Chapter - 24
Blood Circulatory System of Human

Unicellular organisms or unilayer and bilayer multicelluar organism directly in the nutrition and O_2 directly from the medium and excrete CO_2 and excretory materials recives the medium. All the cells of most of the multicellular organism do not have direct contact with the environment, so there is a need of system which can fulfill the requirement of gaseous exchange and food supply and can take away excretory materials from a cell to the environment. This system is called circulatory system.

Circulatory systems are of two types :-

1. **Open Circulatory System :-** In such type of circulation a fluid circulates between cells and tissues i.e. did not flow in special closed ducts e.g. in some molluscs and insects.
2. **Close circulatory system :-** In this system transporting fluid flows in closed ducts e.g. rabbit and human

Composition of blood

Blood :- Blood is a fluid connective tissue. It is a viscous liquid, which has two parts. Plasma and blood corpuscles, human has 5 litre of blood inside.

Plasma:- The fluid part of blood is called plasma. It is light yellow colour alkaline fluid. Blood volume 55% part is of plasma. It contains 90% water and 10% different organic and inorganic substances in soluble or colloidal state. Main organic component is plasma protein 7% to 8%. Inorganic salt and hydrate are 0.9%. Most important ion is Sodium. Discription of component and their functions of plasma is given in table 24.1

Table 24.1 Main components of plasma and their functions

S. No.	Components	Quality	Main Function
1	Water	90%	Regulation of blood pressure and volume transportation
2.	Organic materials		
	Albumin	4.5%	creation of osmotic pressure
	Globulin α, β, γ	2.5%	α, β, transport γ antibody formation
	Fibrinogen	0.3%	Blood Coagulation
	prothrombin	less	Blood Coagulation
	Glucose	0.1%	Nutritive material, cellular fuel
	Amino acids	0.4%	Nutritive material
	Fatty acid, Glycerol	0.5%	Nutritive material
	Harmones, enzymes	less	Regulating material and biocatalysts
	Urea, Uric acid	0.04%	waste materials.
3.	Inorganic materials	0.9%	Regulation of solute potential and pH
	Na^+, K^+, Ca^{2+}, mg^{+2}		
	Cl^-, HCO_3, $HP0_4$, SO_4^{-2}		
	etc.		

Blood Corpuscles

Blood corpuscles are found floating in plasma. There are 45% of corpuscles in blood volume, the percentage of blood corpuscles is know as haematocrit, blood corpuscles are of three types.

(1) Red blood corpuscles or erythrocytes

(2) White blood corpuscles or leucocytes

(3) Blood platelets.

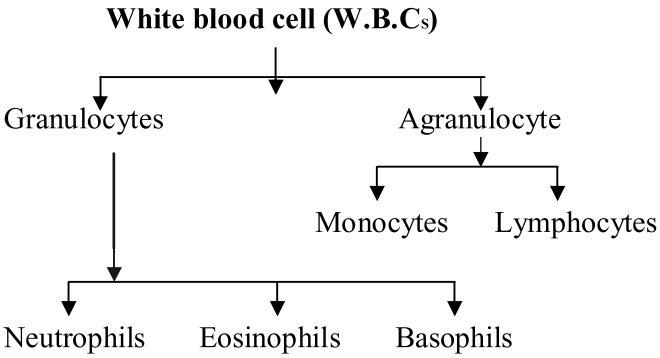
1. Red blood corpuscles or erythrocytes :-

There are main corpuscles. In human blood erythrocytes are 99% of all blood corpuscles. Erythrocyte are non nucleated, spherical, Discoidal and Biconcave. They lack mitochondria. They diameter is 7-8 mm and thickness is 2 mm. These count is about 52 lakhs per cubic mm in adult adult male and about 47 lakhs per cubic mm in an woman. In its colloidal matrix a red pigment protein which is called haemoglobin is present. Haemoglobin is a conjugative protein this works as respiratory pigment. Each molecule of this consists of a harm group with four ferrous (Fe^{2+}) and four polypeptide chains.

Haemoglobin combines with oxygen in reversible order to form oxyhaemoglobin. Carbonic anhydrase is also found in enough quantity. In human the average quantity of haemoglobin is 15 g per decilitre (15 g/dl). The red color of is due to haemoglobin. Erythrocyte are formed with in bone marrow. These have a life span of about 120 days. These are decomposed in spleen and liver when weak and old. Protein part of haemoglobin is degraded into amino acids. The iron part of haem group is stored in liver it becomes and rest part is transformed into bile pigment named billirubin and biliverdin and excreted out.

2. White blood corpuscles or leucocytes

They are nucleated, colorless corpuscles. In an adult these count about 7000 per cubic mm. In human erythrocytes and leucocytes are 600 : 1 ratio these are of different shapes, these are formed in bone marrow and lymphatic tissue their life span may be 4-5 days to several days. Amoeboid



movement is their special feature, leucocyte are of many types.

(I) Granulocyte :- Granules are found in their cytoplasm due to their polymorphic nucleus, these are called polymorphonuclear leucocytes. The nucleus is made of several lobes these lobe are interjointed with fibrous part these are of three type :-

(a) Neutrophils :- Their cytoplasm contains microgranule which are stained both by acidic or alkaline stains with light purple color so they are called neutrophilic; their nucleus have 2-7 lobes, these destroy bacterias. Neutrophils can move across the cell membranes which is called diapedesis. Total leycocytes count have nearby 62% neutrophils.

