BLOOD FLUIDS & CIRCULATION

Blood (Connective Tissue)

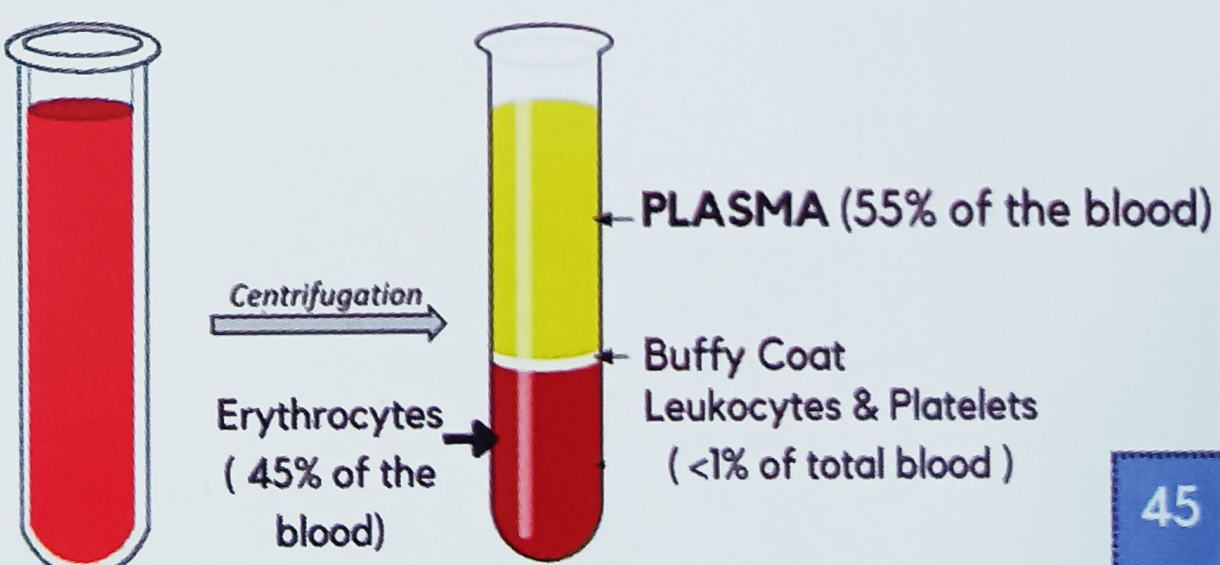
Fluid matrix	Plasma	Formed elements

Plasma (55% of the blood)

Straw coloured, viscous	Plasma is formed of

- **Minerals** (Na^+, Ca^{+2}, Mg^{+2}, HCO_3^-, Cl^- etc.)
- **Water** (90-92%)
- **Proteins(6-8%)** — PROTEIN
  - **Fibrinogen** (Clotting of blood)
  - **Globulins** (defense)
  - **Albumins** (Maintain osmotic balance)
- **Organic Compounds** (glucose, AA, Lipids etc.)

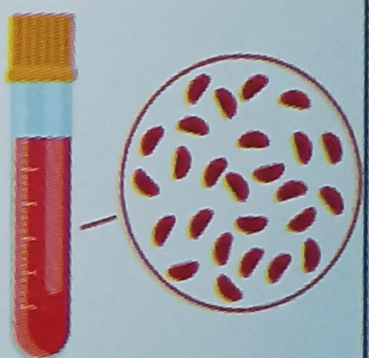
Serum = Plasma - clotting factors (inactive form)



FORMED ELEMENTS = Erythrocytes + Leucocytes + Platelets

1. ERYTHROCYTES - (or RBC's)

- Adult human= 5 to 5.5 million/mm^{-3}
- Nucleus(-); biconcave; red $\xrightarrow{\text{due to}}$ haemoglobin (12-16 gm per 100mL blood)
- Role-transport of gases
- Life span-120 days
- Bone marrow-RBC's are formed here
- Spleen-graveyard of RBC's



