VIJAYABHERI

MALAPPURAM DISTRICT PANCHAYATH
EDUCATIONAL

PROJECT 2021-22

STEP-UP

ZOOLOGY

1st Year

(Supporting Material for Higher secondary/VHSE)

വിദ്യാഭ്യാസപരമായി ഏറ്റവും പുറകിൽ നിന്നിരുന്ന മലപ്പുറം ജില്ല കഴിഞ്ഞ കുറച്ചു വർഷങ്ങൾ കൊണ്ടുണ്ടാക്കിയ നേട്ടങ്ങൾ അഭൂതപൂർവമാണ്. എസ്.എസ്.എൽ.സി, പ്ലസ്ടു, വി.എച്ച്.എസ്.ഇ ഫലത്തിന്റെ കാര്യത്തിൽ മാത്രമല്ല എ പ്ലസ്സ് ലഭിച്ച വിദ്യാർത്ഥികളുടെ എണ്ണത്തിലും വിവിധ മത്സരപരീക്ഷകളിലും നമ്മൾ ഏറെ മുന്നേറി. പൊതുവിദ്യാഭ്യാസ സംരക്ഷണത്തിന്റെ കാര്യത്തിൽ മറ്റു ജില്ലകൾക്ക് നമ്മൾമാതൃകയാണ്. മലപ്പുറം ജില്ലാ പഞ്ചായത്ത് ആവിഷ്കരിച്ചു നടപ്പിലാക്കി കൊണ്ടിരിക്കുന്ന വിജയഭേരി വിദ്യാഭ്യാസ പദ്ധതി, തദ്ദേശ സ്വയംഭരണ സ്ഥാപനങ്ങളുടെ ഇടപെടലുകൾ, ജനപ്രതിനിധികൾ, എസ്. എസ്. കെ, ഡയറ്റ്, വിദ്യാഭ്യാസ ഓഫീസർമാർ ഒപ്പം എല്ലാ നല്ല പ്രവർത്തനങ്ങൾക്കും കൂടെ നിൽക്കുന്ന അധ്യാപകർ എന്നിവരാണ് ഈ നേട്ടങ്ങൾക്കു പിന്നിൽ.

നേട്ടങ്ങൾ ആഘോഷിക്കുന്നതിനോടൊപ്പം അടിയന്തിര ശ്രദ്ധ പതിയേണ്ടുന്ന മേഖലകൾ ഇനിയും ഏറെയുണ്ട്. 10-ാം ക്ലാസ്സിൽ നിന്നും വിജയം നേടി പ്ലസ്സ് 1, വി.എച്ച്.എസ്.ഇ ക്ലാസ്സുകളിൽ എത്തുന്ന വിദ്യാർത്ഥികളിൽ നല്ലൊരു ശതമാനം വിദ്യാർത്ഥികൾ ഹയർ സെക്കണ്ടറി സിലബസ് പിന്തുടരുന്നതിന് ഏറെ പ്രയാസം അനുഭവിക്കുന്നവരാണ്. കോവിഡ് കാരണം സ്കൂൾ പ്രവർത്തി ദിനങ്ങൾ നഷ്ടപ്പെട്ടതോടെ ഭൂരിപക്ഷം വിദ്യാർത്ഥികളും പഠന പ്രയാസങ്ങൾ അനുഭവിക്കുന്നു ഈയൊരു പശ്ചാത്തലത്തിൽ പ്ലസ്ടു , വി. എച്ച്. എസ്. ഇ തലത്തിൽ വിവിധ വിഷയങ്ങൾ അനായാസകരമായി പഠിക്കുന്നതിനും എല്ലാ വിദ്യാത്ഥികളും പ്ലസ്ടു, വി. എച്ച്.എസ്.ഇ പരീക്ഷകളിൽ മികച്ച വിജയം ഉറപ്പു വരുത്തുന്നതിനായി **സ്റ്റെപ്പ് - അപ്പ് 22** എന്ന പേരിൽ പ്രത്യേക മെറ്റീരിയൽ വിജയഭേരി പദ്ധതിയുടെ ഭാഗമായി തയ്യാറാക്കി സ്കൂളുകളിലെത്തിക്കുകയാണ്. തീർച്ചയായും ഈ മെറ്റീരിയൽ അധ്യാപകർക്കും വിദ്യാർത്ഥികൾക്കും ഏറെ സഹായകരമാകുമെന്ന് പ്രതീക്ഷിക്കുന്നു.

ഈ പഠനസഹായി സമയബന്ധിതമായി പൂർത്തീകരിക്കുന്നതിന് നേതൃത്വം നൽകിയ മലപ്പുറം ഡയറ്റ്, ഹയർ സെക്കണ്ടറി ജില്ലാ കോർഡിനേറ്റർ / അസിസ്റ്റന്റ് കോർഡിനേറ്റർ, ശില്പശാലയിൽ പങ്കെടുത്ത അധ്യാപകർ എന്നിവർക്കുള്ള നന്ദിയും കടപ്പാടും പ്രത്യേകം അറിയിക്കുന്നു.

സ്കൂൾതലത്തിൽ അനുയോജ്യമായ സമയം കണ്ടെത്തി രക്ഷിതാക്കളുടെ സഹകരണത്തോടെ ഈ പഠനപ്രവർത്തനങ്ങൾ വിദ്യാർത്ഥികൾക്ക് നൽകണം. അതിനായി എല്ലാ അധ്യാപകരുടെയും സഹകരണം പ്രതീക്ഷിക്കുന്നു.

പ്രസിഡണ്ട്	ചെയർപേഴ്സൺ	അസി: ഡയറക്ടർ	ആർ.ഡി.ഡി	പ്രിൻസിപ്പാൾ
ജില്ലാ പഞ്ചായത്ത്	ആരോഗ്യ വിദ്യാഭ്യാസ	വി.എച്ച്. എസ്.ഇ	മലപ്പുറം	ഡയറ്റ്
മലപ്പുറം	സ്ഥിരം സമിതി	മലപ്പുറം		മലപ്പുറം

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1. LIVING WORLD

PROPERTIES OF LIVING ORGANISMS

1. **Growth:** Increase in number & mass of cells by cell division.
2. **Reproduction:** Production of progeny having features similar to those of parents.
3. **Metabolism:** All biochemical reactions taking place inside a living system.
4. **Cellular organization:** Organisms are made up of one or more cells.
5. **Consciousness:** Ability to sense their environment and respond to environmental stimuli.

DIVERSITY IN THE LIVING WORLD

Taxonomy: Study of **identification, classification** & **nomenclature** of organisms.

Basic processes of taxonomy: Characterization, Identification, Classification & Nomenclature.

Binomial nomenclature: Proposed by **Carl Linnaeus.**

Botanical names are based on **International Code for Botanical Nomenclature (ICBN).**

Zoological names are based on **International Code for Zoological Nomenclature (ICZN).**

Universal rules of Binomial nomenclature

- Scientific names are in ***Latin*** or Latinised and written in ***italics.*** When handwritten, they are underlined.
- Genus name (**Generic name)** starts with capital letter and species name **(specific epithet)** starts with small letter. E.g. ***Homo sapiens***- *Homo* is the genus name and *sapiens* is the species name.
- Name of the author (in abbreviated form) appears at the end of the biological name.

  E.g., *Mangifera indica* Linn. (Linn. = Linnaeus).

TAXONOMIC CATEGORIES

Taxonomic category (Rank)	Taxon (E.g.)
Kingdom	Animalia
↑	
Phylum/Division	Chordata
↑	
Class	Mammalia
↑	
Order	Primata
↑	
Family	Hominidae
↑	
Genus	Homo
↑	
Species	sapiens

- **Taxon:** A unit of classification.
- **Kingdom:** Highest category.
- **Species:** Lowest category.

Organisms with their taxonomic categories

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

TAXONOMICAL AIDS

a. **Herbarium:** Store house of dried plants on sheets.

b. **Botanical gardens:** Collection of living plants.

c. **Museum:** Collection of dead plants and animals.

d. **Zoological Parks (Zoos):** Live wild animals.

e. **Key:** Analytical method of identification of organisms.

f. **Flora:** Account of plant species of a given area.

g. **Manuals:** Information for identification of names of species found in an area.

h. **Monographs:** Information on any one taxon.

VIDEO CLASS

SLIDES OF THIS CHAPTER

QUESTION BANK

2. ANIMAL KINGDOM

BASIS OF CLASSIFICATION

1. Levels of organization	• **Cellular level:** Loose cell aggregates. E.g. Porifera. • **Tissue level:** Cells to tissues. E.g. Cnidarians and Ctenophores. • **Organ level:** Tissues to organs. E.g. Platyhelminthes to chordates. • **Organ system level:** Organs to organ systems E.g. higher animals.
2. Body symmetry (arrangement of similar parts on either side of body)	• **Asymmetrical:** No symmetry. E.g. Most Poriferans, Snails etc. • **Radial symmetry:** Body can be cut into 2 equal halves in any plane along central axis. E.g. some Poriferans, Cnidarians, Ctenophores & adult Echinoderms. • **Bilateral symmetry:** Body can be cut into right & left halves in only one plane. E.g. Flatworms to Chordata (except adult Echinodermata).
3. Embryonic layers	• **Diploblastic:** Ectoderm & endoderm. E.g. Cnidaria & Ctenophora. • **Triploblastic:** Ectoderm, mesoderm & endoderm. E.g. Flatworms to Chordata.
4. Coelom (cavity b/w body wall & gut wall)	• **Acoelomate:** No coelom. E.g. Porifera to Platyhelminthes. • **Pseudocoelomate:** False coelom. E.g. Aschelminthes. • **Coelomate:** True coelom. E.g. Annelida to Chordata.
5. Metamerism	Segmentation. E.g. Annelids (earthworm etc.), Arthropods.
6. Notochord	Mesodermally derived rod on the dorsal side of embryo. Only in Chordata.

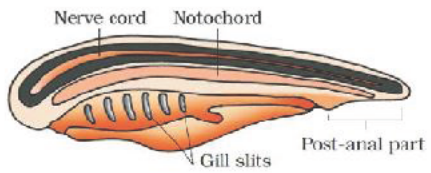
GENERAL CHARACTERS OF DIFFERENT PHYLA

Phyla	Unique features & Examples
Porifera (Sponges)	**Water canal system (water → ostia → spongocoel → osculum).** Spongocoel & canals are lined with **choanocytes** (collar cells). Body is supported by **spicules** and **spongin** fibres. **Examples:** *Sycon (Scypha), Spongilla* (fresh water sponge), *Euspongia* (Bath sponge).
Cnidaria (Coelenterata)	**Tentacles** with **cnidoblasts** (stinging cells). **Gastro-vascular cavity (coelenteron)** with mouth on **hypostome. Polyp** & **Medusa** forms. Some shows **alternation of generation (metagenesis).** **Examples:** *Hydra, Obelia, Aurelia, Physalia* (Portuguese man of war), *Adamsia* (Sea-anemone).
Ctenophora (Comb jellies)	Locomotion is by ciliated **comb plates**. Shows **Bioluminescence** (ability to emit light). **Examples:** *Ctenoplana, Pleurobrachia*
Platyhelminthes (Flatworms)	**Unsegmented, dorso-ventrally flattened body.** Excretion by **Flame cells.** Parasites have **Hooks** & **suckers.** **Examples:** *Taenia solium* (Tape worm), *Fasciola* (Liver fluke), *Planaria.*

Phyla	Unique features & Examples
Aschelminthes (Roundworms)	Pseudocoelomate. Body is circular in cross section. An excretory tube to remove waste through excretory pore. Sexual dimorphism (females are longer than males). **Examples:** *Ascaris* (Roundworm), *Ancylostoma* (Hookworm), *Wuchereria* (Filarial worm).
Annelida (Segmented or Ringed worms)	Segmentation like rings. **Longitudinal & circular muscles** help in locomotion. Locomotory organs: **Parapodia** (in *Neries*). Closed type circulatory system. Excretion by **Nephridia.** **Examples:** *Pheretima* (earthworm), *Hirudinaria* (Leech), *Neries*
Arthropoda (Joint-legged animals)	**Jointed appendages**. Body has 3 regions: **head, thorax** & **abdomen.** Body is covered by **chitinous cuticle (exoskeleton).** Excretion by **Malpighian tubules.** **Examples:** **Economically important insects:** *Apis, Bombyx, Laccifer*. **Vectors:** Mosquitoes, Housefly. **Gregarious pest**: *Locusta*. **Living fossil:** *Limulus* (King crab)
Mollusca (Soft-bodied animals)	Body has **head, visceral mass** & muscular **foot.** Head has **sensory tentacles.** Calcareous shell. Feather-like gills for respiration & excretion. **Mantle** & **radula** (rasping organ) are seen. **Examples:** *Pila* (Apple Snail), *Pinctada* (Pearl Oyster), *Sepia* (Cuttlefish), *Loligo* (Squid), *Octopus* (Devil fish).
Echinodermata (Spiny-skinned animals)	Adults radial. Larvae bilateral. Endoskeleton of calcareous **ossicles** (Spiny bodied). **Water vascular system** present. Excretory system absent. **Examples:** *Asterias* (Starfish), *Echinus* (Sea Urchin), *Echinocardium, Antedon* (Sea Lily), *Cucumaria* (Sea Cucumber), *Ophiura* (Brittle Star).
Hemichordata	Body is formed of **proboscis, collar** & **trunk.** Collar bears **stomochord**. Excretion by **Proboscis gland.** **Examples:** *Balanoglossus* (Tongue worm), *Saccoglossus*

PHYLUM CHORDATA

Differences between Chordata & Non-Chordata



Chordata	Non-Chordata
1. Notochord	Absent
2. Central nervous system is dorsal.	Ventral
3. Pharyngeal gill slits	Absent
4. A post-anal part (tail)	Absent
5. Ventral heart	Dorsal heart

Phylum Chordata is classified into 3 subphyla: **Urochordata, Cephalochordata & Vertebrata.**

UROCHORDATA	CEPHALOCHORDATA	VERTEBRATA
• **Notochord** present only in larval tail. • E.g. *Ascidia, Salpa, Doliolum.*	• Notochord from head to tail region and is persistent throughout life. • E.g. *Branchiostoma* (Amphioxus or Lancelet).	• Notochord in embryo. • It is replaced by cartilaginous or bony **vertebral column.** • **Paired appendages** (fins or limbs).

