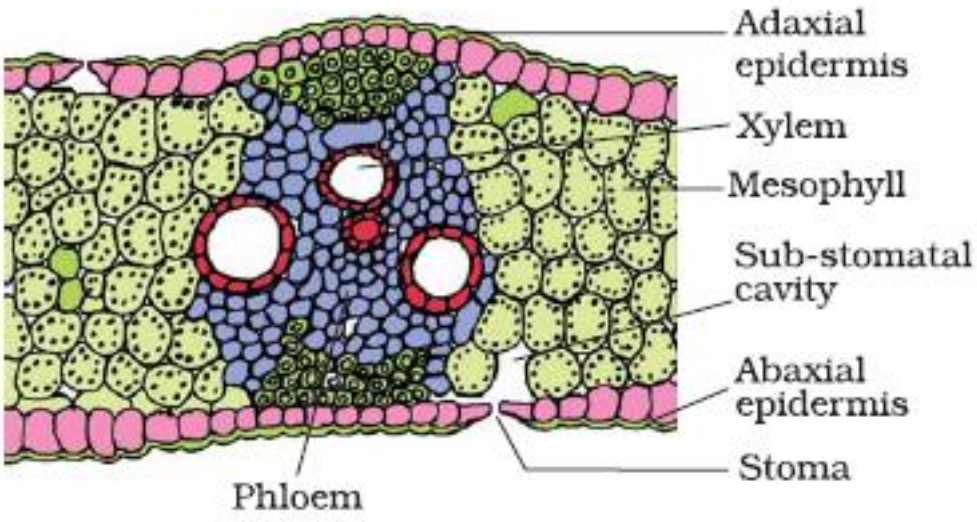
1 Different stages of the secondary growth in a typical dicot

Anatomy of Leaf

Dorsiventral (Dicot) Leaf	Isobilateral (monocot) Leaf
1. Stomata are absent or less abundant on the upper side.	1. The stomata are equally distributed on both sides.
2. Mesophyll is differentiated into two parts upper palisade parenchyma and lower spongy parenchyma.	2. Mesophyll is undifferentitated
3. Bundle sheath is single layered and formed of colourless cells.	3. Bundle sheath may be single or double layered.
4. Hypodermis of the mid-rib region is collenchymatous	4. Hypodermis of the mid-rib region sclerenchymatous.



T.S. of leaf : (a) Dicot



T.S. of leaf : (b) Monocot

SOME IMPORTANT QUESTIONS:

1. **Distinguish between the anatomy of: a) monocot root with dicot root**

   b) monocot stem with dicot stem

2. **Define periderm. Write the various components of periderm.**

Chapter-7

Structural Organization in Animals

POINTS TO REMEMBER

Tissue: A group of similar cells along with intercellular substances which perform a specific function.

Animal Tissues

Epithelial | **Connective** | **Muscular** | **Neural**

Epithelial Tissue

1. Simple epithelium: is composed of a single layer of cells resting on abasement membrane.

2. Compound epithelium: consists of two or more cell layers and has protective function.

Simple: • Composed of single layer of cells.

• Functions as lining for body cavities, ducts and tubes.

1. **Squamous•** single thin layer of flattened cells.

• found in walls of blood vessels, air sacs of lungs for diffusion.

2. **Cuboidal** • single layer of cube like cells.

• found in ducts of glands and tubular parts of nephron for secretion and absorption.

3. Columnar• single layer of tall and slender cells.

• free surface may have microvilli.

• found in lining of stomach and intestine for secretion and absorption.

4. Ciliated• columnar or cuboidal cells with cilia.

• move particles or mucus in specific direction, in bronchioles, fallopian tubes.

Glandular epithelium(for secretion)

Exocrine glands	**Endocrine glands**
• secrete mucus, saliva, oil, milk, digestive enzymes.	• secrete hormones.
• products released through ducts/tubes.	• secrete directly into the fluid bathing the gland

Compound• Made of more than one layer (multi-layered) of cells.

• Provide protection against chemical and mechanical stresses.

• Cover dry surface of skin, moist buccal cavity, pharynx, inner lining of ducts of salivary Glands and pancreatic ducts.

Tight junctions: Plasma membranes of adjacent cells are fused at intervals. They help to stop substances from leaking across a tissue.

Adhering junctions: Perform cementing function to keep neighbouring cells together.

Gap junction: Facilitate the cells to communicate with each other by connecting the cytoplasm of adjoining cells for rapid transfer of ions, and molecules.

Connective tissue: Link and support other tissues / organs of the body.

1. Loose Connective Tissue: Cells and fibres loosely arranged in semi-fluid ground substance

(i) Areolar Tissue:• present beneath the skin.

- contains fibroblasts, macrophages and mast cells.
- serves as a support framework for epithelium.

(ii) Adipose Tissue:• located beneath the skin.

• cells are specialized to store fats.

2. Dense Connective Tissue: Fibres and fibroblasts are compactly packed.

(i) Dense Regular• Collagen fibres present in parallel rows.

• **Tendons** attach skeletal muscle to bone.

• **Ligaments** attach bone to bone.

(ii) Dense Irregular• has collagen fibres and fibroblasts oriented differently.

• This tissue is present in the skin.

3. Specialised Connective Tissue:

(i) Cartilage- made up of chondrocytes and collagen fibres.

(ii) Bones- ground substance is rich in calcium salts and collagen fibres. Osteocytes are present In lacunae.

(iii) Blood- fluid connective tissue, consists of plasma and blood cells-RBC, WBC and platelets

Muscle Tissue

Consists of long, cylindrical, contractile cells called fibres; bring about movement and locomotion.

(i) Skeletal Muscle• Consists of long cylindrical, multinucleated fibres.

• Closely attached to skeletal bones.

• Striated and voluntary.

(ii) Smooth Muscles• Consists of spindle like, uni nucleated fibres.

• Do not show striations and are involuntary.

• Wall of internal organs such as blood vessels, stomach and intestine.

(iii) Cardiac Muscles• Short, cylindrical, uni nucleated fibres, branched fibres
• Occur in the heart wall and are involuntary.
• Intercalated discs for communication.

Neural Tissue

- Neurons are the functional unit and are excitable cells.
- **Neuroglia** cells make up more than half the volume of neural tissue. They protect and support neurons

Cockroach –*Periplaneta americana*is a terrestrial, nocturnal, omnivorous, unisexual, oviparous insect. Body covered by a chitinous, hard exoskeleton of hard plates called **sclerites.**

1. **Head:**Triangular, formed by fusion of 6 segments. Bears a pair of **antennae**, **compound eyes**. **Biting and chewing** type mouth parts consists of **labrum** (upper lip), a pair of **mandibles**,a pair of **maxillae**, **labium** (lower lip), **hypopharynx**(acts as tongue).

2. **Thorax:**3 segments-**prothorax, mesothorax and metathorax**. Bears 2 pairs of wings: Forewings:**tegmina** (mesothoracic).Hindwings: transparent, membranous (metathoracic) and 3 pairs of walking legs in thoracic segments.
3. **Abdomen:10 segments**. Bears a pair of long, segmented **anal cerci** in both sexes and a pair of short, Unjoined **anal styles** in males only. Also have anus and genital aperture at the hind end. Genital aperture surroundedby external genitalia called **gonapophysis or phallomere.**

Anatomy: Study of the morphology of internal organs.

Alimentary canal: Divided into foregut, midgut and hindgut.
Mouth →Pharynx →Oesophagus→**Crop (stores food)→Gizzard (6-teeth for grinding of food)→6-8Hepatic caeca**(at junction of fore and midgut-**secretes digestive juice**) →Hindgut (ileum, colon, rectum)→Anus.

Malpighian tubules: Yellowcoloured thin, filamentous tubules present atthe junction of midgut and hindgut in cockroach; helps in **excretion**. Cockroach is **uricotelic.**

Uricotelic: Animals which excrete nitrogenous waste in the form of **uric acid.**

Blood vascular system:Open types, visceral organs located in haemocoel are bathed in **haemolymph** (colourl plasma and haemocytes).
Heart consists of enlongated muscular tube and differentiated into **13 funnel shaped** chambers with **ostia** on ei side. Blood from sinuses enters heart through ostia and is pumped anteriorly to sinuses again.

Repiratory system: Network of **trachea** which open through 10 pairs of spiracles on lateral side of the body.Spiracles regulated by sphincters. Oxygen delivered directly to cells by tracheal tubes and trachioles.

Excretion and osmoregulation by **Malpighian tubules**; **uricotelic**(Uric acid as excretory product).
Nervous system: Consists of series of fused segmentally arranged **ganglia** joined by paired longitudinally connectives on the ventral side. **Three ganglia inthorax**, **six in abdomen.** Brain represented by **supra-oesophageal ganglion in** head. Sense organs are a pair of antennae, compound eyes(with 2000 hexagonal **ommatidia** for mosaic vision),maxillary palps,labialpalps and anal cerci.

Reproductive system: Dioecious
Male −Pair of testes (4^{th}-6^{th} abdominal segments) →vas deferens →ejaculatory duct→male gonopore.
Glands −Seminal vesicle (stores sperms-spermatophores), mushroom shaped gland (6^{th}-7^{th} segment).

Female reproductive system:
A pair of ovaries in 2^{nd}-6^{th}abdominal segments (with 8 ovarian tubules) →Oviduct →Vagina→Genital chamber pair of **spermatheca**in 6^{th} segment and opens in to genital chamber.

Sperms transferred through spermatophores. Fertilised eggs encased in capsules called **oothecae** (9-10oothecae each with 14-16 eggs); development of *P.americana is* **paurometabolous (Incomplete metamorphosis).** Nymph grows by moulting 13 times to reach adult form.

Interaction with man

• Pests as they destroy food and contaminate it.
• Can transmit a variety of bacterial diseases by contaminating food (Vector).

SOME IMPORTANT QUESTIONS:

1. **Write a short note on mouth parts of Cockroach.**
2. **Mention the function of following: Malpighian tubules, ommatidia in Cockroach.**
3. **Write any two features of sexual dimorphism in Cockroach.**

Chapter-08

Cell – The unit of Life

KEY TERMS

Cell: The structural and functional unit of life.

Cell theory: States that (i) all living organisms are composed of cells. (ii) all cells arise from pre-existing cells.

Cell Organelles: The membrane bound structures in the cells that perform specific functions.

Endocytosis: Transport of material into the cell by an in folding of the cell membrane forming a vesicle.

Active transport: Movement of molecules across membrane by expending energy from ATP.

Passive Transport: Movement of molecules across membrane depending upon concentration gradient of molecules without any requirement of energy.

Osmosis: Movement of water molecule across semi permeable membrane from a region of their higher concentration to a region of their lower concentration.

Facilitated Diffusion: Diffusion of some ions and polar molecules across membranes through special transport proteins.

Vesicles: Round, spherical sac like structures.

Cisternae: Elongated, flattened irregular structures.

Tubules: Branched, tubular irregular structures.

Chloroplasts: Plastids that contain chlorophyll.

Amyloplasts: Leucoplasts (a type of plastid) that store carbohydrates

Elaioplasts: Leucoplasts (a type of plastid) that store oils and fats.

Aleuroplasts: Leucoplasts (a type of plastid) that store proteins.

Histones: Packaging proteins associated with chromosomes.

Microbodies: Enzyme bearing membrane bound minute vesicles.

Polyribosome/Polysome: A chain of ribosomes.

Cytoskeleton: Network of protein filament in the cell that gives support to the cell.

Chromatin: Coiled nucleo-protein fibres present in the nucleus of cell.

Chromosomes: The network of nucleoprotein condenses into small rod like structures called chromosomes during cell division.

Chromatids: Two parts of a chromosome.

Centromere: The primary constriction in a chromosome that holds two chromatids together.

Metacentric chromosome: Centromere at the centre. 

Sub-metacentric chromosome: Centromere near the centre. 

Acro centric chromosome: Centromere sub terminal. 

Telocentric chromosom : Centromere terminal.

Satellite: Chromosomes with a secondary constriction, show a smaller part of chromosome called satellite.

Prokaryotic cells: A cell with naked genetic material and lacks all membrane bound organelles.

Eukaryotic cell: A cell with well organized membrane bound nucleus and number of membrane bound organelles.

Do you Know:

1. Power house of the cell: Mitochondria
2. Suicidal bags of cell: Lysosomes
3. Energy currency of the cell: ATP
4. Protein factory of a cell: Ribosomes
5. Kitchen of a plant cell: Chloroplast

Cells

- Prokaryotic Cell — Bacteria, Blue green Algae, PPLO
- Eukaryotic Cell — Plant, Animal, Fungi

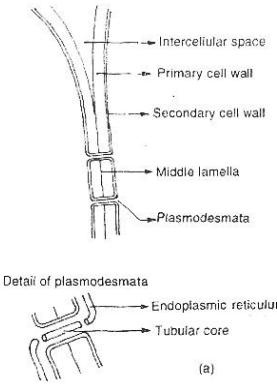
Prokaryotic Cell	Eukaryotic Cell
• Nucleus without nuclear membrane	• Nucleus enclosed within nuclear membrane
1. Capsule	1. Cell wall (Plant Cell)
2. Cell wall	2. Plasma Membrane
3. Plasma Membrane	3. Cytoplasm
4. Cytoplasm	4. Mitochondria
5. Genetic Material (DNA)	5. Endoplasmic Reticulum
6. Ribosomes	6. Golgibodies
	7. Plastids (Plant Cell)
	8. Lysosome
	9. Ribosomes
	10.Vacuoles
	11. Microbodies
	12. Centrosome (Animal Cell)
	13. Cilia

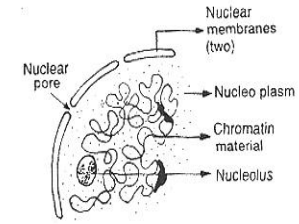
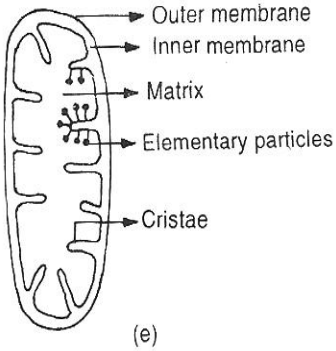
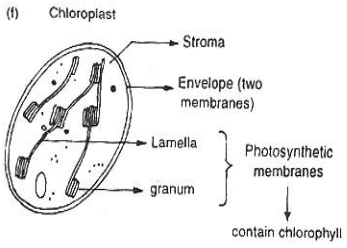
Prokaryotic Cell Structure:

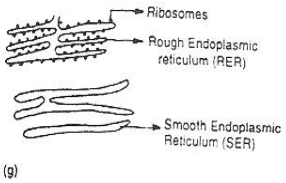
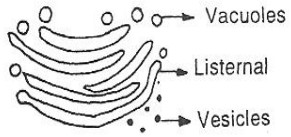
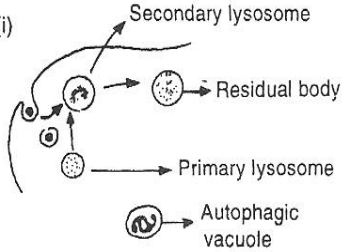
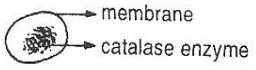
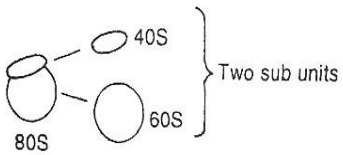
S.N.	Struc`ture	Description	Function

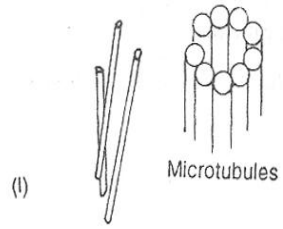
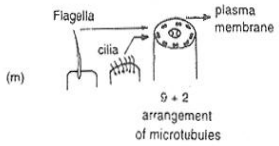
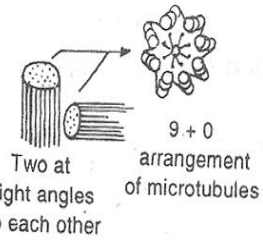
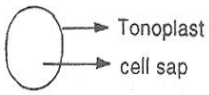
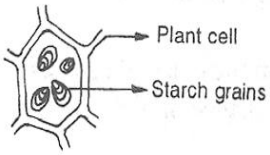
1.	Cell envelope	Cell envelope of different bacteria are of different types. Capsule : Tough envelope Slime Layer : Loose Layer	Act together as a protective unit
2.	Cell wall	It is present beneath the slime layer	Gives shape to the cell, Protection against mechanical and chemical injury.
3.	Plasma membrane	It is a thin membrane beneath the cell wall It is semi - permeable	Controls entry and exit of molecules
4.	Mesosome	Extension of plasma membrane in to the cell.	Increase surface area Secretion Respiration DNA replication
5.	Ribosome	Several ribosome form a chain called polyribosome 70 S type with two sub units 50S + 30S	Protein synthesis
6.	Cytoplasm	Appears granular due to presence of Ribosomes	Store house for food, lipids, glycogen granules
7.	Genetic Material (Nucleoid)	It is composed of DNA, (not enclosed by membrane).	Hereditary Material
8.	Plasmid	Non chromosomal, Circular DNA	
9.	Flagella	Thin, filamentous extension from the cell wall Composed of three parts. Filament, Hook, Basal body	Helps in locomotion
10.	Pilli or Fimbrae	Elongated tubular structures made of special protein are called pilli Small bristle like structures are called fimbrae	Helps in attachment of the bacteria to the host structure.
11.	Inclusion body	Reserve material like phosphate granules, glycogen granules	Stores material

Eukaryotic Cell Structure

Important Points		
Diagram	**Structure**	**Functions.**
Cell wall 	Surrounds plant cells, consists of cellulose. **Primary Wall** formed during cytokinesis. **Secondary wall** formed by thickenings like lignin & suberin. **Middle lamella** Thin layer, has calcium and magnesium pectates **Plasmodesmata** Fine pores in cell walls lined with plasma membrane. Cytoplasmic thread links the cytoplasm of two cells.	Gives mechanical strength, allows to build turgor pressure. Forms pathway for movement of water. Lignification has special functions Holds neighbouring cells together Forms a continuous system of protoplasm between neighbouring cells.
Cytoplasm	Jelly like, aqueous, transparent, colourless ground substance.	Together with nucleus forms the living matter of the cells. All cell organelles are suspended in it.
Cell or plasma Membrane (Fluid Mosaic Model) Fig. 8.4 Page 131 NCERT Biologic Textbook for Class-XI	Outermost covering of animal cells that provides and maintains shape of the cell. It is composed of lipids that are arranged in a bi layer. Cell membrane also possess proteins and carbohydrates	(i) Provides and maintains shape of the cell. (ii) Regulates the transportation of materials in a out of the cell because it is semi-permeable

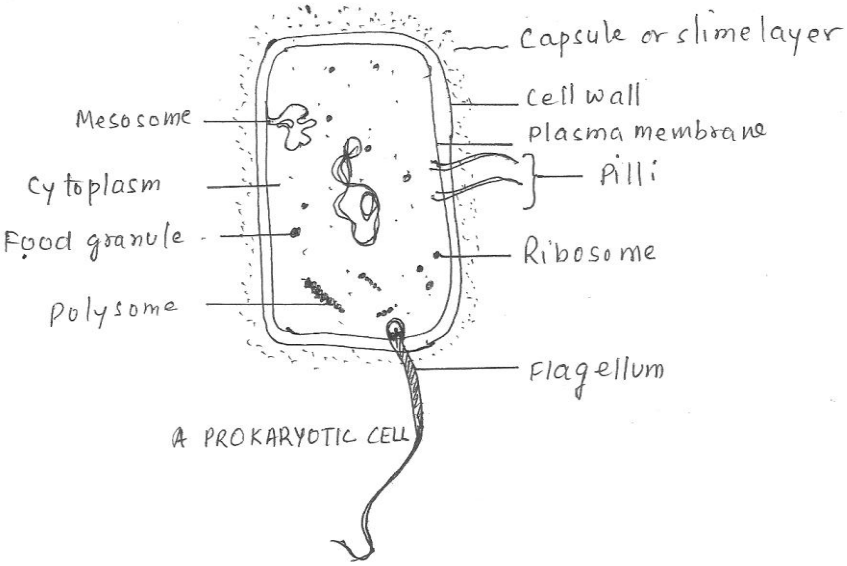
Nucleus  (d)	Enclosed by **nuclear membrane** that has nuclear pores. Contains **chromatin network,** and **nucleolus** embedded in **nucleoplasm**	Contains chromosomes the hereditary substance. Controls all cellular activities.
Mitochondria  (e)	Enclosed by **two membranes,** the inner being folded into **cristae** which bear **elementary particles** (F_0 - F_1 complex)	Sites of Aerobic respiration. Matrix is the site of Krebs cycle and elementary particles of oxidative phosphorylation.
Plastids  	Green plastids contain chlorophyll - Surrounded by **double membrane** enclosing gel like **stroma** through which runs a system of membranes. Stacked ones form **grana.**	Sites of photosynthesis.

Endoplasmic Reticulum  (g)	Could be in the form of cisternae, vesicles and tubules It is of two types Smooth endoplasmic reticulum (SER) without ribosomes Rough endoplasmic reticulum (RER) with ribosomes	RER- transports proteins made by ribosomes SER - site of lipid and steriod synthesis
Golgi complex (h)  	Made up of stacks of flattened membrane bound sacs - **cisternae,** small **vesicles** and large vaculoes. Continuously formed at one end and budded off at the other end.	Transports vesicles. Forms zymogen granules. Involved in secretion and lysosome formation.
Lysosomes (i)  	Spherical sacs having a single membrane, containing hydrolytic enzymes.	Act as phagocytes, autophagic vacuoles. Connected to endocytosis and exocytosis
Microbodies (j)  	Spherical organelles bound by a single membrane. Contents are granular.	Contain catalase which breaks hydrogen peroxide. Sites of glyoxylate cycle in plants.
Ribosomes (k)  	Consist of 2 sub units 80S = 60S & 40S. 70S = 50S & 30S. Have equal parts of RNA and proteins.	Sub units lie free in cytoplasm and unite to form a poly ribosome at the time of protein synthesis.

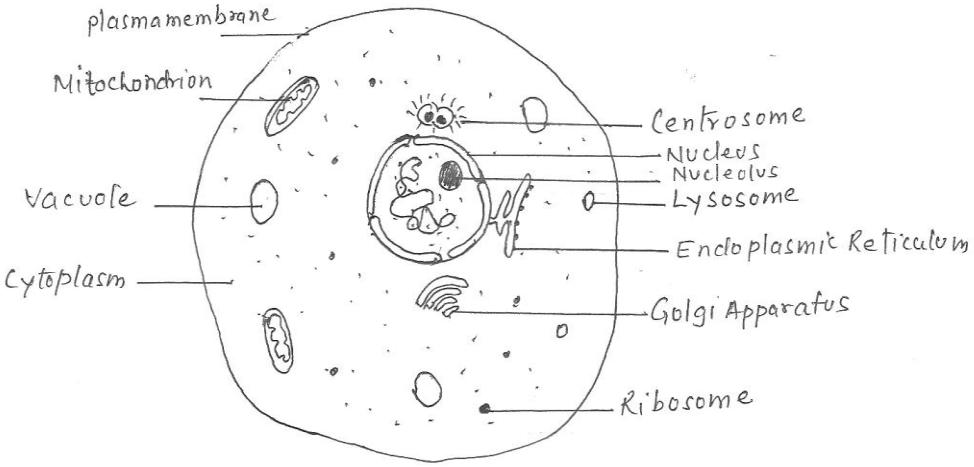
Cytoskeleton (l) 	Complex network of fibrous structures in cytoplasm. **Microfilaments** — Thin fine protein filaments Microtubules — Unbranched hollow and cylindrical, made of fine tubes.	Exocytosis, endocytosis, ceil mobility Movement of chromosomes. Formation of centriole, cilia and flagella
Cilia and flagella 	Contain **9+2 pattern** of microtubules, enclosed by **plasma membrane.**	Movement of the animal, (unicellular), movement of fluids in a particular direction.
Centriole (n) 	**Non membranous organelle** present in pairs near the nucleus in the animal cells. Have **9+0 pattern** of microtubules.	Formation of spindle fibres and help during cell division.
Vacuole (o) 	Small or large sacs bound by a single membrane called **tonoplast.** Contain **cell sap.**	Osmoregulatory in protozoans. Called contractile vacuole. Contain waste products or act as food reserves.
Cell Inclusions (p) 	Contain both organic and inorganic crystals. Found both in animal and plant cells.	Store glycogen granules, fat droplets, aleurone grains or crystals.

Various Components of a cell

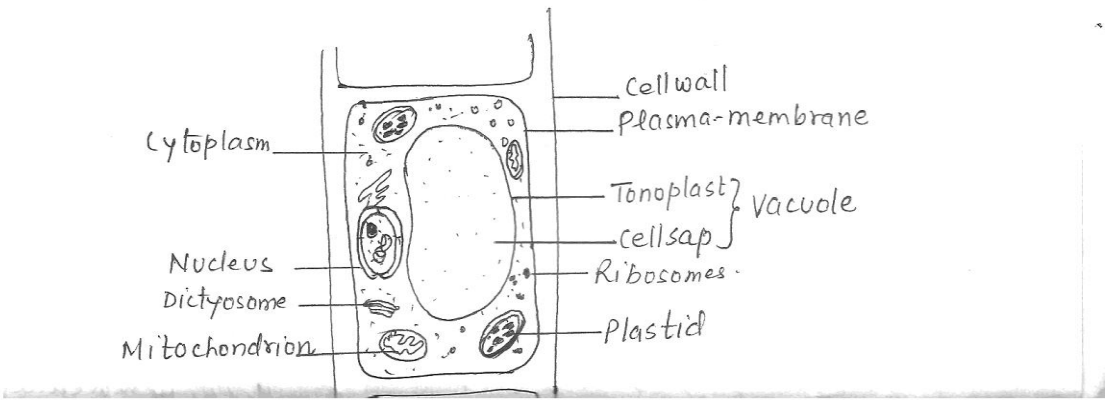
Different types of cells



A PROKARYOTIC CELL



AN ANIMAL CELL



Chapter-09

Biomolecules

KEY TERMS

Biomolecules: all the carbon compounds that are found in living tissues.

Biomacromolecules: Biomolecules with mass more than 800 Daltons. These are polymers example proteins, polysaccharides, Nucleic acids.

Biomicromolecules: The Biomolecules with mass upto 800 Daltons. These are monomers. example Amino acid, Sugar (Monosaccharide), Nucleotides.

Metabolism: The sum total of all the biochemical reaction taking place in a living body.

Metabolites: The essential organic compounds present in living tissue.

Primary Metabolites: Biochemicals formed as product of vital metabolic pathways of organism example sugars, Amino Acids.

Secondary Metabolites: Specialized products formed by alteration of normal metabolic pathway example alkaloids, rubbers. Scents, gums.

Anabolic Pathway: Formation of a complex structure from simple structure.

Catabolic Pathway: Formation of simpler substances from a complex structure.

Enzyme: The catalyst that hasten the rate of metabolic reactions.

Glycosidic Bond: The chemical bond formed between the Aldehyde or Ketone group of one monosaccharide and the Alcohol group of another.

Peptide Bond: The chemical bond formed between the Carboxyl group (COOH) of one Amino acid and the Amino group (NH_2) of another is called Peptide bond $(-CO-NH)$

Ester bond: The chemical bond formed between the Phosphate and the Hydroxyl group of sugar.

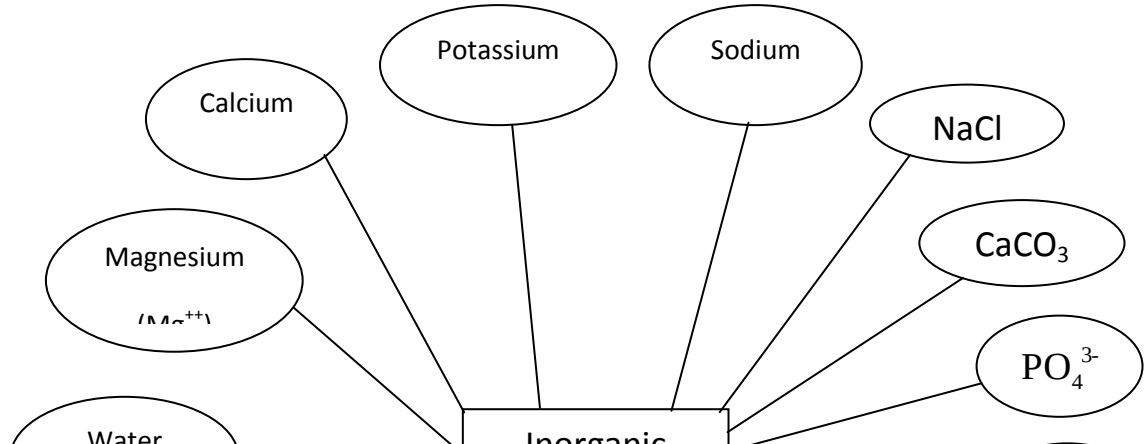
Activation energy: The amount of energy required to initiate a reaction.

GIST OF THE LESSON:

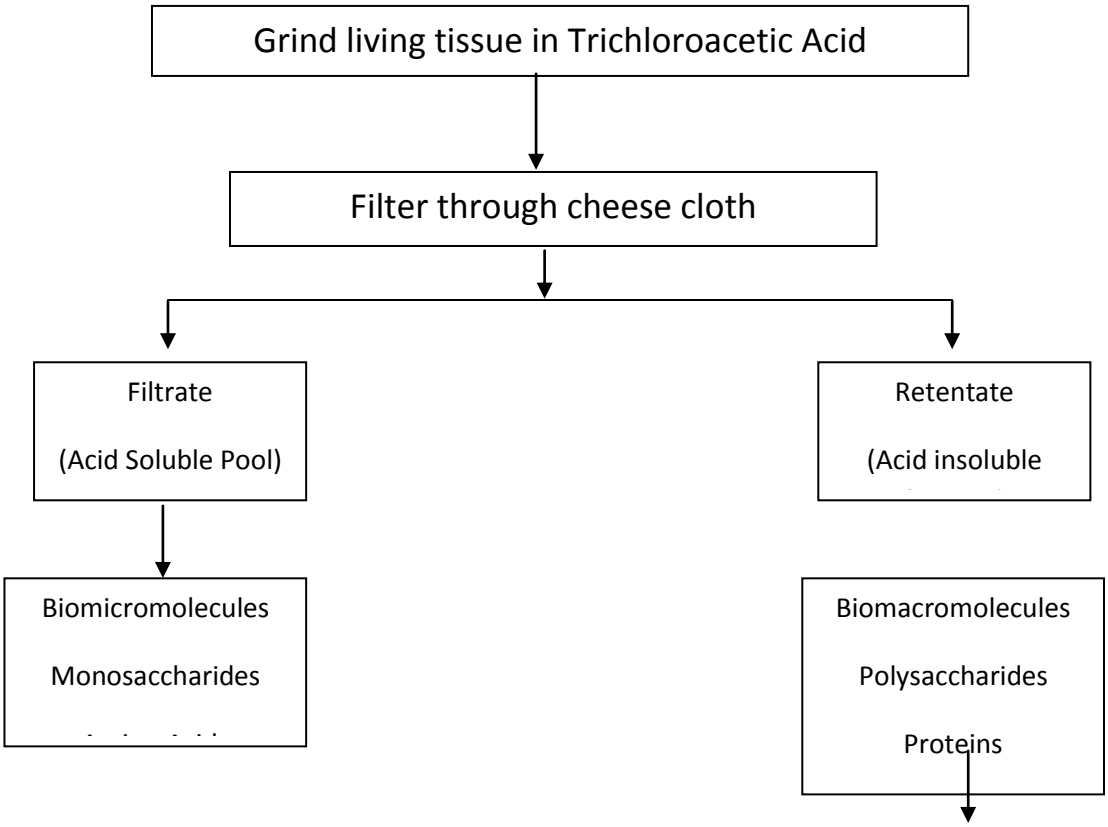
- All cells, tissue are composed of chemical substances.
- The molecules present in living tissue may be organic or inorganic.

- Chemical analysis of living tissue reveals the type of organic & inorganic compounds present in living organisms.
- Organic compounds are carbohydrates, fats, protein, nucleic acid and inorganic compound are salts, minerals, water.
- The organic molecules vary in size from simple molecular such as amino acids to giant molecules proteins.
- Smaller molecule (Biomicromolecules) have molecules mass upto 800 Dalton and are monomers Ex. monosaccharide, Amino acids, Nucleotides.
- Larger molecules (Biomacromolecules) have molecular mass more than 800 Dalton and are polymers Ex : Polysaccharide, Proteins, Nucleic Acid.
- The monomers are linked by bonds to form polymers.
- One type of biomolecules changes into some other biomolecules i.e. all biomolecule have a turn over.
- Living processes can take place only in a non equilibrium steady state. This is termed as <u>living state.</u>
- All metabolic conversions are Catalysed by Enzymes.
- Enzymes are Proteins that can hasten the rate of Metabolic conversion.

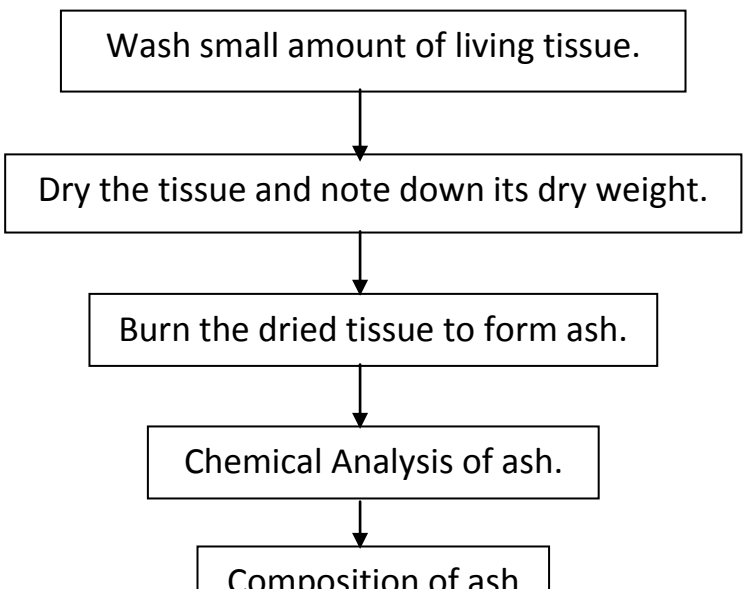
Mind Map



CHEMICAL ANALYSIS OF ORGANIC COMPOUNDS



Chemical Analysis of inorganic compounds



Different Biomolecules

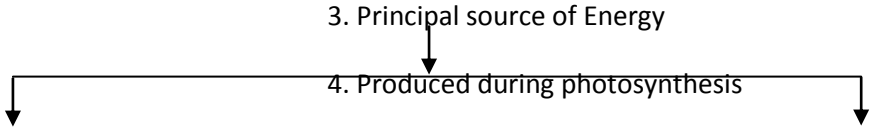
1. **Carbohydrates**

1. Compounds of C, H & O

2. General formula $C_nH_{2n}O_n$

3. Principal source of Energy

4. Produced during photosynthesis



Sugars

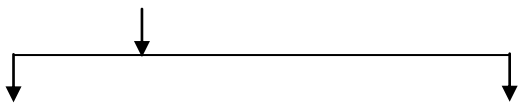
1. Small molecules

2. Low molecular weight

3. Sweet

4. Readily soluble in water

5. Crystalline



Monosaccharide

(simple sugar)

Disaccharide

made by joining two molecule of monosaccharide by glycosidic bond

Polysaccharides

1. Macromolecule

2. High molecular weight

3. Not sweet

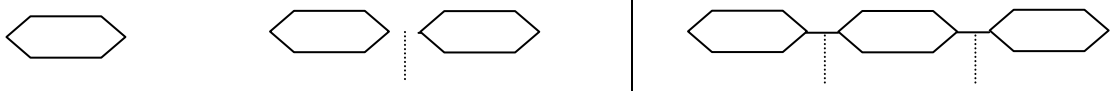
4. Insoluble or slightly soluble in water

5. Non-crystalline

Made by joining many

monosaccharides

Ex: Glucose	Ex : Maltose	Ex :	
Fructose	Sucrose	Cellulose Starch Inulin Glycogen	Homopolymers (formed by repeated polymerisation of one type of monosaccharides)
Galactose	Lactose	Chitin	Heteropolymer (formed by polymerisation of more than one type of monosaccharides)

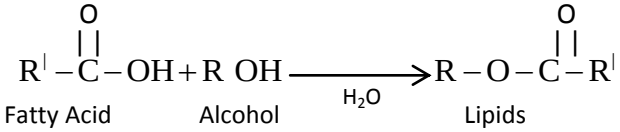


Glycosidic bond

Glycosidic bonds

2. Lipids

- Heterogenous group of organic compound made up of C, H & and few atoms of oxygen.
- They are insoluble in water & soluble in non-polar organic solvents.
- Lipids are esters of Fatty acids & an alcohol.



- Fatty acids are large molecules containing an acidic group.

  General Formula R.COOH

  R = Alkyl group

COOH = Acidic Group

- True fats are esters of fatty acids and glycerol and are also called triglycerides. (Glycerol is trihydroxypropane)
- Oils are rich in unsaturated fatty acids that have low melting point.
- Phospholipids are lipids with a phosphate group. Ex : Lecithin

Phospholipids { Head : Phosphate group - polar - water attracting (Hydrophilic)

Tail: Hydrocarbons of fatty acid- nonpolar- water repellant (hydrophobic)

They play important role in the formation of cell-membran.

- Glycolipids are lipids with a carbohydrate.
- Lipoprotein are lipids with a protein molecule.
- Cholesterol is composed of fused hydrocarbon rings and a long hydrocarbon chain.

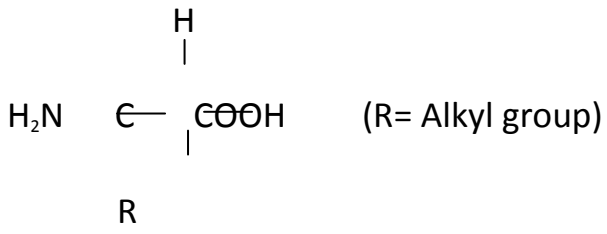
Difference between unsaturated and saturated Fatty Acids :

Unsaturated fatty acids	Saturated fatty acids
1. Contain one or more double or triple bonds between carbon atoms. 2. Melt at lower temperature. Ex. Oleic Acid	1. Do not have any double bond or triple between carbon atoms. 2. Melt at higher temperature. Ex. Palmitic Acid

3. Proteins

- Proteins are Heteropolymers containing strings of small units called Amino Acids.
- A peptide bond is formed between Carboxyl group of one Amino Acids and Amino group of the successive Amino Acids.
- Enormous types of Protein result from 20 Amino Acids.
- Amino Acids are organic compound containing one Amino group and one carboxylic group as substituents on the same carbon i.e. α carbon.

- General Formula



(R= Alkyl group)

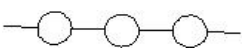
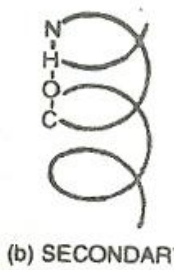
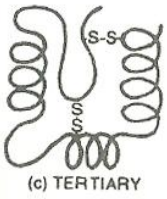
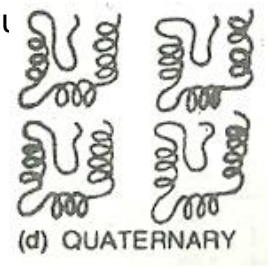
- Due to ionizable nature of -NH_2 & -COOH group, the structure of Amino Acids change in different pHs.
- As the Amino Acids carry both positive & negative charges simultaneously, such substances are called Zwitterions.
- Depending on the availability of Amino Acids, these can be categorized into

Essential Amino Acids	Non Essential Amino Acids
Cannot be synthesised in the body of animals They must be obtained from diet. Ex. : Valine	Can be synthesised in the body of animal. Not essential in our diet. Ex. : Glutamic Acid, Alanine

- Based on the number of Amino and Carboxyl group, Amino Acids are categorised as **acidic, basic & neutral**.

Acidic	Neutral	Basic
Have more than one carboxylic group	Have only one acidic & one basic group	Have more than one basic group
Ex. : Glutamic Acid	Ex. : Alanine	Ex. : Lysine

- Depending on the structure of the protein they can be categorised into four types.

Structure	Properties	Example
1. Primary Structure 	• Linear arrangement of amino acids • Amino acids are held by peptide bonds	Insulin
2. Secondary Structure  (b) SECONDARY	• Protein threads get helical shape (Pleated Sheet Structure) • Amino acids are held by peptide bonds and inter molecular hydrogen bonds.	Silk Fibre
3. Tertiary Structure  (c) TERTIARY	• Polypeptide chains folded into three dimensional globular structure. • Stabilized by ionic bond, hydrogen bonds, disulphide bonds	Enzymatic protein
4. Quaternary Stru  (d) QUATERNARY	• Relative folding of two are more similar or dissimilar polypeptides upon one other in the form of a cube. • Stabilised by hydrogen bonds and electrostatic linkage.	Haemoglobin formed of two sub units. α- type and β- type

Nucleic Acids

These are the most essential molecules of life. They form the genetic material of all organisms including virus.

Nucleic acids are made up of large number of nucelotides.

Nucleotide

1. **Structure:** Each nucleotide contains three components.

