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BODY FLUIDS AND CIRCULATION

SYLLABUS

Composition of blood, blood groups, coagulation of blood; Composition of lymph and its function; Human circulatory system-Structure of human heart and blood vessels; Cardiac cycle, cardiac output, ECG, Double circulation; Regulation of cardiac activity; Disorders of circulatory system-Hypertension, Coronary artery disease, Angina pectoris, Heart failure.

KEY CONCEPTS

INTRODUCTION

* System which transport material like nutrient, gases, hormone etc. to the various parts of the body and remove waste materials from the body cells known as Circulatory System.
* Study of circulatory system is called angiology.
* Father of angiology = William Harvey
* The whole circulatory system is originated from Mesoderm but the inner layer of heart's wall (endocardium) and inner layer of blood vessels's wall (enderthelium) is endodermal in origin.

Types of circulatory system :

Circulatory system is of two types :

1. Open Circulatory system :

* In this system circulatory fluid flows in the body cavity without any special closed tubular system.
* Circulatory fluid is filled in spaces. Normally irregular spaces are called Haemocoel and circulating fluid is called Haemolymph.
* In this system, cells directly come in contact with Haemolymph.
* Eg. Arthropoda (Expect cephalopods), all molluscs.

2. Closed Circulatory system :

* In this circulatory system fluid flows in the closed tubes. These tubes are called blood vessels.
* Cells do not remain directly in contact with the blood. Closed blood circulation is more efficient.
* Eg. Annelids, Vertebrates, Cephalopods (Sepia, Octopus).

BLOOD

* Blood is a special connective tissue consisting of a fluid matrix, plasma, and formed elements.
* Plasma is a straw coloured, viscous fluid constituting nearly 55 per cent of the blood. 90-92 per cent of plasma is water and proteins contribute 6-8 per cent of it.
* Fibrinogen, globulins and albumins are the major proteins.
* Fibrinogens are needed for clotting or coagulation of blood. Globulins primarily are involved in defense mechanisms of the body and the albumins help in osmotic balance.
* Plasma contains small amounts of minerals like Na^+, Ca^{++}, Mg^{++}, HCO_3,Cl^-, etc. Glucose, amino acids, lipids, etc., are also present in the plasma as they are always in transit in the body.

Factors for coagulation or clotting of blood are also present in the plasma in an inactive form. Plasma without the clotting factors is called serum.

* Erythrocytes, leucocytes and platelets are collectively called formed elements and they constitute nearly 45 per cent of the blood.
* Erythrocytes or red blood cells (RBC) are the most abundant of all the cells in blood.
* A healthy adult man has, on an average, 5 millions to 5.5 millions of RBCs mm^{-3} of blood.
* RBCs are formed in the red bone marrow in the adults.

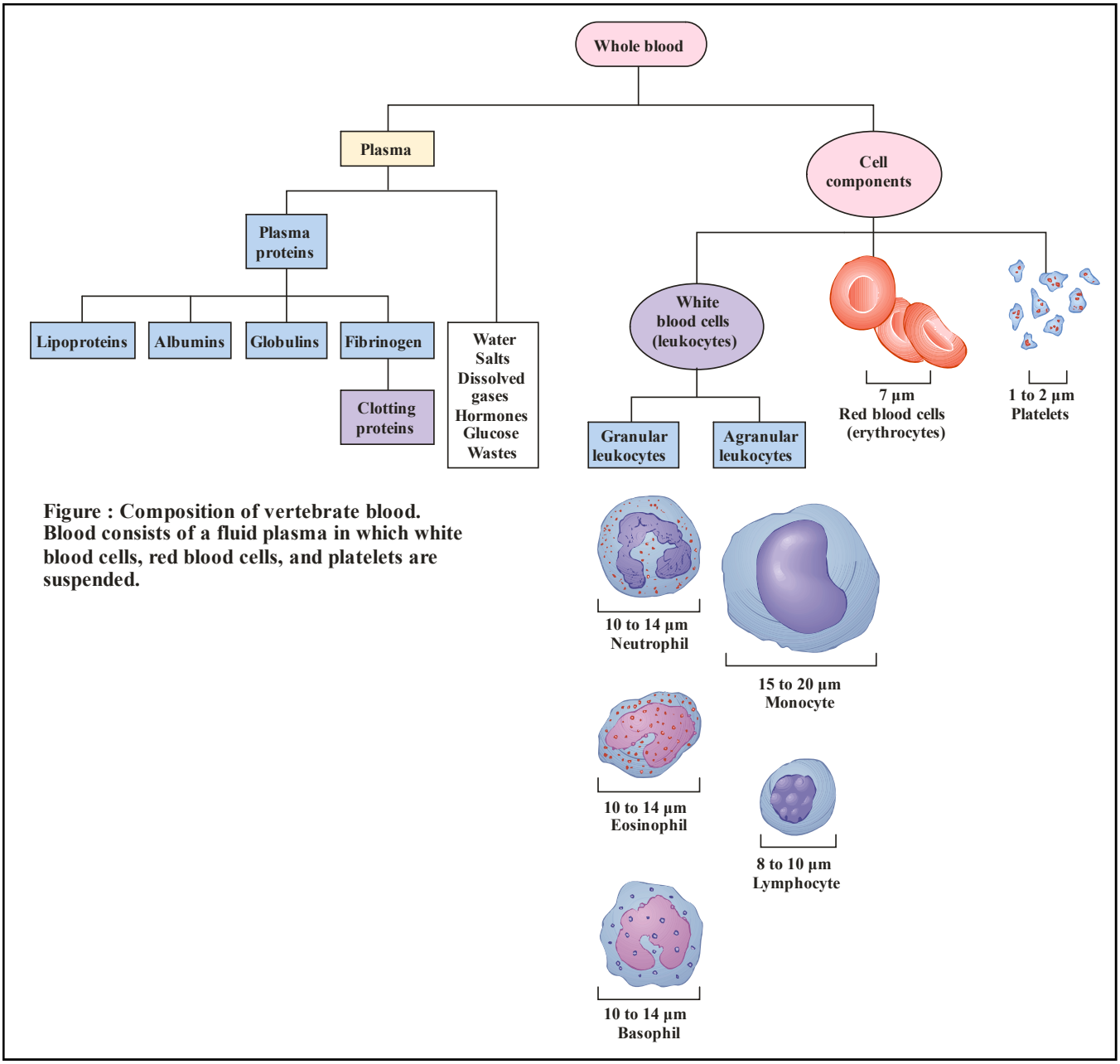


Figure : Composition of vertebrate blood. Blood consists of a fluid plasma in which white blood cells, red blood cells, and platelets are suspended.

* RBCs are devoid of nucleus in most of the mammals and are biconcave in shape.
* They have a red coloured, iron containing complex protein called haemoglobin, hence the colour and name of these cells.
* A healthy individual has 12-16 gms of haemoglobin in every 100 ml of blood. These molecules play a significant role in transport of respiratory gases.

* RBCs have an average life span of 120 days after which they are destroyed in the spleen (graveyard of RBCs).
* Leucocytes are also known as white blood cells (WBC) as they are colourless due to the lack of haemoglobin.
* They are nucleated and are relatively lesser in number which averages 6000-8000mm^{-3} of blood. Leucocytes are generally short lived.
* Two main categories of WBCs - granulocytes and agranulocytes. Neutrophils, eosinophils and basophils are different types of granulocytes, while lymphocytes and monocytes are the agranulocytes.
* Neutrophils are the most abundant cells (60-65 per cent) of the total WBCs and basophils are the least (0.5-1 per cent) among them. Neutrophils and monocytes (6-8 per cent) are phagocytic cells which destroy foreign organisms entering the body.
* Basophils secrete histamine, serotonin, heparin, etc., and are involved in inflammatory reactions.
* Eosinophils (2-3 per cent) resist infections and are also associated with allergic reactions.
* Lymphocytes (20-25 per cent) are of two major types - 'B' and 'T' forms. Both B and T lymphocytes are responsible for immune responses of the body.
* Platelets also called thrombocytes, are cell fragments produced from megakaryocytes (special cells in the bone marrow).
* Blood normally contains 1,500,00-3,500,00 platelets mm^{-3}.
* Platelets can release a variety of substances most of which are involved in the coagulation or clotting of blood.
* A reduction in their number can lead to clotting disorders which will lead to excessive loss of blood from the body.

BLOOD GROUPS

ABO grouping:

* ABO grouping is based on the presence or absence of two surface antigens (chemicals that can induce immune response) on the RBCs namely A and B.
* Similarly, the plasma of different individuals contain two natural antibodies (proteins produced in response to antigens).
* The distribution of antigens and antibodies in the four groups of blood, A, B, AB and O are :

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

* Group 'O' blood can be donated to persons with any other blood group and hence 'O' group individuals are called 'universal donors'.
* Persons with 'AB' group can accept blood from persons with AB as well as the other groups of blood. Therefore, such persons are called 'universal recipients'.

Rh grouping :

* Antigen, the Rh antigen similar to one present in Rhesus monkeys (hence Rh), is observed on the surface of RBCs of majority (nearly 80 per cent) of humans. Such individuals are called Rh positive (Rh+ve) and those in whom this antigen is absent are called Rh negative (Rh-ve).
* 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.
* A special case of Rh incompatibility (mismatching) has been observed 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.
* However, 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 her 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. This can be avoided by administering anti-Rh antibodies to the mother immediately after the delivery of the first child.

COAGULATION OF BLOOD

* A clot or coagulam formed mainly of a network of threads called fibrins in which dead and damaged formed elements of blood are trapped.
* Fibrins are formed by the conversion of inactive fibrinogens in the plasma by the enzyme thrombin.
* Thrombins, in turn are formed from another inactive substance present in the plasma called prothrombin.