CLASSIFICATION OF VERTEBRATA

CLASS CYCLOSTOMATA

- All are ***ectoparasites*** on some fishes.
- Elongated body without scales and paired fins.
- Sucking and circular mouth ***without jaws.***
- ***Cartilaginous cranium*** and ***vertebral column.***
- Marine, but migrate for ***spawning*** to fresh water.
- E.g. *Petromyzon* (Lamprey) and *Myxine* (Hagfish).

SUPERCLASS PISCES (FISHES)

Class Chondricthyes (Cartilaginous fishes)	Class Osteichthyes (Bony fishes)
Cartilaginous endoskeleton.	**Bony endoskeleton.**
Ventral mouth.	Terminal mouth.
Gill slits without operculum.	**Gills** covered by **operculum.**
Skin with **placoid scales.**	Scales are **Cycloid, ctenoid** etc.
No air bladder. So, needs to swim to avoid sinking.	**Air bladder** for buoyancy.
In males, pelvic fins bear **claspers.** Internal fertilization. Many are **viviparous.**	External fertilisation. Mostly **oviparous.**
Examples: *Scoliodon* (Dogfish), *Pristis* (Saw fish), *Carcharodon* (Great white shark), *Trygon* (Sting ray), *Torpedo* (Electric ray).	**Examples: Marine:** *Exocoetus* (flying fish), *Hippocampus* (seahorse). **Fresh water:** *Labeo* (Rohu), *Catla* (Katla), *Clarias* (Magur). **Aquarium:** *Betta* (Fighting fish), *Pterophyllum* (Angel fish).

SUPERCLASS TETRAPODA

Class Amphibia	Class Reptilia	Class Aves (Birds)	Class Mammalia
Live in aquatic & terrestrial habitats. Need water for breeding. ***Moist skin*** without scales. ***Cloaca***. Cold-blooded. **Examples:** *Bufo, Rana, Hyla, Salamandra, Ichthyophis (Limbless amphibia).*	Dry & cornified skin, epidermal ***scales*** or ***scutes***. Crawling locomotion. Cold-blooded. **Examples:** *Chelone, Testudo, Chameleon, Calotes, Crocodilus, Alligator, Hemidactylus, Naja, Bangarus, Vipera.*	***Feathers, beak & wings.*** Dry skin without glands except ***oil gland*** at tail base. Hind limbs have ***scales.*** Pneumatic bones. Digestive tract has ***crop*** & ***gizzard***. Warm-blooded. **Examples:** *Corvus, Columba, Psittacula, Struthio.*	***Mammary glands***. Skin with ***hair.*** Teeth different types. ***Viviparous.*** Warm-blooded. **Examples:** *Ornithorhynchus, Macropus, Pteropus, Camelus, Macaca, Rattus, Canis, Felis, Elephas, Equus.*

VIDEO CLASS

SLIDES OF THIS CHAPTER

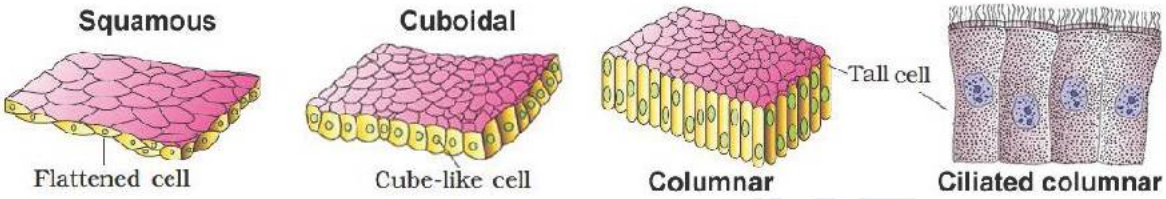
QUESTION BANK

3. STRUCTURAL ORGANISATION IN ANIMALS

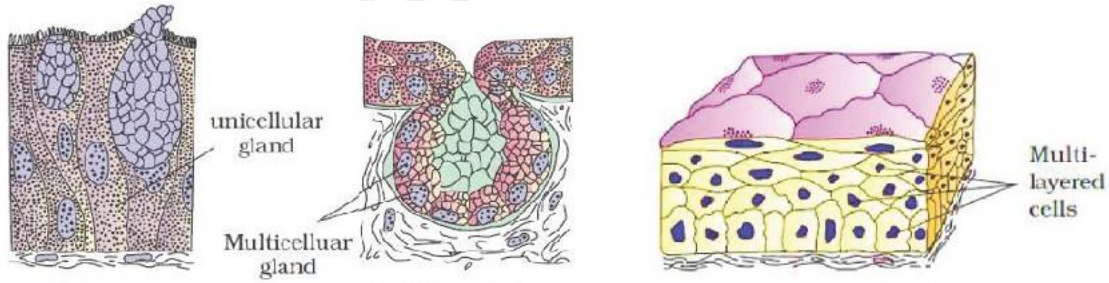
ANIMAL TISSUES (Epithelial, Connective, Muscle & Neural Tissues)

1. Epithelial tissues (Epithelium)

Types		Location	Function
a. Simple (single layered)	Squamous	Walls of blood vessels & alveoli.	Diffusion.
	Cubical (cuboidal)	Ducts of glands and nephrons.	Secretion & absorption
	Columnar	Lining of stomach and intestine.	Secretion & absorption
b. Compound (Multi-layered)		Skin, buccal cavity, pharynx etc.	Protection.



Modification of columnar or cuboidal cells	
Ciliated epithelium - Bear cilia. - Seen in bronchioles & fallopian tubes. - **Function:** move substances over epithelium.	**Glandular epithelium**: For secretion. 2 types: **Unicellular** (E.g. Goblet cells) & **Multicellular** (E.g. salivary glands). Based on mode of secretion, glands are 2 types: ▪ **Exocrine glands:** have ducts. E.g. Salivary gland. ▪ **Endocrine glands:** Ductless. Produce **hormones.**



Cell junctions: The junctions that provide link between adjacent cells. 3 types:

a. **Tight junction:** Stop substances from leaking across a tissue.

b. **Adhering junction:** Perform cementing to keep neighbouring cells together.

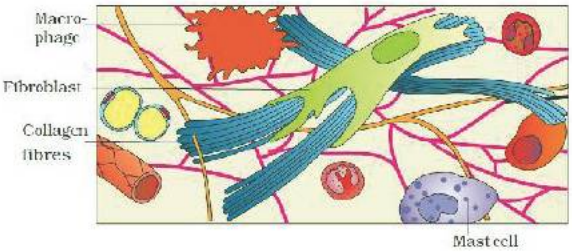
c. **Gap junction:** For communication b/w adjoining cells by connecting cytoplasm for rapid transfer of ions, molecules etc.

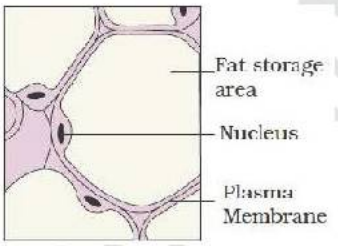
2. Connective tissues

Types		Location/ Features/ Function
Loose CT Loosely packed Fibres and fibroblasts.	Areolar	Under skin. Support for epithelium.
	Adipose	Under skin. Its cells (adipocytes) store fats.

Dense CT Compactly packed Fibres and fibroblasts.	Dense regular (Tendon & Ligament)	Collagen fibres are regular. Tendon: Attach muscles to bones. Ligament: Attach bone to bone.
	Dense irregular	Fibroblasts & fibres are irregular. Present in skin.
Specialized CT	Cartilage	Pliable due to ***chondroitin salts.*** Cartilage cells → **chondrocytes**.
	Bone	Non-pliable. Rich in **calcium salts.** Bone cells → **osteocytes.** Function: Protection, support, locomotion.
	Blood	Fluid CT. Circulation.

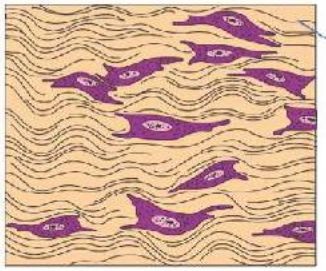
Areolar tissue

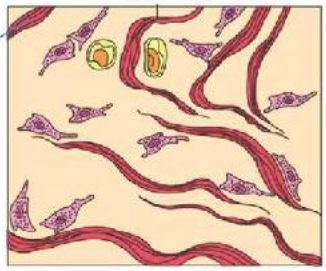




Adipose tissue

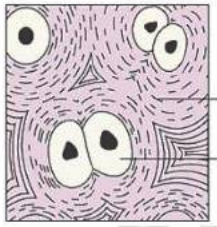
Dense regular

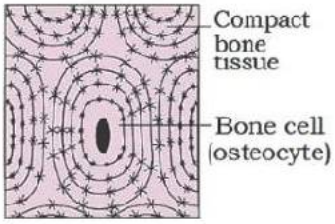




Dense irregular

Cartilage

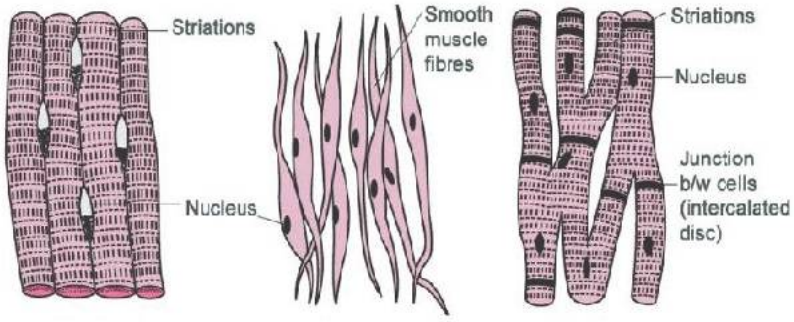




Bone

3. Muscle tissues	**Skeletal** (striated or voluntary)	Attached to bones. Striations present.
	Visceral (Non-striated/ smooth)	Involuntary & fusiform. No striations. Found in blood vessels, stomach, intestine.
	Cardiac	Involuntary. Seen in heart. Communication junctions (intercalated discs).

Muscle tissues:
a. Skeletal
b. Smooth
c. Cardiac



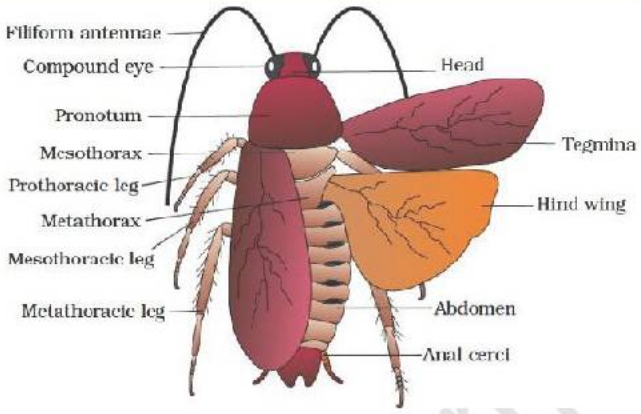
4. Neural tissue: Neural system. Made up of neurons & Neuroglia.

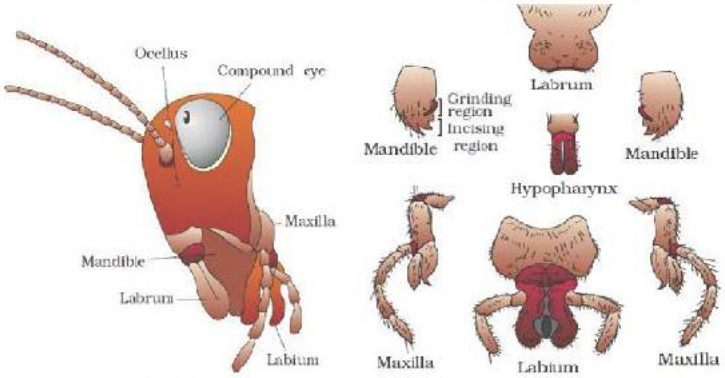
MORPHOLOGY OF COCKROACH (*Periplaneta americana*)

Chitinous exoskeleton (cuticle).

Body has 3 regions – **head, thorax** and **abdomen.**

- **Head:** Antennae, compound eyes. Biting & chewing mouth parts.
  Mouthparts: labrum (upper lip), 2 **mandibles,** 2 **maxillae, hypopharynx** (tongue) & a **labium** (lower lip).
- **Thorax:** 3 parts: **prothorax, mesothorax** & **metathorax.**
  2 pairs of wings:
  - **Forewings (mesothoracic)** or **tegmina:** Opaque, dark.
  - **Hind wings (metathoracic):** Transparent, used in flight.
- **Abdomen:** 10 segments.





