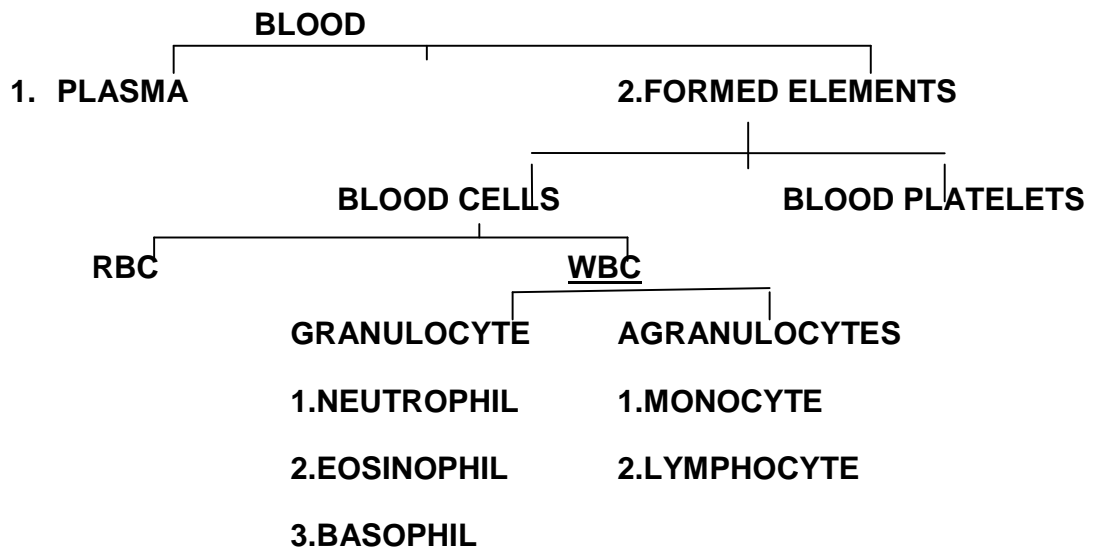


BODY FLUIDS AND CIRCULATION



PLASMA

- Straw colour. Viscous fluid
- Nearly 55% of blood , and 90-92% of plasma is water.
- Contains-Proteins namely
 - 1.Fibrinogen -function- (Clotting of blood)
 - 2.Albumin (Osmotic balance)
 - Globulins (Defense Mechanism)
- And also Contains minerals like
 - Na⁺, Ca⁺, mg⁺, HCO₃⁻,cl⁻ etc...
 - Glucose, amino acid, lipids etc...
 - Factors for Clotting of blood.
- **Plasma without clotting factors is called Serum.**

RBC (ERYTHROCYTES)

- 5-5.5 million of RBC's /mm³.
- Formed from bone marrow in adult.
- Nucleus absent in most of the mammals.

- Red coloured, due to the presence of iron containing pigment hemoglobin.
- Normal health man-12-16 gms of Hb/100ml of blood.
- Hb helps in the transportation of respiratory gases.
- Average life span of RBC -120 days.
- After which they destroyed in the spleen (Graveyard of RBC)

WBC (LEUCOCYTES)

- Nucleated
- Colourless due to the lack of hemoglobin
- 6000-8000/mm³ of blood.
- Short lived.

Two types of WBC

1.GRANULOCYTES

- Presence of granules in the cytoplasm.
- Granulocytes includes Neutrophil, Eosinophi and Baophil

1.NEUTROPHILS

- Neutrophils are the most abundant cells (60-65 per cent) of the total WBCs
- Phagocytic cells.
- Destroy foreign organism entering the body.
- Nucleus multilobed, 2-7 lobes.

2.BASOPHILS

- Secrete histamine, heparin, serotonin and are involved inflammatory reaction.
- Nucleus is bi or trilobed
- Basophils are the least (0.5-1 per cent) among WBC.

3.EOSINOPHILS

- Resist infections and also associated with allergic reactions.