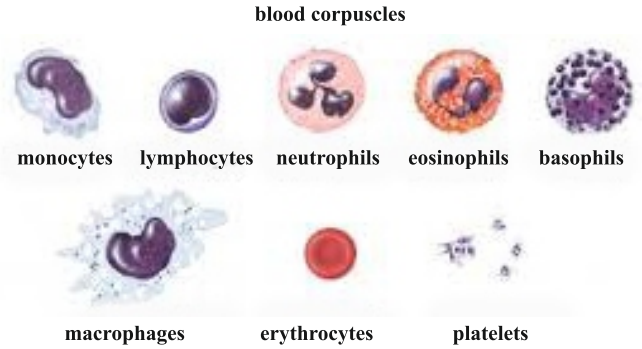


Fig. 24.1 Blood corpuscles of human

(b) Eosinophils :- These have equal size big granules in the cytoplasm which get stained dark blue or pink with acidic stain such as eosine. They have bilobed nucleus. They have less diapedesis and phagocytic power. They increase in number during parasitic infection

and some antiallergies reactions. They have anti histaminic property, eosinophil count 2.5% of total leucocytes.

(c) Basophils :- They have some differently shaped granules in the cytoplasm, which get deep blue stain with basic stains such as methylene blue, They have nucleus which is of 2-3 lobes, they produce histamine and heparin they count 0.5% of total leucocytes.

(ii)Agranulocytes :- They are also called mononuclear leucocytes, they do not have granules in their cytoplasm, nucleus is oval or bean shaped, they are average 8-20 μm in size, they are of two types :-

(A) Monocytes :- They are big sized cells, they are 12-15 μm in size. They have been shaped big nucleus, they are phagocytic. They reach tissues with blood. In the tissue they enlarges to big sized (80 μm) than they are called macrophages. Macrophages are highly phagocytic, which can engulf big particles and bacteria. Macrophage and neutrophils together make a system of phagocytes in the body which acts against infection in the form of first line of immuaity, these cells are about 5% of total leucocytes.

(B) Lymphocytes :- They are spherical cells with oval nucleus. The cytoplasm is in very small quantity around the nucleus like a ring. These originate in thymus gland and lymphatic tissue from such cells which are formed in bone marrow. They have very limited amoebiod movement but they are not phagocytic. Their life span is about 2 to 100 days or more. These are also found in body tissues and lymph besides blood. These cells are nearly 30% of the total count of leucocytes. Small sized (diameter 6-8 μm) leucocytes are more in number, large sized (diameter 10-20 μm) leucocytes are less in number. Small size lymphocytes produce T-cell and B-cells which form antibodies for immunity and kill the foreign cells.

3. Platelets :- They are very small (2-4 μm) they lack nucleus and are irregular in shape. These are produced in bone marrow. Their number count in blood is three lacs per cubic mm and life span is 5-7 days. They are degraded in liver and spleen. They are important to initiate the process of clot formation of blood.

Functions of Blood

1. Transportation of O_2 :- Haemoglobin of red blood corpuscles (RBCs) with O_2 in lung form a very temporary compound oxyhaemoglobin and carry it to different body tissue and make oxygen available for different oxidising vital activities in the cells.

2. Transportation of CO_2:- In the body cell, CO_2 is produced in metobolic activities in the form of end product. The blood transports CO_2 upto lungs to exhale it out.

3. Distribution of food:- Food materials are carried by blood in dissolved form from the alimentary canal to all the tissue of the body for growth, repair and energy.

4. Regulation of body temperature :- The function to maintain body temperature alike is done by blood.

5. Transport of hormone :- Hormone are the secretion of endocrine glands. Blood transport them to directed sites to regulate different biological systems and reactions.

6. Protection against disease :- The white blood corpuscles of blood i.e. phagocyte, engulf harmful bacteria and destroy them. In addition produce antibodies for blood to kill in coming harmful and pathogenic bacteria, viruses and external protein which are collectively called antigens.

7. Repair of injury :- White blood corpuscles (WBC) have a specific role in healing the wound injury, damaged body parts. WBC or leucocytes induced the cells of the injured body region for necessary growth.

8. Formation of blood clotting :- The blood

clot forms quickly on bleeding from an injury and wound. Which stop the bleeding in addition, due to the formation of clot one gets proper help to heal up wound.

9. Transport of excretory waste :- Excretory products formed due to metabolism like urea and uric acid are being transported by blood to excrete out from the body.

10. Water balance :- Water is most necessary component for the exchange and transport of physical substances, all the biochemical reactions are also possible only in liquid water medium, justified quantity of water is being made available by blood to tissue cells. Blood is credited for the excretion of extra body water as it transport the additional body water to kidneys.

11. Diagnosis of Diseases:- The diagnosis of disease has become possible by blood tests by proper examination of different component and chemicals present in blood.

Blood groups

All humans do not have alike blood and it may have several types of differences from one another, on the basis of different types of antigens present on the surface of the blood corpuscles blood can be divided into several different groups. Antigen or agglutinogens are such substances which promote the formation of antibody or agglutinins. There are two main groups of antigens in human which are called ABO system and Rh system.