(a) Pentose Sugar

(b) Nitrogen base

(c) Phosphoric Acid

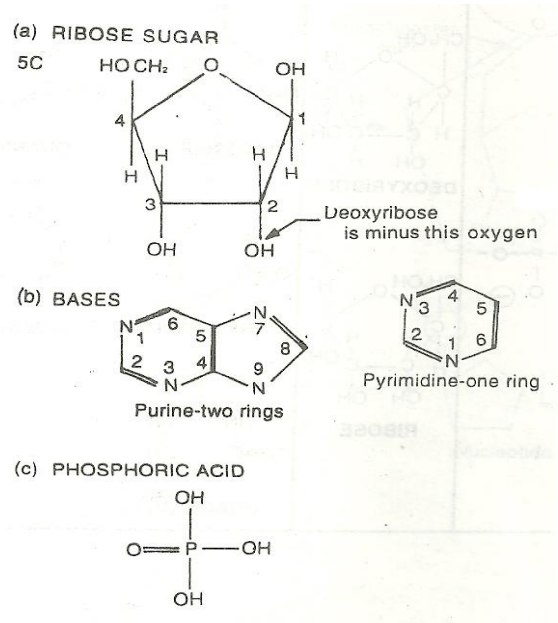
(a) Sugar : There are two kinds of nucleic acids, containing two types of pentose sugars. Ribonucleic acid (RNA) contains **ribose sugar,** Deoxyribonucleic acid (DNA) contains **deoxyribose sugar.**

(b) Nitrogen base : There are two categories of base purines and pyrimidines.

(i) Purines : Have 2 rings in their structure, example Adenine, Guanine.

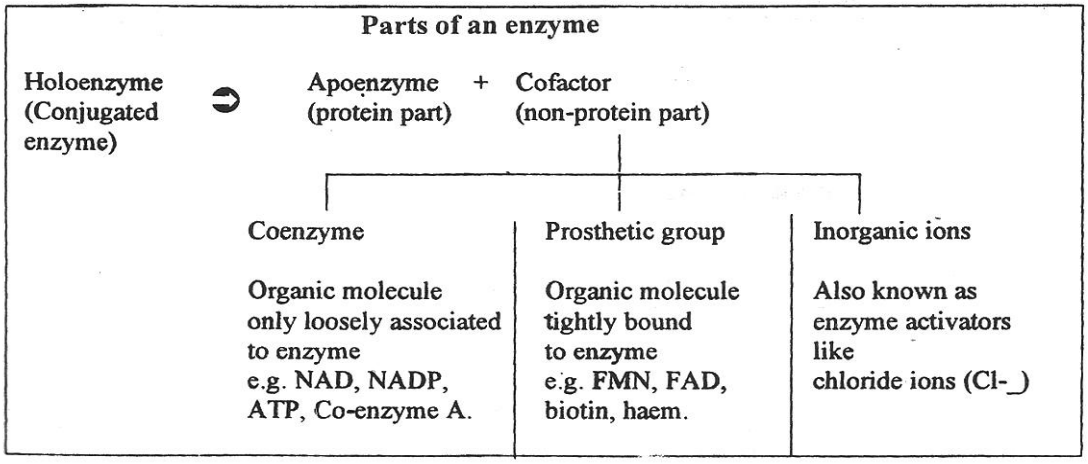
(ii) Pyrimidines : Have one ring in their structure. Cytosine, Thymine and Uracil (Uracil is present in RNA only in place of thymine)

(c) Phosphoric Acids : It contains a phosphate group. It combines two nucleotides together by formation of **phosphodiester bond.**

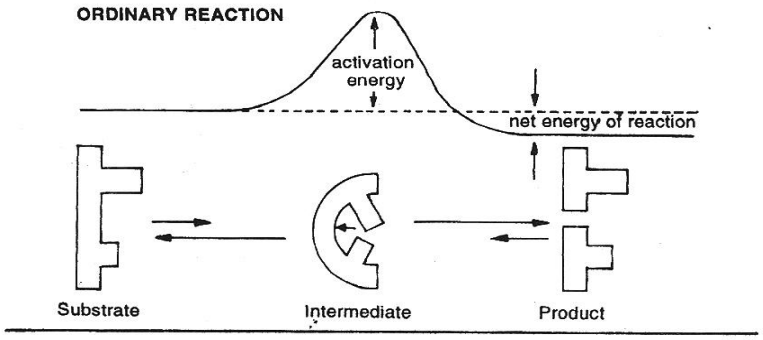


Enzymes

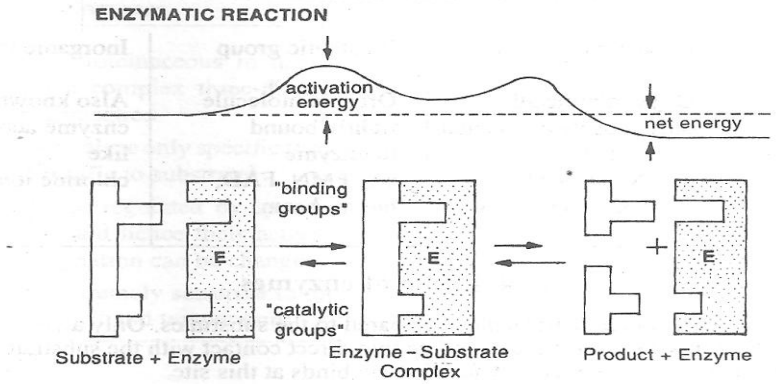
All enzymes are proteinaceous in nature. Some enzymes need a nonprotein part as well.



An example of a Metabolic pathway without/ with Enzyme.



(a) Non-enzymatic Reaction



(b) Enzymatic Reaction.
Enzyme lowers the activation energy and explains Lock & Key Hypothesis.

Properties of enzymes

1. Always proteinaceous in nature.
2. Lower the activation energy and thereby increase the speed of reaction.
3. Remain unchanged at the end of the reaction and can be used again.

4. Work best at optimum temperature which is generally the normal body temperature.

   Inactivated by very low temperatures.

5. Extremely sensitive to pH.

6. **Substrate-specific :** A given enzyme will catalyse only one reaction or a type of reaction.

7. The activity of an enzyme is also sensitive to the presence of specific chemicals that bind to the enzyme. When the binding of the chemical shuts off enzyme activity, the process is called **inhibition** and the chemical is called an **inhibitor.**

Classification of Enzymes:

Oxidoreductases/dehydrogenases:

S reduced + S' oxidised $\rightarrow$ S oxidised + S' reduced.

Transferases:

S - G + S' $\rightarrow$ S + S' - G

Hydrolases: Enzymes catalysing hydrolysis reactions.

Lyases :

X Y

| |

C – C $\rightarrow$ X - Y + C = C

Isomerases: Includes all enzymes catalysing inter-conversion of optical, geometric or positional isomers.

Ligases: Enzymes catalysing the linking together of 2 compounds.

SOME IMPORTANT QUESTIONS:

1. Explain primary,secondary and tertiary structure of protein.
2. Write any four properties of a Biocatalyst.

3. Distinguish between DNA & RNA.

****

Chapter-10

Cell Division

KEY TERMS

Cell Division: It is the process by which new cells are formed from pre existing cells

Cell Cycle: The sequence of events by which a cell duplicates its genome and eventually divides into daughter cells.

Karyokinesis: Division of the nucleus.

Cytokinesis: Division of cytoplasm.

Quiscent stage: It represents an inactive stage where cell are metabolically active but do not undergo division.

Kinetochores: The small dice shaped structure at the surface of centromere, serve as the site of attachment of the spindle fibres to the centromere of the chromosome.

Bivalent: Pair of homologous chromosomes.

Tetrad: It refers to the four chromatid stage formed during meiosis.

Chiasmata: X shaped structures formed at the site of crossing over during prophase of meiosis.

Crossing over: It is the phenomenon of exchange of equivalent segment between Non- Sister chromatids of homologous chromosomes (prophase of meiosis)

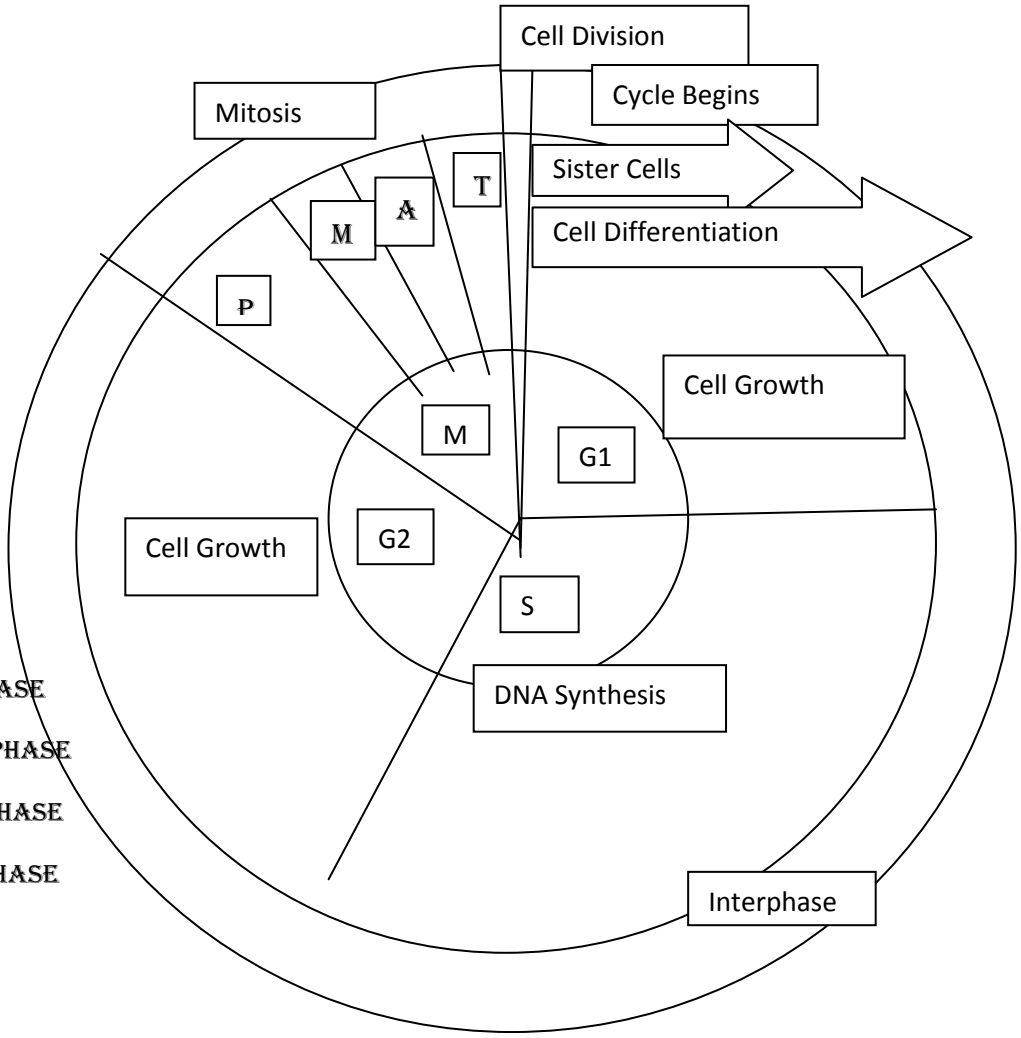
Homologous Chromosomes: Two similar chromosomes, one contributed by the male parent and other by the female parent.

Synapsis: A close association & pairing of homologous chromosomes during prophase of meiosis.

GIST OF THE LESSON

1. All cell reproduce by dividing into two cells.
2. Each parent cell gives rise to two daughter cells each time they divide.
3. Cycles of growth and division allow a single cell to form structures consisting of millions of cells.
4. The sequence of events by which a cell duplicates its genome, synthesizes the constituents of the cell and eventually divides into two daughter cells is termed as cell cycle.
5. DNA synthesis occurs only during one specific stage in the cell cycle.
6. The replicated DNA (Chromosomes) are distributed to the daughter nuclei by a complex series of events during cell division.

CELL CYCLE (INTERPHASE + M-PHASE)

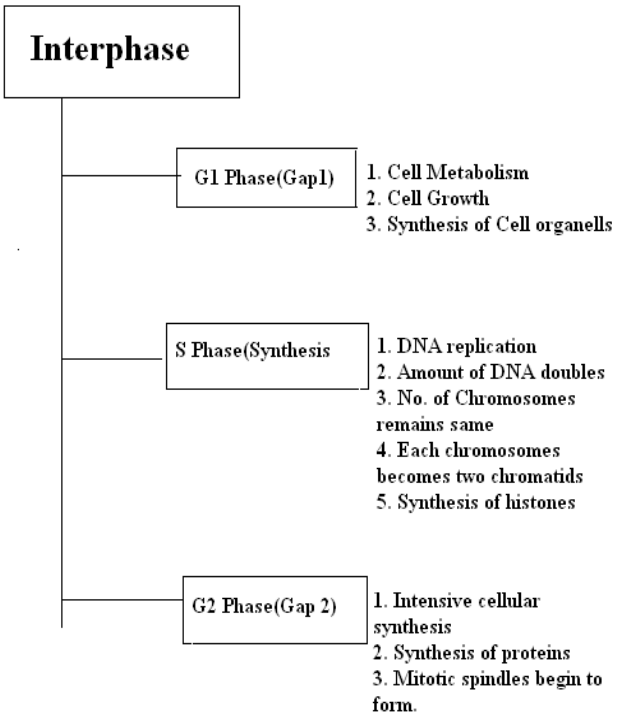


P- PROPHASE

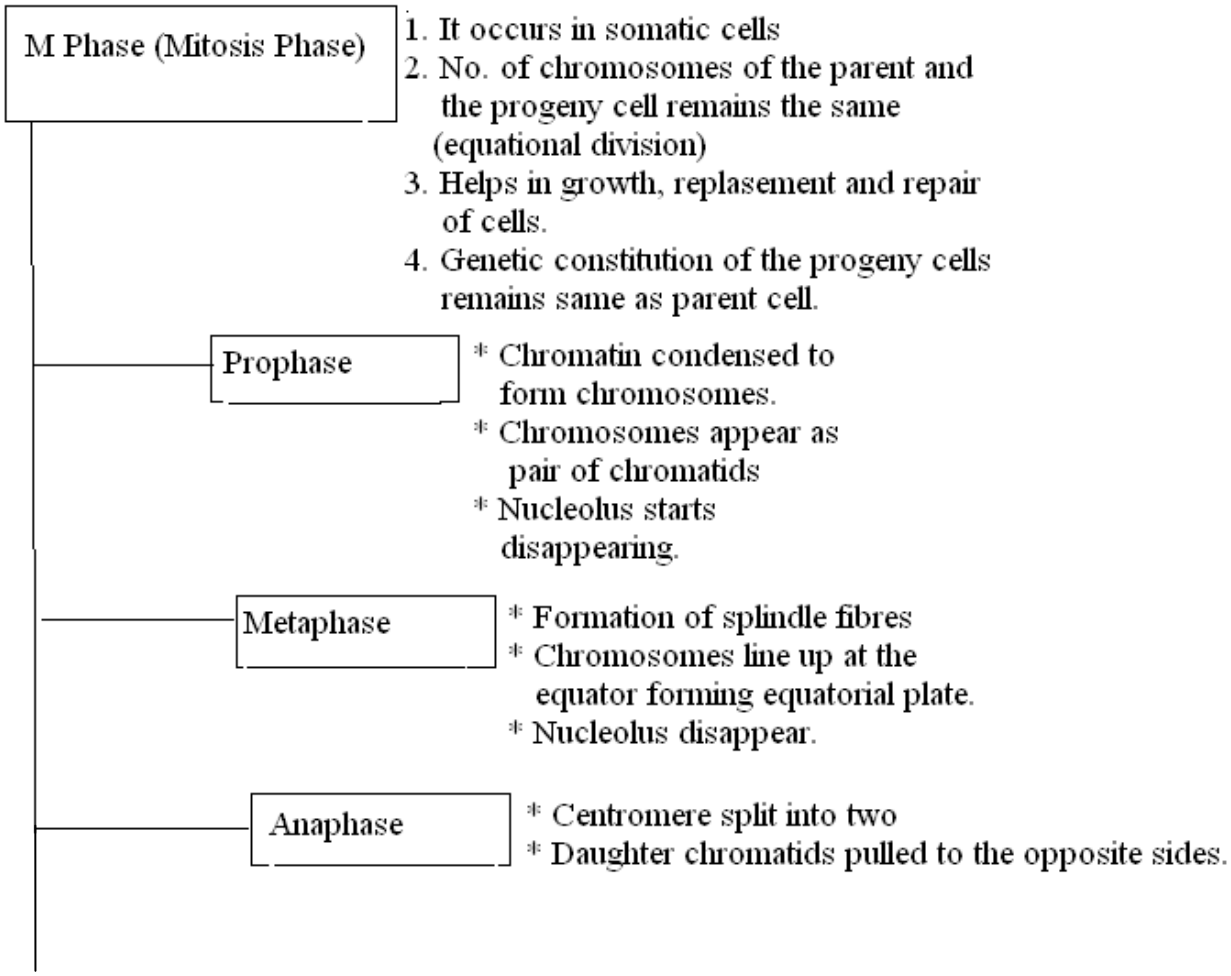
M- METAPHASE

A- ANAPHASE

T- TELOPHASE


Interphase
G1 Phase(Gap1)
1. Cell Metabolism
2. Cell Growth
3. Synthesis of Cell organells
S Phase(Synthesis
1. DNA replication
2. Amount of DNA doubles
3. No. of Chromosomes remains same
4. Each chromosomes becomes two chromatids
5. Synthesis of histones
G2 Phase(Gap 2)
1. Intensive cellular synthesis
2. Synthesis of proteins
3. Mitotic spindles begin to form.

MITOSIS

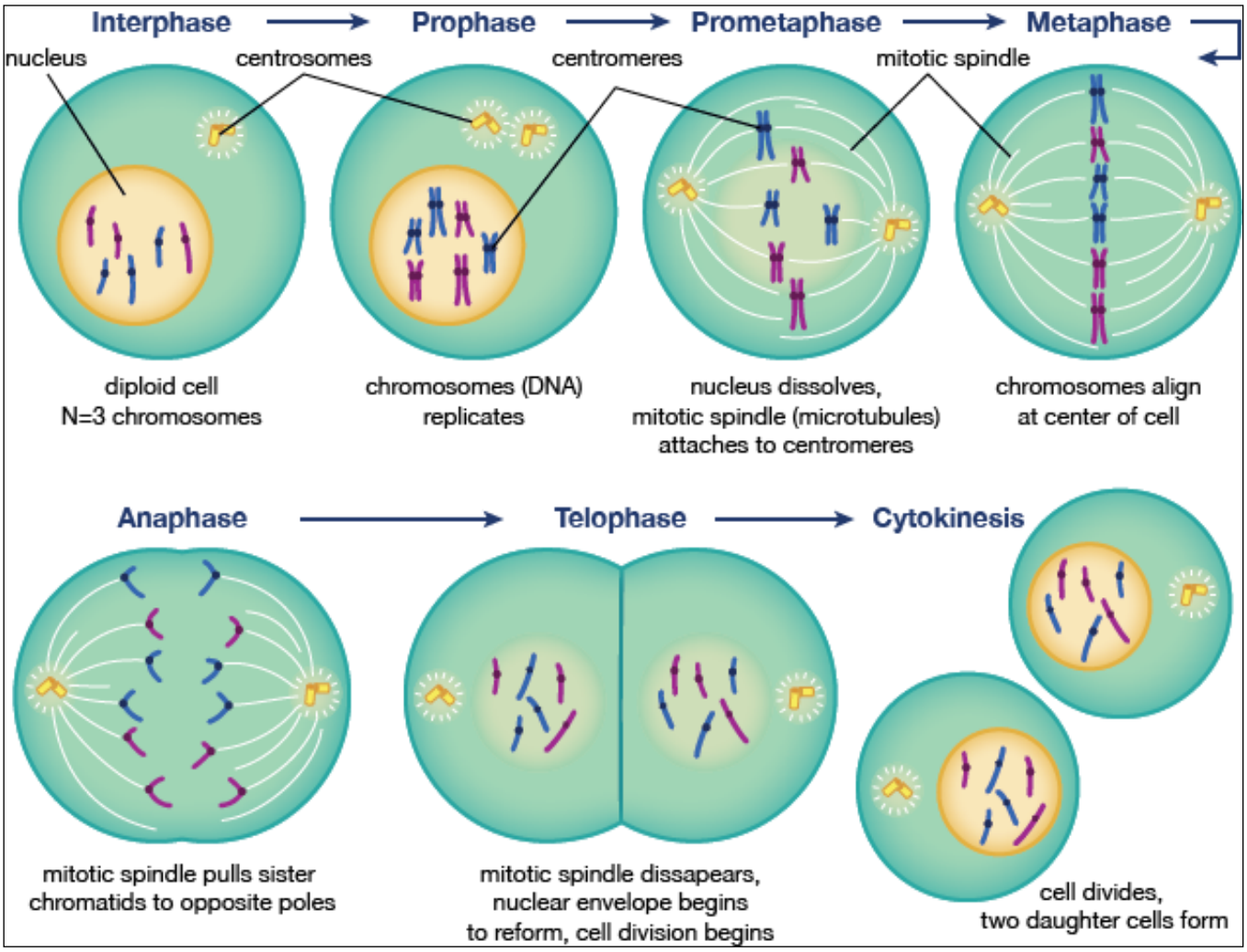

M Phase (Mitosis Phase)
1. It occurs in somatic cells
2. No. of chromosomes of the parent and the progeny cell remains the same (equational division)
3. Helps in growth, replasement and repair of cells.
4. Genetic constitution of the progeny cells remains same as parent cell.
Prophase
* Chromatin condensed to form chromosomes.
* Chromosomes appear as pair of chromatids
* Nucleolus starts disappearing.
Metaphase
* Formation of splindle fibres
* Chromosomes line up at the equator forming equatorial plate.
* Nucleolus disappear.
Anaphase
* Centromere split into two
* Daughter chromatids pulled to the opposite sides.

Telophase

* Chromosomes reach the poles of the cell
*Nuclear membrane and Nucleolus reappear.
* Nucleus divided into two daughter nuclei

Cytokinesis

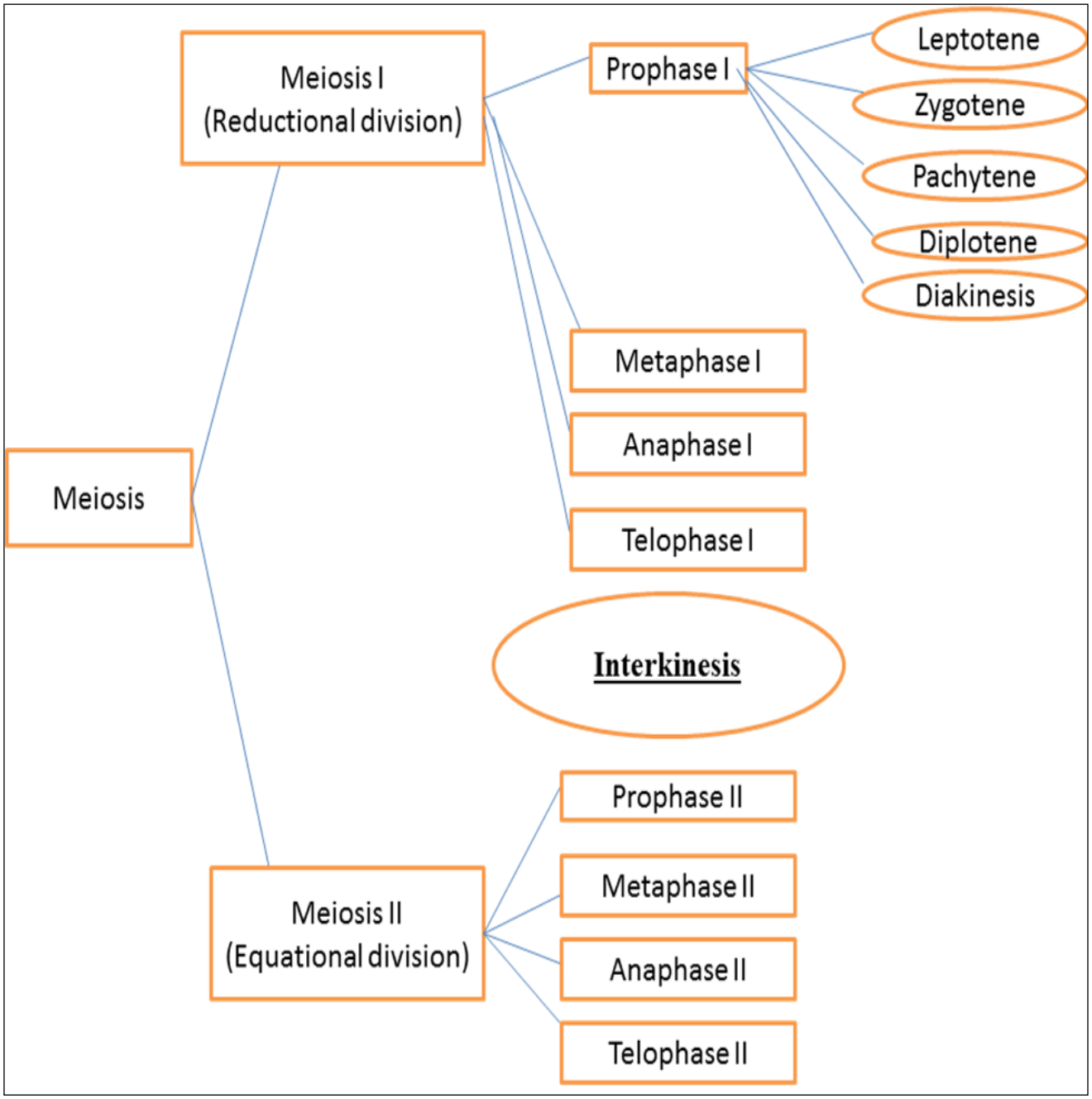
* The cytoplasm of the cell divided into two equal parts.
* In animal cells, the cell membrane invaginates, dividing the cytoplasm into two.
* In plant cells a cell plate divides the cell int two.
* The mitochondria and other organells get distributed between the two daughter cells
* The parent cell completely divides into two daughter cells with their own nucleus.



Diagrammatic representation of different stages of mitosis

MEIOSIS

1. It takes place in gametes (Gametes are formed form specialized Diploid cells)
2. The no. of chromosomes in the daughter cells reduces by half (Haploid).
3. Four haploid daughter cells are formed (Reduction division)
4. Exchange of genetic material takes place resulting in variations in the daughter cells.
5. Involves two cycles of nuclear and cell division called Meiosis I and Meiosis II



Meiosis I

Prophase I

Leptotene

1. mes.

2. Beaded appearance of chromosomes.

Zygotene

1. Homologous chromosomes paired by synapsis (synaptonemal complex)

Pachytene

1. Appearance of tertad
2. Crossing over between non sister chromatids of homologous chromosomes at chiasmata.

Diplotene

1. Dissolution of the synaptonemal complex.
2. X shape structures called chiasmata remains.

Diakinesis

1. Terminalisation of chiasmata
2. Spindles assembled to prepare the homologous chromosomes for separation.
3. Nuclear envelop and nucleolus disappears.

Metaphase I

1. Homologus Chromosomes line up on the spindle fibre attached by centromeres.

Anaaphase I

1. A Homologus pair separates.
2. Each chromosome still has 2 chromatids and moves to opposite direction.

Telophase I& after Cytokinesis

1. Each cell has haploid no. of chromosomes but each chromosome still has two chromatids.

Meiosis II

Prophase II

1. Nuclear membrane and nucleolus disappear.
2. Chromosomes become compact.
   In some cells prophase II may be absent.

Metaphase II

1. Chromosomes line at equator.

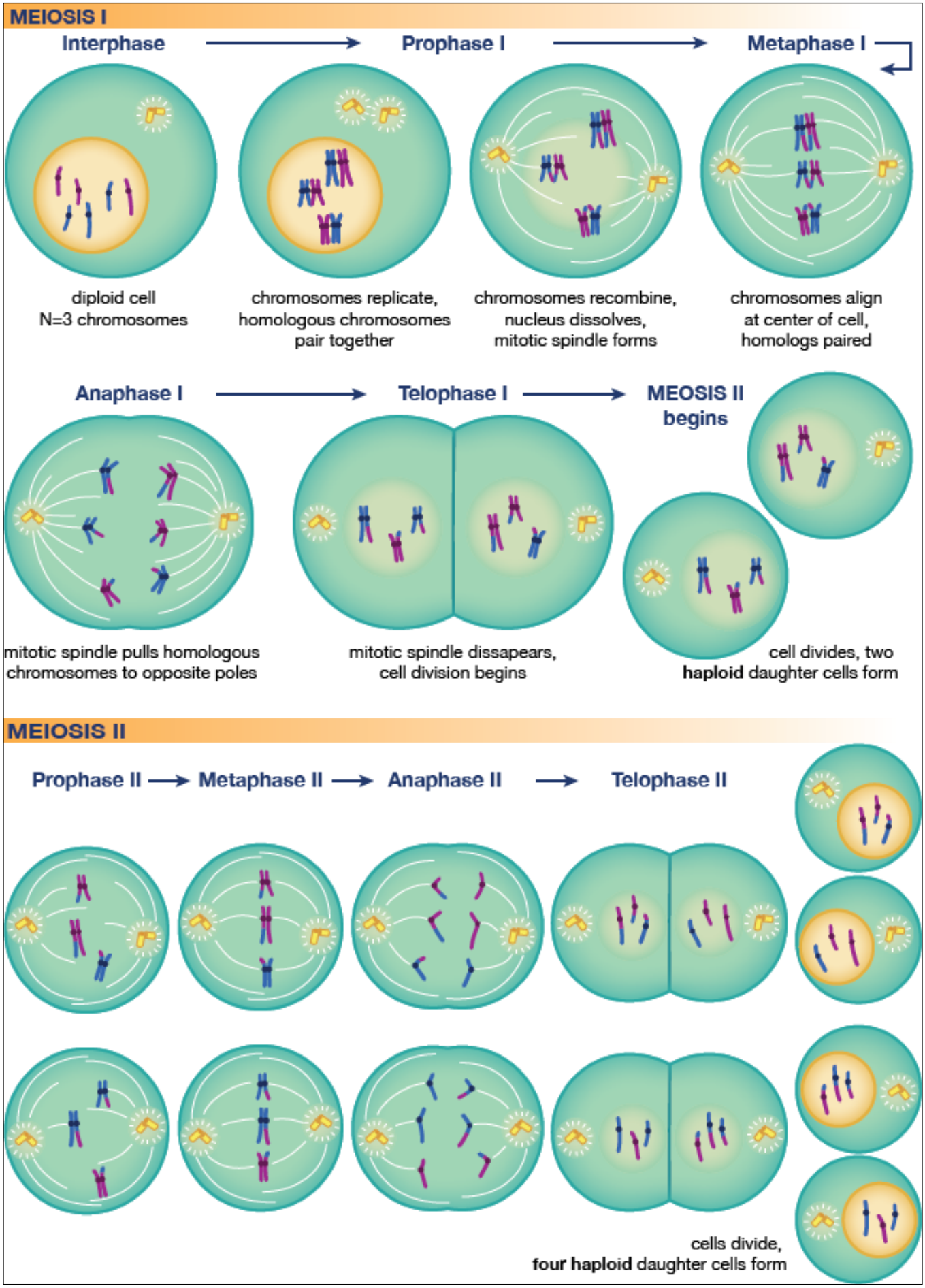
Anaphase II

1. Spliting of centromere and hence chromatids separate.

Telophase II & after Cytokinesis

1. Each cell has half no. of chromosomes.
2. Each chromosome is a single unit and may be different in each cell due to crossing over.

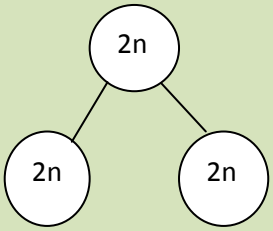
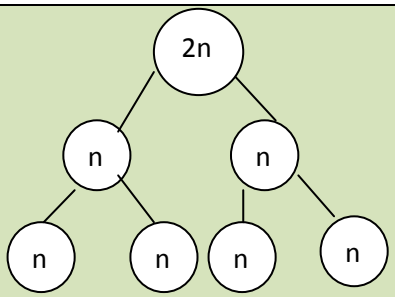
After meiosis II four haploid daughter cells are formed.



Diagrammatic representation of different stages of meiosis

DIFFERENCE BETWEEN MITOSIS & MEIOSIS

	Mitosis	Meiosis

1. Diagrammatic representation	 (for a diploid cell)	
2. Occurrence	Occurs in diploid cells, may occur in haploid cells also	Occurs in Diplois cells
3. Kind of Cell	Somatic Cells	Reproductive cells (Gametes)
4. No. of cells produced	Two daughter cells	Four daughter cells
5. Significance	• Chromosome no. remains same as that of the parent cell (equational division) • Daughter cells produced have identical genetic constitution as that of the parent cell. • Results in growth and repair, replacement of cells.	• Chromosome no. reduces to half the no. of chromosomes present in the parent cell.(reduction division) • Daughter cells produceds have variation in the genetic constitution. • Results in the formation of gametes. • Helps in the consevation of chromosome no. is sexually reproducing organisms.

SOME IMPORTANT QUESTIONS:

1. Why mitosis is called an equational division?
2. Describe various events during prophase I of Meiosis I.
3. Which type of cell division takes place at the time of gametogenesis in Haploid organisms.

****

Chapter-11

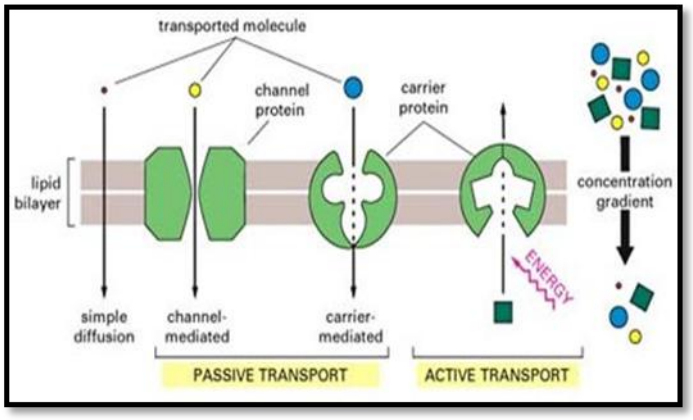
Transport in Plants

Means of Transport:

- There are three means of transport in plants-

i. **Diffusion**-

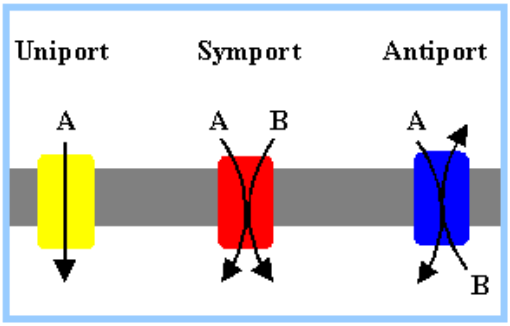
- Passive & random movement of ions or molecules.
- Do not involve expenditure of energy.
- Occurs along Concn.gradient.



- Diffusion rate depends upon Concn.gradient, Permeability of membrane,temp. & Pressure.

ii. **Facilitated diffusion**-

- Movement of substances across the membranewith the help of membrane proteins, do not involve expenditure of energy.
- Occurs along Concn.gradient.
- It may be Symport (Two type of molecules transported across the membrane in same direction) or Antiport (two type of molecules transported in the opposite direction across the membrane) or Uniport (Transport of single type of molecule across the membrane independent of other molecules).



iii. **Active Transport**-

- Movement of substances across the membrane through membrane proteins.
- Involves expenditure of energy.
- Occurs against the Concn.gradient.

Water Potential:

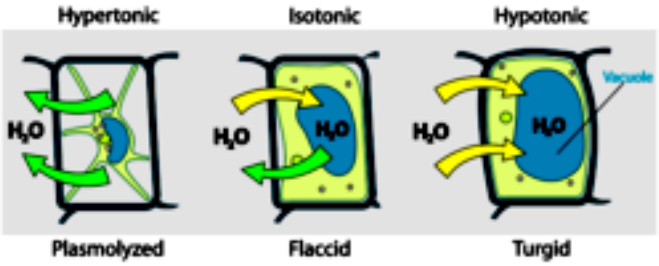
- The free energy of water is called as water potential. It is denoted by the greek letter ψ (psi) & its unit is Pascal.
- Water potential of pure water is taken as zero and addition of solute causes lowering of water potential.Therefore water potential of a solution is always considered negative.
- Two major components that determine water potential are solute potential(ψ_s) & pressure potential (ψ_p).
- Water potential is affected by solute Concn.(addition of solute causes lowering of water potential) &pressure(causes increase in water potential).

Osmosis:

- Movement of water molecules across a semipermeable membrane from the region of its higher Concn.to lower Conc. is called as osmosis.
- Net direction & rate of osmosis depends upon pressure gradient and Concn.gradient.
- The pressure required to stop the entry of water into the solution is called as osmotic pressure.It is a positive pressure and numerically equal to osmotic potential (solute potential) which is negative.

Plasmolysis:

- Shrinking of the protoplast and its movement away from the cell wall due to exosmosis(outward movement of water) is called as plasmolysis.
- The external solution is said to be isotonic if it has the same solute Concn.as cytoplasm. Cells placed in such solutions shows no net movement of water.
- The external solution is called as hypertonic if it has more solute Concn than the cytoplasm. Cells placed in such solution show exosmosis.



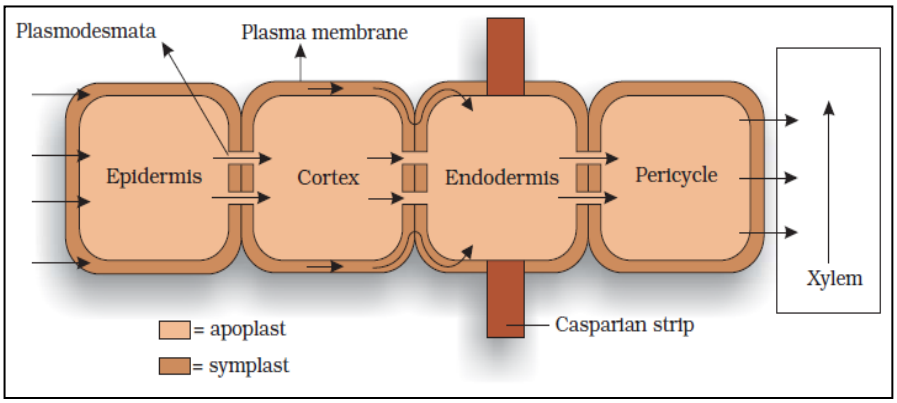
- The external solution is called as hypotonic if it has less solute Concn than the cytoplasm. Cells placed in such solution show endosmosis and becomes turgid.

Imbibition:

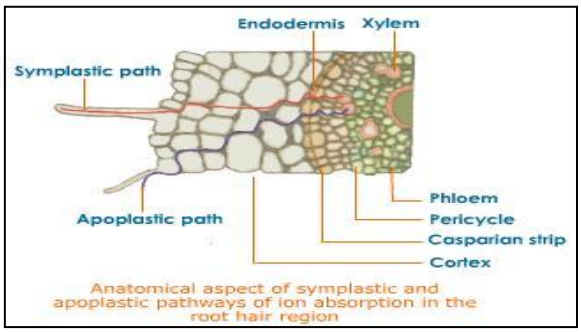
- Movement or diffusion of water along a gradient into an adsorbent is called as imbibition.

- It is responsible for seedlings to come out of the soil.
- Two conditions necessary for imbibition are- gradient between the surface of adsorbent & the liquid/water imbibed, and affinity between the adsorbent & the imbibed liquid.

Absorption of water in Plants:



- Absorption of water is carried out by the root hairs through diffusion.
- Absorbed water moves by two pathways from root hairs- Apoplast and Symplast pathway.
- Movement of water extensively through the non living components i.e.cell wall & intercellular spaces without crossing any membrane and along gradient is called as apoplast pathway.
- Movement of water through the cytoplasm of cells and plasmodesmata involving crossing of membrane and aided by cytoplasmic streaming is called as symplast pathway.



- Most of water flow in roots through apoplast till endodermis, after that it takes symplast pathway to reach upto the xylem vessels.

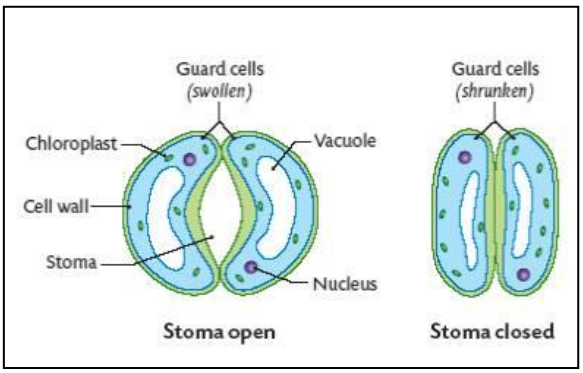
Upward movement of water in plants:

- **Root pressure**-
  - Active absorption & accumulation of various ions in the root cells causes decrease in water potential and drives entry of water from soil solution into the root cells.
  - It causes development of positive root pressure which pushes water upto a certain height.
  - Root pressure is responsible for coming out of liquid droplets in herbaceeous plants through a special opening (hydathodes) called as guttation.

