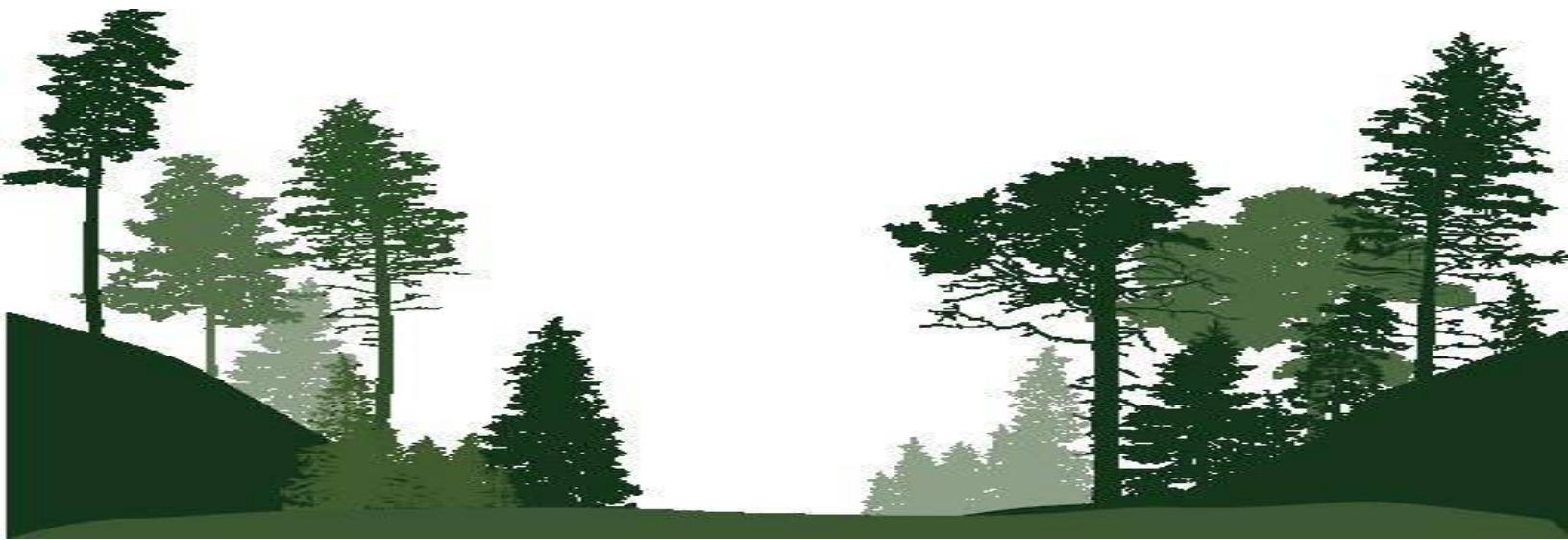
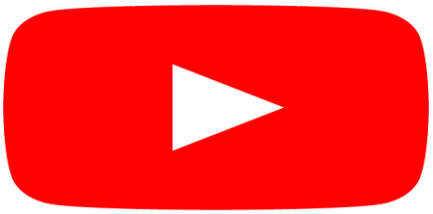
HIGHER SECONDARY ZOOLOGY
FOCUS AREA BASED NOTES
CLASS-11

Prepared by

Navas Cheemadan
HSST (Jr) Zoology
Sullamussalam Oriental HSS
Areekode
navas9895@gmail.com





Click the logo For Video lessons

Chapter-01
LIVING WORLD

Scientific Names

Scientific Name of Man : ***Homo sapiens***
Scientific Name of Housefly : ***Musca domestica***

Taxonomic AIDS

Taxonomical Aids

- Taxonomic studies of various species of plants, animals and other organisms are useful in agriculture, forestry, industry and in general in knowing our bio-resources and their diversity.
- These studies would require correct **classification and identification** of organisms.
- Identification of organisms requires **intensive laboratory and field studies.**
- The collection of actual specimens of plant and animal species is essential and is the prime source of taxonomic studies.
- It is used for classification of an organism, and the information gathered is also stored along with the specimens. In some cases the specimen is preserved for future studies.
- Biologists have established certain procedures and techniques to store and preserve the information as well as the specimens. Some of these taxonomic aids are explained below

1. Herbarium

- Herbarium is **a store house** of collected plant specimens that are dried, pressed and preserved on sheets.
- Further, these sheets are arranged. according to a universally accepted system of classification.
- These specimens, along with their descriptions on herbarium sheets, become a store house or repository for future use .
- The herbarium sheets also carry a label providing information **about date and place of collection, English, local and botanical names, family, collector's name**, etc.
- Thus Herbaria also serve as quick referral systems in taxonomical studies.

2.Botanical Garden

- These specialised gardens have **collections of living plants for reference**.
- Plant species in these gardens are grown for identification purposes and each plant is labelled indicating **its botanical/scientific name and its family.**

The famous botanical gardens (Royal botanical garden) are at Kew (England),

Indian Botanical Garden, Howrah (India) and at National Botanical Research Institute, Lucknow (India).

3.Museum

- Museums have collections of **preserved plant and animal specimens** for study and reference.
- Specimens are preserved in the containers or jars in preservative solutions.
- Plant and animal specimens may also be preserved as dry specimens.
- Insects are preserved in **insect boxes** after **collecting, killing and pinning.**
- Larger animals like birds and mammals are usually **stuffed** and preserved.

- Museums often have collections of **skeletons of animals** too.

4.Zoological Park

- These are the places where wild animals are kept in protected environments under human care
- This **enable us to learn about their food habits and behaviour.**
- All animals in a zoo are provided, as far as possible, the conditions similar to their natural habitats

5. Key

- Key is another taxonomical aid used for identification of plants and animals based on the **similarities and dissimilarities**.
- Each statement in the key is called a **lead**.
- The keys are based on the contrasting characters generally **in a pair** called **couplet.** It represents the choice made between two opposite options. This results in **acceptance of only one and rejection of the other**
- Separate taxonomic keys are required for each taxonomic category such as family, genus and species for identification purposes.
- Keys are generally analytical in nature.
- Flora, manuals, monographs and catalogues are some other means of recording descriptions. They also help in correct identification.

Other Taxonomic Aids

Besides above mentioned taxonomic aids, **Flora, manuals, monographs and catalogues** are some other means of recording descriptions and also serves as taxonomic aid for correct identification

Flora

- It contains the actual account of habitat and distribution of **plants of a given** area.
- These provide the index to the plant species found in a particular area.

Manuals

- They are useful in providing information for identification of **names of species** found in an area.

Monographs

- It contains information on **any one taxon.**

Catalogues

Scan QR code for video lessons

Chapter-02
ANIMAL KINGDOM

Symmetry

Animals can be categorised on the basis of their symmetry.

a) Asymmetry :

Here the body **cannot** be divided into two equal halves in any plane

Eg: Phylum Porifera

b) Radial symmetry :

When any plane passing through the central axis of the body divides the organism into two identical halves

Eg; Phylum Coelenterata
Phylum Ctenophora
Phylum Echinodermata

c) Bilateral symmetry :

Here the body can be divided into identical left and right halves in only one plane is called Bilateral symmetry

Germ layers

a) Diploblastic animals :

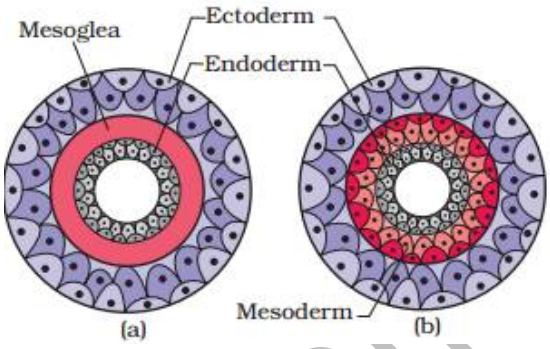
Animals in which the cells are arranged in two embryonic layers, **an external ectoderm and an internal endoderm**, are called diploblastic animals, An undifferentiated layer, **mesoglea**, is present in between the ectoderm and the endoderm

e.g., Phylum : coelenterate
Phylum : Ctenophora

b) Triploblastic animals :

Those animals in which the developing embryo has a **Three germinal layer, such as ectoderm, endoderm and mesoderm** are called triploblastic animals, Here the mesoderm is located in between the ectoderm and endoderm,

Eg Phylum Platyhelminthes to Chordata



Coelom :

The cavity present between body wall and gut is called **Coelom.** The body cavity is lined by **mesoderm** .Based On Coelom animals are classified into

a) **Acoelmate** :

Animals without coelom

Eg:Porifera,cnidaria,ctenophore, Platyhelminthes

b) **Pseudocoelomates:**

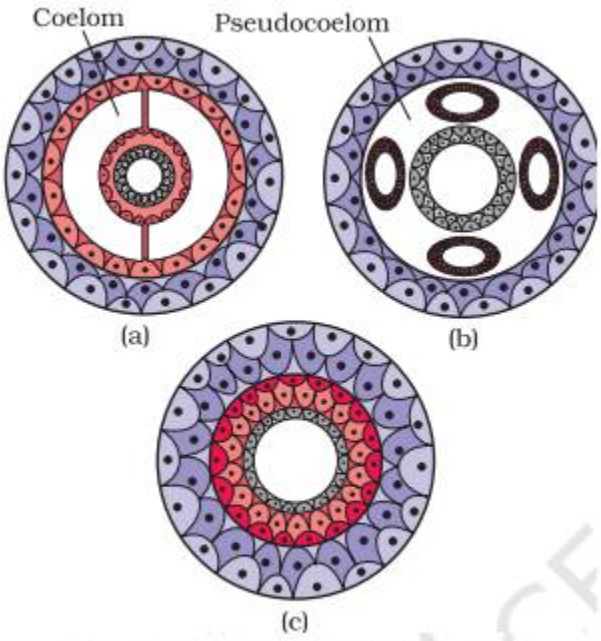
In some animals, the body cavity is not lined by mesoderm**, instead, the mesoderm is present as scattered pouches in between the ectoderm and endoderm.** Such a body cavity is called pseudocoelom and the animals possessing them are called pseudocoelomates,

e.g., Phylum aschelminthes

c) **Coelomates**

Animals possessing coelom are called **coelomates,**

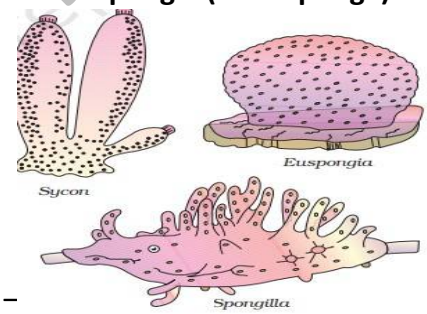
e.g.,annelids, molluscs, arthropods, echinoderms, hemichordates and chordates



Diagrammatic sectional view of :
(a) Coelomate (b) Pseudocoelomate
(c) Acoelomate

01-Phylum Porifera

- Sponges have a water transport or canal system.
- Water enters through minute pores (ostia) in the body wall into a central cavity, spongocoel, from where it goes out through the osculum.
- **Function of Water transport system**
  It is helpful in
  a)Food gathering,
  b)Respiratory exchange and
  c)Removal of waste.
- **Choanocytes or collar cells** line the spongocoel and the canals.
  - **Examples: Sycon (Scypha),**
  - **Spongilla (Fresh water sponge)**
  - **Euspongia (Bath sponge).**



02- Phylum Cnidaria (Coelenterata)

- The name cnidaria is derived from the cnidoblasts or cnidocytes (which contain the stinging capsules or nematocytes) present on the tentacles and the body.

  Functions of Cnidoblasts
  - ✓ It is used for anchorage,
  - ✓ It is used defense and
  - ✓ It is used for the capture of prey

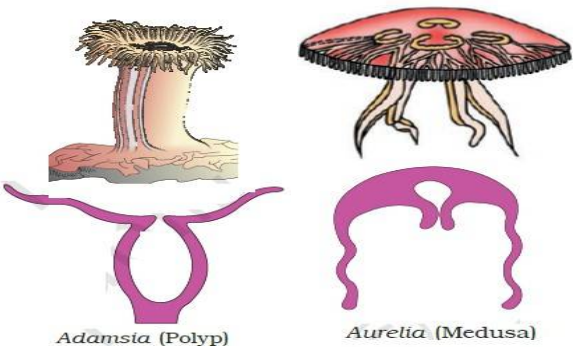
Diagrammatic view of Cnidoblast

- Cnidarians exhibit **two basic body forms** called **polyp and medusa**.The Polyp is a sessile and cylindrical form like Hydra, Adamsia, etc. whereas, the Medusa is umbrella-shaped and free-swimming like Aurelia or jelly fish. Those cnidarians which exist in both forms **exhibit alternation of generation (Metagenesis**), i.e., polyps produce medusae asexually and medusae form the polyps sexually (e.g., Obelia).
-

Polyp	**Medusa**
Sessile	Free swimming type
Cylindrical form	Umbrella shape
It produce medusa by asexual reproduction	It produce polyp sexual reproduction
Eg: Hydra, Adamsia	**Eg:Aurelia (Jelly fish)**

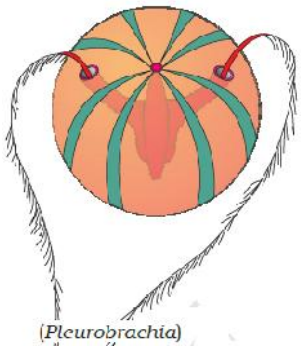
Examples:

Physalia (Portuguese man-of-war),
Adamsia (Sea anemone),
Pennatula (Sea-pen),
Gorgonia (Sea-fan) and
Meandrina (Brain coral).



03-Phylum Ctenophora

- Ctenophores, commonly known as sea walnuts or comb jellies
- The body bears eight external rows of ciliated **comb plates**, which help in locomotion
- Bioluminescence (the property of a living organism to emit light) is well-marked in ctenophores.
- **Examples:** ***Pleurobrachia* and *Ctenoplana***



04-Phylum platyheminthes

- These are mostly **endoparasites** found in animals including human beings

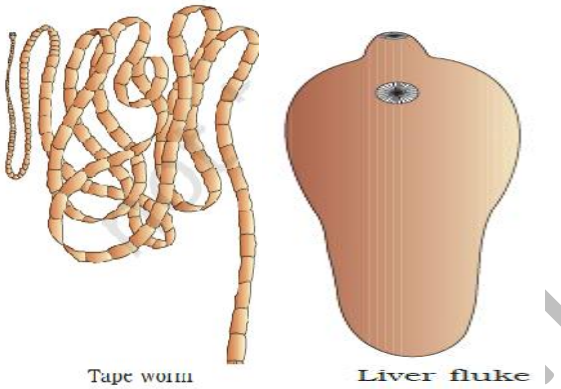
Parasitic adaptations

a) Hooks and suckers are present in the parasitic forms.

b) Some of them absorb nutrients from the host directly **through their body surface.**

c) **Presence of anaerobic respiration**

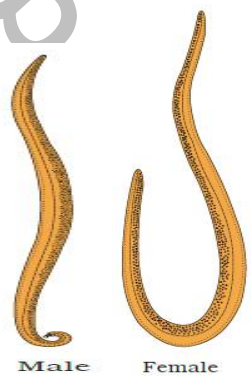
- Specialised cells called **flame cells** help in **osmoregulation and excretion.**
- **Examples:** ***Taenia* (Tapeworm),**
  ***Fasciola* (Liver fluke).**



05-Phylum Aschelminthes

- The body of the aschelminthes **is circular in cross-section, hence, the name roundworms**
- In Aschelminthes **females are longer than males**

Examples : Ascaris (Round Worm),
Wuchereria (Filaria worm),
Ancylostoma (Hookworm).



06-Phylum Annelida

- Their body surface is distinctly marked out into **segments or metameres** and, hence, the phylum name Annelida **(Latin, annulus : little ring)**
- Aquatic annelids like **Nereis** possess lateral appendages, **parapodia**, which help in swimming.
- **Nephridia** (sing. nephridium) **help in osmoregulation and excretion.**

Examples : Nereis,
Pheretima (Earthworm)
Hirudinaria (Blood sucking leech).

07- Phylum Arthrodpoda

- This is the **largest phylum** of Animal kingdom which includes insects
- Excretory Organ is **Malpighian tubules.**

Economically important insects –

Apis (Honey bee),
Bombyx (Silkworm),
Laccifer (Lac insect)

Vectors –

Anopheles, Culex and Aedes (Mosquitoes)

08-Phylum Mollusca

- This is the **second largest animal phylum**
- The animals belongs to this Phylum has a file-like rasping organ **for feeding, called radula** in the Mouth
- **Examples:**
  - ***Pila* (Apple snail),**
  - ***Pinctada* (Pearl oyster),**
  - ***Sepia* (Cuttlefish),**
  - ***Loligo* (Squid)**
  - ***Octopus* (Devil fish)**
  - ***Aplysia* (Seahare),**
  - ***Dentalium* (Tusk shell)**
  - ***Chaetopleura* (Chiton)**


Pila


Octopus

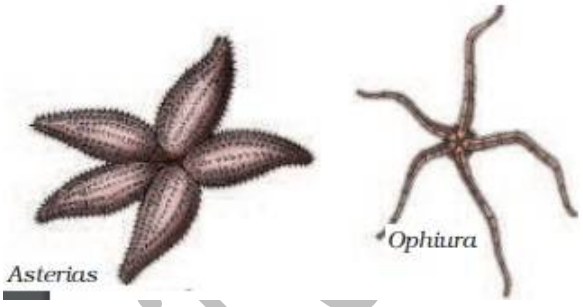
09-Phylum Echinodermata

- **The most distinctive feature of echinoderms is the presence of water vascular system**

Functions of water vascular system

a)It helps in locomotion,
b)It helps to capture and t**ransport of food**
c**)**Helps in **respiration.**

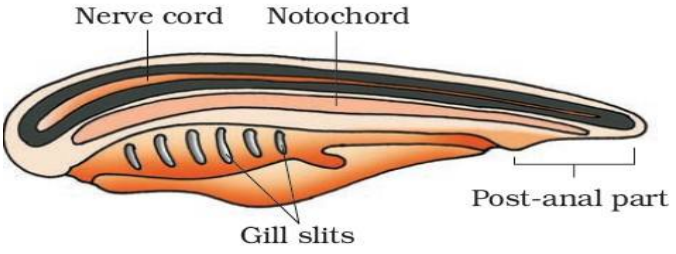
Examples: Asterias (Star fish),
Echinus (Sea urchin),
Antedon(Sea lily),
Cucumaria (Sea cucumber) and
Ophiura (Brittle star).


Asterias

Ophiura

10- Phylum Chordata

- Animals belonging to phylum Chordata are fundamentally characterised **by the presence of**
  - **a notochord,**
  - **a dorsal hollow nerve cord and**
  - **paired pharyngeal gill slits**
- These are bilaterally symmetrical, triploblastic, coelomate with organ-system level of organisation.
- They possess **a post anal tail** and a closed circulatory system



Chordata characteristics

Comparison between Chordates and Non chordates

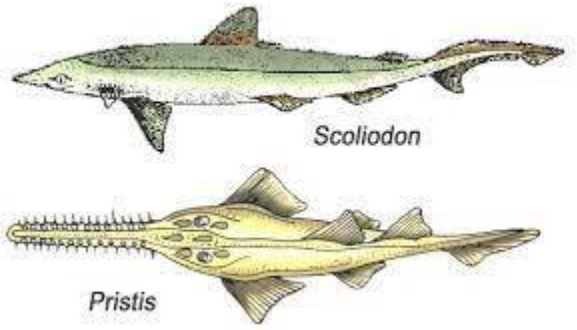
Chordates	Non-chordates
Notochord present.	Notochord absent.
Central nervous system is dorsal, hollow and single.	Central nervous system is ventral, solid and double.
Pharynx perforated by gill slits.	Gill slits are absent.
Heart is ventral.	Heart is dorsal (if present).
A post-anal part (tail) is present.	Post-anal tail is absent.