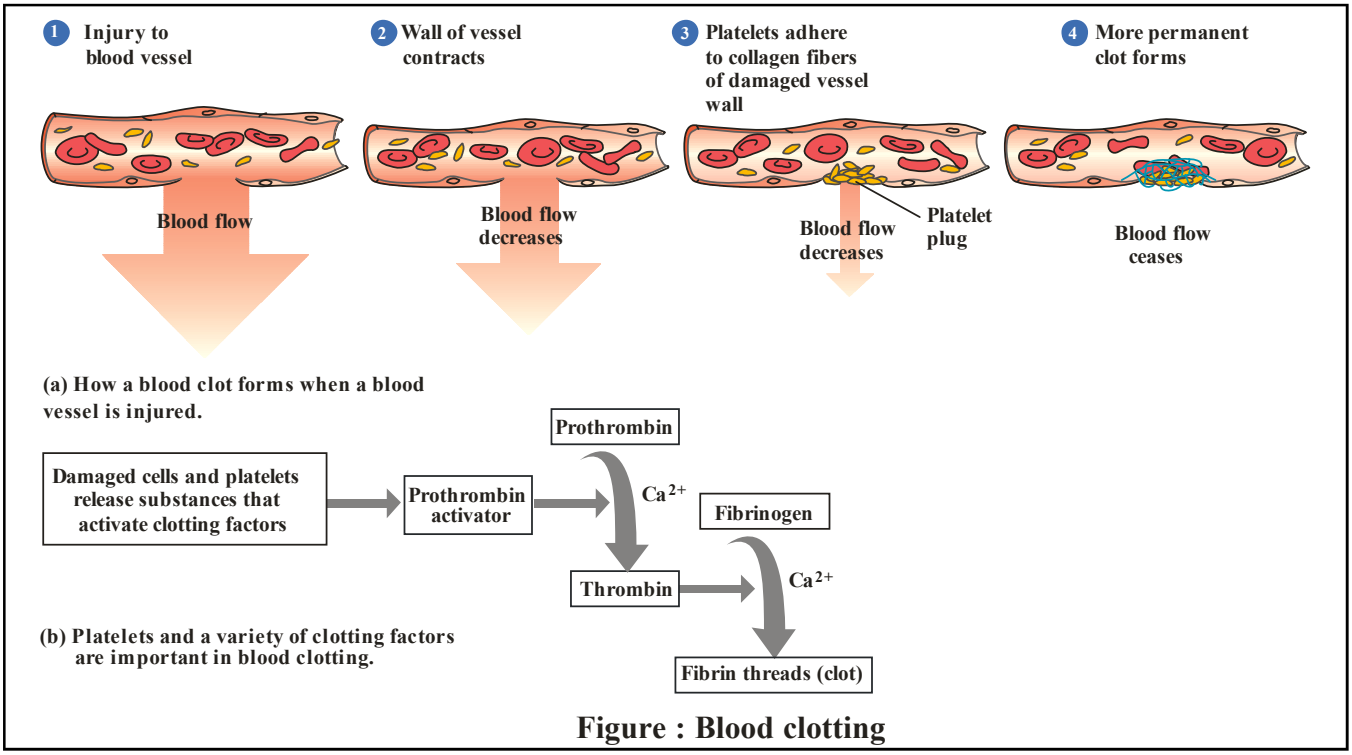


Figure : Blood clotting

* An enzyme complex, thrombokinase, is required for the above reaction. This complex is formed by a series of linked enzymic reactions (cascade process) involving a number of factors present in the plasma in an inactive state.
* An injury or a trauma stimulates the platelets in the blood to release certain factors which activate the mechanism of coagulation.
* Calcium ions play a very important role in clotting.
* **The plasma clotting factors:**
  - I. Fibrinogen
  - II. Prothrombin
  - III. Tissue thromboplastin
  - IV. Calcium ions (Ca^{2+})
  - V. Proaccelerin (Labile factor)
  - VI. Presence has not been proved.
  - VII. Proconvertin (stable factor)
  - VIII. Antihaemophilic factor A
  - IX. Antihaemopbilic factor B (Christmas factor)
  - X. Stuart-Prower factor
  - XI. Plasma thromboplastin antecedent
  - XII. Hageman factor
  - XIII. Fibrin stabilizing factor

LYMPH

* 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.

* 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 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.
* Lymph = Blood - [RBC + platelets + plasma proteins of high molecular weight]
* In human primary lymphatic (lymphoid) organs of the body are the Red bone marrow and Thymus gland. They are called primary lymphatic organs because they produce B and T cells the lymphocytes that carry out immune response.
* Haemopoietic stem cells in red bone marrow gives rise to B Cell and pre-T cells. Pre-T cells then migrate to thymus gland. Secondary lymphatic organs are the lymph nodes and spleen

Lymph Capillaries :

* These are blind at one end.
* These are very soft and thin walled tubes.
* They are wider than blood capillaries and their diameter is not uniform.

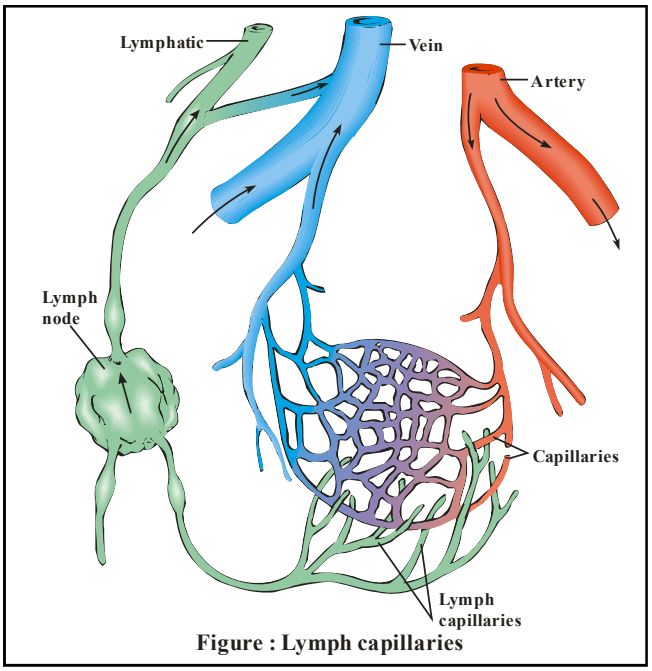


Figure : Lymph capillaries

* These are present in all the parts of body except hairs, cornea, spinal cord, cartilages, epidermis, brain, spleen and bone marrow.
* Closed system of capillaries starts from inter cellular spaces. Lymph enters in these capillaries.
* Capillaries pass this lymph to lymph vessels.

Lymph Vessels:

* The lymphatic capillaries join to form lymph vessels.
* In the structure, these are similar to the veins, but in these, thin wall and more valves are found than veins.
* All lymph vessels open into two big thoracic lymph duct. These are:

(i) **Right thoracic lymph duct:** It is the small duct. It receive lymph from the right side of the head, neck, thorax and right arm. It opens into the right subclavian vein.

(ii) **Left thoracic lymph duct:** It is the long duct. It receives lymph from the left side of the head, neck, thorax, left arm, both hind limbs and alimentary canal. It opens into the left subclavian vein.

* In the abdominal cavity behind the diaphgram a bag like structure attached with left thoracic lymph duct called cisterna chyli. It is called second heart of body.

Lymph Nodes:

* These are made up of lymphoid tissue.
* The lymphatic nodes occur at intervals in the course of the lymphatic vessels.
* They contain lymphocytes, plasma cells and fixed macrophages.
* The lymph filters through the lymphatic nodes.
* The macrophages remove microorganism, cellular debris and foreign particles from the lymph.
* Lymphatic nodes can detect and destroy cancer cells also.
* The lymphatic nodes also add lymphocytes and antibodies to the lymph.
* The lymphatic nodes are specially abundant in specific regions such as the groins, armpits and neck.

Spleen :

* The spleen is a large (7-10 cm. in diameter), bean-shaped, vascular, dark-red organ located in the abdomen just below the diaphragm at the tail of the pancreas behind the stomach.
* It is the largest lymph nodes.
* It is also called blood bank of body.
* It is the Graveyard of RBC.
* It is Mesodermal in origin.
* Like lymph nodes, spleen has hilus, where splenic artery, vein and efferent lymphatic vessels pass through.
* Spleen never filter lymph, because has no afferent lymphatic vessel.
* Histologically it is formed by following structure

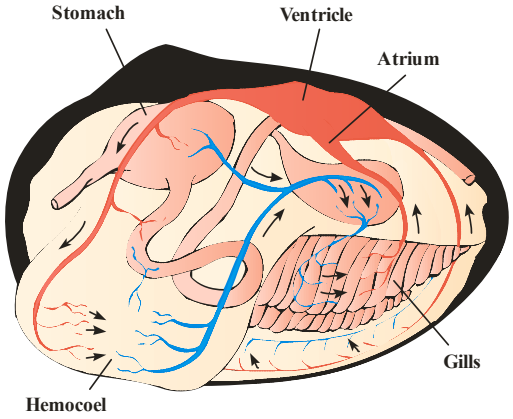
(a) **Capsule :** It is the outer covering of spleen formed of dense connective tissue and smooth muscles. The outer layer of the capsule is the serous coat formed of visceral peritoneum.

(b) **Trabeculae :** Narrow fold like septa or trabeculae extend inwards from the capsule, dividing the spleen tissue into several incomplete lobules. They provide support and convey blood vessels in to the interior of spleen.

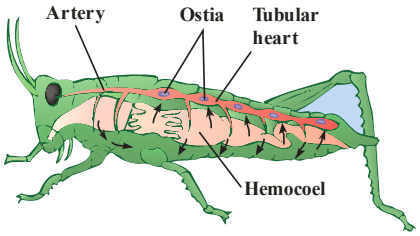
(c) **Splenic pulp :** The reticulo-endothelial tissue is called splenic pulp. It contains a denser network of blood capillaries, small sinuses and fine blood vessels. The meshes of this network are studded with numerous splenic cells, red, blood corpuscles, macrophages and lymphocytes.

CIRCULATORY PATHWAYS

* The circulatory patterns are of two types - open or closed.
* Open circulatory system is present in arthropods and molluscs in which blood pumped by the heart passes through large vessels into open spaces or body cavities called sinuses.
* Annelids and chordates have a closed circulatory system in which the blood pumped by the heart is always circulated through a closed network of blood vessels. This pattern is considered to be more advantageous as the flow of fluid can be more precisely regulated.
* All vertebrates possess a muscular chambered heart.
* Fishes have a 2-chambered heart with an atrium and a ventricle.



(a) In most mollusks, the heart pumps hemolymph into blood vessels that conduct it to the hemocoel. After bathing the cells, the hemolymph enters vessels that conduct it to the gills. The hemolymph is recharged with oxygen and then returned to the heart.



(b) In arthropods, a tubular heart pumps hemolymph into arteries that deliver it to the sinuses of the hemocoel. After circulating, hemolymph re-enters the heart through ostia in the heart wall.

Figure : Open circulatory systems
In mollusks and arthropods, a heart pumps the blood into arteries that end in sinuses of the hemocoel. Hemolymph circulates through the hemocoel.