- **Transpiration Pull**-
  - Also called as cohesion tension theory and was given by Dixon & Jolly.
  - Most of the water transport in the plants occurs by this method.
  - A transpiration pull (tension or negative pressure) is created at the leaf surface causing lowering of water potential.
  - Thus a negative water potential is exerted from the leaf surface through stem to the root tips.
  - Since water potential of the soil solution is higher than that of the root cells, water enters the root hair and moves radially across to reach the xylem.
  - Water is pulled up as continuous column due to the cohesive force among the water molecules and adhesive force between the water molecules and the lignocellulosic cell wall of xylem vessels.

Transpiration:

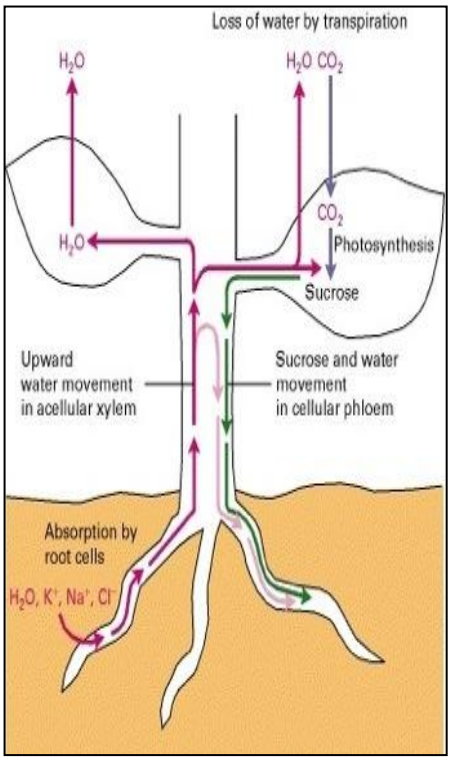
- Loss of water in the form of water vapour through stomata is called as transpiration.
- Stomata are the pores found in the leaves guarded by two guard cells.These guard cells are bean shaped in dicot leaves and dumb-bell shaped in grasses. The immediate cause of opening and closing of stomata is change in turgidity of guard cells.



- Dicot leaves have more stomata on lower surface than on upper surface, while monocot leaves have almost equal number of stomata on both the surfaces.
- Factors that affect rate of transpiration are – temp., light, humidity, wind speed, no. & distribution of stomata etc.
- Acc to Curtis: “Transpiration is an essential evil of plants”

Uptake and transport of mineral ions:

- Mineral ions enter root both passively as well as actively, but mostly they are taken up by active transport.
- After reaching to the xylem through active or passive uptake, they are further transported up the stem to all parts of the plant through the transpiration stream by method of mass or bulk flow system.

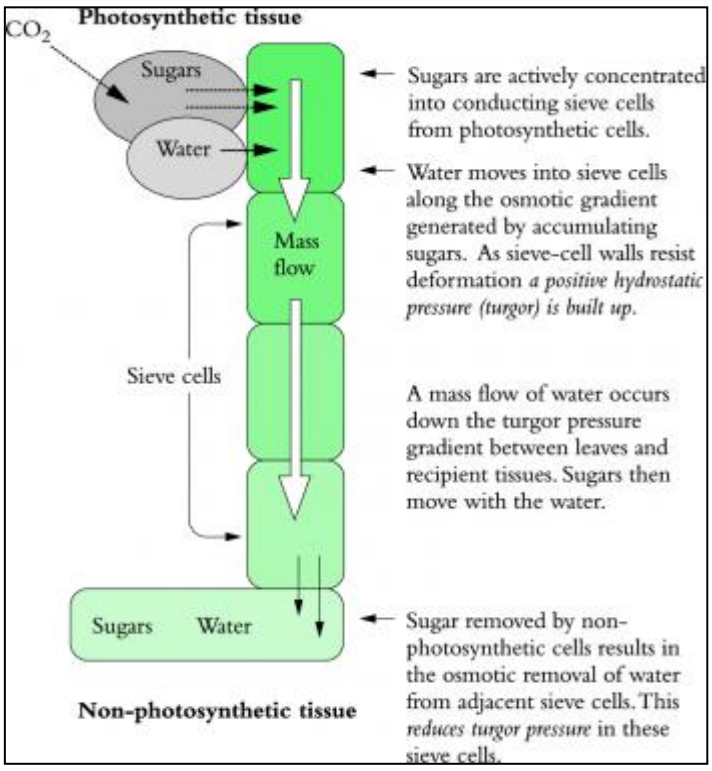


Phloem transport:

- Phloem transport is bidirectional, because source –sink relationship can vary.
- The source for phloem transport is leaf and the sink may be any part that needs food or storage organ.
- Phloem sap mainly contains water, sucrose, amino acids, hormones etc.
- The long distance movement of substances through the vascular tissues (xylem & phloem) in plants is called as translocation.

Mass flow hypothesis:

- Also called as pressure flow hypothesis.
- It was proposed by Munch.
- Loading of sucrose (active transport of sucrose from leaf mesophyll tissues to companion cells and then into sieve tubes) at the source(leaf) causes decrease of water potential in the phloem, resulting in entry of water into sieve tubes from adjacent cells by osmosis.
- Hydrostatic pressures build up in the phloem sap that moves to regions of lower pressure (sink).
- Unloading of sucrose and other sugars(sucrose and other sugars move actively out of phloem) into the cells of sink causes increase in water potential of phloem and water moves out of the phloem.



SOME IMPORTANT QUESTIONS:

1. What will happen when a cell is placed in Hypertonic solution?
2. Write a short note on water potential.
3. Distinguish between guttation and transpiration.
4. Explain most widely accepted theory for upward movement of water.

Chapter-12

Mineral Nutrition

- Technique of growing plants in a nutrient solution (complete absence of soil) is called as hydroponics. It was discovered by Von Sachs (1860).
- Hydroponic/Soil less Culture technique is employed to find out the elements essential for plant growth, ascertain deficiency symptom and nowadays for commercial production of crops like tomato, seedless cucumber etc.
- Depending upon the quantity in which an essential element is required by the plants, nutrients may be-
  - **Macronutrient**(required in amount more than 10 m mole/kg of dry matter).
  - **Micronutrient or trace element**(required in amount less than 10 m mole/kg of dry matter).
- On the basis of function, essential elements may be-
  - Structural element (as components of biomolecules) like-C,H,O,N
  - Components of energy related compounds like Mg in chlorophyll and phosphorus in ATP
  - Activator or inhibitor of enzymes like Mo activator of nitrogenase, Zn^{+2} of alcohol dehydrogenase.
  - Alter the osmotic potential of a cell like Potassium .

Category of Nutrients	Name of element	Form in which absorbed by plants	Functions/ Role played
Macro Nutrients	1-Nitrogen	NO_3^-, NO_2^- or NH_4^+	Major constituent of Proteins, nucleic acids, vitamins and hormones.
	2-Phosphorus	$H_2PO_4^-$ or HPO_4^{2-}	Constituent of cell membranes, nucleic acids, nucleotides & required for all phosphorylation reactions.
	3-Potassium	K^+	Maintains anion-cation balance in cells, involved in protein synthesis, opening and closing of stomata, turgidity of cells.
	4-Calcium	Ca^{2+}	Required for permeability of cell membrane, formation of mitotic spindle, formation of middle lamella.
	5-Magnesium	Mg^{2+}	Constituent of chlorophyll, maintains structure of ribosome, activates enzymes of respiration & photosynthesis, involved in DNA & RNA synthesis .
	6-Sulphur	SO_4^{2-}	Constituent of amino acid (Methionine &Cysteine), several Co-enzymes, ferredoxin &Vitamins (Biotin, Thiamine & CoA).
Micro Nutrients	1-Iron	Fe^{3+}	Constituent of proteins involved in electron transfer (ferredoxin, cytochromes), activates catalase enzyme and essential for formation of chlorophyll.
	2-Manganese	Mn^{2+}	Necessary for photolysis of water in photosynthesis, activates enzymes involved in photosynthesis, respiration & nitrogen metabolism.
	3-Zinc	Zn^{2+}	Required for synthesis of auxin, activates carboxylases
	4-Copper	Cu^{2+}	Required for over all metabolism, associated with enzymes involved in redox reactions.
	5-Boron	Bo_3^{3-} $B_4O_7^{2-}$	Required for uptake& utilization of Ca^{+2},membrane functioning, pollen germination, cell elongation, cell differentiation and carbohydrate translocation.
	6-Molybdenum	MoO_2^{2-}	Component of nitrogenase and nitrate reductase enzymes.
	7-Chlorine	Cl^-	Anion-Cation balance in cell, necessary for photolysis of water in photosynthesis.

Deficiency Symptoms-

- Common deficiency symptoms are-
- Chlorosis (loss of chlorophyll)- yellowing of leaves caused due to deficiency of N,K, Mg, S, Fe, Mn, Zn & Mo.
- Necrosis (Death of tissues)-caused due to deficiency of Ca, Mg, Cu, K.
- Inhibition of cell division- caused due to deficiency of K, N, & Mo.

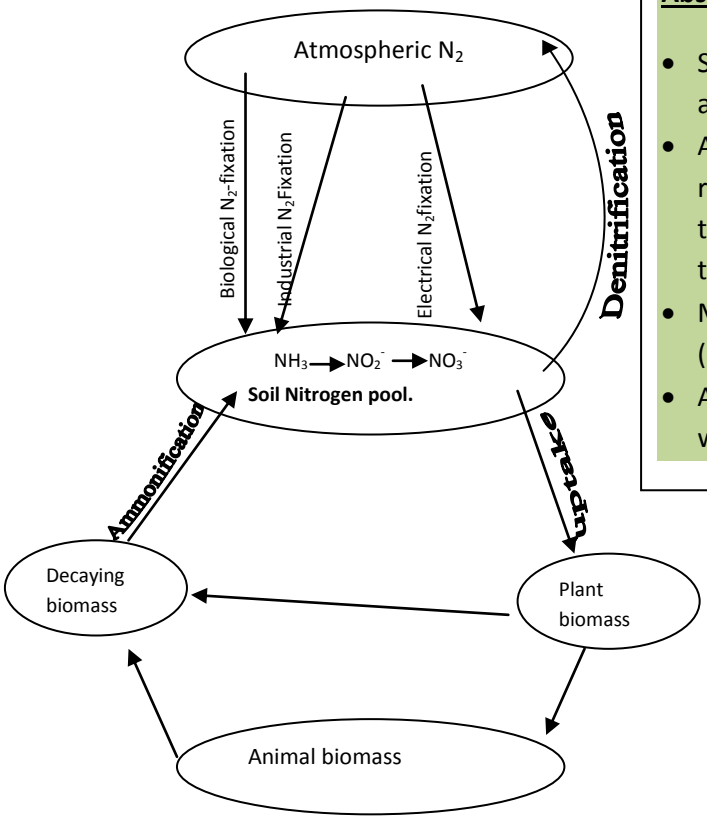
- Delay in flowering-caused due to deficiency in N, S, and Mo.

Micronutrients can be toxic

- Mineral ion Conc. in tissues that reduces the dry weight of tissues by about 10% is called as **toxic**.
- Moderate decrease in micronutrients causes deficiency symptoms and moderate increase causes toxicity.
- It may be that excess of an element (toxicity) may inhibit the uptake of another element.

- The Conc. of the essential element below which plant growth is retarded is called as **Critical Conc**.
- Morphological changes that are observed due to deficiency (below Critical Concns.) of a particular element are called as **deficiency symptoms**.
- Deficiency symptoms of some elements like S, Ca, etc. first appear in young tissues, while other elements like N, K, Mg. in older tissues. Because those elements which are actively mobile can be transported from senescing organs to younger parts and show deficiency symptoms first in older parts, while those which are immobile shows symptoms first in younger parts.

Nitrogen Cycle



Absorption and translocation of Nutrients-

- Soil acts as reservoir for many nutrients and plants absorb them through roots.
- Absorption of elements occur in two parts-in first part rapid uptake of ions in free space or outer space of cell through passive process and in second part ions are taken slowly into inner space of cell.
- Movement of ions is called as flux, which may be influx (inward movement) or efflux (outward movement).
- Absorbed mineral salts are translocated through xylem with ascending sap by means of transpiration pull.

- Process of conversion of molecular nitrogen (N_2) into compounds of nitrogen is called as nitrogen fixation. Nitrogen fixation may be

Industrial N_2-fixation like forest fires, **Electrical N_2-fixation** **Biological N_2-fixation**

Automobile, Exhaust, Haber's process of NH_3 synthesis etc.	Conversion of N_2into No, NO_2, N_2O by lightning and UV- radiations.	Carried out by living beings Like-bacteria, BGA (Blue, Green Algae) etc.

Symbiotic N_2 fixation-

- Most common symbiotic association observed is between Rhizobium bacteria and roots of leguminous plants (Gram,Pea etc.)
- Small outgrowths called as nodules are formed on roots which, act as site of N_2 fixation.

Steps of Nodule Formation

Rhizobium in soil interacts with roots of leguminous plants.

⇩

Rhizobia multiply, colonise and get attached to epidermal & root hair cells.

⇩

Curling of root hair & invasion of bacteria into root hair.

⇩

Produce infection thread & carry bacteria into root cortex.

⇩

Initiate nodule formation in the cortex.

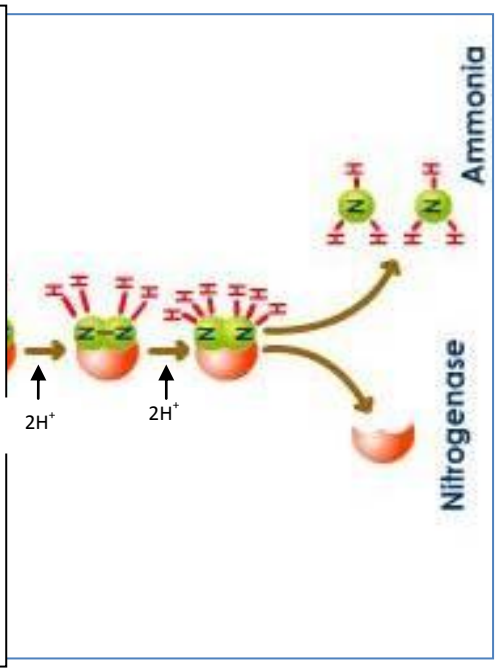
- ***Ammonification*** *is conversion of organic nitrogen (dead plants & animals)into ammonia.*
- ***Nitrification*** *is conversion of ammonia into Nitrate (oxidation of NH_3 into NO_3^-). It is carried out in two steps by Nitrifying bacteria (chemoautotrophs).*
- *$NH_3 \rightarrow$ NO_2^- (by Nitrosomonas, Nitrosococcus bacteria)* (Nitrite)
- *$NO_2^- \rightarrow$ NO_3^- (by Nitrobacter)* (Nitrite → Nitrate)

Mechanism of Nitrogen fixation

- An enzyme Nitrogenase (Mo-Fe protein complex)catalyses the conversion of N_2 into NH_3 in root nodules.
- Enzyme Nitrogenase is highly sensitive to molecular oxygen and requires anaerobic condition to function.
- Anaerobic condition in root nodules is provided by a pink coloured pigment called as leg haemoglobin which acts as oxygen scavenger by binding with O_2. Leg-haemoglobin is product of interaction between Rhizobium & leguminous plant. Either of two cannot have it alone.

Fate of Ammonia *NH_3 soon get converted into NH_4^+, as NH_3 is toxic to plants.*

- *NH_4^+ undergoes reductive amination, in which it reacts with α-ketoglutaric acid to from glutamic acid(amino acid).*
- *Then by transfer of amino group form one amino acid (glutamic acid) to the group of a keto acid, other amino acids and this process is called as* ***transamination*** *catalysed by an enzyme transaminase.*



SOME IMPORTANT QUESTIONS:

1. Describe the various events in nodule formation.
2. Write the significance of Leghaemoglobin in Symbiotic Biological Nitrogen fixation.
3. Write any three deficiency symptoms in plants.

Chapter-13

Photosynthesis in Higher Plants

- A physico-chemical process by which green plants use light energy to synthesise organic compounds (glucose) is called as photosynthesis.
- It is important for all living beings for two reasons:

  i. Primary source of all food on earth.
  ii. Releases oxygen into atmosphere.

Historical Background

Joseph Priestely (1770) revealed the essential role of air in the growth of plants.

⇩

Jan Ingenhousz showed that only green parts of the plants could release O_2.

⇩

Engelmann described the action spectrum of photosynthesis.

⇩

Julius Von Sachs (1854) proved that Glucose is produced when plant grows and glucose is stored in the form of starch.

⇩

Van Niel demonstrated that photosynthesis is essentially light dependent and inferred that oxygen evolved during process comes from H_2O not from CO_2.

- The present day equation of photosynthesis was given by Van Niel as follows-

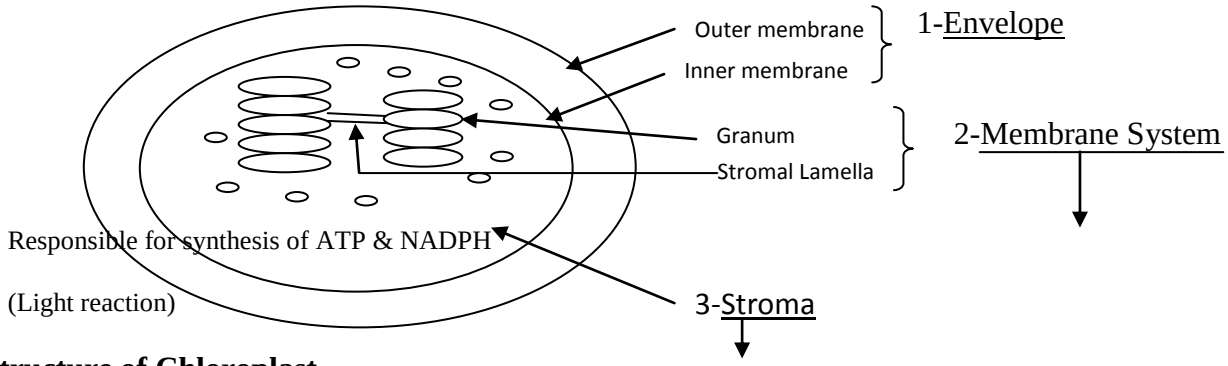
$$6CO_2+12H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6+6H_2O+6O_2$$

Why $12H_2O$ shown in equation not $6H_2O$?

- *Because it has been already proved that oxygen evolved during photosynthesis comes from H_2O not from CO_2.*
- *In case if $6H_2O$ is used then $6O_2$ will not be released (only $3O_2$ is produced).*
- *So, $12H_2O$ produces $6O_2$ and out of $12H_2$ molecules $6H_2$ is used in making of glucose and rest $6H_2$ with oxygen of CO_2 form $6H_2o$ as product.*

Site of Photosynthesis

- Occurs in Green parts of the plant (mainly in leaves but also in green stems & sepals of flower).
- Cells of green part contain chloroplast, a cell organelle which is actually involved in carrying out photosynthesis. (site of photosynthesis in cell).



Structure of Chloroplast

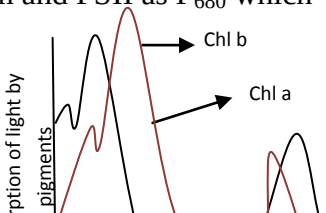
Responsible for CO_2 reduction to form glucose (Dark reaction)

Phtosynthetic Pigments-

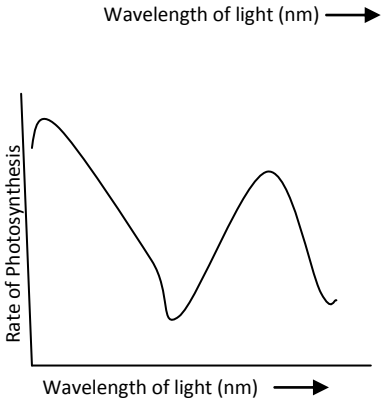
- Pigments involved in photosynthesis are-

Sl. No.	Name of Pigment	Colour of Pigment	Function/Role
1.	Chlorophyll a	Bright Green or bluish green	Actually involved in photosynthetic process (Reaction centre)
2.	Chlorophyll b	Yellowish green	Called as accessory pigments, because not directly involved in photosynthetic process but help in photosynthesis by- 1. Absorbing light at different wavelengths and passing it to reaction centre. 2. Protect chlorophyll from photo oxidation.
3.	Xanthophylls	Yellow	
4.	Carotene	Yellow to yellow orange	

- Process of destruction of chlorophyll at high light intensity and oxygen is called as **photooxidation**.
- Only visible spectrum of light (400 nm-700 nm) is utilized by Plants in photosynthesis. Therefore it is called as **PAR (Photosynthetically active radiation)**.
- Pigments are organized in thylakoid membrane in the form of two photosystems-**photosystem I &II**.They are named so according to the order in which they have been discovered.
- Each photo system contains, a reaction centre (Chl a molecule only) and light harvesting complex(other pigment molecules).
- Reaction centre of PSI is called as P_{700} as it absorbs light at 700nm and PSII as P_{680} which absorbs light at 680nm.
- Graph plotted between amount of light absorbed by photosynthetic pigments and different wavelengths of



visible spectrum (white light) is called as **absorption spectrum.**.



- Graph plotted between rate of photosynthesis (measured by O_2 released) and different wavelength of visible spectrum is called as **action spectrum**.

Mechanism of Photosynthesis-

Photosynthesis occurs in two steps-

i. Light reaction or photochemical phase
ii. Dark reaction or biosynthetic phase.

Light Reaction-

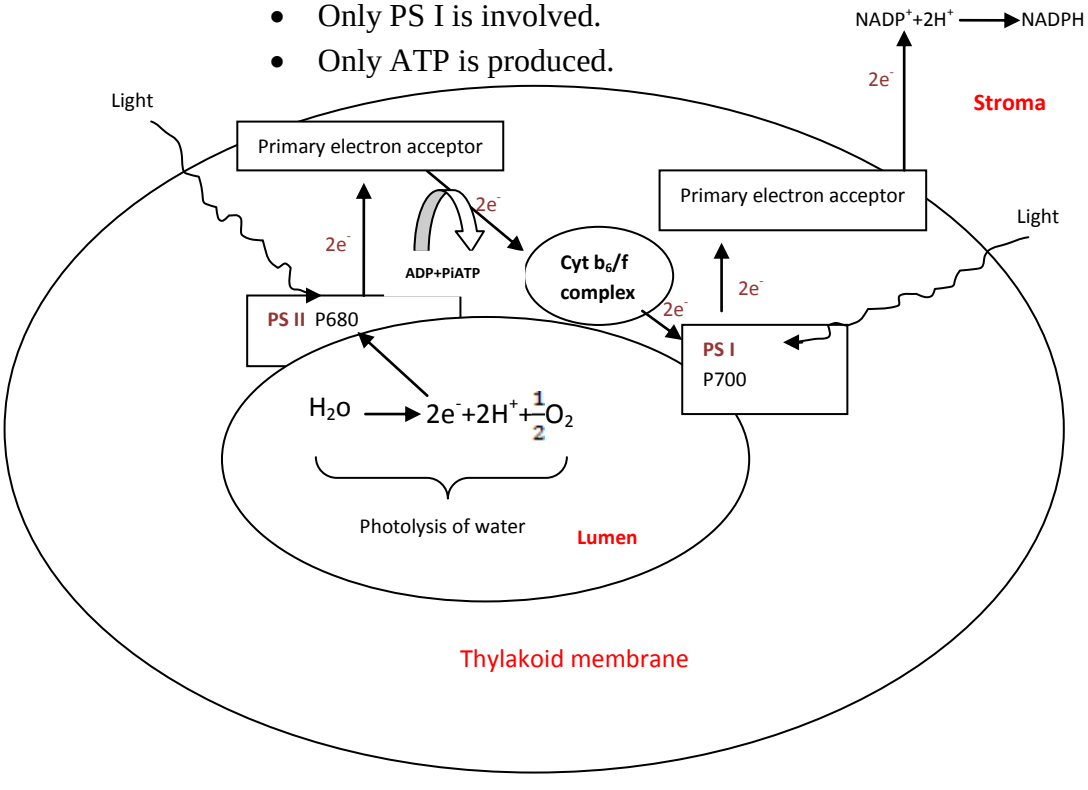
- Occurs in grana
- Directly depends on light, so also called as light dependent phase.
- Products of this step are-
  a. O_2 → released by photolysis of water (light induced splitting of water)
  b. ATP → synthesized by photophosphorylation.
  c. NADPH (Reduced Coenzyme, Nicotinamide dinucleotide phosphate)
- Synthesis of ATP molecules in chloroplast from ADP & inorganic phosphate (Pi) using light energy is called as **Photophosphorylation**. It is of two types-

a. Non-cyclic

- Occurs due to unidirectional/non-cyclic electron transport.
- Both PS II & PS I are involved.
- Products are ATP, NADPH & O_2.

b. Cyclic

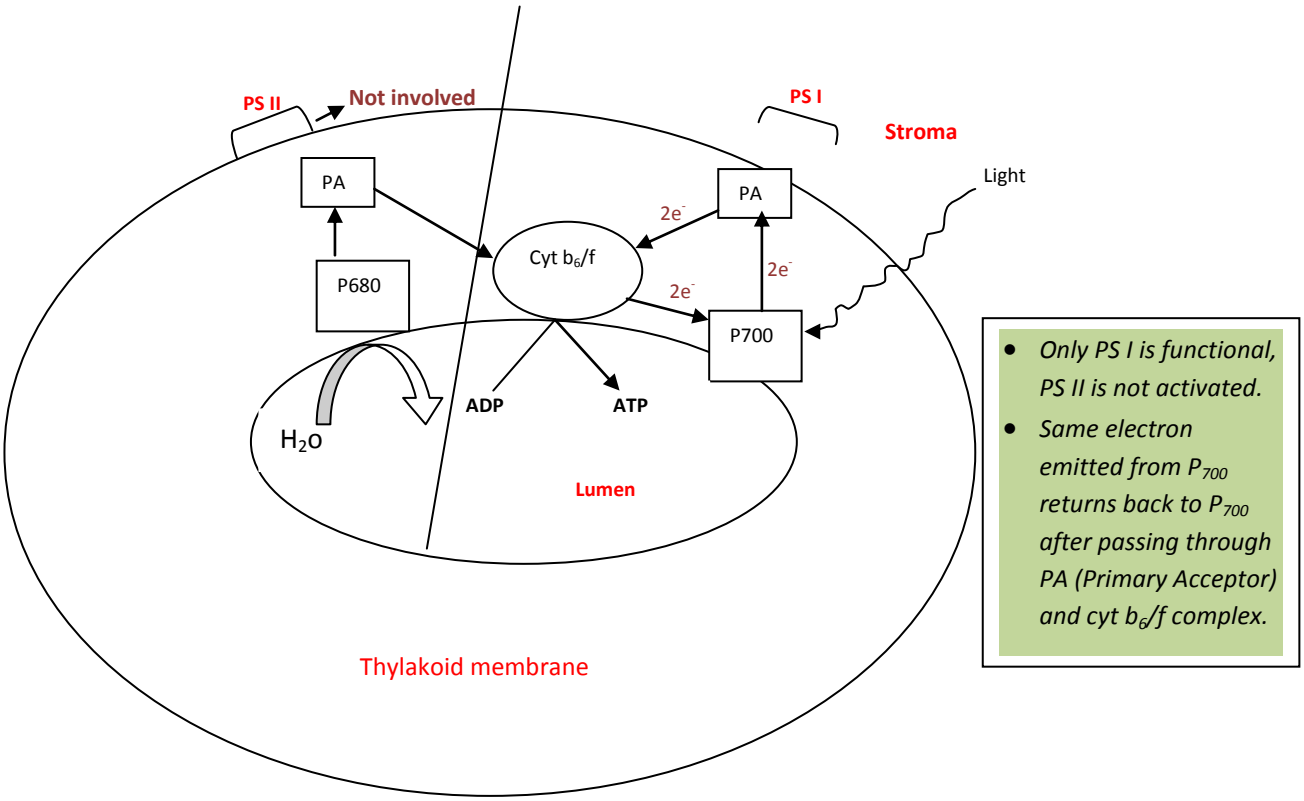
- Occurs due to cyclic electron transport (same electron returns back to reaction centre of PS I).
- Only PS I is involved.
- Only ATP is produced.



Z-Scheme of electron transport/ non cyclic

Unidirectional*- i. e.*

- *Both PSII & PSI illuminated to emit electron, accepted by their corresponding PA(primary acceptor).*
- *Loss of electron at P_{680} is replaced by electrons generated by splitting of H_2O & at P_{700} , by electron emitted from P_{680} (through PA, cyt b_6/f complex).*
- *Electron emitted from PS I is ultimately accepted by $NADP^+$ (Oxidized) and form NADPH (reduced) after taking H^+ released from photolysis of water.*



- *Only PS I is functional, PS II is not activated.*
- *Same electron emitted from P_{700} returns back to P_{700} after passing through PA (Primary Acceptor) and cyt b_6/f complex.*

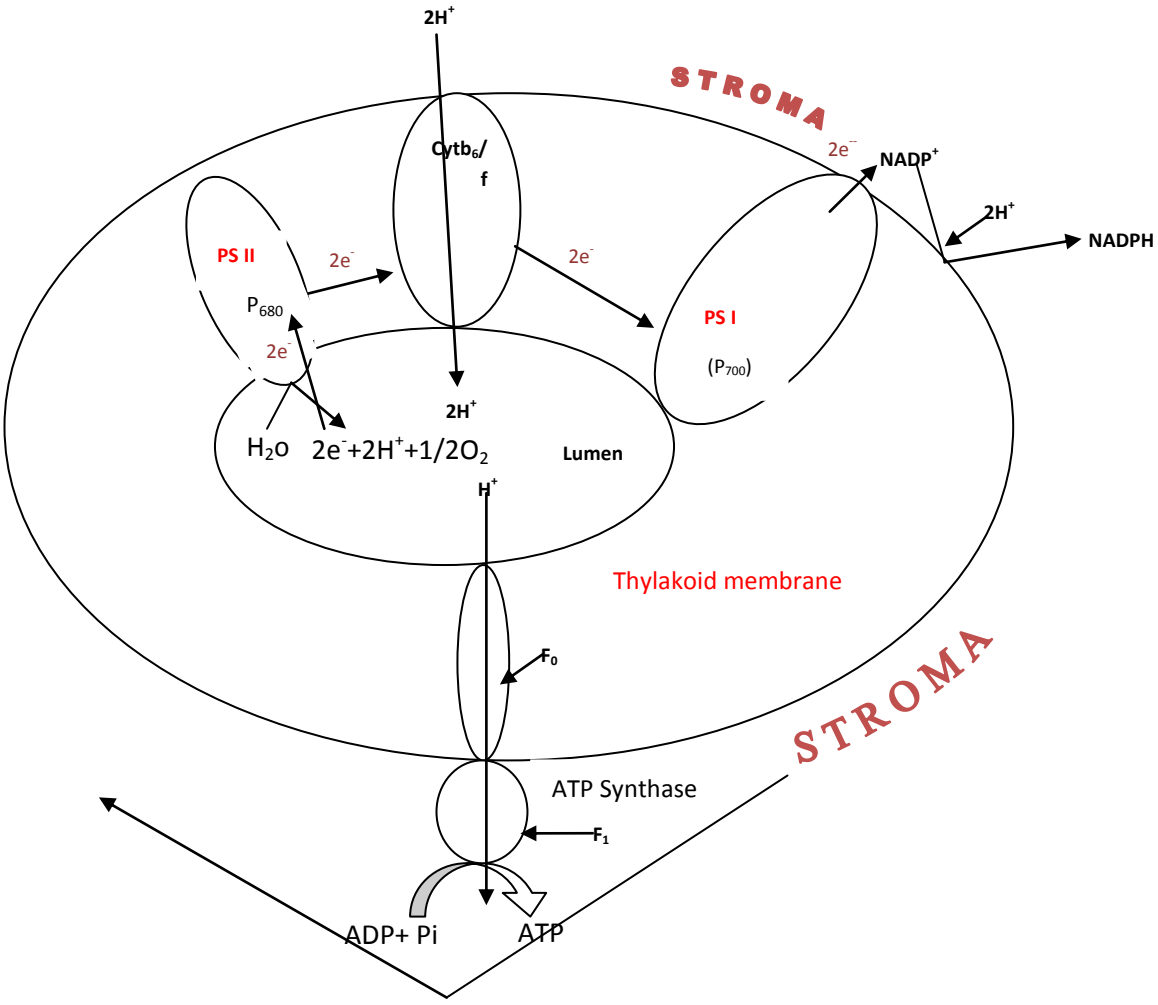
Cyclic electron transport

Chemiosmotic hypothesis:

(An explanation for mechanism of ATP synthesis due to electron transport during light reaction)

- Due to illumination of PS II & PSI simultaneously an electron is emitted both from P_{680}& P_{700} which is accepted by corresponding primary acceptors.
- Primary acceptor of P_{680}transfers their electrons to a hydrogen carrier which removes a proton from stroma and releases it into grana lumen with transfer of electron to P_{700}.

- Primary acceptor of P_{700} transfers electron to $NADP^+$ which takes proton from stroma (proton obtained from photolysis of water) and reduced to NADPH.
- Splitting of water molecule produces $2H^+ + 2e^- \& \frac{1}{2}O_2$ in lumen of thylakoid membrane, of which electron is transferred to P_{680} and proton accumulates in lumen.
- As a result proton in stroma decrease in number and in thylakoid lumen increase in number creating a proton gradient.
- When this gradient is broken down due to release of protons from thylakoid lumen to stroma through ATP synthase (F_0-F_1 particle), huge amount of energy is released.
- This energy is utilized in ATP synthesis from ADP & Pi.



Schematic representation of chemiosmotic hypothesis

Dark Reaction

- Occurs in stroma.

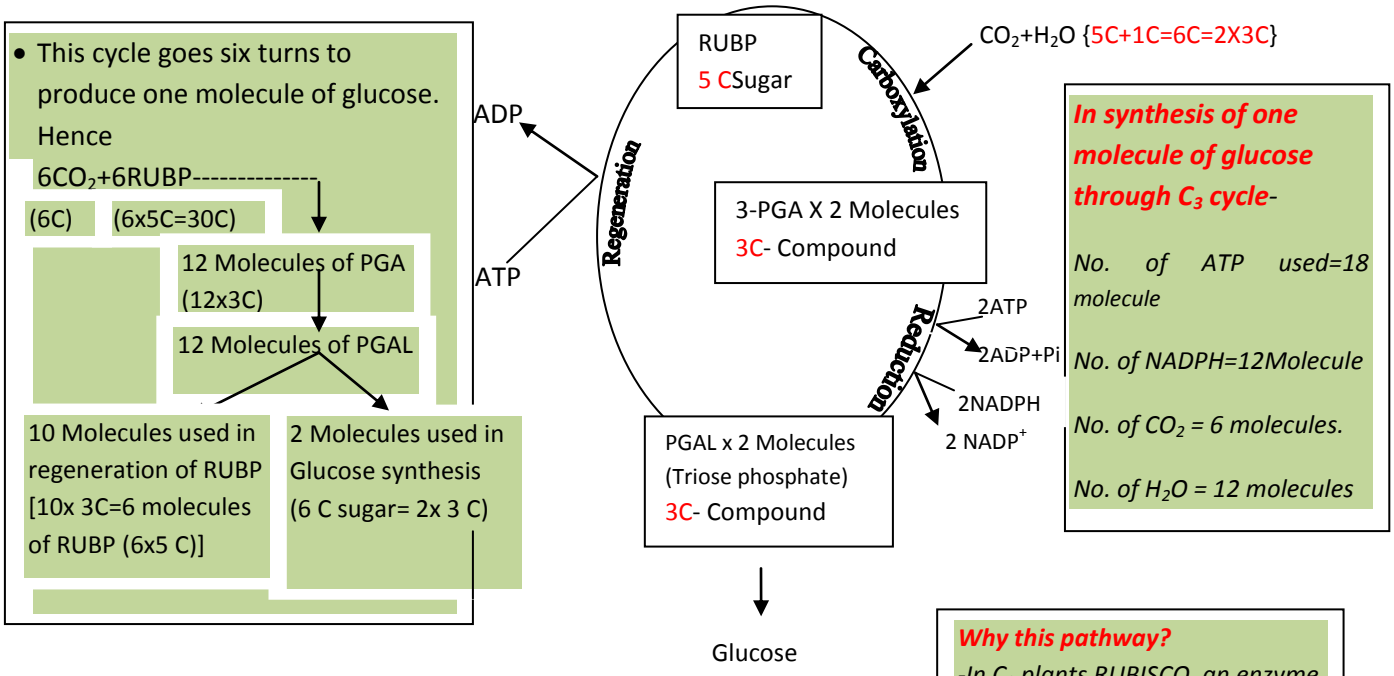
- Does not depend on light, hence called light independent phase.
- In this phase CO_2 fixation or reduction occurs to synthesize glucose, hence called biosynthetic phase.
- Products of light reaction (only ATP & NADPH) are utilized in this phase.
- There are two different pathways of CO_2 fixation occurring in different plants.

1. Calvin Cycle or C_3 Cycle

- Discovered by Melvin Calvin, hence called calvin cycle.
- First stable product is 3-carbon compound hence called C_3 cycle and plants having this pathway of CO_2 fixation are called as C_3 plants.
- It occurs in following three steps-
  a. **Carboxylation**, in which CO_2 combines with primary acceptor called RUBP (ribulose 1,5 bisphosphate) in the presence of enzyme RUBISCO (Ribulose, 1.5 bisphosphate carboxylase oxygenase) to produce two molecules of PGA (Phosphoglyceric acid).

  b. **Reduction**, in which 2 molecules of PGA get reduced to 2 molecules of PGAL (Phosphoglyceraldehyde, triose sugar) using 2ATP and 2 NADPH.

  c. **Regeneration**, in which again primary acceptor (RUBP) is synthesized from PGAL & ATP.



2. C_4 Cycle or Hatch & Slack Pathway-

- Discovered by Hatch & Slack, so called as Hatch &Slack Pathway.
- First stable product is 4- carbon compound (OxaloaceticAcid) hence called C_4-cycle and plants having this cycle are called as C_4 plants.
- C_4 plants have special kind of leaf anatomy called as "Kranz anatomy"

Why this pathway?

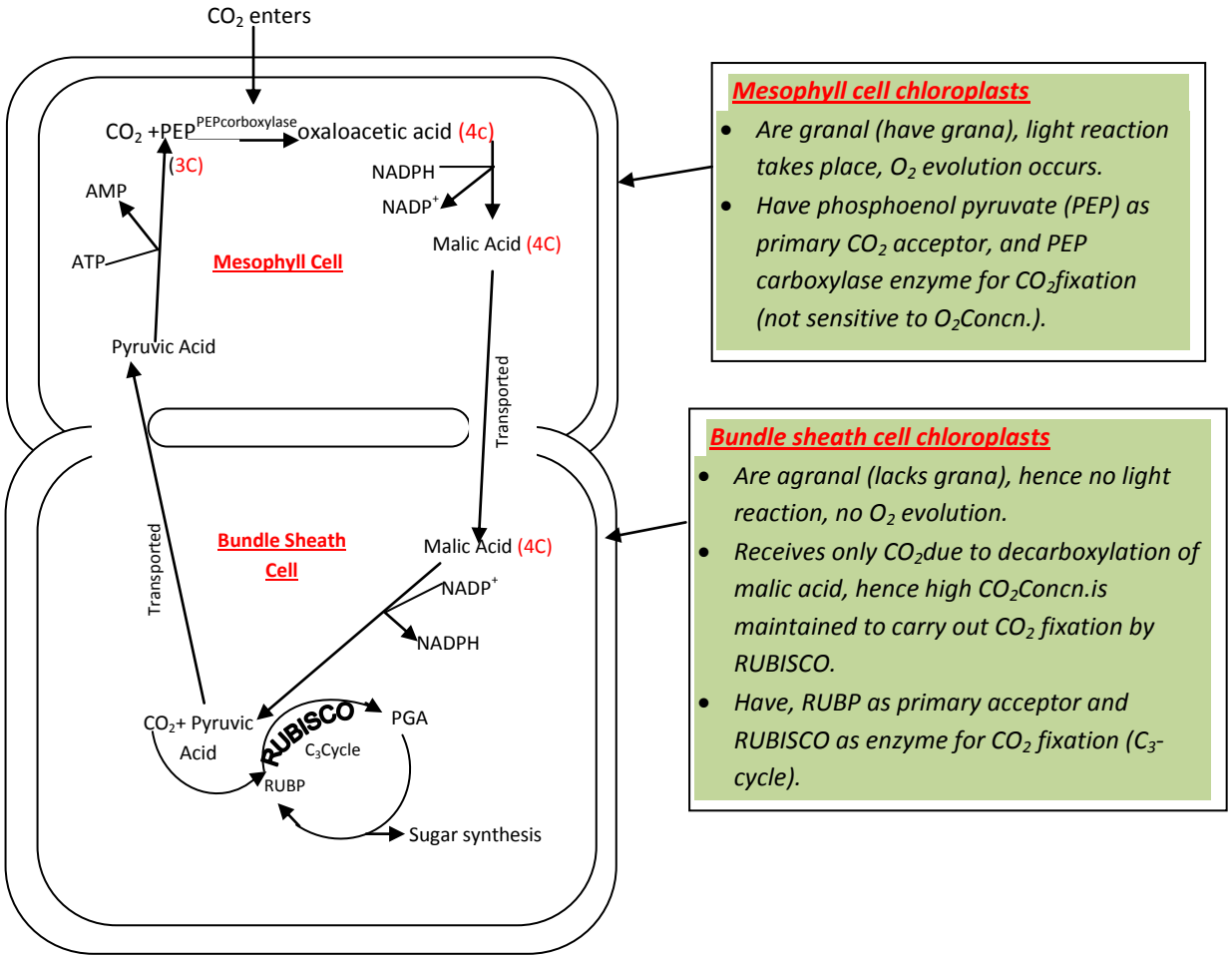
-In C_3 plants RUBISCO, an enzyme used in CO_2 fixation is very much sensitive to relativeConcn.Of CO_2& O_2 in the chloroplast.