2. LEUCOCYTES

Colourless (lack haemoglobin)	Short Lived
6000-8000 mm-3 blood	Nucleated

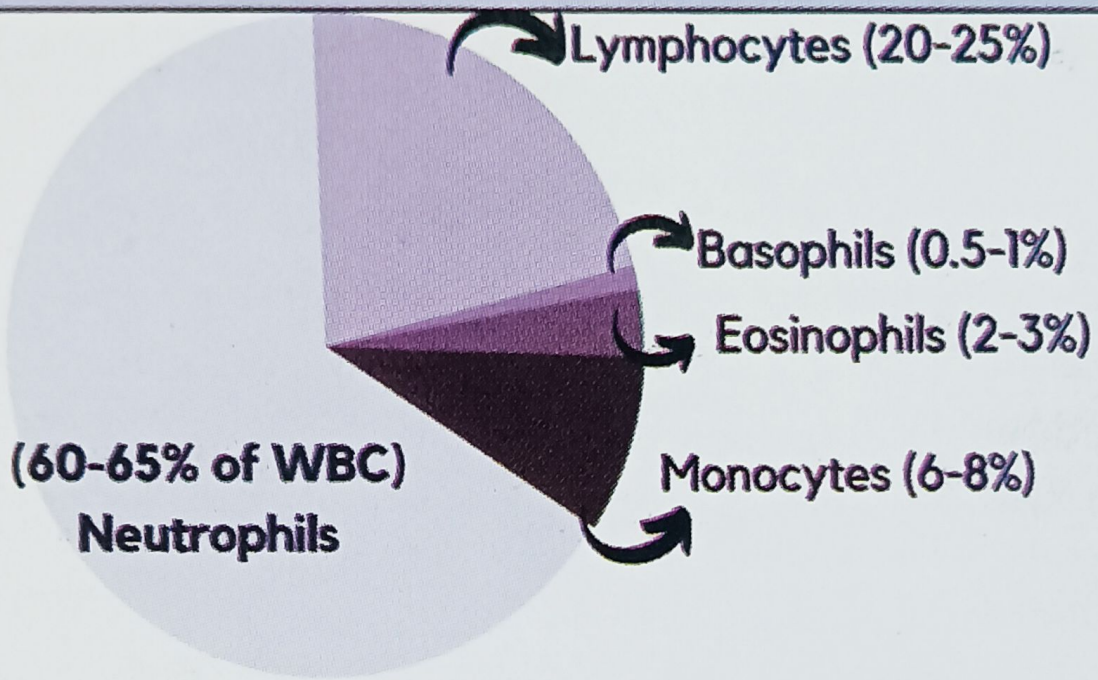
Types

Granulocytes

- **Neutrophils** (Most abundant) phagocytes
- **Eosinophils** Resist infection Immune response
- **Basophils** (Least abundant) Secrete histamine, serotonin, heparin (inflammatory reaction)

Agranulocytes

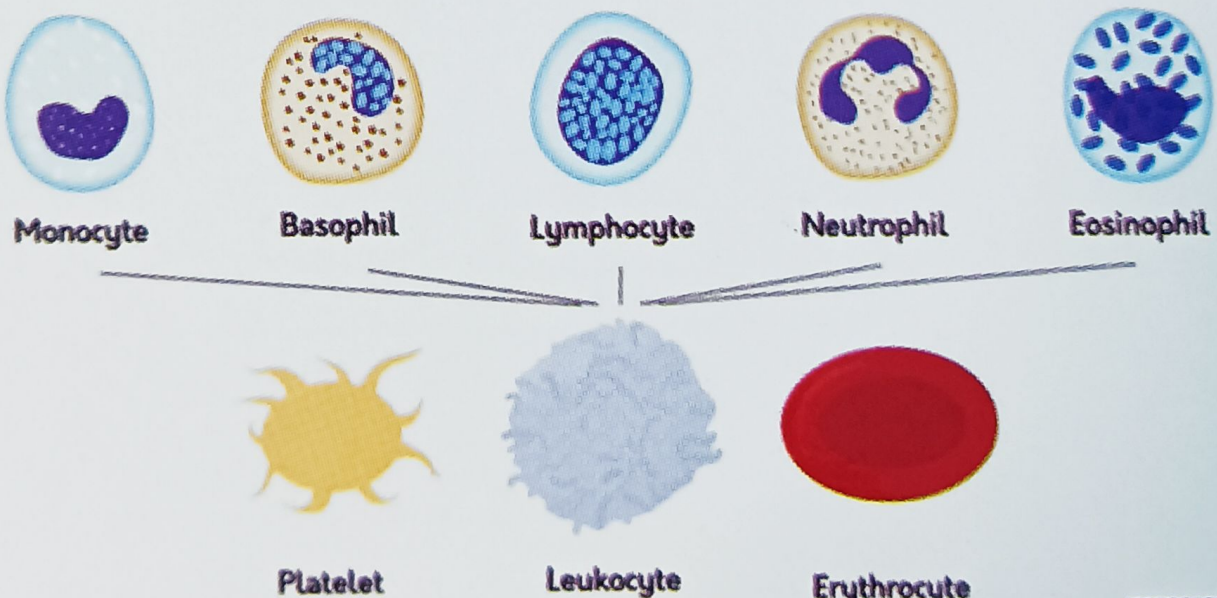
- **Lymphocytes** (B & T Lymphocytes) -Immune responses
- **Monocyte** -Phagocytes