1. ABO system:- ABO system has two types of antigens. They were discovered by Landsteiner (1900), according to this antigen A and B are found on the surface of erythrocytcs. They are glycoprotein. Two types of antibodies are found in plasma-anti-A or a and anti-B or b, on the basis of differences between the presence of antigen and antibodies blood of the human species is of four types. The description of these is given in table 24.2.

Table 24.2 Human blood group (ABO system)

S. No.	Blood group	Antigen	Antibodies	Can give blood	Can take blood	% in Indian
1	O Universal donor	absent	a and b both	A,B,AB O	O	34.5%
2	A	A	b	A, AB	O, A	23.5%
3	B	B	a	B, AB	O, B	34.5%
4	AB Universal recipient	A, B both	absent	AB	AB, A, B, O	7.5%

If in some body's blood, blood of different blood group is mixed together than due to antigen antibody reaction erythrocytes stick together and form bunches, this activity is known as agglutination. If somebody is given blood without matching blood group, than due to said reaction his death may occur. Individuals of O blood group are called universal donors, because their blood may be given to individuals other than his blood group, no agglutination occurs because no antigen is present in their RBC. Individuals with AB blood group donate only to AB group individual but these can accept blood from a person with any blood groups so they are called universal recipient **Inheritance of blood groups** - Bernstein (1924-25) told that ABO blood groups are hereditary character of human. Inheritance of this depends on three genes, these gence are for the development of antigen A-α^a gene, for the development of B - α^b and for O-α^o gene, out of these α^a and α^b genes are dominant over α^o

Table 24.3 Inheritance of blood groups

S. No.	Blood groups in parents		Expected blood group in children
	Father	Mother	
1	O	O	O
2	O	A	O, A
3	O	B	O, B
4	O	AB	A, B
5	A	A	A, O
6	A	B	O, A, B, AB
7	A	AB	A, B, AB
8	B	B	B, O
9	B	AB	A,B, AB
10	AB	AB	A, B, AB

1. Rh System :- This is discovered by landsteiner and weiner (1940) in *Rhesus* monkey. This system is based upon the presence or absence of Rh-antigen on the surface of erythrocyte. Rh-antigen is also called as Rh^- factor. Those people who have Rh antigen on RBC, are called Rh^+ positive and which do not have Rh antigen are called Rh-negative (Rh^-). In India about 93% people are Rh^+ and about 7% people are Rh^-. There is normally no antibody or agglutanin is found in the plasma. If we transfuse Rh^+ blood again and again, to the Rh^- individual, it develops anti Rh^- antibody or agglutanin. This is called isoimmunisation because antigen and antibody both are of the same type. If Rh^- mother pregnant more than one time with Rh^+ child than serious problem is created because of Rh factor is inherited, Rh^+ dominant and Rh- is recessive, Rh^+ child from a Rh^- mother receives Rh factor from his father. At the time of child birth of Rh^+ child Rh antigen enters the mother's blood. Anti Rh antibodies develop because of this antigen. Normally, antibodies are not is such a big quantity that can harm the first born child, but afterwards at the time to pregnancy Rh antibodies from mother's blood through placenta reacts with the foetal blood which destroy RBC of feotous. This fatal disease of the baby in the womb or newly born is called erythroblastosis foetalis. Child suffering from this disease is called rhesus child. Generally this child's birth is before time and anaemia is found in him. The child can be saved by replacing the total blood with clean blood. The child can also be saved by injecting Rh mother intra venously with Rh^- antibody just 72 hrs before delivary.

Blood Clotting or Blood Coagulation

The contents of the blood convert into gel like structure just after coming out from the blood vessels which is called clot, the process of the formation of clot is called coagulation. This a safety system which checks the pathogens entering through the wound into the body and also checks the loss of blood. Coagulation depends upon several (about 13) coagulation factors present in the blood. The factors initiating the coagulation are coagulation activation factors and factors that stop coagulation are anticoagulant. When some blood vessel or blood is damaged, the coagulant factors activate and function as enzyme and coagulation takes place. In coagulation process fibrinogen, thrombin, platelets and some other factors are important. The common process of coagulation is completed in three steps : (fig 24.2).

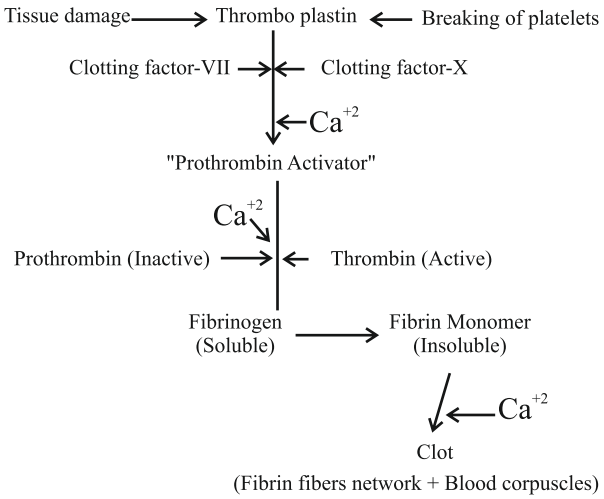


Fig. 24.2 : mechanism of blood coagulation

1. Formation of prothrombin activator :- There are different coagulation factors present in blood flowing in blood vessels in inactive form. When the blood vessel or the components of blood are damaged then these factors gradually get activated and coagulation starts, during oozing of blood the blood platelets break down in contact with air, from these and from damaged tissue, thromboplastin comes out. It contains glycoprotein and phospholipid. Thromboplastin activates VII and X coagulation factors, these all together with Ca^{+2} form a complex which is called prothrombin activator.