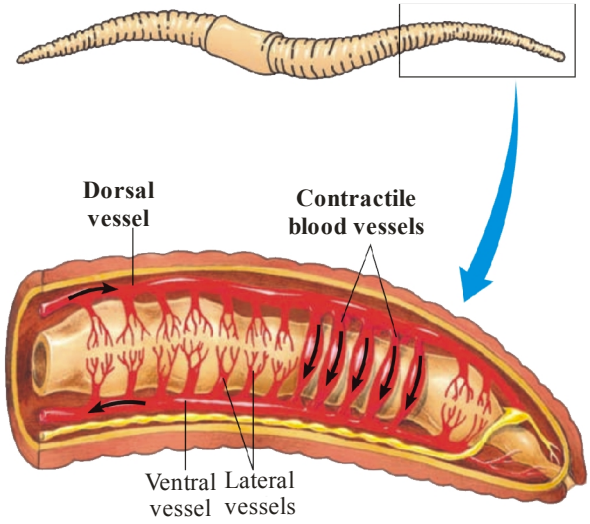
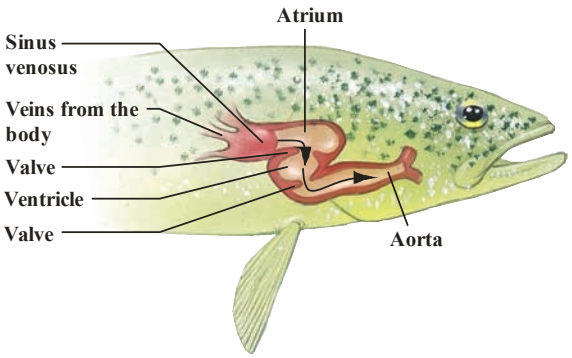


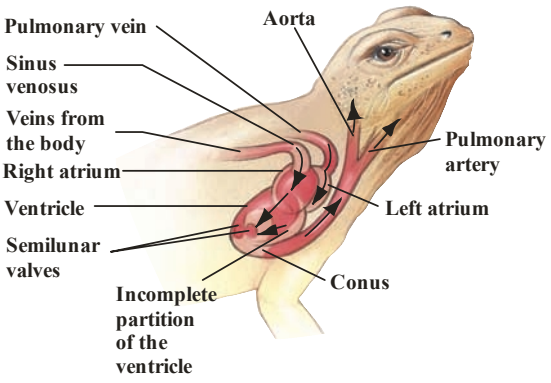
Figure : Closed circulatory system of the earthworm. Blood circulates through a continuous system of blood vessels. Five pairs of contractile blood vessels deliver blood from the dorsal vessel to the ventral vessel.

* Amphibians and the reptiles (except crocodiles) have a 3-chambered heart with two atria and a single ventricle, whereas crocodiles, birds and mammals possess a 4-chambered heart with two atria and two ventricles.
* In fishes the heart pumps out deoxygenated blood which is oxygenated by the gills and supplied to the body parts from where deoxygenated blood is returned to the heart (single circulation).
* In amphibians and reptiles, the left atrium receives oxygenated blood from the gills/lungs/skin and the right atrium gets the deoxygenated blood from other body parts. However, they get mixed up in the single ventricle which pumps out mixed blood (incomplete double circulation).
* In birds and mammals, oxygenated and deoxygenated blood received by the left and right atria respectively passes on to the ventricles of the same sides. The ventricles pump it out without any mixing up, i.e., two separate circulatory pathways are present in these organisms, hence, these animals have double circulation.

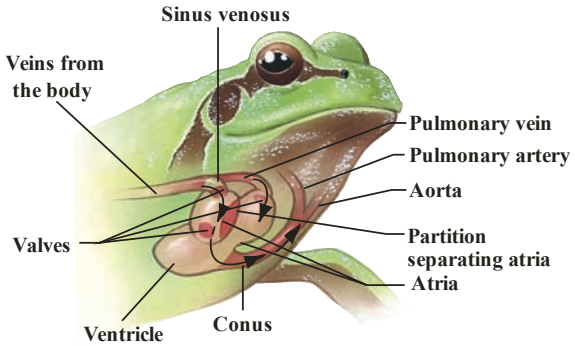
The four-chambered heart and double circuit that separates oxygen-rich from oxygen-poor blood are important adaptations that evolved as vertebrates diversified and some became active, terrestrial, endothermic animals



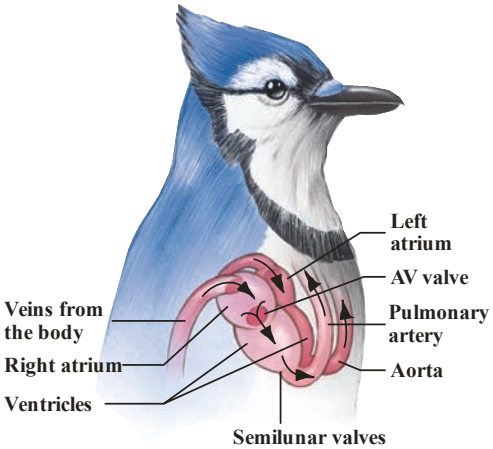
(a) Fishes. The single atrium and ventricle of the fish heart are part of a single circuit of blood flow.



(c) Reptiles (except birds). The reptilian heart has two atria and two ventricles. In most nonavian reptiles, the wall separating the ventricles is incomplete, so blood from the right and left chambers mixes to some extent. In crocodiles and alligators, the septum is complete and the heart consists of four separate chambers.



(b) Amphibians. In amphibians, the heart consists of two atria and one ventricle; blood flows through a double circuit.



(d) Birds and mammals. In birds and mammals, the two atria and two ventricles separate oxygen-rich blood from oxygen-poor blood.

Figure : Evolution of the vertebrate cardiovascular system

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.
* In human beings Circulatory System is of two type –

(i) **Blood vascular system :** In this, circulatory fluid is blood. This system includes blood, blood vessels, and Heart. This is found in higher invertebrates and all vertebrates.

(ii) **Lymphatic system :** In this, circulatory fluid is lymph. This system includes lymph, lymphoid tissue and lymph vessels. It is found in higher vertebrates.

* Heart, the mesodermally derived organ, is situated in the thoracic cavity, in between the two lungs, slightly tilted to the left. It has the size of a clenched fist.
* It is protected by a double walled membranous bag, pericardium, enclosing the pericardial fluid.

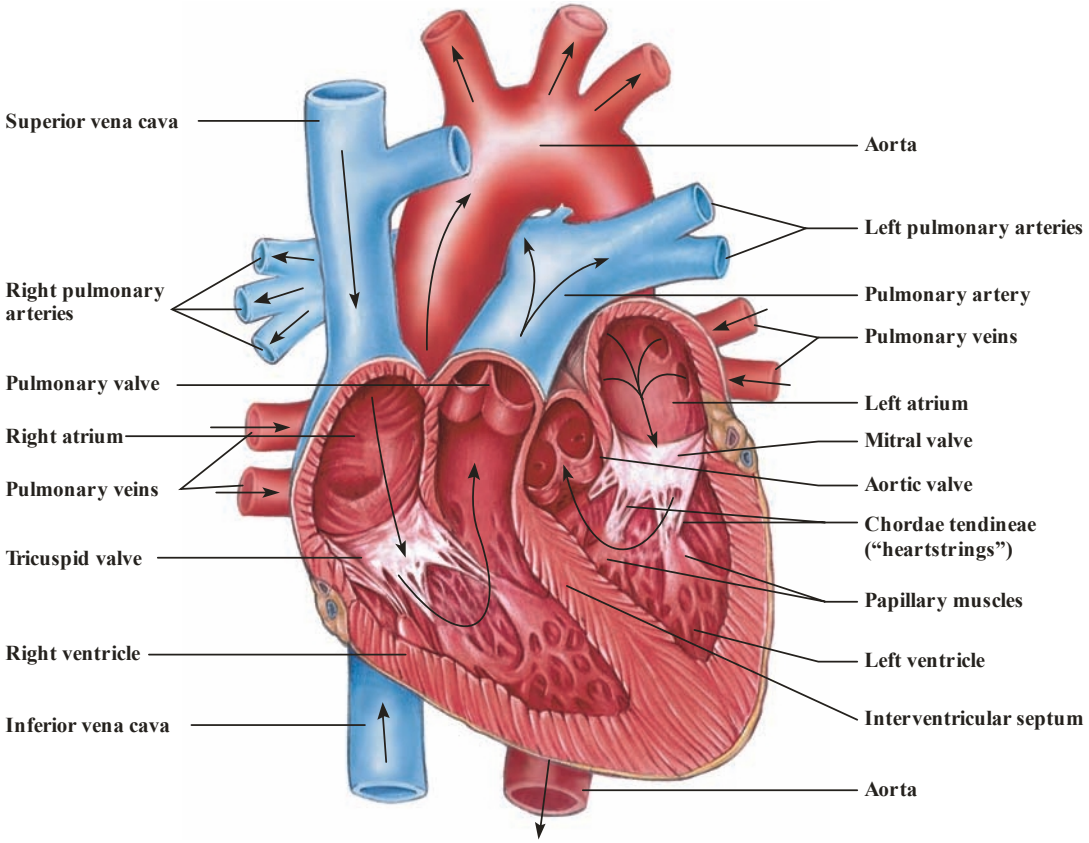


Figure : Section through the human heart showing the valves.
Note the right and left atria, which receive blood, and the right and left ventricles, which pump blood into the arteries. Arrows indicate the direction of blood flow.

* The heart wall consists of connective tissue, blood vessels and cardiac muscle fibres in 3 different layers - Epicardium, Myocardium and Endocardium.

(i) **Epicardium :** The outermost epicardium, also called visceral layer of the serous pericardium, is the thin, transparent outer layer of the wall. It is composed of mesothelium and connective tissue. Visceral pericardium, joined to myocardium by connective tissue.

(ii) Middle, highly vascular layer, composed of cardiac muscle fibres joined together by intercalated disc. The connective tissue in myocardium acts as cardiac skeleton. Myocardium is thickest where the endocardium is thinnest.

(iii) **Endocardium :** Innermost layer lining the cavity of heart and consisting of endothelium of squamous cells resting on thin basement membrane of loose connective tissue.

* Heart has four chambers, two relatively small upper chambers called **atria** and two larger lower chambers called **ventricles**.
* A thin, muscular wall called the interatrial septum separates the right and the left atria, whereas a thick-walled, the inter-ventricular septum, separates the left and the right ventricles
* The atrium and the ventricle of the same side are also separated by a thick fibrous tissue called the atrio-ventricular septum. However, each of these septa are provided with an opening through which the two chambers of the same side are connected. The opening between the right atrium and the right ventricle is guarded by a valve formed of three muscular flaps or cusps, the tricuspid valve, whereas a bicuspid or mitral valve guards the opening between the left atrium and the left ventricle.
* The openings of the right and the left ventricles into the pulmonary artery and the aorta respectively are provided with the semilunar valves.
* The valves in the heart allows the flow of blood only in one direction, i.e., from the atria to the ventricles and from the ventricles to the pulmonary artery or aorta. These valves prevent any backward flow.
* The walls of ventricles are much thicker than that of the atria.
* A specialised cardiac musculature called the nodal tissue is also distributed in the heart. A patch of this tissue is present in the right upper corner of the right atrium called the **sino-atrial node (SAN).** Another mass of this tissue is seen in the lower left corner of the right atrium close to the atrio-ventricular septum called the **atrio-ventricular node (AVN).** A bundle of nodal fibres, atrioventricular bundle (AV bundle) continues from the AVN which passes through the atrio-ventricular septa to emerge on the top of the interventricular septum and immediately divides into a right and left bundle.

