



RPF / RPSF

Sub - Inspector (SI)

Railway Recruitment Board (RRB)

Volume - 2

General Science



INDEX

S No.	Chapter Title	Page No.
1	Biology	1
2	Chemistry	30
3	Physics	49
4	Environment Issue	59
5	India's Space Program	94
6	India's Defence program	99
7	Major Research Institutions of India	107

1

CHAPTER

Biology

The Cell

- **Simplest and most basic unit** of life.
- **Discovered:** Robert Hooke (1665)
- All living things made up of cells- **structural, functional, and biological unit of life.**
- Has the **ability to duplicate itself** on its own.
- aka "**building blocks of life.**"

Cell Structure and its components

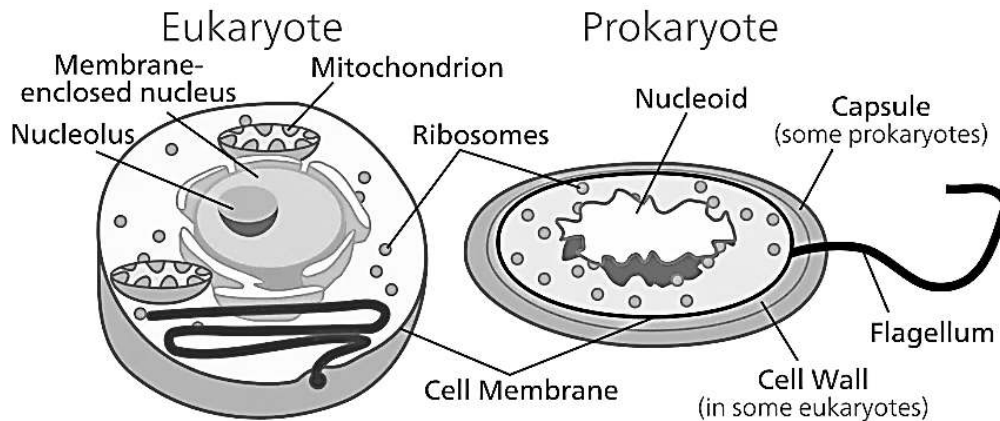
Cell Organelles

- Present within a cell & **perform certain specific functions to carry out life's processes.**

Plasma / Cell Membrane	• Outermost covering of the cell • Separates contents of cell from its external environment. • A selectively permeable membrane as it allows entry and exit of some materials in and out of the cell.
Cell Wall	• ONLY in plants • Outside the plasma membrane. • Mainly composed of cellulose. ○ Cellulose: A complex substance - provides structural strength to plants.
Cytoplasm	• Jelly-like substance present between cell membrane & nucleus. • Fluid content inside plasma membrane. • Contains many specialised cell organelles (mitochondria, golgi bodies, ribosomes, etc)
Nucleus	• Contains chromosomes that contain information for inheritance of features from parents to next generation in form of DNA • Plays a central role in cellular reproduction. • Nuclear membrane- a double-layered covering on nucleus. ○ Allows transfer of material from inside nucleus to its outside, i.e., to cytoplasm.
Nucleolus	• Ribosome synthesis site regulating cellular activity and reproduction.
Gene	• Unit of inheritance in living organisms.
Protoplasm	• Entire content of a living cell [cytoplasm + nucleus]. • aka living substance of the cell.
Chromosomes	• Rod-shaped structures • Visible only when the cell is about to divide. • Contain information for inheritance of features from parents to next generation in the form of DNA (deoxyribo nucleic acid) • Composed of DNA and Protein.
DNA molecules	• Contains information necessary for constructing and organising cells. • Functional segments of DNA - genes.

Vacuoles	● Empty structure in cytoplasm ● Act as storage sacs for solid or liquid contents. ● Common in plant cells. ● Smaller in animal cells. ● Substances stored- amino acids, sugars, various organic acids and some proteins.
Endoplasmic Reticulum	● A large network of membrane-bound tubes and sheets. ● 2 types : 1. Rough endoplasmic reticulum [RER] ○ Has ribosomes attached to its surface. ○ Ribosomes - sites of protein manufacture. 2. Smooth endoplasmic reticulum ○ Helps in the manufacture of fat molecules, or lipids, important for cell function. ○ Some of these proteins and lipids help in building the cell membrane k/a membrane biogenesis. ● Serve as channels for transport of materials between various regions of cytoplasm or between the cytoplasm and the nucleus. ● Also functions as a cytoplasmic framework providing a surface for some biochemical activities of cells.
Golgi Apparatus/ Complex	● A system of membrane-bound vesicles arranged parallel to each other in stacks called cisterns. ● Packages and dispatches material synthesised near ER to various targets inside and outside the cell. ● Stores, modifies and packages products in vesicles. ● Involved in the formation of lysosomes. ○ Membrane-bound sacs filled with digestive enzymes. ○ Kind of waste disposal system of the cell. ○ Help to keep the cell clean by digesting any foreign material as well as worn-out cell organelles.
Mitochondria	● Aka powerhouse of the cell. ● Energy required for various chemical activities is released by mitochondria in the form of ATP (Adenosine Triphosphate) molecules. ● 2 membranes: ○ Outer membrane- porous ○ Inner membrane - deeply folded. ■ Folds create a large surface area for ATP-generating chemical reactions.
ATP	● aka energy currency of the cell. ● Body uses energy stored in ATP for making new chemical compounds and for mechanical work.
Ribosomes	● Site of protein synthesis. ● Polyribosomes or Polysomes: Several ribosomes may attach to a single mRNA and form a chain. ● Prokaryotes- ribosomes are associated with the plasma membrane of the cell.
Cilia and Flagella	● Hair-like outgrowths of the cell membrane. ● Cilia - small structures which work like oars, causing the movement of either the cell or the surrounding fluid. ● Flagella - comparatively longer and responsible for cell movement. ● Prokaryotic bacteria have flagella but structurally different from eukaryotic flagella.
Centrosome and Centrioles	● Centrosome- an organelle usually containing 2 cylindrical structures called centrioles. ● Surrounded by amorphous pericentriolar materials. ● Both the centrioles in a centrosome lie perpendicular to each other