-At higher CO_2Concn. behaves as carboxylase and at higher O_2Concn.behaves as oxygenase.

-Since light reaction releases O_2, hence itsConcn.risesup.Thus RUBISCO starts behaving as oxygenase and binds RUBPwith O_2 instead of CO_2 resulting in no synthesis of sugars.

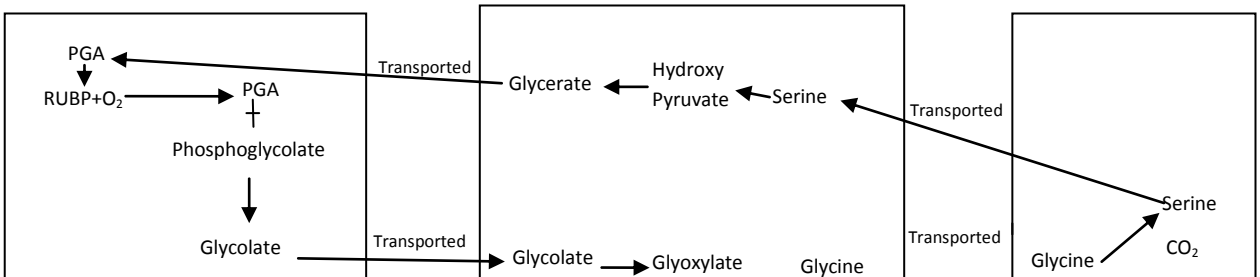
-To avoid this some plants evolved a new mechanism i. e. C_4

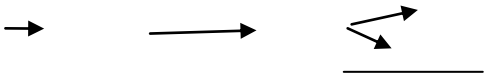
- (Presence of two types of photosynthetic cells, i.e. mesophyll cells and bundle sheaths cells).
- In C_4 plants (Maize, sugar cane etc.) both C_3 cycle (In bundle sheath cell chloroplasts) & C_4 cycle (In mesophyll cell chloroplasts) occurs.



Photorespiration

- Is a wasteful process that occurs in C_3 plants, as no synthesis of sugar ATP, NADPH takes place.
- At high temp. and high O_2 Concn., RUBISCO functions as oxygenase and catalyses the combination of O_2 and formation of one PGA & one phosphoglycolate molecules.
- In this process three cell organelles- chloroplast, peroxisomes and mitochondria are involved.





Chloroplast ***Peroxisome*** ***Mitochondria***

Factors Affecting photosynthesis

- According to Blackman's law of limiting factors "if a chemical process is affected by more than one factors, then the rate of the process will directly depend on the factor nearest to its minimal value".
- As photosynthesis is affected by number of internal (No., Size, and orientation of leaves, merophyll cells & chloroplasts etc.) and external factors (light, CO_2 Conc, temp., soil water etc.), it's rate will also directly depend on the factor nearest to its minimal value.
- Light intensity and quality affect rate of photosynthesis. Light of wavelengths 400nm-700nm is effective for photosynthesis. With increase in light intensity, rate of photosynthesis increases, but at higher light intensity rate decreases either due to the destruction of chlorophyll or due to other factors that becomes limiting.
- Only dark reaction is affected by temperature as it is enzyme catalysed reaction and enzymes remain inactive at low temp. while become denatured at high temperatures.
- Rate of photosynthesis increases with increase in CO_2Concn. upto a certain limit (upto 500 µl/L in C_3& 360 µl/L in C_4 plants).
- Lower availability of soil water causes stomatal closure causing decreased supply of CO_2, hence decrease in photosynthesis.

SOME IMPORTANT QUESTIONS:

1. Explain Chemiosmotic hypothesis.
2. Distinguish between cyclic and non cyclic photo phosphorylation.
3. Why photo respiration is considered as a wasteful process?
4. Write a short note on Kranz anatomy.

Chapter-14

Respiration in Plants

- Respiration is a biochemical process involving breakdown of C-C bonds of complex organic molecules by oxidation leading to step wise release of energy in the cells. It is called as cellular respiration, because the site of respiration is cell.
- Steps of respiration is common in all eucakaryotic cell, whether plants or animals.
- The substrate that undergoes oxidation in the process of respiration is called as respiratory substrate. It may be carbohydrate, protein, fat or organic acid.

Difference between Respiration in plants and animals

- *Only the difference lies in mechanism of gaseous exchange, which is called as breathing (in animals) because of involvement of some specialized organs/cells.*
- *Plants do not have any specialized organ for gaseous exchange, rather this function is performed in them by stomata & lenticels.*

Why plants can get along without respiratory organs?

- *Because, each part of plants can fulfill their need of gaseous exchange & very little transfer of gases occur.*
- *Rate of respiration in root, stem, leaves is very low, hence no great demands for gas exchange.*
- *Plant cells are located quite close to surface, so no much distance for diffusion of gases.*

Types of respiration-

- May be aerobic (molecular oxygen is required) or anaerobic (molecular oxygen is not required).

Mechanism of respiration-

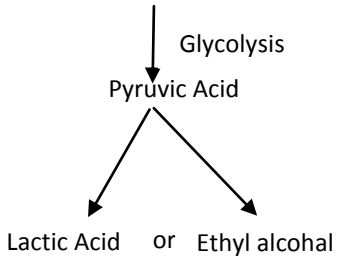
- Both anaerobic and aerobic respiration starts with Glycolysis.
- **In anaerobic (In cytoplasm of cell)**

  Glucose

In aerobic

Glucose

Glycolysis



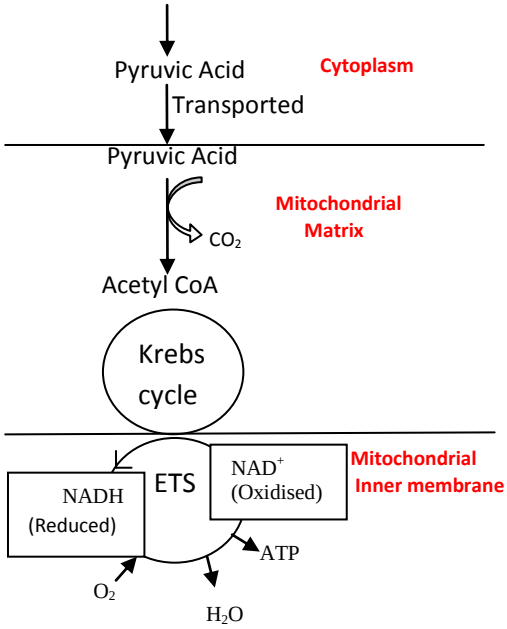
- It is incomplete oxidation and end products are lactic acid or ethyl alcohol & CO_2, and 2 ATP molecules from one molecule of glucose.

Equation-

$C_6H_{12}O_6 \longrightarrow$ Ethyl Alcohal+CO_2+Energy

OR

$C_6H_{12}O_6 \longrightarrow$ Lactic acid + Energy



It is complete oxidation and end products are CO_2,H_2O and 36 ATP molecules from one glucose molecule.

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

Glycolysis-

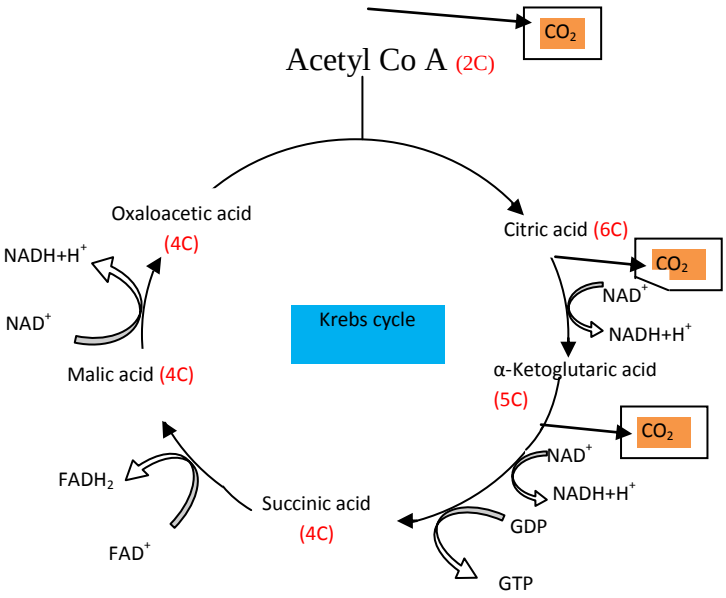
Glucose (6C)
↓ ATP → ADP
G-6-PO_4 (6C)
↓
Fructose-6-PO_4
↓ ATP → ADP
Fructose 1,6- bisphoshate (6C)
↓
Dihydroxyacetone Phosphate (3C) ⇄ 3-phosphoglyceraldehyde (3C)
↓ NAD^+ → NADH
1,3 bisphosphoglycerate
↓ ADP → ATP
3-Phosphosphoglycerate
↓
2-Phosphoglycerate
↓
Phosphoenol pyruvate
↓ ADP → ATP
Pyruvic Acid (3C)

- *Occurs in cytoplasm.*
- *1 molecule of glucose at the end of this step produces-*
  - *2 molecules of Pyruvic Acid (3C)*
  - *2 molecules of NADH+H^+*
  - *4 molecules of ATP, out of which 2 molecules are consumed during the process, so net gain is only 2 molecules of ATP.*
  - *In anaerobic respiration pyruvic acid receives hydrogen from NADH and forms lactic acid (in human striated muscles, bacteria) or ethyl alcohol & CO_2 (called as fermentation. Ex. in yeast).*
  - *In aerobic respiration, pyruvic acid is transported into mitochondria to enter into Krebs cycle.*

Krebs cycle-

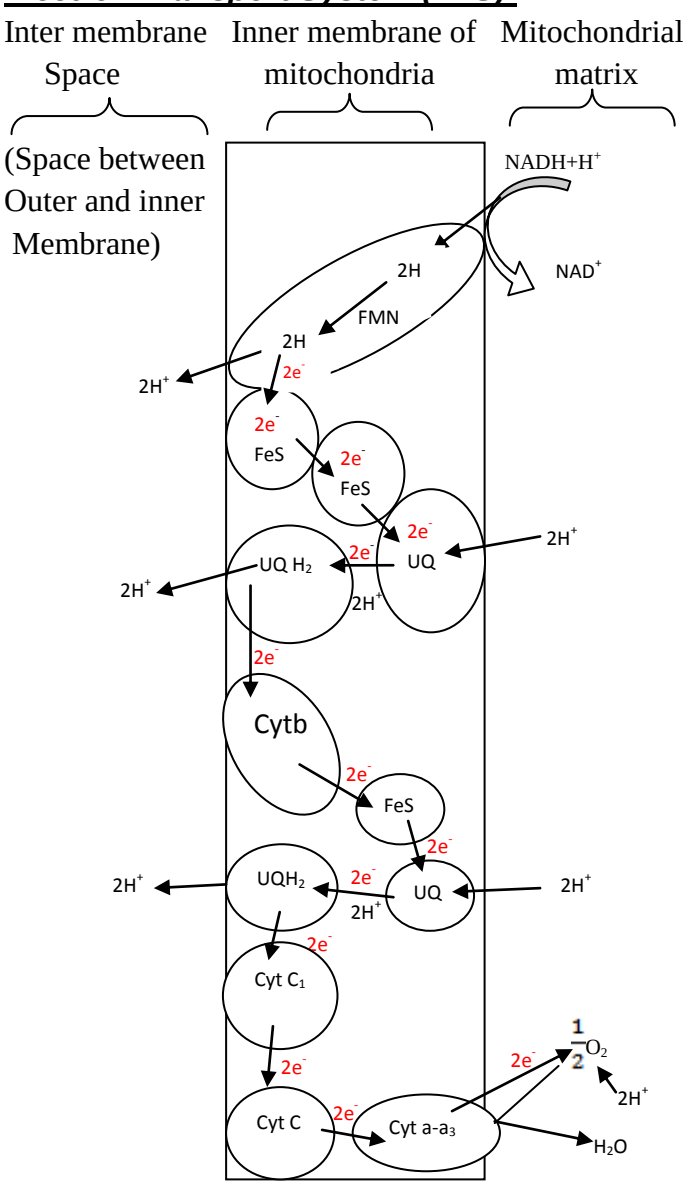
Co A
Pyruvate (3C)
NAD^+ → $NADH+H^+$

- *Occurs in mitochondrial matrix.*
- *Called as Krebs cycle, because it was discovered*



From 1 molecule of Pyruvic acid

Electron Transport System (ETS)-



- *All NADH+H$^+$ Produced during Glycolysis & Krebs cycle is oxidized by NADH-dehydrogenase and electrons are transported to Ubiquinone(UQ)via FMN.*
- *In ETS, , Molecular Oxygen (O_2)acts as terminal electron acceptor.*
- *Electrons from NADH+H$^+$ is transported through FMN, UQ (Hydrogen Carrier, Cytochromes(b,C_1,C,a-a_3) and finally to O_2 which takes 2H$^+$ from matrix and form H_2O.*
- *During transport of electron, proton (H$^+$) is pumped by UQ to inter membrane space from matrix causing formation of proton gradient (due to increase in protons in inter membrane space and decrease in matrix).*
- *Breaking of this gradient and return of these protons(H$^+$)through ATP synthase/ F_o-F_1 particle/ oxysomes located in inner membrane cause synthesis of ATP.*
- *Since oxidation of NADH+H$^+$ is the cause of formation of proton gradient and ATP synthesis thereupon, so this method of ATP synthesis is called as oxidative phosphorylation.*
- *Return of 2H$^+$ from inter membrane space to matrix through ATP synthase release sufficient energy to synthesise one ATP molecule.*
- *On oxidation of 1 molecule of NADH+H$^+$ pumps 6H$^+$, therefore it produces 3 ATP molecules while oxidation of $FADH_2$ pumps only 4H$^+$, so it produces 2 ATP molecules.*

Net Gain of ATP

- After complete oxidation of 1 molecule of glucose-

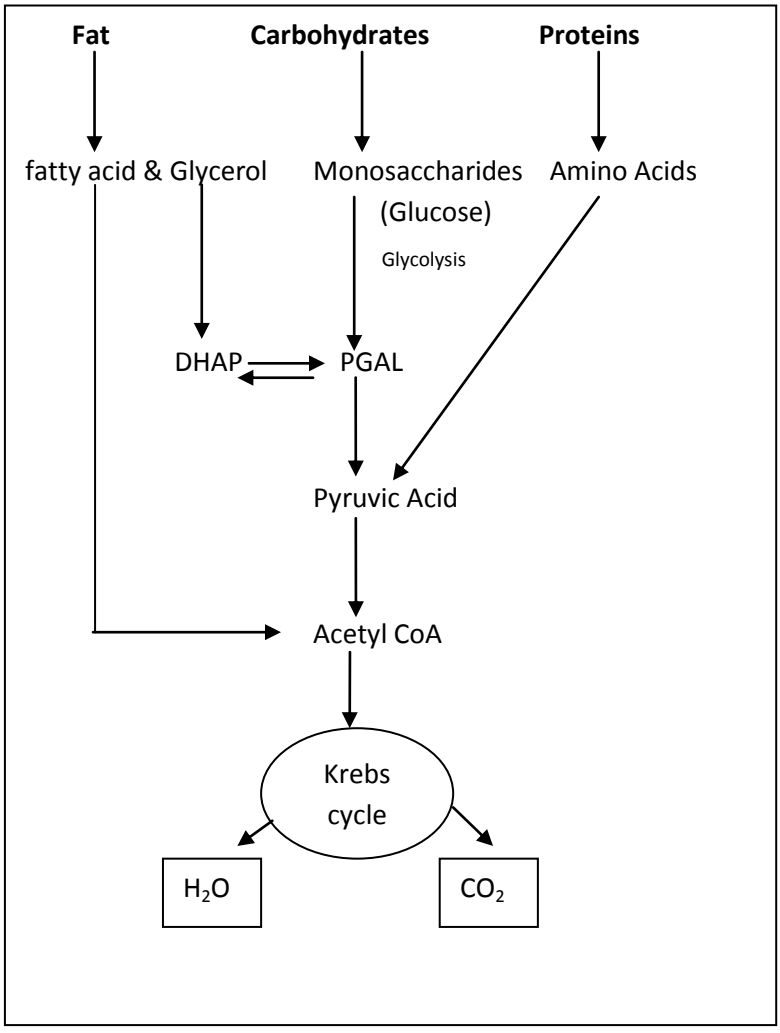
1. **Glycolysis**- → 2ATP = 2ATP
   → $2NADH+H^+$ (2x3 ATP) = 6ATP

2. **Pyruvic Acid to Acetyl CoA**- → $2\ NADH+H^+$ (2x 3ATP)= 6 ATP
3. **Krebs Cycle**- → 2GTP= 2ATP
   → $6NADH+H^+$ (6x3ATP) = 18 ATP
   → $2FADH_2$ (2 x 2 ATP)= 4ATP

Total=38 ATP

- So, Complete Oxidation of 1 molecule of glucose produces molecules 38ATP molecules.
- In eucaryotes 2ATP is consumed in transportation of $NADH+H^+$ from cytoplasm (Produced in Glycolysis) to mitochondria for oxidation. Hence the net gain is 36ATP molecules.

Break Down of different respiratory substrates-



- *Respiratory pathway is called as amphibolic pathway because it involves break down of respiratory substrate (catabolic) to release energy as well as also contribute to synthesis of other compounds (anabolic) by providing carbon skeletons.*
- *Respiratory quotient(RQ) is ratio of the volume of CO_2 evolved to the volume of O_2 consumed in respiration.*

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

- *RQ of different respiratory substrates are-*
  - *Carbohydrate=1*
  - *Fat= less than 1*
  - *Protein=less than 1*
  - *Organic acids=more than 1*
- *RQ in case of anaerobic respiration is infinite as no oxygen is consumed.*

SOME IMPORTANT QUESTIONS:

1. Define Glycolysis. Where does it takes place? Write various steps of Glycolysis.

2. Give schematic representation of Kreb's Cycle.

3. Define RQ. Calculate the Value of RQ when Respiratory substrate is: Carbohydrate, organic acid.

Chapter-15

Plant Growth and Development

- An irreversible permanent increase in size of an organ/parts/cell is called as growth.
- Plant growth is indeterminate i. e. capable to unlimited growth throughout life, because of presence of meristems at certain locations in their body.
- Form of growth where new cells are always being added to the plant body by the activity of meristem is called as open form of growth.
- In plants apical meristem is responsible for primary growth (increase in height) and lateral meristems for secondary growth (increase in thickness).

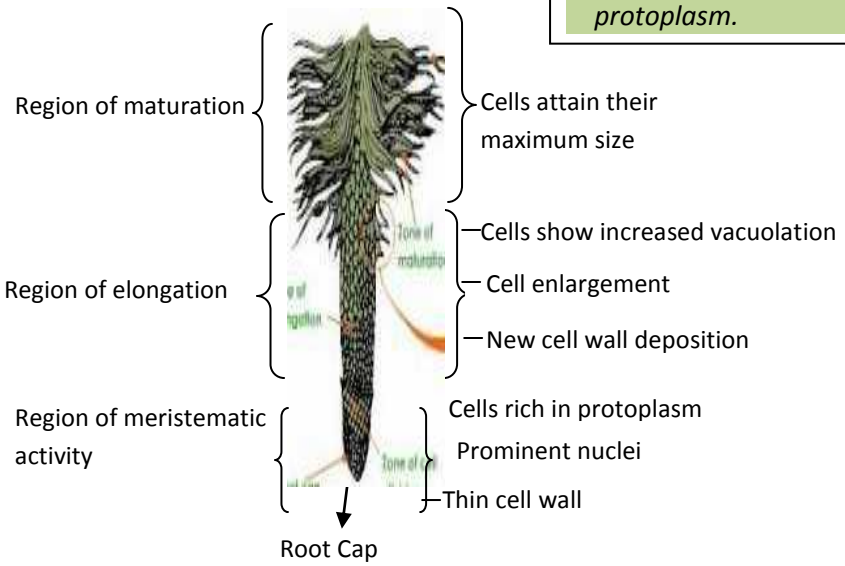
Phases of Growth-

Three phases of growth

i. Meristematic
ii. Elongation
iii. Maturation

Growth is measured as-

- *Increase in*
  - *Fresh weight*
  - *Dry weight*
  - *Length or area*
  - *Volume/Size*
  - *Cell number*
- *At cellular level, growth is mainly due to increase in protoplasm.*



Conditions for growth-

Following are essential elements for growth-

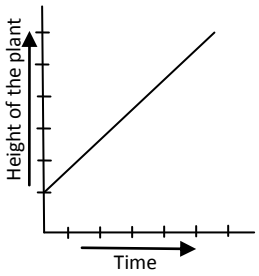
- *Water for cell enlargement(causes increase in size) and as medium for enzymatic activities.*
- *Oxygen for release of metabolic energy.*
- *Nutrients for synthesis of protoplasm & source of energy.*
- *Optimum temperature*

Growth Rate-

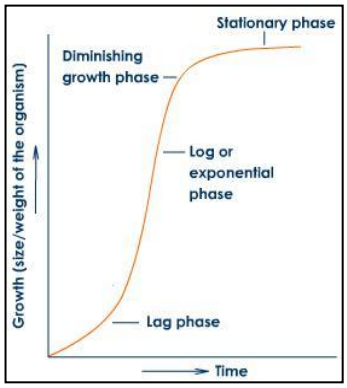
- Increase in growth per unit time is called as growth rate.
- It may be-

i. <u>Arithmatic growth (2,4,6,8,10 etc.)</u>

- If one of the daughter cells formed by mitosis continues to divide while other undergoes differentiation and maturation.
- Growth curve plotted is linear.



ii. Geometric Growth (4, 8, 16, 32, etc.)



- Also called as exponential growth and have three phases- initial slow (lag phase), increases rapidly (exponential/log phase) and then slows down (stationary phase).
- Growth curve plotted is S-shaped called sigmoid curve. This curve is characteristics of living organisms growing in natural environment.

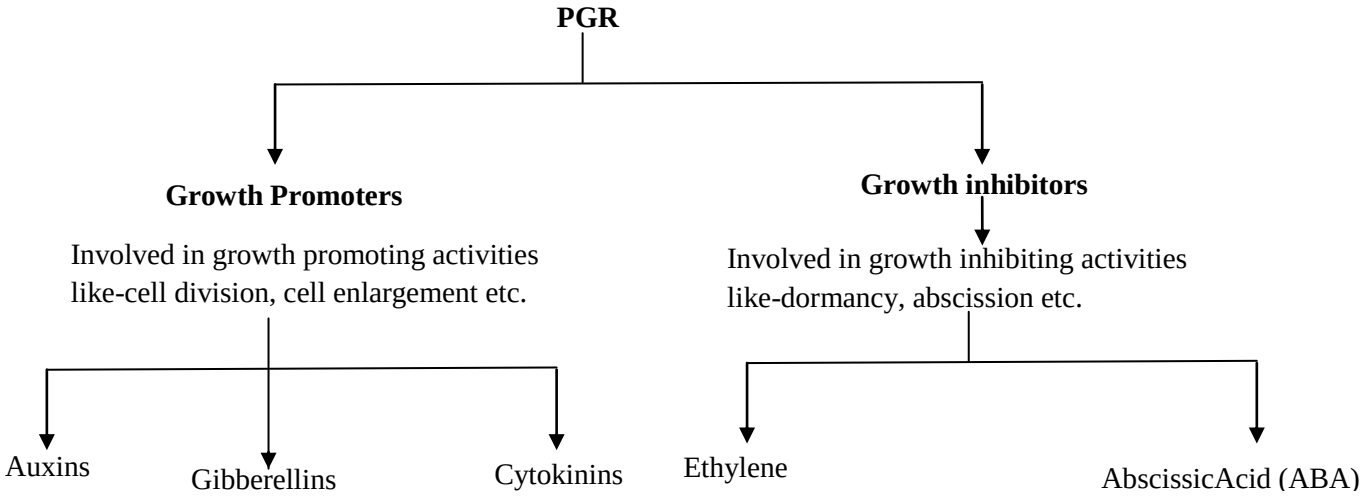
Development-

- Sum of growth and differentiation is called as development.
- Includes all changes that an organism undergoes throughout life from seed germination to senescence.
- Development in plants is under control of intrinsic and extrinsic factors. Intrinsic factors include both intracellular (genetic) or intercellular factors (plant growth regulators). Extrinsic factors include light, temperature, water, oxygen, nutrition etc.

Plant Growth Regulators (PGR)

- Small, simple molecules secreted in very small quantities which influence physiological functions in plants are called as plant growth regulators or plant hormones or phytohormones.

Type of Plant Growth Regulators



Growth Promoters-

Name of Hormone	Physiological Effects	Application/Uses

1. ***Auxin-*** • ***first isolated from human urine.*** • ***IAA, IBA are natural auxins isolated from plants.*** • ***NAA, 2, 4-D are synthetic auxins.***	• *Cause apical dominance.* • *Prevent premature fall of leaves, flowers, fruits etc.*	• *Initiate rooting in stem cuttings.* • *Promote flowering in pineapple.* • *Induce parthenocarpy in tomatoes.* • *2, 4-D used as weedicide.*
2. ***Gibberellins-*** ***All are acidic, hence also called Gibberellic acid.***	• *Bolting and flowering in rosette plants.* • *Cause elongation of internodes.* • *Break seed dormancy.* • Can elongate genetically dwarf plants.	• *Increase the length of grape stalks.* • *Delay senescence, hence fruit can be left on trees for longer period.* • *Increases lengths of internodes in sugarcane, thereby increases yield.*
3. ***Cytokinins***	• *Cause growth of lateral buds and overcome apical dominance.* • *Promote production of new leaves, and chloroplasts in leaves.* • *Promote adventitious shoot formation*	• *Used to delay leaf senescence.*

Growth Inhibitors –

Name of Hormone	Physiological Effects	Application/Uses
1. ***Abscissic Acid (ABA)*** • ***Also called as stress hormone, because increases tolerance of plants to various stresses.***	• *Reduces seed dormancy* • *Stimulates closure of stomata under water stress conditions.* • *Stimulates formation of abscission layer and abscission of leaves, flowers and fruits.*	• *Prolongs dormancy of seed for storage.*
2. ***Ethylene*** • ***Only gaseous hormone.*** • ***Also called as fruit ripening hormone, because hastens ripening of fruits.***	• *Promotes horizontal growth of seedlings.* • *Induces apical hook formation in dicot seedlings.* • *Promotes senescence and abscission of leaves and flowers.* • *Promotes root growth and root hair formation.*	• *It hastens fruits ripening in tomato and apple.* • *Promotes production of female flowers on a monoecious plant.*

Photoperiodism –

- Phenomenon in which the plants respond to relative length of day and night to which they are exposed for flowering is called as photoperiodism.
- Site of perception of light for photoperiodism is the leaf where a pigment called phytochrome perceives the light stimulus.

- It has been hypothesized that after exposure of plants to inductive conditions, florigen (a hormonal substance) is synthesized which migrates from leaves to shoot apices for inducing flowering.
- Based upon the duration of light required for photoperiodic responses plants can be categorized as--

Plants

Long day Plants (LDPs)

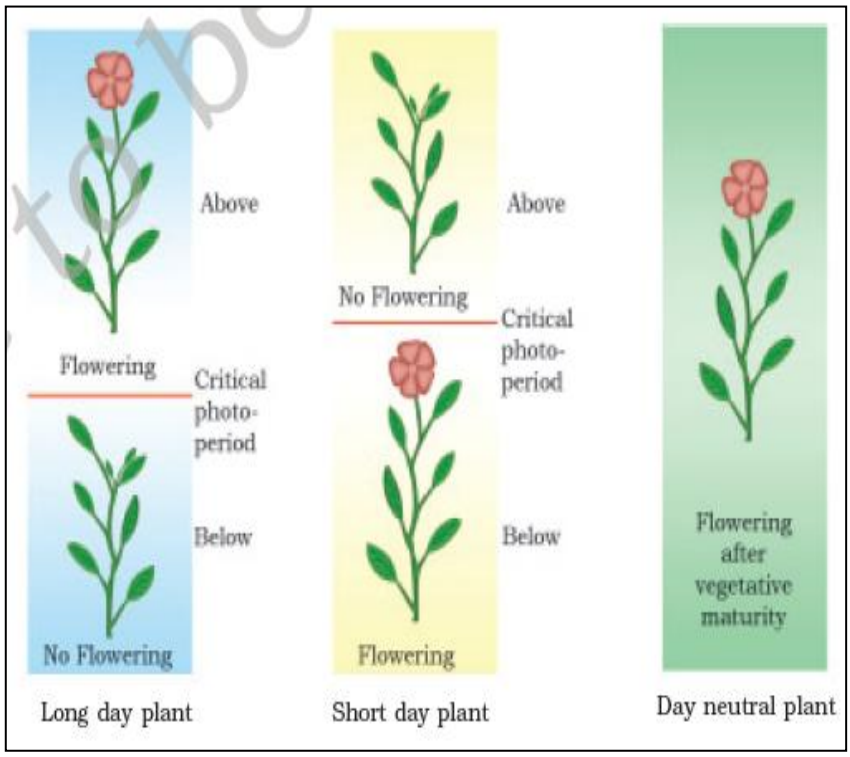
Requires exposure of light more than critical duration
Ex. Radish, sugar beet.

Short Day Plants(SDPs)

Requires exposure of light less than critical duration.
Ex- Tobacco, Chrysanthemum

Day Neutral Plants (DNPs)

Flowering not influenced by duration of light.
Ex. Tomato, Cotton etc.



- Phenomena in which the apical bud suppresses the growth of lateral buds is called as **apical dominance.**
- Sudden elongation of the internodes just prior to flowering is called as **bolting**.
- Low temperature treatment given to the seeds/seedlings to induce early flowering is called as **vernalisation**.

SOME IMPORTANT QUESTIONS:

1. Distinguish between arithmetic and geometric growth.
2. Write any four physiological effects of Auxins.
3. Which plant hormone is known as stress hormone and why?

Chapter-16

Digestion and Absorption

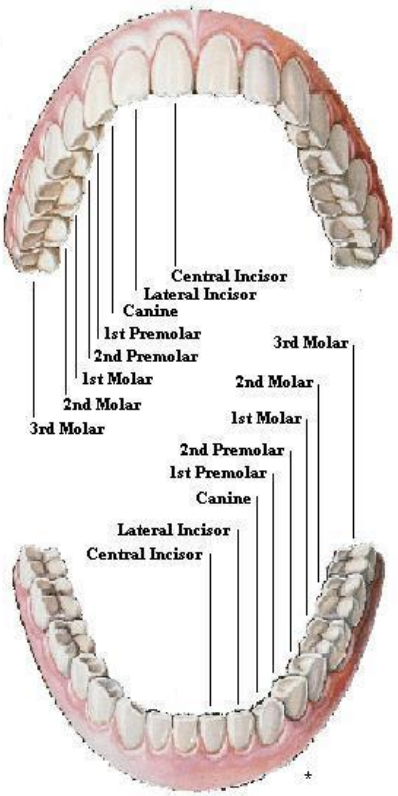
Holozoic nutrition – When whole plants/ their parts and whole animals/their parts or both are consumed either in solid or liquid form through mouth- eg. most animals.

Digestion – Break down of complex, non-absorbable food substances into simple, absorbable form by hydrolysis of bonds by digestive enzymes (hydrolases).

Alimentary canal – Tubular structure from mouth to anus (6-9 meters long).

Bucco - Pharyngeal Cavity – Space bounded dorsally by skull and ventrally by throat. Has three parts –

- **Vestibule** - space bounded by lips and cheeks and gums and teeth.
- **Buccal / oral cavity –** surrounded by upper jaw (fixed) and lower jaw (movable).
  - **Tongue –** Musculo-sensory, protrusible organ, an organ of taste, helps in chewing, swallowing and speech.
  - **Teeth –** masticating organ, used for cutting, chewing and grinding.



HETERODONT DENTITION

- **Thecodont –** Teeth embedded in sockets of jaw bones (of mandible – lower jaw and maxilla- upper jaw).

- **Diphyodont** - two sets of teeth that develop during life time - milk /temporary/ deciduous teeth (start erupting after six months of birth and appear between six to twenty four months). Get replaced by a set of permanent or adult teeth, (28 teeth erupt between 6 to 14 years while dentition is complete by 24 years of age).

- **Heterodont –** Presence of **different types (four)** of teeth in permanent set i.e. **– incisors** , **canines** , **premolars** and **molars.**

Formula showing the number and arrangement of teeth in one half of each jaw in the order I, C,PM, M, is called dental formula (I,C,PM and M denote *incisors*, *canines*, *premolars* and *molars*, respectively).

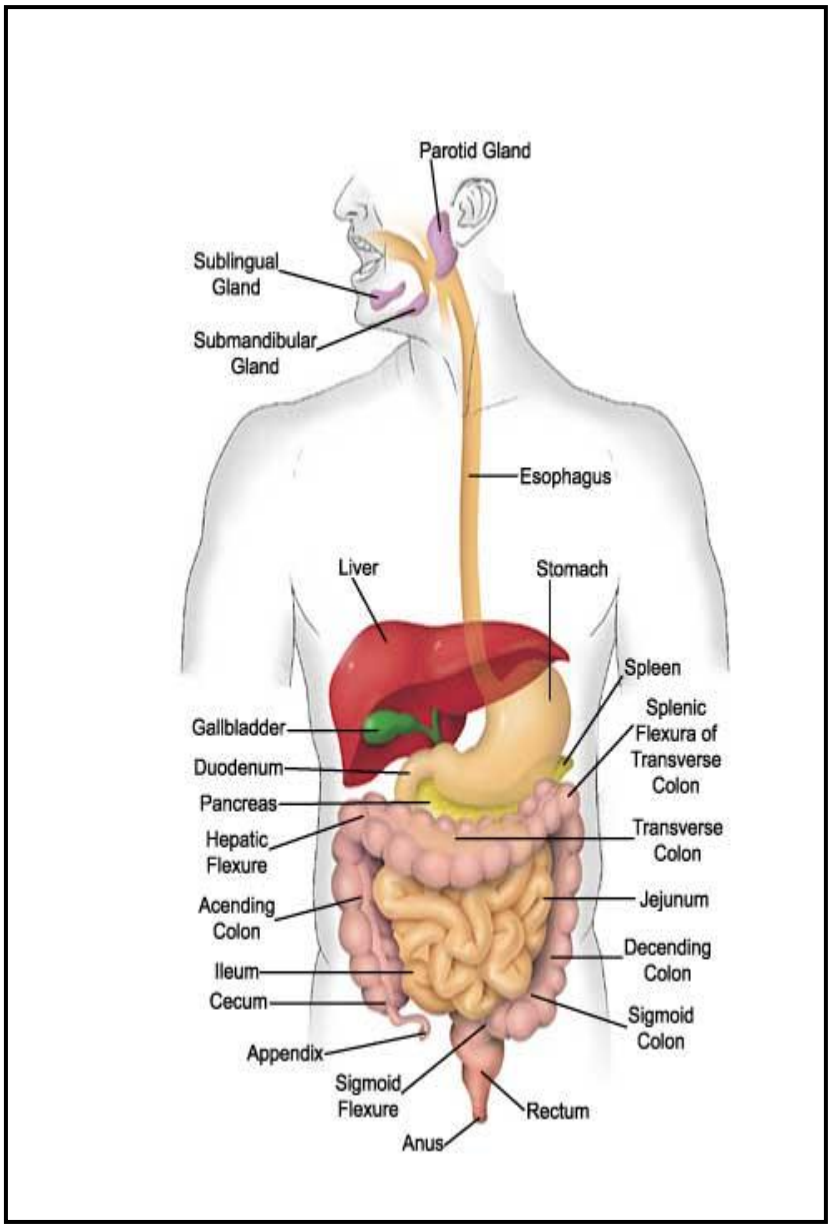
Dental formula of milk teeth – I 2/2, C 1/1, PM 0/0, M 2/2 or 2102/2102 =20. Premolars and last molar absent. Grow twice during life time-Diphyodont.

Dental formula of adult human is : I 2/2, C 1/1, PM 2/2, M 3/3 or 2123/2123= 32 (12 teeth appear only once – Monophyodont – 0021/0021)

- **Pharynx -** Serves as a common passage for food and air.

Nasopharynx – Lies behind the nasal chambers.

Oropharynx – lies behind the buccal cavity and is the passage for food bolus.



Laryngopharynx – lowest part of phary nx.

Laryngopharynx - has two apertures – anterior slit – like **glottis** (leads into trachea/ wind pipe, bears a cartilaginous flap – epiglottis, which covers the glottis to prevent the entry of food into it, during swallowing) and **posterior gullet** (leads into oesophagus / food pipe).

Funct ion- serves as passa ge for the food from the oral cavity to the oesophagus.

- **Oesophagus** - 22-25 cm narrow, muscular tube, extends posteriorly and carries food into stomach by peristalsis.
- **Stomach** –is a wide, 'J' shaped, bag like, distensible, muscular sac.

Function – food reservoir and mechanical churning and subsequent digestion of food.

- **Small intestine** – narrow tube, longest part (6 mts in an living adult), has 3 parts –

Duodenum – 'U' shaped, widest, shortest part (25 cm), receives hepato - pancreatic duct{joint duct from liver (hepato) and pancreas}.

Jejunum – Long , coiled, middle part.

Ileum - Longest part , highly coiled, opens into large intestine.

Functions – Completion of digestion, absorption of digested food.

- **Large intestine** – shorter (1.5 meters) and wider than small intestine, has 3 parts –

Caecum –A small blind sac coming off the colon at the latter's junction with the ileum.

Vermiform appendix –A short (8 cm), slender, worm – like projection in caecum (vestigial organ in humans).

Colon – Long, sacculated, has 4 regions – ascending colon, transverse colon, descending colon, sigmoid colon.

Rectum – Leads into an anal canal which opens out at the anus guarded by two anal sphincters.

Digestion of food

- Starts in the oral cavity in humans, continues in the stomach and is completed in small intestine.

Buccal cavity

- Salivary glands

– secrete salivary juice/ saliva into the buccal cavity and salivary amylase or ptyalin (pH= 6.8) and lysozyme (kills bacteria).

- Mucus in saliva lubricates and adheres masticated food particles into a bolus which is swallowed and conveyed through pharynx and oesophagus by successive waves of muscular contractions (**peristalsis**) into the stomach.

Mucus and bicarbonates in gastric juice – lubricate the food and protect mucosal epithelium from excoriation by highly concentrated HCl.

Functions of HCl – to convert inactive enzymes into active enzymes, destroys bacteria in food, stops action of saliva on food.

Stomach

– Gastric glands –secrete acidic gastric juice (pH= 1.8) from 3 types of gland cells:

1) Oxyntic cells / parietal cells – secrete hydrochloric acid which kills microbes and provide acidic medium for activation of pepsin enzyme.
2) Chief cells/ peptic cells / zymogen cells – secrete gastric enzymes as proenzymes – pepsinogen, prorennin.
3) Mucous cells / Goblet cells – secrete mucus.

- Stomach stores food for 4-5 hours and mixes the food thoroughly with acidic gastric juice by churning movements of its muscular wall and is called chyme.

Small intestine

– Chyme gets mixed with three digestive juices which function in alkaline medium. – 1) Bile (from liver), 2) Pancreatic juice (from pancreas), 3) Intestinal juice (from intestine).

- **Liver** – largest gland in our body, weighing 1.2-1.5 kg in an adult human, located in upper right side of abdominal cavity just below the diaphragm, dark red and spongy.

Gall bladder- A thin walled muscular, situated below right lobe of liver. Bile juice is temporarily stored in Gall Bladder.

Bile – yellowish green, alkaline fluid containing bile salts (help in emulsification of fat), sodium bicarbonate, glycocholate, taurocholate, bile pigments (bilirubin and biliverdin), cholesterol, phospholipids etc. **Bile juice does not contain any enzyme**, yet essential for digestion because of its ability to emulsify fats.

- **Pancreas** - is an elongated, compound (having both endocrine and exocrine parts) gland situated between the limbs of the 'U' shaped duodenum.
  Acini - Exocrine part. Secrete an alkaline pancreatic juice containing sodium bicarbonate, proenzymes: trypsinogen, chymotrypsinogen and procarboxypeptidases, and other enzymes like – pancreatic amylase, pancreatic lipase and nucleases.

  Islets of Langerhans - Endocrine part. Secretes hormones – insulin and glucagon.

- **Intestinal glands** – numerous, microscopic glands present in the mucosa of small intestine. Two types – **crypts of Lieberkuhn and Brunner's glands**.