  These branches give rise to minute fibres throughout the ventricular musculature of the respective sides and are called **purkinje fibres**. These fibres alongwith 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. However, the number of action potentials that could be generated in a minute vary at different parts of the nodal system. 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}).
* Less number of heart beat than normal is called Bradycardia.
* More rate of heart beat than normal is called tachycardia.
* Rate of heart beat increases :
  (i) After taking food
  (ii) Exercise
  (iii) Decrease blood pH
  (iv) Increase acidity and CO_2 concentration
  (v) Increase in temperature
  (vi) Tension/shock
  (vii) In high B.P.
* **Regulation of heart beat :** The centre controlling the heart rate (cardiac centre) is present in medulla oblongata of brain and possess chemoreceptors sensitive for CO_2, O_2 and also for blood pressure. This centre is under the influence of hypothalamus which is the controller of autonomic activities.

(1) **Nervous control :** Brain receives two sets of nerve fibres: Sympathetic and para sympathetic or vagal.

* When there is increase in blood CO_2, the sympathetic nerve fibres stimulate S.A. node by producing sympathin(adrenaline+ noradrenaline). This compound induces impulse generation by inducing entry of Ca^{2+} into cardiac muscles. So, heart beat and force of contraction increase (Tachycardia). After action, sympathin is destroyed by sympathenase, COMT (catechol orthomethyl transferase) and MAO (Mono Amino Oxidase).

* When there is increase in blood O_2, the parasympathetic or vagal (10th cranial) nerve inhibits S.A. node by producing acetylcholine. This compound increases contraction time and hence, heart beat is decreased (Bradycardia). After action, acetyl choline is destroyed by enzyme acetyl choline esterase (AchE). This chemical regulation of heart beat on behalf of nerves was discovered by Otto Loewi.
* **Vagus escape :** Stimulation of vagus nerve decreases the heart rate but its continuous stimulation shows no further decrease. This phenomenon is called Vagus escape.

(2) **Hormonal control :** Hormones from adrenal medulla adrenaline and nor adrenaline accelerate the heart beat, the latter under normal conditions and the former at the time of emergency. Thyroxine hormone also increases the heart beat by increasing energy production.

* **Pounding :** Very fast heart beat during some conditions like anger and love.
* **On the basis of origin of heart beat two types of heart**

(i) **Neurogenic heart:** In this heart, beat is initiated by a nerve impulse coming from a nerve ganglion situated near the heart. So in this wave of contraction is generated outside the heart in the ganglion. If nerve supply is cut off then heart beat stops. Eg. Invertebrates (some annelids, most arthorpods)

(ii) **Myogenic heart:** In this heart, beat is originated by a group of muscle fibres which is situated in the wall of the heart. So in this wave of contraction is generated inside the heart. Eg. Vertebrates, Mollusca Phylum.)

Blood vessels :

The study of blood vessels is called Angiology. The blood vessels are of following types :

(1) **Arteries :**

* Thick walled, carrying oxygenated blood (deoxygenated in pulmonary artery) from heart to various parts of body.
* These blood vessels are grouped as Aorta which branches to form arteries which further divides into thinner branches called arterioles inside the organ.
* Average diameter of arteriole is 120µm, the arterioles further divide into smaller vessels called meta-arterioles (70 µm) which divide into capillaries.
* At the beginning of capillary, the arterioles posses circular muscles called precapillary sphincter which regulates flow of blood into the capillaries which is called vasomotion.
* Smooth muscles of arteries innervated by sympathetic fibers, their stimulation control vasoconstriction and vasodilation.
* Smooth muscles of arteries and arterioles also limit bleeding from wounds by producing vascular spasm during cut. Arteries two types.
  (i) Conducting or elastic arteries
  (ii) Distributing or muscular arteries.
* Elastic or conducting arteries receive blood from heart and do not provide it to any organ rather they provide blood to other atreries and are pressure reservoirs of blood.
* Muscleless end of meta-arteriole is called thoroughfare channel or preferential channel.
* The largest artery is dorsal / abdominal aorta (systemic aorta).

(2) **Capillaries :**

* Smallest blood vessels, discovered by Marcello Malpighi (also layered nucleated squamous epithelial cells called endothelium resting on a basement membrane).
* These are also called as exchange vessels as they are the site of exchange of material between blood and tissue because of least barrier in them.
* The capillaries can be grouped into two categories:

(i) **Arteriolar capillary :** Which supplies nutrition, respiratory gases etc. to the body cells.

(ii) **Veinular capillaries :** Which collect the metabolic wastes from the body cells.

* Capillaries possess about 7% of total body blood and are present near almost all cells of body in the intercellular spaces. The tissues which are devoid of intercellular spaces are also devoid of capillary. They are called avascular tissues.
* Capillaries are surrounded by cells of connective tissue called pericapillary cells.

Some of these cells are contractile and phagocytic in nature and are called Rouget cells or pericytes.

* Continuous capillaries are without fenestra/ aperture, hence are less permeable. These are present in organs such as lungs, muscles, connective tissues and brain tissues.
* Fenestrated capillaries possess apertures/fenestra and are found in those organs where there is maximum need of permeability such as endocrine glands, intestinal villi, cavities of brain, kidney, ciliary body of eye.
* Sinusoids are irregularly dilated capillaries found in organs where there is decrease in flow rate such as liver, spleen, bone marrow, parathyroid, pituitary gland. In liver, sinusoids are branches of venules and open into venules while in other organs, they originate from arteriole and unite to form venules.

(3) Veins :

* These are thin walled, carrying deoxygenated blood (oxygenated in pulmonary vein) from tissues to the heart.
* Venules, smallest branches, unite to form veins which in turn unite to form vena cava.
* The largest vein is inferior vena cava/post caval.
* Varicose veins is stout, blood filled painful veins specially of the limbs due to defective watch pocket valves.

CARDIAC CYCLE

* The action potential causes the atria and then the ventricles to undergo contraction (systole) followed by their relaxation (diastole).
* The systole forces the blood to move from the atria to the ventricles and to the pulmonary artery and the aorta.
* The cardiac cycle is formed by sequential events in the heart which is cyclically repeated and is called the cardiac cycle.
* About 70 mL of blood is pumped out by each ventricle during a cardiac cycle and it is called the **stroke or beat volume.**
* Volume of blood pumped out by each ventricle of heart per minute is called the **cardiac output** and it is equal to the product of stroke volume and heart rate (approx 5 litres).
* During each cardiac cycle two prominent sounds are produced which can be easily heard through a stethoscope.
* The first heart sound (lub) is associated with the closure of the tricuspid and bicuspid valves whereas the second heart sound (dub) is associated with the closure of the semilunar valves.
* **Blood pressure :** The pressure exerted by the blood on the wall of the blood vessels in which it is present is called blood pressure. It is usually measured in brachial artery by an instrument called sphygmomanometer (invented by Riva-Rocci). Arterial blood pressure is of 2 types :

(1) Systolic blood pressure : It is the pressure exerted by blood on the walls of the blood vessels due to the systole of ventricles and is equal to 120 mm Hg. During ventricular systole, there is expansion in the artery due to the uncoiling of elastic layer. Hence, the pressure is maximum in arteries but gradually decreases in capillaries and veins.

(2) Diastolic blood pressure : It is the pressure exerted on walls of blood vessels when the ventricles are relaxed. During ventricular diastole, the uncoiled elastic layer recoils leading to normalization of artery. Hence, blood pressure drops down to 80 mm Hg. Thus, blood pressure in normal person is systolic/diastolic pressure i.e. 120/80 mm Hg.

(3) Pulse pressure : The difference between systolic and diastolic pressures is called pulse pressure and its normal value is 120-80 mm Hg = 40 mm Hg. It provides information about the condition of arteries.

(4) Mean arterial pressure : It is the average pressure of systolic and diastolic pressures. As the blood remains in the systolic phase for shorter period and in the diastolic phase for longer period, the mean pressure of blood lies near the diastolic pressure.

The normal ratio of systolic pressure to diastolic pressure to pulse pressure is about 3 : 2 : 1.

The rhythmic changes in electrical activity of the heart are responsible for the cardiac cycle, thpattern of contraction and relaxation that takes place during each heartbeat.

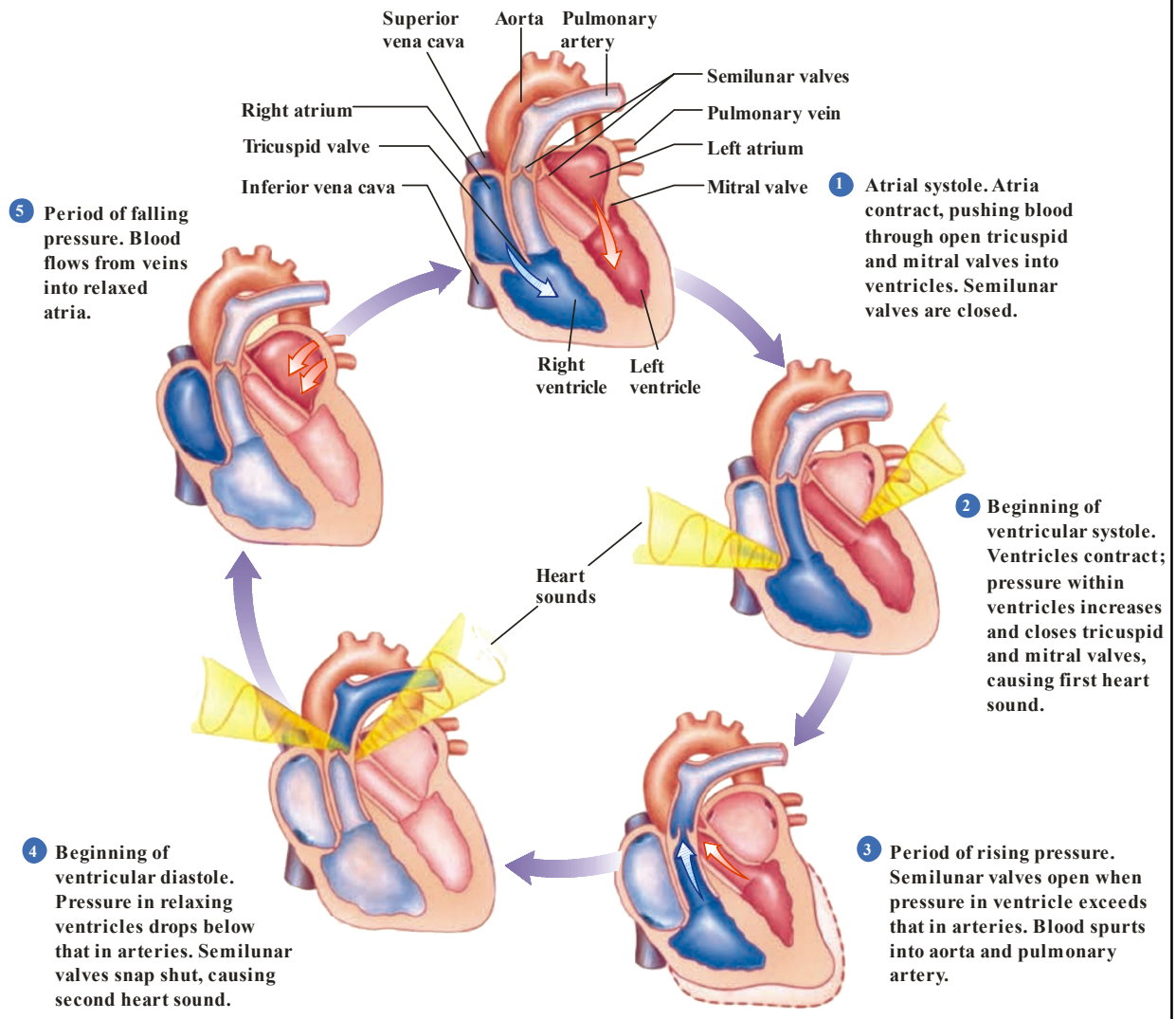


Figure : The cardiac cycle
The cycle comprises contraction of both atria followed by both ventricles. Arrows indicate the direction of blood flow; dotted lines indicate the change in size as contraction occurs.