Super class Pisces

Class – Chondrichthyes

- Their skin is tough, containing minute **placoid scales**
- **They lack air bladder** ,Due to the **this bladder**, they have to swim constantly to avoid sinking

Examples: Scoliodon (Dog fish),
Pristis (Saw fish),



Class – Osteichthyes

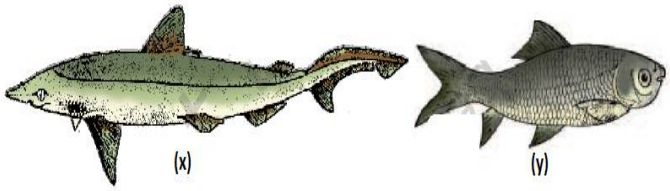
- **Air bladder is present** which regulates buoyancy
- Skin is covered with **cycloid/ctenoid scales**

Examples:

- **Hippocampus (Sea horse)** –Marine fiish
- **Catla (Katla)-Fresh water fish**

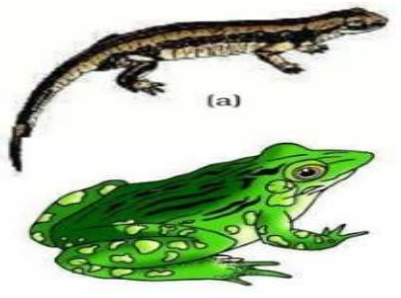
Difference between Chondrichthyes and Osteichthyes

Class – Chondrichthyes	Class – Osteichthyes
They are marine animals	It includes both marine and fresh water fishes
They have cartilaginous endoskeleton	They have bony endoskeleton.
Mouth is located ventrally	Mouth is mostly terminal
Gill slits are separate and without operculum (gill cover).	They have four pairs of gills which are covered by an operculum on each side
The skin minute placoid scales	Skin is covered with cycloid/ctenoid scales
Air bladder absent	Air bladder is present
many of them are viviparous	They are mostly oviparous



Class – Amphibia

- In Amphiia, Alimentary canal, urinary and reproductive tracts open into a common chamber called **cloaca** which opens to the exterior.
- Respiration is by **gills, lungs and through skin.**
- **Examples:**
  - **Rana (Frog)**
  - **Salamandra (Salamander),**



Examples of Amphibia :
(a) *Salamandra*
(b) *Rana*

Class – Reptilia

- The class name refers to their creeping or crawling mode of locomotion **(Latin, repere or reptum, to creep or crawl).**
- They are mostly terrestrial animals and their body is covered by **dry and cornified skin, epidermal scales or scutes**
- Snakes and lizards shed their scales as **skin cast.**

Examples: **Chelone (Turtle),**
Testudo (Tortoise),
Chameleon (Tree lizard),
Calotes (Garden lizard),
Crocodilus (Crocodile),
Alligator (Alligator).
Hemidactylus (Wall lizard),

- **Poisonous snakes – Naja (Cobra),**
Bangarus (Krait),
Vipera (Viper).

Class – Aves

The characteristic features of Aves (birds) are the presence of feathers and most of them can fly except flightless birds (e.g., Ostrich).

Flght adaptation of birds

a) They possess beak
b) The forelimbs are modified into wings
c) Endoskeleton is fully ossified (bony) and the long bones are hollow with air cavities (pneumatic).
d) Air sacs connected to lungs supplement respiration.

- The hind limbs generally have scales and are modified for walking, swimming or clasping the tree branches.
- Skin is dry without glands except the oil gland at the base of the tail.
- Respiration is by lungs.
  - *Examples :* ***Corvus*** **(Crow),**
  - ***Columba*** **(Pigeon),**
  - ***Psittacula*** **(Parrot),**
  - ***Struthio*** **Ostrich),**
  - ***Pavo*** **(Peacock),**
  - ***Aptenodytes*** **(Penguin),**
  - ***Neophron*** **(Vulture).**

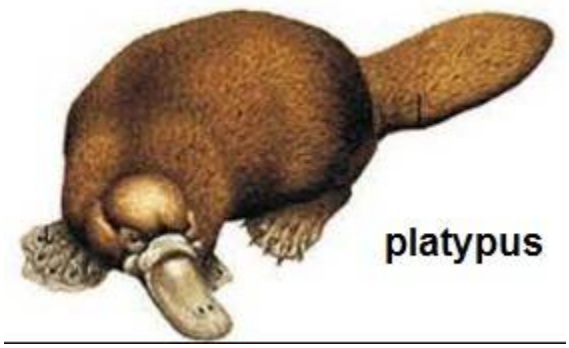
Class mammalia

- They are found in a variety of habitats – polar ice caps, deserts, mountains, forests, grasslands and dark caves. Some of them have adapted to fly(*Pteropus* (Flying fox) or live in water.
- **The most unique mammalian characteristic is the presence of milk producing glands (mammary glands) by which the young ones are nourished**.
- They have two pairs of limbs, adapted for walking, running, climbing, burrowing, swimming or flying
- The skin of mammals is unique in possessing hair.
- External ears or pinnae are present.
- Different types of teeth are present in the jaw.
- Heart is four chambered.
- They are homoiothermous.
- Respiration is by lungs.
- Sexes are separate and fertilisation is internal. They are viviparous with few exceptions and development is direct.

Examples :

Oviparous-
Ornithorhynchus (Platypus);

Viviparous -
Macropus **(Kangaroo),**
Pteropus **(Flying fox),**
Camelus **(Camel),**
Macaca **(Monkey),**
Rattus **(Rat),**
Canis **(Dog),**
Felis **(Cat),**
Elephas **(Elephant),**
Equus **(Horse),**
Delphinus **(Common dolphin),**
Balaenoptera **(Blue whale),**
Panthera tigris **(Tiger),**
Panthera leo **(Lion).**



Scan QR code for video lessons

Chapter-03
STRUCTURAL ORGANISATION IN ANIMALS

Animal Tissue

- Tissues are group of similar cells along with intercellular substances perform a specific function.
- Tissues are broadly classified into **four types**:

A) Epithelial tissue
B) Connective tissue
C) Muscular tissue
D) Neural tissue

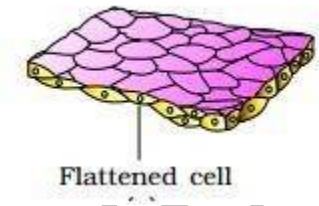
A) Epithelial tissue

- Epithelial tissues provide **a covering or a lining for some part of the body.**
- Based on the **number of layers,** epithelial tissues are of two types namely
  - **a)simple epithelium**
  - **b) Compound epithelium**

i)Simple epithelium

- it is composed of **a single layer of cells**
- On the basis of structural modification of the cells, simple epithelium is further divided into three types. These are
  - **i) Squamous epithelium**
  - **ii) Cuboidal epithelium**
  - **iii) Columnar epithelium**

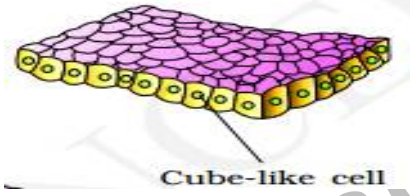
i) Squamous epithelium



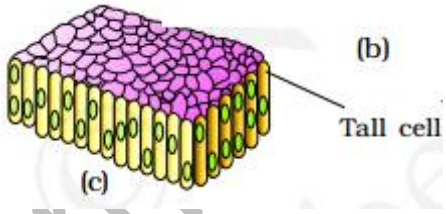
- The squamous epithelium is made of a single thin layer of **flattened cells** with irregular boundaries.
- **Location :**They are found in the walls of **blood vessels and air sacs of lungs**
- **Function:** They are involved in functions like forming a **diffusion** boundary.

ii) Cuboidal epithelium

- The cuboidal epithelium is composed of a single layer of **cube-like cells**.
- **Location :**This is commonly found in **ducts of glands and tubular parts of nephrons** in kidneys
- **Function:** its main functions are **secretion and absorption**.



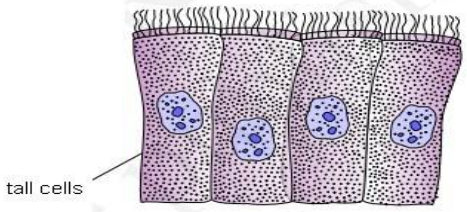
iii) Columnar epithelium



- The columnar epithelium is composed of a single layer **of tall and slender cells**.
- Their nuclei are located at the base.
- **Location :** They are found in the lining **of stomach and intestine and**
- **Function:** it **help in secretion and absorption.**

Ciliated Epithelium

- If the **columnar or cuboidal cells bear cilia on their free surface they are called ciliated epithelium** .
- Their function is to **move particles or mucus** in a specific direction over the epithelium.
- They are mainly present in the inner surface of hollow organs like **bronchioles and fallopian tubes**



.

Functional modification of epithelium

Some of the columnar or cuboidal cells get specialized for secretion and are called **glandular epithelium** They are mainly of two types:

i) Unicellular glandular epithelium:

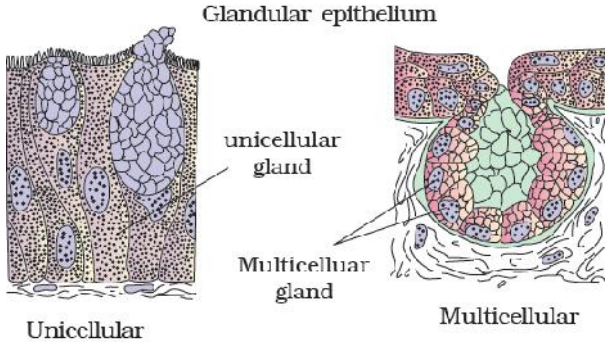
it consist of isolated glandular cells

eg: goblet cells of the alimentary canal

ii) Multicellular glandular epithelium,

it consist of cluster of cells

eg: salivary gland



Types of glands

On the basis of the mode of pouring of their secretions, glands are divided into two categories namely

i) Exocrine gland

ii) Endocrine glands.

i) Exocrine glands:

These glands secrete mucus, saliva, ear wax, oil, milk, digestive enzymes and other cell products. These products are **released through ducts or tubes**

ii) Endocrine glands

The secretion of these glands are called Hormones. they do not have ducts. The Hormones are secreted directly into the fluid (Blood). Hence this gland is called **ductless gland.**

Junctional Complex

In nearly all animal tissues, specialised junctions provide both structural and functional links between its individual cells. Three types of cell junctions are found in the epithelium and other tissues. These are called as

i) Tight junction,
ii) Adhering junction
iii) Gap junctions.

i) Tight junctions:

- Tight junctions **help to stop** substances from leaking across a tissue.

ii) Adhering junctions

- it perform **cementing** to keep neighboring cells together.

iii) Gap junctions

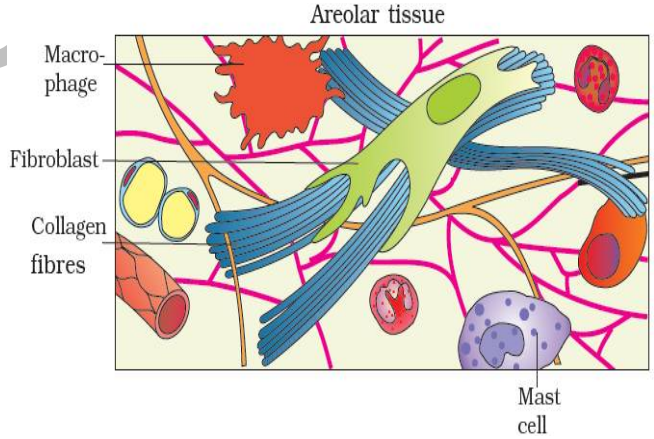
- it facilitate the cells **to communicate** with each other by **connecting the cytoplasm** of adjoining cells, for rapid **transfer of ions, small molecules and sometimes big molecule**

B) Connective tissue

- Connective tissues are **most abundant and widely distributed in the body of complex animals**.
- **They are named connective tissues because of their special function of linking and supporting other tissues/organs of the body.**

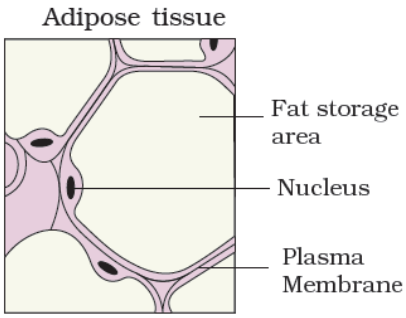
Areolar tissue:

- It is a connective tissue present beneath the skin.
- **Function :** it serves as a **support framework for epithelium**.
- It contains **fibroblasts** (cells that produce and secrete fibres), **macrophages and mast cells**.



Adipose tissue:

- It located mainly beneath the skin.
- **Function :** The cells of this tissue are specialised to **store fats.**
- **The excess of nutrients which are not used immediately are converted into fats and are stored in this tissue**



Tendon and Ligaments

These are dense regular connective tissue

Tendons:

It attach skeletal muscles to bones

2.ligaments

It attach one bone to another bone

C) Muscular tissue

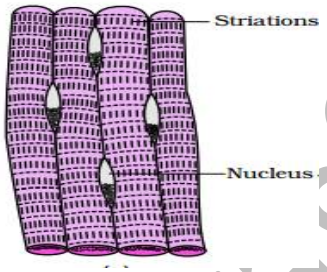
Muscles play an active role in all the movements of the body. Muscles are of three types,

i) Skeletal muscles

ii) Smooth muscles

iii) Cardiac muscles

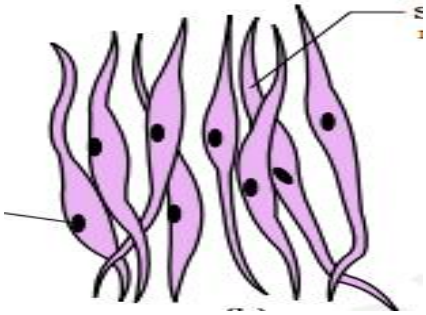
i) Skeletal muscles



- This tissue is closely attached to skeletal bones.
- They have a striped appearance under the microscope hence this muscles are also called **striated muscles or striped muscles.**
- As their activities are under the voluntary control of the nervous system, they are known as **voluntary muscles too.**
- They are primarily involved in locomotory actions and changes of body postures.

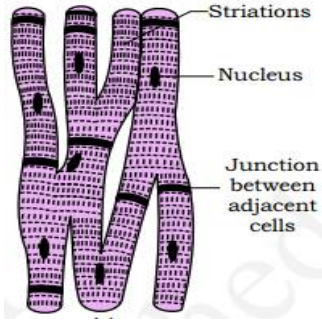
Eg: **biceps and triceps muscles**

ii) Smooth muscles



- The smooth muscle fibres **taper at both ends** (fusiform) and do not show striations ,hence the name smooth muscles/Non striped/Non striated msucles.
- Cell junctions hold them together and they are bundled together in a connective tissue sheath.
- This type of muscles is present in the wall of internal organs such as the **blood vessels, stomach and intestine.,hence called Viceral muscle.**
- Their activities are not under the voluntary control of the nervous system and are therefore known as **involuntary muscles.**
- They assist, for example, in the transportation of food through the digestive tract and gametes through the genital tract

iii) Cardiac muscles



- Cardiac muscles are the **muscles of heart .**
- Many cardiac muscle cells assemble in a **branching pattern** to form a cardiac muscle.
- **Communication junctions (intercalated discs**) at some fusion points **allow the cells to contract as a unit, i.**e., when one cell receives a signal to contract, its neighbours are also stimulated to contract.
- Based on appearance, **cardiac muscles are striated. They are involuntary** in nature as the

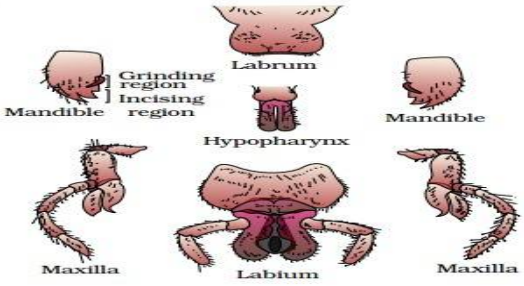
nervous system does not control their activities directly

D) Neural tissue

- Neurons, the unit of neural system are excitable cells.
- **The neuroglial cells protect and support neurons.**
- Neuroglia make more than one half the volume of neural tissue in our body

COCKROACH

- The mouth parts consisting of
  - **A labrum (upper lip),**
  - **A pair of mandibles,**
  - **A pair of maxillae**
  - **A labium (lower lip)**.
- A median flexible lobe, acting as tongue (**hypopharynx**), lies lies within the cavity enclosed by the mouthparts

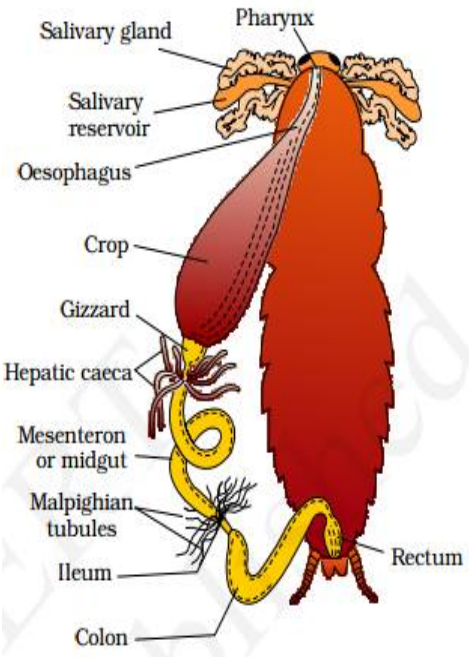


Digestive system

Digestive system consist of alimentary canal and digestive glands

Alimentary canal of Cockroach

The alimentary canal is divided into three regions: foregut, midgut and hindgut



a)foregut:

- it starts with **mouth**.
- The mouth opens into a short tubular **pharynx**, leading to a narrow tubular passage called **oesophagus**.
- This in turn opens into a sac like structure called **crop** used for **storing of food**.
- The crop is followed by **gizzard or proventriculus**.
- It has an outer layer of thick circular muscles and thick inner cuticle forming **six highly chitinous** plate called **teeth**.
- Gizzard helps in **grinding the food particles**. The entire foregut is lined by cuticle.
- A ring of 6-8 blind tubules called **hepatic or gastric caecae** is present at the junction of foregut and midgut, which secrete **digestive juice**.

b) midgut:

- At the junction of midgut and hindgut is present another ring of **100-150 yellow coloured thin filamentous Malpighian tubules**.
- They help in removal of excretory products from haemolymph.

c)Hindgut:

- The hindgut is differentiated into **ileum, colon and rectum**.
- The rectum opens out through anus

Nervous system

- The nervous system of cockroach consists of a series of fused, **segmentally arranged ganglia** joined by **paired longitudinal connectives** on the ventral side.
- **Three ganglia lie in the thorax, and six in the abdomen**.
- The nervous system of cockroach is spread throughout the body.
- **The head holds a bit of a nervous system while the rest is situated along the ventral (belly-side) part of its body**. That is why if the head of a cockroach is cut off, it will still live for as long as one week.
- The brain is represented by **supra-oesophageal ganglion** which **supplies nerves to antennae and compound eyes**.

