Chapter 02 Body fluids and circulation

CONTENT

1. INTRODUCTION

- All living cells have to be provided with nutrients, O_2 and other essential substances. Also, the waste or harmful substances produced, have to be removed continuously for healthy functioning of tissues. It is therefore, essential to have efficient mechanisms for the movement of these substances to the cells and from the cells.
- Different groups of animals have evolved different methods for this transport.
- Simple organisms like sponges and coelenterates circulate water from their surroundings through their body cavities to facilitate the cells to exchange these substances.
- More complex organisms use special fluids within their bodies to transport such materials.
- **Blood** is the most commonly used body fluid by most of the higher organisms including humans for this purpose.
- Another body fluid is **lymph,** also helps in the transport of certain substances.

2. BLOOD

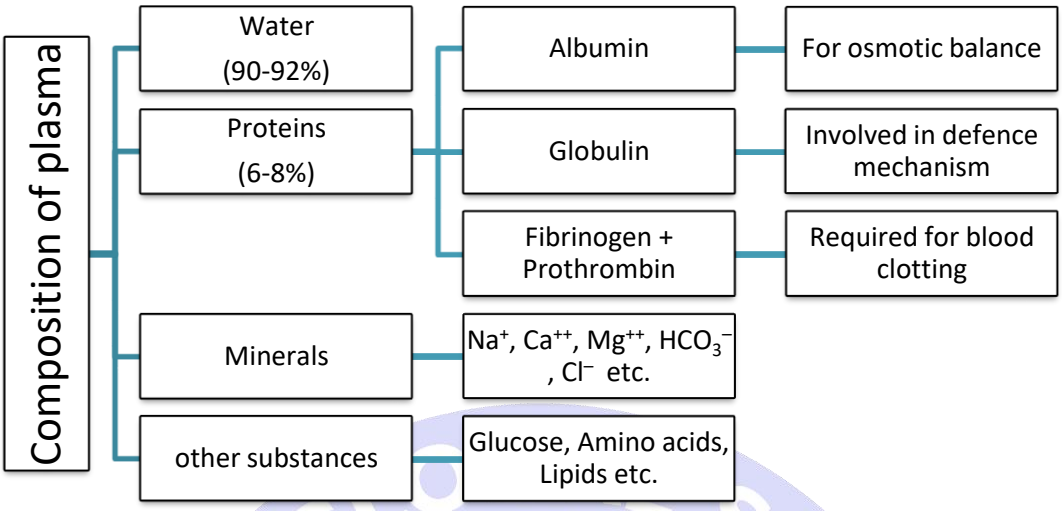
- Blood is a special connective tissue consisting of a fluid matrix, plasma, and cellular portion called formed elements.
- The plasma constitutes approximately 55% of the blood and the formed elements account for the remaining 45%.
- Study of blood – **Haematology.**
- Process of blood formation **Haemopoiesis** (in bone marrow).

DETECTIVE MIND

- Colour of blood – Red (due to blood pigment Haemoglobin)
- pH of blood – 7.4 (Slightly alkaline)
- Blood by weight – 7 to 8% of body weight
- Blood by volume – 5 - 6 litres in male and 4 - 5 litres in female.
- Blood is a false connective tissue because: -
  - Cells of blood have no power of division.
  - Fibres are completely absent in blood.
  - Matrix of blood is produced & synthesized by liver and lymphoid organs.

2.1 PLASMA

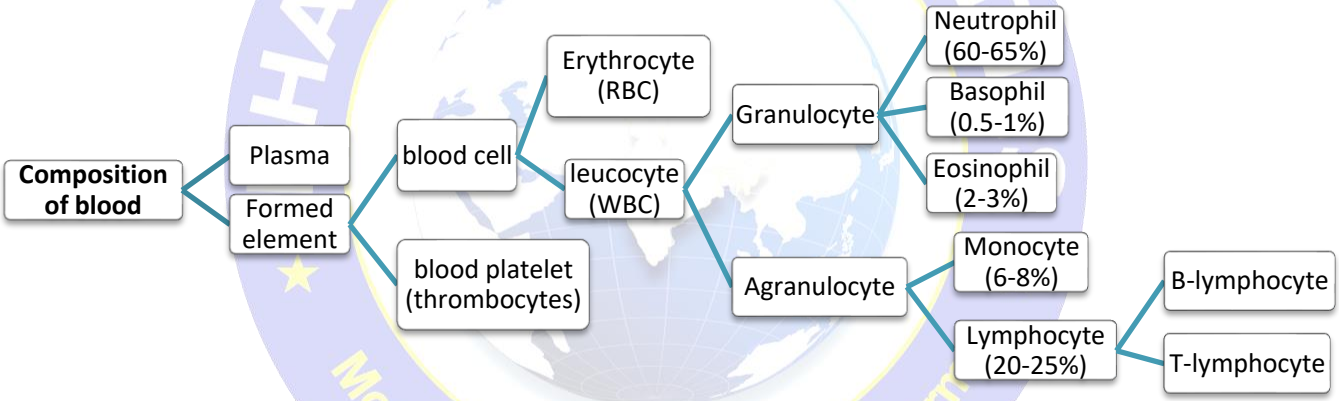
- Matrix of blood is called Plasma.
- It is a straw coloured viscous fluid.



- Plasma without the clotting factor is called **serum**.

2.2 FORMED ELEMENTS

- Erythrocytes, leucocytes and platelets are collectively called formed elements and they constitute nearly 45% of the blood.

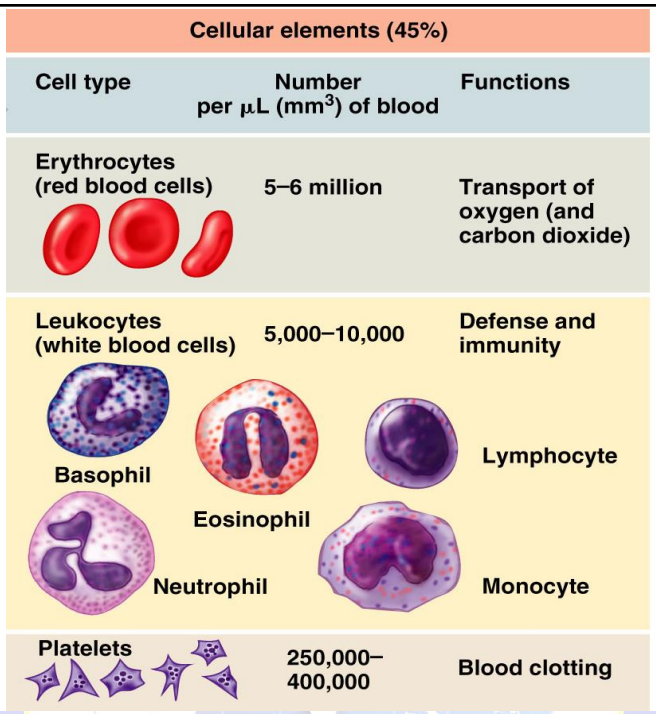


(I) Erythrocytes (Red Blood Corpuscles)