Mouth parts

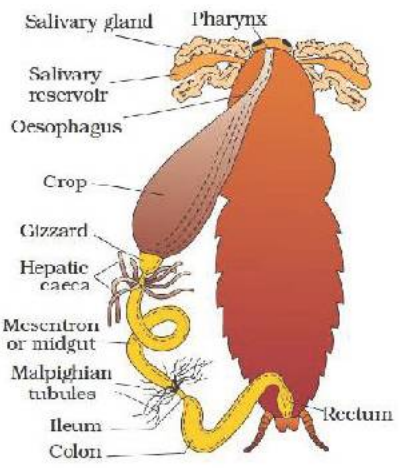
Differences between male & female cockroaches (Sexual dimorphism)

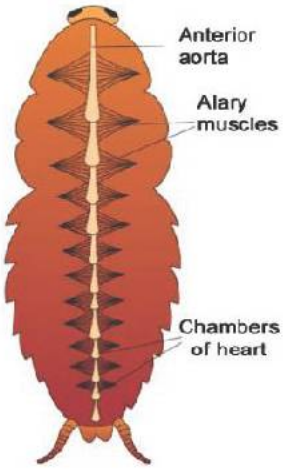
Male	Female
i. Wings beyond the tip of the abdomen.	Wings up to the tip of abdomen.
ii. Anal styles present	Absent

ANATOMY OF COCKROACH

Digestive system: Alimentary canal has 3 parts: **foregut, mid gut** & **hindgut.**

- **Foregut: Mouth → pharynx → oesophagus → crop** (to store food) **→ gizzard (proventriculus-** for grinding food).
- **Mid gut (Mesenteron):** 6-8 tubules **(hepatic** or **gastric caecae)** are seen at the junction of foregut & mid gut. They secrete digestive juice.





- **Hindgut**: It includes **ileum, colon** & **rectum.**

Excretory system: Uricotelic. Excretory organ is **Malpighian tubules**.

Respiratory system: Trachea with **10 pairs spiracles.** Branches of **tracheal tubes** are **tracheoles.** They carry oxygen from the air to all parts.

Circulatory system: Open type.

Haemolymph (blood)= colourless plasma + haemocytes.
Blood from sinuses (haemocoel) → ostia → heart → anterior aorta → sinuses.

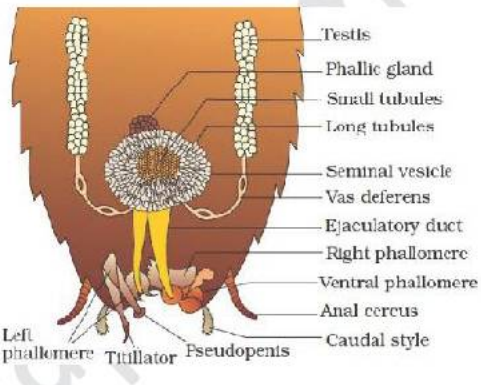
Nervous system: 3 ganglia in thorax and 6 in the abdomen.

- The head holds only a bit of nervous system. So, if the head of cockroach is cut off, it will still live for one week.
- **Supra-oesophageal ganglion** (brain).
- **Sense organs:** Antennae, eyes, maxillary palps, labial palps, anal cerci etc.
- Each compound eye has 2000 **ommatidia.** Cockroach can receive several images of an object **(mosaic vision).**

Reproductive system

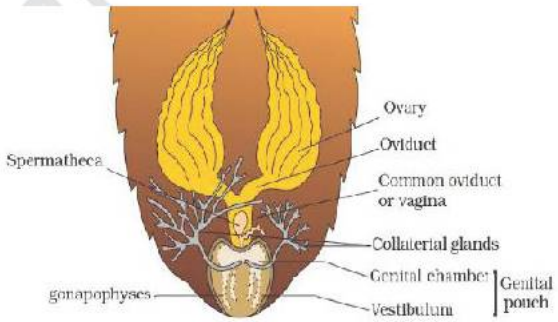
Male reproductive system: 2 **testes, seminal vesicles, accessory glands & external genitalia (male gonapophysis** or **phallomeres).**
Testis → vas deferens → seminal vesicle → ejaculatory duct → male gonopore.

- **Seminal vesicles**: To store sperms. Sperms → **spermatophores.**
- **Accessory glands: mushroom gland** & **phallic gland**. They nourish the sperms.



Female reproductive system: **2** large **ovaries, oviducts, spermatheca, genital chamber, Colleterial glands etc.**

- Each ovary has **8 ovarian tubules (ovarioles)** containing developing ova.
- **Oviducts** unite into a **median oviduct (vagina) → genital chamber.**
- A pair of **spermatheca** is present. Fertilised eggs are encased in **oothecae.**



Development is **paurometabolous** (nymphal stage- 13 times moulting).

VIDEO CLASS

SLIDES OF THIS CHAPTER

QUESTION BANK

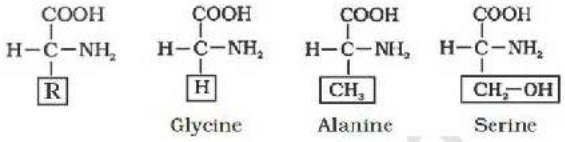
4. BIOMOLECULES

BIOMICROMOLECULES (BIOMOLECULES)

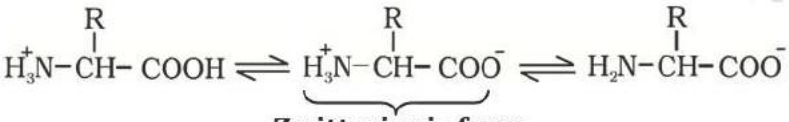
Molecular weight: **18 to 800 Dalton (Da).** Include amino acids, sugars, nitrogen bases, lipids etc.

1. AMINO ACIDS

- **Acidic amino acids:** e.g. Glutamic acid, Aspartic acid.
- **Basic amino acids:** e.g. Lysine, Arginine.
- **Neutral amino acids:** e.g. Valine.



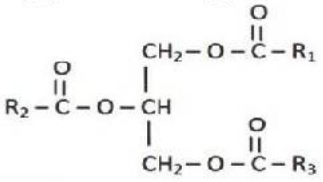
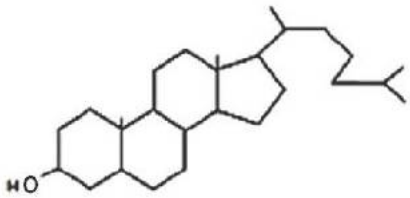
If both $-NH_2$ & $-COOH$ are ionized, it is called **Zwitterion.**



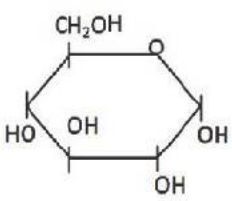
2. LIPIDS

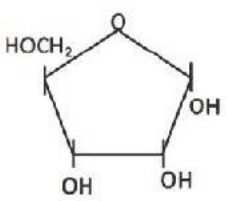
E.g. **Fatty acids** (R-COOH).

- **Saturated fatty acids:** No double bond b/w carbon atoms. E.g. Palmitic acid (CH_3 - $(CH_2)_{14}$ - COOH), Stearic acid.
- **Unsaturated Fatty acids:** One or more C=C bonds. E.g. Oleic acid, Arachidonic acid (20 C).

Glycerol (trihydroxy propane): CH_2-OH | CH-OH | CH_2-OH	Fatty acids are esterified with glycerol → **monoglycerides, diglycerides** & **triglycerides**.  **Triglyceride**
Phospholipids (FA+ glycerol + phosphate) found in cell membrane. **E.g. Lecithin.**	**Cholesterol** 

3. SUGARS (CARBOHYDRATES)

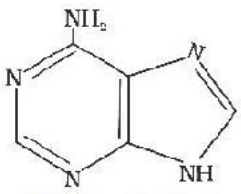

Glucose ($C_6H_{12}O_6$)


Ribose ($C_5H_{10}O_5$)

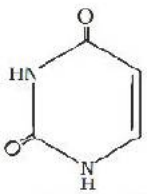
4. NITROGEN BASES

a. **Purines:** Adenine (A) & Guanine (G).

b. **Pyrimidines:** Cytosine (C), Thymine (T) & Uracil (U).



Adenine (Purine)



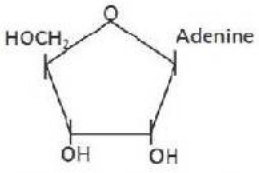
Uracil (Pyrimidine)

Nitrogen base + Sugar → Nucleoside

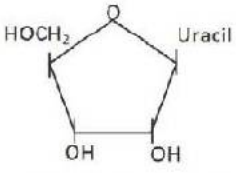
E.g. Adenosine, Guanosine, Cytidine, Thymidine, Uridine.

N. base + Sugar + Phosphate → Nucleotide

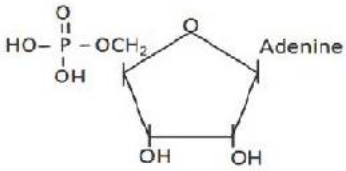
E.g. Adenylic acid,
Guanylic acid,
Cytidylic acid,
Thymidylic acid,
Uridylic acid.



Adenosine (A + Sugar)



Uridine (U + Sugar)



Adenylic acid

BIOMACROMOLECULES (MACROMOLECULES)

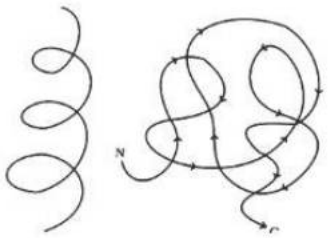
1. PROTEINS

They are heteropolymer of amino acids to form polypeptides. i.e., amino acids linked by **peptide bonds.**

Structural levels of protein

- **Primary structure:** Sequence of amino acids, i.e. the positional information in a protein.
- **Secondary structure:** Polypeptide folded as helix.
- **Tertiary structure:** Helical polypeptide chain is further folded giving 3-D view.
- **Quaternary structure:** Assembly of 2 or more polypeptide or subunits. E.g. Haemoglobin.

Secondary structure



Tertiary structure

Functions of proteins:

- For growth and tissue repair.
- Transport nutrients across cell membranes. E.g. GLUT-4.
- Acts as intercellular ground substance. E.g. collagen.
- Acts as antibodies, receptors, hormones, enzymes, pigments etc.

Most abundant protein in animal world: **Collagen**
Most abundant protein in biosphere: **RuBisCO**

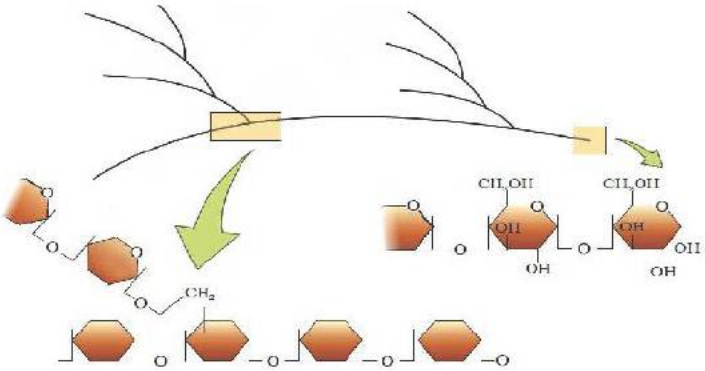
2. POLYSACCHARIDES (COMPLEX CARBOHYDRATES)

Polymers of sugars (monosaccharides). E.g.

- **Starch, Cellulose, Glycogen:** Homopolymers of glucose
- **Inulin:** Homopolymer of fructose.
- **Chitin:** Homopolymer of **N-acetyl glucosamine.**

Glycosidic bond: Formed b/w monosaccharides.

Diagrammatic representation of glycogen



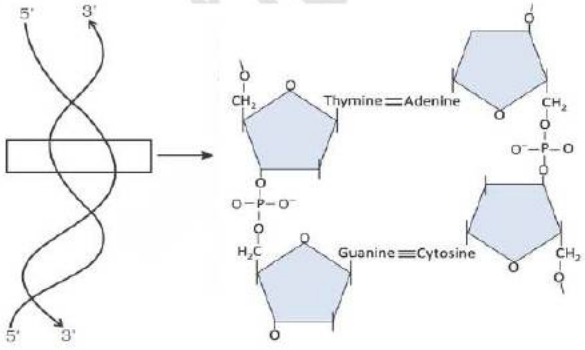
3. NUCLEIC ACIDS (DNA & RNA)

Heteropolymer of **nucleotides.** i.e. **polynucleotide.**

Structure of DNA (Watson - Crick Double Helix Model)

- 2 **polynucleotide strands** arranged antiparallelly.
- Steps are formed of **Nitrogen base pairs.**
- **Nitrogen bases:** A, G, C & T. Uracil absent.
- A pairs with T **(A=T)** by **2 hydrogen bonds.**
  G pairs with C **(G≡C)** by **3 hydrogen bonds.**

Bond b/w sugar (deoxyribose) and phosphate is **phosphodiester bond.**



METABOLISM

Anabolic (Biosynthetic) pathway	Catabolic pathway
Simple molecules → complex structures.	Complex molecules → simple structures.
It consumes energy.	It releases energy (stored as ATP - energy currency)
E.g. acetic acid → cholesterol, Amino acids → protein.	E.g. glycolysis, respiration etc.

Metabolites (intermediate products of metabolism).