Sensory organs

- In cockroach, the sense organs are **antennae, eyes, maxillary palps, labial palps, anal cerci,** etc.
- The compound eyes are situated at the dorsal surface of the head.
- Each eye consists of about **2000 hexagonal ommatidia** With the help of several ommatidia, a **cockroach can receive several images of an object. This kind of vision is known as mosaic vision with more sensitivity but less resolution, being common during night (hence called nocturnal vision**).

Chapter-04
BIOMOLECULES

Primary and secondary metabolites

- Metabolites are organic compounds constantly utilized in various metabolic activities in the cells.
- There are two types of metabolites

a)Primary metabolites:

- It is essential to the growth of the cell.
- They are produced continuously during the growth phase and are involved in primary metabolic processes such as respiration and photosynthesis
  Eg: **proteins, nucleic acids, and polysaccharides**

b)Secondary metabolites :

- They are the compounds which are derived by pathways from primary metabolic routs, and are not essential to sustain the life of cells.
- These compounds do not have a continuous production
- Secondary metabolites are the end products of primary metabolites such as alkaloids, toxins, steroids, essential oils, lectins, drugs etc

Some Secondary Metabolites

Pigments	Carotenoids, Anthocyanins, etc.
Alkaloids	Morphine, Codeine, etc.
Terpenoides	Monoterpenes, Diterpenes etc.
Essential oils	Lemon grass oil, etc.
Toxins	Abrin, Ricin
Lectins	Concanavalin A
Drugs	Vinblastin, curcumin, etc.
Polymeric substances	Rubber, gums, cellulose

Examples for some Proteins and their Functions

Some Proteins and their Functions

Protein	Functions
Collagen	Intercellular ground substance
Trypsin	Enzyme
Insulin	Hormone
Antibody	Fights infectious agents
Receptor	Sensory reception (smell, taste, hormone, etc.)
GLUT-4	Enables glucose transport into cells

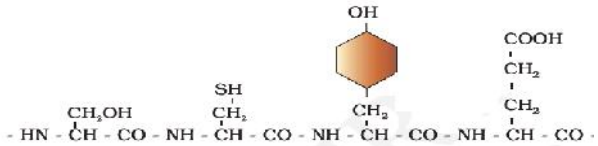
PROTEINS

- Proteins are polypeptides formed of number of amino acids linked together by means of **Peptide bond**.
- **Peptide bond is formed is formed when the carboxyl (-COOH) group of one amino acid reacts with the amino (-NH2) group of the next amino acid with the elimination of a water** (the process is called **dehydration**)
- Proteins are formed of number of **different amino acids** and hence proteins are **heteropolymers.**
- **Based on structure proteins can be classified into**
  - **a)Primary structure of proteins**
  - **b)Secondary structure of protein**
  - **c)Tertiary structure of protein**
  - **d)Quaternary structure**

a)Primary structure of proteins

- Here the amino acids are arranged in a line .If a protein is imagined as a line, the left end represented by the **first amino acid** and the right end represented by the **last amino acid.**

- The first amino acid is also called as N-terminal amino acid. The last amino acid is called the C-terminal amino acid.
- The primary structure of protein gives the **positional information** of amino acids in a protein.



b)Secondary structure of protein

- If the polypeptide is coiled to form of a helix (similar to a revolving staircase) the structure is called secondary structure of protein.
- In proteins, only **right handed helices** are observed.

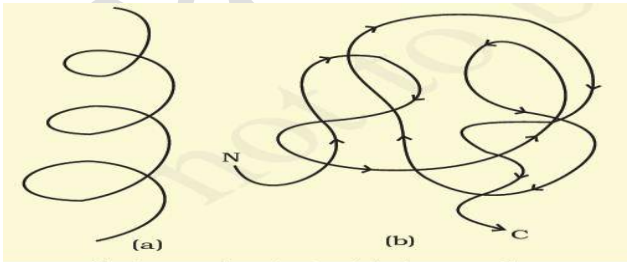
c)Tertiary structure of protein

- If protein chain is also folded upon itself like a hollow woolen ball, giving rise to the tertiary structure. 3-dimensional view of a protein.
- **Tertiary structure is absolutely necessary for the many biological activities of proteins.**

d)Quaternary structure

- If proteins are formed of more than one polypeptide chain or subunits
- The manner in which these individual folded polypeptides or subunits are arranged with respect to each other (e.g. linear string of spheres, spheres arranged one upon each other in the form of a cube or plate etc.) is the architecture of a protein otherwise called the quaternary structure of a protein.

Eg: **adult Haemoglobin** consist of 4 subunits. It consist of 2α and 2β chain.



Cartoon showing : (a) A secondary structure and (b) A tertiary structure of proteins

Nature of Bond linking monomer in a polymer

a)Peptide bond

- In a polypeptide or protein, amino acids are linked by peptide bond
- Peptide bond is formed is formed when the carboxyl (-COOH) group of one amino acid reacts with the amino (-NH2) group of the next amino acid with the elimination of a water (the process is called dehydration)

b)Glycosidic bond

- In a polysaccharide the individual monosaccharides are linked by glycosidic bond
- This bond is also formed by dehydration (elimination of water)

c)Phosphodiester bond

- In a nucleic acid a phosphate moiety links the 3' Carbon of one sugar of one nucleotide to the 5'-carbon of sugar of the succeeding nucleotide .
- The bond between, the phosphate and hydroxyl group of sugar is an ester bond. as there is one such ester bond on either side,it is called **phosphodiester bond**

Structure of DNA

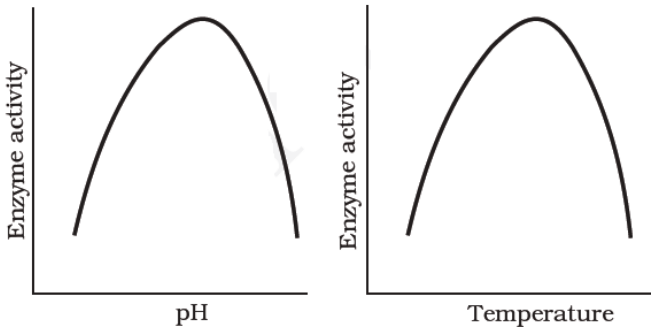
Structure of DNA-Scan QR Code for Part-01

Structure of DNA-Scan QR code for part-2

Factors affecting enzyme activity

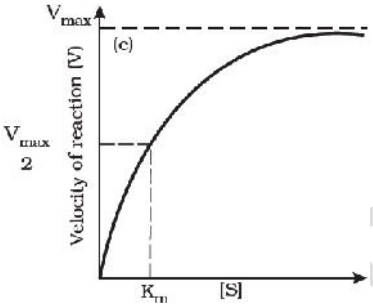
The activity of an enzyme can be affected by a change in the conditions which can **alter the tertiary structure of the protein**. These include temperature, pH, change in substrate concentration or binding of specific chemicals that regulate its activity

a)Temperature and pH



- Enzymes generally function in a narrow range of temperature and pH.
- Each enzyme shows its highest activity at a particular temperature and pH called the **optimum temperature** and **optimum pH.**
- Activity declines both below and above the optimum value.
- **Low temperature preserves the enzyme in a temporarily inactive state whereas high temperature destroys enzymatic activity** because proteins are **denatured by heat.**

b) Concentration of Substrate



- With the increase in substrate concentration, the velocity of the enzymatic reaction rises at first. The reaction ultimately reaches a maximum velocity (Vmax) which is not exceeded by any further rise in concentration of the substrate.
- This is because the enzyme molecules are fewer than the substrate molecules and after saturation of these molecules, **there are no free enzyme molecules to bind with the additional substrate molecules**

Classification and Nomenclature of Enzymes

Thousands of enzymes have been discovered, isolated and studied. Most of these enzymes have been classified into different groups based on the type of reactions they catalyse. Enzymes are divided into **6 classes** each with **4-13 subclasses** and named accordingly by a four-digit number.

1.Oxidoreductases/dehydrogenases:

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

S reduced + S' oxidised → S oxidised + S' reduced.

2.Transferases:

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

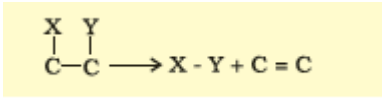
S - G + S' → S + S' - G

3.Hydrolases:

Enzymes catalysing **hydrolysis** of ester, ether, peptide, glycosidic, C-C, C-halide or P-N bonds.

4.Lyases:

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



5.Isomerases:

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

6.Ligases:

Enzymes catalysing **the linking together of 2 compounds,** e.g., enzymes which catalyse joining of C-O, C-S, C-N, P-O etc. bonds.

Co-factors

- The protein art of an enzyme is called **apoenzyme.**
- The non protein part of en enzyme is called **cofactor.**
- Three kinds of cofactors may be identified: **prosthetic groups, co-enzymes and metal ions.**

a)Prosthetic groups:

- They are organic compounds and are distinguished from other cofactors in that they are **tightly bound to the apoenzyme**.

Example:

- in **peroxidase and catalase**, which catalyze the breakdown of hydrogen peroxide to water and oxygen**, haem** is the prosthetic group

and it is a part of the active site of the enzyme.

b)Co-enzymes :

- They are also organic compounds but their association with the apoenzyme is only **transient, usually occurring during the course of catalysis.**
- The essential chemical components of many coenzymes are vitamins, e.g., coenzyme nicotinamide adenine dinucleotide (NAD) and NADP contain the vitamin niacin.

c)Metal ions :

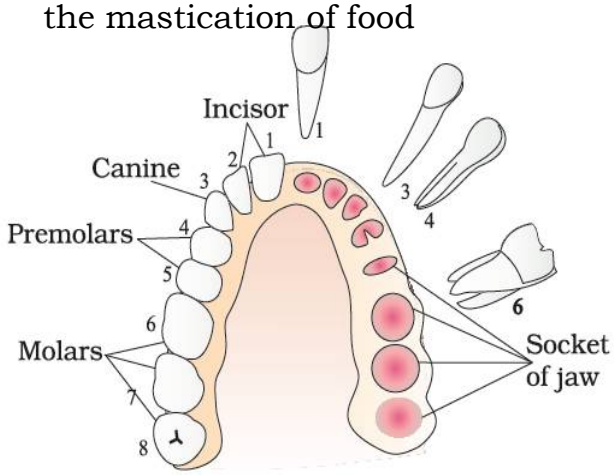
- A number of enzymes require metal ions for their activity which form coordination bonds with side chains at the active site and at the same time form one or more cordination bonds with the substrate,
- e.g., **zinc** is a cofactor for the proteolytic enzyme **carboxypeptidase.**
- Catalytic activity is **lost** when the co-factor is removed from the enzyme

Scan QR Code to Watch Biomolecule video lesson

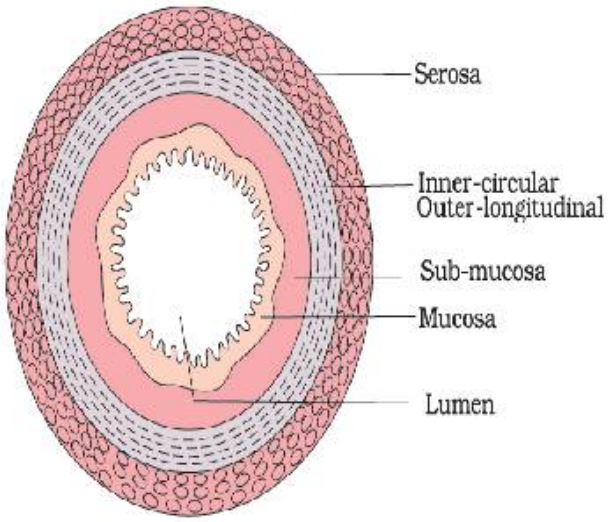
Chapter-05
Digestion and Absorption

Teeth

- **Thecodont**: Each tooth is embedded in a socket of jaw bone. This type of attachment is called **thecodont**.
- **Diphyodont :** Majority of mammals including human being forms two sets of teeth during their life, a set of **temporary** milk or deciduous teeth replaced by a set of **permanent or adult teeth**. This type of dentition is called **diphyodont**.
- **Heterodont :** An adult human has 32 permanent teeth which are of four different types (**Heterodont dentition**), namely,
    - Incisors (I),
    - Canine (C),
    - Premolars (PM)
    - Molars (M).
- **Dental formula :**
  Arrangement of teeth in each half of the upper and lower jaw in the order I, C, PM, M is represented by a dental formula which in human is $\frac{2123}{2123}$
- The hard chewing surface of the teeth, made up of **enamel**, helps in the mastication of food



Transverse section of human Gut/ Layers in the wall of Alimentary canal



The wall of alimentary canal from oesophagus to rectum possesses four layers namely **serosa, muscularis, sub-mucosa and mucosa**.

a) Serosa :

- It is the outermost layer
- It is made up of a thin **mesothelium** (epithelium of visceral organs) with some connective tissues.

b)Muscularis:

- it is formed by **smooth muscles** usually arranged into an **inner circular and an outer longitudinal layer**.
- An oblique muscle layer may be present in some regions.

c) sub mucosal layer :

- it is formed of **loose connective tissues**
- It also contains nerves, blood and lymph vessels.

- In duodenum, glands are also present in sub-mucosa (brunner's gland).

d) mucosa layer :

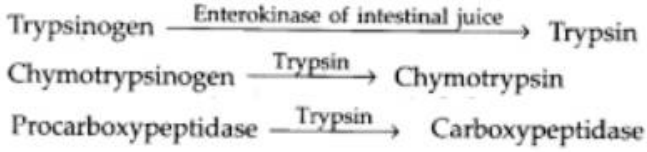
- The innermost layer lining the lumen of the alimentary canal is the mucosa.
- This layer forms irregular folds in the stomach called **gastric rugae**.
- Mucosa layer also forms small finger-like foldings called **villi** in the small intestine.
- Mucosa forms glands in the stomach (gastric glands) and crypts in between the bases of villi in the intestine (crypts of Lieberkuhn).
- Mucosal epithelium has goblet cells which secrete mucus that help in lubrication of food while passing through gut.

Functions of Mucus and Bicarbonate ion

- The mucus and bicarbonates present in the gastric juice play an important role in **lubrication and protection of the mucosal epithelium from excoriation by the highly concentrated hydrochloric acid**

Inactive Enzymes in pancreatic juice

- **Trypsinogen**
- **Chymotrypsinogen,**
- **Procarboxypeptidases,**
- Trypsinogen is activated by an enzyme, **enterokinase, secreted by the intestinal mucosa** into active **trypsin**, which in turn activates the other enzymes in the pancreatic juice.



Functions of Goblet cells

- It secrete **Mucus**
- secretion of mucus which helps in adhering the waste (undigested) particles together and **lubricating it for an easy passage** in Large intestine.

Intestinal juice or succus entericus.

- The secretions of the brush border cells of the mucosa along with the secretions of the goblet cells constitute the intestinal juice or **succus entericus**.
- This juice contains a variety of enzymes like **disaccharidases (e.g., maltase), dipeptidases, lipases, nucleosidases,** etc.

DISORDERS OF DIGESTIVE SYSTEM

- The inflammation of the intestinal tract is the most common ailment due to bacterial or viral infections. The infections are also caused by the parasites of the intestine like tapeworm,roundworm, thread worm, hook worm, pin worm, etc.

1. **Jaundice:**
   The **liver** is affected, skin and eyes turn yellow due to the deposit of bile pigments.
2. **Vomiting:**
   - It is the ejection of stomach contents through the mouth. This reflex action is controlled by the vomit centre in the **medulla**.

- A feeling of nausea precedes vomiting.

3. **Diarrhoea:**
   The **abnorma**l frequency of bowel movement and **increased liquidity** of the faecal discharge is known as diarrhoea. It **reduces the absorption of food.**
4. **Constipation:**
   In constipation, the faeces are **retained** within the rectum as the bowel movements occur **irregularly.**

5. **Indigestion:**

In this condition, the food is not properly digested leading to a feeling of fullness. The causes of indigestion are

- Inadequate enzyme secretion,
- Anxiety,
- Food poisoning,
- Over eating, and
- Spicy food.

Scan QR Code for video lesson

Chapter-06
BREATHING AND EXCHANGE OF GASES

Human Respiratory System

- **Pharynx:**
  It is the common passage for food and air.
- **Glottis :**
  Opening of larynx/Trachea is called Glottis.
- **Epiglottis** :
  It is a cartilaginous flap epiglottis to prevent the entry of food into the glottis –during swallowing
- **Pleura:**
  Lungs are covered by a double layered **pleura**, with **pleural fluid** between them. It reduces friction on the lung-surface.
- The outer pleural membrane is in close contact with the thoracic lining whereas the inner pleural membrane is in contact with the lung surface.
- **Steps In Breathing**
  (i) Breathing or pulmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out.
  (ii) Diffusion of gases (O_2 and CO_2) across alveolar membrane.
  (iii) Transport of gases by the blood.
  (iv) Diffusion of O_2 and CO_2 between blood and tissues.
  (v) Utilisation of O_2 by the cells for catabolic reactions and resultant release of CO_2

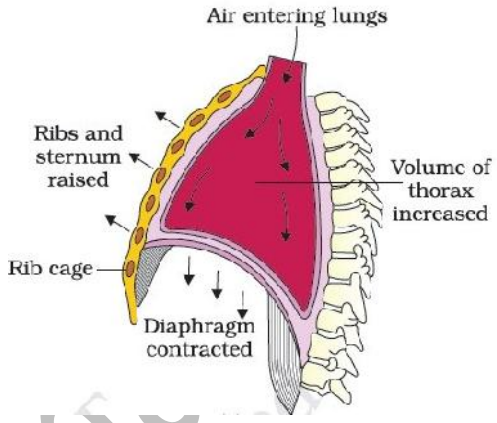
MECHANISM OF BREATHING

- Muscles involved in respirations are **Diaphragm, Intercostal muscle (Muscles between ribs)Abdominal muscle**
- Breathing involve two stages

a)Inspiration
b)expiration

a)Inspiration

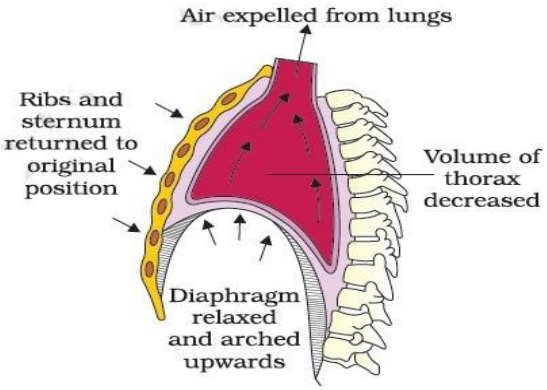
- It is the process by which during which atmospheric air is **drawn in.**
- Inspiration can occur if the pressure within the lungs (intra-pulmonary pressure) is less than the atmospheric pressure, i.e., there is a negative pressure in the lungs with respect to atmospheric pressure.