- The erythrocytes are the most abundant of all cells in blood.
- Mammalian RBCs are biconcave, circular & non-nucleated.
- A healthy adult man has, on an average, 5 million to 5.5 million of RBCs mm^{-3} of blood.
- In RBC, higher cell organelles like mitochondria & golgi complex are absent.
- Antigen of blood group is present on the surface of RBC.
- Single RBC is pale yellow in colour while group of RBC appear red in colour.
- In RBC, red coloured iron containing respiratory pigment **haemoglobin** is present. These molecules play a significant role in transport of respiratory gases.
- Organs which produce RBC's called **Erythropoietic organs**.
- I^{st} RBC produced by yolk sac. During embryonic life RBC are produced by Liver, Spleen, Placenta, Thymus gland.
- In adult stage RBC is produced by **Red Bone Marrow** which filled in between trabeculae of spongy bones.
- Maturation of RBC's occurs by Vit. B_{12} & folic acid.
- A healthy individual has 12-16 gm of haemoglobin in every 100 ml of blood.
- RBCs have an average life span of 120 days after which they are destroyed in the spleen (graveyard of RBC s).

DETECTIVE MIND

- In mature RBC nucleus + mitochondria + Golgibody + ER is absent.
- Enzymes of kreb's cycle & aerobic respiration is absent in RBC.
- Glycolysis & anaerobic respiration occurs in RBC.
- In RBC carbonic anhydrase enzyme is present, which helps in CO_2 transport.



DETECTIVE MIND

Haemoglobin:

It is composed of two components: Haem (5%) , Globin (95%) (Protein part)

Haem (Iron and Porphyrin)

- Iron present in the form of Fe^{+2}
- Each molecule of Hb carries 4 molecules of O_2.

(II) Leucocytes (WBC)

- They are colourless due to the lack of haemoglobin.
- **TLC** - (Total leucocyte count). Number of WBC / mm^3 ® 6000 - 8000 / mm^3 (± 2000 - 3000) of blood.
- Leucocytes possess nuclei and other cell organelles and can move in an amoeboid fashion.
- These are generally short lived.
- On the basis of nucleus & nature of cytoplasm, Leucocyte are of two types :

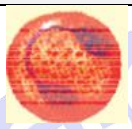
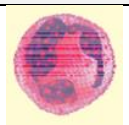
(A) Granulocytes

- In their cytoplasm granules are present which can be stained by specific dye.
- Nucleus is multilobed and lobes are interconnected by protoplasmic strand.
- Due to presence of lobed nucleus they are called as polymorphonuclear WBC.
- Produced in Bone marrow.
- These are -

(i) Eosinophils

(ii) Basophils

(iii) Neutrophils

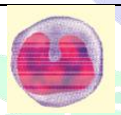
Characterstics	*Eosinophils*	*Basophils*	*Neutrophils*
Nucleus	Bilobed	S- shaped	3-5 Cobes
Life span	14 hrs	10 hrs	12 hrs
Stain with	Acidic dye like eosin	Basic dye like methylene blue	Any dye (acidic/ basic/ neutral)
Number	2-3% of TLC	0.5-1% of TLC (min. in no.)	60-65% of TLC (Max. in no.)
Functions	They protect body against the allergy and parasitic infection.	Secrete and transport heparin, serotonin, histamine etc.	Phagocytic in nature; Destroy becteria and viruses by phagocytosis.
Structure			

(B) Agranulocytes

- Cytoplasm is clear & agranular.
- Nucleus do not divide in lobes so called as mononuclear WBC.
- Produced in bone marrow.
- These are –

(i) Monocytes

(ii) Lymphocytes

Characterstics	*Monocytes*	*Lymphocytes*
Nucleus	**Kidney Shaped**	**Rounded**
Life span	Less than 24 hrs in blood	5-7 days in blood
Number	6-8% of TLC	20-25% of TLC
Functions	Also called "scavengers of blood" because they engulf damaged or dead and minute bits of blood corpuscles	• T-killer – direct kill microbes • T-helper – stimulate B-lymphocytes to produce antibody • T-suppresser – suppresses T-killer and protect immune system. • B-lymphocytes – Produce and transport antibodies.
Structure		

(III) THROMBOCYTES (PLATELETS)

- Life span - 2-4/5 days.
- Number - 1.5 - 3.5 lakh/mm^{-3} of blood.
- These are non nucleated and are cell fragments produced from **megakaryocyte** cells of bone marrow.
- In shape platelets are disc like, oval shaped or biconvex.
- In their cytoplasm basophilic granules are present which can be stained by methylene blue.

Function:

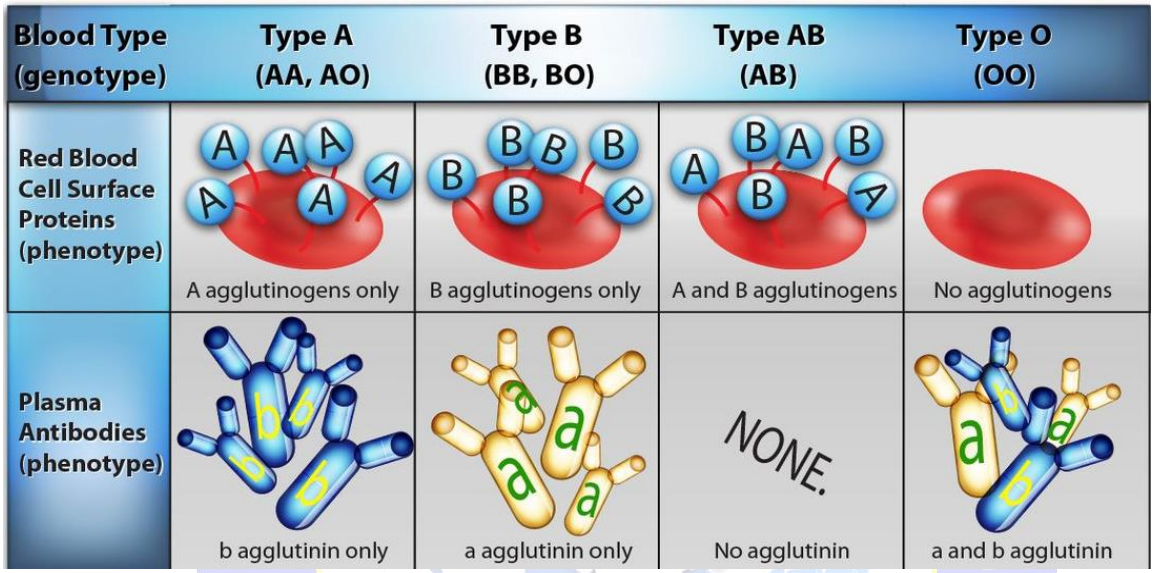
1. Repair endothelium of blood vascular system by the formation of platelet plug because they have tendency to attach on gelatinous or mucilagenous surface.
2. Synthesize thromboplastin which help in blood clotting.
3. Synthesize serotonin.