ELECTROCARDIOGRAPH (ECG)

* ECG is a graphical representation of the electrical activity of the heart during a cardiac cycle.

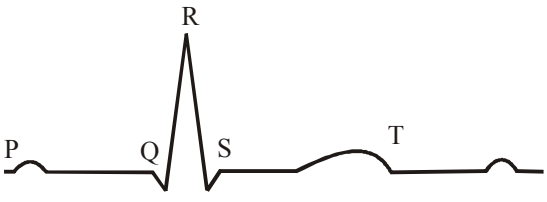


Figure : Standard ECG

* Each peak in the ECG is identified with a letter from P to T that corresponds to a specific electrical activity of the heart.
* The P-wave represents the electrical excitation (or depolarisation) of the atria, which leads to the contraction of both the atria.
* The QRS complex represents the depolarisation of the ventricles, which initiates 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.
* Obviously, by counting the number of QRS complexes that occur in a given time period, one can determine the heart beat rate of an individual.

* Since the ECGs obtained from different individuals have roughly the same shape for a given lead configuration, any deviation from this shape indicates a possible abnormality or disease.

DOUBLE CIRCULATION

* In the fishes only deoxygenated blood flow in the heart, this type of heart is called "Venous heart".
* In the fishes only two chambers (one auricle and one ventricle) present in the heart.
* In the fishes single circulation is present.
* In the Aves, mammals, Double blood circulation is found. Right portion of heart collects impure blood from body and sends it into the lungs. So in the right portion impure blood is present and this circulation takes place between heart and lungs. This is called pulmonary circulation.

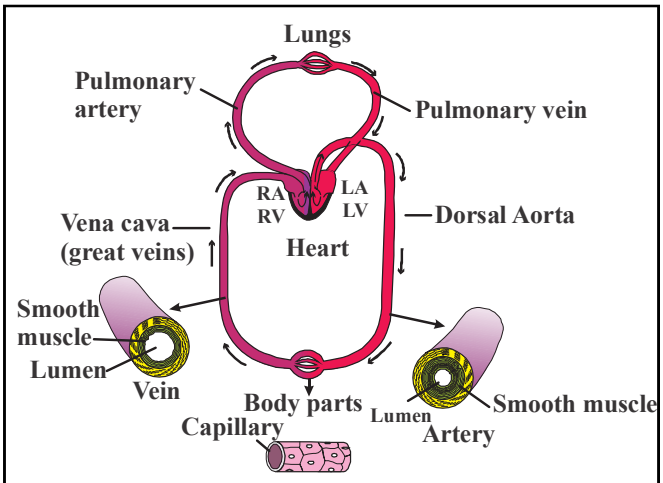


Figure : Schematic plan of blood circulation in human

In the left portion of heart takes pure blood from lungs and distributes it to whole body. So in left portion pure blood is present and this circulation takes place between heart and body. This called systemic circulation. So in the mammals blood flow in the heart twice in a time, so it is double blood circulation.

* 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.
* **Arterial system :** It involves aorta, arteries, arterioles and meta-arterioles. It supplies oxygenated blood to all parts of the body except lungs.
* The left ventricle of the heart pumps the oxygenated blood into a single, question marked shaped, long vessel called left carotid-systemic aorta. It is the largest blood vessel of the body.
* After ascending from the heart, the systemic aotra turns and descends down to the level of lower border of fourth lumbar vertebra. At its distal extremity, it bifurcates into right and left common iliac arteries. The sytemic aorta has following parts-

(1) **Ascending aorta :** It gives off left and right coronary arteries.

(2) **Descending aorta :** The aorta turns towards the back of heart and finally converts into dorsal aorta. The descending dorsal aorta is called thoracic aorta in throcic region and abdominal aorta in abdominal region.

* **Venous system :** It originates in tissues by union of capillaries and ends in the atrium of heart. It includes two major veins - superior and inferior vena cava which drain the deoxygenated blood into the right atrium.

(1) **Superior vena cava (pre caval) :** Single, formed by the union of right and left brachiocephalic (innominate) veins. It collects blood from head, neck, arms and chest region.

(2) **Inferior vena cava :** It is the largest vein, originated in inferior lumbar region by the union of right and left common iliac veins and opens into right atrium by separate opening. It collects blood from all body structures below the diaphragm.

PORTAL SYSTEM

* In this system the vein starts from capillaries and ends in capillaries.
* When venous blood is collected from some part of body is redistributed by capillaries in some other organ instead of being returned directly to the heart is called as portal system.

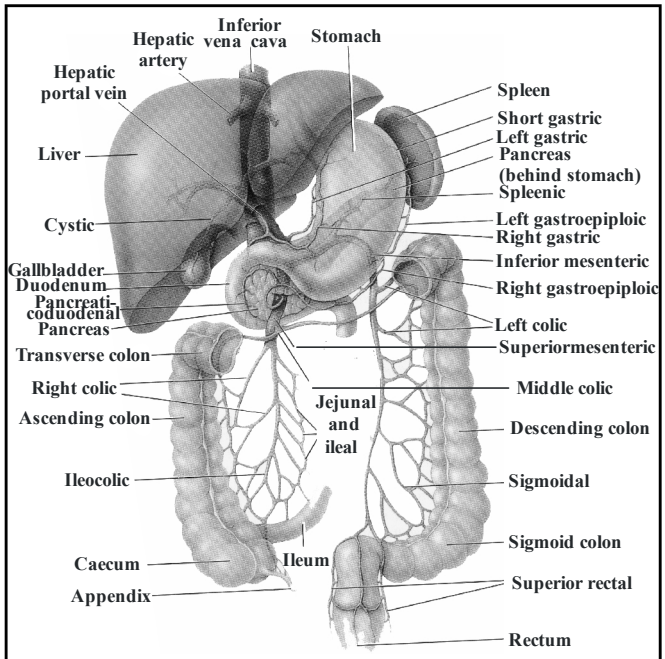


Figure : Human hepatic portal system

Types of portal system

(i) Renal Portal System :

* In this system vein which collect blood from posterior parts of body and legs, enter into the kidney. This vein is called Renal Portal Vein.
* Now this vein divides into capillaries and form renal portal system. This system is found in lower vertebrates like Amphibians, fishes.
* This system is absent in human and rabbit.

(ii) Heptaic Portal System:

* It is found in all vertebrates.
* In this system, veins which collect blood from digestive and absorptive parts of alimentary canal, enter into the Liver this is called heptaic portal vein.
* Now in Liver it divides into capillaries and form hepatic portal system.
* This vein is made up of four veins

(a) Lienogastric vein : collects blood from stomach, spleen

(b) Duodenal vein : Carries blood from pancrease, duodenum

(c) Anterior Mesentric vein : From ileum, caecum and colon

(d) Posterior Mesentric vein : Rectum and anus.

(iii) Hypothalamo hypophysial portal system :

* This system occurs in mammalian brain.
* This is present between hypothalamus and anterior lobe of the pituitary gland.
* Hypophysial portal vein carries blood from the hypothalamus of the brain to the anterior lobe of the pituitary gland.
* This portal system enables the hormones of hypothalamus to reach the anterior lobe of the pituitary gland.

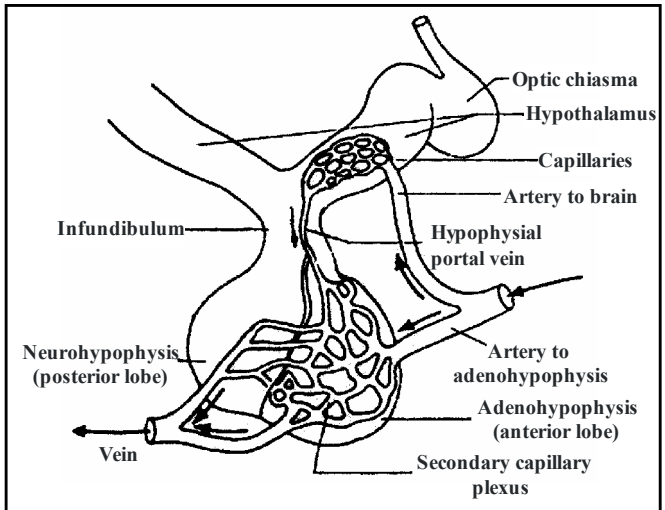


Figure : Human hypophysial portal system

DISORDER

* **High Blood Pressure (Hypertension):** Hypertension is the term for blood pressure that is higher than normal (120/80). In this measurement 120mm Hg (millimetres of mercury pressure) 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 (140 over 90) or higher, it shows hypertension.
* **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 by deposits of calcium, fat, cholesterol and fibrous tissues, which makes the lumen of arteries narrower.
* **Angina:** It is also called 'angina pectoris'. A symptom of acute chest pain appears when no enough oxygen is reaching the heart muscle. Angina can occur in men and women of any age but it is more common among the middle-aged and elderly. It occurs due to conditions that affect the blood flow.
* **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).