- **Intestinal juice/succus entericus (pH = 8.3) -** Mixture of secretions of crypts of Lieberkuhn – secrete enzymes (aminopeptidases, dipeptidases, intestinal amylase, maltase, sucrase, lactase, intestinal lipase, nucleotidases, nucleosidases and enteropeptidases/ enterokinase etc.) and mucus. Brunner's glands – secrete alkaline watery fluid and mucus.
- **Mucus glands** – Mucosal epithelium of entire digestive tract has goblet cells which produce mucus (lubricates food and digestive tract, protects underlying cells from digestive enzymes).

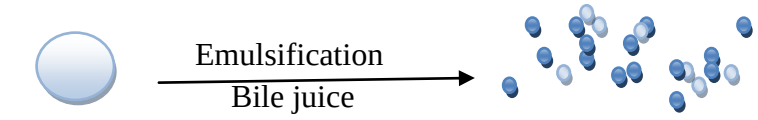
Duodenum – receives bile juice and pancreatic juice, creates alkaline medium for the activity of pancreatic enzymes.

Large intestine – Though no digestion takes place in large intestine but absorption of water & formation of faeces occurs here.

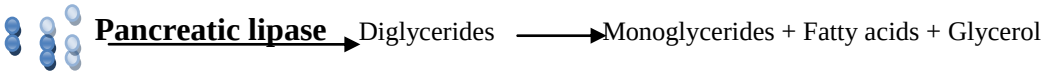
Digestion of fat –

Action of bile –

Emulsification of fats- Breaking of large fat droplets into many small droplets which provides larger surface area for lipase activity.



Action of Pancreatic lipase- principal fat digesting enzyme and digests emulsified fats in stages.



SUMMARY OF DIGESTION

Part of alimentary tract	Name of glands	Enzyme	Optimum pH	Substrate acted upon	End products
Buccal cavity	**Salivary glands**	**Salivary amylase (Ptyalin)**	**6.8**	**Starch**	**Maltose**
Oesophagus	-	**No Enzyme**	-	-	-
Stomach	**Gastric glands**	**1) Pepsin** **2) Rennin (only in calves of ruminants) and some amount in human infants.** **3) Gastric lipase**	**1.8 – 3.2**	**1) Proteins** **2) Casein (milk protein)** **3) Fats**	**1) Peptones** **2) Ca-paracaseinate** **3) Glycerol + Fatty acids**
Liver	**Hepatocytes**	**Bile (No Enzyme)**	**7.1-8.2**	**Fats**	**Emulsify fats**
Pancreas	**Acini**	**1) Trypsin**	**7.1- 8.3**	**1) Proteins**	**1) Peptones + olypeptide**

Maximum absorption of food - in Jejunum.

		3) Carboxypeptidase 4) Amylase 5) Lipase 6) Nucleases		2) Milk proteins 3) Peptides 4) Starch 5) Fats 6) RNA, DNA	2) Coagulation 3) Dipeptides + Amino acids 4) Maltose 5) Glycerol+ Fatty Acids 6) Nucleotides
Small Intestine	**Crypts of Lieberkuhn**	1) Enterokinase 2) Erepsin 3) Dipeptidase 4) Lipase 5) Maltase 6) Sucrose 7) Lactase 8) Nucleotidase 9) Nucleosidase	**7.6**	1) Trypsinogen 2) Peptides 3) Dipeptide 4) Fats 5) Maltose 6) Sucrose 7) Lactose 8) Nucleotides 9) Nucleosides	1) Trypsin 2) Dipeptide + amino acids 3) Amino acids 4) glycerol + Fatty Acids 5) Glucose 6) Glucose + Fructose 7) Glucose + Galactose 8) Nucleosides 9) Free bases
Large Intestine		**No digestive enzyme, only mucus**	-	**Lubricates faeces**	-

CONTROL OF ENZYME SECRETION

Part of Alimentary Canal	Hormone Secreted	Activity
1) Stomach epithelium	Gastrin	Promotes secretion of HCl & Pepsin
2) Duodenal epithelium	1) Enterogasterone	Slows gastric contraction & stops the secretion of gastric juice.
	2) Secretin	Pancreatic juice
	3) Duocrinin	release of mucus in Duodenum
	4) Pancreozymin	Digestive enzymes in Pancreatic juice
	5) Cholecystokinin	Contraction of Gall Bladder
3) Epithelium of Duodenum and Ileum	Enterocrinin	Succus entericus

4) Intestinal Villi	**Villikinin**	**Movement of villi to increase absorption**

Absorption of digested food

– process through which digested food diffuses through the intestinal mucous membrane and reaches the blood or lymph.

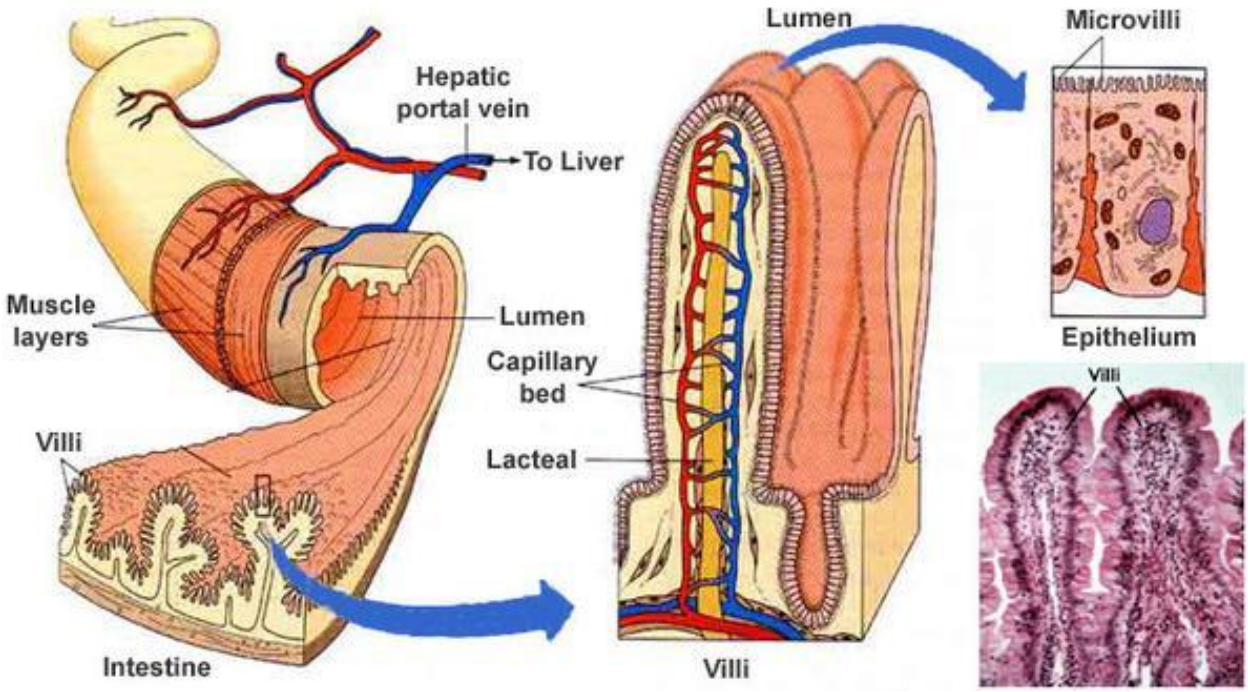
Different processes facilitating absorption of digested food

Simple diffusion – Movement of molecules along the concentration gradient of molecules without any requirement of energy. (**some glucose, amino acids, chloride ions**).

Active transport – Movement of molecules across semipermeable membrane against the concentration gradient requiring energy from ATP (**amino acids, glucose, sodium**).

Facilitated Diffusion: Diffusion of some ions and polar molecules across membranes through special transport proteins (**fructose and some amino acids**).

Osmosis: Movement of water molecules across semi permeable membrane from a region of their higher concentration to a region of their lower concentration (**transport of water**).



Fats

Micelles –water soluble droplets having a combination of fatty acids, monoglycerides and bile salts.

Chylomicrons – Protein- coated water soluble fat droplets.

- Fatty acids, monoglycerides and glycerol (insoluble) cannot be absorbed into the blood.
- They first form micelles into the intestinal mucosa.
- Then are reconstructed to triglycerides in absorptive cells and are released into lymph vessels as chylomicrons.
  Lymph vessels ultimately release absorbed substances into the blood stream.

Assimilation of food

- Blood transports absorbed food materials to different body cells where food is utilized for energy, growth and repair.

Egestion / Defaecation

- **Faeces** (Undigested and unabsorbed wastes, solidified into coherent structures) in small intestine are passed on to the large intestine.
- No digestion in large intestine.
- Water, minerals and drugs get absorbed.
- **Egestion –** Faeces are eliminated through the anus by a voluntary process carried out by mass peristaltic movement.

Disorders of digestive system

- **Jaundice** – Liver affected. Skin and eyes turn yellow due to accumulation of bile and its absorption in blood.
- **Vomiting** – Ejection of stomach contents through mouth (reflex action).Nausea precedes vomiting.
- **Diarrhoe**a – Abnormal frequency of bowel movement and increased liquidity of faecal discharge. Reduces absorption of food.
- **Constipatio**n – Faeces retained in rectum due to irregular bowel movements.
- **Indigestion** – Food not properly digested leading to feeling of fullness.
- **Kwashiorkor** – protein deficiency disease commonly affecting children between1 to 3 years of age.
- **Marasmus** – is protein – energy malnutrition (PEM). Mainly occurs in age group of one year in newly born baby.

SOME IMPORTANT QUESTIONS:

1. **Explain the role of gastric juice in digestion.**
2. **Explain the process of digestion and absorption of fats in human digestive system.**
3. **Name any three pancreatic enzyme.**

Breathing and Exchange of Gases

Breathing / Ventilation – First step of respiration, refers to the movements that send fresh air or with dissolved in water to the respiratory organs (inspiration) and removes foul air or water from them (expiration).

External respiration – intake of oxygen by the blood from water or air in the respiratory organs and elimination of carbon dioxide.

Internal respiration – involves uptake of oxygen by tissue cells via tissue fluid, oxidation of food in tissue cells leading to production of carbon dioxide, water and energy, storage of energy in the form of ATP and release of CO_2 from tissue cells into blood via tissue fluid.

Respiration – a physico-chemical **catabolic** process which involves exchange of environmental oxygen with the carbon dioxide produced in the cells during oxidation, at a moist surface to utilize the oxygen for the **oxidation of glucose** in the mitochondria (power house of cell) to produce the energy, some of which is stored in ATP molecules as **biological useful energy**.

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

(Glucose) (Oxygen) (Carbon dioxide) (Released) (Water) (Reused) (Stored as ATP)

$ATP \xrightarrow{\text{Hydrolysis}} ADP + Pi + \text{Energy used in life activities}$

Aerobic respiration – involves use of molecular oxygen for break down of respiratory substrate and release of carbon dioxide simultaneously. Occurs in most animals and plants.

Anaerobic respiration –does not utilize molecular oxygen, for the breakdown of organic substrate and CO_2 may or may not be released.

In Yeast -

$C_6H_{12}O_6 \longrightarrow 2\,C_2H_5OH + 2CO_2 + \text{Energy}$

(Glucose) (Ethanol)

In Certain Bacteria and Parasitic Worms *(Ascaris, Tapeworm)*

$C_6H_{12}O_6 \longrightarrow 2CH_3CHOHCOOH + \text{Energy}$

(Glucose) (Lactic acid)

Types of respiration –

Cutaneous respiration – Exchange of respiratory gases through the thin, moist, permeable and highly vascularised skin.

Buccopharyngeal respiration – Exchange of respiratory gases through thin, vascular lining of buccopharyngeal cavity. In frog

Branchial respiration – Exchange of respiratory gases in gills.

Pulmonary respiration – Exchange of gases through lungs.

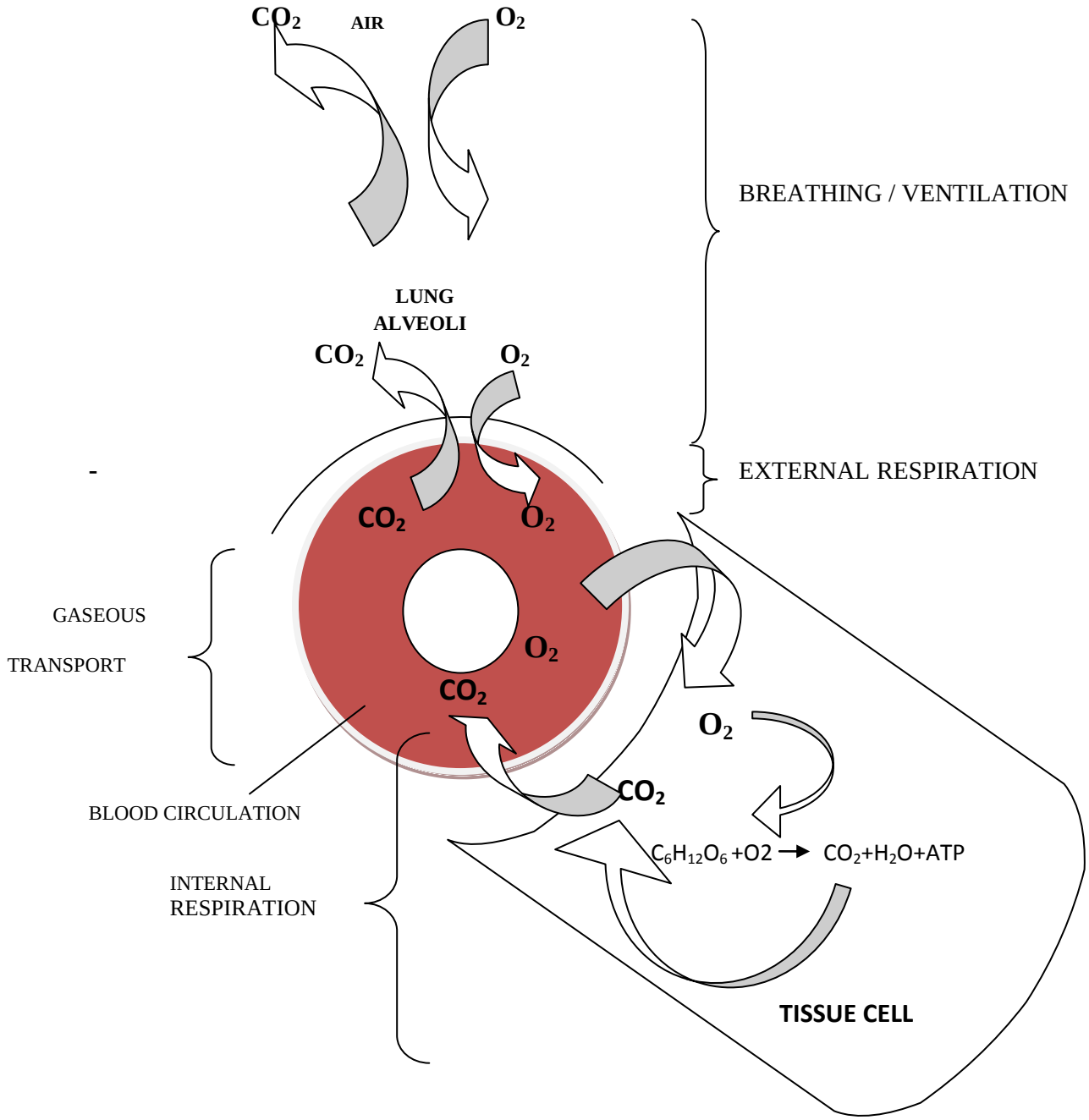
Respiratory surface – an efficient respiration requires a thin, permeable, moist, large and highly vascular surface in direct or indirect contact with source of oxygen (air/ water) and presence of a respiratory pigment.

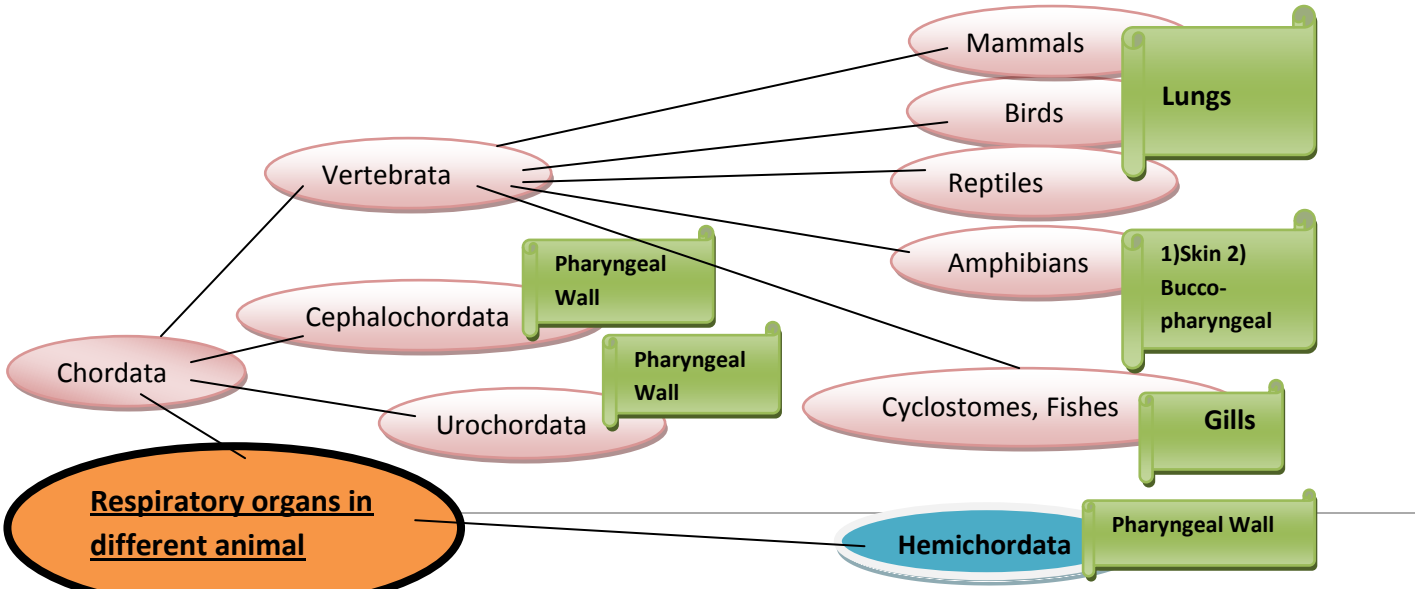
Respiratory pigments – Greatly increase the capacity of blood to carry oxygen and carbon dioxide.

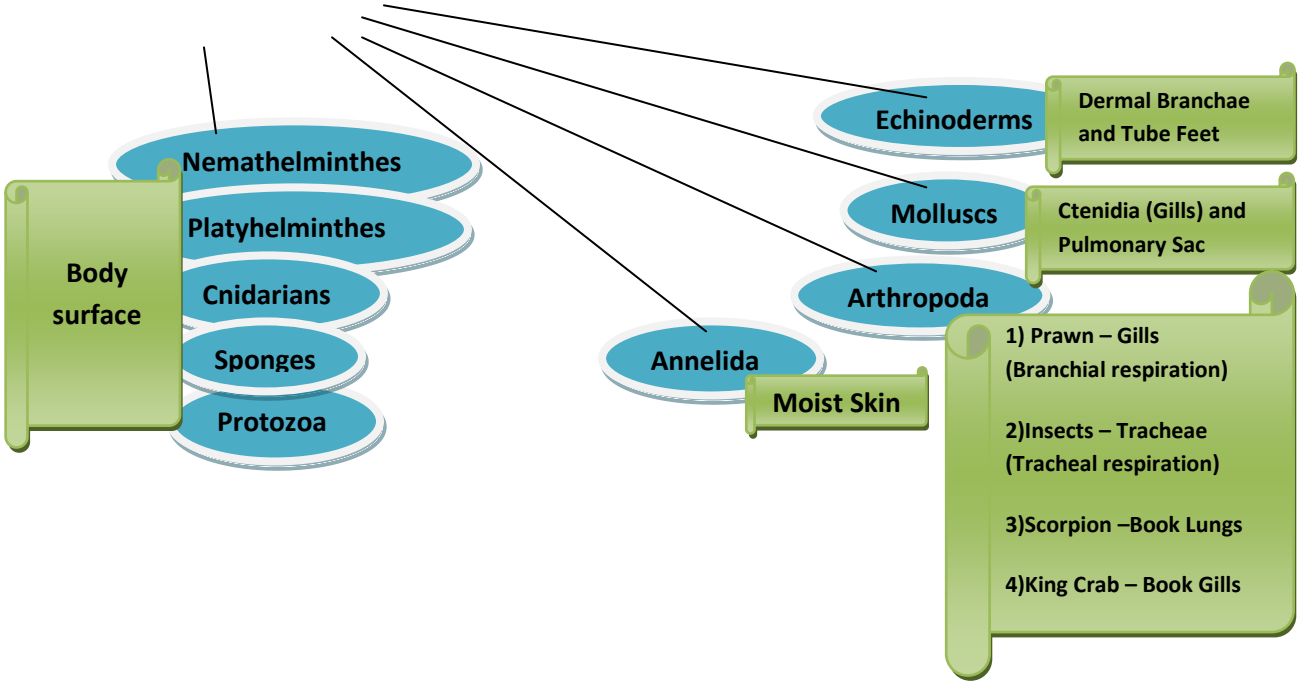
Haemocyanin – respiratory pigment in plasma in crustaceans and mollusks contains Cu

Haemoglobin - respiratory pigment in the red blood cells in vertebrates and in annelids in the plasma contains Fe.

BREATHING Vs RESPIRATION



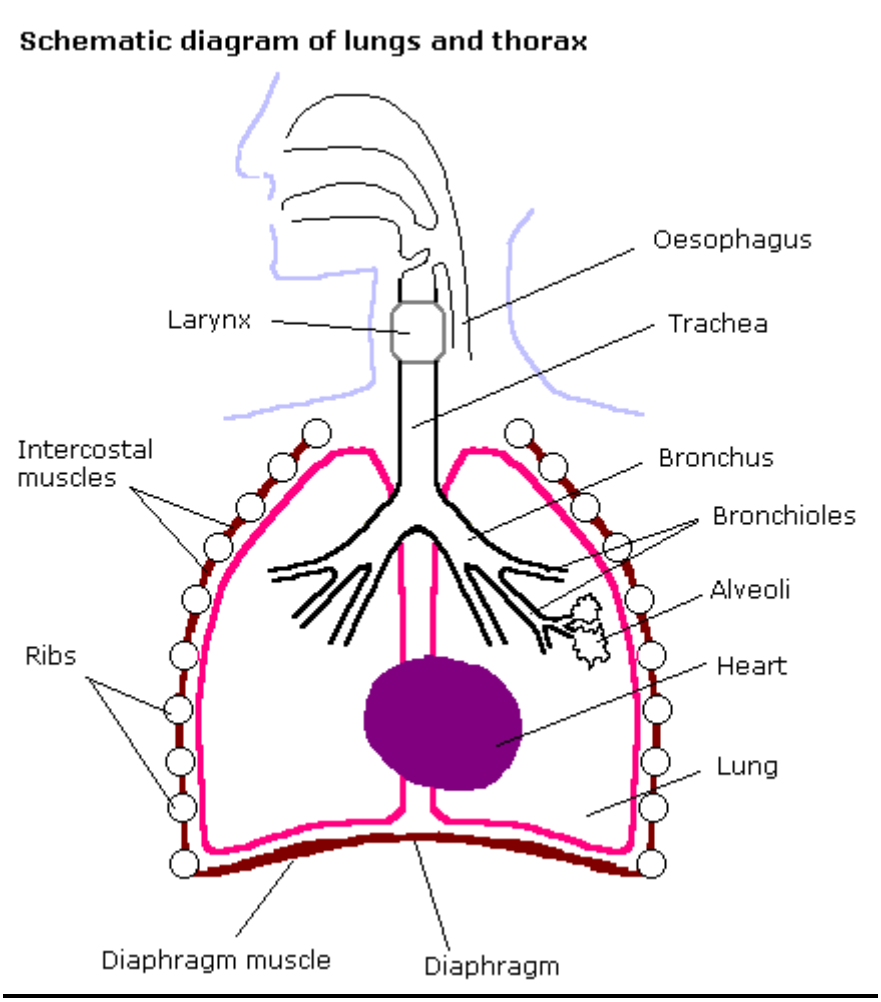


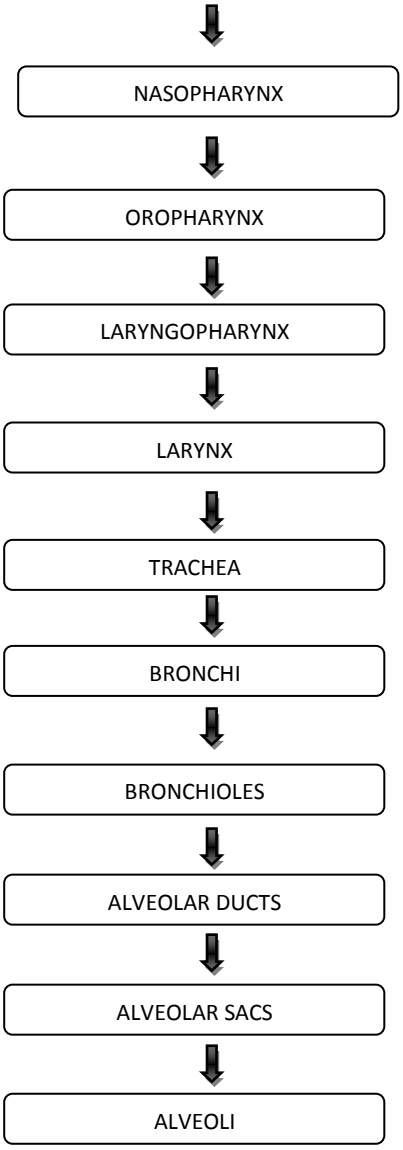


HUMAN RESPIRATORY SYSTEM

PASSAGE OF AIR

NOSTRILS





Larynx – "Adam's apple"

Glottis – Aperture in laryngopharynx which opens into trachea.

Epiglottis – A cartilaginous flap present at the anterior margin of glottis. It projects into the pharynx opposite the uvula. During swallowing, larynx moves upward to close the glottis to check the entry of food into it.

Trachea/ Windpipe – thin walled tube extends downward through the neck.

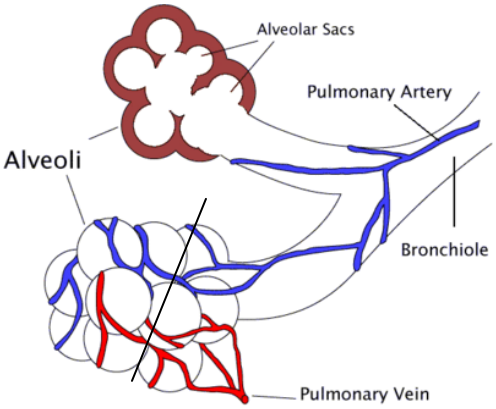
Bronchi – Trachea divides into two tubes called bronchi in the middle of the thorax.

Bronchioles – Bronchi divide and re-divide into tertiary bronchi which divide into alveolar ducts which enter into alveolar sacs.

Lungs – Human respiratory organ, located in the thoracic cavity.

Alveolar sac – In the lung, each alveolar duct opens into a blind chamber, the alveolar sac which appears like a small bunch of grapes.

Alveoli / Air sacs – The central passage of each alveolar sac gives off several small pouches on all sides, the alveoli or air sacs.



Alveolar wall – is very thin (0.0001 mm) wall composed of simple moist, non-ciliated, squamous epithelium which easily recoil and expand during breathing.

Advantages of nasal breathing over mouth breathing

Air passing through nasal chambers is subjected to warming, moistening, sterilization and cleaning specially by virtue of the presence of hair and mucus which holds the dust particles and bacteria of the passing air, which are absent

Respiratory membrane – consists of alveolar epithelium, epithelial basement membrane, a thin interstitial space, capillary basement membrane and capillary endothelial membrane (total thickness= 0.3µm). Hence, diffusion of gases between the blood and alveolar air occurs easily and quickly.

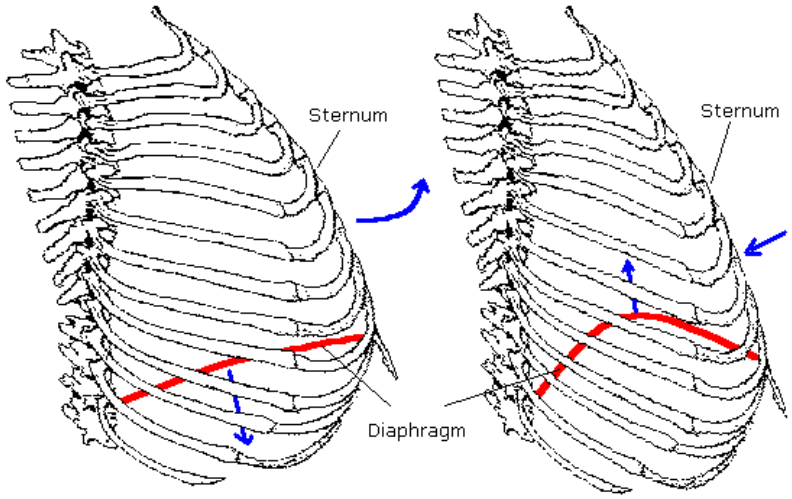
BREATHING MECHANISM –

Breathing is brought about by alternate expansion and contraction of the thoracic cavity wherein the lungs lie.

Inspiration/ Inhalation/ Breathing in – Intake of fresh air.

Expiration/ Exhalation/ Breathing out – elimination of foul air.

Breathing in and out



Breathing in:
Sternum is lifted upwards and outwards as intercostals contract. Diaphragm descends, thoracic volume increases, pressure decreases, air is inhaled.

Breathing out:
Sternum is pulled downwards and inwards as intercoastals relax. Diaphragm ascends, decreasing thoracic volume, increasing pressure thereby causing exhalation.

Partial pressure – of a gas is the pressure it exerts in a mixture of gases.

Gaseous exchange – In alveoli

- is due to higher partial pressure of oxygen in alveoli than in blood, hence oxygen diffuses from alveoli into the blood through respiratory membrane.

- Oxygen combines with haemoglobin in red blood cells to form **oxyhaemoglobin**.
- Carbon dioxide in lung capillaries has higher partial pressure than that in the alveoli, hence it diffuses from blood into alveoli.
- Alveolar air thus becomes foul and is renewed
-

– In tissues

- Exchange occurs between blood and tissue cells via tissue fluid. Blood in tissue capillaries have partial pressure of oxygen higher than that in the tissue cells.
- Tissue cells constantly use oxygen in oxidation that produces carbon dioxide, hence, here partial pressure of O_2 is lower and partial pressure of CO_2 is higher than the blood coming to them.
- Due to these differences in the partial pressures of CO_2 and O_2 between blood and tissue cell, O_2 separates from oxyhaemoglobin and diffuses from the blood into the tissue fluid and then into the tissue cells and CO_2 diffuses from the tissue cells into the tissue fluid and thence into the blood.

Vital capacity is higher in athletes and sportsmen.

In young man than in old man.

Smoking reduces the vital capacity of the lungs and decreases the capacity for strenuous muscular activity.

GASEOUS TRANSPORT IN BLOOD

Oxygen transport –

- **As solution –** 3% of O_2 is transported in dissolved state in plasma.

- **As oxyhaemoglobin –** 97% of oxygen diffuses from plasma into the R.B.Cs. An oxyhaemoglobin molecule may carry 1 to 4 oxygen molecules of O_2.
  - **Oxygenation -** Hb loosely joins with Fe^{++} ions of Hb to form bright red oxyhaemoglobin.

$$\underset{\text{(Haemoglobin)}}{Hb_4} + 4O_2 \underset{\text{In tissues}}{\overset{\text{In lungs}}{\rightleftharpoons}} \underset{\text{(Oxyhaemoglobin)}}{Hb_4O_8}$$

A fully saturated oxyhaemoglobin molecule carries 4 oxygen molecules.

- **Haemoglobin –** A fall in the p CO_2. of blood due to its diffusion in the alveoli and when exposed to high p O_2 in the respiratory organs haemoglobin readily combines with oxygen and -
  - Releases oxygen equally readily when exposed to low p O_2 in the tissues and high p CO_2 favour dissociation of oxyhaemoglobin to purplish red reduced haemoglobin and molecular oxygen. Haemoglobin is returned to lungs for reuse in oxygen transport.
- **Oxygen dissociation curve of haemoglobin –** The sigmoid curve showing relationship between the percentage saturation of haemoglobin in blood and the pO_2 of the blood.
  - When fully saturated, each gram of haemoglobin combines with nearly1.34ml of oxygen.
  - H+ concentration, CO_2 tension, temperature affect the curve. Increase in their concentration decreases the affinity of haemoglobin for oxygen.

Carbon Dioxide Transport

- As Solution- 7% of the CO_2 dissolves and is carried in the plasma.

- As bicarbonate ions – 70% of CO_2 into the R.B.Cs. Here it combines with water to form carbonic acid in the presence of enzyme carbonic anhydrase.
  Carbonic acid dissociates into bicarbonate and H^+.
- As carbaminohaemoglobin – 23% of CO_2 entering the R.B.Cs. loosely combines with the amino group ($-NH_2$) of the reduced haemoglobin (Hb) to form carbaminohaemoglobin. The reaction releases oxygen from oxyhaemoglobin.
- Every 100 ml of deoxygenated blood delivers approximately 4ml of CO_2 to the alveoli.

Pulmonary air volumes and capacities

Pulmonary / Lung volumes – The quantities of air the lungs can receive, hold or expel under different conditions.

Pulmonary capacity – refers to a combination of two or more pulmonary volumes.

Tidal volume – Volume of air normally inspired or expired in one breath without any effort (500ml for an average adult human male).

Inspiratory reserve volume (IRV) –extra amount of air which can be inhaled forcibly after a normal inspiration (2000-2500 ml).

Expiratory reserve volume (ERV) – the extra amount of air which can be exhaled forcibly after a normal expiration (1000 -1500 ml).

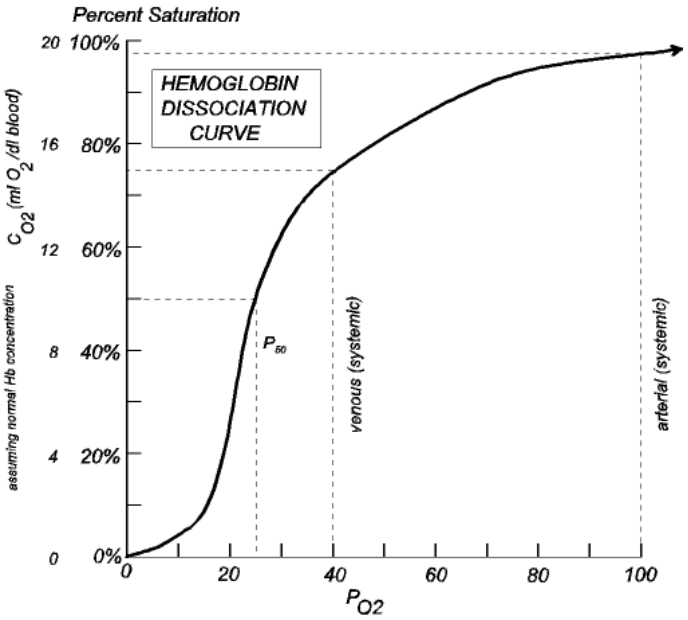
Vital capacity (VC) – Amount of air which one can inhale with maximum effort and also exhale with maximum effort (3.5 – 4.5 litres in normal adult).

TV+ IRV+ ERV = VC

Residual volume (RV) – the air that always remains in the lungs even after forcible expiration. It enables lungs to continue exchange of gases even after maximum exhalation or on holding the breath.

Inspiratory capacity (IC) – Total volume of air which can be inhaled after a normal expiration(IC = TV + IRV = 2500 – 3000 ML).

Functional residual capacity (FRC) – FRC=RV + ERV = 2500 to 3000 ml.

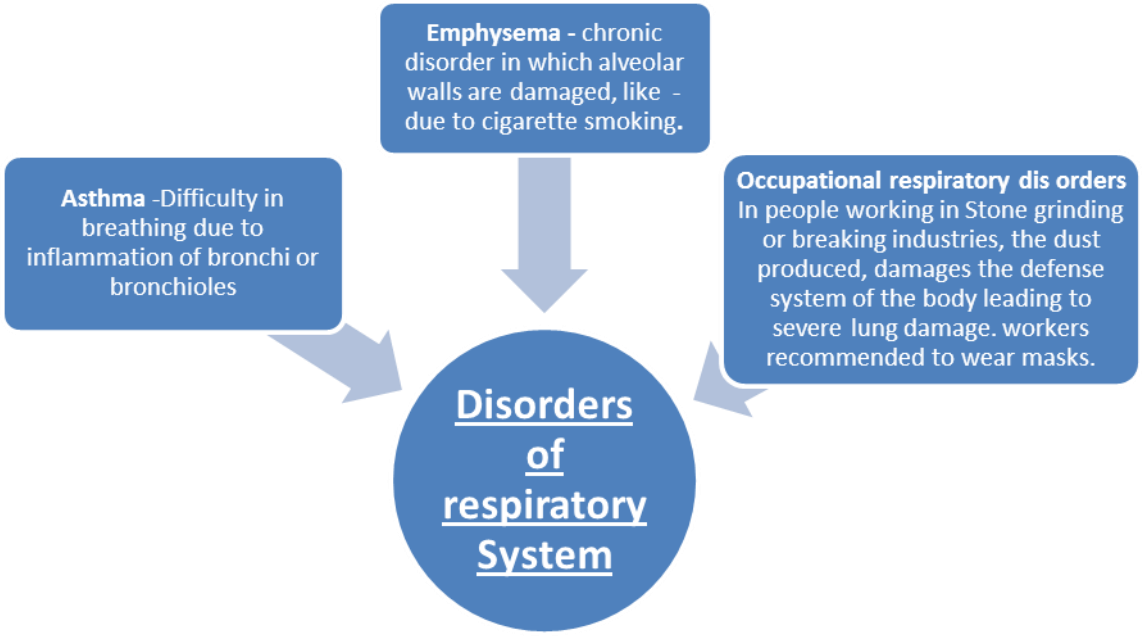


Total lung capacity (TLC) – TLC =VC+ RV (5000 -6000ml).

Regulation of respiration

- Respiratory rhythm centre in the medulla of brain - mainly responsible for this regulation.
- Pneumotaxic centre in pons region of the brain moderates functions of respiratory rhythm centre.
- A chemosensitive area, adjacent to rhythm centre is highly sensitive to CO^2 and H^+ ions. Increase in them activates this center, which in turn signal the rhythm centre to make necessary adjustments in the respiratory process by which these substances can be eliminated.

- Receptors associated with aortic arch and carotid artery- also sensitive to CO^2 and H^+ ion concentrations and send signals to rhythm centre for remedial action.



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SOME IMPORTANT QUESTIONS:

1.Explain oxygen dissociation curve.

2. Describe various methods of CO2 Transportation.

3. Define Vital Capacity and Total lung capacity.

Chapter-18

Body Fluids and Circulation

Need – Body fluids need to be circulated constantly to supply nutrients, oxygen and other essential substances and for simultaneous removal of the wastes, for the healthy functioning of a living organisms.

Circulatory system – **Blood vascular system and lymphatic system are together referred to as Circulatory system.**

BLOOD VASCULAR SYSTEM –

Heart- Special contractile blood pumping organ.

Blood vessels – Tubes associated with heart into which the blood is pumped and circulated. Artery, Veins and Blood capillaries.

Blood - Fluid connective tissue, consists of a fluid matrix, plasma and formed elements.

Blood is a safer circulating fluid than environmental water because it is not affected by external changes like temperature variation, pollution etc.

Blood contains carrier molecules (haemoglobin, haemocyanin, plasma proteins) that can transport much larger amounts of nutrients and gases than water.

BLOOD

Plasma

- Plasma is a straw coloured, viscous fluid constituting nearly 55 per cent of the blood.
- 90-92 per cent of plasma is water and proteins contribute 6-8per cent of it.
- Fibrinogen, globulins and albumins are the major proteins.
- Plasma without the clotting factors is called serum.
- Fibrinogens are needed for clotting or coagulation of blood.
- Globulins -primarly are involved in defense mechanisms of the body
- Albumins - help in osmotic balance.
- Glucose, amino acids, lipids, etc., are also present in the plasma as they are always in transit in the body.
- Plasma also contains small amounts of minerals like Na+, Ca++, Mg++, HCO_3^- etc.
- Factors for coagulation or clotting of blood are also present in the plasma in an inactive form.

Formed Elements

(Erythrocytes, leucocytes and platelets -They constitute about 45 per cent of the blood.)

Erythrocytes or red blood cells (RBC) -most abundant of all

- The cells in blood. **Erythrocytes** or red blood cells (RBC) -most abundant of all the cells in blood.
- A healthy adult man has, on an average, 5 millions to 55 millions of RBCs mm-3 of blood. RBCs are formed in the red bone marrow in the adults. RBCs are devoid of nucleus in most of the mammals and are biconcave in shape.They have a red coloured, iron containing complex protein called haemoglobin, hence the colour and name o f these cells. A healthy individual has 12-16 gms of haemoglobin in every 100 ml of blood. These molecules play a significant role in transport of respiratory gases. RBCs have an average life span of 120 days after which they are destroyed in the spleen (graveyard of RBCs).