2. **Conversion of prothrombin into thrombin :-** prothrombin is a protein found in plasma, it converts into active form thrombin by 'prothrombin activator'.

3. **Conversion of fibrinogen into fibrin and formation of Clot -** Fibrinogen is a soluble protein found in plasma, with the help of thrombin it is hydrolysed into fibrin monomers which is fibrous and insoluble. Fibrin monomers quickly polymerize and form long fibrin fibers. These fibers connects to each other and forms a net like structure. Blood cells entagle in this net. Thus, the structure formed by fibrin fibers and blood cells is called clot. Clot gradually strengthened and blood oozing stops. After clot formation the fluid part of blood separates from it which is called serum. Serum is like plasma, but it does not contain fibrinogen normally, coagulation takes a time 6 to 10 minutes.

Blood Vessels

The tubular structures in which the blood flows are called blood vessels. There are three main types of blood vessels arteries, veins and capillaries. Thin arteries are known as arterioles and thin veins are called venules. The flow of blood from heart is through arteries, arterioles, capillaries, venule, vein recarried blood into the heart. There are three layers of tissues in the walls of artery and vein -

1. Tunica externa : It is the outer most layers which is formed of connective tissue, in which mainly nonelastic collagen fibres are present.

2. Tunica Media : It is the middle layer. In it unstripped muscles are arranged in circular manner and some elastic fibres are also found.

3. Tunica intima :- It is inner most layer made up to squamous epithelium cells this is also called endothelium, its inner most surface is as smooth as glass.

Arteries and arterioles :- Vessels which carry blood from heart to far places are called arteries their tunica media is more thick and the internal diameter is also less than veins, flow of blood is fast and with high pressure. There are no value in these. Only at the starting point of aorta and pulmonary trunk a semilunar valve are found. Aorta is the biggest artery which carry pure blood to every part of the body, pulmonary arteries carry impure blood to lungs. Thin branches of arteries are called artrioles their walls have inner epithelium and around it are some muscles are present. Many arterioles and their capillaries have circular and muscular sphinctors these sphinctors, control blood flow in the capillary network.

Capillaries : These are the thinest blood vessels, there diameter is about 4-10 mm the length of capillary is not more than 0.3 mm, these are so thin that the blood cells after curving can pass thorugh them. Capillaries together form a large network in the whole body their walls are made of only endothelium, their walls are permeable for water and solutes. The blood flow is very slow in

capillaries. The exchange of different substances between blood and body cells takes place through capillaries.

Veins and Venules :- The vessels which carry blood from various parts of the body towards heart are called veins. From capillaries blood comes in very thin branch of vein, these thin branches are called venules. The wall of venule has a thin layer of collagen fibres. They are rigid and non elastic. This blood from venules comes in veins. The tunica media of vein wall is a thin layer, this has less muscles and elastic fibres. Therefore, these are less elastic, these have inner diameter more than arteries. Long veins and veins of the lower part have valves at different places through out its length. These check the flow of blood in opposite direction. In these the blood flow is slow and at low pressure, precavals and post cavals are the biggest vein in the body, which carry impure blood to heart. Pulmonary veins carry pure blood to heart.

External structure of human heart

Human heart is a muscular organs. Its size is similar to human's fist. It originates from mesoderm. Human heart is situated in the mediastinal space between both lungs. In thoracic cavity slightly towards left. Its anterior surface is towards, Sternum. Posterior surface is towards oesophagus and lower surface towards disphragm. Heart is surrounded by double membrane, pericardium. There is a fluid in the space between pericardria, which is called pericardial fluid. This fluid decreases friction between heart and near by tissues during heart beat. Human heart wall is made of three layers. The outer most layer is fibrous, which is called epicardium, the middle layer is thick and muscular, which is called Myocardium and the inner most layer is made of elastic tissues, and endothelium which is called endocardium. The muscular layer of heart is made of cardiac muscles, heart walls has connective tissue and blood capillaries. The nerve cells are lacking in it. Some

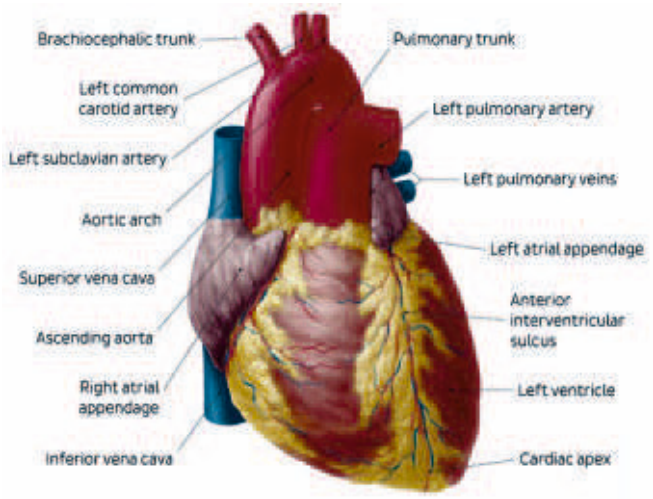


Fig. 24.3 External structure of human heart

nerve fibres from autonomous nervous system come in the heart.