CONCEPT REVIEW

* Small, simple invertebrates, such as sponges, cnidarians, and flatworms, depend on **diffusion** for internal transport. Larger animals require a specialized circulatory system, which typically consists of **blood**, a **heart**, and a system of blood vessels or spaces through which blood circulates. In all animals, **interstitial fluid**, the tissue fluid between cells, brings oxygen and nutrients into contact with cells.
* Arthropods and most mollusks have an **open circulatory system** in which blood flows into a **hemocoel**, bathing the tissues directly.
* Some invertebrates and all vertebrates have a **closed circulatory system** in which blood flows through a continuous circuit of blood vessels.
* The vertebrate circulatory system consists of a muscular heart that pumps blood into a system of **arteries, capillaries,** and **veins**. This system transports nutrients, oxygen, wastes, and hormones; helps maintain fluid balance, appropriate pH, and body temperature; and defends the body against disease.
* **Plasma** consists of water, salts, substances in transport, and plasma proteins, including albumins, globulins, and fibrinogen.
* **Red blood cells**, also called **erythrocytes**, transport oxygen and carbon dioxide. Red blood cells produce large quantities of **hemoglobin**, a red pigment that binds with oxygen.
* **White blood cells**, also called leukocytes, defend the body against disease organisms. Lymphocytes and monocytes are agranular white blood cells; neutrophils, eosinophils, and basophils are granular white blood cells.
* **Platelets** patch damaged blood vessels and release substances essential for blood clotting.
* **Prothrombin** is converted to thrombin, which catalyzes the conversion of fibrinogen to an insoluble protein, **fibrin**. Fibrin forms long threads that form the webbing of the clot.
* Arteries carry blood away from the heart; veins return blood to the heart.
* **Arterioles** constrict (vasoconstriction) and dilate (vasodilation) to regulate blood pressure and distribution of blood to the tissues.
* Capillaries are the thin-walled exchange vessels through which blood and tissues exchange materials.
* The vertebrate heart has one or two **atria**, which receive blood, and one or two **ventricles**, which pump blood into the arteries.
* The fish heart consists of a single atrium and ventricle that are part of a single circuit of blood flow.

* In terrestrial vertebrates, complex circulatory systems separate oxygen-rich from oxygen-poor blood; this allows the higher metabolic rate needed to support an active terrestrial life style.
* Amphibians have two atria and a ventricle, and blood flows through a double circuit so that oxygen-rich blood is partly separated from oxygen-poor blood. Most reptiles have a wall that partly divides the ventricles, minimizing the mixing of oxygen rich and oxygen-poor blood.
* The four-chambered hearts of birds and mammals separate oxygen-rich blood from oxygen-poor blood.
* The heart is enclosed by a **pericardium** and has valves that prevent backflow of blood. The valve between right atrium and ventricle is **the right atrioventricular (AV) valve**, or **tricuspid valve**. The valve between left atrium and ventricle is the mitral valve. **Semilunar valves** guard the exits from the heart. Cardiac muscle fibers are joined by **intercalated discs.**
* The **sinoatrial (SA) node**, or **pacemaker**, initiates each heart beat. A specialized electrical conduction system coordinates heartbeats.
* One complete heartbeat makes up a **cardiac cycle.** Contraction occurs during **systole**. The period of relaxation is **diastole**. At the beginning of ventricular systole, the closing of the AV valves, makes a low-pitched "lub" sound. The closing of the semilunar valves, the beginning of ventricular diastole, makes a short, loud, sharp "dup" sound.
* **Cardiac output (CO)** equals stroke volume times heart rate. Stroke volume depends on venous return and on neural messages and hormones, especially epinephrine and norepinephrine.
* According to **Starling's law of the heart**, the more blood delivered to the heart by the veins, the more blood the heart pumps.
* Heart rate is regulated mainly by the nervous system and is influenced by hormones and body temperature.
* **Blood pressure** is the force blood exerts against the inner walls of the blood vessel. Blood pressure is greatest in the arteries and decreases as blood flows through the capillaries.
* The **pulmonary circulation** connects heart and lungs; the systemic circulation connects the heart and the tissues.
* In the pulmonary circulation, the right ventricle pumps blood into the **pulmonary arteries**, one going to each lung. Blood circulates through pulmonary capillaries in the lung and then is conducted to the left atrium by a **pulmonary vein.**
* In the systemic circulation, the left ventricle pumps blood into the **aorta**, which branches into arteries leading to the body organs. After flowing through capillary networks within various organs, blood flows into veins that conduct it to the **superior vena cava** or **inferior vena** cava which returns blood to the right atrium.
* The **coronary arteries** supply the heart muscle with blood.
* The **hepatic portal system** circulates nutrient-rich blood through the liver.
* The **lymphatic system** collects interstitial fluid, and returns it to the blood. It plays an important role in homeostasis of fluids. The lymph system also defends the body against disease and absorbs lipids from the digestive tract.
* **Lymphatic vessels** conduct lymph, a clear fluid formed from interstitial fluid, to the thoracic duct and right lymphatic duct in the shoulder region; these ducts return lymph to the blood circulatory system.
* **Lymph nodes** are small masses of tissue that filter bacteria and harmful materials out of lymph.

IMPORTANT POINTS

* Universal recipient blood group is AB.
* The artery can be distinguished from the vein in having thicker walls.
* Blood group AB has no antibody.
* O blood group has no antigens.
* Sodium oxalate is the common anticoagulant used for preserving blood.
* Purkinje fibres are muscles fibres.
* A vein that breaks up into capillaries is hepatic portal vein.
* Pacemaker of heart is SA node.

* Origin of heart beat and its conduction is represented by
  SA node → AV node → Bundle of His → Purkinje fibres
* The hormone that stimulates heart beat is adrenaline.
* Mitochondria are absent in RBC.
* Systole causes exit of blood from ventricles.
* Bivuspid valve = Heart Nephron = Kidney
  Alveoli = Lungs Cerebrum = Brain
* Systematic circulation of oxygenated blood starts from left ventricle.
* Neutrophils, eosinophils, basophils are granulocytes.
* Pulmonary artery drains deoxygenated blood from right ventricles.
* In ECG, T wave represent diastole of auricles and ventricles.
* Cardiac impulse that accomplishes heart beat is delayed at AV node.
* Artery is a vessel that carries blood away from heart.
* 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.
* Parasympathetic neural signals (another component of ANS) decrease the rate of heart beat, speed of conduction of action potential and thereby the cardiac output.
* Adrenal medullary hormones can increase the cardiac output.
* Ischaemia : Inadequate flow of blood to a part of the heart caused by obstruction to its blood supply.
* A Blue baby is the name given to abnormal human baby who has a hole in the ventricular septum so that pure and impure blood mix.
* Dextrocardia : Human heart get displaced right side of the chest.
* World's first heart transplant was done by a team of doctors headed by Prof. Christian Bernard on 3rd Dec. 1967.
* India's first heart transplant was done by a team of doctors led by Dr. P.Venugopal on 3rd August, 1994.
* LDL (Low density lipoprotein) : It is harmful for our body, its high concentration in blood causes heart disease and thus termed as bad lipoprotein.
* **HDL (High density lipoprotein) :** It's higher concentration reduces the risk of heart disease thus termed as good lipoprotein.
* Blood donation day - 1st October.
* The action potential generated at S.A. node travels throughout the auricles at a velocity of 0.3 m/sec.
* **Superior vena cava or precaval :** Brings deoxygenated blood from head and upper parts of the body into the right auricle through an opening which is single in human and cat and two in rabbit as there are 2 precavals - right and left in rabbit.
* **Inferior vena cava or post caval :** Drains deoxygenated blood from middle and lower parts of the body into the right auricle through a single opening which is bordered by a membranous, falciform fold which is a remnant of the foetal valve of Eustachian.
* **Coronary sinus :** Returns deoxygenated blood from heart wall into right auricle through a single opening.
* **Pulmonary vein :** Four pulmonary veins, two from each lung, carry oxygenated blood from the lungs and open into the left auricle through four openings. In rabbit, the pulmonary veins open in the left auricle through 2 openings.
* **Pulmonary aorta/arch :** Arises from upper left corner of right ventricle through a single opening and divides into right and left pulmonary arteries which carry deoxygenated blood to the lungs for oxygenation.
* **Systemic aorta :** Arises from upper right corner of left ventricle through a single opening and has 3 regions - ascending aorta, arch of aorta and descending aorta. It distributes oxygenated blood to various body parts except lungs.

* **Right A.V. valve or Tricuspid valve :** Present between right auricle and right ventricle. It consists of 3 membranous flaps or cusps.
* **Left A.V. valve or Bicuspid or Mitral valve:** Present between left auricle and left ventricle. It consists of 2 flaps or cusps. The bicuspid valve resembles mitre or topi of bishop, hence, also called as Mitral valve.
* **Semilunar valves :** At the base of pulmonary arch and systemic aorta, three membranous, pocket-shaped flaps called semilunar valves are present. They allow the passage of blood from ventricles to respective blood vessels, but prevent the return of blood.
* Increase in Na^+ ions in blood or in cardiac muscles, decrease heart rate.
* Increase in Ca^{2+} ions in blood increase heart beat but if they are injected in cardiac muscles, heart stops in contracted phase which is called Systolic Arrest.
* Injection of K^+ ions in heart muscles stop impulse generation. So, heart stops in diastolic or Relax phase.
* Blood flows through the pulmonary circulation in the following sequence:
right atrium → right ventricle → pulmonary arteries → pulmonary capillaries (in lungs) → pulmonary veins → left atrium.
* Blood circulation through the systemic circuit, let us trace a drop of blood from the heart to the right leg and back to the heart:
Left atrium → left ventricle → aorta → right common iliac artery → smaller arteries in leg → capillaries in leg → small veins in leg → common iliac vein → inferior vena cava → right atrium.

* **Table : Cell Components of Blood**

	Normal range	Function	Pathology
Red Blood Cells (RBCs)	Male: 4.2-5.4 million/µL, Female:3.6-5 million/µL,	Oxygen transport; carbon dioxide transport	Too few: anemia Too many: polycythemia
Platelets	150,000-400,000/µL	Essential for clotting	Clotting malfunctions; bleeding; easy bruising
White Blood Cells(WBCs)	5000-10,000/µL		
Neutrophils	About 60% of WBCs	Phagocytosis	Too many: may be due to bacterial infection, inflammation, myelogenous leukemia
Eosinophils	1%- 3% of WBCs	Play some role in allergic response.	Too many: may result from allergic reaction, parasitic infestation
Basophils	l% of WBCs	May play role in prevention of inappropriate clotting.	
Lymphocytes	25%-35% of WBCs	Produce antibodies; destroy foreign cells.	A typical lymphocytes present in infectious mononucleosis; too many may be due to lymphocytic leukemia, certain viral infections.
Monocytes	6% of WBCs	Differentiate to form macrophages.	May increase in monocytic leukemia and fungal infections.

QUESTION BANK

EXERCISE - 1 (LEVEL-1) [NCERT EXTRACT]

SECTION - 1 (VOCABULARY BUILDER)

Choose one correct response for each question.

For Q.1-Q.6

Match the column I with column II.