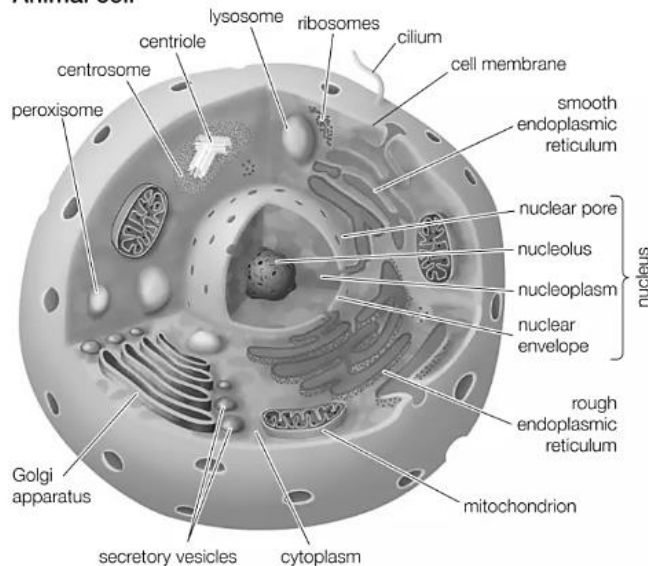
Types of Cells



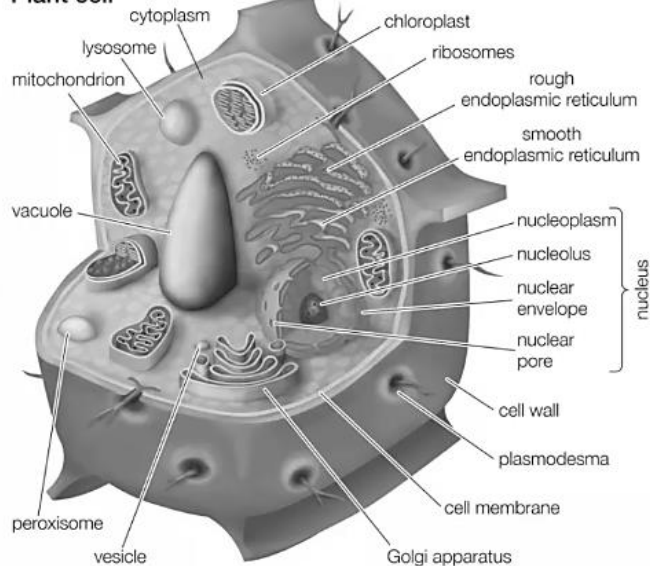
Prokaryotic Cell	Eukaryotic Cell
• Primitive/undeveloped nucleus.	• Has true or developed nucleus
• Size - 0.2 - 2.0 micrometers	• Size- 10- 100 micrometers.
• Simpler in structure	• More complex
• Organelles not membrane-bound	• Organelles membrane bound & specific in function.
• DNA arranged in circular shape	• DNA linear in shape
• Cytoplasm present, but lacks in most cell organelles.	• Consists of both cytoplasm and organelles
• Cell wall present. • Made of mucopeptide or peptidoglycan	• Usually, absence of cell wall here. • Made of cellulose
• Cell division - binary fission, transduction, conjugation, and transformation	• Cell division - mitosis
• Mitochondria absent	• Mitochondria present.
• Endoplasmic reticulum not present.	• Endoplasmic reticulum present.
• Ribosome present	• Ribosome present
• Plasmids commonly found. ○ A small, circular, double-stranded DNA molecule distinct from a cell's chromosomal DNA. ○ Naturally exist in bacterial cells.	• Plasmids very rarely found
• Only asexual reproduction.	• Both sexual and asexual reproduction.
• Have a single origin of replication	• Have multiple origins of replication
• Only 1 chromosome.	• Many chromosomes present
• Eg. Bacteria and Archaea.	• Eg. Plant and animal cells.

Plant and Animal Cells

Animal cell



Plant cell



	Animal Cell	Plant Cell
Nucleus	Present	Present
Cilia	Present	Very rare
Shape	Round (irregular shape)	Rectangular (fixed shape)
Chloroplast	NO chloroplasts	Chloroplasts present
Cytoplasm	Present	Present
Endoplasmic Reticulum	Present	Present
Ribosomes	Present	Present
Mitochondria	Present	Present
Vacuole	One or more small vacuoles (much smaller than plant cells).	One large central vacuole taking up 90% of cell volume.

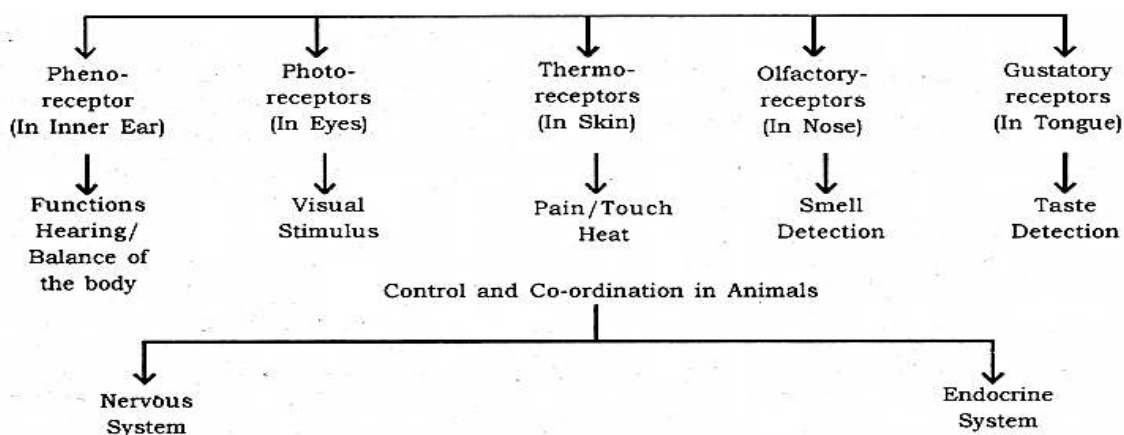
Control and Coordination

In animals

Nervous system and hormonal system are responsible for control and coordination.

Receptors:

- Specialized tips of nerve fibres that collect information to be conducted by nerves.
- In the sense organs of the animals.



- **Types:**

- 1. **Nervous System**

- A **highly complex regulatory system** in animals.
- **Coordinates actions & transmits sensory information** and **signals** to/from the different parts of body.
- **Neuron** - **structural and functional unit** of entire system.
- **Functions:**
 - **Receives information** from the **environment**.
 - Receive the information from the **various body parts**.
 - **Act accordingly** through muscles and glands.
- **Movement**- **ability** of an organism **to move** a **particular body part**.
- **Locomotion** - **ability** of an organism **to move** its **whole body** from one place to another.

Neuron

- **Structural and functional unit of the nervous system**
- **Coordinates and controls the complex actions** in animals.
- **Specialized cells** responsible for **transmission of nerve impulses**.
- **3 parts-**

- 1. **Axon-**

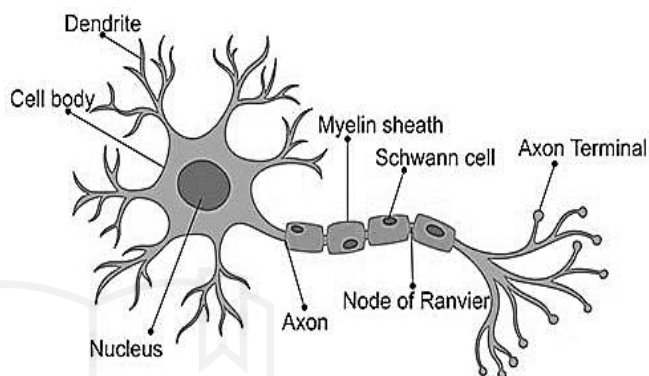
- **Tail of the neuron**.
- **Ends in fine hair-like structures** k/a **axon terminals** which rely on nerve impulses
- **Axons** - **myelinated** or **unmyelinated**.
- **Impulse transmission** is faster in **myelinated neurons**.

- 2. **Cyton/soma/cell body-**

- **Star-shaped** having various **hair-like structures** k/a **dendrites** which **receive the nerve impulses**

- 3. **Myelin Sheath-**

- An **insulating sheath** on **axon**.
- **Insulates axon** against **nerve impulse** from its **surroundings**.
- **Dendrites** **receive the impulse** from other neurons.
- **Cyton** or **Soma** cells **process the impulse- transmitted** to the **Axon**. Gets transmitted either to other neurons or to muscles for taking necessary action.



- **Types :**

1. **Sensory** neurons- Receive the signals from a sense organ
2. **Motor** neurons- Send the signals to a gland or muscle
3. **Relay** or association neuron- Relay signals between a motor neuron and sensory neuron.