- Nucleus bilobed
- Constitute 2-3 per cent of total WBCs

AGRANULOCYTE

- Clear cytoplasm without granules
 - Includes
 - 1.Monocyte
 - 2.Lymphocyte

1.MONOCYTE

- Phagocytic cells.
- Kidney shaped nucleus.
- Constitute 6-8 per cent of total WBCs

2.LYMPHOCYTE

- Two types
 - T. lymphocyte
 - B. lymphocyte
- Large nucleus
- Responsible for immune response
- Constitute 20-25 per cent of total WBCs

PLATELETS (THROMBOCYTES)

- Produced from megakaryocytes (Special cells in bone marrow)
- 1,5 lakhs- 3,5 lakhs/cm³
- Helps in the clotting of blood.

BLOOD GROUPS

- ABO grouping
- Based on the presence or absence of antigen present on the surface of RBC there are 4 types of blood groups. They are A,B, AB and O

- The plasma of different blood groups contain two natural antibodies

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

- **O' group blood**

- Antigen is absent in o group blood
- Can be donated to persons with any other blood group

Hence 'O' group individuals are called 'universal donors'.

'AB' group

Antibodies are absent in AB blood group

can accept blood from any other blood group persons

called 'universal recipients'.

Rh GROUPING

Rh positive (Rh +ve)-

In this group the surface of RBC have Rh antigen (similar to one present in Rhesus monkeys (hence Rh),

Rh negative (Rh -ve).-Rh antigen is absent

An Rh-ve person, if exposed to Rh+ve blood, will form specific antibodies against the Rh antigens. Therefore, Rh group should also be matched before transfusions

ERYTHROBLASTOSIS FOETALIS (Rh INCOMPATIBILITY)

- Rh incompatibility (mismatching) between the Rh-ve blood of a pregnant mother with Rh+ve blood of the foetus.

- Rh antigens of the foetus do not get exposed to the Rh-ve blood of the mother in the first pregnancy as the two bloods are well separated by the placenta.

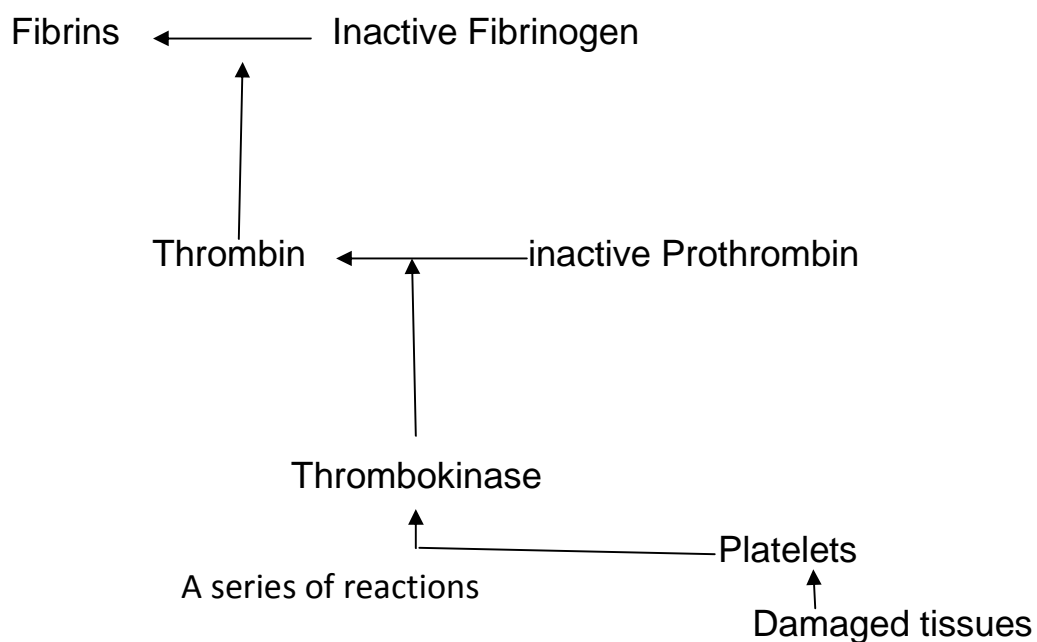
During the delivery of the first child, there is a possibility of exposure of the maternal blood to small amounts of the Rh+ve blood from the foetus. In such cases, the mother starts preparing antibodies against Rh in her blood

In case of subsequent pregnancies, the Rh antibodies from the mother (Rh-ve) can leak into the blood of the foetus (Rh+ve) and destroy the foetal RBCs. This could be fatal to the foetus or could cause severe anaemia and jaundice to the baby. This condition is called erythroblastosis foetalis

Blood Clotting

This is a mechanism to prevent excessive loss of blood from the body.