2.3 BLOOD GROUP

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

ABO Grouping

- Blood groups are of 4 types A, B, AB, O.
- A, B and O blood group discovered by **Landsteiner**.
- In blood transfusion, the blood of the donor has to be carefully matched with the blood of a recipient before any blood transfusion to avoid severe problems of clumping (destruction of RBC).
- Blood group $\mathbf{O^-}$ is universal donor & Blood group $\mathbf{AB^+}$ is universal acceptor.



BLOOD GROUPS AND DONOR COMPATIBILITY

Blood Group	Antigen on RBCs	Antibodies in Plasma	Donor's Group
A	A	Anti-B	A, O
B	B	Anti-A	B, O
AB	A, B	Nil	AB, A, B, O
O	Nil	Anti-A, B	O

Rh Grouping

- Discovered by **Landsteiner** & **Wiener** in Rhesus monkey
- It is also observed on the surface of RBCs of majority of humans (nearly 80%).
- Rh antigen is due to dominant gene. So, if one of the gamete possess gene of Rh factor, its offspring will be always Rh^+.
- If antigen is present then Rh^+. If antigen is absent then Rh^-.

% Ratio of Rh		
	$\mathbf{Rh^+}$	$\mathbf{Rh^-}$
In India	97%	3%
In World	80%	20%

- In Rh^+ antibody is absent for this antigen. Rh antibody is also absent in Rh^- blood.
- If Rh^+ blood is transfused to Rh^- then 1^{st} blood transfusion is complete successfully but during I^{st} blood transfusion Rh antibodies are formed in receiver's blood. So, in next blood transfusion, agglutination of blood takes place.
- **Packed cell volume** (PCV): % volume or total number of blood corpuscles in blood.

2.3 BLOOD CLOTTING (COAGULATION OF BLOOD)

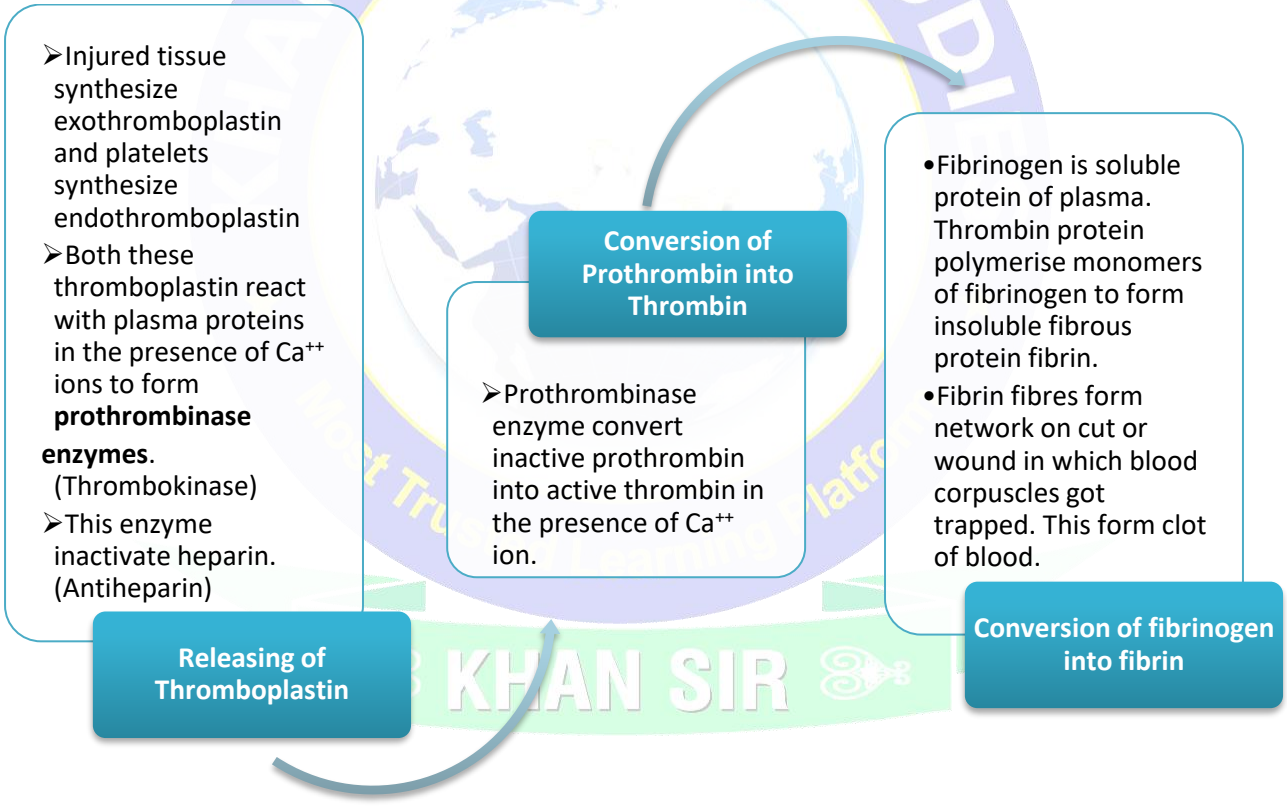
- Blood flows from cut or wound but after some times it stops automatically, it is called clotting of blood.
- Bleeding time 1 - 3 min. Clotting time 2 - 8 min.

Mechanism of blood clotting (Enzyme Cascade theory):

- Proposed by **Macfarlane & Co-workers**.
- According to this theory there are 3 steps in blood clotting:

SPOT LIGHT

- If mother is Rh^- & father is **Rh^+** then offspring may be Rh^+. In this case 1st pregnancy is completely successful but at the time of 1st delivery Rh antibody is formed in mother's blood due to damaged blood vessel. So, in next pregnancy death of foetus or could cause severe anemia and Jaundice in the earlier stage due to agglutination of blood called **erythroblastosis foetalis**.
- Anti-Rh antibodies are given to mother within 72 hrs after the delivery of first child, to destroy foetal RBC which prevent Rh-antibodies formation in mother.