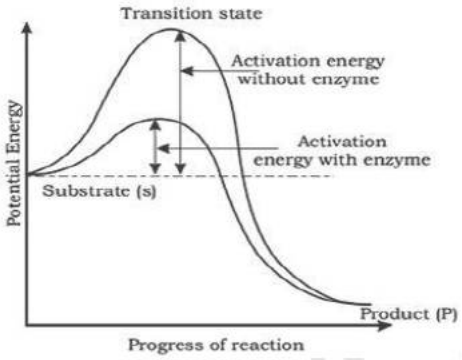
- **Primary metabolites:** Have identifiable functions in physiological processes. E.g. amino acids, sugars, nucleic acids, lipids, vitamins etc.
- **Secondary metabolites:** They are not directly involved in growth, development or reproduction. E.g. **Pigments** (Carotenoids, Anthocyanins etc), **Alkaloids** (Morphine, Codeine), **Terpenoids, Essential oils** (Lemongrass oil etc.), **Drugs** (Vinblastine, curcumin etc.), **Polymers** (Rubber, gums, cellulose etc.).

ENZYMES (Biological catalysts)

Almost all enzymes are proteins. ***Carbonic anhydrase*** is the fastest enzyme.
Ribozymes: Nucleic acids (RNA) that behave like enzymes.

Nature of enzyme action (catalytic cycle): E + S → ES → EP → E + P

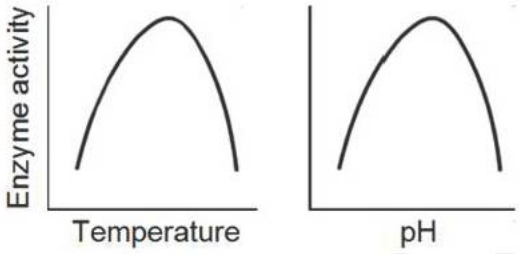
- The substrate binds to the **active site** of enzyme **(E+S).**
- Formation of **enzyme- substrate complex (ES).**
- Formation of **enzyme- product complex (EP).**
- Release of the products from enzyme **(E+P).**

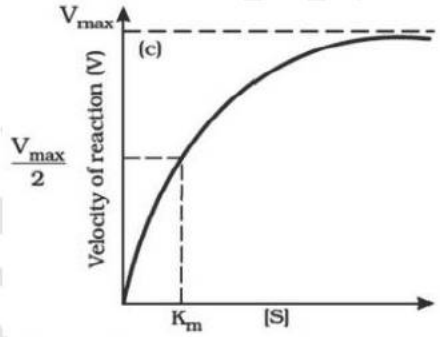


Activation energy is the additional energy to start a chemical reaction. Enzymes lower the activation energy. As a result, speed of the reaction increases.

Factors affecting enzyme activity

a) Temperature & pH: Enzymes show highest activity at optimum temperature & pH. Activity declines below and above optimum value.





b) Concentration of substrate: With the increase in substrate concentration, the velocity of enzyme action rises at first and reaches a *maximum velocity (Vmax).* This is not exceeded by further rise in concentration because enzyme molecules are fewer than the substrate molecules.

c) Presence of Inhibitor: Binding of inhibitor shuts off enzyme activity. The inhibitor closely similar to the substrate is called **competitive inhibitor.** It competes with substrate for the binding site of the enzyme.

E.g. ***Malonate*** is similar to the substrate ***succinate.*** So, it inhibits ***succinic dehydrogenase.***

Classification and nomenclature of enzymes

Oxido-reductases / Dehydrogenases	Catalyze oxido-reduction b/w two substrates. S reduced + S' oxidized → S oxidized + S' reduced
Transferases	Catalyze transfer of a group. S-G + S' → S'-G + S
Hydrolases	Catalyze hydrolysis of ester, ether, peptide, glycosidic, C-C, C-halide or P-N bonds.
Lyases	Catalyze removal of groups leaving double bonds. X-C-C-Y → X-Y + C=C
Isomerases	Catalyze inter-conversion of optical geometric or positional isomers.
Ligases	Catalyze the linking of 2 compounds together (joining of bonds like C-O, C-S, C-N, P-O etc.).

Co-factors

- Non-protein component bound to enzyme to make the enzyme catalytically active.
- **Apo-enzyme:** Protein portion of enzyme.
- **Co-factor + Apoenzyme = Holoenzyme.**
- Co-factors are 3 types:

Prosthetic group	Organic Tightly bound to apoenzyme E g **Haem.**
Co-enzymes	Organic. Transient binding to apoenzyme. Many co-enzymes contain vitamins. E.g. **NAD** and **NADP** contain **niacin.**
Metal ions	E.g. **Zn** is a cofactor for ***Carboxypeptidase.***

VIDEO CLASS

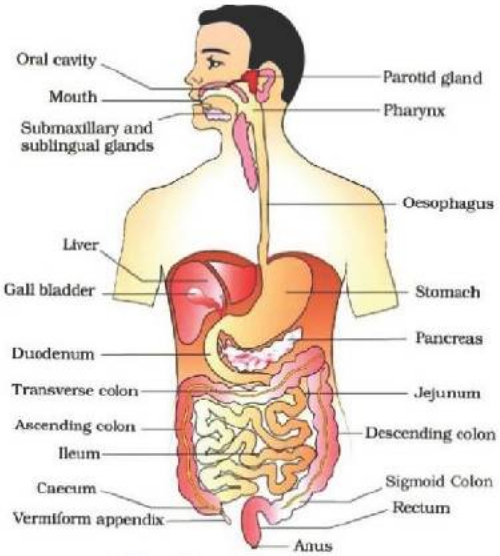
SLIDES OF THIS CHAPTER

QUESTION BANK

5. DIGESTION AND ABSORPTION

Alimentary canal:

Mouth → Buccal cavity → Pharynx → Oesophagus → Stomach (cardiac → fundic → body → pyloric) → Small intestine (Duodenum → Jejunum → Ileum) → Large intestine (Caecum → Colon → Rectum) → Anus.



Gastro-oesophageal sphincter: Between oesophagus stomach.

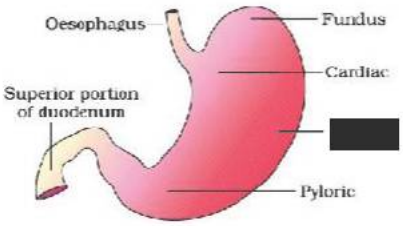
Pyloric sphincter: Between Stomach & small intestine.

Anal sphincter: Guards anus.

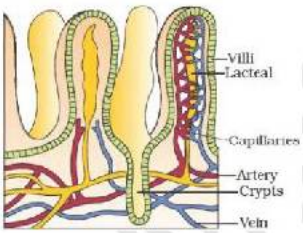
Rugae: longitudinal folds in stomach wall.

Villi: Finger-like structures at the mucosa of small intestine. It has capillary network and **lacteal** (lymph vessel).

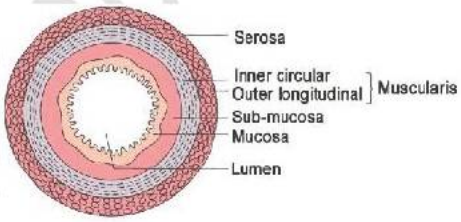
Vermiform appendix: finger-like structure arising from the caecum.



Stomach



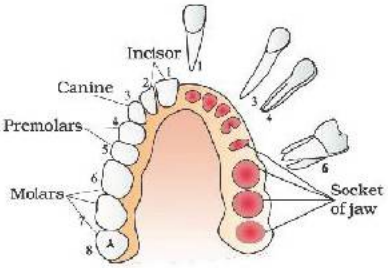
Villi



Transverse section of human gut

Human dentition is Thecodont, Heterodont & Diphyodont.

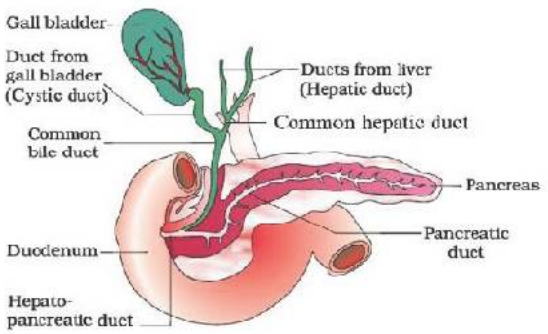
- **Thecodont:** teeth are placed in the jaw sockets.
- **Heterodont:** different kinds of teeth - **incisors (I), canines (C), premolars (PM) & molars (M).**
- **Diphyodont:** teeth appear twice in lifetime - **milk (deciduous) teeth** (20) and **permanent teeth** (32).



Human dental formula (of permanent teeth): $\frac{2123}{2123}$

Digestive glands

1. **Salivary glands:** Parotids, Submaxillary & Sublingual → Saliva
2. **Gastric glands:** Secretes Gastric juice.
   - **Mucus neck cells:** Secrete **mucus.**
   - **Chief (peptic) cells:** Secrete ***pepsinogen & prorennin***.
   - **Oxyntic (parietal) cells:** Secrete **HCl** & **intrinsic factor.**
3. **Liver:** Secretes Bile juice. Bile is transported from liver to duodenum as follows:
   Bile → hepatic duct → gallbladder → cystic duct → common bile duct → common hepato-pancreatic duct → duodenum.
   Hepato-pancreatic duct is guarded by ***sphincter of Oddi***.
4. **Pancreas:** Secretes Pancreatic juice.
5. **Intestinal glands:** Secretes intestinal juice (Succus entericus).



Digestive glands & Juice	Digestive enzymes/ components	Role in digestion
1. Salivary glands → Saliva **Site of action:** Buccal cavity	*Salivary amylase (Ptyalin) & Lysozyme.*	Starch $\xrightarrow[pH\ 6.8]{Salivary\ amylase}$ Maltose
2 Gastric glands → Gastric juice **Site of action:** Stomach	*Pepsinogen* *Rennin* *Gastric lipase*	Pepsinogen (inactive) $\xrightarrow{HCl}$ Pepsin (active) Protein $\xrightarrow{Pepsin}$ Proteoses + Peptones (peptides) Rennin digests milk protein in infants. **Chyme:** Acidic pasty food formed in stomach.
3. Liver → Bile **Site of action:** Small intestine	No enzyme. Bile pigments, Bile salts, Phospholipids Cholesterol	Emulsification of fats (***fat*** → ***micelles***). It increases surface area for the action of *lipase.* Bile also activates *lipase.*
4. Pancreas → Pancreatic juice **Site of action:** Small intestine	*Trypsinogen* *Chymotrypsinogen* *Procarboxypeptidase* *Pancreatic amylase* *Pancreatic lipase* *Nucleases*	Starch $\xrightarrow{Amylase}$ Disaccharides Trypsinogen $\xrightarrow{Enterokinin}$ Trypsin Chymotrypsinogen $\xrightarrow{Trypsin}$ Chymotrypsin Procarboxypeptidase $\xrightarrow{Trypsin}$ Carboxypeptidase Proteins, Peptones, Proteoses $\xrightarrow[Carboxypeptidase]{Trypsin/Chymotrypsin}$ Dipeptides Fats $\xrightarrow{Lipases}$ Diglycerides $\xrightarrow{Lipases}$ Monoglycerides Nucleic acids $\xrightarrow{Nucleases}$ Nucleotides
5. Intestinal glands → Intestinal juice **Site of action:** Small intestine	*Dipeptidase* *Maltase* *Lactase* *Sucrase* *Lipase* *Nucleotidase* *Nucleosidase*	Dipeptides $\xrightarrow{Dipeptidase}$ Amino acids Maltose $\xrightarrow{Maltase}$ 2 Glucose Lactose $\xrightarrow{Lactase}$ Glucose + Galactose Sucrose $\xrightarrow{Sucrase}$ Glucose + Fructose Nucleotides $\xrightarrow{Nucleotidase}$ Nucleosides Nucleosides $\xrightarrow{Nucleosidase}$ Sugars + Bases Di- & monoglycerides $\xrightarrow{Lipases}$ Fatty acid + Glycerol

ABSORPTION OF DIGESTED PRODUCTS

Absorption is 2 types- passive and active.

a) <u>Passive absorption (Passive transport):</u>

Higher concentrated region to lower concentrated region. It includes **osmosis** & **diffusion.**

Diffusion is 2 types:

i. **Simple diffusion:** E.g. ***glucose, amino acids,*** $\mathbf{Cl^-}$.

ii. **Facilitated diffusion:** Diffusion with the help of carrier proteins. E.g. **glucose, amino acids**.

b) <u>Active absorption (Active transport):</u>

Absorption against concentration gradient. E.g. absorption of ***amino acids, monosaccharides*** like ***glucose***, electrolytes like Na^+ etc.

Absorption of lipids:

Bile salts & phospholipids convert lipids to water-soluble droplets ***(micelles)*** → small protein coated fat globules ***(chylomicrons)*** → transported into ***lacteals*** in the villi → lymph → blood.

Absorption in different parts of alimentary canal:

- **Mouth:** Certain drugs.
- **Stomach:** Water, simple sugars, some drugs & alcohol.
- **Small intestine:** All nutrients. It is the ***chief area of absorption*** due to villi, its length and coiled nature.
- **Large intestine:** Water, some minerals & drugs.