Leucocytes are also known as white blood cells (WBC) as they are colourless due to the lack of haemoglobin.

- They are nucleated and are relatively lesser in number which averages 6000-8000 mm-3 of blood.
- Leucocytes are generally short lived.
- We have two main categories of WBCs
- Agranulocytes and granulocytes.

Blood Platelets also called **thrombocytes**, are cell fragments produced from megakaryocytes (special cells in the bone marrow). Blood normally contains 1,500,00-3,500,00 platelets mmñ3. Platelets can release a variety of substances most of which are involved in the coagulation or clotting of blood. A reduction in their number can lead to clotting disorders which will lead to excessive loss of blood from the body.

Agranulocytes

Monocytes (6-8 per cent) are phagocytic cells which destroy foreign organisms entering the body.

Lymphocytes (20-25 per cent) are of two major types Band T forms.

- Both B and T lymphocytes are responsible for immune responses of the body.

Granulocytes

Neutrophils are the most abundant cells (60-65 per cent) of the total WBCs are phagocytic.

Eosinophils (2-3 per cent) resist infections and are also associated with allergic reactions.

Basophils are the least (0.5-1 per cent) among them.

- **Basophils** secrete histamine, serotonin, heparin, etc., and are involved in inflammatory reactions.

Blood Groups

- Two groupings are ABO and Rh.

ABO grouping: Father of blood Grouping Carl landsteiner

- ABO grouping is based on the presence or absence of two surface antigens (chemicals that can induce immune response) on the RBCs namely A and B.
- Plasma of different individuals contains natural antibodies (proteins produced in response to antigens).
- Blood of a donor has to be carefully matched with the blood of a recipient before any blood transfusion to avoid severe problems of clumping (destruction of RBC).

Combinations of antigens and antibodies in different blood groups

Blood group	Antigen (on the surface of R.B.Cs)	Antibody (in plasma)	Alleles
A	A	anti B	I^AI^A, I^Ai
B	B	anti A	I^BI^B, I^Bi
AB	A and B	None	I^AI^B
O	None	anti A and anti B	i i

Blood Groups and Donor Compatibility

Donor	Recipients agglutinating blood of O A B AB	Possible recipients having blood group	Prospective donors having blood group	Remarks
O	− − − −	O, A, B, AB	O	Donor
A	+ − + −	A, AB	O, A	−
B	+ + − −	B, AB	O, B	−
AB	+ + + −	AB	O, A, B, AB	Universal recipient

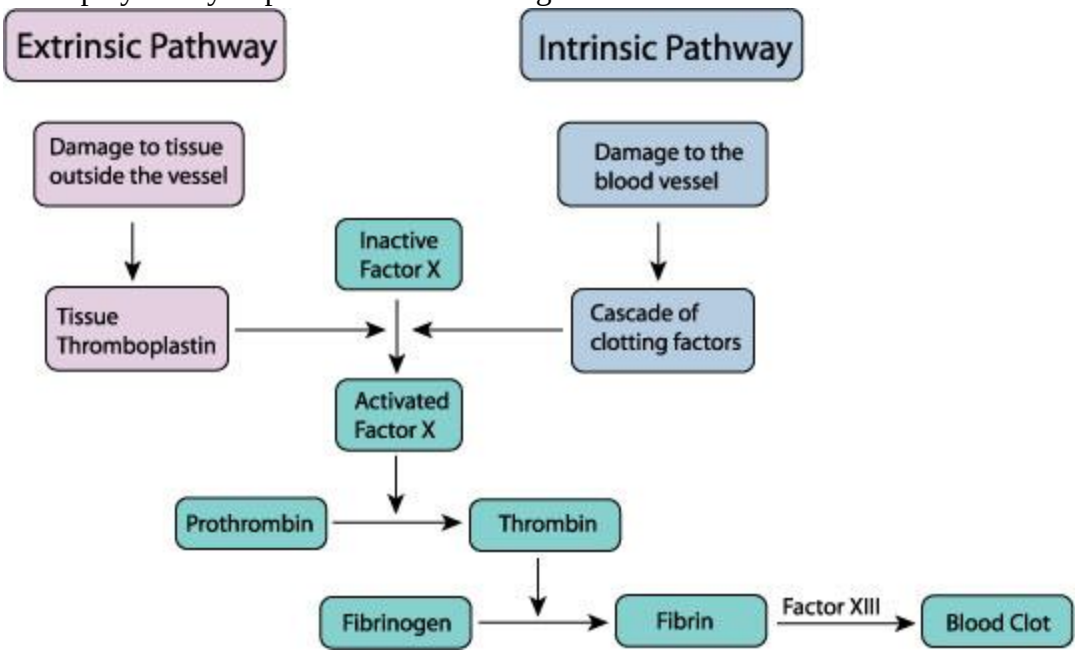
- Blood group O can be donated to persons with any other blood group - hence called universal donors.
- Persons with AB group can accept blood from persons with AB as well as from people with other groups of blood- hence called universal recipients.

Rh grouping

- **Rh positive** (Rh+ve) - Rh antigen similar to one present in Rhesus monkeys (hence Rh), observed on the surface of RBCs of majority (nearly 80 per cent) of humans.
- **Rh negative** (Rh-ve) - those in whom this antigen is absent .
- An Rh-ve person, if exposed to Rh+ve blood, will form specific antibodies against the Rh antigens.
- Blood transfusion - Rh group should also be matched before transfusions.
- ***Erythroblastosis foetalis*** - A special case of Rh incompatibility (mismatching) observed between the Rh-ve blood of a pregnant mother with Rh+ve blood of the foetus.
- **First pregnancy** - Rh antigens of the foetus do not get exposed to the Rh-ve blood of the mother as the two bloods are well separated by placenta.
- During delivery of first child, there is a possibility of exposure of the maternal blood to small amounts of Rh+ve blood from the foetus.
- The same mother starts preparing antibodies against Rh antigen in her blood.
- **Subsequent pregnancies** - the Rh antibodies from the mother (Rh-ve) can leak into the blood of the foetus (Rh+ve) and destroy the foetal RBCs.
- Could be fatal to the foetus or could cause severe anaemia and jaundice to the baby- *erythroblastosis foetalis*.
- Can be avoided by administering anti-Rh antibodies to the mother immediately after the delivery of the first child.

Coagulation of Blood

- Usually the blood stops flowing after sometime after an injury or trauma due to coagulation or clotting.
- Mechanism to prevent excessive loss of blood from the body.
- A dark reddish brown scum formed at the site of a cut or an injury over a period of time - clot or coagulam .
- Calcium ions play a very important role in clotting.



LYMPH (TISSUE FLUID)

- **TISSUE FLUID -** When blood passes through capillaries in tissues, some water along with many small water soluble substances move out into spaces between the cells of tissues leaving larger proteins and most of the formed elements in blood vessels.
- It has same mineral distribution as that in plasma.
- Exchange of nutrients, gases, etc., between the blood and cells always occur through this fluid.
- An elaborate network of vessels called **lymphatic system** collects this fluid and drains it back to major veins.
- **Lymph** –Fluid present in the lymphatic system.

Lymph

- is a colourless fluid containing specialised lymphocytes .
- responsible for the immune responses of the body.
- Lymph is also an important carrier for nutrients, hormones, etc.
- Fats are absorbed through lymph in the lacteals present in the intestinal villi.

CIRCULATORY PATHWAYS

Types of blood vascular system

Open circulatory system – The main blood vessels arising from the heart pour the blood into tissue spaces called sinuses.
-The blood comes in direct contact with the tissue cells thus exchanging respiratory gases, food materials and waste products directly between blood and tissue cells.
-Blood flows slowly through the open sinuses because of lack of enough blood pressure.
-Respiratory pigment, if any, is dissolved in blood plasma and red corpuscles are absent.
-Found in some arthropods and most molluscs.

Haemolymph – No distinction between blood and tissue fluid in animals with open circulatory system. Hence, blood / body fluid is appropriately called haemolymph. .

Closed circulatory system –blood remains in blood vessels while circulating through the body and never comes in direct contact with the tissue cells.
-Blood is distinct from the body fluid.

Course of blood circulation –

Heart → Aortic arch → Arteries → Arterioles → Capillaries

-Tissue cells pass the wastes into the tissue fluid and thence into the capillaries which unite to form venules → vein → vena cavae → open into heart.

Human Circulatory System

- Human circulatory system/ blood vascular system comprises **Heart (**a muscular chambered organ**)**, **blood vessels** (a network of closed branching vessels) and **blood**(the fluid which is circulated).
- **Heart-** situated in the thoracic cavity, in between two lungs, slightly tilted to left, size of a clenched fist.
  -pericardium - double walled membranous bag, protects heart, encloses pericardial fluid.
  -has four chambers- **atria -** small upper chambers, **ventricles** - two larger lower chambers
  - **interatrial septum** - A thin, muscular wall, separates the right and the left atria.
  - **inter-ventricular septum** - thick-walled, separates left and right ventricles.
  -atrio-ventricular septum- a thick fibrous tissue that separates atrium and ventricle of same side, each of these septa are provided with an opening through which the two chambers of the same side remain connected.

INTERNAL STRUCTURE OF HUMAN HEART

-Tricuspid valve - opening between right atrium and right ventricle is guarded by this valve formed of three muscular flaps or cusps,
-Bicuspid or mitral valve - guards opening between left atrium and left ventricle, allows flow of blood only in one direction, i.e., atria → ventricles, valves prevent any backward flow.

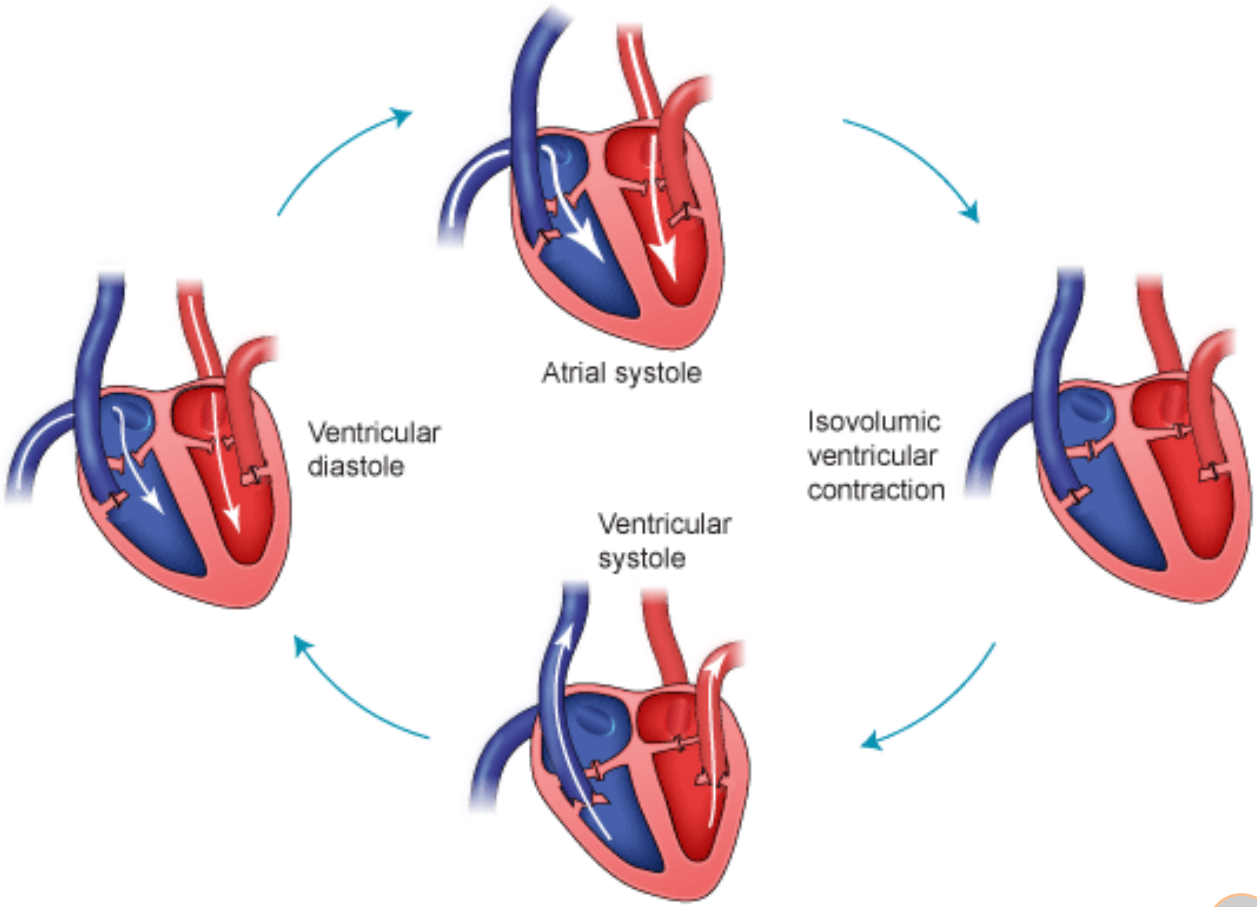
Cardiac Cycle / Functioning of heart

- **Joint diastole** - all the four chambers of heart are in a relaxed state.
  - the tricuspid and bicuspid valves are open,
  - blood from pulmonary veins and vena cava flows into the left and right ventricle, respectively through the left and right atria.
  - semilunar valves are closed at this stage.
- **Atrial systole** -The SAN now generates an action potential which stimulates both atria to
- undergo a simultaneous contraction.

  -This increases the flow of blood into the ventricles by about 30 per cent.
- **Ventricular systole** - action potential is conducted to the ventricular side by the AVN and AV bundle from where the bundle of His transmits it through the entire ventricular musculature.

-This causes the ventricular muscles to contract - ventricular systole.

- **Atrial diastole** -
  - relaxation (diastole) of the atria.
  - coincides with the ventricular systole.
- **Closure of tricuspid and bicuspid valves** - Ventricular systole increases the ventricular pressure causing the closure of tricuspid and bicuspid valves due to attempted backflow of
  blood into the atria.



CARDIAC CYCLE

Pacemaker (SAN)

- **autoexcitable** - The nodal musculature has the ability to generate action potentials without any external stimuli.
- the number of action potentials that could be generated in a minute vary at different parts of the nodal system.
- SAN can generate the maximum number of action potentials, i.e., 70-75 min^{-1}, and is responsible for initiating and maintaining the rhythmic contractile activity of the heart.
- Therefore, SAN is called the pacemaker.
- Our heart normally beats 70-75 times in a minute (average 72 beats min^{-1}).

Opening of semilunar valves -As the ventricular pressure increases further, the Semi Lunar valves guarding the pulmonary artery (right side) and aorta (left side) are forced open, allowing the blood in the ventricles to flow through these vessels into the circulatory pathways.

- **ventricular diastole** –Now the ventricles relax (diastole)
- **Closure of semilunar valves** - ventricles relax
  - ventricular pressure falls
  - causing the closure of semilunar valves which prevents the backflow of blood into the ventricles.
- **Opening of tricuspid and bicuspid valves -** As the ventricular pressure declines further, the tricuspid and bicuspid valves are pushed open by the pressure in the atria exerted by the blood which was being emptied into them by the veins.
  The blood now once again moves freely to the ventricles.
- **Joint diastole** -The ventricles and atria are now again in a relaxed (joint diastole) state, as earlier.

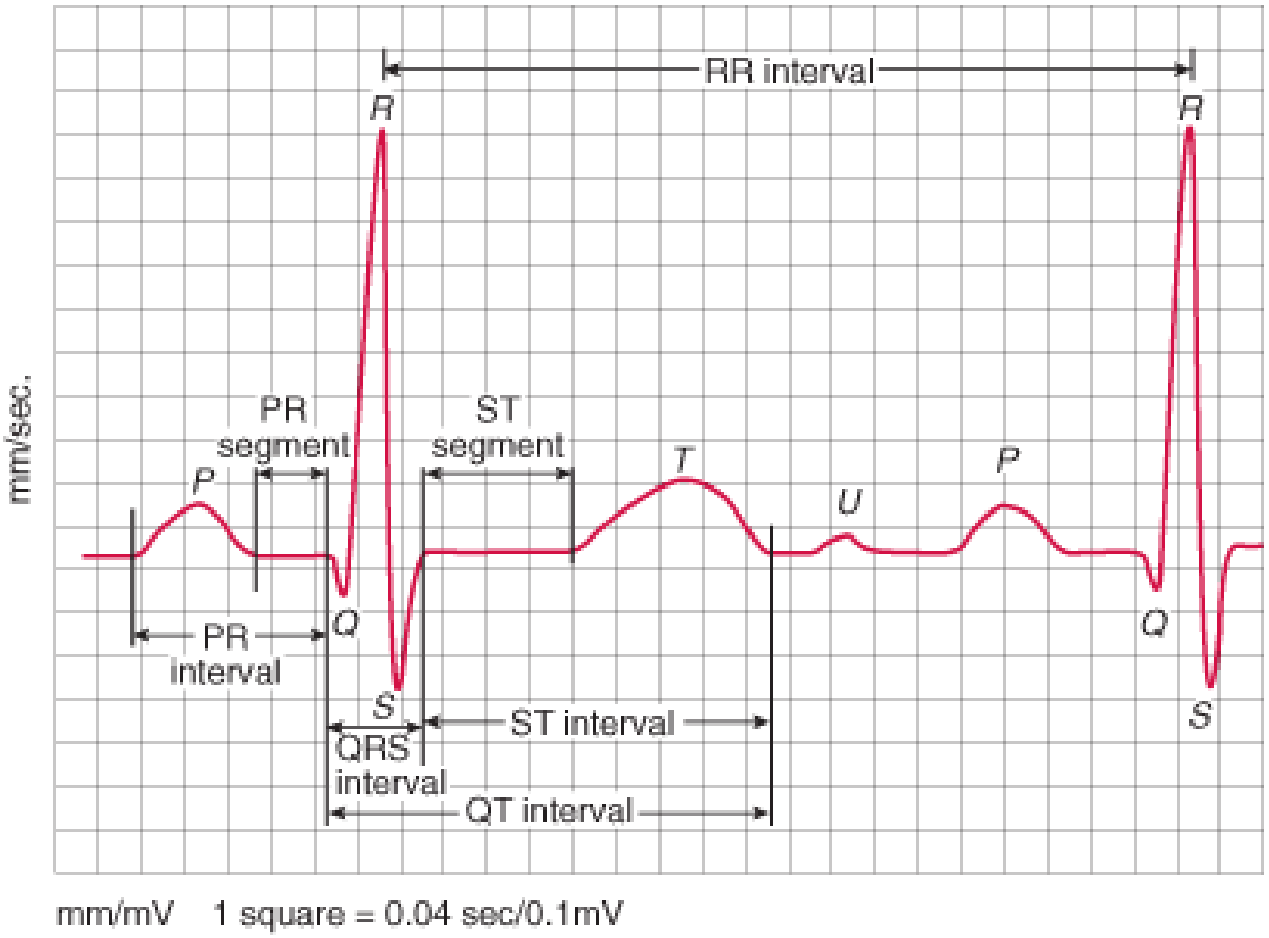
This sequential event in the heart which is cyclically repeated is called the **cardiac cycle**.
-the heart beats 72 times per minute, i.e., that many cardiac cycles are performed per minute.
-From this it could be deduced that the duration of a cardiac cycle is 0.8 seconds.

Stroke volume - During a cardiac cycle, each ventricle pumps out approximately 70 ml of blood.

- **Cardiac output-** stroke volume multiplied by the heart rate (no. of beats per min.) gives the cardiac output.
  -volume of blood pumped out by each ventricle per minute and averages 5000 mL or 5 litres in a healthy individual.
  - **Heart sounds** - During each cardiac cycle two prominent sounds are produced which can be easily heard through a stethoscope. These sounds are of clinical diagnostic significance.
- **First heart sound (lub)** is associated with the closure of the tricuspid and bicuspid valves
- **Second heart sound (dub)** is associated with the closure of the semilunar valves.

Electrocardiogram (ECG)

- Graphical representation of the electrical activity of the heart during a cardiac cycle is called as ECG & machine used to obtain an ECG is called as electrocardiograph.
- To obtain a standard ECG (a patient is connected to the machine with three electrical leads (one to each wrist and to the left ankle) that continuously monitor heart activity.



Electrocardiogram

A standard ECG-

- Each peak in the ECG is identified with a letter from P to T that corresponds to a specific electrical activity of the heart.
- **P-wave** - represents electrical **excitation (or depolarisation) of the atria**,which leads to the contraction of both the atria.

-The QRS complex represents the **depolarisation of the ventricles**, which initiates the ventricular contraction.

- The contraction starts shortly after Q and marks the beginning of the systole.

-The T-wave represents the return of the ventricles from excited to normal state (**repolarisation**).

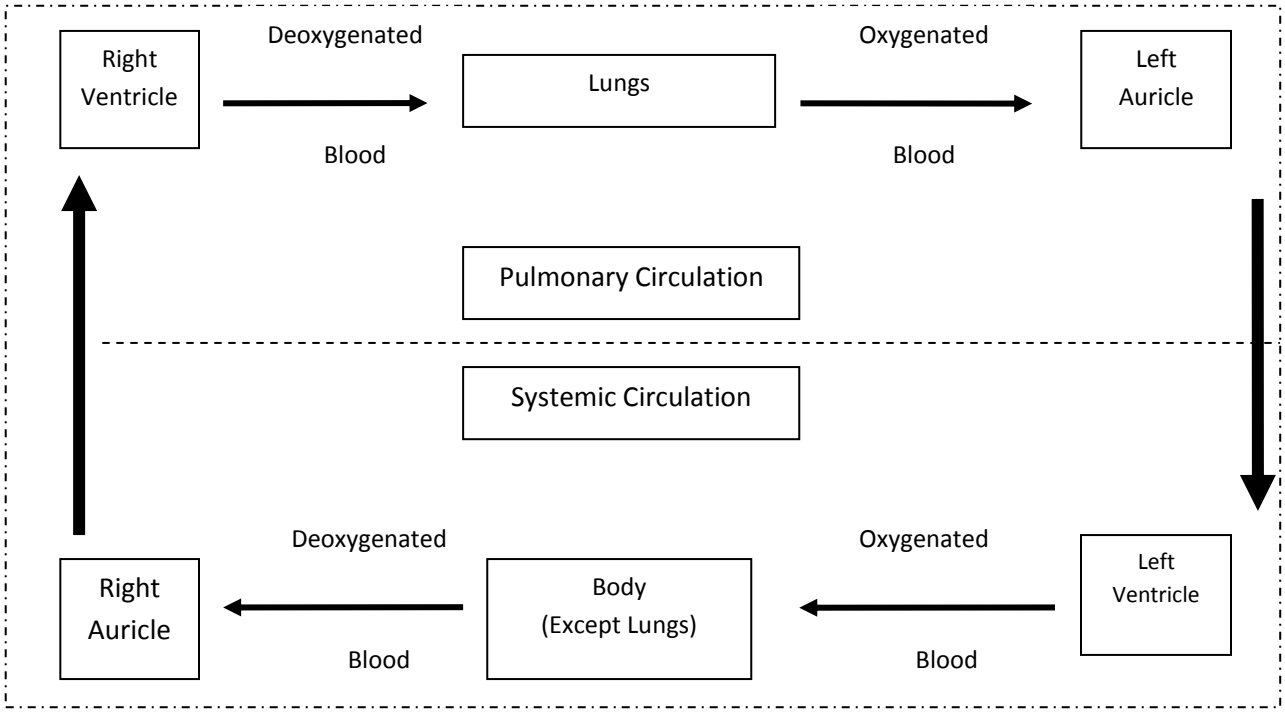
- The end of the T-wave marks the end of systole.

- Since the ECGs obtained from different individuals have roughly the same shape for a given lead configuration, any deviation from this shape indicates a possible abnormality or disease.

DOUBLE CIRCULATION

- Blood passes through the heart twice in each complete circuit round the body.
- Blood pumped by the right ventricle enters the pulmonary artery, whereas the left ventricle pumps blood into the aorta.
- **Pulmonary circulation** - deoxygenated blood pumped into the pulmonary artery is passed on to the lungs from where oxygenated blood is carried by the pulmonary veins into left atrium.
- **Systemic circulation** - oxygenated blood entering the aorta is carried by a network of arteries, arterioles and capillaries to tissues from where the deoxygenated blood is collected by a system of venules, veins and vena cava and emptied into right atrium.
  - The systemic circulation provides nutrients, O_2 and other essential substances to the tissues and takes CO_2 and other harmful substances away for elimination.

  -The deoxygenated and oxygenated blood remain fully separate and there is a complete double
  circulation..



Double circulation of blood

-
-

Hepatic portal system- A unique vascular connection exists between the digestive tract and liver.The hepatic portal vein carries blood from intestine to the liver before it is delivered to the systemic circulation.

- Coronary circulation - special coronary system of blood vessels is present in our body exclusively for the circulation of blood to and from the cardiac musculature.

REGULATION OF CARDIAC ACTIVITY

- **Myogenic heart** - Normal activities of the heart are regulated intrinsically, i.e., auto regulated by specialised muscles (nodal tissue).
- A special neural centre in the medulla oblangata can moderate the cardiac function through autonomic nervous system (ANS).
- Neural signals through the sympathetic nerves (part of ANS) can increase the rate of heart beat,the strength of ventricular contraction and thereby the cardiac output.
- Parasympathetic neural signals (another component of ANS) decrease the rate of heart beat, speed of conduction of action potential and thereby the cardiac output.
- Adrenal medullary hormones can also increase the cardiac output.

DISORDERS OF CIRCULATORY SYSTEM

- **High Blood Pressure (Hypertension):** blood pressure higher than normal i.e. (120/80 where, 120 mm Hg (millimetres of mercury pressure) is the systolic, or pumping pressure and 80 mm Hg is the diastolic, or resting pressure.
  -If repeated checks of blood pressure of an individual is 140/90 (140 over 90) or higher, it shows hypertension.
  -High blood pressure leads to heart diseases and affects vital organs like brain and kidney.
- **Coronary Artery Disease (CAD)/ Atherosclerosis:** affects the vessels that supply blood to the heart muscle.
  -caused by deposits of calcium, fat, cholesterol and fibrous tissues, which makes the lumen of arteries narrower.
- **Angina / Angina pectoris**- acute chest pain appears when no enough oxygen is reaching the heart muscle.
  -occur in men and women of any age, but is more common among the middle-aged and elderly.
  - occurs due to conditions that affect the blood flow.
- **Heart Failure / congestive heart failure:** state of heart when it is not pumping blood effectively enough to meet the needs of body.
  -main symptom - congestion of the lungs.
  -Heart failure is not same as cardiac arrest (when the heart stops beating) or heart attack (when the heart muscle is suddenly damaged by an inadequate blood supply).

SOME IMPORTANT QUESTIONS:

1.Which part of human heart is known as natural pace maker and why?

2. What does P,QRS, and T represent in an ECG?

3. What are heart sounds and when does these are generated?

4. Explain cardiac cycle.

Chapter-19

Excretory Products and Their Elimination

Excretory products:

Products (like- ammonia, urea, uric acid, carbon dioxide, water and ions like Na^+, K^+, Cl^-, phosphate, sulphate, etc.) get accumulated in animals either due to metabolic reactions or by other means and need to be eliminated totally or partially from the body, as they may prove harmful for the body.

Nitrogenous excretory wastes:

Ammonia, **urea** and **uric acid** are the major forms of nitrogenous wastes excreted by the animals.
Ammonia - most toxic form and animal requires large amount of water for its elimination.
Urea – is less toxic than ammonia but more toxic than uric acid and animal requires less amount of water for its elimination.
Uric acid- least toxic, can be removed with a minimum loss of water by the animal.

Excretion:The process of removal of waste products from the body is called as excretion.

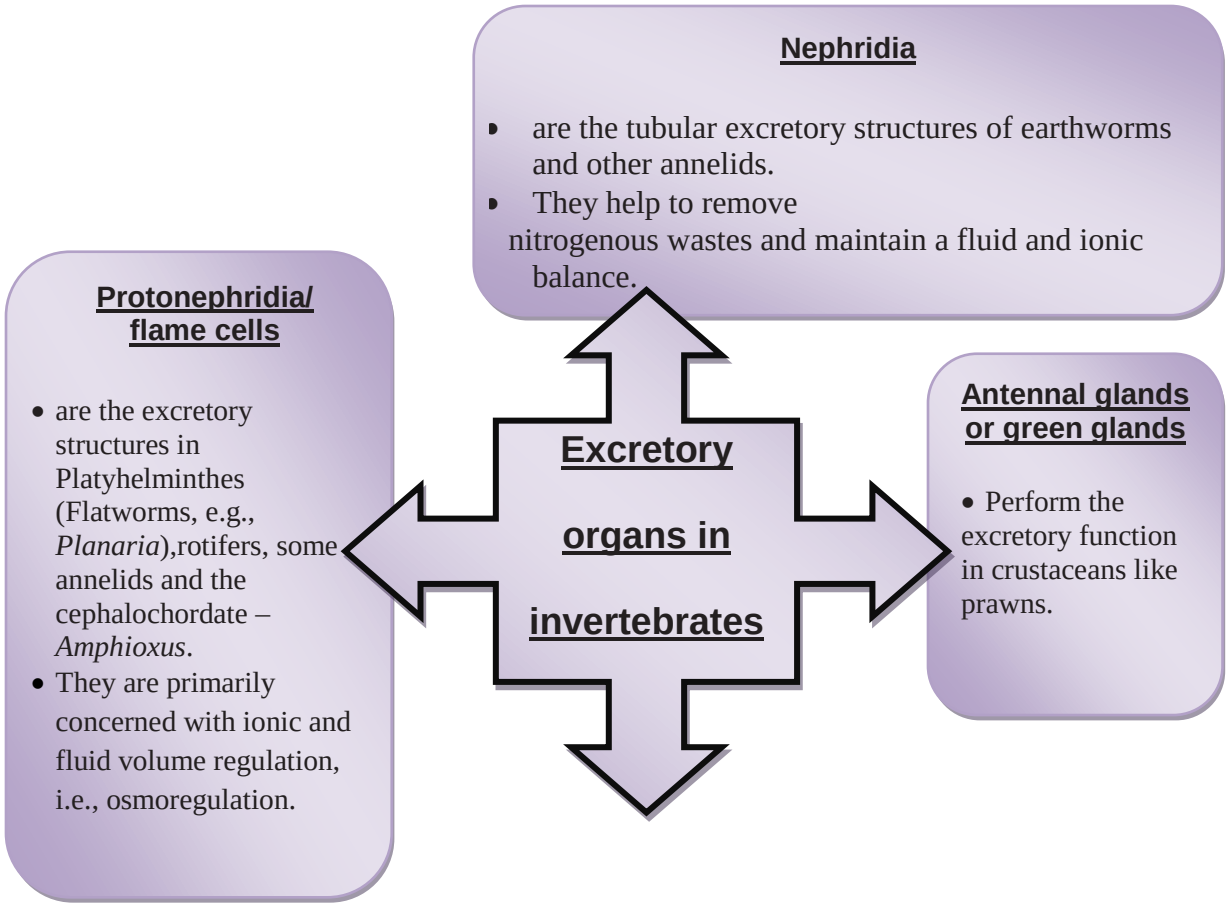
Excretion

On the basis of type of excretory products

Ammonotelism
- Excretion of ammonia.
- Bony fishes,aquatic amphibians and aquatic insects.

Ureotelism
- Excretion of urea.
- Mammals, many terrestrial amphibians and marine fishes mainly excrete urea.

Uricotelism
- Excretion of Uric acid.
- Reptiles, birds, land snails and insects excrete nitrogenous wastes as uric acid in the form of pellet or paste with a minimum loss of water.

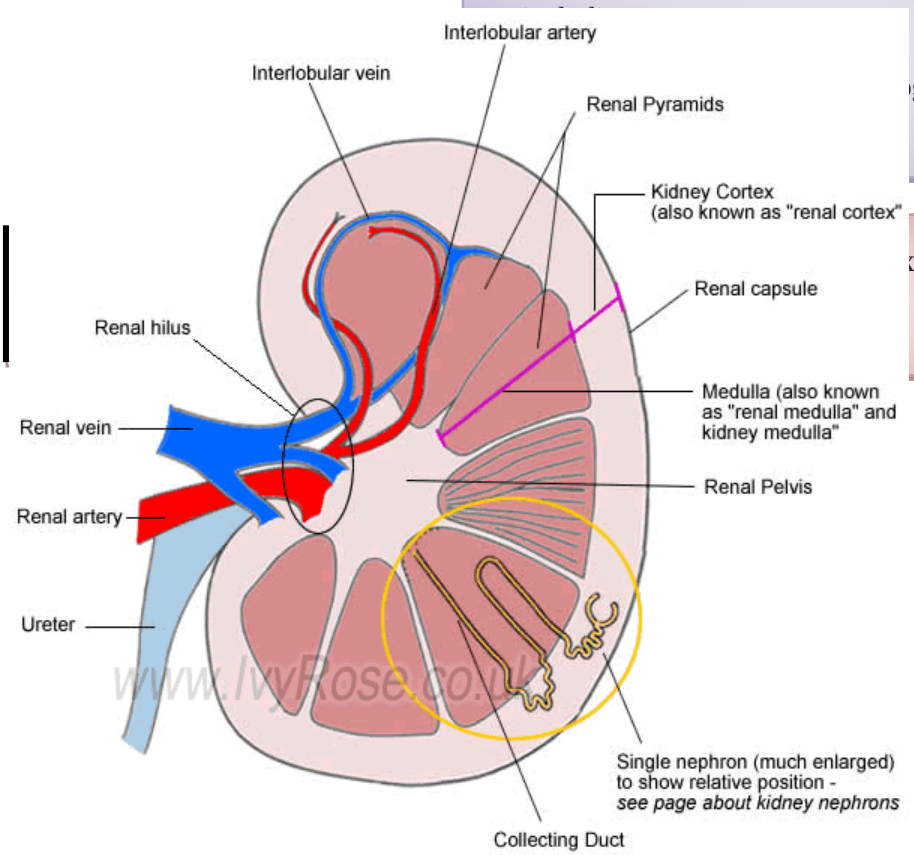

Nephridia
are the tubular excretory structures of earthworms and other annelids.
They help to remove nitrogenous wastes and maintain a fluid and ionic balance.
Protonephridia/ flame cells
are the excretory structures in Platyhelminthes (Flatworms, e.g., Planaria),rotifers, some annelids and the cephalochordate – Amphioxus.
They are primarily concerned with ionic and fluid volume regulation, i.e., osmoregulation.
Excretory organs in invertebrates
Antennal glands or green glands
Perform the excretory function in crustaceans like prawns.

Malpighian tubules

- are the excretory structures of most of the insects

genous wastes and

tubular organs



Human Excretory System

- In humans, the excretory system consists

of -

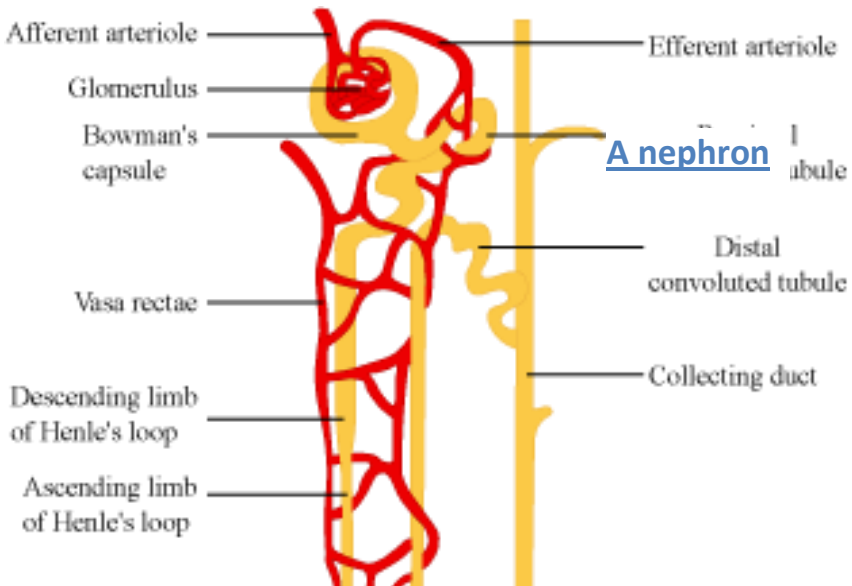
- kidneys(a pair)
- ureters(one pair)
- a urinary bladder
- a urethra

Kidneys

- are reddish brown, bean shaped structures situated between the levels of last thoracic and third lumbar vertebra close to dorsal inner wall of abdominal cavity.
- 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.

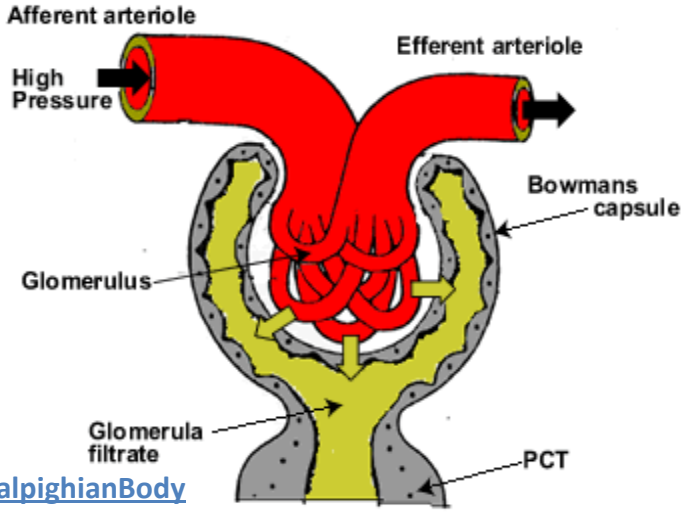
Internal Structure of Kidney

- **Hilum** - a notch towards the centre of inner concave surface of kidney. Through it ureter, blood vessels and nerves enter.
- **Renal pelvis-** a broad funnel shaped space inner to hilum.
- **Calyces-** are projections in the renal pelvis called calyces.
- **Capsule -** is a tough outer layer of kidney.
- **Cortex-**There are two zones inside the kidney. The outer zone is called cortex .
- **Medulla -** The inner zone inside the kidney is called medulla.
- **Medullary pyramids-** are conical masses in medulla which project into the calyces (sing.:
- calyx).
- **Columns of Bertini -** The cortex extends in between the medullary pyramids as renal columns called **Columns of Bertini.**
- **Nephrons** - complex tubular structures, which form the structural and functional units of kidney.
- Each kidney has nearly one million **nephrons.**
- Each nephron has two parts – the **glomerulus** and the **renal tubule**.



A nephron

- **Afferent arteriole -** a fine branch of renal artery entering Bowmen's capsule carrying blood to the glomerulus.
- **Glomerulus -** a tuft of capillaries formed by the afferent.
- **Efferent arteriole-** Blood from the glomerulus is carried away by an efferent arteriole.
- **Bowman's capsule -** renal tubule begins with a double walled cup-like structure called **Bowman's capsule**, which encloses the glomerulus.
- **Malpighian body or Renal corpuscle-** Glomerulus alongwith Bowman's capsule.
- **Proximal convoluted tubule** (PCT) **-** The renal tubule continues further to form a highly coiled network – **proximal convoluted tubule** (PCT).
- **Henle's loop -** A hairpin shaped, next part of the tubule which has a descending and an ascending limb.
- **Distal convoluted tubule** (DCT) – The ascending limb continues as another highly coiled tubular region called **distal convoluted tubule** (DCT).
- **Collecting duct-** a long, straight tube which extends from cortex of the kidney to the inner parts of medulla and DCTs of many nephrons open into it.
- **Renal pelvis -** many collecting ducts converge and open into the renal pelvis through medullary pyramids in the calyces.
- Malpighian corpuscle, PCT and DCT of the nephron are situated in the cortical region of the kidney whereas the loop of Henle dips into the medulla.



MalpighianBody

- **Cortical nephrons -** the nephrons (majority) in which, the loop of Henle is too short and extends only very little into the medulla.
- **Juxta medullary nephrons-** the nephrons (some) in which the loop of Henle is very long and runs deep into the medulla.
- **Peritubular capillaries-** The efferent arteriole emerging from the glomerulus forms a fine capillary network around the renal tubule called the peritubular capillaries.
- **Vasa recta -** A minute vessel of peritubular capillary network runs parallel to the Henle's loop forming a 'U' shaped *vasa recta*.
  - *Vasa recta* is absent or highly reduced in cortical nephrons.

Urine formation

- It involves three main processes which takes place in different parts of the nephron -

1) Glomerular filtration
2) Reabsorption and
3) Secretion

1) Glomerular filtration / ultra filtration

- First step in urine formation, is the filtration of blood, which is carried out by the glomerulus and is called **glomerular filtration**.
- On an average,1100-1200 ml of blood is filtered by kidneys per minute which constitute roughly 1/5th of the blood pumped out by each ventricle of the heart per minute.
- The glomerular capillary blood pressure causes filtration of blood through 3 layers, i.e., the endothelium of glomerular blood vessels, the
- epithelium of Bowman's capsule and a basement membrane between these two layers.
- **Podocytes**– are epithelial cells of Bowman's capsule which are arranged in an intricate manner so as to leave some minute spaces called filtration slits or slit pores.
- **Ultra filtration** - Blood is filtered so finely through these membranes, that almost all the constituents of the plasma except the proteins pass onto the lumen of the Bowman's capsule. Hence, considered as a process of **ultra filtration.**
- **Glomerular filtration rate** (GFR) -The amount of the filtrate formed by the kidneys per minute.
- GFR in a healthy individual is approximately 125 ml/minute, i.e., 180 litres per day.
- **Regulation of glomerular filtration rate -** The kidneys have built-in mechanisms for regulation of glomerular filtration rate.
  By juxta glomerular apparatus (JGA) –
  - is a special sensitive region formed by cellular modifications in the distal convoluted tubule and the afferent arteriole at the location of their contact.
  - efficient mechanism of regulation of GFR.
  - A fall in GFR activates the JG cells to release **renin** which can stimulate the glomerular blood flow and thereby the GFR back to normal.