3. LYMPH

- Lymph is a colourless fluid containing specialised lymphocytes which are responsible for the immune responses of the body.
- As the blood passes through the capillaries in tissues, some water along with many small water soluble substances move out into the spaces between the cells of tissues leaving the larger proteins and most of

the formed elements in the blood vessels. This fluid released out is called **the interstitial fluid or tissue fluid.**

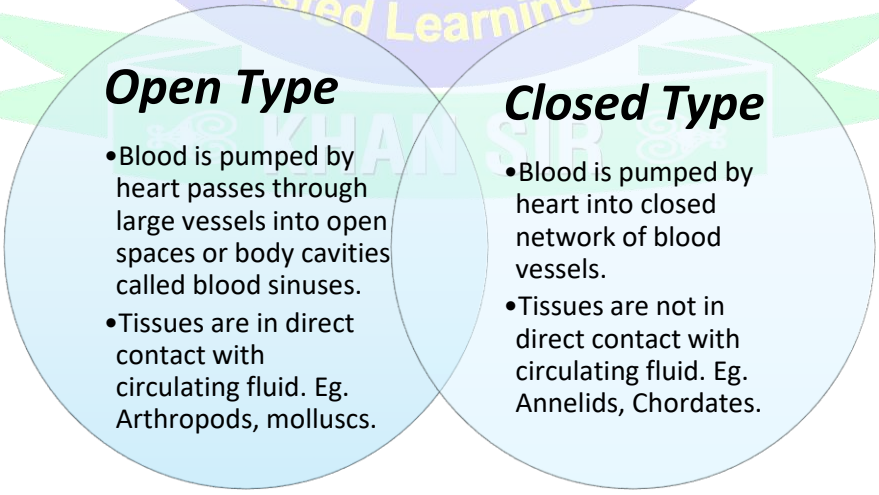
- It has the same mineral distribution as that in plasma. Exchange of nutrients, gases, etc., between the blood and the cells always occur through this fluid.
- An elaborate network of vessels called the **lymphatic system** collects this fluid and drains it back to the major veins. The fluid present in the lymphatic system is called lymph. Lymph is an important carrier for nutrients, hormones, etc.
- Fats are absorbed through lymph in the **lacteals** present in the intestinal villi.
- Passage of lymphatic circulation:

Comparision between blood and lymph

Blood		Lymph	
(1)	It forms circulatory system	(1)	It forms lymphatic system
(2)	RBCs present	(2)	RBCs Absent
(3)	Neutrophills more	(3)	Lymphocytes in largest amount
(4)	Soluble proteins in large amount but insoluble proteins in small amount	(4)	Soluble proteins in small amount but insoluble proteins in large amount
(5)	O_2 & nutrients in large amount but CO_2 very less	(5)	O_2 & nutrients in small amount but CO_2 in large amount
(6)	Colour - red	(6)	colourless, just like water
(7)	More WBCs	(7)	Lesser WBCs
(8)	Clotting time: less	(8)	Clotting time: Comparatively more

4. CIRCULATORY SYSTEM

- The circulatory pathways are of two types:



- **TYPE OF BLOOD CIRCULATION AND HEART IN VERTEBRATES:**

	Fishes	*Amphibians*	*Reptiles*	*Crocodiles, Aves, Mammals*
No. of heart Chambers	2	3	3	4
Atria	1	2	2	2
Ventricles	1	1	1	2
Type of circulation	Single Circulation	Incomplete Double Circulation	Incomplete Double Circulation	Double Circulation

- **Evolutionary sequence is present in vertebrates heart** :-
  (1) **Fishes** have **"Venous-Heart"** In their heart, deoxygenated blood enters from one side and from the other side sent to the gills for oxygenation. This is called the **"Single Heart Circuit"**.
  (2) In **amphibians** and **Reptiles** the auricles are divided into right and left. Right auricle gets deoxygenated left auricle gets oxygenated blood from the gills/lungs /skin. But only 1 ventricle is present or is incompletely divided. So after coming here the oxygenated and deoxygenated blood mix up. This is called **Incomplete double circulation**.
  (3) In some **reptiles** (Crocodile, Gavialis and Alligator) and in **all birds and mammals** the heart is divided into 2 auricles and 2 ventricles. So while circulating inside the heart the oxygenated and deoxygenated blood remain separated. The right portion of the heart collects deoxygenated blood from the body and sends it to the lungs for oxygenation, while the left portion takes oxygenated blood from the lungs and distributes it to the whole body. This is called **Double circulation**.
- In human beings **(on the basis of circulating fluid)** two types of circulatory system are observed:
  (1) Blood circulatory system: It consist of Blood, Blood vessels, Heart.
  (2) Lymphatic system: It consist of lymph, lymph vessels, lymph nodes.
- The right portion of the heart is called as the **"Pulmonary-Heart"** and the left portion is termed as the **"Systemic-heart"**. This is termed as **"Double Circulation of Heart"**, because the blood has to pass through the heart twice before being delivered to systemic organs.

SYSTEMIC HEART :

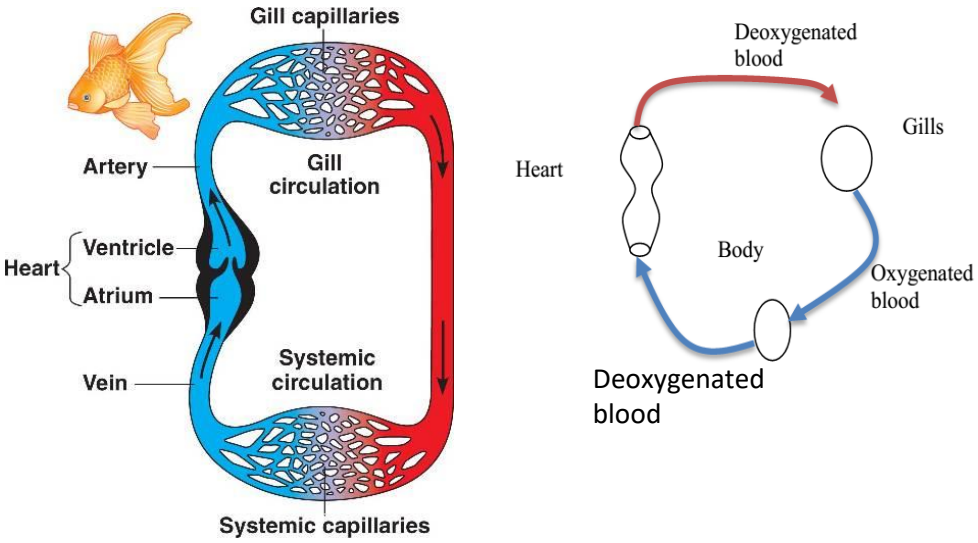
Left part of the heart (i.e. **left atrium** and **left ventricle**) contain the blood which is to be pumped into the ***systemic circulation***, therefore it is called systemic heart. The main purpose of such a circulation is to transport oxygen, as well as nutrients to the body tissues, and to remove carbondioxide and other harmful nitrogenous waste from them.

PULMONARY HEART :

Right part of the heart (i.e. **right atrium** and **right ventricle**) contain the blood which is to be pumped in ***pulmonary circulation*** for oxygenation, therefore it is called pulmonary heart. The pulmonary circulation is responsible for regular oxygenation of the deoxygenated blood which is received by the right auricle.

TYPES OF CIRCULATION OF BLOOD

1. **Single Circulation :** Example : Fishes.