3. PLATELETS/THROMBOCYTES

150000-350000 Platelets/mm^3	Function-coagulation blood

Produced from megakaryocytes (in bone marrow)



Blood groups

ABO Grouping - Based on surface antigens

BLOOD GROUPS	A	B	AB	O
Antigen (on RBC)	A	B	A, B	-
Antibody	Anti B	Anti A	-	Anti A, B
Donor	A, O	B, O	A, B , AB, O	O
Recipients	A, AB	B, AB	AB	A,B,AB,O

Universal Donor : 'O' ; Universal Acceptor : 'AB'

Rh Grouping-(also present in Rhesus monkey)

- Rh antigen **present** = Rh +ve (80% population)
- Rh antigen **absent** = Rh -ve

Rh +ve blood → **Rh -ve person** → Antibodies formed against Rh antigen

Erythroblastosis Foetalis

Rh incompatibility b/w Rh -ve blood of pregnant mother & Rh +ve blood of foetus.(usually happens in 2nd pregnancy as mother's blood forms antibodies against Rh antig

Coagulation Blood

-In response to injury, to prevent blood loss
-A dark reddish brown scum is formed on injured site.
-Clot is formed by network of threads (fibrins)

Injured tissue → releases → **Thromoboplastin** → Ca (II)

Blood platelets → releases → **Platelet factor 3** → Ca (II)

→ **Prothrombinase** → Inactivates heparin

Prothrombin —Ca(II)→ **Thrombin**

Thrombin → Catalyse → **Fibrinogen** → **Fibrin**

Fibrin + Blood cells —form→ **Clot**

LYMPH (Tissue fluid/Interstitial fluid)

- Lymph is colourless fluid, present in lymphatic system, containing lymphocytes responsible for immune response
- Same mineral distribution as plasma
- Function-exchange of gases and nutrients between blood & cells, carrier of hormones.

Circulatory pathways

OPEN	CLOSED
• Blood flows through body cavities (sinuses) • Direct contact with tissues • Low pressure • Slow, Less efficient e.g.-Arthropods, Molluscs	• Blood flows trough network of blood vessels • No direct contact • High pressure • Fast & more efficient e.g.-Annelids, Chordates

Chambers	Atrium	Vent.	Example	Circulation
2	1	1	Fishes	Single
3	2	1	Amphibians, Reptiles (Except Crocodile)	Incomplete double
4	2	2	Crocodiles, Birds, Mammals	Double