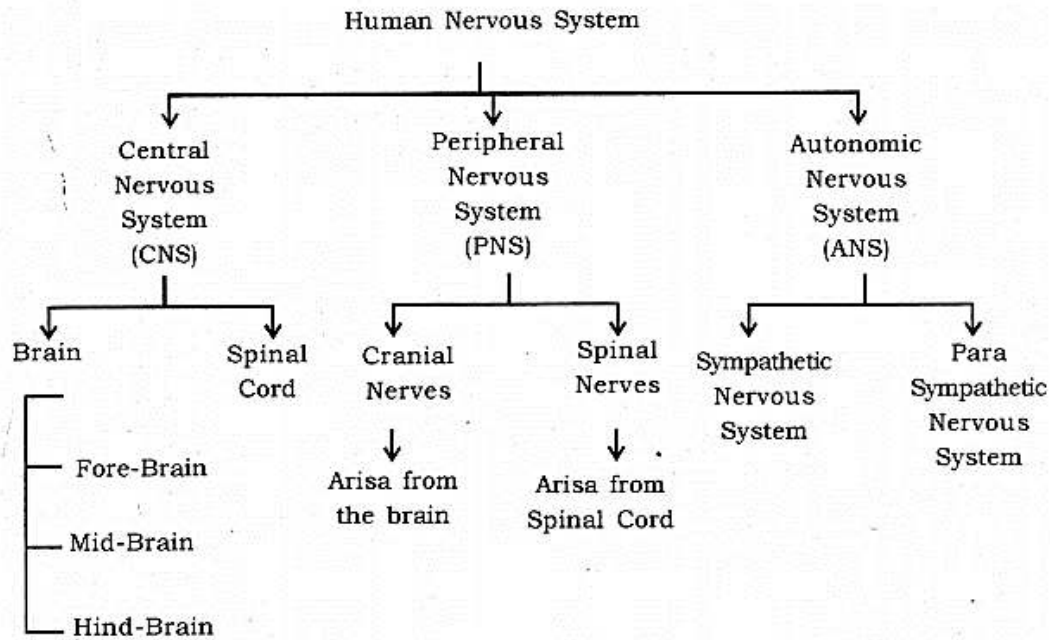
- **Synapse**

- A **microscopic gap** between **two adjacent neurons**.
- A **point contact** between **terminal branches** of **axon** of one neuron and with the dendrite of another neuron.
- **Convert electric signals** into **chemicals** that can cross over gap between axon and dendrite.
- **Chemical message** is **passed** to **next neuron** and **converted back** to the **electrical signal** for **interpretation**.

- **Neuromuscular Junction:**

- **Point** where a **muscle fibre** comes in **contact** with a **motor neuron** carrying nerve impulse from the control nervous system.

Human nervous system



1. Central Nervous System:

- Brain + spinal cord.
- Brain controls all the functions in the human body.
- Spinal cord works as relay channel for signals between brain and peripheral nervous system.

Human Brain

- A highly complex organ mainly composed of nervous tissue.
- Tissues highly folded to accommodate a large surface area in less space.
- Covered by a 3-layered system of membranes k/a meninges.
- Cerebrospinal fluid filled between meninges cushions the brain against mechanical shocks.
- 3 parts:

1. Fore-brain:

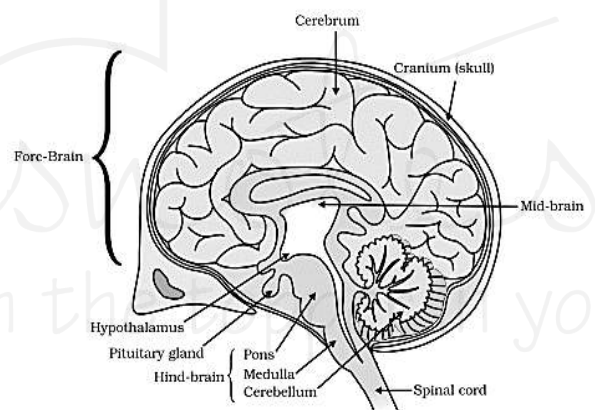
- Composed of the cerebrum.
- Cerebrum- Largest part in human brains.
- Divided into 2 hemispheres k/a cerebral hemispheres.
- Functions:
 - Controls voluntary motor actions.
 - Site of sensory perceptions, like tactile and auditory perceptions.
 - Site of learning and memory.

2. Mid-brain:

- Composed of the hypothalamus.
- Hypothalamus- lies at the base of the cerebrum.
- Controls sleep and wake cycle (circadian rhythm) of the body.
- Controls the urges for eating and drinking.

3. Hind-brain:

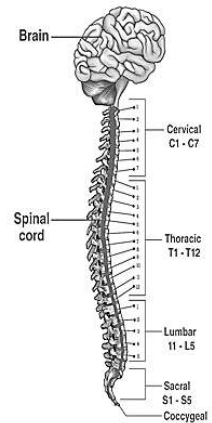
- Composed of cerebellum, pons, medulla, oblongata.
- Cerebellum- lies below cerebrum and at back of whole structure.
 - Coordinates the motor functions.
 - Eg. riding a bicycle, ensures perfect coordination between pedalling and steering control.
 - Controls posture and balance.
 - Controls the precision of voluntary action.



- **Medulla: Forms brain stem**, along with the pons.
 - **Lies at the base of brain** and **continues** into **spinal cord**.
 - **Controls** various **involuntary functions**, like hear beat respiration, etc.
 - **Controls involuntary actions**.
 - **Eg:** Blood pressure, salivation, vomiting.
- **Pons:**
 - **Relays impulses** between **lower cerebellum** and **spinal cord**
 - **Regulates respiration**.

Spinal cord:

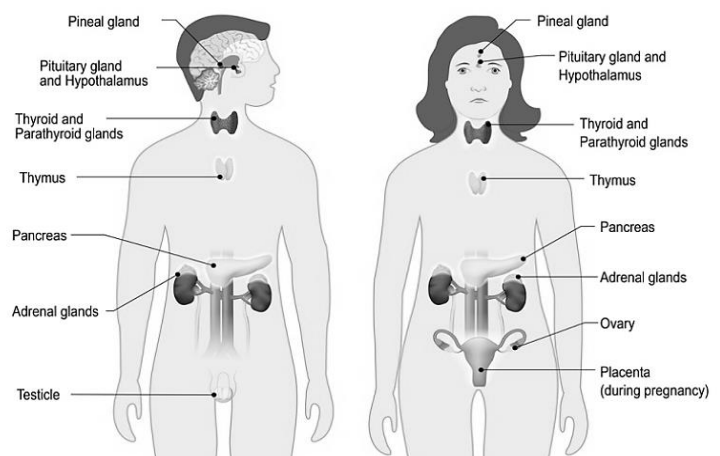
1. **Controls reflex actions** and conducts messages between different parts of body and brain.
2. **Reflex Action:**
3. **Sudden and involuntary response to stimuli.**
4. **Helps organisms to quickly adapt** to an **adverse circumstance** that could cause bodily harm or even death.
5. **Eg.** Pulling our hands away immediately after touching a hot or cold object.
6. **Reflex Arc:**
7. **Path** through which nerves signals, **involved** in a **reflex action**, travel.
Receptor → Sensory neuron → Relay neuron → Motor neuron → Effector (muscle)
2. **Peripheral Nervous System:**
 - **Cranial nerves + spinal nerves.**
 - **12 pairs of cranial nerves** coming out of brain and go to the organs in the head region.
 - **31 pairs of spinal nerves** coming out of spinal cord and go to the organs which are below the head region.
3. **Autonomous Nervous System:**
 - **Composed of a chain of nerve ganglion** which **runs along spinal cord**.
 - **Controls** all the **involuntary actions** in the **human body**.
 - **2 parts :**
 - A. **Sympathetic Nervous System:**
 - **Increases activity** of an **organ** as required.
 - **Eg.** during running, there is an increased demand for oxygen by the body - fulfilled by an increased breathing rate and increased heart rate.
 - B. **Parasympathetic Nervous System:**
 - **Decreases the activity** of an organ and thus has a calming effect.
 - **Eg.** during sleep, breathing rate slows down and so does the heart rate.
 - Helps in the **conservation of energy**.