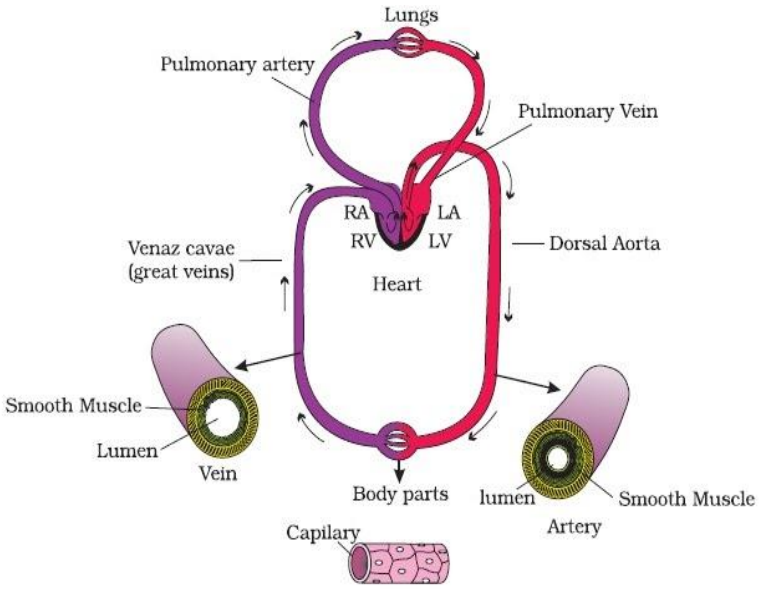
CIRCULATORY SYSTEM OF FISH

2. **Incomplete double circulation :** Two circuits are not completely separated, due to incomplete separation of ventricle.
   Ex.- Amphibia, Reptiles.
3. **Double Circulation:**

- The blood flows strictly by a fixed route through **Blood Vessels**—the arteries and veins.

Blood Vessel
- **Tunica intima** → An inner lining of squamous endothelium.
- **Tunica media** → A middle layer of smooth muscle and elastic fibres.
- **Tunica externa** → An external layer of fibrous connective tissue with collagen fibres.

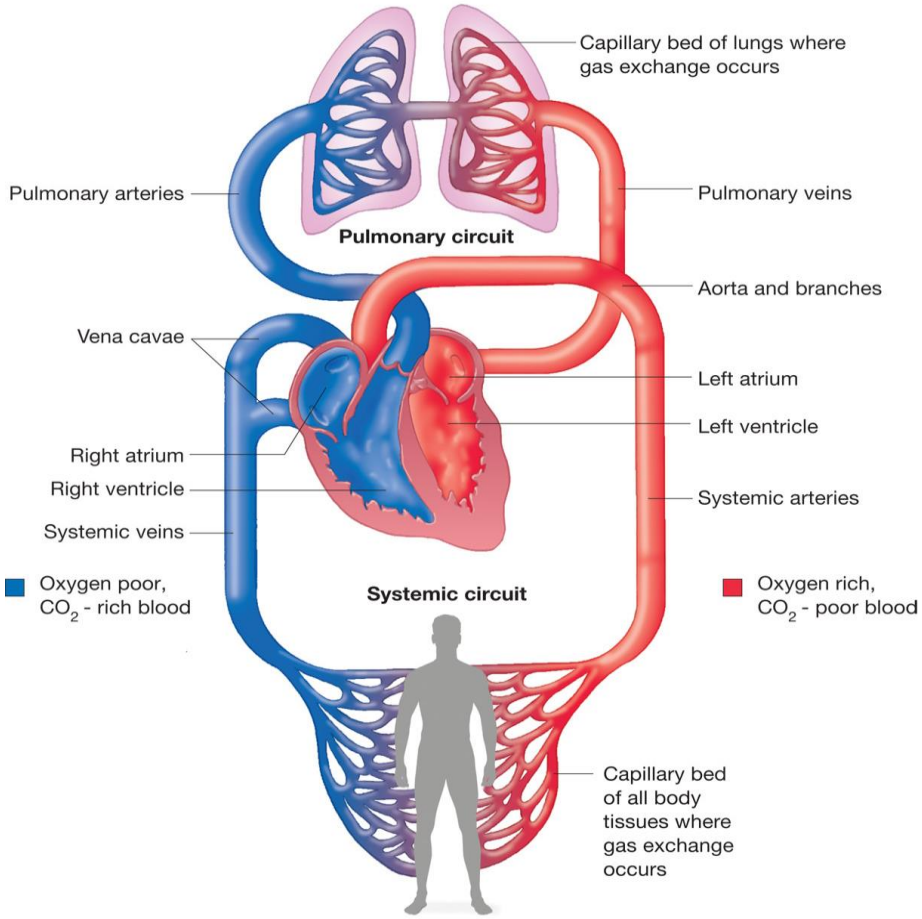
- The tunica media is comparatively thin in the veins.
- The blood pumped by the right ventricle enters the pulmonary artery, whereas the left ventricle pumps blood into the aorta. The deoxygenated blood pumped into the pulmonary artery is passed on to the lungs from where the oxygenated blood is carried by the pulmonary veins into the left atrium. This pathway constitutes the **pulmonary circulation**.
- The oxygenated blood entering the aorta is carried by a network of arteries, arterioles and capillaries to the tissues from where the deoxygenated blood is collected by a system of venules, veins and vena cava and emptied into the right atrium. This is the **systemic circulation**.
- The systemic circulation provides nutrients, O_2 and other essential substances to the tissues and takes CO_2 and other harmful substances away for elimination.
- A unique vascular connection exists between the digestive tract and liver called **hepatic portal system**.
- The hepatic portal vein carries blood from intestine to the liver before it is delivered to the systemic circulation.
- A special coronary system of blood vessels is present in our body exclusively for the circulation of blood to and from the cardiac musculature.
- **Example -** Birds, Mammals



SCHEMATIC PLAN OF BLOOD CIRCULATION IN HUMAN

4.1 HUMAN CIRCULATORY SYSTEM:

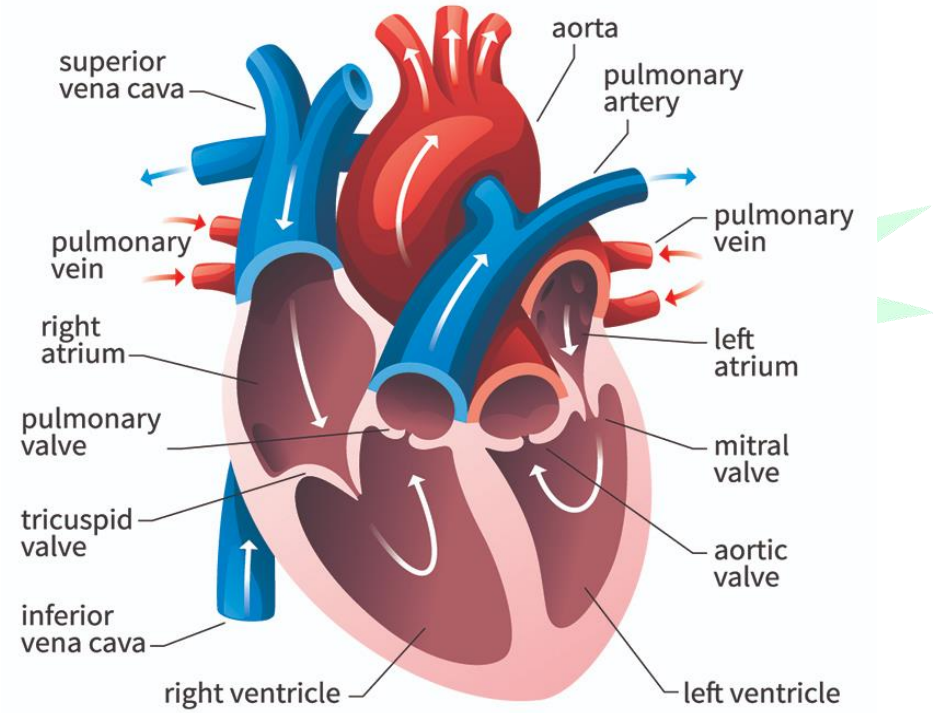
- Human circulatory system, also called the "blood vascular system" consists of a muscular chambered heart, a network of closed branching blood vessels and blood, the fluid which is circulated.