Absorbed nutrients are incorporated into tissues **(assimilation).**

Undigested substances form **faeces.** It enters caecum through ***ileo-caecal valve.***

DISORDERS OF DIGESTIVE SYSTEM

1. **Jaundice:** Skin and eye turns yellow due to the deposition of bile pigments. It indicates liver damage.
2. **Vomiting:** Ejection of stomach content through mouth.
3. **Diarrhoea:** Frequent elimination of watery faeces. It reduces the absorption of food.
4. **Constipation:** Infrequent elimination of dry stool. It is due to decreased peristalsis in colon.
5. **Indigestion:** Condition leading to feeling of fullness due to improper digestion.

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SLIDES OF THIS CHAPTER

QUESTION BANK

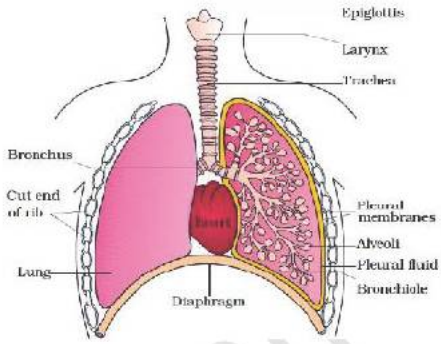
6. BREATHING AND EXCHANGE OF GASES

HUMAN RESPIRATORY SYSTEM

1. Air passages

External nostrils → nasal passage → nasal chamber → pharynx → glottis → larynx → trachea → primary bronchi → secondary bronchi → tertiary bronchi → bronchioles → terminal bronchioles → alveoli.

Epiglottis closes ***glottis*** to prevent entry of food into larynx.



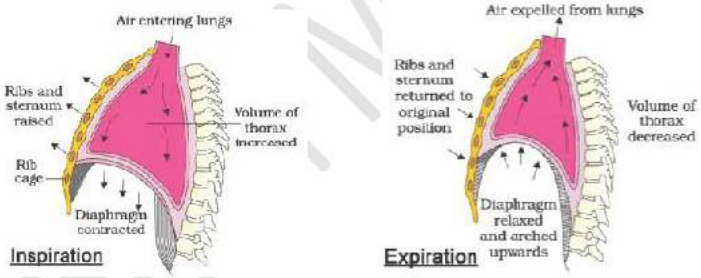
2. Lungs

- Lungs are covered by double-layered ***pleura.***
- ***Alveoli (air sacs) are the structural and functional units of lungs.***

MECHANISM OF BREATHING

a) **Inspiration: Diaphragm & External intercostal** muscles **contract** → thoracic volume increases → pulmonary volume increases → *intra-pulmonary pressure* decreases → air into lungs.

b) **Expiration:** Intercostal muscles & diaphragm relax → thoracic volume decreases → pulmonary volume decreases → *intra-pulmonary pressure* increases → air moves out.



Spirometer: *To measure respiratory rate.*

Normal respiratory (breathing) rate*: 12-16 times/min*

Respiratory volumes/capacities	Amount (ml)
Tidal volume (TV): Volume of air inspired or expired during a normal respiration.	**500**
Inspiratory reserve volume (IRV): Additional volume of air that can inspire by forceful inspiration.	**2500-3000**
Expiratory reserve volume (ERV): Additional volume of air that can expire by a forceful expiration.	**1000-1100**
Residual volume (RV): Volume of air remaining in lungs after a forcible expiration.	**1100-1200**
Inspiratory capacity (IC): Total volume of air inspired after a normal expiration (TV+IRV).	**3000-3500**
Expiratory capacity (EC): Total volume of air expired after a normal inspiration (TV+ERV).	**1500-1600**

Respiratory volumes/capacities	Amount (ml)
Functional residual capacity (FRC): Volume of air in lungs after normal expiration (ERV+RV).	**2100-2300**
Vital capacity (VC): Volume of air that can breathe in after a forced expiration or Volume of air that can breathe out after a forced inspiration (ERV + TV + IRV).	**3500-4500**
Total lung capacity (TLC): Volume of air in lungs after a maximum inspiration (RV + ERV + TV + IRV or VC + RV).	**5000-6000**

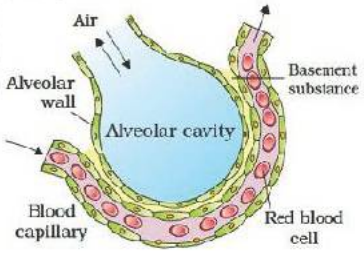
GAS EXCHANGE

Gas exchange occurs by simple diffusion between **1. Alveoli & blood 2. Blood & tissues**
Alveoli are the primary sites of gas exchange. Factors influencing gas exchange are:

- **Pressure/ concentration gradient**

	Atmospheric air	Alveoli	Deoxygenated blood	Oxygenated blood	Tissues
pO_2 (mm Hg)	159	104	40	95	40
pCO_2 (mm Hg)	0.3	40	45	40	45

- **Solubility of gases:** Solubility of CO_2 is 20-25 times higher than that of O_2.
- **Thickness of diffusion membranes:** 3 layers- **Squamous epithelium** of alveoli + **Endothelium** of capillaries + **Basement substance.** Its total thickness is very less → easy gas exchange.
- **Surface area:** Presence of alveoli increases surface area → gas exchange increases.



GAS TRANSPORT (O2 TRANSPORT & CO2 TRANSPORT)

1. O_2 TRANSPORT (from lungs to various tissues)

a. **By blood plasma (3%):** O_2 + plasma → tissues.
b. **As oxyhaemoglobin (97%):** O_2 + haemoglobin (Hb) → oxyhaemoglobin.

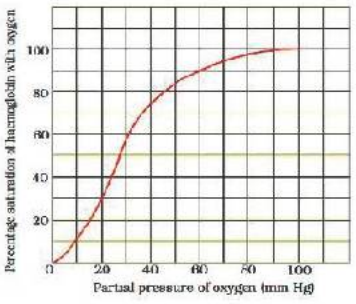
$$Hb_4 + 4O_2 \underset{\text{Low } pO_2/\text{ High } pCO_2 \text{ (Tissues)}}{\overset{\text{High } pO_2/\text{ Low } pCO_2 \text{ (lungs)}}{\rightleftharpoons}} Hb_4O_8$$

- **In alveoli:** pO_2 high, pCO_2, H^+ ion and temperature are low → formation of oxyhaemoglobin.
- **In tissues:** pO_2 low, pCO_2, H^+ ions and temperature are high → Hb_4O_8 dissociates to release O_2.

Oxygen-haemoglobin dissociation curve

It is a sigmoid curve obtained when percentage saturation of Hb with O_2 is plotted against the pO_2.

It is used to study the effect of factors like pCO_2, H^+ concentration etc., on binding of O_2 with Hb.



2. CO_2 TRANSPORT (from tissues to lungs)

a. **As carbonic acid (7%):** Through plasma.
b. **As carbamino-haemoglobin (20-25%):** CO_2 + Hb → carbamino-haemoglobin → lungs → CO_2 dissociates.

c. As bicarbonates (70%):

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

In alveoli: Reaction in opposite direction.

REGULATION OF RESPIRATION

Respiratory centres in Brain:

- **Respiratory rhythm centre:** In **medulla oblongata**. It regulates respiratory rhythms.
- **Pneumotaxic centre:** In **Pons**. It moderates functions of respiratory rhythm centre.
- **Chemosensitive area:** Seen adjacent to the rhythm centre. Increase in the concentration of CO_2 and H^+ activates this centre.

DISORDERS OF RESPIRATORY SYSTEM

- **Asthma:** Difficulty in breathing due to inflammation of bronchi and bronchioles.
- **Emphysema:** Damage of alveolar walls → decreases respiratory surface. Major cause is cigarette smoking.
- **Occupational respiratory disorders:** Exposure of industrial dusts → fibrosis of lungs → lung damage.

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SLIDES OF THIS CHAPTER

QUESTION BANK

7. BODY FLUIDS AND CIRCULATION

Types of circulation:

- **Single circulation:** In fishes. Heart receives impure blood only ***(venous heart).***
  Deoxygenated blood → to heart → to gills → oxygenated blood → to body parts → deoxygenated blood → to heart.
- **Incomplete double circulation:** In amphibians & reptiles. Left atrium gets oxygenated blood from gills/ lungs/skin. Right atrium gets deoxygenated blood from other body parts. They get mixed up in single ventricle. It pumps out mixed blood.
- **Double circulation:** In birds & mammals. Right atrium gets deoxygenated blood and passes to right ventricle. Left atrium gets oxygenated blood and passes to left ventricle. The ventricles pump it out separately.

BLOOD VASCULAR SYSTEM (HEART, BLOOD & BLOOD VESSELS)

BLOOD (Plasma + Formed elements)

Plasma (55%)	• **Constituents:** Water, Plasma proteins, organic & inorganic components. • **Plasma proteins: Fibrinogen** (blood coagulation), **Globulins** (act as antibodies) & **Albumins** (osmotic balance). • ***Serum*=** Plasma without clotting factors.

Formed elements (45%)

RBC (Erythrocytes)	- Biconcave non-nucleated cells. - **Count:** 5 - 5.5 millions/ mm^3.	- **Average lifespan:** 120 days. - **Function:** CO_2 and O_2 transports.
WBC (Leucocytes) **Types of WBC:** *Granulocytes & Agranulocytes*	- Colourless nucleated cells. - **Count:** 6000-8000 /mm^3. - **Function:** Part of immune system. **Granulocytes:** • **Neutrophils:** 60-65%. Function: Phagocytosis. • **Eosinophils:** Resist infections. Allergic reactions. • **Basophils:** Cause inflammation. Secrete histamine, serotonin, heparin.	**Agranulocytes:** • **Lymphocytes**: Smallest WBC with largest nucleus. Cause immune responses. • **Monocytes:** Largest WBC. For phagocytosis.
PLATELETS	- **Count:** 1.5 - 3.5 lakhs /mm^3.	- **Function:** Blood clotting.

BLOOD COAGULATION

Clumped **platelets & tissues** release ***thrombokinase (Prothrombinase)*** → ***Thrombokinase*** hydrolyses ***prothrombin*** to ***thrombin*** → ***Thrombin*** converts ***fibrinogen*** to ***fibrin*** → ***Fibrin*** trap dead & damaged blood cells to form ***clot (coagulum).***

BLOOD GROUPS: ABO grouping

Blood group	Antigens on RBC	Antibodies in plasma	Can donate blood to	Donor's group
A	A	Anti-B	A & AB	A, O
B	B	Anti-A	B & AB	B, O
AB (Universal recipient)	A, B	Nil	AB only	A, B, AB & O
O (Universal donor)	Nil	Anti-A & Anti-B	A, B, AB & O	O only

Rh grouping based on Rhesus (Rh) factor (Antigen)

- **Rh+ve** = presence of Rh factor and **Rh-ve** = absence of Rh factor. **Anti-Rh antibodies** are not naturally found.

Erythroblastosis foetalis

- **Rh incompatibility** between the Rh-ve blood of a pregnant mother and Rh+ve blood of the foetus.
- During first delivery, maternal blood may be exposed to some foetal blood (Rh+ve) → Rh antibodies in maternal blood.
- In her next pregnancies, Rh antibodies leak into the foetal blood (Rh+ve) and destroy the foetal RBCs.
- It can be avoided by administering **anti-Rh antibodies** to the mother immediately after the first delivery.

HEART

- It is protected by ***pericardium.***
- 4 chambers- two ***atria*** and two ***ventricles***.
- Walls of ***ventricles*** are **thicker** than that of atria.
- A ***tricuspid valve*** guards the opening b/w right atrium & right ventricle.
- A ***bicuspid (mitral) valve*** guards opening b/w left atrium & left ventricle.
- Opening of right ventricle to ***pulmonary artery*** and opening of left ventricle to ***aorta*** have ***semi-lunar valves.*** They prevent backward flow of blood.

CONDUCTING SYSTEM OF HEART

- It includes **nodal tissues [Sino-atrial node (SAN) & Atrio-ventricular node (AVN)], bundles & Purkinje fibres.**
- Fibres + bundles = ***Bundle of His.***
- **SAN** initiates contraction of heart by generating action potentials. So, it is called ***pacemaker.***
- Normal activities of heart are auto-regulated by ***nodal tissues.*** So, it is called **myogenic heart.**

CARDIAC CYCLE

Cyclic process of heart to pump blood. A cardiac cycle is completed in **0.8 second.** It has 3 stages:

1. **Joint diastole:** Relaxed state of all chambers. Blood from **pulmonary vein** and **vena cava** flows into **left** & **right ventricles** through **left** and **right atria. Semilunar valves** are **closed** at this stage.

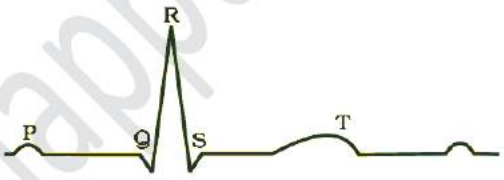
2. **Atrial systole:** Contraction of atria due to action potential from SAN. This increases the flow of blood into the ventricles.
3. **Ventricular systole:** Action potential from SAN → AVN→ AV bundle → bundle of His → *ventricular musculature.* As a result, ventricles contract (*ventricular systole).* So semilunar valves open and deoxygenated blood enters the ***pulmonary artery*** from ***right ventricle*** and oxygenated blood enters the ***aorta*** from ***left ventricle.***

- **One heartbeat = a cardiac cycle.** So, normal heartbeat: **70-75 times/min.**
- **Stroke volume:** Volume of blood pumped out by each ventricle during a cardiac cycle. It is about **70 ml.**
- **Cardiac output: Stroke volume x heart rate (70 x 72).** It is about **5000 ml.** Cardiac output of an athlete is very high.
- **Heart sounds:** First sound **(lub)** is due to closure of *tricuspid* and *bicuspid valves*. Second sound **(dub)** is due to closure of the *semilunar valves*. ***One heartbeat = a lub + a dub.***

ELECTROCARDIOGRAPH (ECG)

Instrument used to get ***electrocardiogram*** *(graphical representation* of *electrical activity* of the heart). ECG consists of the following waves:

- **P-wave:** Represents excitation ***(depolarization)*** of atria during ***atrial systole.***
- **QRS-complex:** Represents ***depolarization*** of ventricles ***(Ventricular systole).***
- **T-wave:** Represents the ***repolarisation*** of ***ventricles.***



Deviation in **ECG** indicates abnormality of heart. So, ECG has great clinical significance.