Endocrine System

- **Made up of interconnected glands** that create **hormones**.
- **Almost every cell, organ, and function in our body is influenced by the endocrine system.**
- **Aids** - regulation of mood, growth and development, tissue function, metabolism, and sexual and reproductive functions.
- Also k/a **ductless system** as the endocrine glands **secrete** their **hormones** directly into **bloodstream**.

ENDOCRINE SYSTEM



Hormones released by endocrine glands

Endocrine Gland	Location	Hormones Produced	Functions
Pituitary gland (aka master gland)	Base of brain	• Growth hormone (GH). • Thyroid stimulating hormone (TSH). • Follicle stimulating hormone (FSH)	• GH stimulates growth. • TSH stimulates the functioning of thyroid gland. • FSH stimulates follicles during ovulation.
Thyroid Gland	Neck	• Thyroxine	• Controls general metabolism and growth in the body.
Adrenal gland	Above kidneys	• Adrenalin	• Prepares the body for emergency situations and hence is also called 'Fight and flight' hormone.
Pancreas	Near stomach	• Insulin	• Controls blood sugar level
Testis (male)	In Scrotum	• Testosterone	• Sperm production, development of secondary sexual characters during puberty.
Ovary (female)	Near uterus	• Oestrogen • Progesterone	• Egg production, development of secondary sexual characters during puberty.

Reproduction in Human Beings:

- **Method:** sexual reproduction.
- **Male -**
 - Produces male gametes called **sperms**.
 - Sperms have **tail** and are **motile**.
 - Produced in **large numbers** in **testes**.
 - **No food stored**.
- **Female -**
 - Produces female gametes called **ova**.
 - Ovum is **bigger, non-motile** and **only one ovary** produces **one ovum** in **one month**.
 - **Contain stored food**.
- **Both the gametes** are **microscopic, unicellular** and have **half** the number of **chromosomes** than **body cells**.
- Human beings become **reproductively active** from the onset of **puberty**.
- **Puberty-**
 - **Period during adolescence** when **rate of general body growth** begins to **slow down** and **reproductive tissues** begin to **mature**.
 - **Age** of puberty in human **males**- 11 to 13 yrs of age, while in **females** - 10 to 12 yrs. of age.
 - **Associated with** physical, mental, emotional and psychological **changes** in boys and girls occurring slowly k/a **secondary sexual characters**.
- **Eg.**
 - **Thick dark hair** start growing in **genital areas & armpits**.
 - **Skin** becomes **oily** and **pimples** may appear on the **face**.
 - **Boys** - **beard** and **mustache** start appearing, **voice** begins to **crack**, **reproductive organs** develop and start producing releasing **sperms**.
 - **Girls** - **breast size** begins to **increase**, **skin** of the **nipples** **darkens**, **menstruation** starts.
- **Copulation:** act of **mating** between the male and female partner.

Male Reproductive System:

Parts:

1. A pair of testes.

- Present **outside the body** in a pouch k/a scrotum.
- **Oval shaped**.
- **Functions:**
 - Producing **testosterone** – a male sex hormone.
 - Producing **sperms** (spermatogenesis) – a carrier of man's genes.

2. Scrotum

- A **sac of thick skin** that **protects** and **surrounds** the **testes**.
- **Controls temperature** of **testes** since they have to be at a slightly lower temperature than body temperature for suitable sperm creation.
- **Muscles** in the wall **allow** the **testes to hang** far from the body or **shrink** to pull them closer for protection and warmth.

3. Epididymis:

- A **coiled tube** that **stores** the **sperms** formed in testes.

4. Vas deferens

- A **long tube connecting urethra & epididymis**.

5. Glands:

A. Seminal vesicles

- A **pair of glands** found in **male pelvis**
- **Produce** many of the **constituent ingredients of semen**.
- Provide around **70% of total volume of semen**.

B. Prostate gland

- **Largest accessory gland** in male reproductive system.
- **Secretes proteolytic enzymes** into **semen**, which breaks down clotting factors in the ejaculate.
- **Allows the semen to remain** in a **fluid state**, moving throughout the **female reproductive tract** for potential fertilisation.

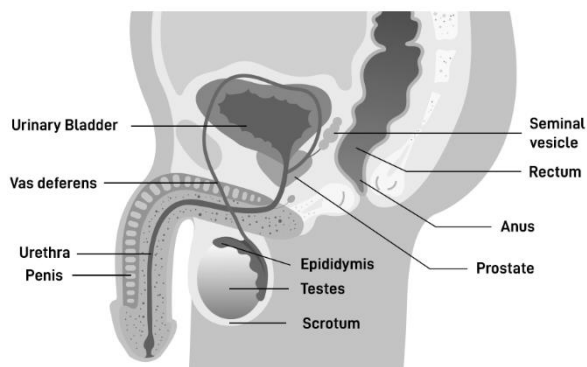
C. Bulbourethral glands / Cowper's glands

- Pair of **pea shaped exocrine glands** located posterolateral to the membranous urethra.
- **Contribute to final volume of semen** by producing a **lubricating mucus secretion**.

Semen = Sperms + Liquid part

6. Penis

- **Male external genitalia**.
- Has **3 cylindrical spaces** of **erectile tissue**.
- **Becomes rigid** when these spaces are **filled** with **blood**.
- **Tissues help** in the **erection** of the penis and **facilitate insemination**.
- **Foreskin** covers the **enlarged end** of the **penis** k/a **glans penis**.



Female Reproductive System

Parts:

1. Ovaries

- **Main female sex organ.**
- **Produce female gamete 'ovum'** and various hormones.
- **Situated** one on **both** the **side** of the **lower abdomen**.
- **Connected** to **uterus** and **pelvic wall** through ligaments.
- A **thin covering** of **epithelium**- encloses ovarian stroma.
- **Ovarian follicle** - **basic unit** of female **reproductive system**.

2. Fallopian Tubes / oviducts

- A **pair** of **muscular tubes** and **funnel-shaped structures**
- **Extend** from **right** and **left** of the superior corners of uterus to edge of ovaries.
- **Each tube** is **covered** by **cilia** that functions by **carrying** the **ovum** to the **uterus**.

3. Uterus

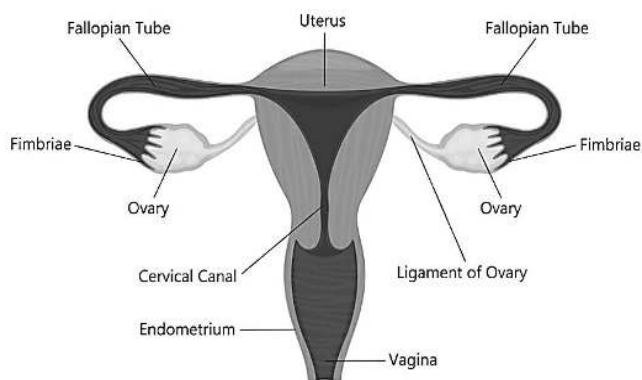
- aka **womb**.
- A **muscular, inverted pear-shaped** organ.
- **Wall** has **three layers**-
 - Inner glandular layer
 - Middle thick layer
 - Outer thin layer.
- **Site of growth and development** of **fertilised egg**.