- Inspiration is initiated by the **contraction of diaphragm which increases the volume of thoracic chamber in the antero-posterior axis.**
- **The contraction of external inter-costal muscles lifts up the ribs and the sternum causing an increase in the volume of the thoracic chamber in the dorso-ventral axis.**
- The overall increase in the thoracic volume causes a similar increase in pulmonary volume. An increase in pulmonary volume decreases the intra-pulmonary pressure to less than the atmospheric pressure which forces the air from outside to move into the lungs, i.e., inspiration.

b)Expiration

- it is the process by which the alveolar air is released out. expiration takes place when the intra-pulmonary pressure is higher than the atmospheric pressure
- **Relaxation of the diaphragm and the inter-costal muscles returns the diaphragm and sternum to their normal positions and reduce the thoracic volume and thereby the pulmonary volume**.



- This leads to an increase in intra-pulmonary pressure to slightly above the atmospheric pressure causing the expulsion of air from the lungs, i.e., expiration

  - We have the ability to increase the strength of inspiration and expiration with the help **of <u>additional muscles</u> in the abdomen.**

- On an average, a healthy human breathes **<u>12-16 times/minute</u>**. The volume of air involved in breathing movements can be estimated by using a **<u>spirometer</u>**

Respiratory Volumes and Capacities

<u>Tidal Volume (TV):</u>

Volume of air inspired or expired during a normal respiration. It is approx. **500 mL.,**
i.e., a healthy man can inspire or expire approximately 6000 to 8000 mL of air per minute.

<u>Residual Volume (RV):</u>

Volume of air remaining in the lungs even after a forcible expiration.
This averages **1100 mL to 1200 mL**

TRANSPORT OF GASES

a) Transport of oxygen

- About **97 per cent** of O_2 is transported by **RBCs** in the blood.
- The remaining **3 per cent** of O_2 is carried in a **dissolved state** through the **plasma**.
- **Haemoglobin is a red coloured iron containing pigment present in the RBCs.** O_2 can bind with haemoglobin in a **reversible** manner to form oxyhaemoglobin.
- **Each haemoglobin molecule** can carry a maximum of **four molecules of O2 .**
- **In the alveoli, there is high pO_2, low pCO_2, lesser H+ concentration and lower temperature, the factors are all favourable for the formation of oxyhaemoglobin.**

$$Hb + O_2 \xrightarrow[\substack{PO_2\uparrow \\ PCO_2\downarrow \\ Temp\downarrow \\ H^+\downarrow}]{Alveolus} \text{oxyHaemoglobin}$$

- In the tissues, **low pO_2, high pCO_2 , high H+ concentration and higher temperature exist,** this conditions are favourable for **dissociation of oxygen from the oxyhaemoglobin.**

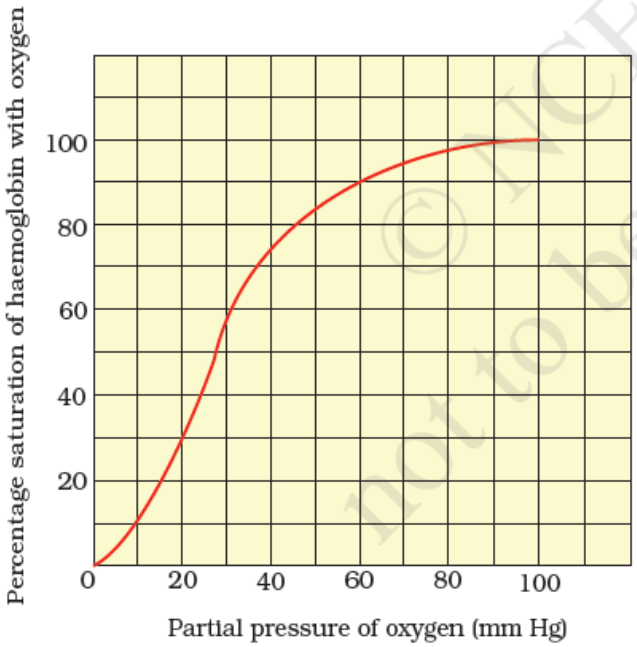
$$\text{oxyhaemoglobin} \xrightarrow[\substack{PO_2\downarrow \\ PCO_2\uparrow \\ Temp\uparrow \\ H^+\uparrow}]{Tissues} Hb + O_2$$

Every 100 ml of oxygenated blood can deliver around **5 ml of O_2** to the tissues under normal physiological conditions.

Oxygen dissociation curve

- **A sigmoid curve** is obtained when **<u>percentage saturation of haemoglobin with O_2 is plotted against the pO_2</u>** .
- **This curve is called the Oxygen dissociation curve and is highly useful in studying the effect of factors like**

pCO_2, H+ concentration, etc., on binding of O_2 with haemoglobin.



Scan QR code
for video lesson

DISORDERS OF RESPIRATORY SYSTEM

1.Asthma

It is a difficulty in breathing causing wheezing due to **inflammation of bronchi and bronchiole**s.

2.Emphysema

It is a chronic disorder in which alveolar walls are damaged due to which respiratory surface is decreased. One of the major causes of this is **cigarette smoking.**

3. Occupational Respiratory Disorders:

In certain industries, especially those involving grinding or stone-breaking, so much dust is produced that the defense mechanism of the body cannot fully cope with the situation. Long exposure can give rise to inflammation leading to **fibrosis** (proliferation of fibrous tissues) and thus causing serious lung damage. **Workers in such industries should wear protective masks**.

Eg: Silicosis
Asbestosis

Chapter-07
BODY FLUIDS AND CIRCULATION

BLOOD GROUPS

Various types of grouping of blood has been done. Two such groupings – the **ABO and Rh** – are widely used all over the world.

a) ABO Blood grouping

- 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.
- the plasma of different individuals contain two natural antibodies (proteins produced in response to antigens). during blood transfusion, any blood cannot be used; the 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**)

Blood Group	Antigens on RBCs	Antibodies in Plasma	Donor's Group
A	A	anti-B	A, O
B	B	anti-A	B, O
AB	A, B	nil	AB, A, B, O
O	nil	anti-A, B	O

- **'O' blood** can be donated to persons with any other blood group (Because 'O' blood groud contains no antigen, so the recipient ody willnot make any antibody against it) and hence 'O' group individuals are called '**universal donors'.**
- Persons with **'AB' group** can accept blood from persons with AB as well as the other groups of blood (AB blood group can receive any blood group because it contains no antibodies). Therefore, such persons are called '**universal recipients'.**

Donor	Reciepient
A blood group	A,AB
B blood group	B,AB
AB blood group	AB
O blood group	A,B,AB,O

b) Rh grouping

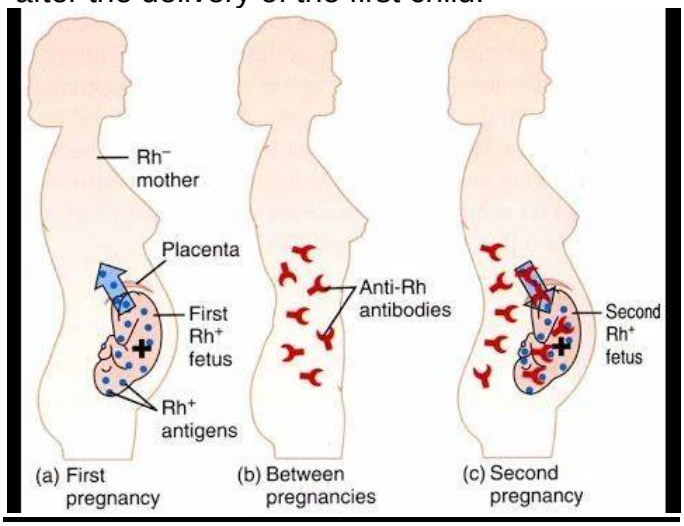
- The Rh antigen is present in **Rhesus monkeys** (hence Rh), is also observed on the surface of RBCs of majority (**nearly 80%**) of humans.
- Individuals with Rh antigen is called are called **Rh positive (Rh+ve)** and those in whom this antigen is absent are called **Rh negative (Rh-ve).**
- An Rh-ve person, if exposed to Rh+ve blood, will form **specific antibodies** against the Rh antigens. Therefore, Rh group should also be matched before transfusions.

Erythroblastosis foetalis

- A special case of Rh incompatibility (mismatching) has been observed between the **Rh-ve blood of a pregnant mother with Rh+ve blood of the foetus**.
- Rh antigens of the foetus do not get exposed to the Rh-ve blood of the mother in the first pregnancy as the two bloods are well separated by the placenta.
- However, during the delivery of the first child, there is a possibility of **exposure of the maternal blood to small amounts of the Rh+ve blood from the foetus**. In such cases, the mother starts preparing **antibodies against Rh antigen** in her blood.
- In case of her 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. This could be fatal to the foetus or could cause **severe anaemia** and **jaundice to the baby**. This

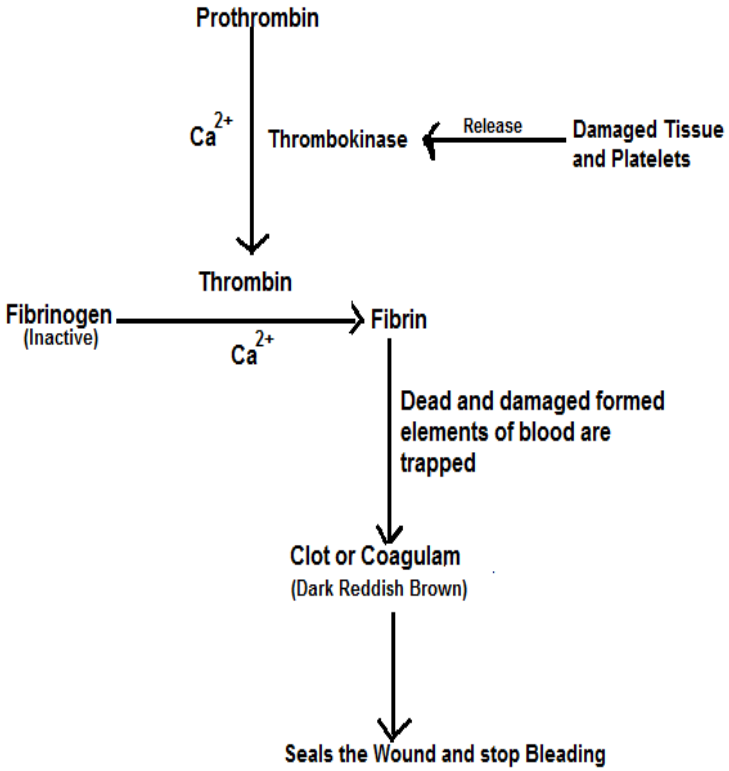
condition is called **erythroblastosis foetalis**.

- This can be avoided by administering **anti-Rh antibodies** to the mother immediately after the delivery of the first child.



Coagulation of blood

- An injury or a trauma stimulates the **platelets** in the blood to release certain factors which activate the mechanism of coagulation.
- Certain **factors released by the tissues** at the site of injury also can initiate coagulation.
- **Calcium ions** play a very important role in clotting.
- We can see a **dark reddish brown scum** formed at the site of a cut or an injury over a period of time. It is **a clot or coagulam** formed mainly of a network of threads called **fibrins** in which dead and damaged formed elements of blood are trapped.
- Fibrins are formed by the conversion of **inactive fibrinogens** in the plasma by the enzyme **thrombin**.
- Thrombins, in turn are formed from another inactive substance present in the plasma called **prothrombin**. An enzyme complex, **thrombokinase**, is required for the above reaction.
- This complex is formed by a series of linked enzymic reactions (cascade process) involving **a number of factors present in the plasma in an inactive state.**



Human Circulatory system

- **Pericardium:**

  Human Heart is protected by a double walled membranous bag called pericardium, enclosing the pericardial fluid.

- **Tricuspid valve:**

  The opening between the right atrium and the right ventricle is guarded by a valve formed of three muscular flaps or cusps called the tricuspid valve,

- **Bicuspid Valve /Mitral Valve**

  The opening between the **left atrium and the left ventricle** is guarded by a valve called bicuspid or **mitral valve guards**

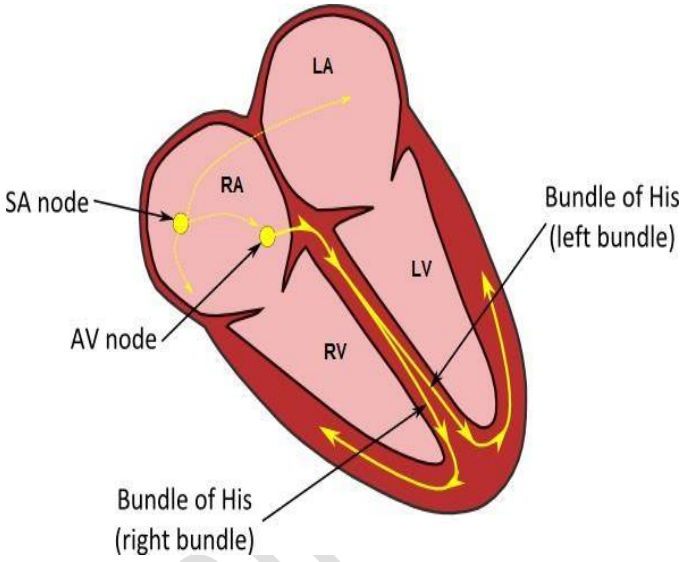
- **Semilunar Valves**

  The openings of the right and the left ventricles into the pulmonary artery and the aorta respectively are provided with the **semilunar valves.**

The valves in the heart allows the flow of blood only in one direction, i.e., from the atria to the ventricles and from the ventricles to the pulmonary artery or aorta. These valves prevent any backward flow

Conducting system of human heart

- The entire heart is made of **cardiac muscles.**
- The walls of ventricles are much thicker than that of the atria.
- A **specialised cardiac musculature** called the **nodal tissue** is also distributed in the heart .
- A patch of this tissue is present in the right upper corner of the right atrium called the **sino-atrial node (SAN).**
- Another mass of this tissue is seen in the lower left corner of the right atrium close to the atrio-ventricular septum called the **atrio-ventricular node (AVN).**
- A bundle of nodal fibres, **atrioventricular bundle (AV bundle)** continues from the AVN which passes through the atrio-ventricular septa to emerge on the top of the interventricular septum and immediately divides into a right and left bundle. These branches give rise to minute fibres throughout the ventricular musculature of the respective sides and are called **purkinje fibres**. These fibres alongwith right and left bundles are known as **bundle of His**.
- The nodal musculature has the ability to generate action potentials **without any external stimuli, i.e., it is autoexcitable**. Hence human heart is called **Myogenic**. However, the number of action potentials that could be generated in a minute vary at different parts of the nodal system.
- The 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, it is called the **pacemaker**.
- Our heart normally beats **70-75 times in a minute** (average 72 beats min^{-1}).



SAN→ AVN→ AV Bundle (Bundle of His)→ Purnkinje Fibre

SAN→ Atrial Systole→AVN→AV Bundle (AV Bundle)→ Purkinje Fibre→ Ventricular systole

Cardiac Cycle

- Sequential event in the heart which is cyclically repeated is called the cardiac cycle and it consists of systole and diastole of both the atria and ventricles

Atrial Systole:

- Contraction of the Atria is called atrial systole.
- The SAN generates an **action potential** which stimulates both the atria to undergo a simultaneous contraction – the atrial systole
- Under normal conditions, about 70% of the blood passively flows into ventricles. **Rest of the blood (30%) is pumped into ventricle by Atrial systole**

Atrial Diastole

- The relaxation of Atrial chamber is called Atrial diastole
- Just after Atrial systole, the atria relax.

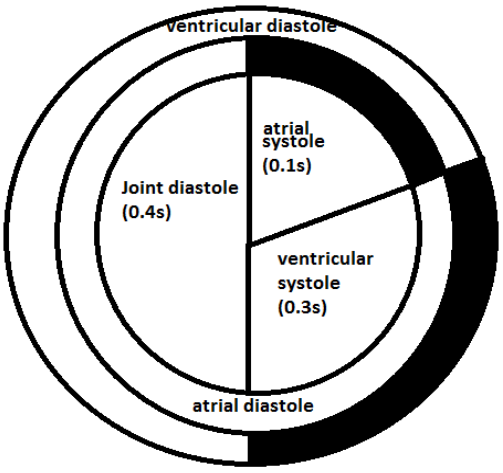
- This helps for the refilling of the blood in both atria

Ventricular Systole

- Contraction of ventricles are called Ventricular systole
- It begins when ventricular chambers (Right and Left ventricles) are full of blood
- The action potential transmit to the entire ventricular muscles through AVN,AV bundle and Purnkinje fibre
- During ventricular systole Both Tricuspid and Bicuspid valve closed, to prevent back flow of blood to Atrium
- As the ventricular pressure increases further, the **semilunar valves guarding the pulmonary artery (right side) and the aorta (left side) are forced open**, allowing the blood in the ventricles to flow through these vessels into the circulatory pathways.

Ventricular Diastole

- The **relaxation of Ventricular chamber** is called **Ventricular diastole**
- At the end of ventricular systole, the ventricle relax.
- Ventricular diastole causes ventricular pressure falls causing the closure of semilunar valves which prevents the backflow of blood into the ventricles. 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.



HEART BEAT

During each cardiac cycle two prominent sounds are produced which can be easily heard through a **stethoscope**.

- **The first heart sound (lub)**
  This sound is associated with the closure of the tricuspid and bicuspid valves (It occurs during ventricular systole) whereas
- **The second heart sound (dub)**
  This sound is associated with the closure of the semilunar valves (it occurs during ventricular diastole).

  - These Heart beat sounds are of **clinical diagnostic significance.**
  - 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**.
  - During a cardiac cycle, each ventricle pumps out approximately 70 mL of blood which is called the **stroke volume**. The stroke volume multiplied by the heart rate (no. of beats per min.) gives the cardiac output.

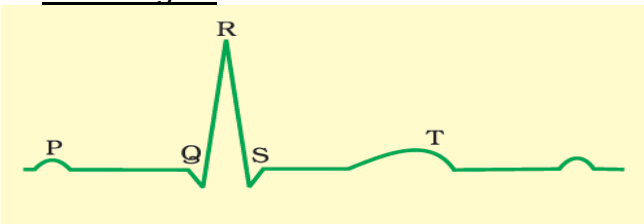
Cardiac output=stroke volume×heart beat

Therefore, **the cardiac output** can be defined as the volume of blood pumped out by each ventricle per minute and averages **5000 mL or 5 litres** in a healthy individual.

- The body has the ability to alter the stroke volume as well as the heart rate and thereby the cardiac output. For example, **the cardiac output of an athlete will be much higher than that of an ordinary man**

ELECTROCARDIOGRAPH (ECG)

- ECG **is a graphical representation of the electrical activity of the heart during a cardiac cycle**.
- **Electro-cardiograph** is a machine is used to obtain an **electrocardiogram** (ECG).
- 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 the heart activity.
- For a detailed evaluation of the heart's function, multiple leads are attached to the chest region.



Diagrammatic presentation of 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.

- **The P-wave**
  It represents the electrical excitation (or depolarisation) of the atria, which leads to the contraction of both the atria.
- **The QRS complex**
  It 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**
  It represents the return of the ventricles from excited to normal state (repolarisation). The end of the T-wave marks the end of systole.