A clot or coagulum formed by a network of fibrins in which dead formed elements of blood are trapped.



LYMPHATIC SYSTEM

- Contains Lymph
Lymph vessels (Lymphatics)
- Water and other substances are filtered out from the blood plasma to the intercellular spaces of the cells, to form the interstitial fluid or tissue fluid.

- Exchange of nutrients & gases occurs through this fluid.
- Contains all the elements of blood except RBC, platelets and some proteins.
- A network of lymphatic vessels collects this fluid and drains it back to the major veins.
- The fluid present in the lymphatic system is called the lymph.
- Lymph is a colourless fluid containing specialised lymphocytes which are responsible for the immune responses of the body.
- Lymph is also an important carrier for nutrients, hormones, etc
- Fats are absorbed through lymph in the lacteals present in the intestinal villi.

CIRCULATORY PATHWAYS

- The circulatory patterns are of two types – open or closed.
- Open Circulatory System- blood pumped by the heart passes into open spaces called sinuses.

Eg Arthropods and Molluscs.

- Closed Circulatory System- blood is always circulated through a closed network of blood vessels.
- more advantageous as the flow of fluid can be more precisely regulated.
- Eg.-Annelids and chordates.

Chambered Heart: All vertebrates possess a muscular chambered heart.

- Fishes - 2-chambered heart with an atrium and a ventricle.
- Amphibians and the reptiles (except crocodiles) - 3-chambered heart with two atria and a single ventricle, But in crocodiles 4 Chambered
- Birds and mammals - 4-chambered heart with two atria and two ventricles.

HUMAN CIRCULATORY SYSTEM includes

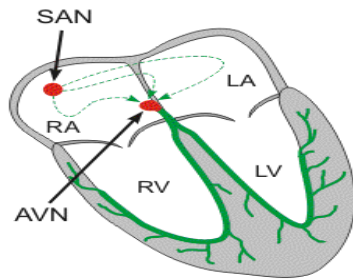
- Muscular chambered heart,
- A network of closed branching blood vessels and
- Blood

HEART

- Protected by double walled **pericardium**, enclosing the pericardial fluid.
- Four chambers, Two smaller atria and two larger ventricles.
- 1. **Interatrial septum**- separates the right and the left atria.
- 2. **Inter-ventricular septum**-separates the left and right ventricles.
- 3. **Atrio-ventricular septum** -separates the atrium and the ventricle of the same side.
- **Tricuspid valve**- present between the right atrium and the right ventricle- Prevent the backward flow of blood from right ventricle to right auricle.
- **bicuspid or mitral valve** -Present between the left atrium and the left ventricle – Prevent the backward flow of blood from left ventricle to left auricle.
- **semilunar valves** valve present in the opening of ventricles into the pulmonary artery and the aorta- prevent any backward flow to the ventricles

Conduction of Heart Beat

- **Sino-atrial node (SAN)**.- Specialised tissue called nodal tissue present in the right upper corner of the right atrium .
- **Atrio-ventricular node (AVN)**- Another mass of nodal tissue in the left corner of the atrio-ventricular septum
- **Atrio-ventricular bundle (AV bundle)**-From AVN, arises a bundle of nodal fibres called atrio-ventricular bundle (AV bundle)
- AV bundle passes through the atrio-ventricular septa and immediately divides into a right and left bundle.
- The Right and left bundle divides into minute fibres called **purkinje fibres**.



SAN, sinoatrial node; AVN, atrio-ventricular node; RA, right atrium; LA, left atrium, RV, right ventricle; LV, left ventricle.