HUMAN CIRCULATORY SYSTEM

STRUCTURE OF HEART:

- Heart is **mesodermally** derived organ, is situated in thoracic cavity in between the lungs, slightly tilted to the left.
- It has the size of a clenched fist.
- Heart is protected by a double layered bag called **pericardium**. The narrow space in between these two membranes is called **pericardial cavity** in which pericardial fluid is present.
- The heart of man is four chambered. Two relatively small upper chambers called **Atria** and two larger lower chambers called **ventricles**.
- The atrium and the ventricle of the same side are separated by a thick fibrous tissue called the **atrio-ventricular septum.**
- The right and left atria are separated by a thin muscular wall called **Inter atrial septum**. Which is shifted slightly towards left. So right atrium is slightly bigger than left atrium.
- Ventricular part is broad, muscular and light colour. Ventricles have thicker walls than auricles.
- The septa which divide the two ventricles are termed as **Inter-ventricular septum**. It is oblique or tilted toward Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.
- Left ventricle is more muscular and thick walled then right because it has to pump blood into those arteries which distribute blood throughout the body while right ventricle has to pump blood only to the lungs.
- Left ventricle is the largest chamber of heart.
- **Right Atrium:** Receives one **SVC** (superior venacava), one **IVC** (inferior venacava) and one opening of **coronary sinus** in human. The SVC & IVC bring deoxygenated blood from the upper and lower body parts respectively.
- **Right Ventricle:** Receives deoxygenated blood through tricuspid valves from right atrium.
  Drains the deoxygenated blood into pulmonary artery through which it reaches lungs for oxygenation.
- **Left atrium:** Receives oxygenated blood from lungs via pulmonary vein.
  This oxygenated blood is drained into left ventricle through bicuspid valves. **In human four pulmonary veins** open into LA through separate openings.
- **Left Ventricle :** Receives oxygenated blood from left atrium. Drains pure blood into the Aorta from where it is supplied to systemic organs.



SECTION OF HUMAN HEART

- The entire heart is made up of cardiac muscles. A specialised cardiac musculature called the nodal tissue is also distributed in the heart.
- Nodal tisssues are:

(1) **Sinuatrial node (SA node).** It is present in right upper corner of the right atrium.

- The SAN can generate the maximum number of action potentials, i.e., 70-75 min^{-1}, and is responsible for initiating and maintaining the rhythmic contractile activity of the heart. Therefore, it is called the **pacemaker**. Our heart normally beats 70-75 times in a minute (average 72 beats min^{-1}).

(2) **Internodal pathway** connects the SA node to the AV node.

(3) **Atrioventricular node (AV Node).** It is situated in the lower left corner of the right atrium close to the atrioventricular septum. It is capable of generating impulse at rate of about 40/min.

(4) **Bundle of His (AV Bundle).** It is the connection between the atrial and ventricular musculature. It begins at the AV node and then divides into left and right branches as it descends down towards ventricles.

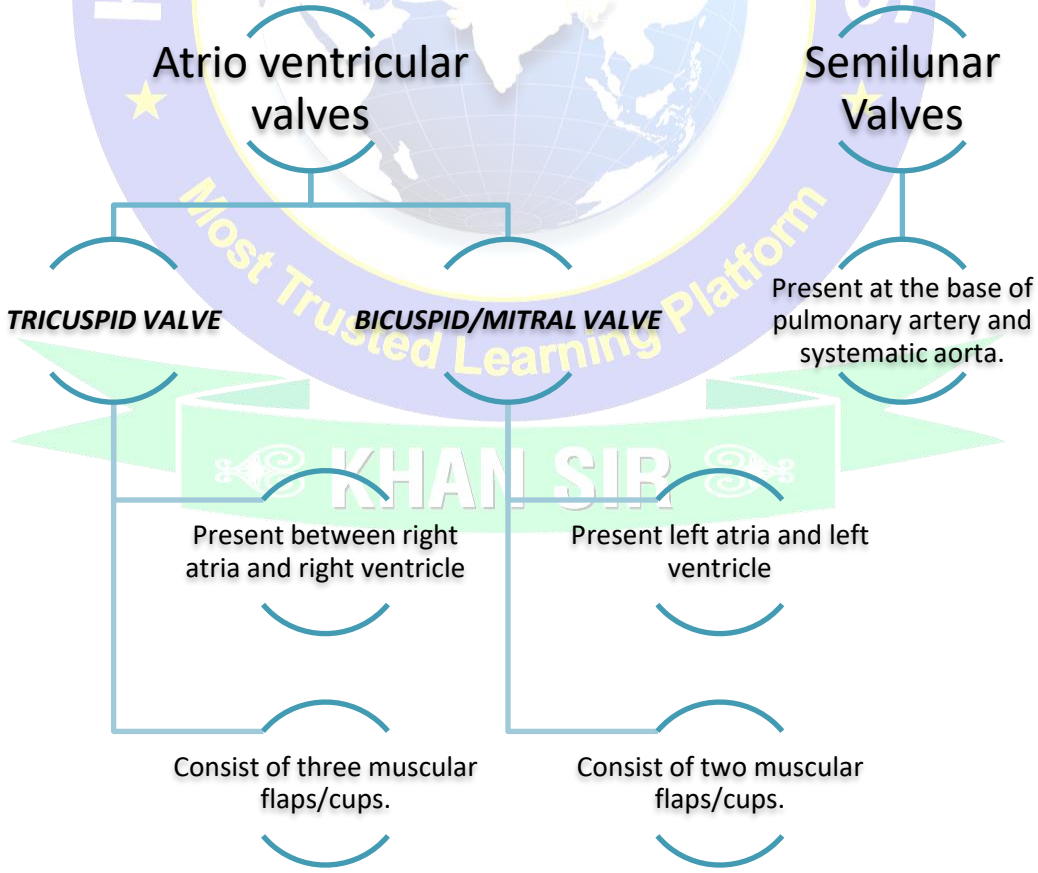
- Branches of the AV bundle descends on the interventricular septum and is distributed to the ventricle after dividing into Purkinje fibres.