2) Reabsorption

- **Reabsorption-**is the process in which nearly 99 per cent of the filtrate has to be reabsorbed by the renal tubules.
- **Tubular epithelial cells-** present in different segments of nephron perform this either by **active or passive mechanisms**.
- **Active mechanism** – When the substances are absorbed against their concentration gradient by the expenditure of energy.
- Substances like glucose, amino acids, Na+, etc., in the filtrate are reabsorbed actively.
- **Passive mechanism -** When the substances are absorbed along their concentration gradient.Their is no expenditure of energy.
- The nitrogenous wastes are absorbed by passive transport. -
- Reabsorption of water also occurs passively in the initial segments of the nephron .

3) Tubular secretion

- During urine formation, the tubular cells secrete substances like H^+, K^+ and ammonia into the filtrate.

- an important step in urine formation as it helps in the maintenance of ionic and acid base balance of body fluids.

FUNCTION OF THE TUBULES

Proximal Convoluted Tubule (PCT):

- **Reabsorption**- PCT is lined by simple cuboidal brush border epithelium which increases the surface area for reabsorption.
- Nearly all essential nutrients, and 70-80 per cent of electrolytes and water are reabsorbed by this segment.
- **Maintenance ofpH and ionic balance of body fluids-** by selective secretion of hydrogen ions, ammonia and potassium ions into the filtrate and by absorption of $HCO3^-$ from it.

Henle's Loop:

- **Maintenance of high osmolarity of medullary interstitial fluid** this region plays a significant role in it.
- 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 filtrate pass upward, it gets diluted due to the passage of electrolytes to the medullary fluid.

Distal Convoluted Tubule (DCT):

- **Conditional reabsorption of Na^+ and water** takes place in this segment.
- **Reabsorption of $HCO3^-$**.
- **Maintenance the pH and sodium-potassium balance in blood** by selective secretion of hydrogen and potassium ions and NH3.

Collecting Duct:

- **Concentration of urine** - Large amounts of water is reabsorbed from this region to produce a concentrated urine.

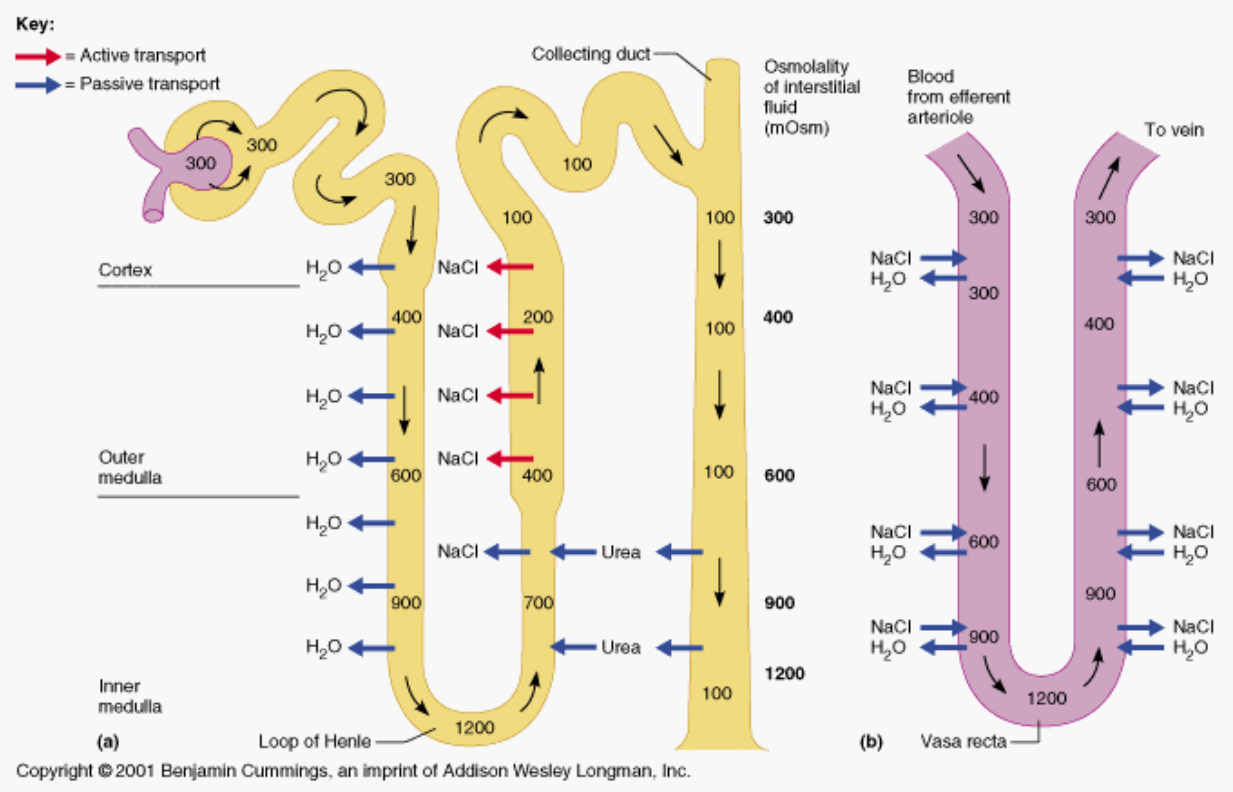
- This mechanism helps to maintain a concentration gradient in the medullary interstitium.
- Presence of such interstitial gradient helps in an easy passage of water from the collecting tubule thereby concentrating the filtrate (urine).
- Human kidneys can produce urine nearly four times concentrated than the initial filtrate formed.

- **Maintenance of osmolarity**- It allows passage of small amounts of urea into the medullary interstitium to keep up the osmolarity.
- **Maintenance of pH and ionic balance of blood** - by the selective secretion of H^+ and K^+ ions.

Mechanism of concentration of the filtrate /Counter current mechanism:

- The **Henle's loop** and ***vasa recta***play a significant role in this.
- **Counter current** - Flow of filtrate in the two limbs of Henle's loop is in opposite directions and thus forms a counter current.
  The flow of blood through the two limbs of *vasa recta* is also in a counter current pattern.
- The proximity between the Henle's loop and *vasa recta*, as well as the counter current in them help in maintaining an increasing osmolarity towards the inner medullary interstitium, i.e., from 300 $mOsmolL^{-1}$ in the cortex to about 1200 $mOsmolL^{-1}$ in the inner medulla.
- This gradient is mainly caused by **NaCl** and **urea.**
- **counter current mechanism**
  - NaCl is transported by the ascending limb of Henle's loop which is exchanged with the descending limb of *vasa recta*.
  - NaCl is returned to the interstitium by the ascending portion of *vasa recta*. Similarly, small amounts of urea enter the thin segment of the ascending limb of Henle's loop which is transported back to the interstitium by the collecting tubule.
  - This transport of substances facilitated by the special arrangement of Henle's loop and *vasa recta* is called the **counter current mechanism.**

Counter current mechanism



Regulation of kidney function

- The hypothalamus, JGA and the heart efficiently regulate the functioning of kidneys
- Osmoreceptors in the body are activated by changes in blood volume, body fluid volume and ionic concentration.
- **Hypothalamus**
  - Excessive loss of fluid from the body activates these receptors which stimulate hypothalamus to release **antidiuretic hormone (ADH) or vasopressin** from **neurohypophysis**.
  - ADH facilitates water reabsorption from DCT thereby preventing diuresis (excessive loss of water from the body).
  - **Increase in body fluid volume** can switch off the osmoreceptors and suppress the ADH release thus retaining the required water in the body.
  - ADH constricts blood vessels causing an increase in blood pressure which increases the glomerular blood flow and thereby the GFR.

- **JGA (Juxtaglomerular apparatus) and Renin-Angiotensin mechanism**
  - A fall in glomerular blood flow / glomerular blood pressure/GFR - activates JG cells to release **rennin.**
  - Angiotensinogen (blood)Angiotensin I

    ↓

    AngiotensinII
    (powerful vasoconstrictor)
    increases
    ↓
    Glomerular blood pressure and GFR

    Adrenal cortex Aldosterone (released)

    ↓

    reabsorption of Na+ and water from distal part of the tubule

    ↓

    Increase in blood pressure and GFR

- **Heart**

- Increase in blood flow to atria of heart causes release of **Atrial Natriuretic Factor** (ANF).
- ANF causes vasodilation (dilation of blood vessels) and thereby decreases blood pressure.
- ANF mechanism acts as a check on the renin-angiotensin mechanism.

MICTURITION

Urine formed gets stored in urinary bladder till a voluntary signal is given by the central nervous system (CNS) for contraction of smooth muscles of bladder and simultaneous relaxation of the urethral sphincter causing the release of urine character.

Role of other organs in excretion:

- **Lungs** - remove large amounts of CO_2 (18 litres/day) and also significant quantities of water every day.
- **Liver-** secretes bile-containing substances like bilirubin, biliverdin, cholesterol, degraded steroid hormones, vitamins and drugs. Most of these substances ultimately pass

- An adult human excretes, on an average, 1 to 1.5 litres of urine per day.
- The urine formed is a light yellow coloured watery fluid which is slightly acidic (pH-6.0) and has a characteristic odour. On an average, 25-30 gm of urea is excreted out per day. Various conditions can affect the characteristics of urine.
- Analysis of urine helps in clinical diagnosis of many metabolic disorders as well as malfunctioning of the kidney.
- For example, presence of glucose (Glycosuria) and ketone bodies (Ketonuria) in urine are indicative of diabetes mellitus (due to lack of insulin secretion from Pancreas).

out alongwith digestive wastes.

Disorders of the excretory system

- **Uremia** - Malfunctioning of kidneys leading to accumulation of urea in blood and may lead to kidney failure.
- In such patients, urea can be removed by a process called **hemodialysis**.
- - Blood drained from a convenient artery is pumped into a dialysing unit after adding an anticoagulant (heparin).
    - The unit contains a coiled cellophane tube surrounded by a fluid

  (dialysing fluid) having the same composition as that of plasma except the nitrogenous wastes.
    - The porous cellophane membrance of the tube allows the passage of molecules based on concentration gradient.
    - As nitrogenous wastes are absent in the dialysing fluid, these substances freely move out, thereby clearing the blood.
    - The cleared blood is pumped back to the body through a vein after adding anti-heparin to it.
- **Kidney transplantation** - ultimate method in the correction of acute **renal failures** (kidney failure).
    - A functioning kidney is used in transplantation from a donor, preferably a close relative, to minimise its chances of rejection by the immune system of the host.
- **Renal calculi:** Stone or insoluble mass of crystallised salts (oxalates, etc.) formed within the kidney.
- **Glomerulonephritis:** Inflammation of glomeruli of kidney.

SOME IMPORTANT QUESTIONS:

1.Explain counter current mechanism.

2. Write the role of Henle's loop in Formation of Urine. In which group of organisms Henle's loop should be longer?

3. Explain the Role of Vasopressin in regulation of Kidney function.

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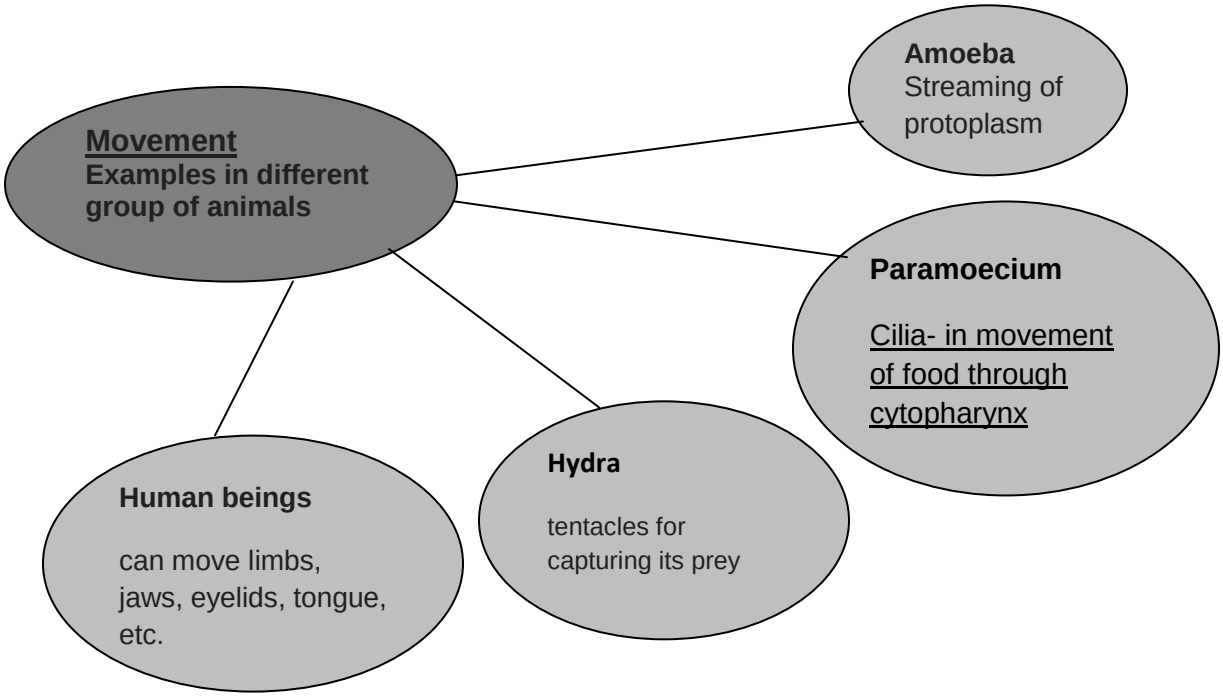
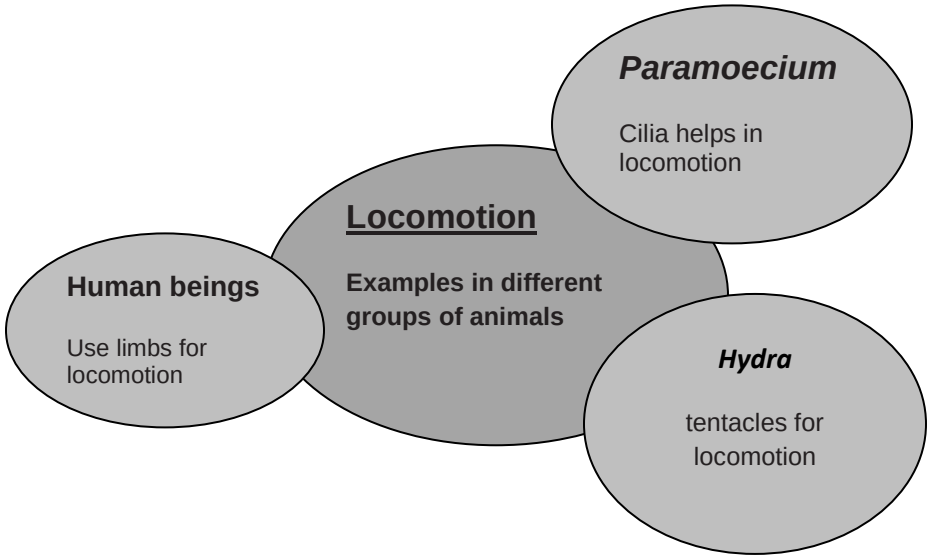
Chapter-20

Locomotion and Movement

- **Movement** - one of the significant features of living beings.

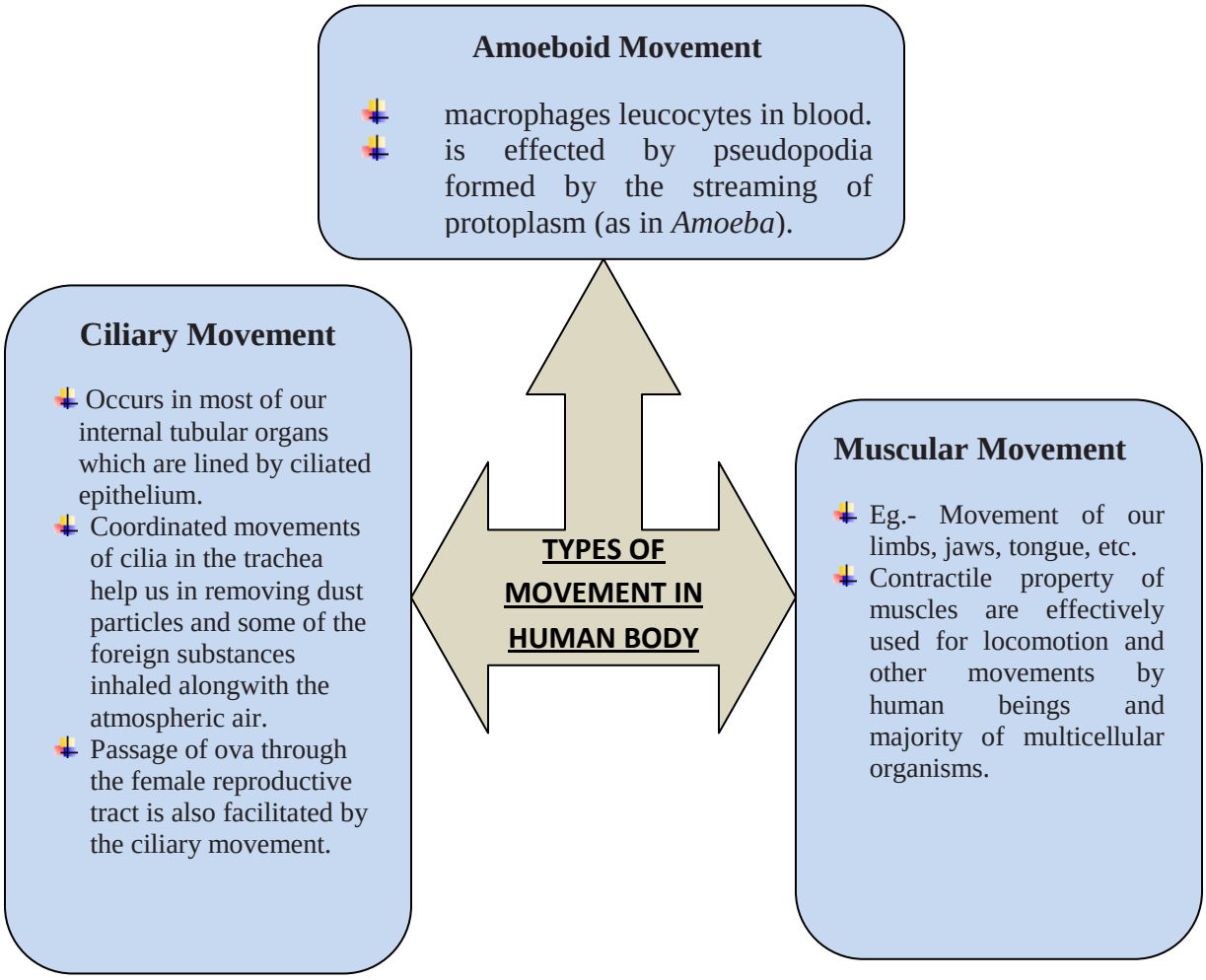


- **Locomotion -** Some voluntary movements result in a change of place or location. Walking, running, climbing, flying, swimming are some forms of locomotory movements.



- Hence,all locomotions are movements but all movements are not locomotions.

- Locomotion is generally for search of food, shelter, mate, suitable breeding grounds, favourable climatic conditions or to escape from enemies/predators.
- Locomotion requires a perfect coordinated activity of muscular, skeletal and neural systems.



Muscle

- Muscle - specialised tissue of mesodermal origin.
- They have special properties like excitability, contractility, extensibility and elasticity.
- Based on their location, three types of muscles are identified :

(i) Skeletal (ii) Visceral (iii) Cardiac.

- **Skeletal muscles**

- associated with the skeletal components of body.
- Striated muscles -They have a striped appearance under the microscope
- Voluntary muscles - As their activities are under the voluntary control of the nervous system.

-They are primarily involved in locomotory actions and changes of body postures.

- **Visceral muscles**

- located in the inner walls of hollow visceral organs of the body like the alimentary canal, reproductive tract, etc.
- Non-striated muscle - do not exhibit any striation.
- Smooth muscles - are smooth in appearance.
- Involuntary muscles- Their activities are not under the voluntary control of the nervous system.

-They assist in transportation of food through the digestive tract and gametes through the genital tract.

- **Cardiac muscles**

-are muscles of heart.
- Many cardiac muscle cells assemble in a branching pattern to form a cardiac muscle.

-Appearance - striated. Are involuntary in nature as the nervous system does not control their activities directly.

Structure of a skeletal muscle:

- **Muscle bundles** or **fascicles-** Many such fascicles are held together by a common collagenous connective tissue layer called **fascia** to form a skeletal muscle in our body.
- **Sarcolemma** – Plasma membrane lining each muscle fibre which encloses sarcoplasm.
- **Sarcoplasm** – Cytoplasm of a muscle cell. Muscle fibre is a syncitium as the sarcoplasm contains many nuclei.
- **Sarcoplasmic reticulum** -Endoplasmic reticulum of the muscle fibres which is the store house of calcium ions.
- **Myofilaments** or **Myofibrils** - a large number of parallel arranged filaments in the sarcoplasm.

-Each myofibril has alternate dark and light bands on it.

-Striated appearance of myofibril is due to the distribution pattern of two important proteins – Actin and Myosin.

-**Light band** contains actin and is called **I-band** or **Isotropic band**.

-**Dark band** called **'A' or Anisotropic band** contains myosin.

-Both proteins are arranged as rod-like structures, parallel to each other and also to longitudinal axis of the myofibrils.

-**Actin filaments** are thinner as compared to myosin filaments, hence are commonly called thin filaments.

-**Myosin filaments** are thick filaments.

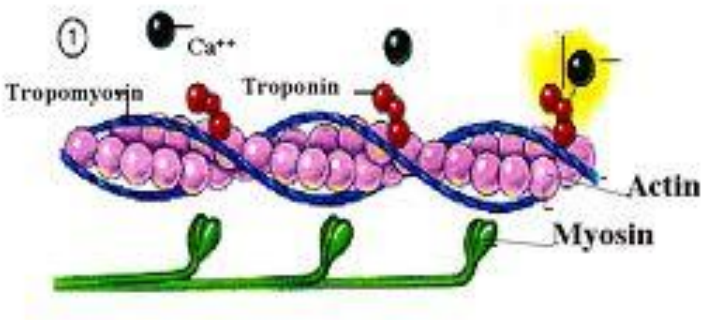
-'**Z' line** - an elastic fibre called 'Z' line which bisects 'I' band.

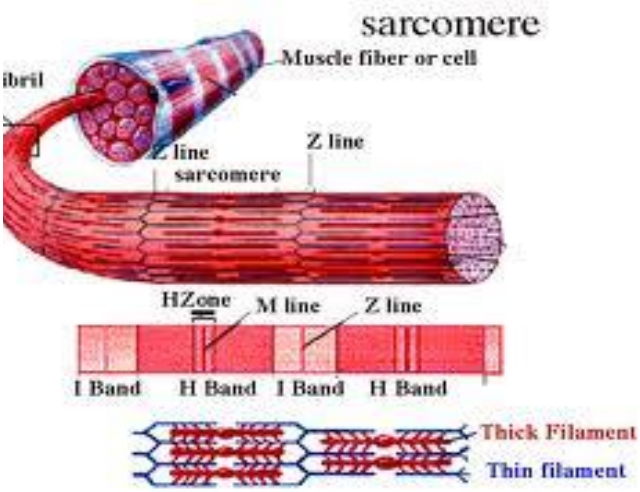
-Thin filaments are firmly attached to the 'Z' line.

- **'M' line**- A thin fibrous membrane that holds together the thick filaments in the middle of 'A' band.
-The 'A' and 'I' bands are arranged alternately throughout the length of the myofibrils.
- **Sarcomere** -Portion of myofibril between two successive 'Z' lines.
- is the functional unit of contraction.
-**'H' zone** - In resting state, central part of thick filament, not overlapped by thin filaments.

Structure of contractile proteins

- **Actin (thin) filament**- each made of two 'F' (filamentous) actins helically wound to each other.
  -'F' actin – each is a polymer of monomeric 'G' (Globular) actins.
  -Tropomyosin -Two filaments of this protein, also run close to the 'F' actins throughout the length of actin filament.
  -Troponin - A complex protein which is distributed at regular intervals on the tropomyosin.
  -In resting state a subunit of troponin masks the active binding sites for myosin on the actin filaments.
- **Myosin (thick) filament**- Each myosin filament is also a polymerised protein. – **Meromyosins**- monomeric proteins.
  - Many such proteins constitute one thick

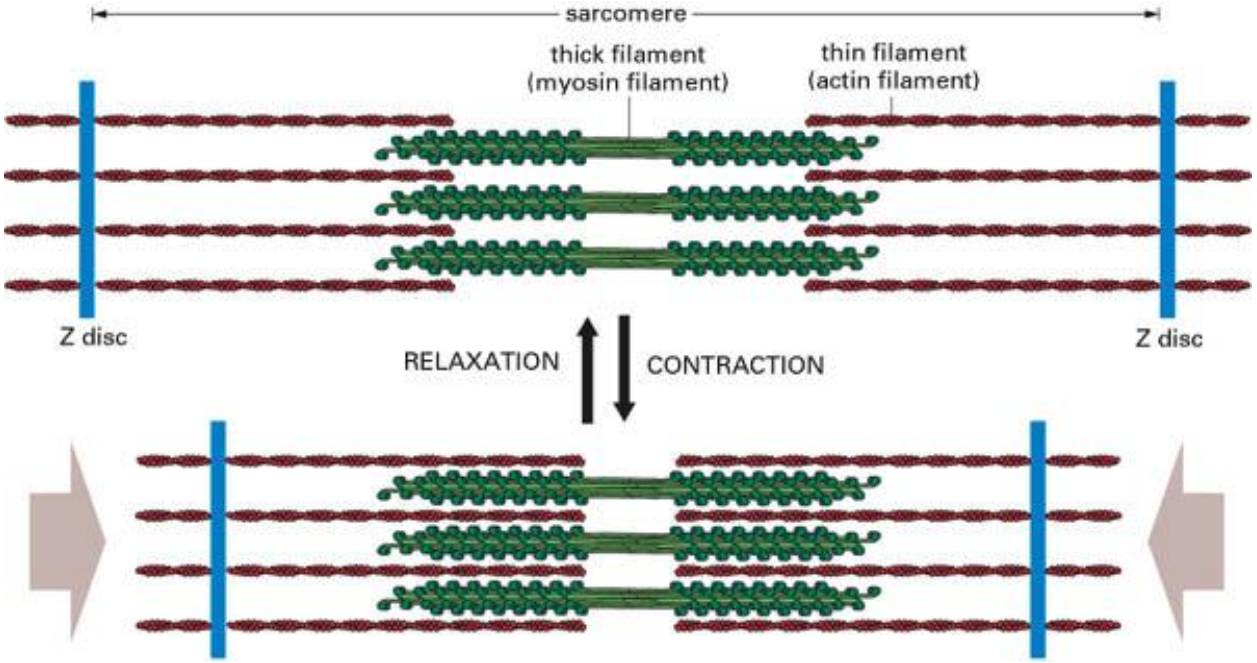




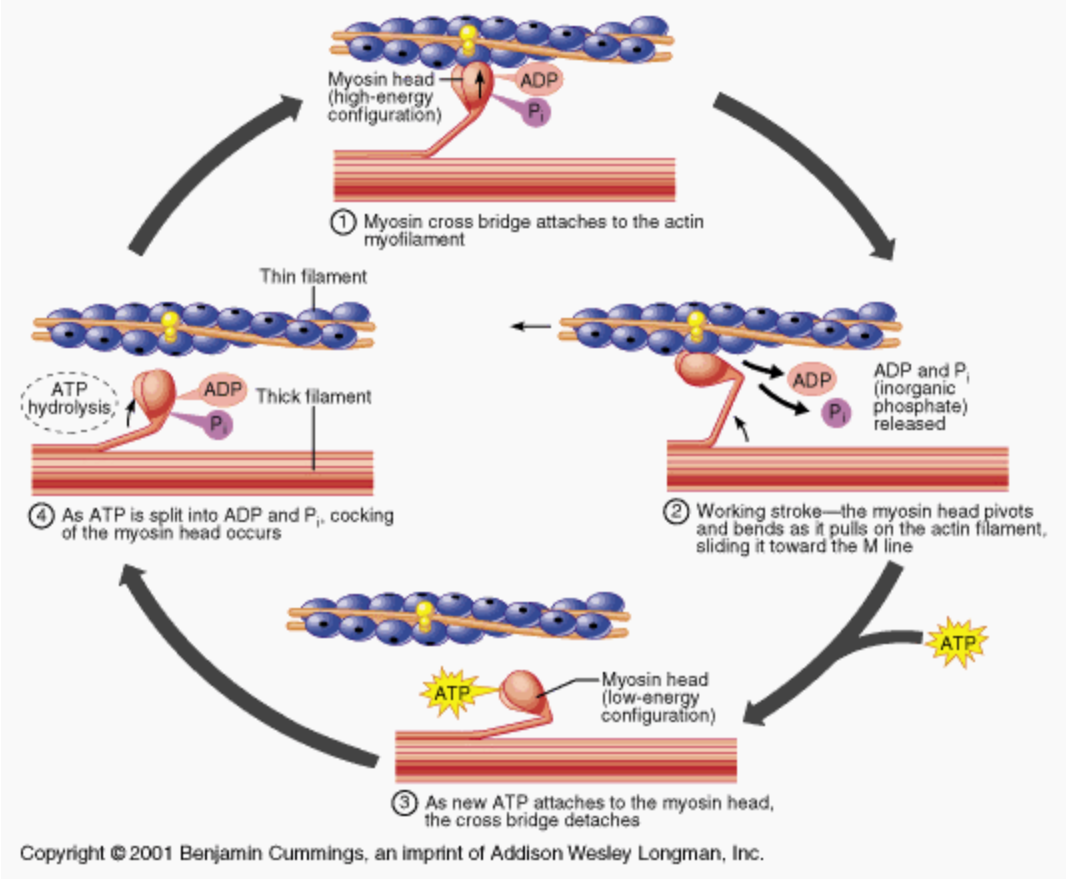
filament.
- Each meromyosin has two important parts, a globular head with a short arm (heavy meromyosin -HMM)and a tail (light meromyosin -LMM).
- **Cross arm** - HMM component, i.e. the head and short arm projects outwards at regular distance and angle from each other from the surface of a polymerised myosin filament and is known as cross arm.
-Globular head is an active ATPase enzyme and has binding sites for ATP and active sites for actin.

Mechanism of muscle contraction

- **Sliding filament theory** - states that contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments.
  - **A motor unit** - A motor neuron alongwith the muscle fibres.
  - **Neuromuscular junction or motor-end plate** - The junction between a motor neuron and sarcolemma of muscle fibre.
  - Muscle contraction is initiated by a signal sent by the central nervous system (CNS) via a motor neuron.
  - A neural signal reaching this junction releases a neurotransmitter (Acetyl choline) which generates an action potential in the sarcolemma.
  -This spreads through the muscle fibre and causes the release of calcium ions into the sarcoplasm.
  - Increase in Ca^{++} level causes binding of calcium with a subunit of troponin on actin filaments thus removing the masking of active sites for myosin.



Sliding Filament Theory Of Muscle Contraction



Formation and Breaking of Cross Bridge

Cross bridge - Utilising the energy from ATP hydrolysis, the myosin head now binds to the exposed active sites on actin and forms a cross bridge.

-This pulls the attached actin filaments towards the centre of 'A' band.

-The 'Z' line attached to these actins are also pulled inwards thereby causing a shortening of the sarcomere (contraction).

-Hence, during shortening of muscle (contraction), the **'I' bands get reduced, whereas the 'A' bands retain the length**.

-Myosin, releases ADP + Pi and goes back to its relaxed state.

-A new ATP binds breaking the cross-bridge .

-ATP is again hydrolysed by myosin head and the cycle of cross bridge formation and breakage is repeated causing further sliding.

-The process continues till the Ca^{++} ions are pumped back to the sarcoplasmic cisternae, resulting in masking of actin filaments.

-Causes the return of 'Z' lines back to their original position(relaxation).

- **Fatigue** - Repeated activation of the muscles can lead to the accumulation of lactic acid due to anaerobic breakdown of glycogen in them, causing fatigue.

- **Myoglobin** - A Red coloured oxygen storing pigment present in muscle, which gives a reddish appearance to them.

- **Red fibres/ Aerobic muscles -** Myoglobin content is high in some muscles which gives them a reddish appearance. Such muscles are called the Red fibres.
-They also contain plenty of mitochondria which can utilise large amount of oxygen stored in them for ATP production. Hence, also called aerobic muscles.

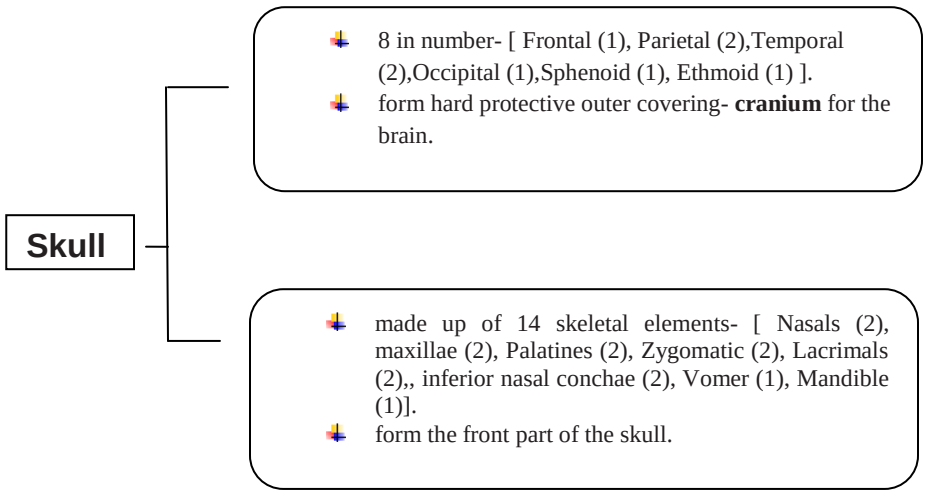
-**White fibres**- Some of the muscles possess very less quantity of myoglobin and therefore, appear pale or whitish.
-Number of mitochondria - also few in them, but the amount of sarcoplasmic reticulum is high and depend on anaerobic process for energy.

Skeletal System

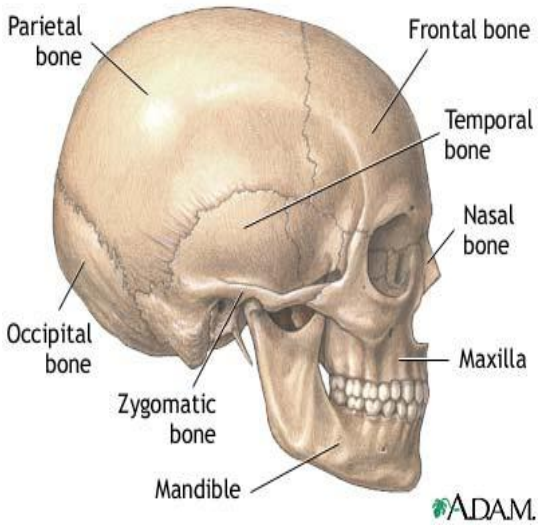
- Has a significant role in movement shown by the body.
- Consists of a framework of bones (206 bones) and a few cartilages (specialised connective tissues).
- **Bone -** has a very hard matrix due to calcium salts in it.
- **Cartilage -** has slightly pliable matrix due to chondroitin salts.
  is grouped into two principal divisions –
- **Axial skeleton** and **Appendicular skeleton**.

Axial skeleton

- comprises 80 bones distributed along the main axis of the body.
- Constitutes,**the skull**, **vertebral column**, **sternum** and **ribs**.
- **Skull (22 bones)**- composed of two sets of bones :



- Skull articulates wtth vertebral column with the help of two occipitalcondyles (dicondylic skull).

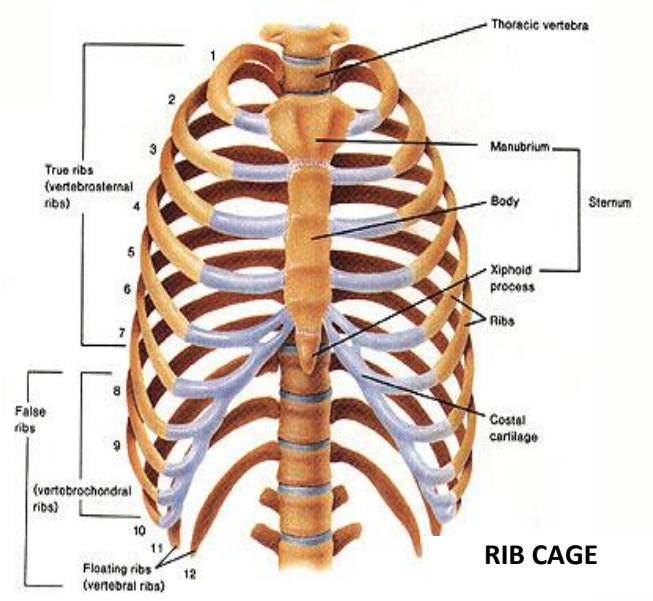


Skull

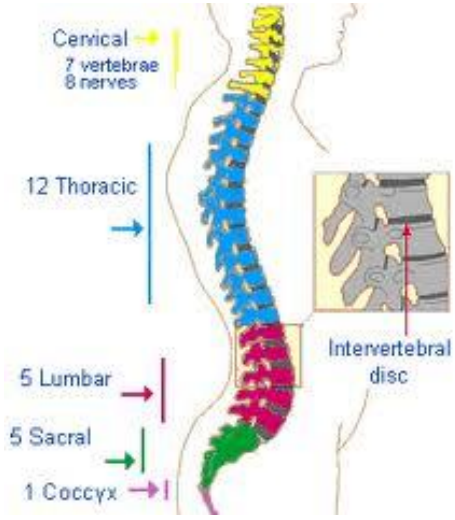
Vertebral column - is dorsally placed.

- Formed by 26 serially arranged units called vertebrae.
- Extends from the base of the skull and constitutes the main framework of the trunk.
- Each vertebra has a central hollow portion (neural canal) through which the spinal cord passes.
- First vertebra is atlas and it articulates with the occipital condyles.
- Vertebral column is differentiated into cervical (7), thoracic (12), lumbar (5), sacral (1-fused) and coccygeal (1-fused) regions starting from the skull.
- Vertebral column protects the spinal cord, supports the head and serves as the point of attachment for the ribs and musculature of the back.
- **Sternum -** is a flat bone on the ventral midline of thorax.
- **Ribs** -12 pairs of **ribs.**

  Each rib - a thin flat bone connected dorsally to the vertebral column and ventrally to the sternum.
- Has two articulation surfaces on its dorsal end and is hence called bicephalic.
- **True ribs**- First seven pairs of ribs.
- Dorsally, they are attached to the thoracic vertebrae and ventrally connected to the sternum with the help of hyaline cartilage.



RIB CAGE

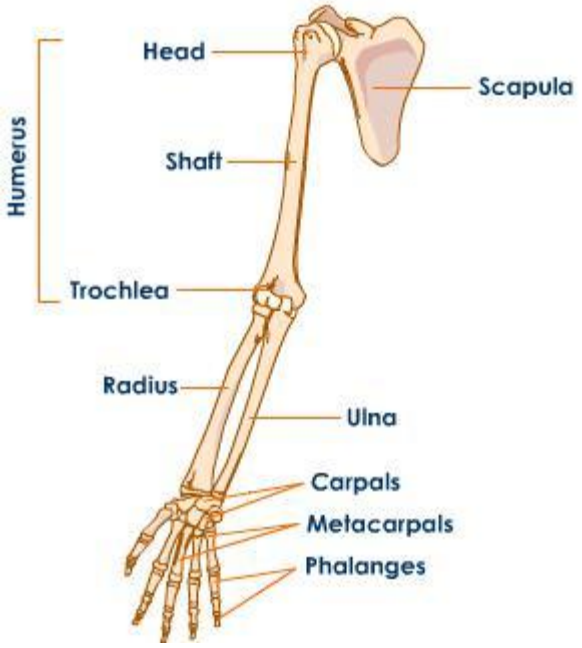


VERTEBRAL COLUMN

- **Vertebrochondral (false) ribs**-The 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.
- **Floating ribs -** Last 2 pairs (11th and 12th) of ribs which are not connected ventrally .
- **Rib cage** - Thoracic vertebrae, ribs and sternum together form the rib cage.

Appendicular skeleton

- **Bones of limbs** alongwith their **girdles** constitute the appendicular skeleton.
- **Bones of limbs –**
- Each **limb** is made of 30 bones.