HUMAN CIRCULATORY SYSTEM

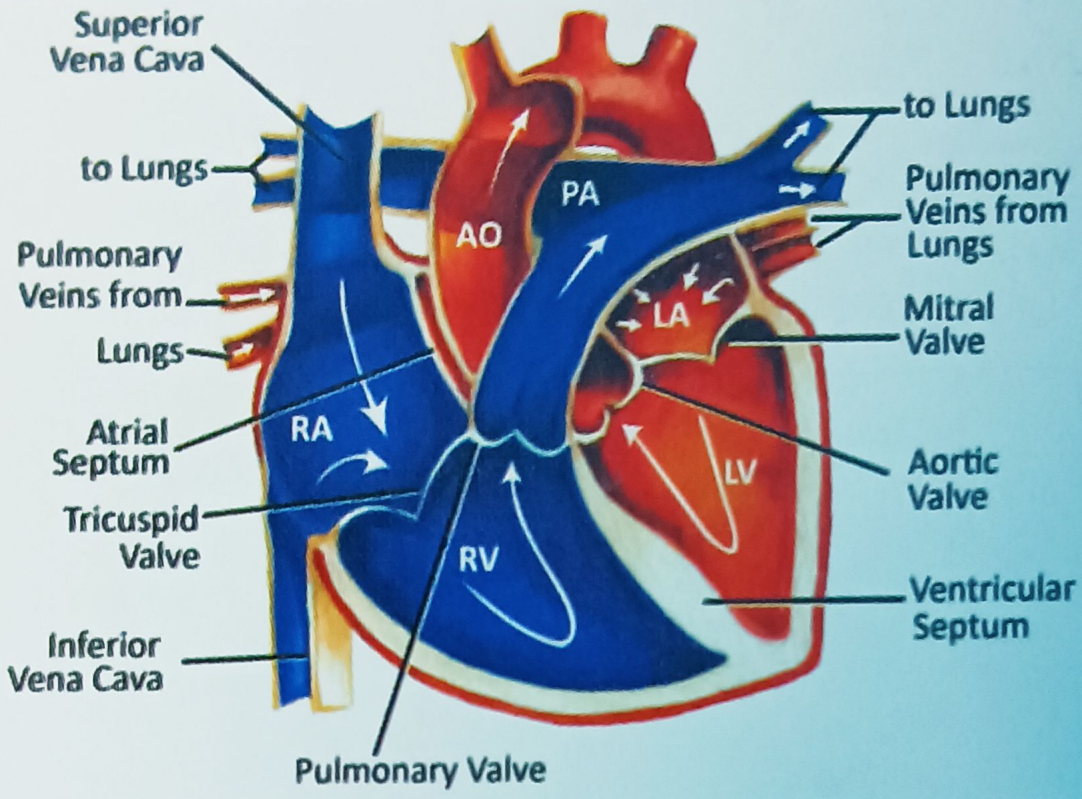
Muscular heart	Network of blood vessels	Blood

HEART

- Mesodermally derived
- Location-Thoracic cavity b/w Lungs
- Slightly tilted towards Left
- Pericardium = double walled membrane

↓
contains pericardial fluid

4 chambered — 2 atria (smaller), 2 ventricle (Larger) — Separated by atrio-ventricular septum → Thick fibrous tissue



- Tricuspid valve (b/w RA & RV)
- Bicuspid/mitral value (b/w LA & LV)
- Semilunar valve (b/w Right, left Ventricles and pulmonary artery, aorta)
- Ventricle wall > Atrial walls (Thickness)

Generation of Action Potential

Heart beats 70-75 times per min.

Sino-atrial node(SAN)

(Pacemaker of heart)

Location-Right upper corner of right atrium

Atrio ventricular node(AVN) → Passes via

Atrio Ventricular septa

bundle of this → divides to 2 bundles → Purkinje fibres

CARDIAC CYCLE - Sequential events in heart(0.8sec)

Tricuspid, Bicuspid valves- **Open**
Semilunar valves- **Closed** → Blood flows via pulmonary vein, venacava → LA and RA → LV and RV → Action potential Generation (SAN)

Stimulates Atrial contraction → Blood flow increases in ventricles (by 30%) → Action potential conducted to AVN & AV bundle → Transmission to Bundle of His (Ventricles contract) → Atria Relaxation; pressure in ventricles increases → Tricuspid, Bicuspid valves close → Semilunar valves open → Blood flows in circulatory pathways → Ventricles Relax; Pressure decrease → Semilunar valves-close Tricuspid, Bicuspid valves-open