-
- Purkinje fibres along with right and left bundles are known as **bundle of HIS**
- The nodal musculature has the ability to generate action potentials without any external stimuli, i.e., it is autoexcitable
- The SAN can generate the maximum number of action potentials, i.e., 70-75 /min, and is responsible for initiating the rhythmic contractile activity of the heart. **Therefore, SAN is called the pacemaker.**
- HEART BEAT
- A contraction and a subsequent relaxation of the chambers of the heart constitute a heart beat.
- The heart beats **72 times per minute**
- **Systole**- Contraction of the chambers of the heart
- **Diastole** –relaxation of heart chambers.
- cardiac cycle consists of systole and diastole of both the atria and ventricles.
- Cardiac cycle has the following events.
- 1.Auricular systole 2.Ventricular Systole 3.Diastole
- 1.AURICULAR SYSTOLE
- Auricles fills with blood.(right atrium receives blood from venacava and left atrium receives blood from pulmonary artery.
- Action potential generates in SAN and Auricle contracts.
- Blood enters into ventricles

2.VENTRICULAR SYSTOLE

- The action potential from SAN conducted to the AVN then AV bundle from where the bundle of HIS. This causes Ventricular systole
- The tricuspid and bicuspid valves are closed.
- Deoxygenated blood enters into the pulmonary artery from the right ventricle.
- Oxygenated blood enters into the aorta from the left ventricle.

3.DIASTOLE

- The auricles and ventricles relax simultaneously (joint diastole).
- Deoxygenated blood from different body parts(through venacava) enters into right auricle
- Oxygenated blood form lungs through pulmonary veins enters into Left auricle.
- Now the semilunar valves close and prevent backward flow of blood from the arteries to the ventricles.
- This time all the four chambers are in relaxed state – Joint diastole
- Heart beat 72 time/minute.
- So the Duration of a cardiac cycle is 0.8 seconds.
- **Stroke volume**. -During a cardiac cycle, each ventricle pumps out approximately 70 ml of blood which is called the stroke volume.
- **Cardiac output** - the volume of blood pumped out by each ventricle per minute
- The stroke volume multiplied by the heart rate (no. of beats per min.) gives the cardiac output
- Averages 5000 ml or 5 litres in a healthy individual.

HEART SOUNDS

Lub	The first heart sound (lub) is associated with the closure of the tricuspid and bicuspid valves (During the contraction of the ventricle).
Dub	The second heart sound (dub) is associated with the closure of the semilunar valves. (During ventricular relaxation)

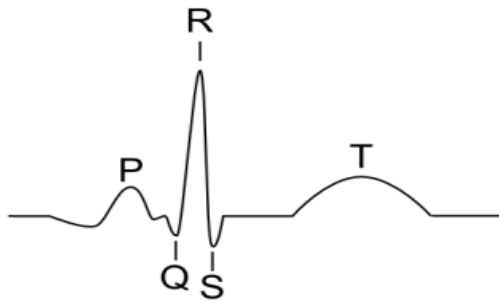
- Normal activities of the heart are regulated intrinsically, i.e., auto regulated by specialised muscles (nodal tissue), hence the heart is called myogenic

- **ECG (ELECTROCARDIOGRAM)**

Graphical representation of the electrical activity of the heart during a cardiac cycle.

Name of Machine-ElectroCaradiograph.Obtaining graph - electrocardiogram.

- To obtain a standard ECG a patient is connected to the machine with three electrical leads (one to each wrist and to the left ankle) that continuously monitor the heart activity.