- By counting the number of QRS complexes that occur in a given time period, one can determine the heart beat rate of an individual.
- The sound "... pip... pip... pip..... peeeeeeeeeeeeeeeeeeeee" produce the ECG when the patient goes into **cardiac arrest (Heart stop beating)**
- **Significance of ECG**
  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. Hence, it is of a great clinical significance.**

DISORDERS OF CIRCULATORY SYSTEM

1. **High Blood Pressure (Hypertension):**
   - ♥ Hypertension is the term for blood pressure that is higher **than normal (120/80)**.
   - ♥ In this measurement **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 also affects vital organs like brain and kidney**
   - ♥ The BP can be checked by **sphygmomanometer**

2. **Coronary Artery Disease (CAD):**
   - ♥ Coronary Artery Disease, often referred to as **atherosclerosis**
   - ♥ It affects the vessels that supply blood to the heart muscle.
   - ♥ It is caused by deposits of calcium, fat, cholesterol and fibrous tissues, which makes the lumen of arteries narrower.

3. **Angina:**
   - ♥ It is also called **'angina pectoris'.**

- ♥ A symptom of acute chest pain appears when no enough oxygen is reaching the heart muscle.
- ♥ Angina can occur in men and women of any age but it is more common among the middle-aged and elderly.
- ♥ It occurs due to conditions that affect the blood flow.

4. **Heart Failure:**

- ♥ Heart failure means the state of heart when it is not pumping blood effectively enough to meet the needs of the body.
- ♥ It is sometimes called **congestive heart failure** because congestion of the lungs is one of the main symptoms of this disease.
- ♥ Heart failure is not the same as **cardiac arrest** (when the heart stops beating) or **a heart attack** (when the heart muscle is suddenly damaged by an inadequate blood supply).

Click on the logo for video lessons

Chapter-08
Excretory Products and Their Elimination

Excretion:

The removal of unwanted substance from the body is called excretion.

Ammonia, urea and uric acid are the major forms of **nitrogenous wastes** excreted by the animals.

1.Ammonotelic

- The process of excreting ammonia is **Ammonotelism**.
- The organism that excrete ammonia is called **ammonotelic**
- Ammonia, as it is readily soluble, is generally excreted by **diffusion across body surfaces or through gill surfaces (in fish)** as ammonium ions.
- Kidneys do not play any significant role in its removal.
- Ammonia is the most toxic form and requires large amount of water for its elimination.
  - **Eg**: Many Bony fishes,
  - Aquatic amphibians and
  - Aquatic insects

2. Urecoltelic

- The process of excreting uric acid is called **urecotelism**.
- The organism that excrete uric acid is called **uricotelic.**
- **Eg** :**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 .**
- **Uric acid is the least toxic** nitrogenous material

3. Ureotelic

- The process of excreting Urea is **Ureotelism.**
- The organism that excrete urea is called **Ureotelic.**

Eg : Mammals, many terrestrial amphibians and marine fishes mainly excrete urea.

- **Ammonia produced by metabolism is converted into urea in the liver of these animals (This cycle is called urea cycle) and released into the blood which is filtered and excreted out by the kidneys.**

HUMAN EXCRETORY SYSTEM

Nephron

Each kidney has nearly **one million** complex tubular structures called **nephrones** , which are **the functional units of kidney** . Each nephrones has two parts –

a) Glomerulus

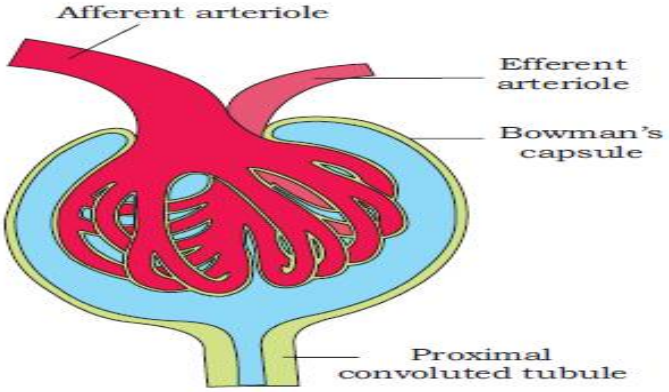
b) Renal tubule.

a) Glomerulus:

- it is a **tuft of capillaries** formed by the **afferent arteriole** – a fine branch of **renal artery**.
- Blood from the glomerulus is carried away by an **efferent arteriole**.

b)Renal tubule

- The renal tubule begins with a **double walled cup-like structure called Bowman's capsule**, which encloses the glomerulus.
- Glomerulus alongwith Bowman's capsule**, is** called the **malpighian body or renal corpuscle**.



- The tubule continues further to form a highly coiled network **– proximal convoluted tubule. (PCT)**.

- A hairpin shaped **Henle's loop** is the next part of the tubule which has a **descending and an ascending limb**.
- The ascending limb continues as another highly coiled tubular region called **distal convoluted tubule (DCT**).
- The DCTs of many nephrons open into a straight tube called **collecting duct**, many of which converge and open into the renal pelvis through medullary pyramids in the calyces.

The 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**.

Peritubular capillaries and vasarecta

- The efferent arteriole emerging from the glomerulus forms **a fine capillary network around the renal tubule** called the **peritubular capillaries**.
- A minute vessel of Peritubular capillary network runs parallel to the Henle's loop forming **a 'U' shaped vasa recta.**

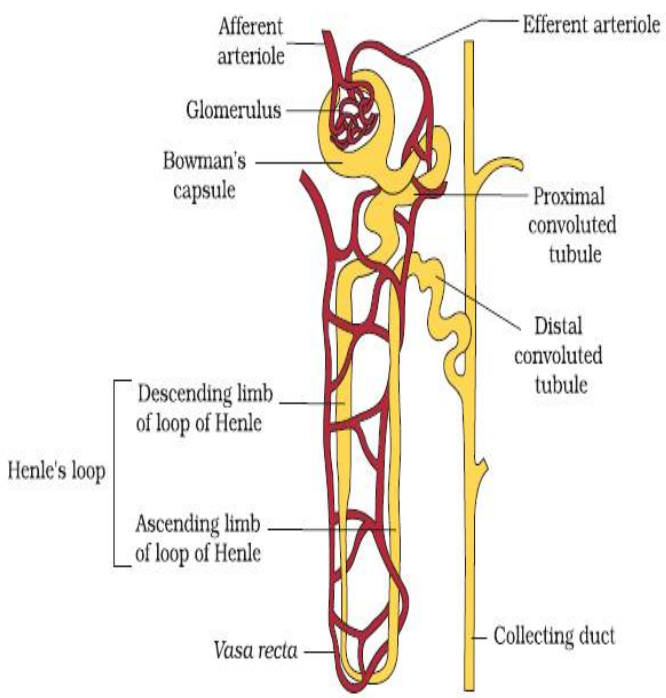
Types of nephrones

a)Cortical nephrons

- In majority of nephrons, **the loop of Henle is too short and extends only very little into the medulla**. Such nephrons are called cortical nephrons.
- Vasa recta is **absent or highly reduced** in cortical nephrones

b)Juxtamedullary nephron

- In some of the nephrons, the loop of **Henle is very long and runs deep into the medulla.** These nephrons are called juxta medullary nephrons.



URINE FORMATION

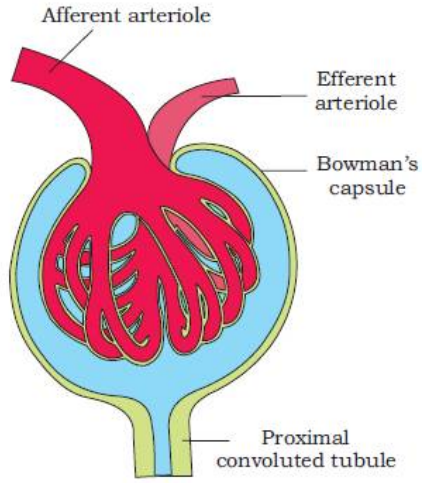
Urine formation involves three main processes namely,

A) Glomerular filtration,
B) Tubular reabsorption
C) Tubular secretion

A) Glomerular filtration

- The 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 the kidneys per minute which constitute roughly **1/5th** of the blood pumped out by each ventricle of the heart in a 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**.
- The epithelial cells of Bowman's capsule called **podocytes** are arranged in an intricate manner so as to leave some minute spaces called **filtration slits or slit pores**.

- 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. Therefore, it is considered as a process of **ultrafiltration.**



B) Tubular reabsorption

- The amount of the filtrate formed by the kidneys per minute is called **glomerular filtration rate (GFR**).
- GFR in a healthy individual is approximately **125 ml/minute**, i.e., **180 litres per day .**
- A normal human being will not excrete such an amount of urine**.**
- **He will excrete 1.5l/day, it shows the 99% of glomerular filtrate is re absorbed.**

i)Re absorption in PCT

- PCT is lined by simple cuboidal brush border epithelium which increases the surface area for reabsorption.
- **Nearly all of the essential nutrients, and 70-80 % of electrolytes and water are reabsorbed by this segment**

ii)Re absorption in Henles loop

- Reabsorption in this segment is **minimum**. However, this region plays a significant role in the maintenance of high osmolarity of medullary interstitial fluid

a)Re absorption in descending limb:

- The descending limb of loop of Henle is **permeable to water but almost impermeable to electrolytes.** This concentrates the filtrate as it moves down

b)Reabsorption in the ascending limb :

- The ascending limb is **impermeable to water but allows transport of electrolytes actively or passively**. Therefore, as the concentrated filtrate pass upward, concentration decreases.

iii)Reabsorption in DCT

- Conditional reabsorption of Na^+ and water takes place in this segment. DCT is also capable of reabsorption of HCO^{3-}

iv)Tubular reabsorption in collecting duct

- Large amounts of water could be reabsorbed from this region to produce a concentrated urine.

C) Tubular secretion

- During urine formation, the tubular cells secrete substances like H+, K+ and ammonia into the filtrate.
- Tubular secretion is also an important step in urine formation as it helps in the maintenance of ionic and acid base balance of body fluids.
- Tubular secretion in various parts is given below

i)Tubular secretion in PCT

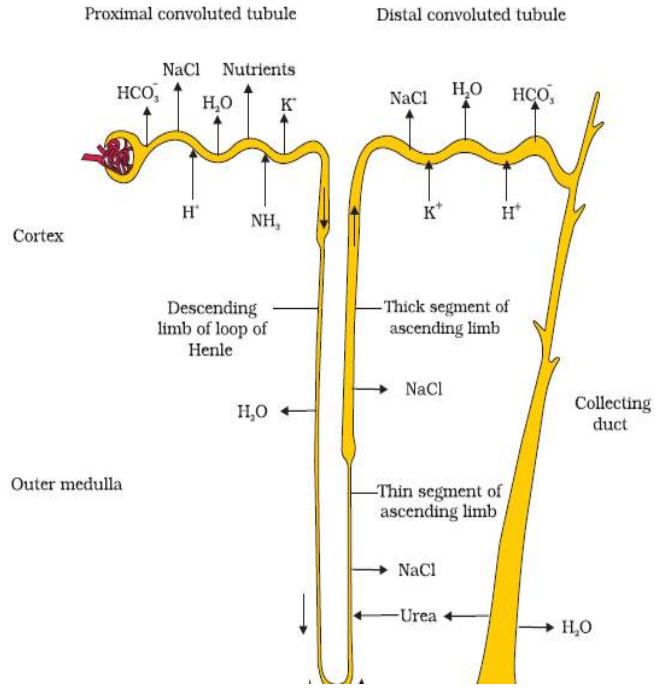
PCT also helps to maintain the pH and ionic balance of the body fluids by **selective secretion of hydrogen ions, ammonia and potassium ions into the filtrate** and by absorption of HCO^{3-} from it.

ii)Tubular secretion in DCT

DCT is also capable of reabsorption of HCO^{3-} and **selective secretion of hydrogen and potassium ions and NH_3** to maintain the pH and sodium-potassium balance in blood.

iii)Tubular secretion in Collecting duct

selective secretion of H+ and K+ ions occurs here.



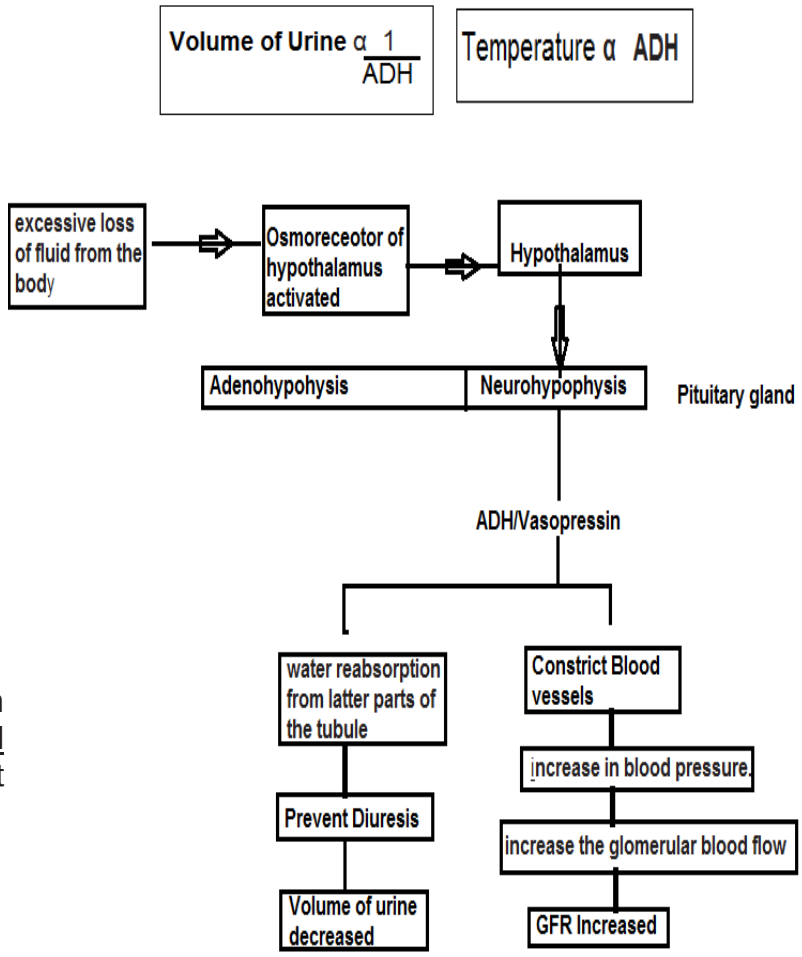
JGA (Juxta glomerular apparatus)

It is a special sensitive region formed by cellular modifications in the distal convoluted tubule and the afferent arteriole at the location of their contact.

Regulation of kidney function

1. Regulation by hypothalamus

- **Osmoreceptors** in the body are activated by changes in blood volume, body fluid volume and ionic concentration.
- An excessive loss of fluid from the body can activate these receptors which **stimulate the hypothalamus to release antidiuretic hormone (ADH) or vasopressin** from the **neurohypophysis**.
- **ADH facilitates water reabsorption from latter parts of the tubule, thereby preventing diuresis (The loss of excess water through urine is called diuresis)**.
-
- ADH can also affect the kidney function by its **constrictor effects on blood vessels**, hence ADH is also called **vasoconstrictor**. This causes an increase in blood pressure. An increase in blood pressure can increase the glomerular blood flow and thereby the GFR.



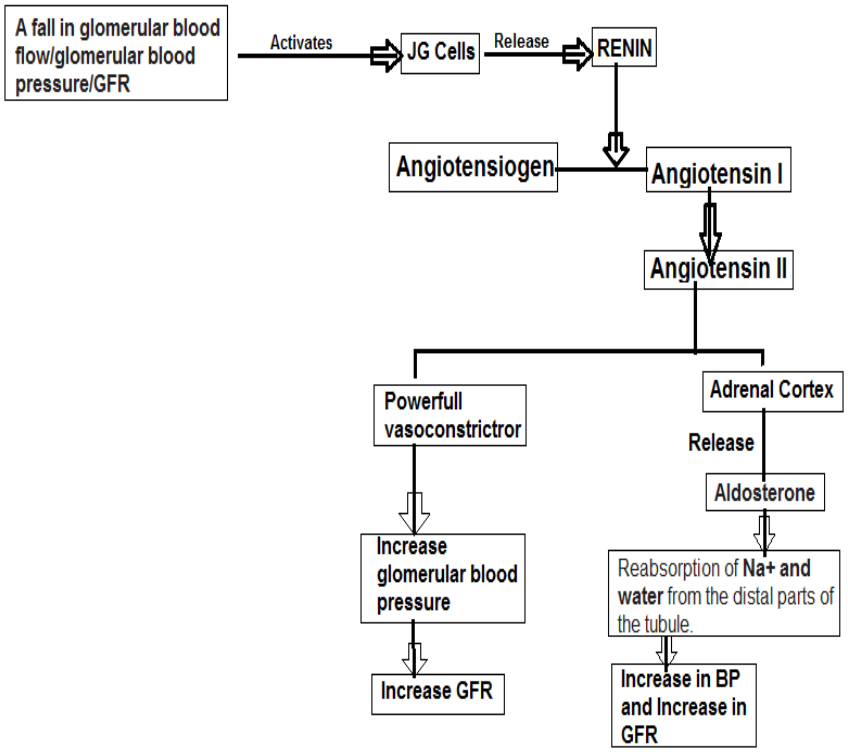
- An increase in body fluid volume can **switch off the osmoreceptors** and suppress the ADH release to complete the feedback.

2. Renin angiotensin mechanism/ Renin angiotensin aldosterone mechanism (RAAS)

- A fall in glomerular blood flow/glomerular blood pressure/GFR can activate the **JG cells** to release **renin** which converts angiotensinogen in blood to angiotensin I and further to angiotensin II.
- Angiotensin II, being a powerful **vasoconstrictor**, increases the glomerular blood pressure and thereby GFR.
- Angiotensin II also activates the adrenal cortex to release **Aldosterone**. Aldosterone

causes reabsorption of **Na+ and water** from the distal parts of the tubule.

- This also leads to an increase in blood pressure and GFR. This complex mechanism is generally known as the **Renin-Angiotensin mechanism**



3. Atrial Natriuretic factor (ANF)

- An increase in blood flow **to the atria of the heart** can cause the release of Atrial Natriuretic Factor (ANF).
- ANF can cause **vasodilation** (**dilation of blood vessels**) and thereby **decrease the blood pressure.**
- ANF mechanism, acts as a **check on the renin-angiotensin mechanism**

DISORDERS OF THE EXCRETORY SYSTEM

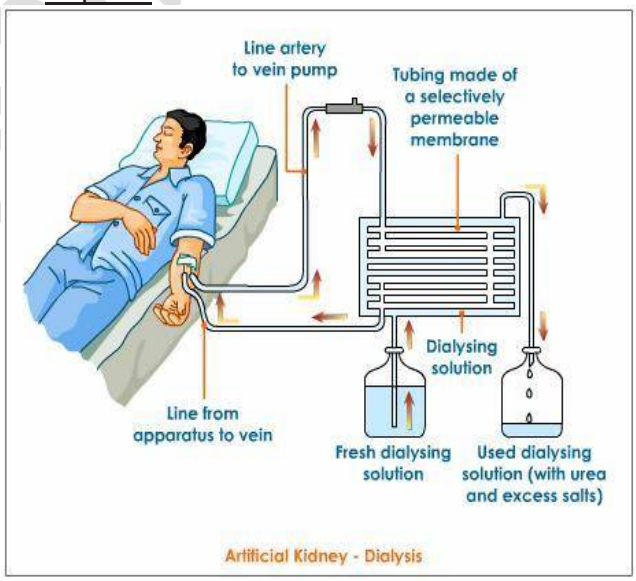
1. Uremia :

✓ Malfunctioning of kidneys can lead to **accumulation of urea in blood**, a condition called **uremia**,

✓ In such patients, urea can be removed by a process called **hemodialysis**.