Q.1

	Column I	Column II
(a)	Fibrinogen	(i) Clotting or coagulation of blood.
(b)	Globulins	(ii) Defence mechanism of body
(c)	Albumins	(iii) Osmotic balance

(A) (a) – (iii), (b) – (ii), (c) – (i)
(B) (a) – (iii), (b) – (i), (c) – (ii)
(C) (a) – (ii), (b) – (i), (c) – (iii)
(D) (a) – (i), (b) – (ii), (c) – (iii)

Q.2

	Column I	Column II
(a)	Basophils	(i) Phagocytes
(b)	Neutrophlls	(ii) Secrete histamine, serotonin and heparin
(c)	Monocytes	(iii) Allergic reaction
(d)	Eosinophils	(iv) Immunity
(e)	Lymphocytes	

(A) (a)–(i), (b)–(ii), (c) – (iii), (d) – (iv), (e)-(i)
(B) (a)–(ii), (b)–(i), (c) – (i), (d) – (iii), (e)-(iv)
(C) (a)–(i), (b)–(i), (c) – (ii), (d) – (iii), (e)-(iv)
(D) (a)–(iv), (b)–(i), (c) – (ii), (d) – (iii), (e)-(iii)

Q.3

	Column I	Column II
(a)	Heart failure	(i) Heart muscle is suddenly damaged by an inadequate blood supply.
(b)	Cardiac arrest	(ii) Chest pain due to inadequate reaching the heart muscles.
(c)	Heart attack	(iii) Atherosclerosis
(d)	Coronary Artery Disease (CAD)	(iv) Heart not pumping blood effectively enough to meet the needs of the body.
(e)	Angina pectoris	(v) Heart stops beating.

Codes
(A) (a)–(iv), (b)–(v), (c) – (i), (d) – (iii), (e)-(ii)
(B) (a)–(v), (b)–(iv), (c) – (i), (d) – (iii), (e)-(ii)
(C) (a)–(iv), (b)–(v), (c) – (i), (d) – (ii), (e)-(iii)
(D) (a)–(v), (b)–(iv), (c) – (ii), (d) – (iii), (e)-(i)

Q.4

	Column I	Column II
(a)	Fishes	(i) One atrium one ventricle.
(b)	Amphibian	(ii) Two atria two ventricles.
(c)	Reptile	(iii) Two atria one ventricle.
(d)	Mammal	

Codes
(A) (a) – (i), (b) – (ii), (c) – (ii), (d) – (iii)
(B) (a) – (iii), (b) – (ii), (c) – (ii), (d) – (i)
(C) (a) – (i), (b) – (iii), (c) – (iii), (d) – (ii)
(D) (a) – (iii), (b) – (iii), (c) – (ii), (d) – (i)

Q.5

	Column I (Waves)	Column II (Interpretation)
(a)	P	(i) Electrical excitationof atria
(b)	QRS	(ii) Repolarisation of ventricles
(c)	T	(iii) Depolarisation of ventricles

Codes
(A) (a) – (i), (b) – (ii), (c) – (iii)
(B) (a) – (i), (b) – (iii), (c) – (ii)
(C) (a) – (iii), (b) – (ii), (c) – (i)
(D) (a) – (iii), (b) – (i), (c) – (ii)

Q.6

	Column I	Column II
(a)	Neutrophile	(i) 20-25% of WBC
(b)	Basophils	(ii) 2-3% of WBC
(c)	Monocytes	(iii) 6-8%of WBC
(d)	Eosinophils	(iv) 0.5-1 % of WBC
(e)	Lymphocytes	(v) 60-65% of WBC

Codes
(A) (a)–(v), (b)–(iv), (c) – (iii), (d) – (ii), (e)-(i)
(B) (a)–(v), (b)–(iv), (c) – (ii), (d) – (iii), (e)-(i)
(C) (a)–(i), (b)–(ii), (c) – (iii), (d) – (iv), (e)-(v)
(D) (a)–(v), (b)–(ii), (c) – (iv), (d) – (iii), (e)-(i)

SECTION - 2 (BASIC CONCEPTS BUILDER)

For Q.7 to Q.26 :

Choose one word for the given statement from the list.

Purkinje fibre, Plasma, Inactive, Serum, Clotting, Deoxygenated, Oxygenated, Neutrophils, Interstitial fluid, Allergic, Calcium, QRS complex, Semilunar; Dub, 12-16, 6-100, Respiratory, 55, 90-92, 6-8, Right, Pulmonary, Left, Aorta, Muscular chambered heart, 2, 3, 4, Nodal tissue, SAN, AVN, O_2, Tissue, CO_2, Atria, Asterial systole, 30, Left atria, Right atria, Nodal musculature.

Q.7 Plasma without _____ factors is called serum.

Q.8 _____ and monocytes are phagocytic cells.

Q.9 Eosinophils are associated with _____ reactions.

Q.10 ____ ions play a significant role in clotting.

Q.11 One can determine the heart beat rate by counting the number of _____ in an ECG.

Q.12 Plasma is a straw coloured viscous fluid constituting nearly ____ % of the blood, ____% of the plasma is water and the protein constitutes ____% of it.

Q.13 The blood pumped by the ____ ventricle enters the ____ artery, whereas the ____ ventricle pumps blood into the ____.

Q.14 The branches of the nodal tissue, which give rise to minute fibres throughout the ventricular musculature of the respective sides are called ____.

Q.15 All vertebrates possesses a ____ Fishes have a ____ chambered heart with atrium and ventricles. Amphibians and reptiles have a ____ chambered heart. Bird and mammals have ____ chambered of heart.

Q.16 A healthy individual has ____ grams of haemoglobin in every ____ mL of blood. These molecules plays a significant role in the transport of ____ gases.

Q.17 In fishes, the heart pumps out ____ blood which is __ by the gills and supplied to the body parts from where deoxygenated blood returns to the heart.

Q.18 SAN generates an action potential which stimulates both the ___ to undergo a simultaneous contraction called ____. This increases the flow of the blood into the ventricles by about ____ percentage.

Q.19 In bird and mammals, the oxygenated blood received by ___ and deoxygenated blood receive by ___. The ventricles pump it out without any mixing up of oxygenated and deoxygenated blood.

Q.20 A specialised cardiac musculature called ____ tissue is distributed in the heart. A patch of this tissue is present in the right upper corner of the right atrium called ____. Another mass of this tissue is seen in the lower left corner of the right atrium close to the atrio-ventricular septum called ____.

Q.21 In amphibians and reptiles, the __ atrium receives oxygenated blood from the gills/lung/skin and ___ atrium gets the ___ blood from other body parts.

Q.22 In the ventricular diastole, the ____ valve closes. This causes the second heart sound ____.

Q.23 Autoexitable fibres/nodes are called ____.

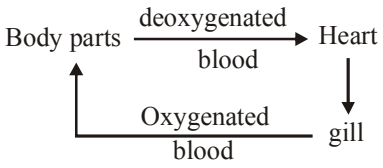
Q.24 As the blood passes through the capillaries some water along with small water soluble substances move out into the spaces between the cells of the tissues. This fluid released out is called the ____.

Q.25 The systemic circulation provides nutrients, ____and other essential substances to the ____ and takes, _____ and other harmful substances away for elimination.

Q.26 Factors for coagulation or clotting of the blood are also present in the ___ in an ___ form. Plasma without the clotting factors is called ___ .

SECTION - 3 (ENHANCE DIAGRAM SKILLS)

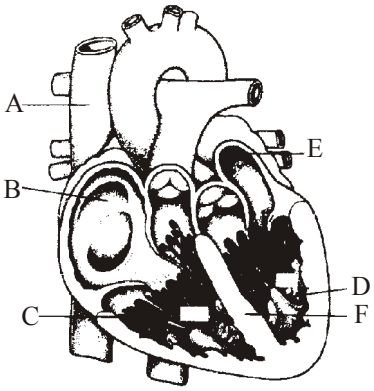
Q.27



Given diagram depicts the circulation in

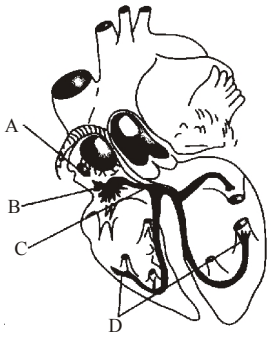
(A) fishes (B) mammals
(C) reptile (D) amphibian

Q.28 Identify A to F in the given diagram of human heart and choose the correct option.



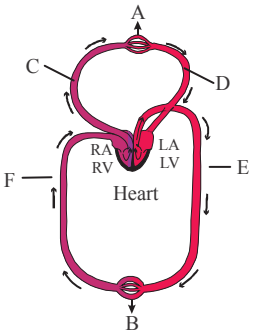
(A) A-Vena cava, B-Right atrium, C-Left atrium, D-Right ventricle, E-Left ventricle, F-Interventricular septum
(B) A-Vena cava, B-Right atrium, C-Right ventricle, D-Left ventricle, E-Left atrium, F-Interventricular septum
(C) A-Vena cava, B-Right atrium, C-Right ventricle, D-Left atrium, E-Left ventricle, F-Interventricular septum
(D) A-Vena cava, B-Left atrium, C-Right ventricle, D-Left ventricle, E-Right atrium, F-Interventricular septum

Q.29 Identify the correct labelling for A, B, C and D and choose the correct option accordingly.



(A) A-Sinoauricular node, B-Atrioventricular node, C-Bundle of His, D-Purkinje fibre
(B) A-Sinoauricular node, B-Atrioventricular node, C-Purkinje fibre, D-Bundle of His
(C) A-Purkinje fibre, B-Atrioventricular node, C-Bundle of His, D-Sinoauricular node
(D) A-Purkinje fibre, B-Bundle of His, C-Sino auricular node, D-Atriventricular node

Q.30 Identify A to F.



Choose the correct option.

(A) A-Lungs, B-Body parts,C-Pulmonary vein, D-Pulmonary artery, E-Dorsal aorta, F-Vena cava
(B) A-Lungs, B-Body parts, C-Pulmonary artery, D-Pulmonary vein, E-Dorsal aorta, F-Vena cava
(C) A-Lungs, B-Body parts, C-Pulmonary artery, D-Pulmonary vein, E-Vena cava, F-Dorsal aorta
(D) A-Body parts, B-Lungs, C-Pulmonary artery, D-Pulmonary vein, E-Vena cava, F-Dorsal aorta

SECTION - 4 (ENHANCE PROBLEM SOLVING SKILLS)

Choose one correct response for each question.

PART - 1 : BLOOD

Q.31 Organisms which circulate water from their surrounding through their body cavities to facilitate the cells to exchange the substances are
(A) Porifera (B) Sponges
(C) Both (A) and (B) (D) None of the above

Q.32 Which of the following option describes all the components of human blood?
(A) A and B blood group
(B) AB and O blood group
(C) Rh and ABO blood group
(D) Rh and AB blood group

Q.33 Erythroblastosis foetalis is a disease in which
(A) adult have severe anaemia and jaundice.
(B) female have severe anaemia and jaundice.
(C) male have severe anaemia and jaundice.
(D) foetus have severe anaemia and jaundice.