- **Bones of hand** (**fore limb**) - **humerus**, **radius** and **ulna**, **carpals** (wrist bones – 8 in number), **metacarpals** (palm bones – 5 in number) and **phalanges** (digits – 14 in number).

- **Bones of the legs (hind limb)** - **Femur** (thigh bone – the longest bone), **tibia** and **fibula**, **tarsals** (ankle bones – 7 in number), **metatarsals** (5 in number) **phalanges** (digits – 14 in number) and a cup shaped bone called **patella** cover the knee ventrally (knee cap).

Pectoral and **Pelvic girdle** bones help in the articulation of upper and lower limbs, respectively with axial skeleton.

- **Pectoral girdle** - consists of a **clavicle** and a **scapula**.
- **Clavicle / collar bone** – Each clavicle is a long slender bone with two curvatures.
- **Scapula** is a large triangular flat bone situated in dorsal part of thorax between the second and seventh ribs.
- Dorsal, flat, triangular body of scapula has a slightly elevated ridge called - spine which projects as a flat, expanded acromion process.
- Clavicle articulates with this.

Fore Limb and Pectoral girdle

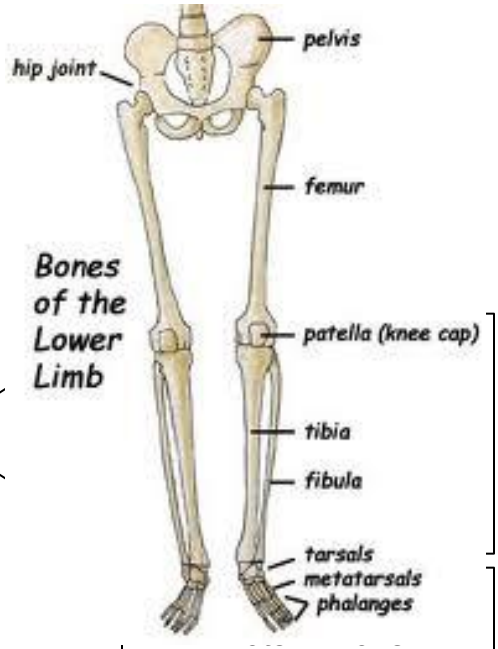
- **Shoulder joint** – Joint at which the glenoid cavity (depression below the acromion) articulates with the head of the humerus. **Pelvic girdle** - consists of two coxal bones.

- **Coxal bones -** Each is formed by the fusion of three bones – **ilium, ischium** and **pubis**.
- **Acetabulum -** cavity formed at the point of fusion of above bones, to which the thigh bone articulates.
- **Pubic symphysis -**The two halves of pelvic girdle meet ventrally to form pubic symphysis containing fibrous cartilage.
- **Pelvic joint** - Joint at which head of femur articulates with the acetabulum.

Joints

- Joints are points of contact between bones, or between bones and cartilages.
- Joints are essential for all types of movements involving the bony parts of the body.
- Force generated by muscles is used to carry out movement through joints, where the joint acts as a fulcrum.
- Joints have been classified into three major structural forms - **fibrous**, **cartilaginous** and **synovial**.
  - **Fibrous joints -** do not allow any movement.
- Eg.- flat skull bones which fuse end-to-end with the help of dense fibrous connective tissues in the form of sutures, to form the cranium.
  - **Cartilaginous joints -** the bones involved are joined together with the help of cartilages.
- Eg.- joint between the adjacent vertebrae in vertebral column is of this pattern and it permits limited movements.

  - **Synovial joints** – have a fluid filled synovial cavity between the articulating surfaces of two bones.
- Such an arrangement allows considerable movement.
- These joints help in locomotion and many other movements.
- Eg.- Ball and socket joint (between humerus and pectoral girdle), hinge joint (knee joint), pivot joint (between atlas and axis), gliding joint (between the carpals) and saddle joint (between carpal and metacarpal of thumb).



Osteoporosis:
- Age-related disorder characterised by decreased bone mass and increased chances of fractures.
- Common cause - decreased levels of estrogen.

Arthritis :
- Inflammation of joints.

Disorders of muscular and skeletal system

Tetany:
- Rapid spasms (wild contractions) in muscle due to

disorder.
- Affects neuromuscular Junction.
- Causes fatigue,

Q. Explain the sliding Filament theory of Muscle Contraction.

Q.2 Name the various bones of Fore limb along with their number.

Q.3 Which type of Girdle is present between femur and axial skeleton?

Q.4 Which pair of ribs is known as floating ribs and why?

Chapter-21

Neural Control and Coordination

Action potential: A sudden change in the electrical charges in the plasma membrane of a nerve fibre.

Aqueous humour : The thin watery fluid that occupy space between lens and cornea in eye.

Blind spot: A spot on retina which is free from rods and cones and lack the ability for vision.

Cerebrospinal fluid: An alkaline fluid present in between inner two layers of meninges.

Cerebellum: A part of hind brain that controls the balance and posture of the body.

Cochlea: A spirally coiled part of internal ear which is responsible for hearing.

Corpus callosum: A curved thick bundle of nerve fibres that joins two cerebral hemisphere.

Depolarisation: A condition when polarity of the plasma membrane of nerve fibre is reversed.

Endolymph: The fluid filled within membranous labyrinth.

Eustachian tube: A tube which connects ear cavity with the pharynx.

Fovea: An area of highest vision on the retina which contain only cones.

Meninges: Three sheets of covering of connective tissue wrapping the brain.

Grey Matter: This shows many convolutions which increase the amount of vital nerve tissue.

Medulla oblongata: Posterior most part of the brain which is continuous with spinal cord and control respiration, heart rate, swallowing, vomiting.

Pons: Thick bundles of fibres on the ventral side of brain below cerebellum.

Foramen magnum: A big aperture in the skull posteriorly through which spinal cord emerges out.

Spinal cord: A tubular structure connected with medulla oblongata of brain and situated in the neural canal of the vertebral column, covered by meninges.

Synaptic cleft: A narrow fluid filled space which separates two membranes of the two neurons at the synapse.

Synaptic vesicles: These are membrane bound vesicles in the axoplasm of the axon terminal and these store neurotransmitter.

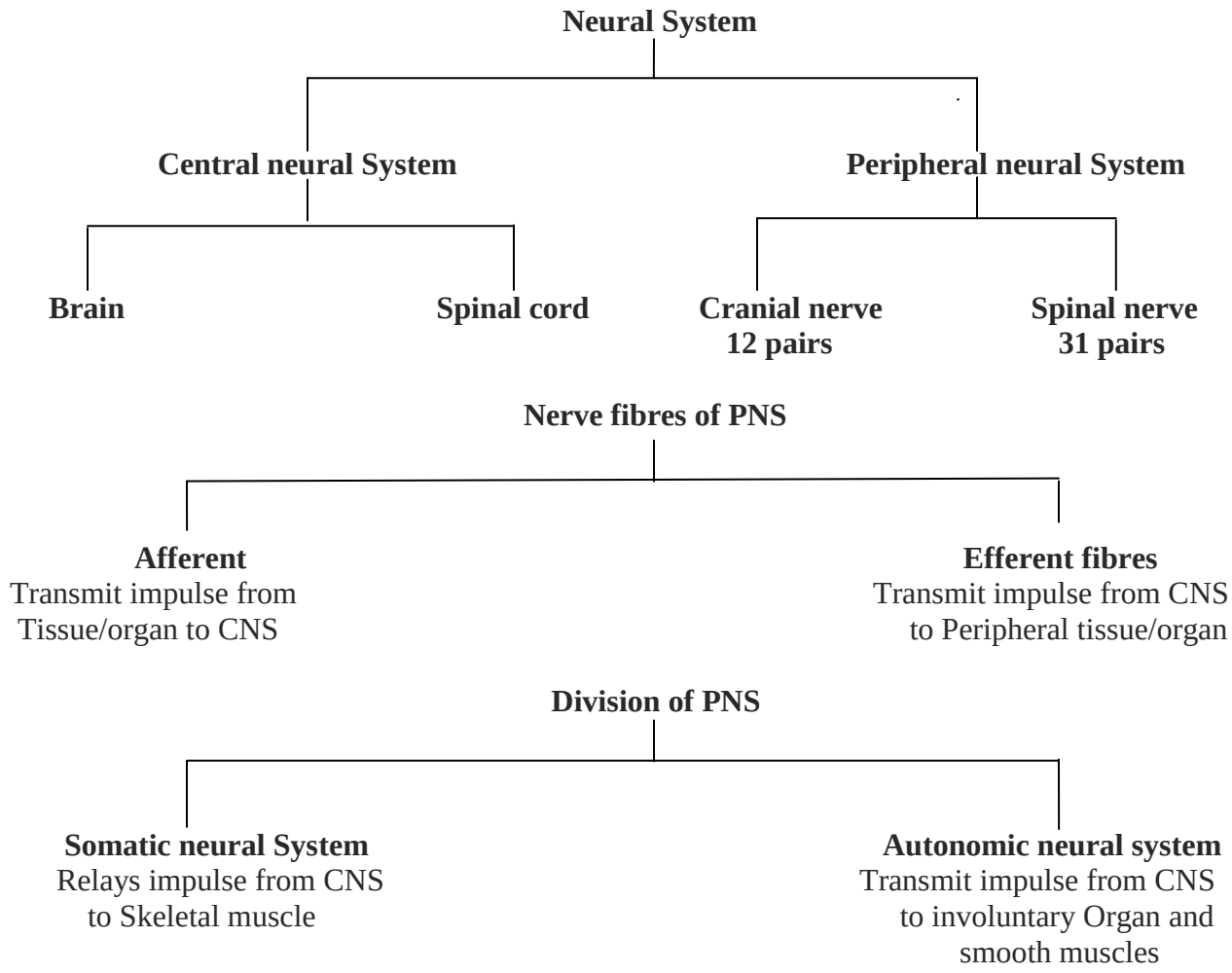
Neurotransmitter: These are chemicals stored in synaptic vesicles, diffuse to reach the membrane of next neuron for its stimulation. Eg Dopamine, acetyl choline.

Synapse: A physiological junction between axon of one neuron and dendrite of next neuron.

CNS − Central neural system

PNS − Peripheral neural system

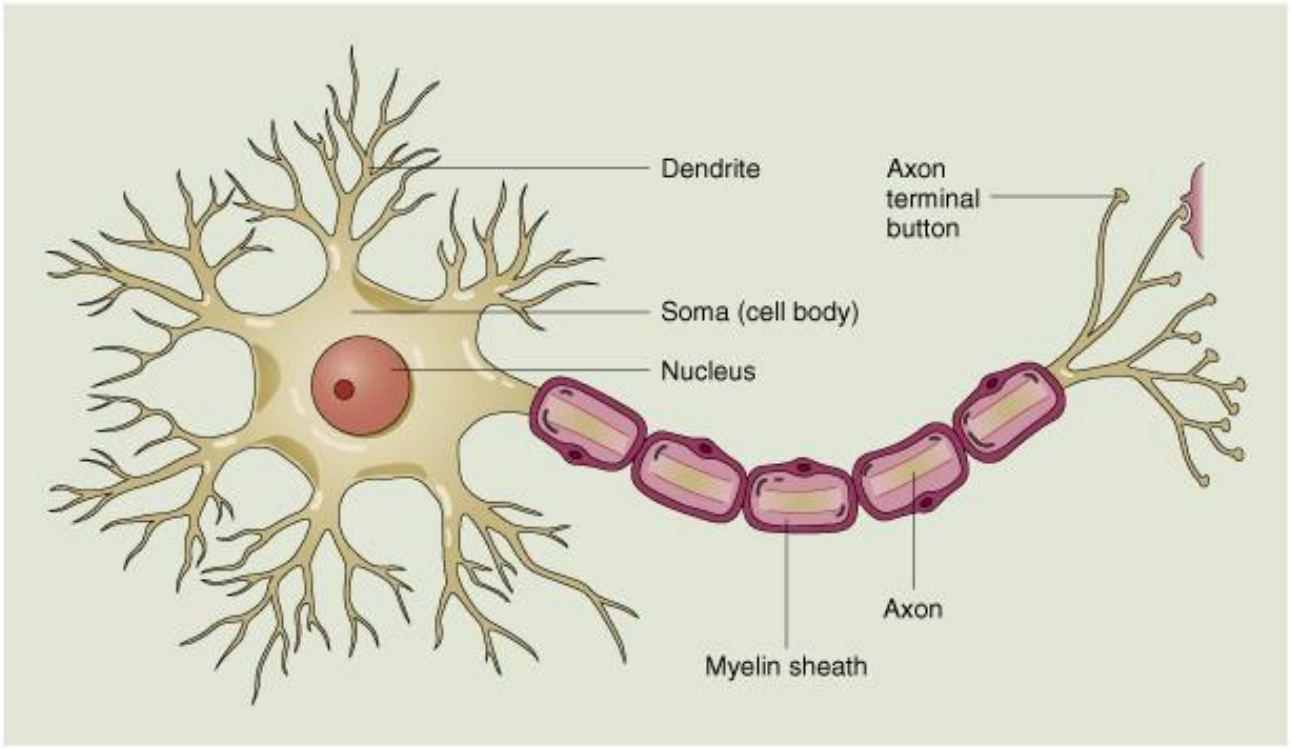
ANS − Autonomic neural system



PARTS OF NEURON:

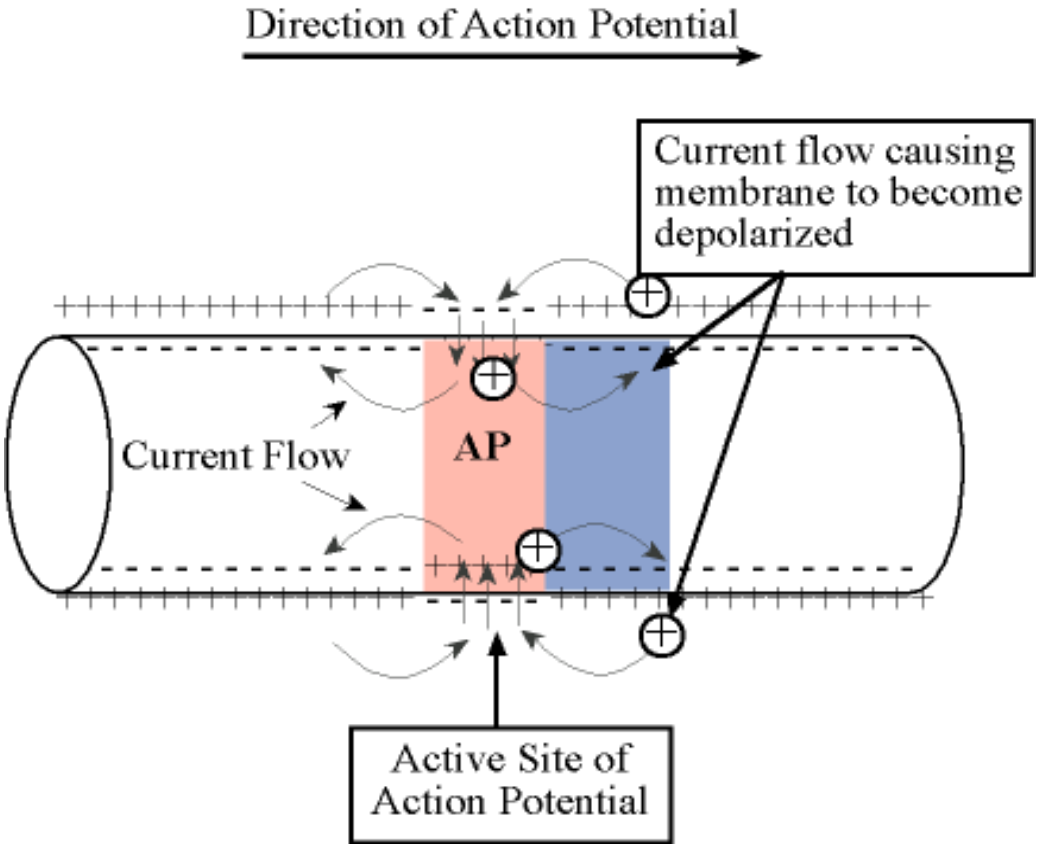
1. **Cell body =** Cytoplasm with nucleus, cell organelles and Nissl's granules
2. **Dendrites =** Short fibres which branch repeatedly and project out of cell.
3. **Axon =** Single, long fibre, branched at distal end.

4. **Multipolar Axon =** One axon and two or more dendrites. Found in cerebral Cortex.
5. **Bipolar Axon =** One axon and one dendrite. Found in ratina of eye.
6. **Unipolar Axon =** Cell body with axon only. Found usually in the embryonic stage.



A

Conduction of nerve impulse along axon:



Polarised membrane/Resting Potential-

In resting phase when neuron is not conducting an impulse, the axonal membrane is called polarised. This is due to difference in concentration of ions across the axonal membrane.

At Rest:

- Axoplasm inside the axon contains high conc. of K^+ and low conc. of Na^+.
- The fluid outside the axon contains low conc. of K^+ and high conc. of Na^+.

CONDUCTION OF NERVE IMPULSE

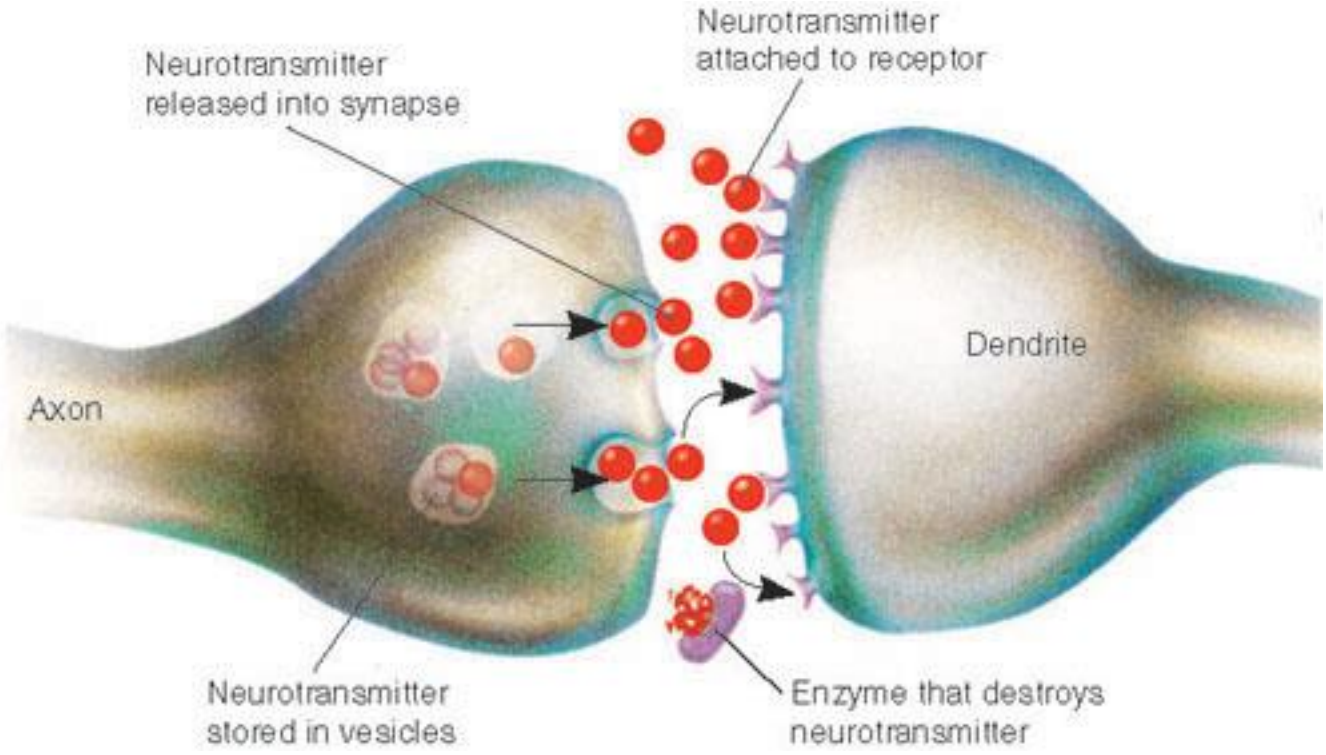
As a result the outer surface of axonal membrane is positively charged and inner surface is negatively charged. The electric potential difference across the resting plasma membrane is called resting potential.

Action Potential: When a nerve fibre is stimulated, the permeability of membrane to Na^+ is greatly increased at the point of stimulus (rapid influx of Na^+) and hence polarity of membrane is reversed and now membrane is said to be depolarised. The electric potential difference across the plasma membrane at that site is called action potential, which infact termed as nerve impulse. Depolarisation is very rapid, so that conduction of nerve impulse along the entire length of axon occurs in fractions of second.

Transmission of Impulses at Synapse:

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

(ii) At chemical synapses: Here the membrane of pre and post-synaptic neuron are separated by fluid filled space called synaptic cleft. Neurotransmitter is 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 bindings open ions channels and allow the entry of ion which generate new potential in post synaptic neuron.



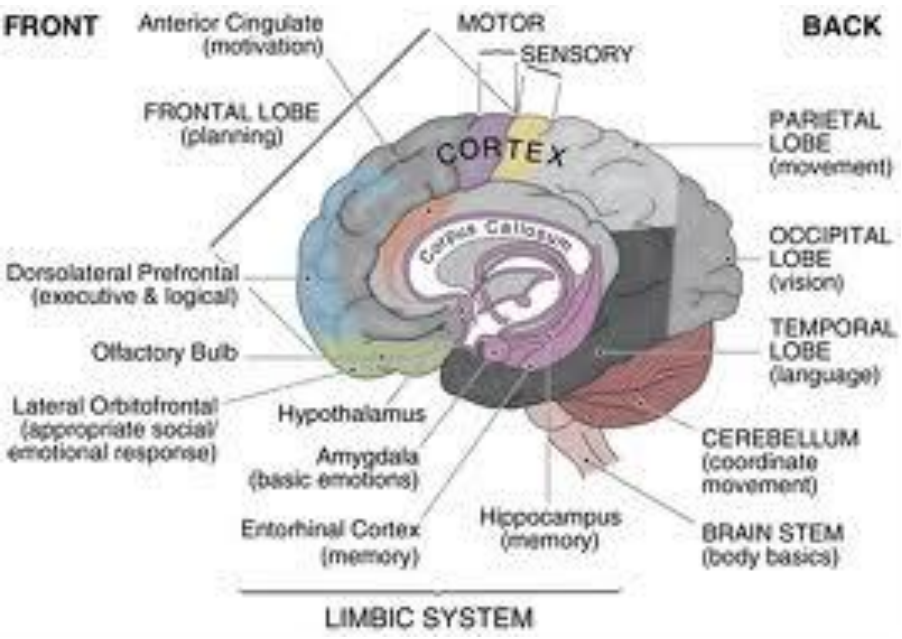
A SYNAPSE

Parts of Brain

Fore brain
(a) Cerebrum
(b) Thalamus
(c) Hypothalamus

Mid brain

Hind brain
(a) Cerebellum
(b) Pons
(c) Medulla oblongata



Sagittal Section of Human Brain

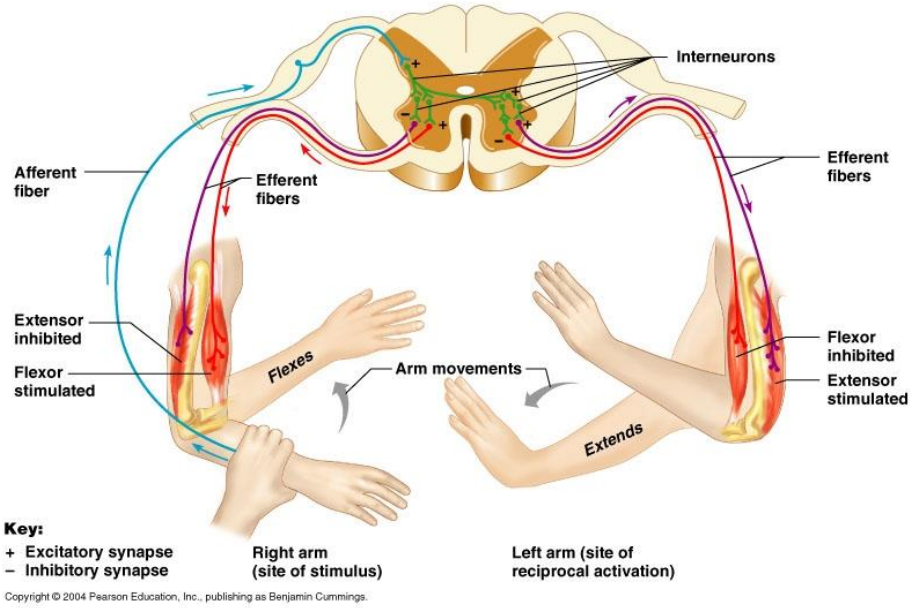
Functions of parts of brain:

Cerebrum: Centre of intelligence, memory and imagination, reasoning, judgement, expression of will power.
Thalamus: Acts as relay centre to receive and transmit general sensation of pain, touch and temperature.
Hypothalamus: Centre for regulation of body temperature, urge for eating and drinking.
Mid brain: Responsible to coordinate visual reflexes and auditory reflexes.
Cerebellum: Maintains posture and equilibrium of the body as well as coordinates and regulates voluntary movement.
Pons varoli: Relays impulses between medulla oblongata and cerebral hemisphere and between the hemisphere of cerebrum and cerebellum.
Medulla oblongata: Centre that control heart beat, breathing, swallowing, salivation, sneezing, vomiting and coughing.

Reflex Action: as a spontaneous, automatic and mechanical response to a stimulus acting on a specific receptor without the will of an animal.

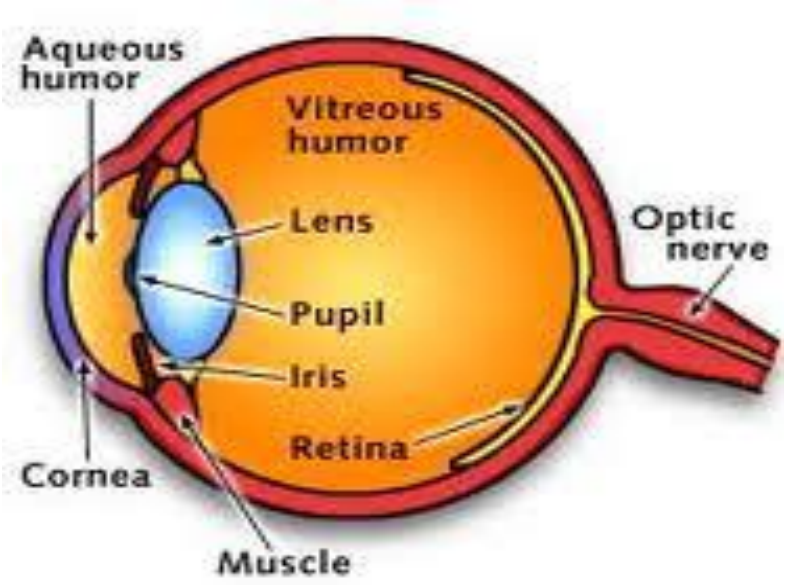
Eg.- movement of diaphragm during respiration, blinking of eyes, coughing, yawning, sneezing etc.

Reflex arc – The path travelled by an impulse in a reflex action is called a reflex arc. It comprises - i) A specific receptor, ii) an afferent nerve iii) a portion of central nervous system, iv) an efferent nerve, v) an effector.



Reflex action and Reflex arc

Organ of Sight – Eye:

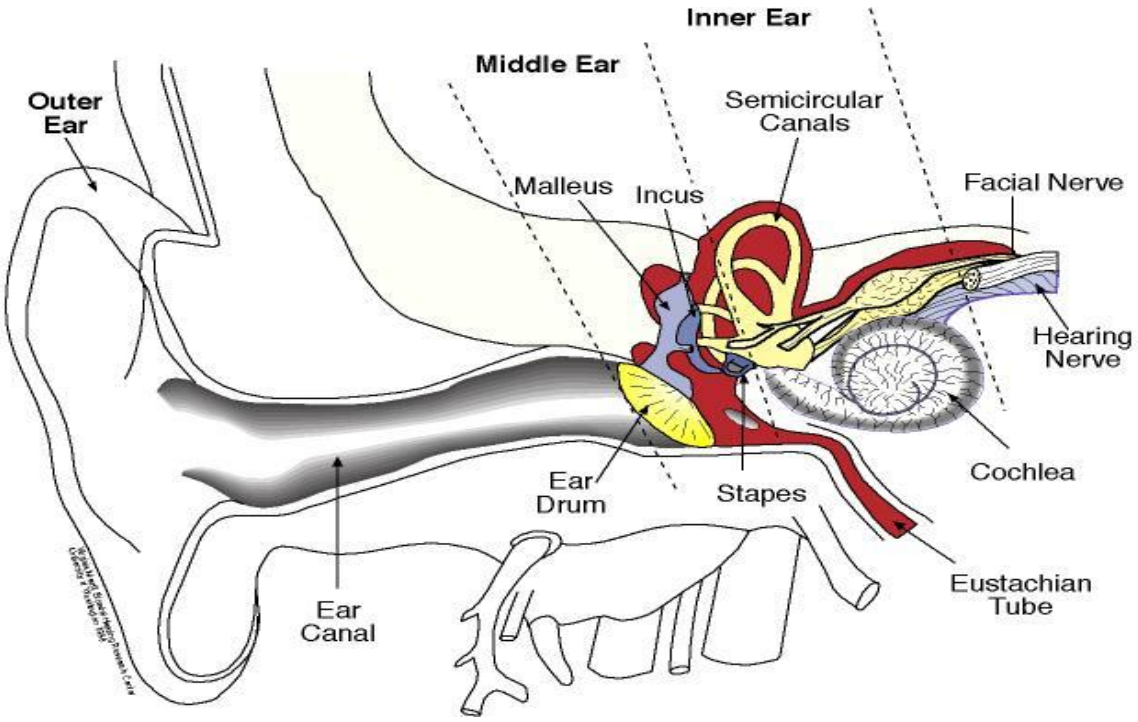


PARTS OF AN EYE

Layer	Component	Function
1. External	Sclera	Protects and maintain shape of the eye ball.

layer	Cornea	Helps to focus light rays.
2. Middle layer	Choroid	Absorb light and prevent light from being reflected within the eye ball.
	Ciliary body	Holds lens, regulate shape of the lens.
	Iris	Control amount of light entering.
3. Inner layer	Retina	Vision in dim light, colour vision, vision in bright light.

Organ of Hearing – Ear



Diagrammatic View of Ear

Portion of the Ear	Component	Function
1. External ear	Pinna	Collect sound waves.
	External auditory canal	Direct sound waves toward ear drum,ear wax prevents the entry of foreign bodies.
2. Middle ear	Tympanic membrane	Acts as resonator that reproduces the vibration of sound.
	Ear ossicles	Transmit sound waves to internal ear.
	Eustachian tube	Helps in equalising the pressure of either side of ear drum.
3. Internal ear	Cochlea	Hearing.
	Vestibular apparatus	Balancing of body.

SOME IMPORTANT QUESTIONS:

1. **Explain conduction of nerve impulse.**
2. **Which part of brain maintain body posture?**
3. **Explain the mechanism of Hearing.**
4. **Draw a labeled diagram of reflex arch.**

Chapter-22

Chemical Coordination & Integration

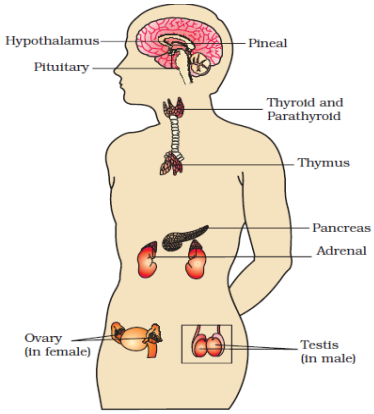
1. **Coordination -** Integration of function between different organs of body.
2. **Endocrine gland**- Ductless gland secreting hormone.
3. **Hormone**- intercellular messengers in trace amounts secreted by Endocrine glands.
4. **Hypoglycemia**- low blood glucose level.
5. **Hyper glycemia**- high blood glucose level.
6. **Diabetes mellitus**- loss of glucose through urine.
7. **Glycogenesis**- conversion of glucose into glycogen.

Introduction:

- Chemical coordination is through hormones.
- Hormones act on target tissue.
- Hormones & neural system together control & coordinate the body physiology.

Endocrine Glands & hormone:

- Ductless glands.
- Secretions are hormones which are directly poured into blood.
- Hormones are non- nutrient chemicals acting as inter-cellular messenger& are produced in trace amounts.



Location of endocrine glands

Human Endocrine System:

- Consist of-Endocrine Glands & diffused tissues or cells.
- Main glands are-Pituitary, Pineal, Thyroid, Adrenal, Pancreas, Parathyroid, Thymus & Gonad others are organs: Hypothalamus, Gastro-intestinal tract, Liver, Kidney, and Heart.

The Hypothalamus:

- Basal part of fore brain.
- Cell groups- called nuclei release hormones of two types-

1-Releasing Hormones- stimulate secretion of pituitary hormones e.g.GnRH.
2-Inhibiting Hormones- inhibit the release of Pituitary hormones.
e.g. Somatostatin.

- These hormones act on anterior pituitary.

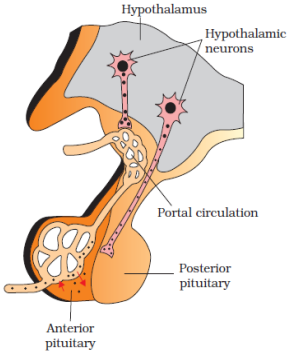


Figure 22.2 Diagrammatic representation of pituitary and its relationship with hypothalamus

The Pituitary Gland:

Pituitary (with Hypothythalamus)

- Placed in Sella Tursica
- Two parts- (1) Adenohypophysis having two regions –pars distalis & pars intermedia
  (2) Neurohypophysis
- Hormones of Pars distalis-

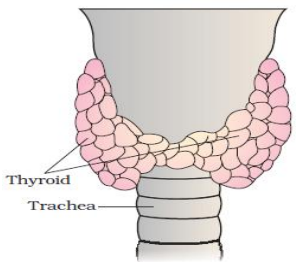
Hormones	Function
Growth Hormone (GH)	Controls body growth. Low secretion – dwarfism High secretion –Gigantism.
Prolactin (PR)	Controls growth of mammary gland & milk formation
Thyroid Stimulating Hormone(TSH)	Stimulates Synthesis & secretion of thyroid hormone
Adrenocorticotropic Hormone(ACTH)	Stimulates synthesis & secretion of glucocorticoids of Adrenal cortex
Luteinising Hormone(LH)	In males synthesis & secretion of androgens. In females induces ovulation.
Follicle Stimulating Hormone(FSH)	Growth & development of ovarian follicles

- Pars-intermedia- produces only one hormone- Melanocyte Stimulating Hormone (MSH).
- MSH regulates Melanin pigmentation of skin.
- Hormones of Neurohypophysis-

Hormones	Function
Oxytocin(birth hormone)	Acts on smooth muscles, uterus wall contraction during child birth, milk ejection.
Vasopressin(Antidiuretic Hormone ADH)	Stimulates resorption of water & electrolytes by kidney.

The Pineal Gland: On dorsal side of brain.

Hormone	Function



Melatonin	Regulates 24-hour rhythm of body & influences temperature, metabolism, pigmentation, menstrual cycle, body defence.

Thyroid Gland

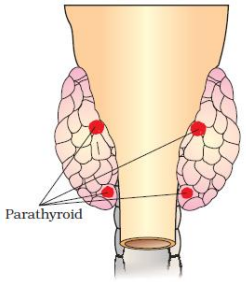
Thyroid Gland:

- Two lobes in gland joined with isthmus.
- Present on either side of trachea. Deficiency disease: Goitre. Hyper secretion-Exo-opthalamia.

Hormone	Function
Tetraiodothyronine or Thyroxin(T_4) & Triiodothyronine(T_3)	Regulate basic metabolic rate, support RBC formation
Thyrocalcitonin	Regulate blood calcium level.

Parathyroid Gland:

- Present on back side of Thyroid gland two in each lobe.
- Secrete one hormone - Parathyroid hormone which increases blood Ca^{++} level.



Parathyroid Gland

Thymus gland:

- Present on dorsal side of Heart & aorta.
- Secrete Thymosins hormone.
- Thymosins regulate T- Lymphocyte differentiation (Cell mediated immunity) & promote antibody formation (Humoral immunity).
- Thymus degenerates in old people.

Adrenal Gland:

- Present at anterior part of each kidney.
- Has two parts- outer cortex & central- medulla.

Hormone	Function
Adrenaline or epinephrine & Noradrenalin or Nor-epinephrine (Emergency Hormone)	Increase alertness, pupilary dilation, piloerection sweating etc, increase heart beat, rate of respiration, breakdown of glycogen into glucose.

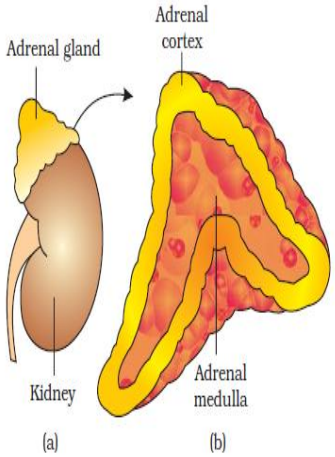


Figure 22.4 Diagrammatic representation of : (a) Adrenal gland on kidney (b) Section showing two parts of adrenal gland

Aldosterone	Balance of water & Electrolytes in body ,blood pressure,
Cortisol	Metabolism of carbohydrates, anti inflamatory reactions & suppress immune response.
Androgenic steroids	Growth of axial, pubic & facial hair.

Pancreas:

- Composite or mixed gland.
- Islet of Langerhans part is endocrine.
- Lack of insulin leads in to Diabetes Mellitus.

Hormone	Function
Glucagon(from α cells)	Glycolysis, increase blood glucose level
Insulin	Glycogenesis,Cellular uptake & utilisation of glucose

Testis:

- Present in scrotal sac.
- Leydig cells of testis produce androgens mainly Testosterone.
- Androgens regulate maturation & functioning of male sex organs, muscular growth, growth of facial & axial hair, aggressiveness, low pitch voice, spermatogenesis & libido.

Ovary:

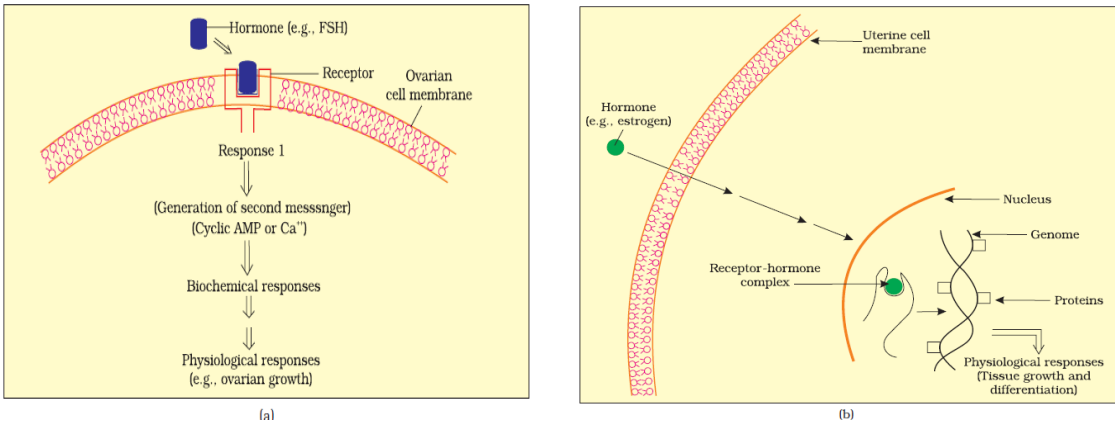
- Produce two groups of hormones-Estrogens & Progesterone.
- Estrogens regulate many actions *viz*. growth & function of female secondary sex organs, growth of ovarian follicles, high pitch voice, growth of mammary glands & sexual behaviour in females.
- Progesterone supports pregnancy & stimulates milk secretion.

Hormones of Heart, Kidney & Gastrointestinal Tract:

Organ	Hormone	Function
Heart	Atrial Natriuretic Factor	Reduces blood pressure.
Kidney	Erythropoetin	Formation of RBC.
Gastrointestinal Tract	Gastrin	Stimulates secretion of HCl & Pepsinogen in stomach.
,,	Secretin	Secretion of water & bicarbonate ions from pancreas.
,,	Cholecystokinin(CCK)	Secretion of pancreatic juice & bile juice.
,,	Gastric Inhibitory Peptide(GIP)	Inhibits gastric secretion & motility.
Several other non endocrine tissues	Growth Factor	Growth, repair& regeneration

Mechanism of Hormone Action:

- Hormones bind to hormone receptors of target tissue cells.
- Protein hormones bind to membrane bound receptors & steroid & thyroid hormones bind to intracellular receptors & make hormone- receptor complex.
- Former generates second messengers *viz*.cAMP, IP_3, Ca^{++} & later interact with genome.
- Above messengers or genome affects the cellular physiology giving required result.



Diagramatic representation of the mechanism of hormone action :
(a) Protein hormone (b) Steroid hormone

Q.1 Explain the mechanism of Hormone action.
Q.2 A persons with swollen throat has been suggested to take sea foods or iodized salt. Comment on possible disorder he is suffering from.\
Q.3 which hormone is considered as Emergency hormone and why?
****