(5) **The Purkinje fibres.** These are distributed through the endocardium of the ventricles and propogate the impulse in the entire ventricle musculature. (18-25 per min.)

- Impulse conduction speed is fastest in purkinje fibres & slowest in A. V Node

VALVES:

- The valves in the heart allows the flow of blood only in one direction from atria to the ventricles from the ventricles to the pulmonary aorta and systemic aorta. These valves prevent any backward flow.



DETECTIVE MIND

- **Wall of Heart:** The wall of heart is made of three layers:
  (i) **Epicardium -** outermost layer, Made of simple squamous epithelium.
  (ii) **Myocardium** - middle layer, thickest, made of cardiac muscle which are striated but involuntary.
  (iii) **Endocardium** - innermost layer, Made of simple squamous epithelium.
- Rhythmic contraction and the relaxation of heart is called **heart beat**. Actually, contraction and relaxation occur separately in atria and ventricles. However, ventricular movements are quite prominent and forceful. Therefore, each heart beat is synonym with **ventricular** or **apex beat**. It increases temporarily with activity and disease.
- The opening of IVC and coronary sinus in right atrium is guarded by eustachian valves and thebesian valves Respectively.
- **Heart rate is higher in women, children and infants and lower in aged persons.**

BLOOD SUPPLY OF HEART (CORONARY CIRCULATION)

- The oxygenated blood is supplied to the heart musculature for its consumption with the help of two coronary arteries, left and right.
- These arteries arise from the common origin at arch of aorta, the left and right coronary arteries then further subdivide into a number of branches carrying blood to different regions of heart.
- The deoxygenated blood from heart walls returns back via coronary veins which drain into the coronary sinus. The coronary sinus opens in the right atrium.

4.2 CIRCULATION THROUGH SPECIAL REGIONS

Apart from the pulmonary or systemic circulation, heart also possesses the following circulatory pathways

(a) Hepatic portal system

- It is the type of portal system, which is universally present in all vertebrates.
- It is a unique vascular system that exists between the digestive tract and liver.
- A vein called hepatic portal vein, carries blood from intestine to the liver (hepatic gland). The liver finally opens into inferior vena cava through its own vein (i.e., hepatic vein) before delivering it to the systemic circulation.

(b) Hypophyseal portal system

- Apart from hepatic portal system, another minor portal system called hypophyseal portal system is also present which consist of two hypophyseal portal veins which carry blood from the hypothalamus (brain) to the anterior lobe of pituitary gland.

DETECTIVE MIND

The mammals have no renal portal system due to the following facts-

(i) It is an evolutionary trend that fishes and amphibians have well-developed renal portal system, while, in reptiles and birds this system gets reduced. Finally in mammals it ultimately disappears.

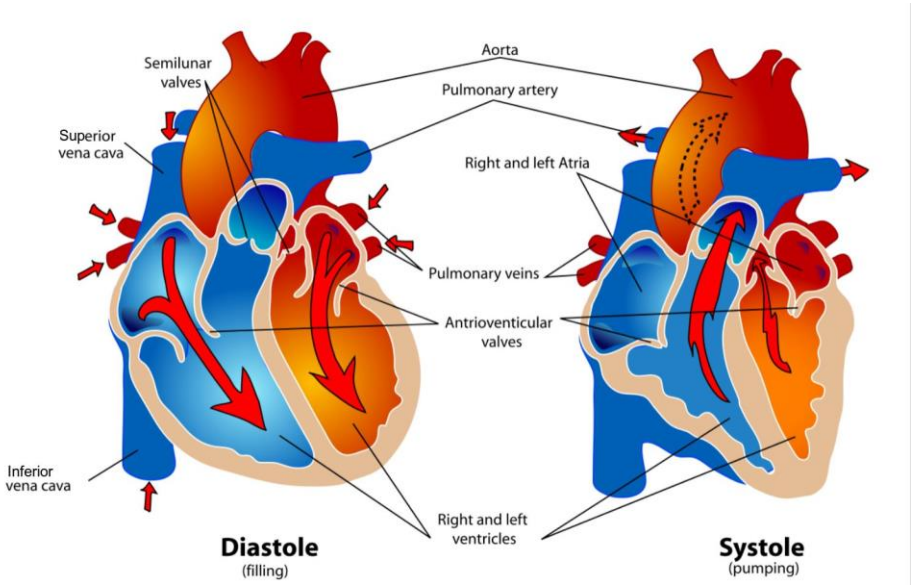
(ii) The heart of mammals is four-chambered, due to which there is a total separation of oxygenated and deoxygenated blood.

(iii) Posterior portion of the body gets oxygenated blood from the heart and after oxidation process, etc., the blood does not contain so much impurities that it should go the kidneys for filtration

4.3 CARDIAC CYCLE

- The serial wise or sequential changes which take place in the heart are called cardiac-cycle.
- The contraction of the atria is termed as atrial-systole, and their relaxation is called atrial-diastole.
- Same way the contraction and relaxation of ventricles is termed as ventricular systole and ventricular diastole.
- The time of cardiac-cycle is 0.8 second.

- In a single cardiac cycle of man :
- $\left.\begin{array}{l}(1)\text{Atrial systole} = 0.1\text{Sec} \\ (2)\text{Atrial diastole} = 0.7\text{Sec}\end{array}\right] 0.8\text{sec}$
- $\left.\begin{array}{l}(3)\text{Ventricular systole} = 0.3\text{Sec} \\ (4)\text{Ventricular diastole} = 0.5\text{Sec}\end{array}\right] 0.8\text{sec}$



- Cardiac cycle has following three steps-

(1) Joint diastole

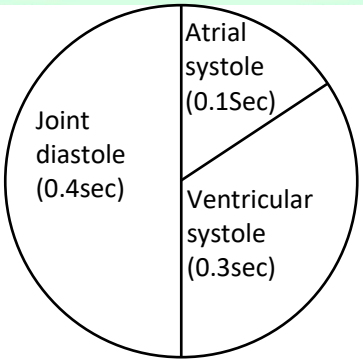
- It's time duration is 0.4 sec.
- In this all chambers of heart are relaxed and atria and ventricles both receives blood
- During joint diastole blood from pulmonary veins and vana cava, fills the left and right atria, respectively. The buildup of pressure that results, causes the AV valves to open and blood to flow from atria to the ventricles. At this stage the semilunar valves are closed.

(2) Atrial systole

- It's time duration is 0.1 sec.
- The SA node now generates an action potential which stimulates both the atria to undergo a simultaneous contraction known as **atrial systole**. It results in increase of blood flow into the ventricles by about 30 percent.

(3) Ventricular systole

- It's time duration is 0.3 sec.
- In this A.V node transmit impulse to ventricles through atrio ventricular bundle and Purkinje fibres due to which contraction occurs in ventricles and pressure in ventricles increases which results in the opening of semilunar valves.