Haemodialysis/Artificial kdiney

- Blood drained from a convenient **artery** is pumped into a **dialysing unit** after adding an **anticoagulant like heparin**.
- The unit contains a coiled **cellophane tube surrounded by a fluid called dialysing fluid.**
- **This fluid** has the same composition as that of plasma except the nitrogenous material.
- This 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

✓ Kidney transplantation is the 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.

2. Renal calculi:

- ✓ Stone or insoluble mass of crystallised salts (**oxalates**, etc.) formed within the kidney.

3.Glomerulonephritis:

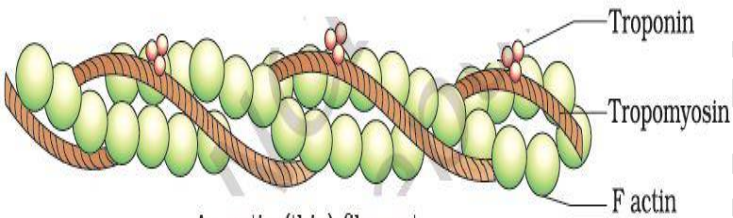
- ✓ **Inflammation** of glomeruli of kidney.

Chapter-09
LOCOMOTION AND MOVEMENT

Structure of Contractile Protein

Actin

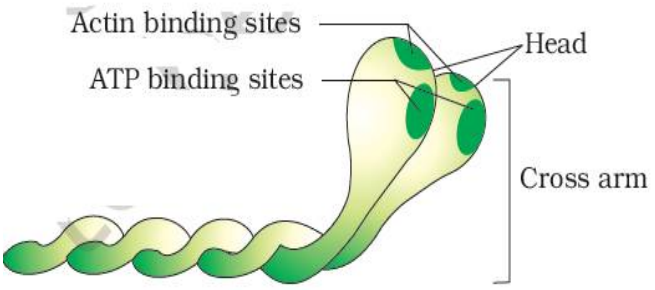
- Each actin (thin) filament is made of **two 'F' (filamentous) actins** helically wound to each other. Each 'F' actin is a polymer of monomeric 'G' (Globular) actins.
- Two filaments of another protein, **tropomyosin** also run close to the 'F' actins throughout its length.
- A complex protein **Troponin** is distributed at regular intervals on the tropomyosin.
- In the resting state **a subunit of troponin masks the active binding sites for myosin on the actin filaments**



An actin (thin) filament

Myosin

- Each myosin (thick) filament is also a polymerised protein.
- Many monomeric proteins called **Meromyosins** constitute one thick filament nt.
- Each meromyosin has two important parts, **a globular head with a short arm and a tail,**
- the former being called the **heavy meromyosin (HMM)** and the latter, **the light meromyosin (LMM).**
- The 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.
- The globular head is an active **ATPase** enzyme and has binding sites for ATP and **active sites for actin**

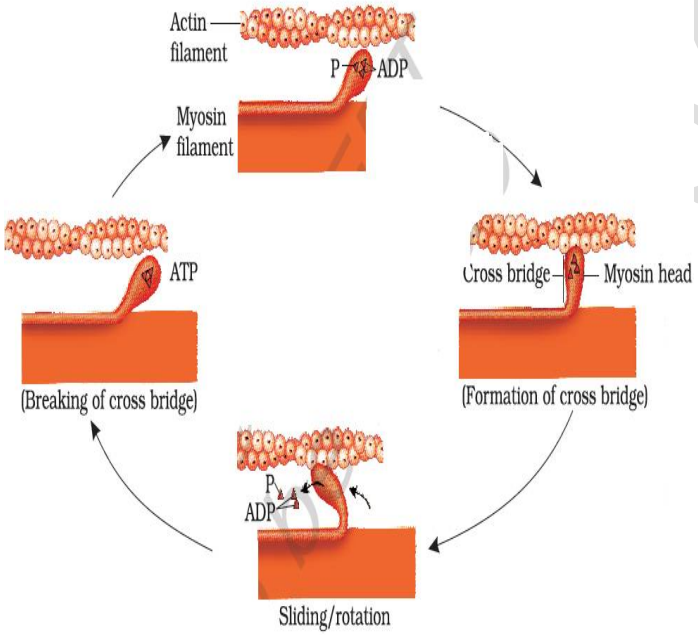


Myosin monomer (Meromyosin)

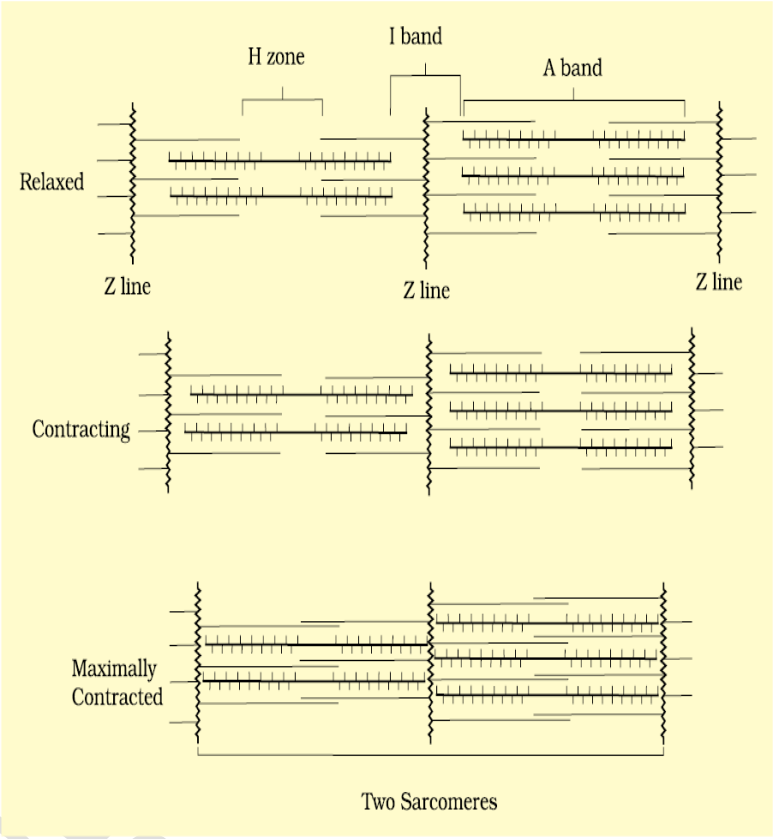
Mechanism of Muscle Contraction

- Mechanism of muscle contraction is best explained by **the sliding filament theory**
- which states that contraction of a muscle fibre takes place by the sliding of the thin filaments over the thick filaments
- Muscle contraction is initiated by a signal sent by the central nervous system (CNS) via a motor neuron.
- A motor neuron along with the muscle fibres connected to it constitute a motor unit. The junction between a motor neuron and the sarcolemma of the muscle fibre is called **the neuromuscular junction or motor-end plate.**
- A neural signal reaching this junction releases a **neurotransmitter** (Acetyl choline) which generates an action potential in the sarcolemma.
- This Action potential or impulse spreads through the muscle fibre and causes the release of **calcium ions** from sarcoplasmic reticulum into the sarcoplasm.
- Increase in Ca++ level leads to the binding of calcium with a subunit of troponin on actin filaments and thereby **remove** the masking of active sites for myosin.
- Utilising the energy from ATP hydrolysis, the myosin head now binds to the exposed active sites on actin to form 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, i.e., contraction.

- **During shortening of the muscle,**
  - **i) shortening of the sarcomere i.e. the adjacent Z line come closer,**
  - **ii) Width of the 'I ' band reduced**
  - **iii) 'H' zone shortens and finally disappear**
  - **iv) The width of the A band remains the same**
- The myosin, releasing the ADP and P1 goes back to its relaxed state. A new ATP binds and the cross-bridge is broken The ATP is again hydrolysed by the 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 the masking of actin filaments.
- This causes the return of 'Z' lines back to their original position, i.e., relaxation.



Stages in cross bridge formation, rotation of head and breaking of cross bridge



Two Sarcomeres

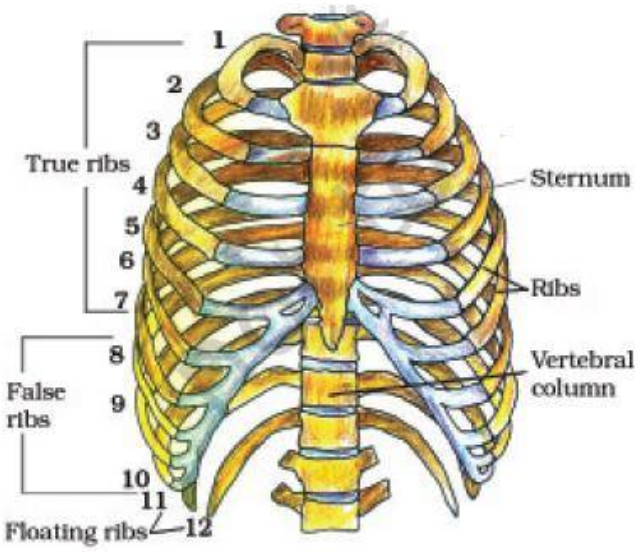
HUMAN SKELETAL SYSTEM

Ribs

- There are **12 pairs** of **ribs.**
- Each rib is a thin flat bone connected dorsally to the vertebral column and ventrally to the sternum.
- It has two articulation surfaces on its dorsal end and is hence called **bicephalic.**
- **First seven pairs of ribs** are called **true ribs.** Dorsally, they are attached to the thoracic vertebrae and ventrally connected to the sternum with the help of hyaline cartilage.
- **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. These are called **vertebrochondral (false) ribs.**
- **Last 2 pairs (11th and 12th) of ribs** are not connected ventrally and are therefore, called **floating ribs.**

RIB CAGE

- Thoracic vertebrae, ribs and sternum together form the rib cage



Ribs and rib cage

JOINTS

- Joints are essential for all types of movements involving the bony parts of the body.
- Joints are points of <u>contact between bones, or between bones and cartilages</u>.
- Force generated by the 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, namely, fibrous, cartilaginous and synovial.

a.Fibrous joints/Immovable joints

- Fibrous joints <u>do not allow any movement</u>.
- This type of joint is shown by the **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.

b.Cartilaginous joints/slightly movable joints

- **cartilaginous joints,** the bones involved are joined together with the help of **cartilages.**
- The joint between the **adjacent vertebrae in the vertebral column** is of this pattern and it permits limited movements.

c.Synovial joints/movable joints

- **Synovial joints** are characterised by the presence of a fluid filled **synovial cavity** between the articulating surfaces of the two bones. Such an arrangement allows considerable movement.

Some synovial joints are given below

- Ball and socket joint (between humerus and pectoral girdle),
- hinge joint (knee joint),
- pivot joint (between atlas and axis),
- Gliding joint (between the carpals)
- saddle joint (between carpal and metacarpal of thumb)

Disorders of SKELETAL SYSTEM

1. **Osteoporosis:**
   Age-related disorder characterised by decreased bone mass and increased chances of fractures. **Decreased levels of estrogen is a common cause**.
2. **Gout:**
   Inflammation of joints due to accumulation of **uric acid crystals.**
3. **Arthritis:**
   It is the Inflammation of joints.

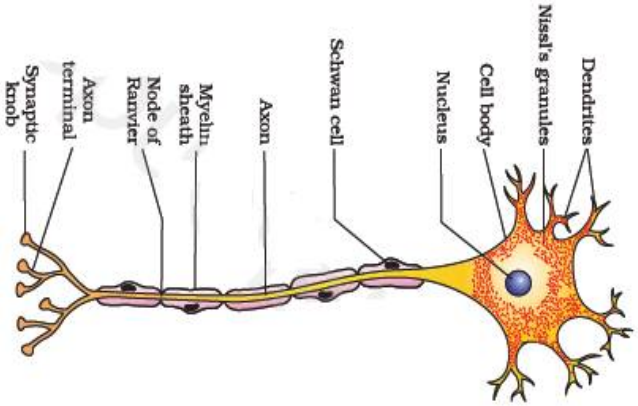
YouTube

Click on the logo for video lesson

Chapter-10
Neural Control and Coordination

NEURON AS STRUCTURAL AND FUNCTIONAL UNIT OF NEURAL SYSTEM

- **Neurons are the structural and functional units of neural system.**
- **Human neural system contains atleast 10 billions neurons**
- Neuron is a microscopic structure composed of three major parts, namely,
  a)Cell body,
  b)Dendrites and
  c)Axon



a) The cell body/Soma/cyton

it contains cytoplasm with typical cell organelles and certain granular bodies called **Nissl's granules**.

b) Dendrites

Short fibres which branch repeatedly and **project out of the cell body** also contain Nissl's granules and are called dendrites.

- These fibres transmit **impulses towards the cell body**.

c) Axon

- The axon is a **long fibre**, the distal end of which is branched (Axonites)
- Each branch terminates as a bulb-like structure called **synaptic knob** which possess **synaptic vesicles** containing chemicals called **neurotransmitters**
  Eg: Acetyl choline, Dopamine etc.
- The axons transmit nerve impulses **away from the cell body** to a synapse or **to a neuro-muscular junction .**

Types of Neurons

(A)Based on the number of axon and dendrites, the neurons are divided into three types

i**) Multipolar Neuron :**

This type of neuron has one axon and two or more dendrites

eg: This type of Neuron is found in the **cerebral cortex**

ii)Bipolar Neuron:

This type of neuron has one axon and one dendrite,

eg: This type of neurons are found in the **retina of eye**

iii) Unipolar Neuron :

This type of neuron has cell body with one axon only;

Eg: This type of neuron found usually in the **embryonic stage**

(B)Based on the presence or absence of Myelin sheath around Axon

Neurons can be classified into **myelinated** and **non myelinated Neuron**

i) Myelinated neuron

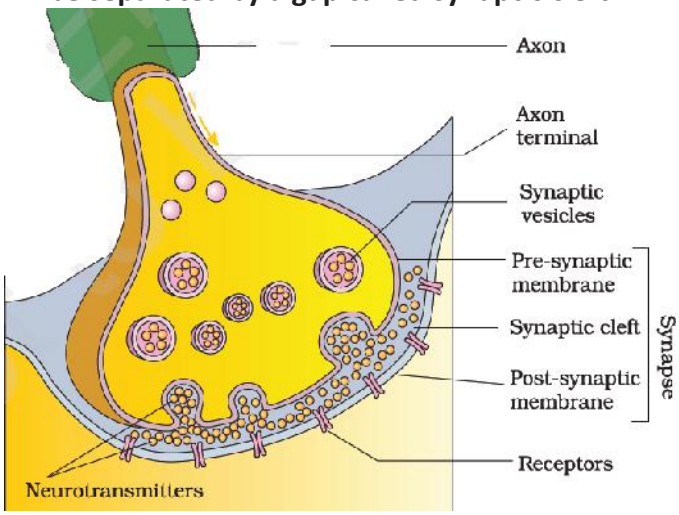
- The myelinated nerve fibres are enveloped with **Schwann cells,** which form a myelin sheath around the axon.
- The **gaps** between two adjacent myelin sheaths are called **nodes of Ranvier**.
- Myelinated nerve fibres are **found in spinal cord and cranial nerves**

b) Nonmyelinated Neuron

- The non-myelinated nerve fibre **is enclosed by a Schwann cell that does not form a myelin sheath around the axon.**
- This type of Neuron is commonly found in **autonomous and the somatic neural systems.**

Transmission of Impulses

- A **synapse** is a junction formed by the membranes of **a pre-synaptic neuron and a post-synaptic neuron, which may or may not be separated by a gap called synaptic cleft.**



There are two types of synapses, namely**, electrical synapses and chemical synapses**.

I) Electrical synapses;

- Here the membranes of pre- and post-synaptic neurons are in **very close proximity**.
- Electrical current can flow directly from one neuron into the other across these synapses.
- Transmission of an impulse across electrical **synapses is very similar to impulse conduction along a single axon**.
- Impulse transmission across an electrical synapse is always **faster than that across a chemical synapse**.
- Electrical **synapses are rare in our system.**

ii) Chemical synapse :

- The membranes of the pre- and post-synaptic neurons are separated by a fluid-filled space called **synaptic cleft.**
- Chemicals called neurotransmitters are involved in the transmission of impulses at these synapses.
- The axon terminals contain **synaptic vesicles.** It is filled with these **neurotransmitters**. When an impulse (action potential) arrives at the axon terminal, it stimulates the movement of the **synaptic vesicles** towards the membrane where they fuse with the plasma membrane and **release** their neurotransmitters in to the synaptic cleft.
- The released neurotransmitters **bind to their specific receptors**, present on the **post-synaptic membrane**.
- This binding opens ion channels allowing the entry of ions which can generate a new potential in the post-synaptic neuron.
- **The new potential developed may be either excitatory or inhibitory.**

HUMAN BRAIN

- The brain is the central information processing organ of our body,
- Brain acts as the '**command and control system**'.

Functions of brain :

- It controls the voluntary movements,
- Balance of the body,
- Functioning of vital involuntary organs (e.g., lungs, heart, kidneys, etc.),
- Thermoregulation, hunger and thirst,
- Circadian (24-hour) rhythms of our body,
- Activities of several endocrine glands
- Human behavior.
- Processing of vision, hearing, speech, memory, intelligence, emotions and thoughts.

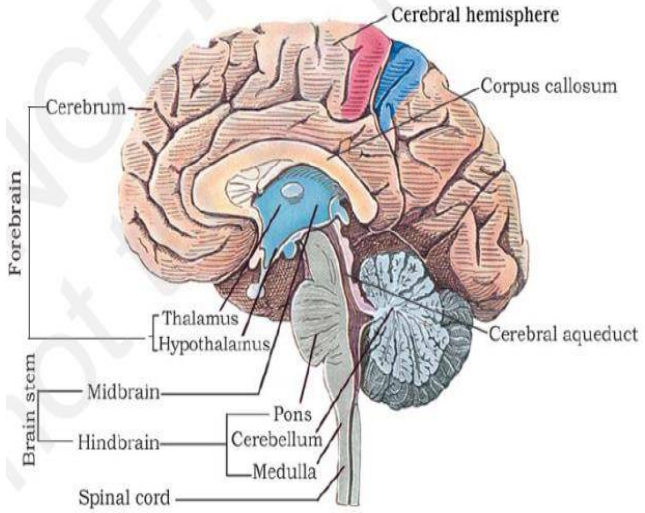
- The human brain is well protected by the skull.
- Inside the **skul**l, the brain is covered by **cranial meninges** consisting of 3 Layers

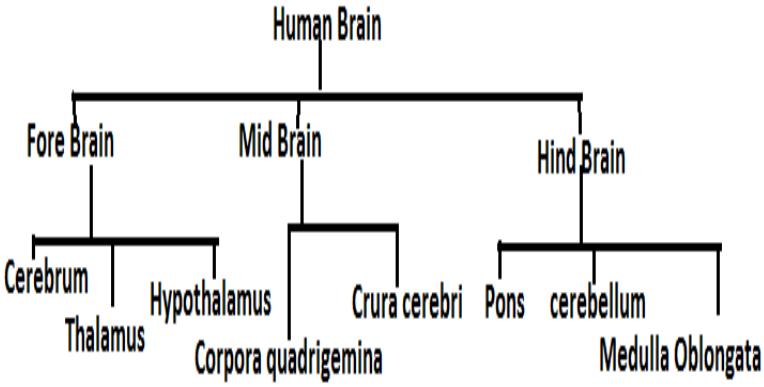
a)Dura mater-Outer Layer

b)Arachnoid- a very thin middle layer called

c)Pia mater- an inner layer (which is in contact with the brain tissue).