4. Cervix

- A **narrow opening** that **connects** **uterus** to **vagina**.

5. Vagina

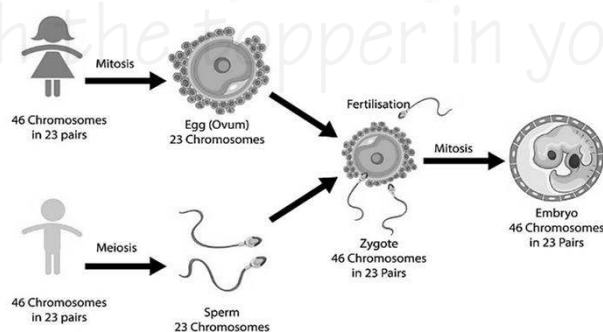
- A **muscular tube** which starts at the lower end of uterus to outside.
- **Cervical canal** + **vagina** = **birth canal**.



Process of reproduction:

- **Sperms** enter through **vaginal** passage by **sexual intercourse**.
- **Travel upwards** and **reach oviduct** where they **fertilise** the egg.
- **Fertilised egg (zygote)** **starts dividing** and **form** a ball of cells or **embryo**.
- **Embryo implanted** in **lining** of **uterus** - **grow** and **develop** organs to **become foetus**.

Human reproduction process



Difference Between Mitosis and Meiosis

Mitosis	Meiosis
One division	Two divisions
Number of chromosomes remains the same	Number of chromosomes is halved
Homologous chromosomes line up separately on the metaphase plate	Homologous chromosomes line up in pairs at the metaphase plate
Homologous chromosome do not pair up	Homologous chromosome pair up to form bivalent
Chiasmata do not form and crossing over never occurs	Chiasmata form and crossing over occurs
Daughter cells are genetically identical	Daughter cells are genetically different from the parent cells
Two daughter cells are formed	Four daughter cells are formed

Menstruation:

- **Loss of blood, mucous, unfertilized ovum and ruptured cells and tissues** of endometrium **through the vagina** of the female.
- A **28-day cycle** occurring in every reproductively active female (from puberty).
- **Flow of blood** - 2 to 8 days.
- If the **ovum does not get fertilized, endometrium starts sloughing off** and there is **loss of blood and mucous** etc. through the vagina.
- If **ovum gets fertilized, endometrium** becomes **thick and spongy** for nourishing the embryo and hence **menstruation does not occur**.
- A lady with a **developing embryo** in her womb is termed as **pregnant**.
- **Beginning of menstruation** at puberty - **menarche**.
- **Stoppage of menstruation** when the woman is 45-55 yrs of age - **menopause**.

Types of fertilisation:

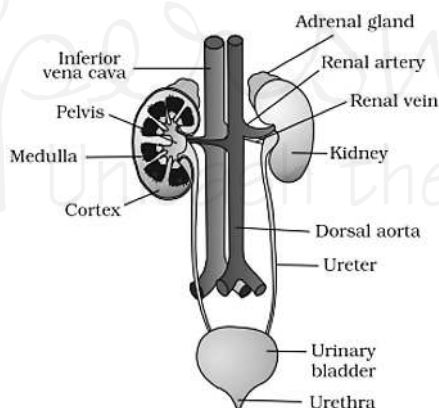
Internal fertilization	External fertilization
It involves the fusion of the male and the female gamete inside the female body.	It involves the fusion of the male and the female gamete outside the female body.
Chances of the survival of the offspring are more. Therefore, a small number of eggs are produced.	Chances of survival of the offspring are less. Therefore, a large number of eggs are produced.
Humans, cows, hens are organisms showing internal fertilization.	Fish, frog, starfish are organisms showing external fertilization

Excretory System

Removal of harmful metabolic wastes from the body of organisms.

Excretion in organisms

- Unicellular organisms, like amoeba remove wastes by simple diffusion from body surface into surrounding water.
- Lower multicellular organisms like flat worms use flame cells while
- Earthworms use nephridia for excretion.
- Higher multicellular organisms like fish, frogs, lizards, birds and humans use kidneys for excretion.



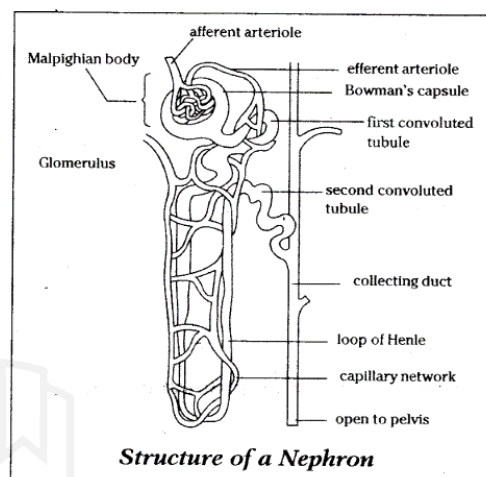
Excretion in Humans

Pair of Kidneys	• Dark red, bean-shaped, 10 cm long, 6 cm wide • Right side slightly lower in position due to liver. • Acts as excretory organ • Also control balance of water and mineral ions in the body. • Divided into 2 parts: ○ External region (comprises of a thick layer followed by fat layer) ○ Internal region (comprises of renal cortex and renal medulla). ▪ Medulla composed of conical masses of tissue leading to pelvis. ▪ Cortex has a random arrangements of tiny tubules called nephrons.
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Pair of Ureters	• Tube-like structures arising from notch, i.e. hilum of each kidney • Connect behind with the urinary bladder. • Carry the urine produced to the urinary bladder.
Urinary bladder	• Muscular sac-like structure. • Stores urine temporarily. • Opening guarded by muscular sphincters. • Sphincters open at time of urination.
Urethra	• Short muscular tube which expels urine out of the body.

Nephrons- Unit of excretion

- **Blood enters kidney** through the **renal artery**, which **branches into** many **capillaries associated with glomerulus**.
- **Water and solute transferred to nephron** at **Bowman's capsule**.
- **Proximal tubule** - amino acids, glucose, and salts **selectively reabsorbed** and **unwanted molecules added** in the **urine**.
- **Filtrate then moves down into loop of Henle**, where more water is absorbed.
- Then, it **moves upwards into distal tubule** and **finally to the collecting duct**.
- **Collecting duct** collects urine from **many nephrons**.
- **Urine formed** in each kidney **enters** a long tube called **ureter**.
- From **ureter** → **urinary bladder** → **urethra**.



Excretion in Plants

- **Water & oxygen excreted** through **stomata**.
- **Other wastes** stored in **leaves, bark** etc. which fall off from the plant.
- **Excrete some waste into the soil** around them through roots.
- **Gums, resin** → In old xylem
- Some **metabolic wastes** in the **form of crystals** of **calcium oxalates** in the leaves of colocasia and stem of Zamikand.