DOUBLE CIRCULATION

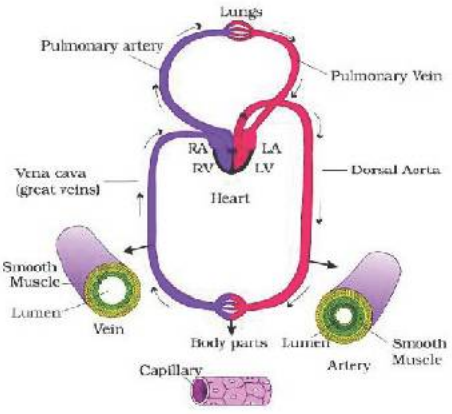
Blood flows through the heart twice for completing its circuit. It includes:

1. **Pulmonary circulation:** b/w lungs and heart.

Deoxygenated blood from right ventricle → to **pulmonary artery** → to **lungs** → ***oxygenated blood*** → to **pulmonary veins** → **left atrium.**

2. **Systemic circulation:** b/w heart and various body parts.

Oxygenated blood from left ventricle → to **aorta** → **arteries** → **arterioles** → **capillaries** → **tissues** → ***deoxygenated blood*** from tissues → **venules** → **veins** → **vena cava** → to **right atrium.**



Systemic circulation provides nutrients, O_2 and other substances to the tissues and takes CO_2 and other harmful substances away for elimination.

- **Hepatic portal system:** It is a system which includes ***hepatic portal vein*** that carries blood from ***intestine*** to the ***liver***.
- **Coronary circulatory system:** It is a system of ***coronary vessels*** that circulate blood to and from ***cardiac musculature.***

LYMPHATIC SYSTEM (Lymph, Lymph vessels & Lymph nodes)

- The fluid filtered into tissues from blood through capillaries is called **tissue fluid.**
- When tissue fluid enters lymphatic system, it is called **lymph**. It drains back to major veins.

Functions of lymph

- Exchange nutrients, gases, etc. b/w blood and cells.
- Transports digested fats, hormones etc.
- Lymphocytes in lymph gives immunity.

DISORDERS OF CIRCULATORY SYSTEM

- **Hypertension (High Blood Pressure):** Normal BP is 120/80 mm Hg. BP >140/90 is called **hypertension.** It causes *heart diseases* and affects *vital organs.*
- **Coronary Artery Disease (CAD) or Atherosclerosis:** Ca, fat, cholesterol etc. are deposited in coronary arteries. So lumen of arteries becomes narrow affecting blood flow.
- **Angina pectoris:** An *acute chest pain* due to O_2 *deficiency* to heart muscles. It occurs due to improper blood flow.
- **Heart Failure:** Inability of heart to pump blood enough to meet the needs of the body. Congestion of the lungs.
- **Cardiac arrest:** Heart stops beating.
- **Heart attack:** Sudden damage of heart muscle due to inadequate blood supply.

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SLIDES OF THIS CHAPTER

QUESTION BANK

8. EXCRETORY PRODUCTS AND THEIR ELIMINATION

Types of Excretion

- **Ammonotelism:** Excretion of Ammonia **(NH_3).** E.g. Aquatic invertebrates, bony fishes, aquatic amphibians.
- **Ureotelism:** Excretion of **urea.** E.g. Cartilaginous fishes, amphibians, mammals.
- **Uricotelism:** Excretion of **uric acid.** E.g. Insects, terrestrial reptiles & birds.

HUMAN EXCRETORY SYSTEM

Includes **kidneys, ureters, urinary bladder** & **urethra.**

Kidney: Covered by **renal capsule.** Blood vessels, nerves, ureter etc. enter the kidney through **hilum.** Hilum leads to **renal pelvis** with renal **calyces.**

A kidney has outer **cortex** & inner **medulla.**

Medulla consists of **medullary pyramids.**

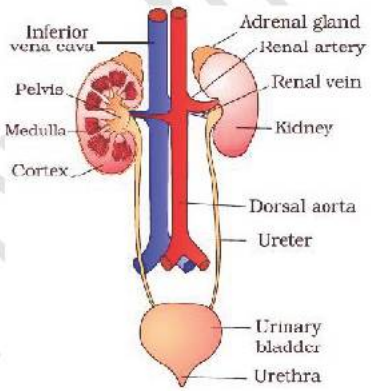
Nephron: Structural & functional units of kidney.

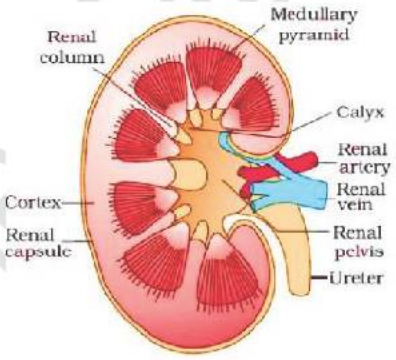
A nephron has 2 parts:

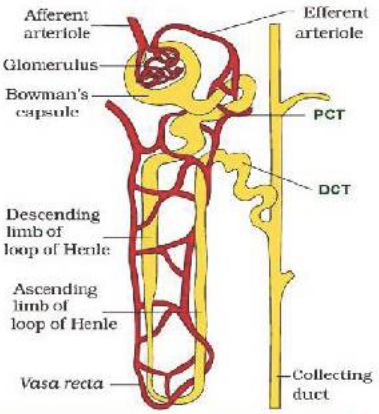
- **Glomerulus:** Capillary network.
- **Renal tubule:** Bowman's capsule + Proximal convoluted tubule (PCT) + Henle's loop + Distal convoluted tubule (DCT).

Glomerulus + Bowman's capsule = Malpighian body.

Types of nephrons: Cortical (85%) & Juxtamedullary (15%).







URINE FORMATION

1. Glomerular filtration (ultrafiltration)

- In glomerulus, blood is filtered through 3 layers- *endothelium of glomerulus, basement membrane & epithelium of Bowman's capsule* (contains **podocytes** that form filtration slits).
- **Glomerular filtration rate (GFR):** Amount of glomerular filtrate formed per minute.
- **Normal GFR = 125 ml/minute,** i.e., 180 litres/day.

2. Reabsorption

- 99% of filtrate is reabsorbed by the renal tubules. So volume of urine released is **1.5 litre.**
- PCT reabsorbs most of the nutrients and 70-80% electrolytes & water.
- In **DCT:** Conditional reabsorption of Na^+ & water.
- **Collecting duct** reabsorbs water to concentrate urine.

3. Tubular Secretion

- **PCT, DCT & Collecting duct** maintain ionic and acid-base balance (pH) of body fluids by selective secretion of H^+, K^+ & NH_3 into filtrate and absorption of HCO_3^- from it.

Mechanism of concentration of the filtrate

- **Henle's loop** & **vasa recta** help to concentrate the urine.
- Flow of filtrate in the 2 limbs of Henle's loop and the flow of blood through the 2 limbs of vasa recta are in opposite directions. This is called **Counter current mechanism.**
- Thus osmolarity increases from **cortex (300 mOsmolL^{-1})** to the **inner medullary interstitium (1200 mOsmolL^{-1}).**
- This gradient is caused by **NaCl** & **urea.**
- DCT & collecting duct produce urine four times concentrated than the initial filtrate formed.

MICTURITION

- It is the release of urine.
- Filled urinary bladder → stretch receptors send impulses to CNS → motor messages → urinary bladder contracts → micturition (1 - 1.5 litre urine (**25-30 g urea)** per day).
- **Micturition reflex:** Neural mechanism of micturition.
- Urine analysis helps in clinical diagnosis of metabolic disorders and malfunctioning of the kidney.

REGULATION OF THE KIDNEY FUNCTION

1. **Regulation by ADH (vasopressin):** **Hypothalamus** → release **ADH** → water reabsorption from **DCT** & **collecting duct**. → prevents **diuresis** → increases body fluid volume.
   ADH → constricts blood vessels → BP increases → increases glomerular blood flow & GFR.
2. **Regulation by JGA (Renin-Angiotensin mechanism):** JGA (Juxta glomerular apparatus) is a region in nephron. Fall in glomerular blood flow/GFR → activates **JG cells** → **renin.**
   Renin converts *angiotensinogen* → *angiotensin I* → *angiotensin II* (vasoconstrictor) → increases glomerular BP & GFR.
   Angiotensin II → adrenal cortex → Aldosterone → reabsorption of Na^+ & water from distal parts of tubule.
3. **Regulation by ANF:** When blood flow increases, the atria of heart releases **Atrial Natriuretic Factor (ANF).** It causes **vasodilation** → BP decreases.

DISORDERS OF EXCRETORY SYSTEM

- **Uremia:** Accumulation of urea in blood due to kidney failure.
- **Renal calculi:** Stone of crystallized salts (oxalates, etc.) formed within the kidney.
- **Glomerulonephritis:** Inflammation of glomeruli.

Hemodialysis: Process of removal of **urea** in patients with uremia.

Blood from artery (+ anticoagulant like heparin) → dialyzing unit → cellophane tube → passage of molecules → Purified blood (+ anti-heparin) → pumped back through a vein.

Kidney transplantation: For acute renal failures.

Receiving kidney from a close relative minimizes rejection by immune system of host.

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SLIDES OF THIS CHAPTER

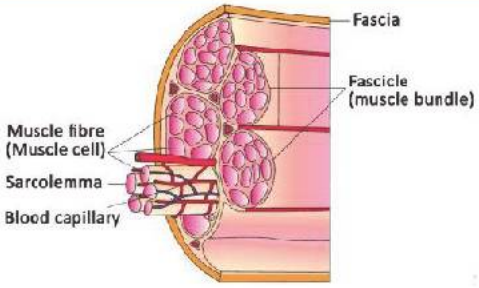
QUESTION BANK

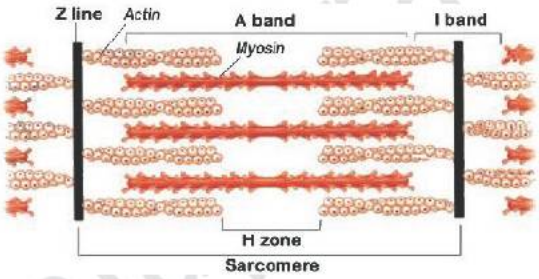
9. LOCOMOTION AND MOVEMENT

Types of movement in human being	- **Amoeboid movement:** By **pseudopodia.** E.g. Macrophages & leucocytes. - **Ciliary movement:** By **cilia.** E.g. trachea & oviducts. - **Muscular movement:** By muscles. E.g. limbs.

	Skeletal (striated)	Visceral (Non-striated)	Cardiac
Types of muscles	Attached to skeleton	In visceral organs	In heart wall
	Striations present	Absent	Present
	Voluntary	Involuntary	Involuntary
	Rich blood supply	Poor blood supply	Rich blood supply

STRUCTURE OF STRIATED MUSCLE

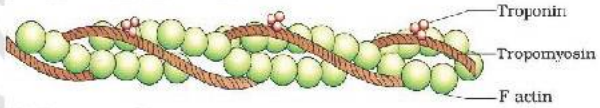


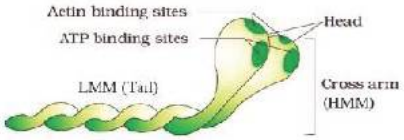


- Skeletal muscle is made of **muscle bundles (fascicles)** containing **muscle fibres.**
- Muscle fibres are lined by **plasma membrane (sarcolemma)** enclosing the **sarcoplasm.**
- Each muscle fibre contains **myofilaments (myofibrils).**
- Each myofibril has **dark (Anisotropic or A-band)** and **light striations (Isotropic or I-band).**
- **I-bands:** Contain actin filaments. It is bisected by a dark band **(Z-line)**. Region b/w 2 Z-lines is called **sarcomere** (functional units of muscle contraction).
- **A-bands:** Contain actin & myosin. Its light middle region **(H zone)** is formed of myosin. **H-zone** has a dark line (**M-line**) at the centre.