The brain can be divided into three major parts: (i) **forebrain**, (ii) **midbrain**, and (iii) **hindbrain**





(i)Fore brain

The forebrain consists of **cerebrum**, **thalamus** and **hypothalamus.**

Cerebrum:

- Cerebrum forms the **major part of the human brain**.
- A **deep cleft** divides the cerebrum longitudinally into two halves, which are termed as **the left and right cerebral hemispheres**. The hemispheres are connected by a t**ract of nerve fibres called corpus callosum**.
- Cerebrum is **the seat of mind and intelligence**

Hypothalamus

- **Hypothalamus** located at the base of the thalamus.
- The hypothalamus contains a number of centres **which control body temperature, urge for eating and drinking**. It also contains several groups of **neurosecretor**y cells, which secrete hormones called **hypothalamic hormones**
- **Eg:**

  Relaeasing hormone (Eg.GnRH)
  Inhibitoryhormone(Eg.Somatostatin)
  ADH(Oxytocin)

(ii)Midbrain

- It is located **between the thalamus/hypothalamus of the forebrain and pons of the hindbrain**.
- A canal called the **cerebral aqueduct** passess through the midbrain.
- The dorsal portion of the midbrain consists mainly of four round swellings (lobes) called **corpora quadrigemina**.

- **Midbrain and hindbrain form the brain stem**

III) Hindbrain

It comprises **pons**, **cerebellum** and **medulla** (also called the **medulla oblongata**).

a) **Pons** (Latin: Bridge)
it consists of fibre tracts that **interconnect different regions of the brain.**

b) **Cerebellum** :
it has very convoluted surface in order to provide **the additional space for many more neurons**. It Concerend with **muscular coordination, maintain posture,orientation and equilibrium of the body**. Cerebellar cortex is grey matter and medulla white matter..

c) The medulla :
Medulla connected to the spinal cord. The medulla **contains centres which control respiration, cardiovascular reflexes ,peristalsisi, vomiting, and gastric secretions (Involuntary functions)**

A) SPINAL CORD

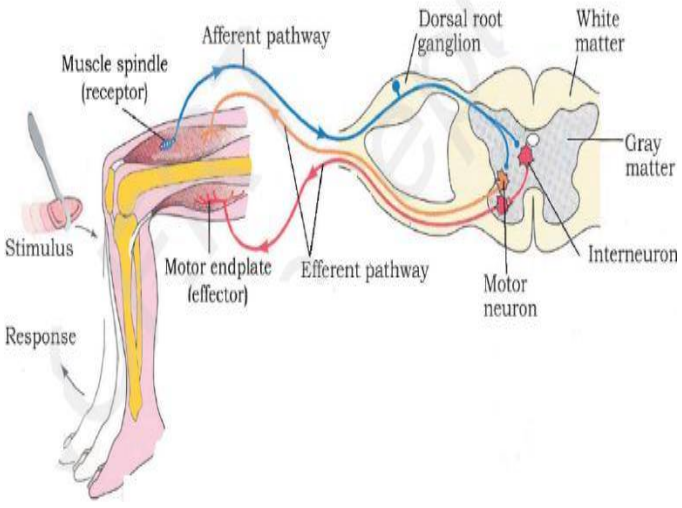
- It act as the link between brain and nerves that stretch throughout the body.
- **Spinal cord is located within the neural canal of vertebral coloumn. Thus Vertebral column protect the spinal cord**
- **The grey matter of spinal cord is inner part and the outer surface of spinal cord Is white matter. Cavity of spinal cord is called central canal.**

Reflex action:

- it is the immediate involuntary response of the body to a stimulation **without the intervention of brain.**
- **Reflex action is under the control of spinal cord.**
- **Reflex arc is the arrangement of neurons in the pathways that always pass through CNS.** The reflex pathway comprises at least **one afferent neuron (receptor**) and **one efferent (effector or excitor)** neuron appropriately arranged in a series.
- The **afferent neuron receives signal from a sensory organ** and transmits the **impulse via a dorsal nerve root into the CNS** (at the level of spinal cord). The **efferent nueuron then carries signals from CNS to the effector**

Ie:

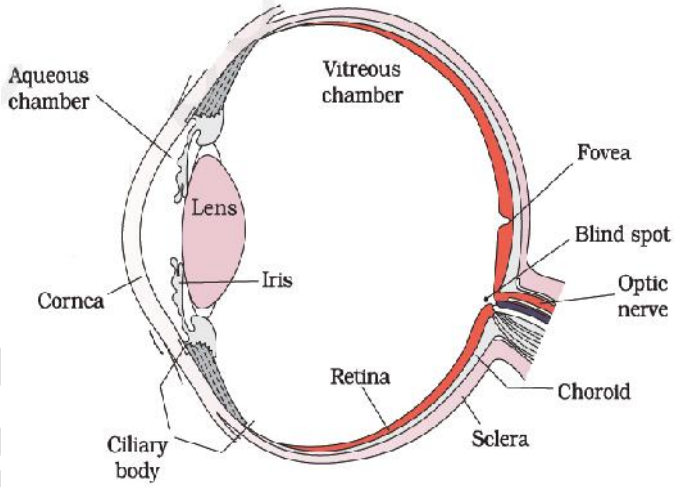
Receptor---→Afferent Neuron--→ spinal cord---→Inter neuron-→Efferent neuron---→Effector



SENSORY ORGANS

1. EYE

- Eyes are located in sockets of the skull called **orbits.**
- The adult human eye ball is nearly a **spherical structure**.
- The wall of the eye ball is composed of three layers, namely **sclera, choroid and Retina**



a)Sclerotic layer:

- It is the external layer of eye
- It is composed of a **dense connective tissue.**
- The anterior portion of sclera is called the **cornea (Transparent part of sclera) and is non vascular**.
- This layer give **shape to the eye ball**

b) Choroid layer

- It is the middle layer
- it contains **many blood vessels and looks bluish in colour**.
- The choroid layer is thin over the posterior two-thirds of the eye ball, but it becomes **thick in the anterior part to form** the **ciliary body**.
- **The ciliary body itself continues forward to form a pigmented and opaque structure called the iris which is the visible coloured portion of the eye**.
- The eye ball contains a transparent crystalline **lens (Biconvex)** which is held in place by **ligaments** attached to the **ciliary body**.

- In front of the lens, the aperture surrounded by the iris is called the **pupil**. **The diameter of the pupil is regulated by the muscle fibres of iris (Round muscle and Radial muscle)**
- The space between the cornea and the lens is called the **aqueous chamber** and contains a thin **watery fluid** called **aqueous humor**.
- The space between the lens and the retina is called the **vitreous chamber** and is filled with a **transparent gel** called **vitreous humor**.

c) Retina

- It is the innermost layer of the eye
- it contains three layers of cells – from inside to outside – **ganglion cells, bipolar cells and photoreceptor cells.**

Photoreceptor cells in Retina

- There are **two types** of photoreceptor cells, namely, **rods** and **cones**.
- These cells contain the light-sensitive **proteins** called the **photopigments**.
- photopigments in the human eyes is composed of
  - **Opsin (a protein) and**
  - **Retinal (an aldehyde of vitamin A)**

Cones

- **The daylight (photopic) vision and colour vision** are functions of cones .
- In the human eye, there are **three types of cones** which possess their own characteristic photopigments that respond **to red, green and blue lights**.
- The sensations of different colours are produced by various combi nations of these cones and their photopigments.
- **When these cones are stimulated equally, a sensation of white light is produced**

Rods

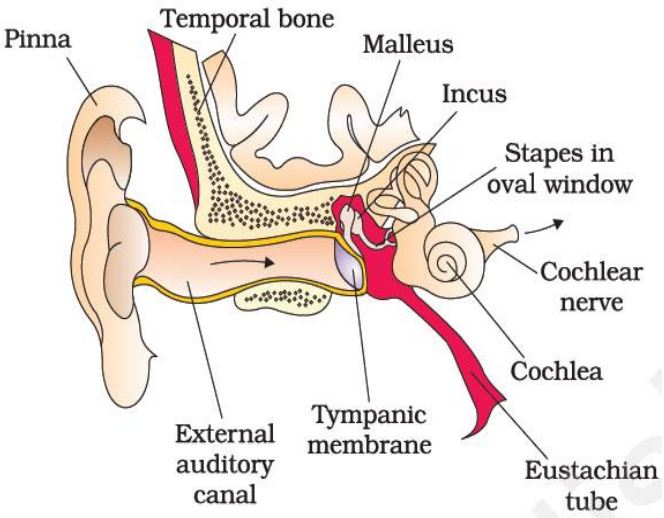
- The **twilight (scotopic)** vision is the function of the rods.
- The rods contain a **purplish-red** protein called the **rhodopsin or visual purple**, which contains a derivative of **Vitamin A**.

The **optic nerves** leave the eye and the retinal blood vessels enter it **at a point medial to and slightly above the posterior pole of the eye ball**. Photoreceptor cells (Cones and rods) **are not** present in that region and hence it is called the **blind spot**.

At the posterior pole of the eye lateral to the blind spot, there is a yellowish pigmented spot called **macula lutea** or **yellow spot** with a central pit called the **fovea**. The fovea is a thinned-out portion of the retina where only the cones are densely packed. It is the point where the **visual acuity (resolution) is the greatest.**

2. The Ear

- The ears Helps in hearing as well as maintenance of body balance, that is why ear is also called **stato-acoustic organ**.
- Anatomically, the ear can be divided into three major sections called the **outer ear**, the **middle ear** and the **inner ear**



a) Outer ear/External ear

- Outer ear consists of the **pinna** and **external auditory meatus** (canal).
- The pinna collects the vibrations in the air which produce sound.
- The external auditory meatus leads inwards and extends up to the **tympanic membrane** (**ear drum**).
- The tympanic membrane is composed of connective tissues covered with skin outside and with mucus membrane inside

- There are very fine hairs and wax-secreting **sebaceous glands** in the skin of the **pinna and the meatus**.

b) Middle ear

- The middle ear contains three ossicles called **malleus**, **incus** and **stapes** which are attached to one another in a **chain-like fashion**.
- The malleus is attached to the tympanic membrane
- the stapes is attached to the **oval window** of the cochlea.

Function of ear ossicle:

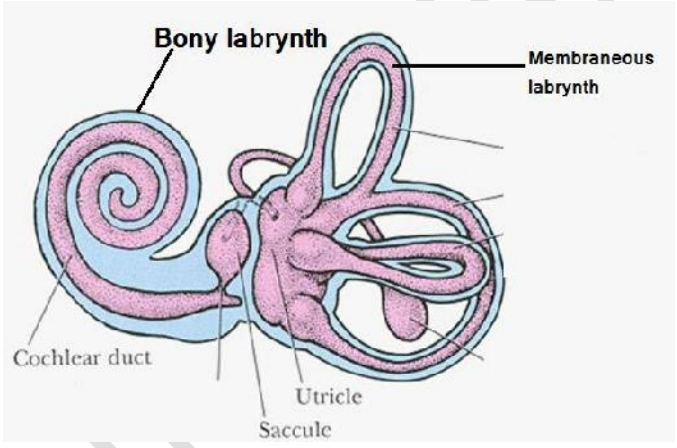
- The ear ossicles increase the efficiency of transmission of sound waves to the inner ear.

Function of Eustachian tube:

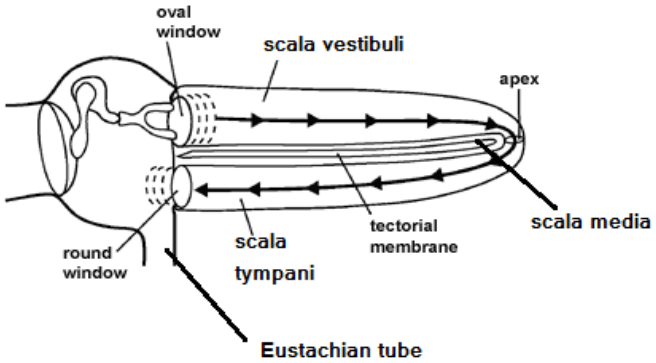
- An **Eustachian tube** connects the **middle ear cavity with the pharynx**. **The Eustachian tube helps in equalising the pressures on either sides of the ear drum.**

c) Inner ear

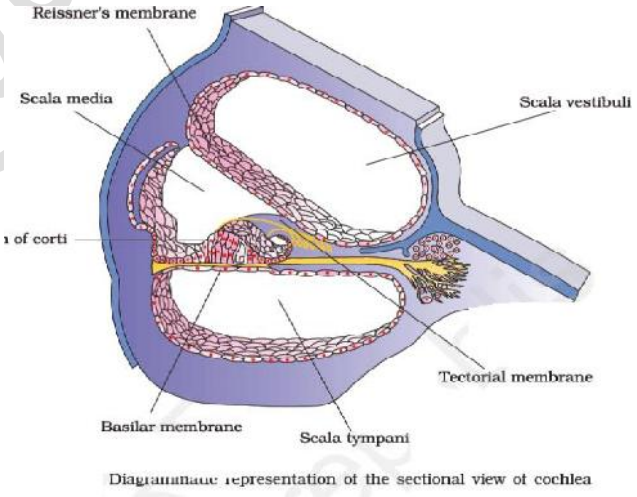
The Inner ear consists of **cochlea, semicircular canal and vestibule**.The fluid-filled inner ear called **labyrinth** consists of two parts, the **bony and the membranous labyrinths**.



- The bony labyrinth is a series of channels. Inside these channels lies the **membranous labyrinth**, which is **surrounded by a fluid called perilymph.**
- **The membranous labyrinth is filled with a fluid called endolymph**. The coiled portion of the labyrinth is called **cochlea**.
- The membranes constituting **cochlea, the reissner's and basilar, divide the surounding perilymph filled bony labyrinth into an upper scala vestibuli and a lower scala tympani**



- The space within cochlea called **scala media** is filled with endolymph.
- **At the base of the cochlea, the scala vestibuli ends at the oval window, while the scala tympani terminates at the round window which opens to the middle ear**.



Diagrammatic representation of the sectional view of cochlea

- The **organ of corti** is a structure located on the basilar membrane
- Organ of corti contains **hair cells** that act as **auditory receptors**.
- A large number of processes called **stereo cilia** are projected from the **apical part of each hair cell**. Above the rows of the hair cells is a thin elastic membrane called **tectorial membrane**.
- The hair cells are present in rows on the internal side of the organ of corti.
- The basal end of the hair cell is in close contact with the **afferent nerve fibres**.

Vestibular apparatus

- The inner ear also contains a complex system called **vestibular apparatus**, located above the cochlea.
- The vestibular apparatus is composed of three **semi-circular canals** and the **otolith organ** consisting of the **saccule and utricle**.

i) Semi circular canal

- Each semi-circular canal lies in a different plane at right angles to each other.
- The membranous canals are suspended in the perilymph of the bony canals.
- The base of canals is swollen and is called **ampulla,** which contains a projecting ridge called **crista ampullaris** which has hair cells.

ii) Otolith Organ

Otolith organ made up of Utricle and Sacule.The saccule and utricle contain a projecting ridge called **macula**. macula is the sensory part of saccule and utricle

- The crista and macula are the specific receptors of the vestibular apparatus **responsible for maintenance of balance of the body and posture**.

Mechanism of Hearing

- ✓ The **external ear** receives sound waves and directs them to the ear drum.
- ✓ The **ear drum** vibrates in response to the sound waves
- ✓ these vibrations are transmitted through the **ear ossicles** (malleus, incus and stapes) to the oval window.
- ✓ The vibrations are passed through the oval window on to the fluid of the cochlea, where they generate waves in the **lymphs**.
- ✓ The waves in the lymphs induce a ripple in the basilar membrane. These movements of the basilar membrane bend the hair cells, pressing them against the **tectorial membrane**. As a result, nerve impulses are generated in the associated afferent neurons.
- ✓ These impulses are transmitted by the **afferent fibres via auditory nerves to the auditory cortex of the brain,** where the impulses are analysed and the sound is recognized

Click on the logo for video lesson

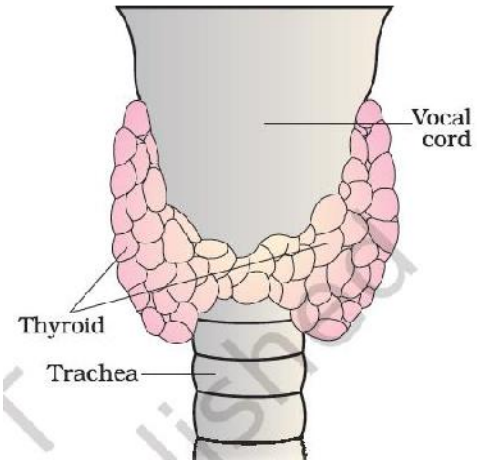
Chapter-11
Chemical Control and Coordination

1.Thyroid Gland

- The thyroid gland is composed of **two lobes** which are located **on either side of the trachea.**
- Both the lobes are interconnected with a thin flap of connective tissue called **isthmus.**
- .Thyroid gland synthesise three hormones, **tetraiodothyronine** or **thyroxine** (T4) .**triiodothyronine** (T3) and **thyrocalcitonin (TCT**)
- **Iodine** is essential for the normal rate of hormone synthesis in the thyroid.

Functions of Thyroid hormones

i) Regulation of the basal metabolic rate.
ii) Support the process of red blood cell formation.
iii) it control the metabolism of carbohydrates, proteins and fats.
iv) Maintenance of water and electrolyte balance is also influenced by thyroid hormones.
v) Thyroid gland also secretes a protein hormone called **thyrocalcitonin (TCT**) which regulates the blood calcium levels.