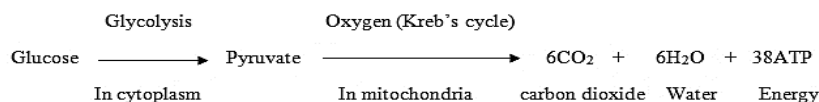
Difference b/w excretion in Plants & animals

Animal (human being)	Excretion	Plant
skin, lung, kidney	excretory organs	no particular organ
water, carbon dioxide, urea, mineral salt, and other nitrogenous materials	excretory materials	water, oxygen, carbon dioxide, latex, gum, acid, resin, oil and alkaloid
perspiration, discharging of urine and cellular respiration	method of excretion	photosynthesis, transpiration and cellular respiration
carbon dioxide is absorbed by green plants to carry out photosynthesis	use of excretory materials	oxygen is absorbed by living things cellular respiration. for

Respiratory System

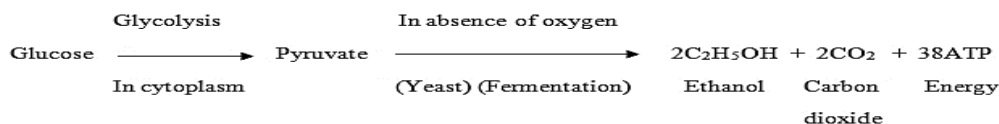
- Involves **2 process**:
 - **Breathing**: Intake of oxygen and release of CO₂.
 - **Breakdown** of **simple food** in order to release energy **inside the cell**.
- An **oxidation reaction** in which **carbohydrate is oxidized to produce energy**.
- **Mitochondria** - site of respiration
- **Steps**:
 - Breaking down of glucose into pyruvate**:
 - In the cytoplasm.
 - Glucose (6 carbon molecule) broken down into pyruvic acid (3 carbon molecule).
 - Breaking down of Pyruvic Acid**:
 - In **mitochondria**
 - **Molecules formed** depend on **type of respiration**:

1. Aerobic respiration:

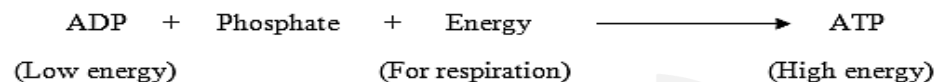


- Occurs in the **presence of oxygen**.
- Pyruvic acid** → carbon dioxide.
- Products:** Energy+ water molecule

2. Anaerobic respiration:



- Occurs in the **absence of oxygen**.
- Products:**
 - Pyruvic acid** → ethyl alcohol or lactic acid.
 - Ethyl alcohol** - yeast or bacteria.
 - Lactic acid** - microbes / muscle cells.
- Storage of energy** released during respiration:
 - Energy produced** is stored as **ATP molecules** in cells of body.
 - Energy released** during respiration **used to make ATP** molecules from ADP and inorganic phosphate.

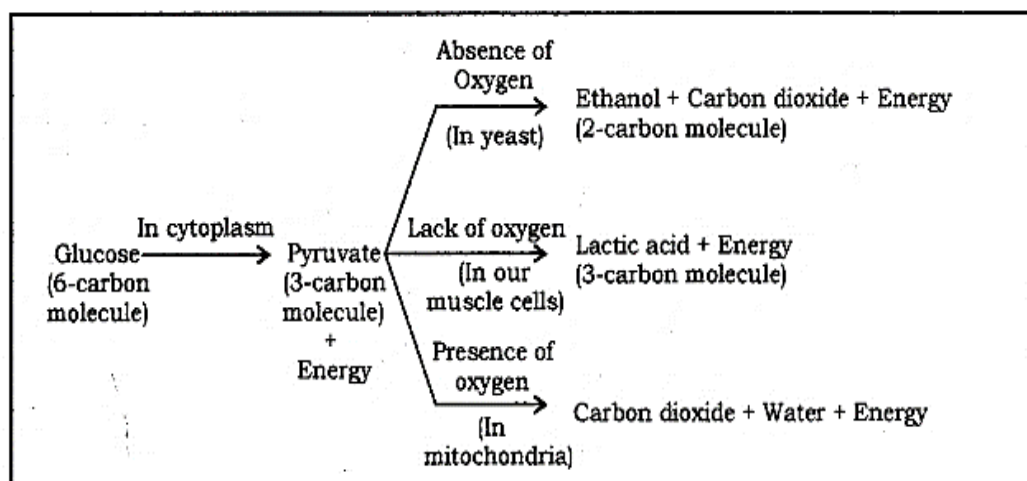


- So, **energy stored as ATP**.
- When **cell need energy**, **ATP broken down** using water to release energy.
- ATP - energy currency** of cells.



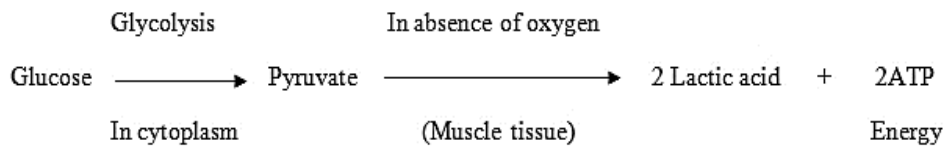
Breathing	Respiration
Mechanism by which organisms obtain oxygen from air and release carbon dioxide .	Includes breathing & oxidation in cells of organisms to release energy.
A physical process.	Physical + biochemical oxidation of food.
Involves the lungs of the organism.	Involves lungs and mitochondria of cells.

Various pathways of breakdown of glucose:



Pain in leg muscles after vigorous activities:

- Due to **vigorous exercise**, **demand** for **oxygen** required by muscles increases.
- **Lack of oxygen** → **anaerobic** respiration → **lactic acid** → **pain** in the **leg muscles**.



Various Modes of respiration in animals:

- **Amoeba** - respiration by simple diffusion of gases through **cell membrane**.
- **Earthworms** - use their **skin** to absorb oxygen from air and remove carbon dioxide.
- **Aquatic** animals like fish, prawns and mussels - **gills**.
- **Insects** - tiny holes called **spiracles** and air tubes called **tracheae**.
- **Mammals**- **lungs**.

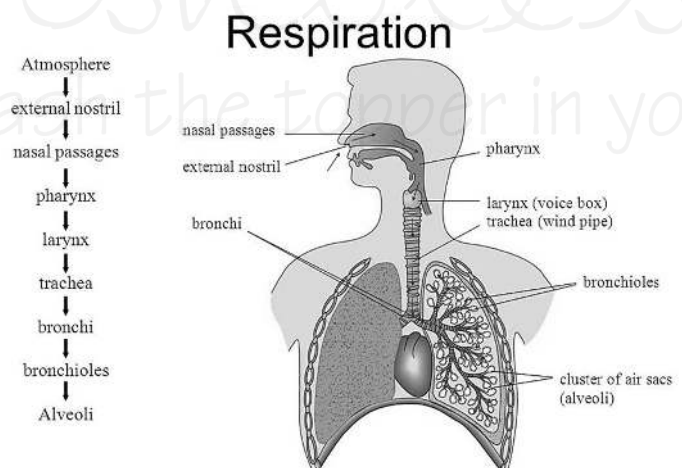
Respiration in Plants:

- Plants respire through different parts like:
 - **Roots**: Have **root hair** that absorb oxygen from soil pores by diffusion.
 - **Barks**: have large holes k/a **Lenticels** that allow gas exchange between the atmosphere and the internal tissues.
 - **Leaves**: Have microscopic pores at the back k/a **Stomata**.