Internal Structure of human heart

There are four chambers in human heart. Two upper thin walled chamber, auricles and two thick walled lower chambers are called ventricles, there is a groove between auricles and ventricles which separates them. It is called auriculo-ventricular furrow or coronary sulcus. Anterior and posterior inter ventricular sulcus are present in between left and right ventricles. Blood is carried from different parts into auricles, four pulmonary veins carry oxygenated (pure) blood to left auricle, other than heart walls, from all the parts of body deoxygenated (impure) blood is carried by precavals and postcaval into right auricle. From heart walls, the impure blood is carried into right auricle by coronary vein and coronary sinus. Pulmonary trunk comes out from right ventricle and divide into two branches which are pulmonary arteries and carry impure blood to their own side lungs. The biggest artery, left aorta comes out from left verticle, which carry pure blood to all parts of the body (except heart).

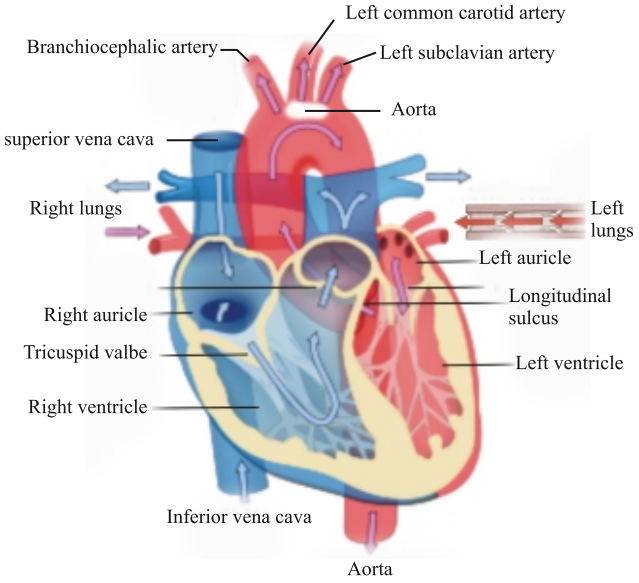


Fig. 24.4 Internal structure of human heart

Coronary arteries supply pure blood to the heart.

All the four chambers of the heart remain separated inside by septa and valves. There is inter auricular septum in between right and left auricle. There is an oval pit on this septum which is called fossa ovalis. There is an aperture at the place of pit in infant which is called foramen ovale. There is inter ventricular septum in between both ventricles. There is atrio ventricular septum made of connective tissue, present in between auricles and ventricles. Auricles and ventricles are connected with auriculo verntricular aperatures. These aperature are guarded by auriculo-ventricular valves. These valves check the flow of blood from ventricles to auricles. Between left auricles and left ventricle is found biscuspid or mitral valve. The valve present in between right auricle and right ventricle is called tricuspid valve. Folds of the valves fibrous chords chordae tendinae are attached with papillary muscles arising from the ventricular walls, and check the innversion of auricles. There are three semilunar valves present inside the pulmonary and aoratic arches each on which check the blood from returning into ventricles. Muscular sphinctor are found on the opening of vena cava and pulmonary veins into heart which check the returning of blood into the veins by contraction. The walls of ventricles are much thicker. The muscles of these protrude into ventricles to from papillary muscles. The wall of left ventricle is three times thicker than right ventricles.

Working of heart :

Human heart works like a muscular pump. Heart pumps the blood, which it recieves from all the body parts to every parts of the body. This activity of the heart is completed by the rhythmic contraction and relaxation of auricles and ventricles. Working of the heart may be understood by dividing it into two parts (1) Heart beat (2) Cardiac cycle.

1. Heart beat - Rhythmic contraction of heart is known as heart beat. Most of the muscles contract due to the stimulation of impulsing nerve, but the stimulation cardiac muscles originate in there muscles itself. Therefore, heart beat is called myogenic. There is a system found in heart for developing Rhythmic impulse for rhythmic contraction of muscles. This system conducts quickly the impulses in the heart. This system is made up of specific cardiac muscles. This is called conducting system of heart. Formation of conducting system is with sino-atrial node (SAN), inter nodal fibres, atrio - ventricular node, (AVN), bundle of his and purkinje fibres, together. Sino-atrial node is situated near the aperture of superior vena cava in right auricle. The necessary impulse for the contraction of heart originate in this node. This small and flat structure is formed by such specified muscles fibres, which have no contraction activity. The specific muscle cells of SAN by auto stimulation capability, create active potential by auto-depolarized for this specility autonomous rhythamic contrataction take place in the heart. The active potential from SAN quickly spreads in the walls of both auricles and both auricle contract nearly together. The transmission of the active potential or impulse from SAN is also there in AVN by internodal fibres. AVN is stimulated on the interauricular septum of left auricle. From AVN impulse is transmitted to both the ventricle in the walls through bundle of his and purkinje fibre by this fibres transmission fastly happen in ventricle, but in AVN the transmission impulse is slow. So the impulse reaches some what a little late in the

ventricle, Only when completion of contration in auricle, the impulse is transmitted in ventricle and the contraction of ventricle takes place. SAN act as the pacemaker of the heart. It impulse production rate is 72 to 80 per minute. Which is much more than the rate of stimulation of AVN and other fibres. So it regulates heart rate by controlling auto stimulation of other node and fibre of the heart.