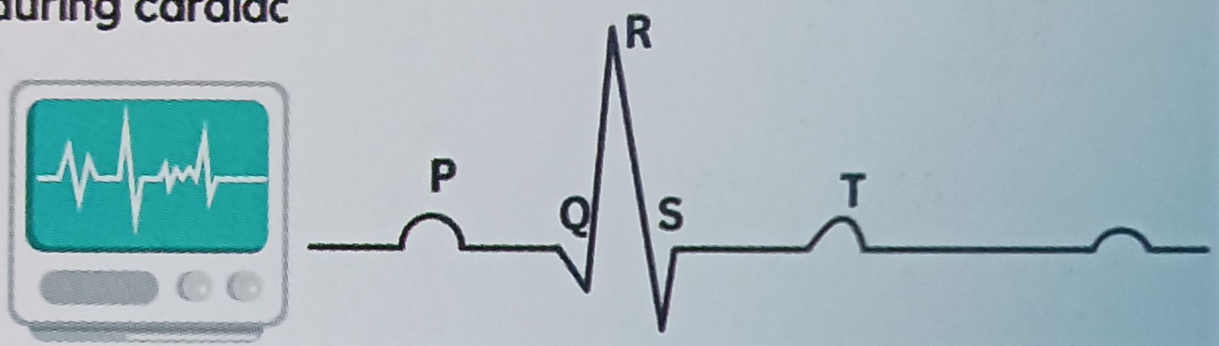
HEART SOUNDS

First heart sound (LUB)	Second heart sound (DUB)
• Closure of tricuspid & bicuspid valves • Long, soft, low pitched • Duration = 0.10 sec • Frequency = 30Hz • Corresponds to 'R' wave	• Closure of semilunar valves • Short, sharp & high pitched • Duration = 0.10 sec • 50Hz • 0.09 sec after 'T' wave

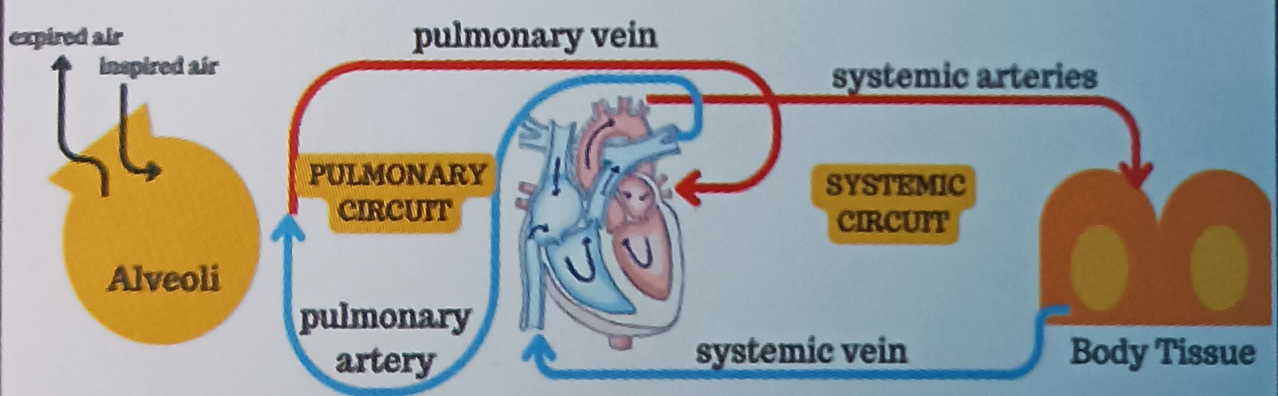
- **Stroke volume**-volume of blood, each ventricle pumps in a cardiac cycle=**70 mL**
- **Cardiac Output** = Stroke volume x no. of beats/min
  = **5000 mL/5Lt**

Electrocardiograph (ECG)

Graphical representation of electrical activity of heart during cardiac



- 'P' Wave-excitation of atria (depolarisation)
- 'PQ' segment-Delay at AV node
- 'QRS' Complex-depolarisation of ventricles
- 'T' Wave-Ventricular Repolarization



- Hepatic portal system-Special vascular connection b/w digestive trace & Liver; later joins systemic circulation

Double Circulation

Artery/Vein

Structure
- →Tunica externa-fibrous connective tissue, collagen fibres(+)
- →Tunica media-smooth muscles, elastic fibres
- →Tunica interna-squamous epithelium

Regulation of Cardiac activity

- Autoregulatory (nodal tissue)-myogenic heart
- Medulla oblangata (ANS)-moderate cardiac function
- Sympathetic nerves (ANS)-increases heart beat, ventricular contraction strength, increases cardiac output
- Parasympathetic neural signals(ANS)-decrease heartbeat, decrease cardiac output, decrease conduction speed.
- Adrenal medulla-increase cardiac output

Disorders

1. **High BP(Hypertension)** - BP more than 120/80(more than normal)(usually 140/90 mmHg) -affects brain, Kidney.
2. **Coronary Artery Disease(CAD) - antherosclerosis**
   a. Ca^{+2} fat, cholesterol & fibrous tissue deposit in arteries
   b. Makes arteries Lumen narrow.
3. **Angina pectoris** - Chest pain, Deficit of O_2 in heart muscles, Common among middle-aged & elderly, Blood flow affected
4. **Heart failure** - heart stops pumping effectively
5. **Cardiac arrest**- heart stops beating
6. **Heart attack**- heart muscles are damaged