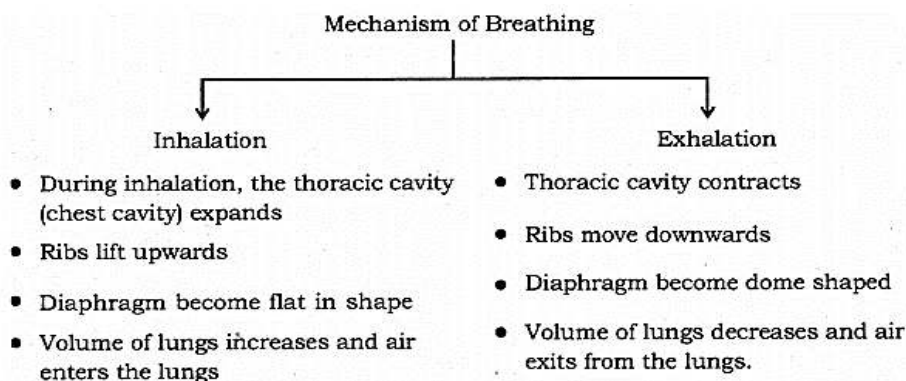
Respiration in humans:

Main parts of human respiratory system:

1. **Nostrils**:
 - **2 nostrils** which **converge** to **form** a **nasal passage**.
 - **Inner lining** of nostrils - **hair** and **mucus** secretion.
 - **Mucus** and **hair** - **filtering dust particles** out from inhaled air.
2. **Pharynx**:
 - A **tube-like structure** which continues after nasal passage.
3. **Larynx**:
 - **Comes after the pharynx**.
 - aka **voice box**.
4. **Trachea**:
 - **Composed of rings of cartilage** which **prevent collapse** of **trachea** in **absence of air**.
5. **Bronchi**:
 - A **pair of bronchi** comes out from the **trachea**, with one bronchus going to each lung.
6. **Bronchioles**:
 - A **bronchus** **divides** into **branches** and **sub-branches** inside the lung.
7. **Alveoli**:
 - **Air sacs** at the **end** of **bronchioles**.
 - **Composed of a very thin membrane** and is the place where **blood capillaries open**.
 - **Oxygen** mixes with the **blood** and **carbon dioxide** **exits** from the blood.



Mechanism of breathing:



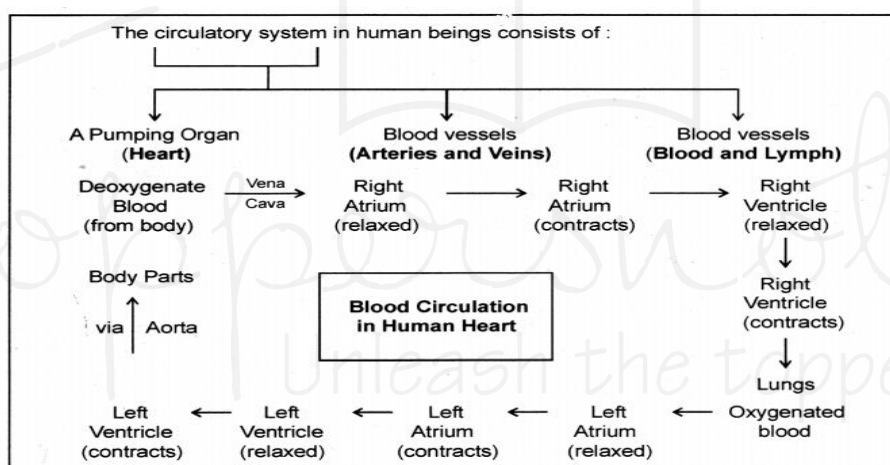
Carbon monoxide poisoning:

- **Carbon monoxide** - formed whenever a **fuel burns** in an **insufficient supply** of air.
- Eg, if coal is **burned** in a **closed space**, then a lot of **carbon monoxide** is **formed**.
- **Haemoglobin** has **more affinity** for **carbon monoxide** than **oxygen**,
- If **carbon monoxide** gas **inhaled** by a person, then it **binds** very **strongly** with **haemoglobin** and **prevents** it from **carrying oxygen** to **brain** and other parts.
- **Lack of oxygen** - **person cannot breathe** properly.
- If **inhaled** for a **long time**, **fatal**.

Circulatory System

- **Movement of substances** like water, waste products & nutrients from one place to another.

Human circulatory system:



1. Heart:

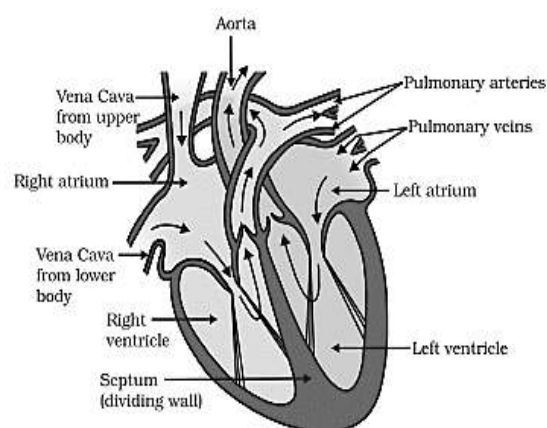
- A **muscular organ** composed of **cardiac muscles**.
 - A **pumping organ** which **pumps the blood**.
 - **4 chambers** - right atrium, right ventricle, left ventricle and left atrium.
 - **Systole**: Contraction of cardiac muscles.
 - **Diastole**: Relaxation of cardiac muscles.

2. Arteries:

- **Thick-walled blood vessels** which **carry oxygenated blood** from **heart** to different **organs**.
- **Exceptions**: Pulmonary arteries - carry deoxygenated blood from heart to lungs.

3. Veins:

- **Thin-walled** blood vessels
- **Carry deoxygenated blood** from different organs to heart
- **Exception**: Pulmonary veins - carry oxygenated blood from lungs to the heart.
- **Valves present** in veins to **prevent back flow** of blood.



4. Capillaries:

- Blood vessels **having single-celled walls**.

5. Blood:

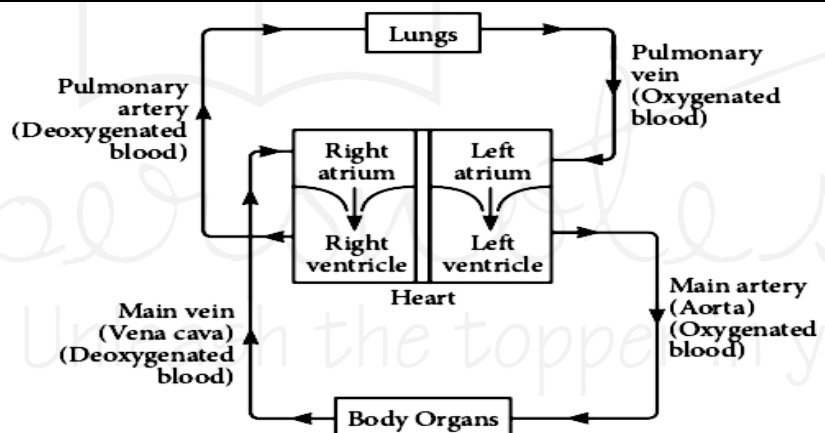
- A **connective tissue** which plays role of **carrier for various substances** in body.
- Composed of :
 - A. **Blood plasma:**
 - A **pale coloured liquid** mostly composed of water.
 - **Forms the matrix of blood**.
 - B. **Blood cells:**
 - **Red Blood Corpuscles (RBCs):**
 - **Circular** in shape.
 - **Contain a red coloured pigment** called **haemoglobin**.
 - **No nucleus**.
 - **Carry oxygen to tissues** and **bring back carbon** dioxide from tissues
 - **White Blood Corpuscles (WBCs):**
 - **Colourless**
 - **Irregular shape**
 - **Prevent body** from **infections** by eating up germs or by producing antibodies to fight antigens.
 - **Platelets:**
 - **Very small fragments** of cells
 - **No nuclei**
 - **Clotting of blood**

6. Lymph:

- **RBCs are absent**.
- **Formed** from **fluid** which **leaks** from **blood capillaries** and goes to the **intercellular space** in the tissues.
- **Collected through lymph vessels** and finally return to blood capillaries.
- Also **plays an important role** in the **immune system**.