2. Cardiac Cycle :- Starting from the begining of one heart beat upto the begining of the next heart beat the serial of the changes occuring in the different parts of the heart is called cardiac cycle. Thus the events occuring in the time completing one heart beat is known as cardiac cycle. Normal cardiac cycle takes 0.8 seconds to complete it. One cycle has two phases. Relaxation phase is called diastole and contraction phase is called systole. The main events of cardiac cycle are change of pressure in aorta, veatricles and auricles, change in volume of ventricle opening and closing of different valves and filling emptying the blood from chambers. Changes in volume are much more clear in ventricle in comparsion to auricles. During cardiac cycle, the blood filled in its chambers is pumped out in the definite direction.

The important phases of cardiac cycle are as follows:-

(i) Atrial diastole :- During cardiac cycle auricles and verticles remain in relaxed state for more time. Auricles remains in relaxed state for about 0.7 seconds. In the relaxed period of these pure blood from lungs through pulmonary veins comes in left auricles and impure blood from other parts of the body through vena cava comes in right auricle. Bicuspid and tricuspid valves in the primary stage of filling of auricles remain closed. As the blood comes in auricles the presence of blood being increases. When it reaches more than the pressure in relaxed veatricles both the valves get opened and most of the blood (about 75%) by inactive flow fills in the ventricles.

(ii) Atrial Systole - Both the auricles contract together as soon the relaxation ends. This is known as atrial systole. Due to contraction of a little blood (about 25%) which remains in the auricles comes in the ventricles. Thus, both the ventricle completely fill up with blood. Atrial systole remains for about 0.1 seconds. As soon as diastole begins blood begins to comes in them.

(iii) Ventricular Systole :- Ventricle contract after the contraction of auricles end. This is called ventricle systole. This remains for 0.3 seconds due to contraction pressure increases in the ventricles. Bicuspid and tricuspid valves close down. Thus, the blood's reverse flow to auricles checked. As the pressure increase than the pressure of aorta and pulmonary trunk both the semilunar valves open and the blood with presure is sent into these vessels. Maximum blood from ventricles goes into arteries.

(iv) Ventricular diastole :- After contraction the ventricles come down in relaxation state. This is called ventricle diastole. In this pressure decreases. To check the blood flowing in opposite direction the semilunar valves close down quickly, atrio-ventricular valves are open due to increased pressure of blood in auricles as the blood comes continuously by the contraction of ventricles filling of ventricles starts ventricular diastole remains for about 0.5.

Heart sound and pulse:- Closing of heart valves make sound. The time of ventricular systole the sound produced closing of atrio-ventricular valves is called Ist sound commonly is said to be 'lubb' as such, at the time of ventricular diastole by the closing of semilunar valves a sound is also produced closing of atrio-ventricular valves is called II heart sound. It is said to be 'dup'.

Double Blood Circulation

In human the blood circulation is called double blood circulation because to complete the circulation in the body blood has pass thorugh heart for two time. Firstly, the impure blood comes in the right part of the heart from different parts of the body which is forwarded to lungs for purification. Purified blood from lungs again comes into left part of the heart, from where it is distributed to the body parts.

Blood collected from different parts of the body is such the right auricles by two precaval and

one post caval. This blood reaches lungs by pulmonary arch. There the blood is oxygenated. The pure blood from the lungs through pulmonary veins comes to left auricles and from where reaches in left ventricle from the ventricle, by carotico systemic arch the pure blood reaches the different parts of the body.

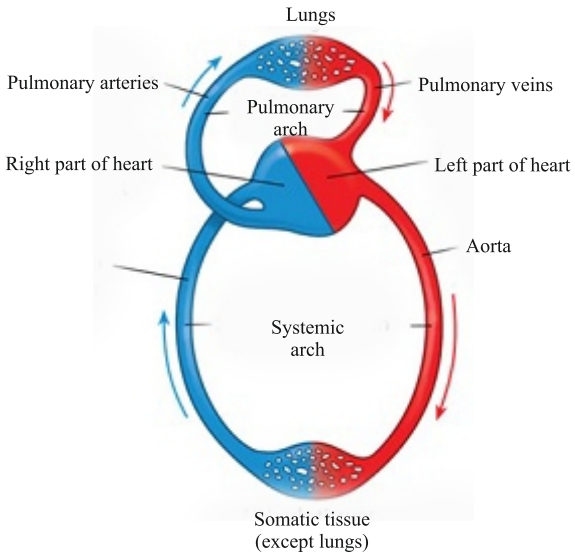


Fig. 24.5 Double circulation of blood

Significance of double blood circulation :

1. Oxygenated and deoxygenated blood never mixes in the heart and blood vessles, i.e. always remains separate
2. To complete a cycle in the body blood has to pass through the heart for two times for the first time total impure blood goes to lungs through the right auricle and ventricle and second time, pure blood from the lungs through pulmonary veins comes to left auricles than in left ventricle and from there by single aorta goes into complete body. In this way it is clear than to complete single cycle blood passes through the heart for two times this is called double blood circulation.