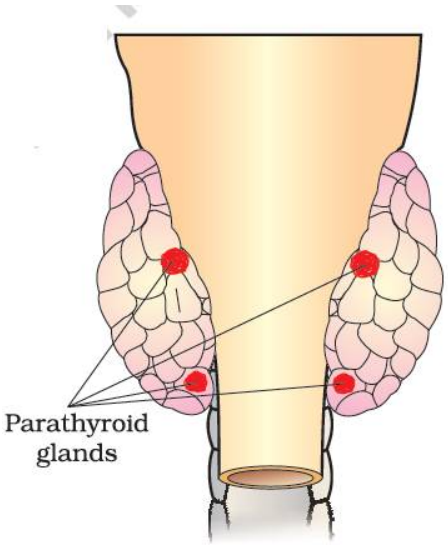


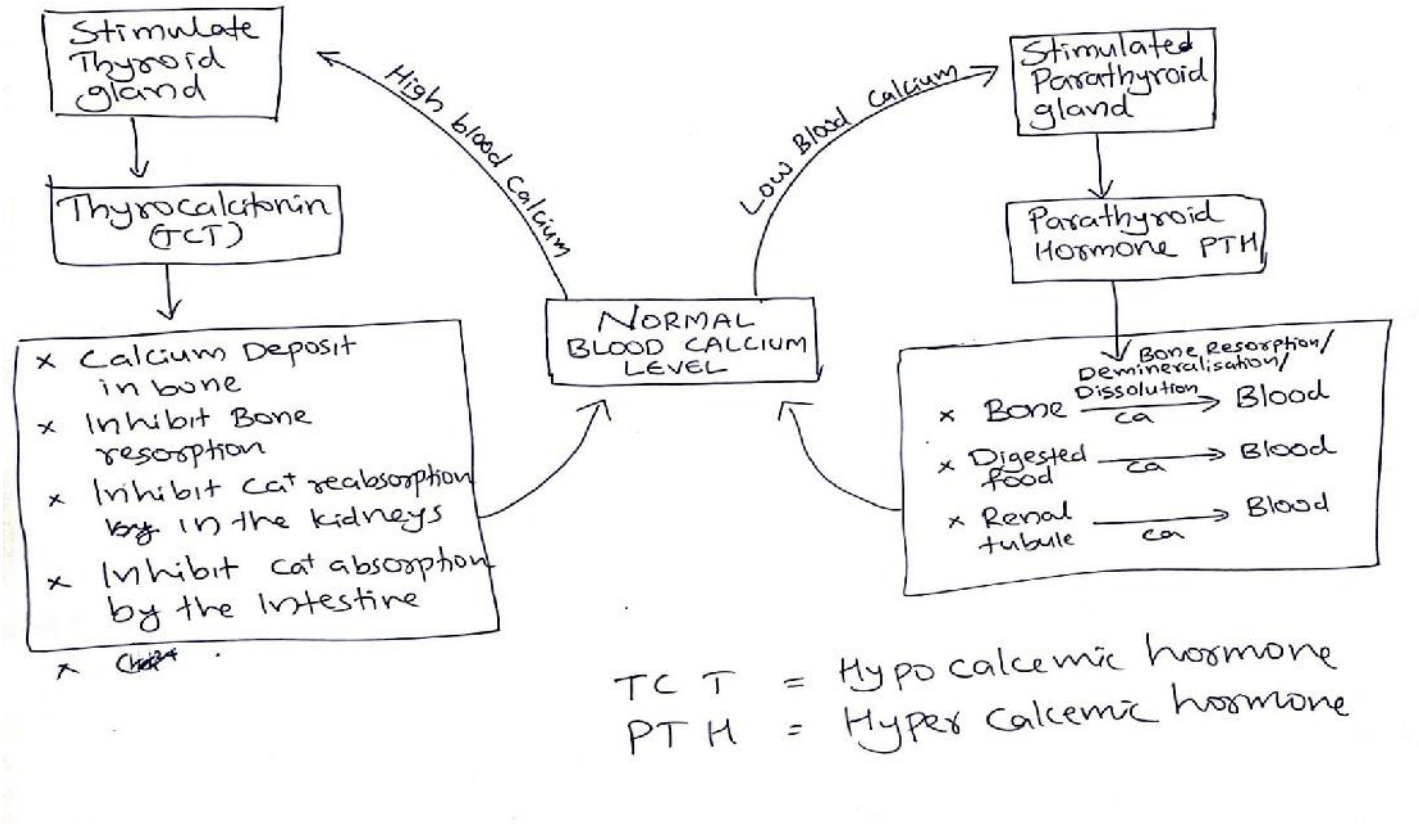
2.Parathyroid gland

- In humans, four parathyroid glands are present on the back side of the thyroid gland, one pair each in the two lobes of the thyroid gland
- The parathyroid glands secrete a peptide hormone called **parathyroid hormone (PTH).**
- The secretion of PTH is regulated by the **circulating levels of calcium ions.**
- Parathyroid hormone (PTH) increases the Ca2+ levels in the blood.
- PTH acts on bones and stimulates the process of **bone resorption** (dissolution/ demineralisation).
- PTH also stimulates reabsorption of Ca2+ by the renal tubules and **increases Ca2+ absorption** from the digested food.

Function of Parathyroid gland

- PTH increase the level of calcium in the blood ,Hence it is called **hypercalcemic hormone**,
  i.e., **it increases the blood Ca2+ levels**.
- **Along with TCT, PTH plays a significant role in calcium balance in the body.**





3.The Pineal Gland/Biological clock

- The pineal gland is located on the dorsal side of forebrain.
- Pineal secretes a hormone called **melatonin.**

Function of Pineal gland

I. Melatonin plays a very important role in the regulation of a **24-hour (diurnal) rhythm of our body**.

For example, it helps in maintaining the normal rhythms of

- sleep-wake cycle,
- body temperature.

II. melatonin also influences

- metabolism,
- pigmentation,
- the menstrual cycle
- our defense capability

4.Adrenal Gland/Supra renal gland

- We have one pair of adrenal glands, one at the anterior part of each kidney, hence the name **supra renal gland.**
- The gland is composed of two types of tissues. The centrally located tissue is called the **adrenal medulla, and outside this lies the adrenal cortex**

The adrenal medulla

It is the centrally located tissue of adrenal gland. it secretes two hormones called **adrenaline or epinephrine and noradrenaline or norepinephrine**. These are commonly called as **catecholamines.**

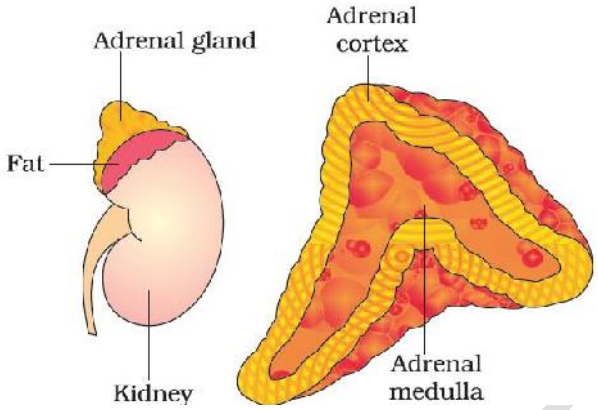
Functions of adrenaline and nor adrenaline

I. Adrenaline and noradrenaline are rapidly secreted in response to stress of any kind and during emergency situations and are called

emergency hormones or hormones of Fight or Flight.

II. These hormones increase alertness, pupilary dilation, piloerection (raising of hairs), sweating etc. Both the hormones increase the heart beat, the strength of heart contraction and the rate of respiration

III. .Catecholamines also stimulate the breakdown of glycogen resulting in an increased concentration of glucose in blood.



5.Pancreas

- Pancreas is a composite gland which acts as both exocrine and endocrine gland hence called mixed gland/heterocrine gland/composite gland
- The endocrine pancreas consists of 'Islets of Langerhans'. There are about 1 to 2 million Islets of Langerhans in a normal human pancreas representing only 1 to 2 per cent of the pancreatic tissue.
- The two main types of cells in the Islet of Langerhans are called α-cells and β-cells.

i) α-cells

- The α-cells secrete a hormone called glucagon
- Glucagon is a peptide hormone, and plays an important role in maintaining the normal blood glucose levels.

Functions of Glucagon

I. Glucagon acts mainly on the liver cells (hepatocytes) and stimulates **glycogenolysis** resulting in an **increased blood sugar (hyperglycemia)**. In addition, this hormone stimulates the process of **gluconeogenesis** which also contributes to hyperglycemia.

II. Glucagon reduces the cellular glucose uptake and utilisation. Thus, glucagon is a **hyperglycemic hormone**.

ii) β-cells

- The β-cells of islets of langerhans secrete insulin.
- Insulin is a peptide hormone, which plays a major role in the regulation of glucose homeostasis.

Functions of Insulin

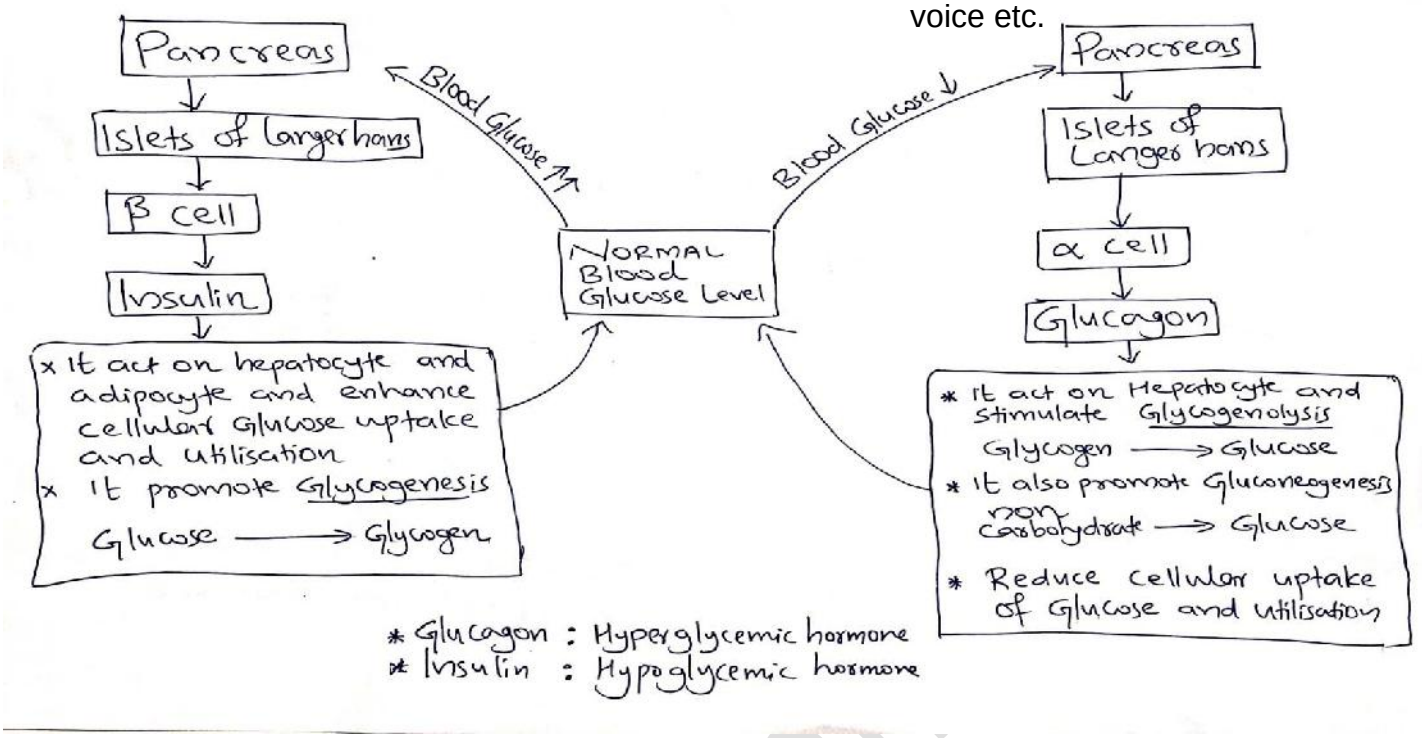
I. Insulin acts mainly on hepatocytes and adipocytes (cells of adipose tissue), and **enhances cellular** glucose uptake and utilisation. As a result, there is a rapid movement of glucose from blood to hepatocytes and adipocytes resulting in **decreased blood glucose levels (hypoglycemia).**

II. Insulin also stimulates conversion of glucose to glycogen (glycogenesis) in the target cells.

Blood glucose homeostasis in blood is thus maintained jointly by the two **– insulin and glucagons.**

- **Prolonged hyperglycemia leads to a complex disorder called diabetes mellitus which is associated with loss of glucose through urine and formation of harmful compounds known as ketone bodies**.
- Diabetic patients are successfully treated with **insulin therapy**.

hair, aggressiveness, low pitch of voice etc.



6.Gonads

a)Testis

- A pair of testis is present in the **scrotal sac** (outside abdomen) of male individuals
- Testis performs **dual functions** as a **primary sex organ** as well as an **endocrine gland.**
- Testis is composed of **seminiferous tubules and stromal or interstitial tissue.**
- The **Leydig cells or interstitial cells**, which are present in the **intertubular spaces** produce a group of hormones called **androgens mainly testosterone**.

Functions of Androgens

I. Androgens regulate the development, maturation and functions of the male accessory sex organs like epididymis, vas deferens, seminal vesicles, prostate gland, urethra etc.

II. These hormones stimulate muscular growth, growth of facial and axillary

III. Androgens play a major stimulatory role in the process of spermatogenesis (formation of spermatozoa).

IV. Androgens act on the central neural system and influence the **male sexual behaviour (libido).**

V. These hormones produce **anabolic (synthetic) effects** on protein and carbohydrate metabolism

b)Ovary

- Females have a pair of ovaries located in the abdomen
- Ovary is the primary female sex organ which produces one ovum during each menstrual cycle. In addition, ovary also produces **two groups of steroid hormones called estrogen and progesterone.**
- Females have a pair of ovaries located in the abdomen

- Ovary is the primary female sex organ which produces one ovum during each menstrual cycle. In addition, ovary also produces **two groups of steroid hormones called estrogen and progesterone.**
- Ovary is composed of ovarian follicles and stromal tissues.

Estrogen

The estrogen is synthesised and secreted mainly by the **growing ovarian follicles**.

Functions of estrogen

I. Stimulation of growth and activities of female secondary sex organs,
II. Development of growing ovarian follicles,
III. Appearance of female secondary sex characters (e.g., **high pitch of voice**, etc.),
IV. Mammary gland development.
V. Estrogens also regulate female sexual behavior.

Progesterone

- After ovulation, the ruptured follicle is converted to a structure called **corpus luteum**, which secretes mainly progesterone.

Functions of progesterone

I. Progesterone **supports pregnancy** (Hence called **pregnancy hormone**)
II. Progesterone also acts on the mammary glands and stimulates the formation of alveoli (sac-like structures which store milk) and milk secretion.

Estrogen

The estrogen is synthesised and secreted mainly by the **growing ovarian follicles**.

Functions of estrogen

i) Stimulation of growth and activities of female secondary sex organs,
ii) development of growing ovarian follicles,
iii) appearance of female secondary sex characters (e.g., **high pitch of voice**, etc.),
iv) Mammary gland development.
v) Estrogens also regulate female sexual behavior.

Progesterone

- After ovulation, the ruptured follicle is converted to a structure called **corpus luteum**, which secretes mainly progesterone.

Functions of progesterone

i) Progesterone **supports pregnancy** (Hence called **pregnancy hormone**)
ii) Progesterone also acts on the mammary glands and stimulates the formation of alveoli (sac-like structures which store milk) and milk secretion.

7.The Hypothalamus.

- Hypothalamus contains several groups of **neurosecretory cells called nuclei** which produce hormones. These hormones regulate the synthesis and secretion of **pituitary hormones.**
- The hormones produced by hypothalamus are of two types, **the releasing hormones** (which stimulate secretion of pituitary hormones) and the **inhibiting hormones** (which inhibit secretions of pituitary hormones).

For example :

- ✓ a hypothalamic hormone called **Gonadotrophin releasing hormone** (GnRH) stimulates the pituitary synthesis and release of **gonadotrophins** (FSH and LH)
- ✓ **somatostatin** from the hypothalamus **inhibits** the release

of **growth hormone** from the pituitary.

- ✓ These hormones(**GnRH and Somatostatin**) are originating in the hypothalamic neurons, pass through axons and are released from their nerve endings. These hormones reach the pituitary gland through a **portal circulatory system** and regulate the functions of the anterior pituitary. The posterior pituitary is under the direct neural regulation of the hypothalamus.

Oxytocin and Vasopressin

Hypothalamus also secrete two hormones namely **Oxytocin (OT) and vasopressin** (ADH), Oxytocin and vasopressin, which are actually synthesised by the hypothalamus and are transported **axonally to neurohypophysis.**

Functions of Oxytocin (OT)

I. It acts on the smooth muscles of our body and stimulates their contraction. In females,
II. it stimulates a vigorous contraction of uterus at the time of child birth (Hence called **delivery hormone**),
III. milk ejection from the mammary gland (hence called **milk ejecting hormone**).

Functions Vasopressin (ADH)

I. Vasopressin acts mainly at the kidney and stimulates **resorption of water and electrolytes** by the **distal tubules** and thereby reduces loss of water through urine **(diuresis)**. Hence, it is also called as **anti-diuretic hormone** (ADH).An **impairment** affecting the synthesis or **release of ADH** results in diminished ability of the kidney to conserve water leading to **water loss and dehydration**. This condition is called **Diabetes Insipidus.**

9.The Pituitary Gland/Master Gland

- The pituitary gland is located in a bony cavity called **sella tursica** and is attached to hypothalamus by **a stalk**
- Pituitary gland is divided anatomically into an **adenohypophysis** and a **neurohypophysis**.

a)Adenohypophysis

- Adenohypophysis consists of two portions, **pars distalis** and **pars intermedia**.

i)The pars distalis

This region of pituitary commonly called **anterior pituitary**, produces

- ✓ growth hormone (GH),
- ✓ prolactin (PRL),
- ✓ thyroid stimulating hormone (TSH),
- ✓ adrenocorticotrophic hormone (ACTH),
- ✓ luteinizing hormone (LH) and follicle
- ✓ stimulating hormone (FSH).

Growth hormone:

- Over-secretion of GH stimulates **abnormal growth** of the body leading to **gigantism**
- **Low secretion of GH** results in stunted growth resulting in pituitary **dwarfism.**
- **Excess** secretion of growth hormone in **adult** especially in the middle age can result in severe disfigurement (especially of the face) called **acromegaly.** It lead to premature death if unchecked. This disease is hard to diagnose in early stages and often goes undetected for many years, until changes in external features become noticeable.

Prolactin (PRL)

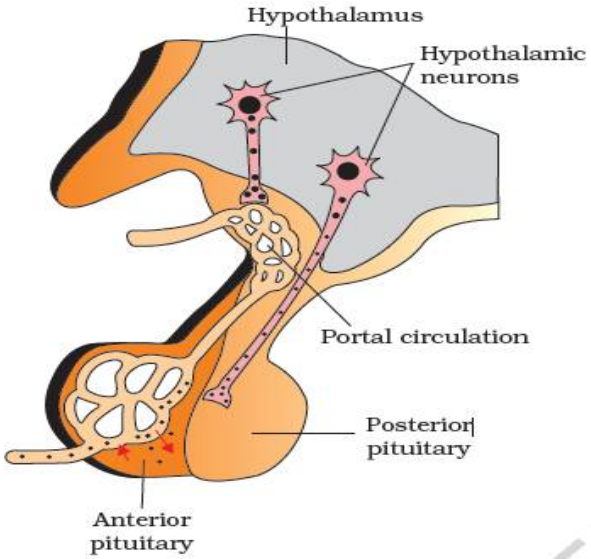
- Prolactin regulates the growth of the mammary glands and formation of milk in them (hence called Milk synthesizing hormone)

TSH :

- TSH stimulates the synthesis and secretion of thyroid hormones from the thyroid gland.

FSH :

In males, FSH regulate spermatogenesis. FSH stimulates growth and development of the ovarian follicles in females



b)Neurohypophysis (pars nervosa)

It is also known **as posterior pituitary**, stores and releases two hormones called oxytocin and vasopressin, which are actually synthesised by the hypothalamus and are transported axonally to neurohypophysis.

- **Hormones are also secreted by some tissues which are not endocrine glands**.

I)Hormones of heart-ANF

atrial wall of our heart secretes a very important peptide hormone called atrial natriuretic factor (ANF), **which decreases blood pressure.** When blood pressure is increased, ANF is secreted which causes **dilation of the blood vessels**. This reduces the blood pressure.

II)Hormones of Kidney- Erythropoietin

The **juxtaglomerular cells(JG cells)** of kidney produce a peptide hormone called **erythropoietin** which stimulates **erythropoiesis (formation of RBC)**

Click on the logo for video lesson