Double circulation

- **Heart receives deoxygenated blood** from different parts of body, and **pumps this blood to lungs**.
- **Oxygenated blood** from lungs **returns to heart** - **pumped again** into different parts of body.
- So, the **blood passes twice through the heart** making **one complete round** through the body k/a **double circulation**



Single circulation	Double circulation
1. Blood flows through heart only once for completing one circulation. It is called single circulation. Eg: Fishes	1. If the blood flows through heart two times for completion of one circulation. It is called double circulation. Eg: Mammals, birds.
2. Pulmonary circulation is absent.	2. Pulmonary circulation is present.
3. Heart consists of two chambers.	3. Heart consists of three or four chambers.
4. Single circulation is seen in fishes.	4) Double circulation occurs in frogs, reptiles, birds and mammals.

Digestive systems in Human beings

- **Components:**

1. **Alimentary Canal:**

- Comprises of mouth, oesophagus, stomach, small intestine and large intestine.

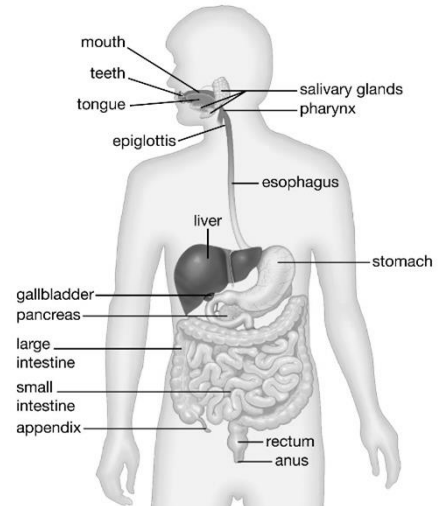
2. **Associated Glands:**

- Salivary gland
- Gastric Glands
- Liver
- Pancreas

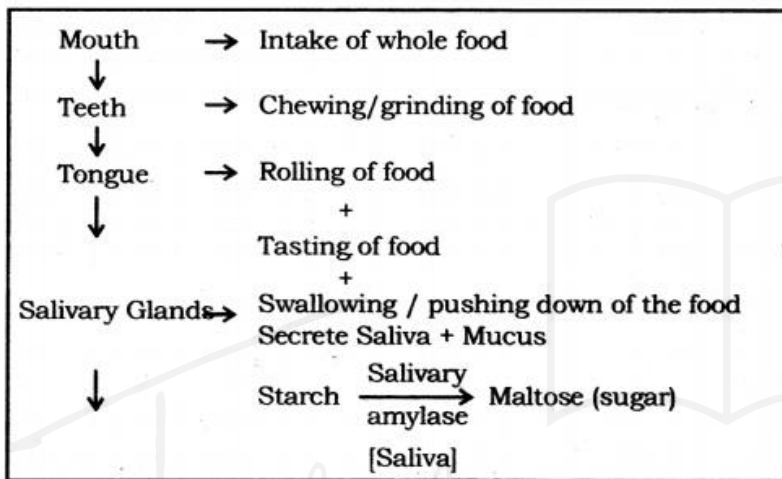
1. **Ingestion:**

- Food is ingested through the mouth.
- Put into the mouth with the help of hands.

2. **Digestion:**



Mouth or Buccal Cavity:



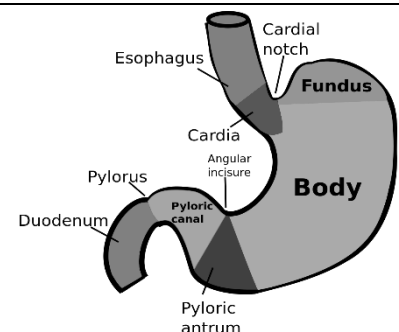
- Mouth has teeth, tongue & salivary glands.
- Tongue - helps in turning over food so that saliva can be properly mixed in it.
- Teeth - help in breaking down food into smaller particles.
- Process of digestion starts in the mouth itself.
 - Saliva contains an enzyme k/a salivary amylase/ ptyalin that converts starch → sugar (sucrose/ maltose).

Oesophagus/ Food Pipe:

- Slightly digested food in the mouth is swallowed by the tongue.
- Goes down food pipe called oesophagus.
- Food enters the food pipe - walls of food pipe start contraction and expansion movements k/a peristaltic movement.
- Pushes the slightly digested food into the stomach.

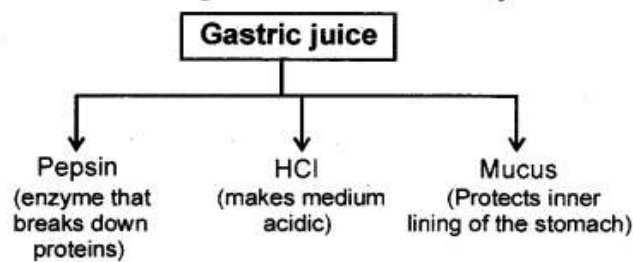
Stomach

- A J-shaped organ.
- Highly muscular walls:
 - Churning the food.
 - Secrete hydrochloric acid that kills germs which may be present in food.
 - Makes medium inside stomach acidic that activates enzyme pepsin - partial digestion of protein.
 - Mucus secreted by walls of the stomach saves inner lining of stomach from getting damaged from hydrochloric acid.



Small Intestine:

Stomach → Gastric glands secrete Gastric juice



- A highly coiled tube-like structure.
- Longer than large intestine but its lumen is smaller than large intestine.
- 3 parts:
 - Duodenum
 - Jejunum
 - Ileum.

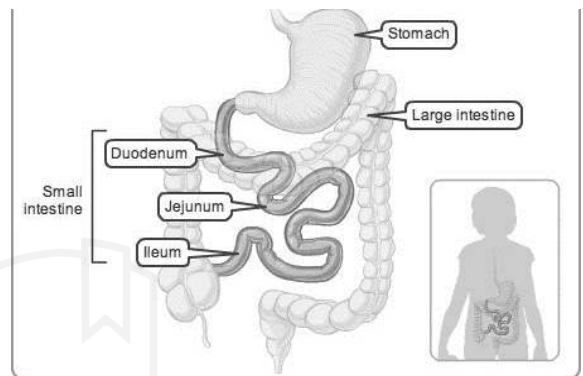
- From stomach, partially digested food enters small intestine.
- Largest part (about 6.5m) of the alimentary canal.
- Very narrow and arranged in the form of a coil.
- Site of complete digestion of food (like carbohydrates, proteins and fats)
- Receives secretion of two glands:

1. Liver

- Secretes bile - a greenish yellow liquid made in the liver and stored in gall bladder.
- Functions of bile:
 - Makes acidic food from stomach alkaline - pancreatic enzymes can act.
 - Break fats present in food into small globules making it easy for enzymes to act and digest them.

2. Pancreas

- Secretes pancreatic juice containing enzymes like pancreatic amylase for breaking down starch, trypsin for digesting proteins and lipase for breaking down emulsified fats.
- Walls of small intestine contain glands which secrete intestinal juice. Enzymes present convert proteins into amino acids, complex carbohydrates into glucose and fats into fatty acids and glycerol.
- Convert large and insoluble food molecules into small water soluble molecules.



Small Intestinal →