Lymphatic System

Lymph, lymph vessels and lymph nodes together form the lymphatic system.

1. Lymph :- Lymph flows in lymphatic system in fluid form, in the capillaries due to pressure blood is filtered, then the filtrate is known as lymph. It is colourless, translucent and alkaline vascular tissue. It is just like blood plasma. Difference is only for that there are protein, calcium and phosphorus in less quantity and excretory substances are more. Lymph has no thrombocytes and red blood corpuscles. It contain lymph cell or lymphocytes.

2. Lymph Vessels :- Lymph also flow in the bdy like blood, various tissues of the body are being immersed in lymph, exchange of gas and substances

Difference between blood and lymph

Blood	Lymph
1. It is generally red in colour	1. It is colourless
2. It has red blood corpuscles	2. It lacks blood corpuscles
3. It has less white blood corpuscles	3. It hase more white blood corpuscles
4. It has protein in much quantity	4. It has protein in less quantity
5. It contain more nutrients and oxygen.	5. It has less amount of nutrient & O_2
6. Blood is common fluid connective tissue	6. Lymph is filtered blood

between cells and blood is done through lymph. The lymph vessels are like vein. Lymph always flows in the vessels toward, heart from the organs, pressure in these is comparatively less than veins. The flow of lymph is due to contraction of wall of lymph vessels and muscles present around them. This system has several smaller vessels.

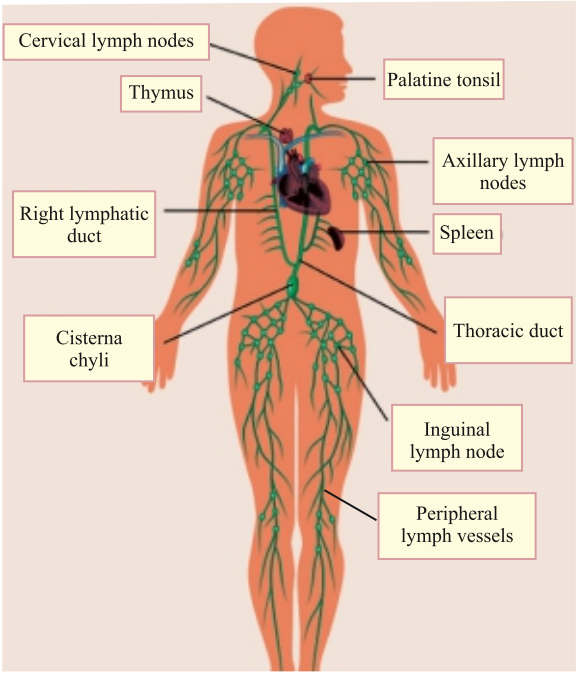


Fig. 24.6 Lymphatic System of Human

The main ducts/vessels are as follows :

(i) Thoracic duct :- It starts from right part of the head and carries lymph to the posterior part of the cervix and thoracic lymph in the posterior, foreskin, abdominal and anterior and left part of the body, head, neck, thorax and forelimb and left subclavian vein and internal cervical begin from the internal jugular vein and opens in the thorax.

(ii) Right Lymphatic duct :- This is located in the neck. It collects lymph from right part of head, neck and forelimbs and thorax. This opens in the venous system right into the joining place of right subclavian vein and right carotid vein.

(3) Lymph nodes :- Lymph glands are situated at several places in the lymph vessels. In these nodes net of lymph capillaries and lymphocytes are situated. Lymph glands are situated near big blood vessels in head, neck, arm pits etc.Tonsils are also lymph nodes.

Functions of lymphatic systems :-

1. Lymph acts as the mediator in between blood and tissues. This takes digested food materials and O_2 from blood and give them to tissue and from tissue it transfer excretocy substances hormones etc to blood.
2. Lymphatic system is helpful for the transport of absorbed nutritive substances specially fats (glycerol and fatty acid)
3. Absorbed fats from intestine passes through lacteal vessels firstly, goes in lymphatic system and then into venous system.
4. White blood corpuscles present in lymph engulf germs.

Diseases related to Heart and circulatory system

1. Hypertension :- In a normal and healthy person at the time of systole and diastole the pressure in artery is equal to 120 and 80 mm Hg respectively. When the systole pressure of atrial blood is more than 140 or high and diastole pressure is more than 80 mm Hg or high and is continuously remain high, then it is called high blood pressure high blood pressure, affects adversely on heart, brain and kidneys.

2. Coronary artery disease (CAD) :- This disease is known as atherosclerosis. In this the vessels supplying blood in cardiac muscles are affected. This is due to blocking of arteries by fats calcium and fibrous tissue deposition. They narrow the cavity of the artery.

3 Heart failure :- In this state heart could not supply enough blood necessary to the different parts of the body. It is also known as congestive heart failure, the main symptoms of this disease is contraction of lungs. Heart failure is not like heart attack. In heart attack heart beat stops at once while in heart failure the blood supply abruptly falls and cradiac muscle damages.