Total period of 1 cycle = 0.8sec

VOLUMES OF BLOOD RELATED WITH CARDIAC CYCLE :

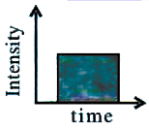
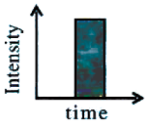
- During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 ml. This volume is known as ***End Diastolic Volume (EDV)***.
- **Stroke volume**. i.e. the volume of blood pumped by each ventricle in the aorta in one heart beat or one cardiac cycle. Its value is 70 ml.
- The remaining volume in each ventricle is now about 50 ml is called **End Systolic Volume (ESV)**.
- Stroke Volume = EDV – ESV = 70 ml (approx).
- **Cardiac output** it is the amount of blood pumped by the each ventricle per minute. Its value in a normal adult is about 5 litre/minute.

Cardiac output = stroke volume × heart rate = 70 × 72 = 5 litre/minute

- The body is able to alter the stroke volume as well as the heart rate and thereby the cardiac output. As for example, the cardiac output of an athlete will be much higher than that of an ordinary man.

HEART SOUNDS :

- During each cardiac cycle two prominent sounds are produced.
- These "**Lubb**" and "**Dub**" sounds of the heart can be heard with the help of an instrument called" **Stethoscope".**

	Ist Heart Sound	**IInd Heart Sound**
1.	LUBB 	DUB 
2.	Dull ; Prolonged	• Sharp, Shorter timed, High pitch
3.	At the beginning of Ventricular Systole.	• At the beginning of ventricular diastole
4.	Caused by Closure of AV valves.	• Caused by Closure of Semilunar valves

- Due to defects in heart valves an abnormal heart sound is produced called **HEART MURMUR**.

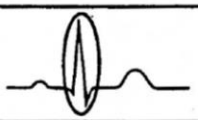
4.4 ELECTROCARDIOGRAM (ECG):

- It is a graphical representation of the electric activity of the heart during a cardiac cycle, the instrument used to obtain the ECG is called electrocardiograph.

- **Standard ECG**
- To obtain standard ECG a patient is connected to the machine with three electrical leads (one to each wrist and to the left ankle) that continuously monitor the heart activity.
- For a detailed evaluation of the heart's function, multiple leads are attached to the chest region.
- Standard ECG includes some characteristic peaks denoted by P, QRS and T letter that corresponds to a specific electrical activity of the heart.

- **Peaks and their interpretations:**
- **P wave:** Depolarisation in atria (Beginning of atrial systole).
- **QRS complex:** Depolarisation in ventricles (Beginning of ventricular systole).
- **T waves:** Repolarisation in ventricle (Beginning of ventricular diastole and joint diastole).
- **The end of T waves marks the end of systole.**
- By counting the numbers of QRS complexes that occur in a given time period, heart beat rate can be determined.

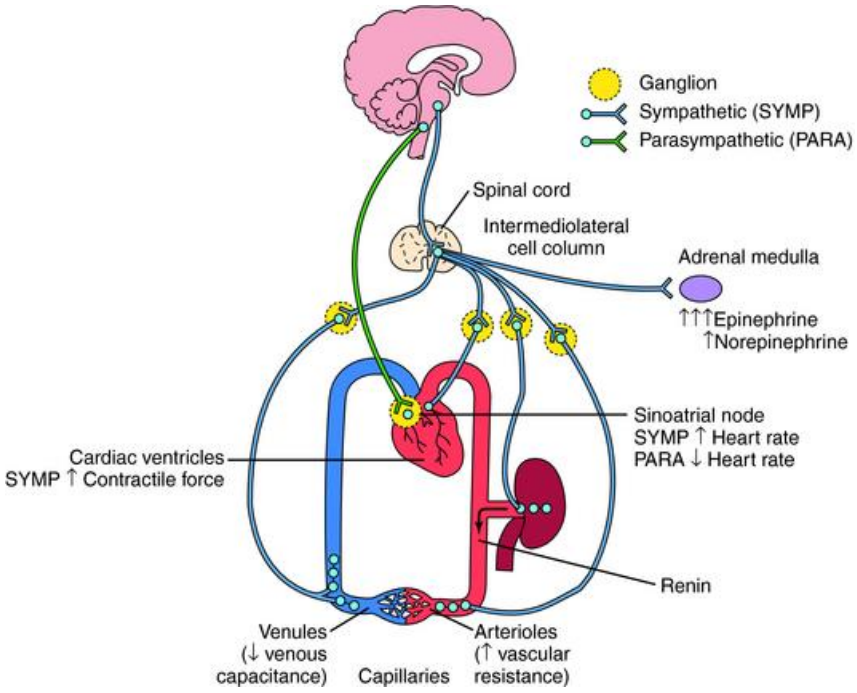
- Since ECG obtained from different individuals have roughly the same shape for same lead configuration, any deviation in the shape indicates a possible abnormality or disease, which is why it is of a great clinical significance.

Electrical Activity	Graphic Depiction	Associated Pattern
Atrial Depolarization		P Wave
Delay at AV Node		PR Segment
Ventricular Depolarization		QRS Complex
Ventricular Repolarization		T Wave
No electrical activity		Isoelectric Line

ECG WAVE PATTERNS PRODUCES BY ELECTRICAL ACTIVITY IN THE HEART

5. REGULATION OF CARDIAC ACTIVITY

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



REGULATION OF CARDIOVASCULAR FUNCTIONS

6. DISORDERS RELATED OF CIRCULATORY SYSTEM

(A) **High blood pressure (Hypertension) :** Hypertension is the term for blood pressure that is higher than normal. A blood pressure of **120/80** is considered normal. In this measurement, 120 mm Hg (millimetres of mercury) is the **systolic**, or pumping, pressure and 80 mm Hg is the diastolic, or resting, pressure. If repeated checks of blood pressure of an individual is 140/90 or higher, it shows hypertension which leads to heart diseases and also affects vital organs like brain and kidney.

(B) **Coronary Artery Disease (CAD) :** Coronary Artery Disease, often referred to as **atherosclerosis**, affects the vessels that supply blood to the heart muscle. It is caused due to the depositions of calcium, fat, cholesterol and fibrous tissues in the arteries supplying the heart musculature. These depositions make the lumen of arteries narrower.

(C) **Angina pectoris :** A symptom of acute chest pain appears when no enough oxygen is reaching the heart muscle. The term **angina pectoris** means chest pain. It can occur both in men and women of any age but is more common among the middle aged and elderly people. It occurs due to conditions that affect the blood flow.

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

(E) **Heart attack (Myocardial infarction) :** Heart attack occurs when the heart muscles are suddenly damaged by an inadequate blood supply.

(F) **Heart - block :** When A.V. Node gets damaged, so contractions do not reach up to ventricles this event is called heart block.

(G) **Cardiac arrest :** Cardiac arrest means complete stoppage of the heart beat i.e., when the heart stops beating.