Structure of contractile proteins

- An **actin filament** is made of **2 filamentous (F) actins.**
- F-actin is a polymer of **Globular (G) actins.**





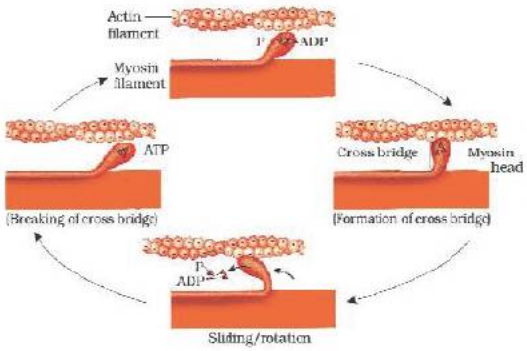
- Actin contains 2 other proteins **(tropomyosin & troponin).**
- **Troponin** has 3 subunits.
- Each myosin filament is a polymer of **Meromyosins.**
- A meromyosin has 2 parts: **Heavy meromyosin or HMM or cross arm & Light meromyosin or LMM (tail).**
- Head of cross arm is an ***ATPase*** **enzyme.**

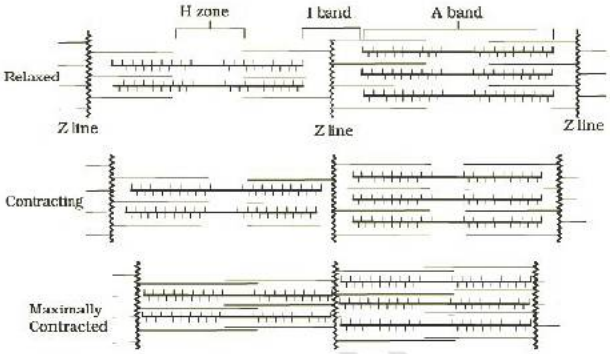
MECHANISM OF MUSCLE CONTRACTION

Sliding filament theory: *Contraction of a muscle fibre occurs by the sliding of thin filaments over thick filaments.*

Steps:

Impulse from **CNS** → **neuromuscular junction** → Synaptic vesicles release **Acetylcholine** → **action potential** in sarcolemma → release of **Ca^{2+}** from sarcoplasmic cisternae → **Ca** binds **troponin** → unmask the active sites for myosin → energy from **ATP hydrolysis** → **myosin head** binds to **active sites** on actin to form **cross bridge** → actin filaments pull towards centre of **A-band** → H-zone disappears → **Z- line** is pulled inwards → **contraction** of **sarcomere.**





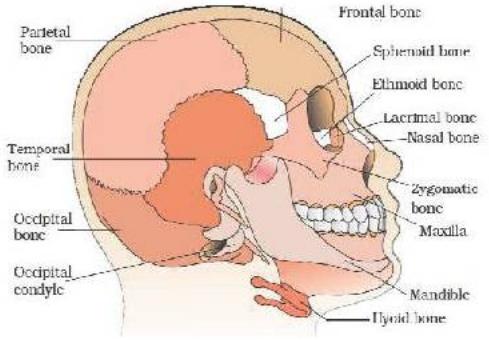
- Repeated activation of muscles → anaerobic breakdown of glycogen → accumulation of lactic acid → **muscle fatigue**.

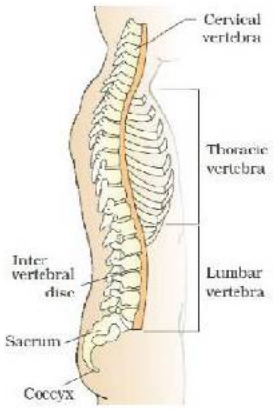
Red (Aerobic) muscles	White muscle
Red colour due to more myoglobin	White colour due to less myoglobin
More mitochondria	Less mitochondria
Aerobic metabolism	Anaerobic metabolism
Slow & sustained contraction	Fast contraction for short period

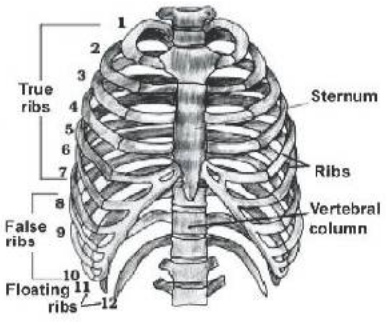
HUMAN SKELETAL SYSTEM (206 bones & few cartilages)

AXIAL SKELETON (80 bones)

Bones of head (29)	Vertebral column	Ribs (12 pairs)	Sternum (1)
• Skull (22): Cranial bones (8) + Facial bones (14). • Ear ossicles (2x3=6) • Hyoid bone (1) Skull articulates with ***First vertebra (atlas)*** by 2 ***occipital condyles (dicondylic skull).***	**26 vertebrae:** • Cervical (7) • Thoracic (12) • Lumbar (5) • Sacrum (1) • Coccyx (1)	• **True ribs (1-7th pairs):** Connected to sternum by ***Hyaline cartilage.*** • **False or vertebro-chondral ribs (8-10th pairs):** Join to the ***7th rib.*** • **Floating ribs (11-12th pairs):** Not connected with sternum or other ribs.	**Breast bone**

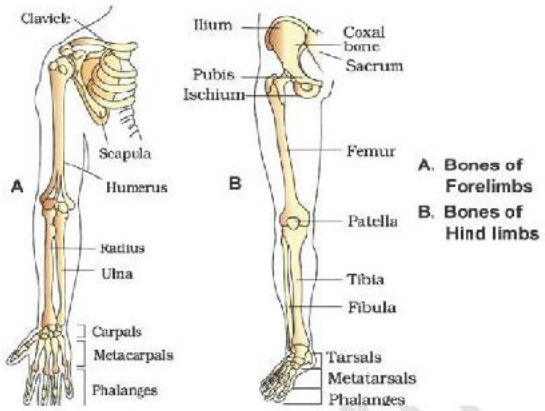






APPENDICULAR SKELETON (126 bones)

- **Bones of forelimbs (2x30 =60):** Humerus (1), Radius (1), Ulna (1), Carpals (wrist bones-8), Metacarpals (Palm bones-5) & Phalanges (14).
- **Bones of hind limbs (2x30 = 60):** Femur (thigh bone -1), Patella (knee cap-1), Tibia (1), Fibula (1), Tarsals (ankle bones-7), Metatarsals (5) & Phalanges (14).
- **Pectoral girdles (2x2=4):** Clavicle (collar bones-2) & Scapula (shoulder blades-2).
  Clavicle articulates with ***acromion*** (elevated ridge) of **Scapula.**
  Acromion has ***glenoid cavity*** into which ***humerus*** articulates to form ***shoulder joint.***



- **Pelvic girdles (2x1=2 coxal bones):** Formed by the fusion of **Ilium, Ischium & Pubis.**
  At the point of fusion of ***Ilium, Ischium*** and ***Pubis*** is a cavity ***(Acetabulum)*** to which the ***thigh bone*** articulates.
  The 2 halves of the ***pelvic girdle*** meet ventrally to form ***pubic symphisis.***

JOINTS

3 types:

- **Fibrous (immovable) joints:** E.g. sutures of skull.
- **Cartilaginous (Slightly movable) joints:** E.g. Joints between the adjacent vertebrae.
- **Synovial (movable) joints:** Have a fluid filled synovial cavity between 2 bones.

Synovial Joints	Examples
Ball & socket	b/w humerus & pectoral girdle.
Hinge joint	Knee joint
Pivot joint	b/w atlas & axis.
Gliding joint	b/w carpals
Saddle joint	b/w carpal & metacarpal of thumb

DISORDERS OF MUSCULAR & SKELETAL SYSTEMS

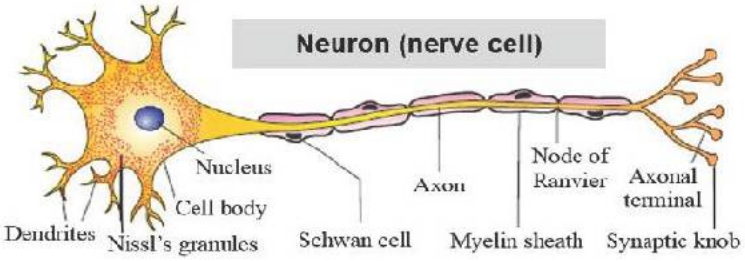
- **Myasthenia gravis:** An auto immune disorder that affects neuromuscular junction. Fatigue and paralysis of muscles.
- **Muscular dystrophy:** Progressive degeneration of skeletal muscles due to genetic disorder.
- **Tetany:** Rapid muscle spasm due to low Ca^{2+} in body fluid.
- **Arthritis:** Inflammation of joints.
- **Osteoporosis:** Age-related disorder. Decreased bone mass causing fractures. Low level of estrogen is a common cause.
- **Gout:** Inflammation of joints due to accumulation of uric acid crystals.

VIDEO CLASS SLIDES OF THIS CHAPTER QUESTION BANK

10. NEURAL CONTROL AND COORDINATION

Neurons are structural & functional unit of neural system.

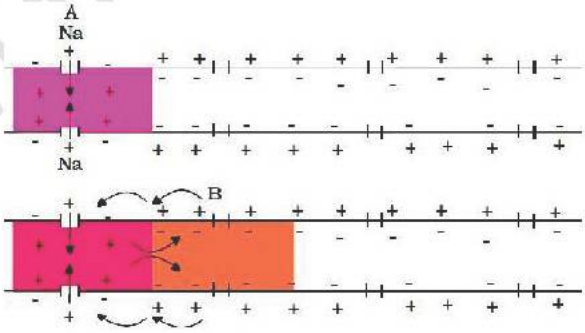
Neuron is made of **Cell body, Dendron** (branches: dendrites) & **Axon** (branches: axonites with synaptic knob).



Types of Neurons	Types of axons
• **Unipolar:** No Dendron. Found in embryo. • **Bipolar:** One dendron. Found in retina. • **Multipolar:** 2 or more dendrons. Most common.	• **Myelinated:** *Schwann cells* with a **myelin sheath** around axon. Gaps b/w adjacent myelin sheaths are called **nodes of Ranvier.** • **Non-myelinated:** Schwann cells without myelin sheath.

GENERATION & CONDUCTION OF NERVE IMPULSES

- In a resting neuron, axoplasm has more K^+ & –vely charged proteins and less Na^+. The fluid outside the axon contains low K^+ & high Na^+. This forms an ionic gradient.
- **Na^+ - K^+ pump** maintains the ionic gradients. It transports **3 Na^+** outwards for **2 K^+** into cell. So membrane is polarized (outer +ve, inner -ve).
- ***Resting potential:*** Potential difference of resting membrane.
- If a stimulus is given, membrane at site A becomes permeable to Na^+ causing rapid influx of Na^+ and reversal of polarity (**depolarization).**
- Electrical potential difference during depolarization is called **action potential** (a nerve impulse).

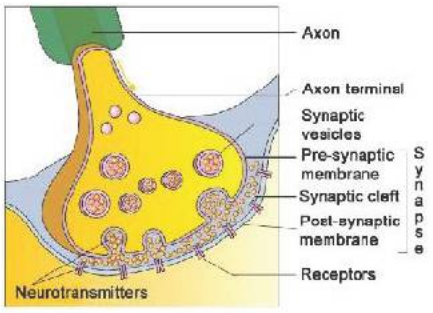


- Action potential is conducted as current flow from site A to B and the process is repeated along the axon.

Synapse:

Functional junction between two neurons. It is 2 types:

1. Electrical synapse: In this, membranes of pre- & post-synaptic neurons are nearest. So impulse transmission is same as along an axon. Impulse transmission is faster than in chemical synapse.



2. Chemical synapse: It has **synaptic cleft** between pre- & post-synaptic neuron. Presynaptic regions have **Synaptic knob.** They contain **synaptic vesicles** filled with **neurotransmitters.**

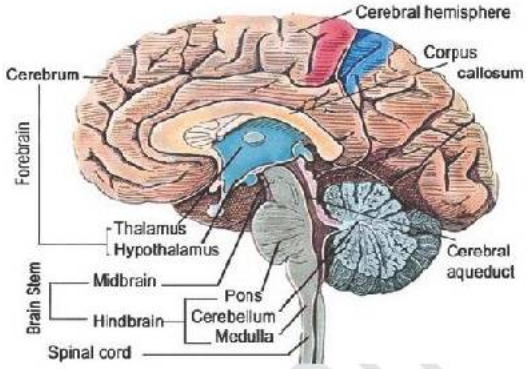
Impulse transmission in chemical synapse:

Impulse reaches at axon terminal → synaptic vesicles bind on plasma membrane → release of neurotransmitter → diffuses across synaptic cleft → combine with receptors on post synaptic membrane → opening of ion channels allowing entry of ions → action potential.

CENTRAL NEURAL SYSTEM (CNS)

A. BRAIN

- Covered by ***cranial meninges*** (outer ***dura mater***, middle ***arachnoid mater*** and inner ***pia mater***.
- The ***subarachnoid space*** is filled with **cerebrospinal fluid (CSF).**



Parts of Brain and their Functions:

Forebrain	**Cerebrum** (2 Cerebral hemispheres with cerebral cortex)	Motor area	Controls voluntary movements of muscles.
		Sensory area	Controls functioning of sense organs
		Association area	For intersensory association, memory & communication
	Thalamus	Coordinating centre (relay station) for sensory and motor impulses.	
	Hypothalamus	Regulates temperature, thirst, hunger & emotions. Secretes hormones.	
Midbrain	**Corpora quadrigemina**	4-lobed structure- Lobes of visual reflex (2) & Lobes of auditory reflex (2)	
Hindbrain	**Cerebellum**	Co-ordinates muscular activities and body equilibrium.	
	Pons varoli	Co-ordinates the activities of eye and ear and regulates respiration.	
	Medulla oblongata	Controls respiration, cardiovascular reflexes, gastric secretions.	
Limbic system: *Amygdala + hippocampus + hypothalamus* etc. It regulates sexual behavior, motivations, emotions.			

B. SPINAL CORD

- Conduction of impulses to and from the brain.
- Centre of spinal reflexes.