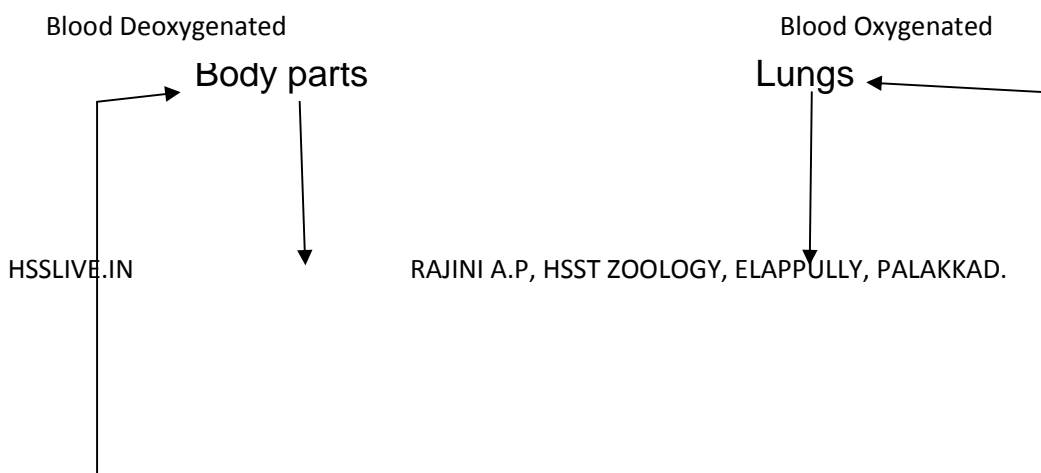


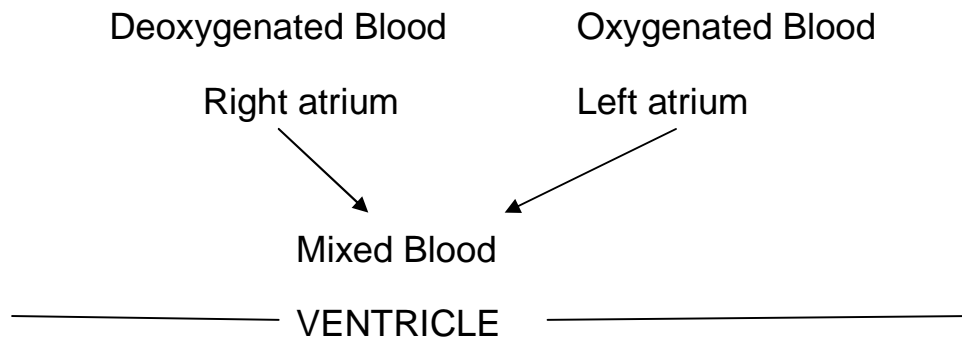
- Each peak is identified with a letter from P to T
- Each peak represents a specific electrical activity of the heart
- P-wave - electrical excitation (depolarisation) of the atria, ie. contraction of atria.
- The QRS complex- depolarisation of the ventricles, ie. the ventricular contraction.
- The contraction starts shortly after Q and marks the beginning of the systole.
- The T-wave represents the return of the ventricles from excited to normal state (repolarisation).
- The end of the T-wave marks the end of systole

- **Single Circulation:**

- (In fishes)The heart ----- deoxygenated blood ----Gills-----oxygenated blood----- body parts -----deoxygenated blood ----- heart.

- **Incomplete Double Circulation:**(In amphibias and reptiles,)





- Blood mixed up in the single ventricle which pumps out mixed blood.
- **Complete Double Circulation**: In birds and mammals,
- oxygenated and deoxygenated blood received by the left and right atria
- passes on to the ventricles of the same sides.
- The ventricles pump it out without any mixing .
- **DOUBLE CIRCULATION includes**
- 1.PULMONARY CIRCULATION
- 2.SYSTEMIC CIRCULATION

PULMONARY CIRCULATION

- Right ventricle -----deoxygenated blood ----- pulmonary artery lungs..... oxygenated blood ----- pulmonary veins ----- left atrium.
- Function-Oxygenate the deoxygenated blood

SYSTEMIC CIRCULATION- left ventricle -----Oxygenated blood ----- aorta arteries-arterioles capillaries----- organs----- deoxygenated blood --venules, veins and vena cava ----- right atrium.

- **Function**-Supply the oxygenated blood to different organs

Hepatic portal system

- 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

DISORDERS OF CIRCULATORY SYSTEM

1.High Blood Pressure (Hypertension)

- (Normal blood pressure 120/80 mmHg).120mmHg is systolic or pressure during pumping of ventricle. And 80mmHG is the diastolic pressure ie. Pressure during resting.
- Arterial blood pressure above the normal level is called hypertension.
- In hypertension the systolic pressure is above 140 mmHg and diastolic pressure is above 90mmHg. (140/90mmHg)
- It leads to heart diseases and also affects vital organs like brain and kidney.

CORONARY ARTERY DISEASE (CAD)

- Affects the vessels that supply blood to the heart muscle.
- Caused by deposits of **calcium, fat, cholesterol and fibrous tissues**, which makes the lumen of arteries narrower.

ANGINA-Angina pectoris

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

HEART FAILURE

- heart cannot pump the blood effectively 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.

Cardiac arrest

- The heart stops beating

Heart attack

- When the heart muscle is suddenly damaged by an inadequate blood supply.