4. Angina :- In this disease blood supply to heart wall is not sufficient due to contraction of or clot is formed in the coronary artery. Thus the cardiac muscles could not get O_2 in proper quantity.

This produce arteriosclerosis. This can happen in any age in man or woman. This disease is more prevelent in middle age or in old age.

5. Myocardial infraction :- It is also called heart attack. Cardiac muscles could not get proper blood supply due to blocking of cornary artery, which damage the muscles and could not work with full capacity.

6. Valvular disease :- Valve of heart do not work properly resulting in reverse flow of blood. This is called valvular disease. Due to this pure and impure blood get mixed.

7. Coronary thrombosis :- Due to formation of clot in coronary artery. Cardiac muscle do not receive sufficient blood. It results in angina.

8. Heart block :- In this disease bundles of his do not work properly, thus, produced impulse of SA node does not reach veantricle resulting in no motion in ventricle and the circulation stops.

9. Rheumatic heart disease :- This disease is causes due to infection of bacteria S*treptococcus viridens*. Due to this disease valves of the heart do not work properly and the cardiac muscles become weak.

10. Ventricular fibrillation :- Every part of ventricles contract differently at last co-ordination and rhythem breaks down.

11. Pericardiatis :- Due to bacterial infection, pericardium gets inflammed and more pericardial fluid is collected. This enlarges the heart and heart remains in pressure. This is lethal state.

Important Points

1. In human for transportation of nutrients, oxygen and waste products, blood circulatory system is found.
2. Circulatory system are of two types - open and closed circulatory system.
3. Blood circulation has three components - blood, heart and blood vessels.
4. In the composition of blood plasma, erythrocytes leucocytes and platelets are found.
5. Important functions of blood are transportation of O_2 transportation of CO_2, temperature regulation, protection from diseases, repairing of wounds, transportation of excretory products and clotting of blood.
6. Human blood groups are divided into A, B, AB and O groups . Every group may be RH^+ and RH^-.
7. Blood group O is called universal donor.
8. Blood group AB is called universal recipient.
9. Blood components after coming out from the blood vessels converted into a gel like structure which is called clot.
10. Heart works as muscular pump.
11. Heart has four chambers. Pure blood flows in left auricle and ventrical, impure blood flows in right auricle and ventricle.
12. Rhythmic contraction of heart is called heart beat.
13. SAN is called pace maker.
14. In cardiac cycle there are two phases systole and diastole
15. Closing of atrio-ventricular valve during contraction of ventricle produces a sound called 'lubb'.
16. Closing of semi lunar valves at the time of ventricle relaxation produces sound call 'dup'.
17. Human have double circulation pulmonary and systemic circulation.
18. Lymphatic system is formed of lymph, lymph vessels and lymph nodes.
19. Important disease of heart circulatory system are hypertension, Angina, Arterial disease, valvular disease etc.

Practice Questions

Multiple choice questions -

1. The origin of human heart is :
   (a) Endodermal
   (b) Ectodermal
   (c) Mesodermal
   (d) Endomesodermal
2. Blood is :
   (a) a tissue
   (b) not a tissue
   (c) fluid matrix tissue
   (d) fluid connective tissue
3. At more heights, human blood corpuscles will have :
   (a) Incerase in number
   (b) Increase in size
   (c) decerase in size
   (d) decrease in number
4. Contraction in heart start from :
   (a) left ventricle
   (b) right ventricle
   (c) left auricle
   (d) right ventricle
5. Important role in clotthing of blood is played by
   (a) neutrophils
   (b) thrombocytes
   (c) erythrocytes
   (d) monocytes.
6. Ventricle contraction is controlled by
   (a) AVN (b) Purkinje fibres
   (c) SAN (d) Papillary muscles.
7. Improtant ion for blood clotting is :-
   (a) K^+ (b) Na^+
   (c) Fe^{2+} (d) Ca^{2+}
8. Lymph function is :
   (a) Supplying O_2 to brain
   (b) transport of CO_2
   (c) returning of WBCs to lymph
   (d) returning of intercellular fluid to blood.
9. Blood pressure of healthy man is :
   (a) 140/90 (b) 120/80
   (c) 110/70 (d) 130/60

Very short answer questions -

1. Where are RBCs formed?
2. Which is necessary protein for blood clotting ?
3. Which blood grouped is called universal receipient?
4. What is pace maker?
5. What is cardiac cycle?
6. Which group of blood is called universal donor?
7. What is plasma?
8. What is erythroblastosis foetalis?
9. Define double blood circulation?

Short answer qeustions -

1. Write differences between closed and open circulatory system?
2. Write functions of blood?
3. What are blood groups in human?
4. Explain Rh system
5. Write difference betweeen artery and vein?
6. Explain the importance of double blood circulation
7. Write differences between blood and lymph.

Essay type questions-

1. Explain the external structure of heart with labelled diagram
2. Explain the inernal structure of heart with labelled diagram.
3. Explain mechanism of human heart

4. Explain the process of blood clotting
5. Explain lymphatic system.
6. Explain the diseases associated with human circulatory system.

Answer Key-

1. (c) 2. (d) 3. (a) 4. (b) 5. (b)
6. (c) 7. (d) 8. (d) 9. (b)