Peripheral neural system (PNS)- Cranial & spinal nerves:

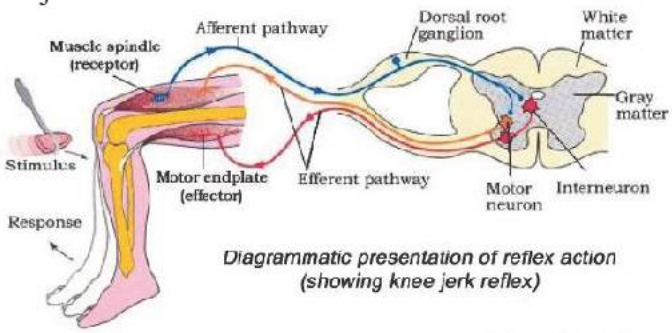
Somatic neural system	Relays impulses from the CNS to skeletal muscles.	
Autonomic neural system (ANS): Transmits impulses from CNS to involuntary organs & smooth muscles.	**Sympathetic nerves**	Prepares body to cope with emergencies, stresses & dangers. It increases heartbeat, breathing rate, constricts arteries and elevates BP.
	Parasympathetic nerves	Returns the body to a resting state and slows down heartbeat, dilates arteries, lowers BP etc.

REFLEX ACTION

It is the ***rapid, involuntary*** and ***unconscious actions*** of body in response to a stimulus. E.g.

- Withdrawal of hand when it touches a hot object.
- Knee jerk phenomenon.

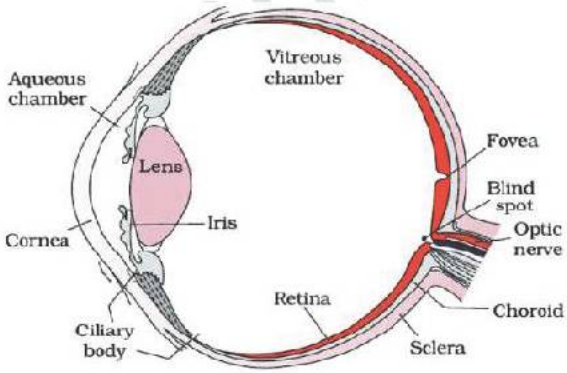
Reflex arc: Pathway of impulses in a reflex action.
Receptor organ → Sensory (afferent) neuron → Interneuron in CNS → Motor (efferent) neuron → effector organ (muscle/gland).



Diagrammatic presentation of reflex action (showing knee jerk reflex)

SENSE ORGANS

EYE



- Eyeball has 3 layers: outer **Sclera**, middle **Choroid** (blood vessels) & inner **Retina.**
- **Cornea:** Anterior transparent portion of sclera.
- **Iris:** Pigmented portion of the eye.
- **Pupil:** Central opening of iris. It regulates the amount of light entering the eye.
- Retina has 3 layers- inner **ganglion cells** middle **bipolar cells &** outer **photoreceptor cells.**
- Photoreceptor cells are 2 types: **rods** and **cones**. They contain ***photosensitive proteins (photopigments).***
- **Cone cells:** For **Daylight (photopic)** vision & colour vision. They contain **photopsin.**
- **Rod cells:** For **Twilight (scotopic) vision.** They contain **rhodopsin.** It contains a derivative of **Vitamin A.**
- **Blind spot:** Region where there are no photoreceptor cells.
- **Macula lutea:** Yellowish pigmented spot with a central pit **(fovea)**. In fovea, only cones are seen. Greatest visual acuity.
- Space between cornea & lens **(aqueous chamber)** contains **aqueous humor.**
- Space between lens and retina **(vitreous chamber)** contains **vitreous humor.**

Mechanism of vision

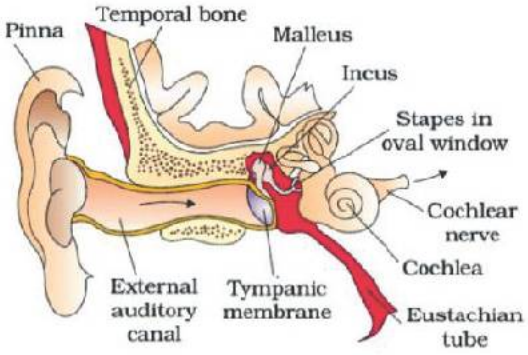
- Light from object → **cornea & lens** → focus on **retina** → dissociation of **retinal** & **opsin** → membrane permeability changes → potential difference in **photoreceptor cells** → action potential in **ganglion cells** → impulses to **optic nerves** → **brain** → vision.

EAR

3 divisions: **External ear, middle ear** & **inner ear.**

- **External ear:** Consists of ***pinna*** & ***auditory meatus (ear canal)*** **& tympanic membrane (ear drum).**

- **Middle ear:** Consists of **tympanic cavity** and **ear ossicles (Malleus, Incus & stapes). Eustachian canal** connects middle ear to pharynx. It equalizes pressure on either side of the eardrum. **Stapes** is **smallest bone** of body.
- **Inner ear:** Consists of **bony labyrinth & membranous labyrinth (cochlea & Vestibular apparatus).**



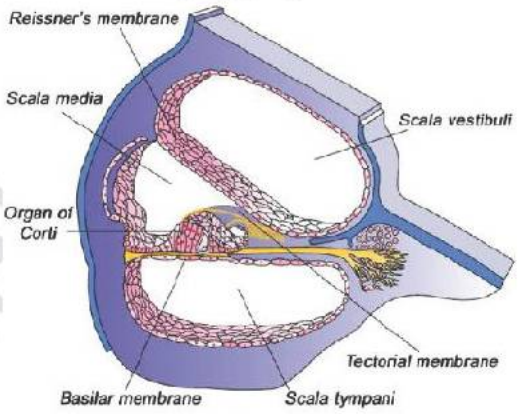
Vestibular apparatus: It includes

- 3 **semicircular canals:** Each canal has an ampulla with **crista ampullaris.**
- **Otolith organ** (utricle + saccule): Consists of the receptor **Macula.**

Crista & Macula help in body **equilibrium & posture.**

Cochlea (organ of hearing):

- It has 3 canals - **scala vestibula, scala media & scala tympani.**
- Scala vestibula & scala media are separated by **Reissner's membrane.**
- Scala media and scala tympani are separated by **basilar membrane**.
- **Organ of Corti:** Receptor organ on the basilar membrane.



Mechanism of hearing:

Pinna collects sound waves → ear canal → tympanic membrane → vibrations → to **ear ossicles & oval window** → **perilymph** in **vestibular canal** → **scala tympani** → **basilar membrane** → **sensory hair cells** press against **tectorial membrane** → impulse → **auditory nerve** → to brain → hearing.

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SLIDES OF THIS CHAPTER

QUESTION BANK

11. CHEMICAL CO-ORDINATION AND INTEGRATION

Glands		Hormones	Functions & other details
Hypothalamus Neurosecretory cells (nuclei)		**Releasing hormones** (E.g. GnRH)	Stimulate secretion of **pituitary hormones.**
		Inhibiting hormones	Inhibit secretion of **pituitary hormones.** E.g. **Somatostatin** inhibits release of GH from pituitary.
		Oxytocin	Contracts smooth muscles. For contraction of uterus during child birth. Milk ejection.
		Vasopressin or Anti-diuretic hormone **(ADH)**	Reabsorption of water & ions by DCT. Deficiency: **Diabetes insipidus.**
Pituitary	**Adeno-hypophysis (Pars distalis + Pars intermedia)**	**Somatotropin (Growth hormone, GH)**	For body growth. **Over-secretion**: **Gigantism** (abnormal growth). **Hyposecretion: Dwarfism** (stunted growth). **Over-secretion** in adults: **Acromegaly.**
		Prolactin (PRL)	Growth of **mammary glands** and **milk production.**
		Thyroid stimulating hormone (TSH)	Stimulates secretion of **thyroid hormones** from thyroid.
		Adrenocorticotrophic hormone (ACTH)	Stimulates secretion of **steroid hormones (glucocorticoids)** from **adrenal cortex.**
		Luteinizing hormone (LH)	**In males:** stimulates synthesis of androgens from testis. **In females:** induces ovulation. Maintains corpus luteum.
		Follicle stimulating hormone (FSH)	Stimulates gonadal activity. **In males, FSH & androgens** regulate **spermatogenesis. In females, FSH** stimulates development of the **ovarian follicles.**
		Melanocyte stimulating hormone (MSH)-	From Pars intermedia. Acts on melanocytes to regulate skin pigmentation.
	Neuro-hypophysis	**Oxytocin & Vasopressin** from hypothalamus.	*See Hypothalamus*
Pineal		**Melatonin**	Regulates diurnal (24-hour) rhythm, metabolism, pigmentation & menstrual cycle.

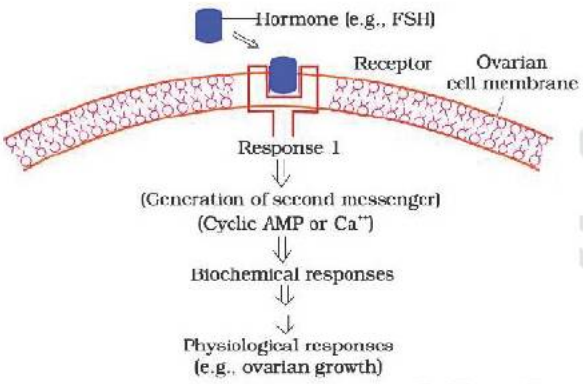
Thyroid Largest endocrine gland		**Thyroxin (tetraiodothyronine, T_4) & Triiodothyronine (T_3)**	• Regulation of **basal metabolic rate (BMR).** • Physical, mental and sexual development. • Support **RBC formation.** • Control **metabolism** of carbohydrates, proteins & fats **Hypothyroidism (Goiter):** deficiency of iodine. **Hyperthyroidism: Exophthalmic goiter (Grave's disease).**
		Thyrocalcitonin (TCT)	Lowers blood calcium **(hypocalcaemic** hormone).
Parathyroid		**Parathyroid hormone (PTH)**	Increases Ca^{2+} level in blood **(hypercalcaemic** hormone)
Thymus		**Thymosins**	Gives immunity. Thymus is degenerated in old people. So, thymosin production decreases and immunity become weak.
Adrenals	**Adrenal cortex**	**Glucocorticoids** (mainly **cortisol**)	- For carbohydrate metabolism. - Stimulate gluconeogenesis, lipolysis and proteolysis. Deficiency: **Addison's disease.**
		Mineralocorticoids (mainly **aldosterone**)	Regulate water & ionic balance, osmotic pressure and BP.
		Androgenic corticoids	For growth of axial hair, pubic hair and facial hair.
	Adrenal medulla	**Adrenaline & Noradrenaline**	Secreted during stress emergency situations so called **emergency hormones** (hormones of Fight or Flight).
Pancreas (Islets of Langerhans)		**Glucagon (from α cells)** Hyperglycemic factor	• For **glycogenolysis** to increase blood sugar **(hyperglycemia).** • Stimulates **gluconeogenesis.** • Reduces the **cellular glucose uptake.**
		Insulin (from β cells) Hypoglycemic factor	• Decreases blood glucose **(hypoglycemia).** • **Glycogenesis.** Deficiency: **Diabetes mellitus**.
Testis (male gonad)		**Androgens** (mainly **testosterone)**	• Maturation of **accessory sex organs** & sex characters. • For **spermatogenesis.**
Ovary (female gonad)		**Estrogen**	• Development of **secondary sex organs & sex characters.** • Development of **ovarian follicles** & **mammary glands.**
		Progesterone	• Supports **pregnancy.** • Development of mammary **alveoli** & **milk secretion.**

HORMONES OF HEART, KIDNEY & GASTROINTESTINAL TRACT

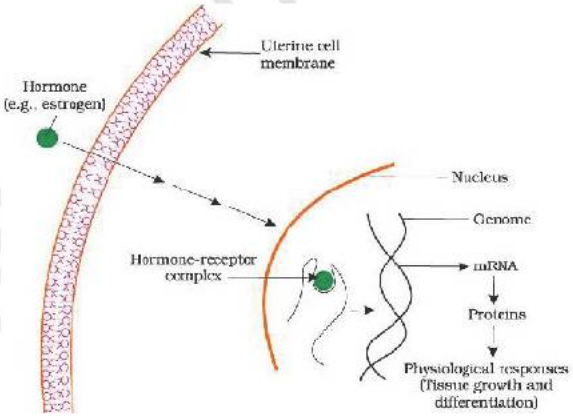
Atrial wall	**Atrial natriuretic factor (ANF)**	Dilation of blood vessels to reduce the BP.
JGA of kidney	**Erythropoietin**	Stimulates **erythropoiesis.**
Gastro-intestinal tract	**Gastrin**	Stimulates secretion of **HCl** & **pepsinogen** from gastric glands.
	Secretin	For secretion of *water & bicarbonate ions* from exocrine pancreas.
	Cholecystokinin (CCK)	For secretion of bile from gall bladder and pancreatic enzymes.
	Gastric inhibitory peptide (GIP)	Inhibits gastric secretion.

MECHANISM OF HORMONE ACTION

- A hormone binds to its specific **receptor** in **target tissue** to form **hormone-receptor complex**.
- It leads to biochemical changes in target tissue and thereby regulates metabolism and physiological functions.



Interaction of hormones (e.g. protein hormone, FSH) with **Membrane-bound receptors.**



Interaction of hormones (e.g. steroid hormones, iodothyronines) with **Intracellular receptors**

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SLIDES OF THIS CHAPTER

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