Q.34 The graveyard of RBC is
(A) liver (B) stomach
(C) spleen (D) bone marrow

Q.35 Lymphocytes (20-25%) are of two major types, B and T forms. They are responsible for
(A) blood coagulation (B) thickness of blood
(C) immune responses (D) All of these

Q.36 What will happen if a Rh –ve person is exposed to the Rh +ve person?
(A) Antigen formation takes place.
(B) –ve and +ve Rh antigen cancel out each other
(C) Nothing will happen
(D) Antibody will form

Q.37 Which one of the following type of cells lack nucleus?
(i) RBC (ii) Neutrophils
(iii) Eosinosphils (iv) Monocytes
(A) i, ii (B) ii, iii
(C) i, iv (D) ii, iv

Q.38 Which of the following is a cell fragment?
(A) Blood platelets (B) Bone cells
(C) Lymphocytes (D) Leucocytes

Q.39 Most abundant cells in the human blood are
(A) WBC (B) Plasma cells
(C) RBC (D) Platelets

Q.40 Major proteins in the human blood are
I. fibrinogen II. globulins
III. albumins
(A) I and II (B) II and III
(C) I and III (D) I, II and III

Q.41 Source of thromboplastin in the human blood is
(A) WBC (B) RBC
(C) Blood platelets (D) Both (B) and (C)

Q.42 Clotting disorders occur mainly due to the reduction in the number of
(A) Granulocytes (B) RBC
(C) WBC (D) Platelets

Q.43 One of the common symptoms observed in people infected with Dengue fever is
(A) Significant decrease in RBC count
(B) Significant decrease in WBC count
(C) Significant decrease in platelets count
(D) Significant increase in platelets count

Q.44 Blood without corpuscles and fibrinogen is called
(A) lymph (B) serum
(C) plasma (D) platelets

Q.45 Leucocytes are colourless due to
(A) lack of water
(B) lack of haemoglobin
(C) presence of extra water
(D) presence of haemoglobin

Q.46 Individuals having Rh antigen are called
(A) Rh negative (Rh–ve)
(B) Rh positive (Rh +ve)
(C) Rh (±)
(D) Rhesus positive

Q.47 Human blood consists of
(A) Fluid matrix (B) Plasma
(C) Formed elements (D) All of the above

Q.48 In humans, RBCs are formed in
(A) red bone marrow (B) heart
(C) lungs (D) yellow bone marrow

Q.49 Mark, among the following a cell which does not exhibit phagocytotic activity
(A) Monocytes (B) Neutrophil
(C) Basophil (D) Macrophage

Q.50 Platelets are
(A) also called thrombocytes
(B) cell fragments
(C) produced from megakaryocytes
(D) All of the above

Q.51 Which of the following statements is incorrect?
(A) A person of 'O' blood group has anti 'A' and anti 'B' antibodies in his blood plasma.
(B) A person of 'B' blood group can't donate blood to a person of 'A' blood group.
(C) Blood group is designated on the basis of the presence of antibodies in the blood plasma.
(D) A person of AB blood group is universal recipient.

Q.52 The name Rh blood group is derived from
(A) chimpanzee (B) monkey
(C) man (D) primitive man

Q.53 pH of the human blood is
(A) between 7-8 (B) between 12-14
(C) between 2-4 (D) between 2-5

Q.54 Blood is a –
(A) mobile connective tissue.
(B) liquid connective tissue.
(C) Both (A) and (B)
(D) semisolid connective tissue.

Q.55 RBCs have an average life span of
(A) 90 days (B) 100 days
(C) 120 days (D) 140 days

Q.56 Universal donors and universal receipients are
(A) A, B and O blood groups, respectively.
(B) O and AB blood groups, respectively.
(C) O and A blood groups, respectively.
(D) AB and O blood groups, respectively.

Q.57 Granulocytes and agranulocytes are the two main categories of
(A) RBC (B) WBC
(C) thrombocyte (D) blood platelets

PART - 2 : LYMPH (TISSUE FLUID)

Q.58 Lymphatic system is an elaborated network of vessels which collect the
(A) interstitial fluid (B) intrastitial fluid
(C) plasma fluid (D) protein fluid

Q.59 The cells involved in inflammatory reactions are
(A) Basophils (B) Neutrophils
(C) Eosinophils (D) Lymphocytes

Q.60 Lymph is a colourless fluid containing specialised
(A) RBC (B) lymphocytes
(C) cells (D) long lined cells

Q.61 Which system has a major role in defence against infection?
(A) Respiratory system (B) Circulatory system
(C) Lymphatic system (D) All of these

Q.62 Lymph is an important carrier for the transport of –
(A) nutrients (B) hormones
(C) platelets (D) Both (A) and (B)

Q.63 Which of the following statement is true for lymph?
(A) WBC and serum
(B) All components of blood except RBCs and some proteins
(C) RBC, WBC and plasma
(D) RBC, WBC and platelets

Q.64 Exchange of gases, nutrient, etc., between the blood and the cells takes place through
(A) RBC (B) WBC
(C) interstitial fluid (D) intrastitial fluid

Q.65 Fats in the human body are absorbed through
(A) lymph (B) phagocytes
(C) monocytes (D) Both (B) and (C)

Q.66 Which of the following acts as 'middle man of the body'?
(A) Plasma (B) Lymph
(C) RBC (D) WBC

PART - 3 : CIRCULATORY PATHWAYS

Q.67 In an open circulatory system,
(A) there is no distinction between the blood and the tissue fluid.
(B) of tissue fluid is absent.
(C) no need of blood vessels.
(D) open space or sinuses are absent.

Q.68 The first heart sound 'Lubb' occurs in which phase of the cardiac cycle?
(A) isometric relaxation (B) atrial diastole
(C) ventricular systole (D) ventricular diastole

Q.69 In reptiles and amphibians, there is no clear cut separation of oxygenated and deoxygenated blood because they have –
(A) only one atrium (B) only one ventricle
(C) only two atria (D) only two ventricles

Q.70 Atrial diastole takes place when
(A) right atrium is filled with blood.
(B) left atrium is filled with blood.
(C) both atriums are filled with blood.
(D) both ventricles are filled with blood.

Q.71 ECG is a graphical representation of the electric activity of the heart during
(A) cardiac systole
(B) cardiac diastole
(C) cardiac cycle
(D) ventricular and atrial diastole

Q.72 The wall of the ventricles are much thicker than that of atrium because
(A) It has to pump the blood.
(B) It has to receive the blood.
(C) It is present below the atrium.
(D) It has to store the blood.

Q.73 Which among the followings is correct during each cardiac cycle?
(A) The volume of blood pumped out by the Rt and Lt ventricles is same.
(B) The volume of blood pumped out by the Rt and Lt ventricles is different.
(C) The volume of blood received by each atrium is different.
(D) The volume of blood received by the aorta and pulmonary artery is different.

Q.74 Which nodal fibres lies along the right and left ventricles (interventricular septum) ?
(A) Bundle of His (B) Purkinje fibre
(C) Neural tissue fibre (D) Cardiac tissue fibre

Q.75 All reptiles have a three-chambered heart except
(A) snake (B) crocodile
(C) lizard (D) Both (B) and (C)

Q.76 Bicuspid valves are found in between
(A) right ventricle and right auricle.
(B) right ventricle and left auricle.
(C) left ventricle and left auricle.
(D) right ventricle and left auricle.

Q.77 During each cardiac cycle, prominant sounds are produced which can be easily heard through stethoscope. They are –
(A) lub (B) dub
(C) tick (D) Both (A) and (B)

Q.78 Open circulatory system is present in
(A) arthropods and mammals
(B) mollusca and aves
(C) arthropods and mollusca
(D) mammals and aves

Q.79 What would be the cardiac output of a person having 72 heart beats per minute and a stroke volume of 50 ml?
(A) 360 mL (B) 3600 mL
(C) 7200 mL (D) 5000 mL

Q.80 When two atria contract simultaneously and results in the blood pumping into ventricles, this is called –
(A) arterial diastole (B) arterial systole
(C) ventricular diastole (D) ventricular systole

Q.81 Which of the following correctly explains a phase/ event in cardiac cycle in a standard electrocardiogram?
(A) QRS complex indicates atrial contraction.
(B) QRS complex indicates ventricular contraction.
(C) Time between S and T represents atrial systole.
(D) P-wave indicates beginning of ventricular contraction.

Q.82 Which wave of human heart out of P, Q, R, S, T is used for determining the heart beat of an individual?
(A) P (B) QRS
(C) T (D) RS

Q.83 Opening of the right ventricle to the pulmonary artery and left ventricle to the aorta is provided with –
(A) bicuspid valve (B) tricuspid valve
(C) semilunar valve (D) All of these

Q.84 Duration of a cardiac cycle is
(A) 0.6 second (B) 0.7 second
(C) 0.8 second (D) 0.9 second

Q.85 Which of the following is incorrect?
(A) Heart is endodermal in origin.
(B) Human heart is situated in the between the two lungs slightly tilted to left.
(C) Heart is a double walled membranous bag.
(D) Human heart has two atria and two ventricles.

Q.86 When all the four-chambers of the heart are in relaxed state, it is called
(A) joint systole (B) joint diastole
(C) systole (D) diastole

Q.87 Closed Circulatory system is present in
(A) annelids and chordates.
(B) arthropods and annelids.
(C) arthropods and chordates.
(D) molluscs and annelids.

Q.88 Cardiac cycle is a cyclic event that occur in
(A) single beat (B) double beat
(C) atrium (D) ventricle

Q.89 To obtain a standard ECG, the patient is connected to the machine with three electrical leads. These three electrical lead are connected as one each to the
(A) biceps and third one at the ankle.
(B) triceps and third one at the ankle.
(C) thigh and third one at the ankle.
(D) wrist and third one at the ankle.

Q.90 The second heart sound (dubb) is associated with the closure of
(A) Tricuspid valve
(B) Semilunar valves
(C) Bicuspid valve
(D) Tricuspid and bicuspid valves.

Q.91 Tricuspid valve is present in between
(A) right atrium and right ventricle.
(B) right atrium and left ventricle.
(C) left atrium and left ventricle.
(D) left atrium and right ventricle.

Q.92 Cardiac output is
(A) volume of the blood pumped out by each ventricle per minute.
(B) volume of the blood contained in the entire heart.
(C) volume of the oxygenated blood pumped by heart.
(D) volume of the deoxygenated blood pumped by heart.

Q.93 SA node is called the pacemaker of heart because –
(A) it can change the contractile activity generated by AV node.
(B) it delays the transmission of impulse between the atria and ventricles.
(C) it gets stimulated when it receives neural signals.
(D) it initiates and maintains the rhythmic contractile activity of heart.

Q.94 ECG depicts the depolarisation and repolarisation processes during the cardiac cycle. In the ECG of a normal healthy individual one of the following waves is not represented.
(A) Depolarisation of atria
(B) Repolarisation of atria
(C) Depolarisation of ventricles
(D) Repolarisation of ventricles

Q.95 Bicuspid and tricuspid valve opens when
(A) blood from the pulmonary artery and vena cava flows into the left and right ventricles, respectively.
(B) blood from the pulmonary vein and vena cava flows into left and right ventricles, respectively.
(C) blood from the pulmonary vein and vena cava flows into left and right atrium, respectively.
(D) oxygen from the pulmonary vein and vena cava flows into left and right atrium, respectively.

Q.96 Advantage of closed circulatory system is that
(A) exchange occurs more rapidly.
(B) flow of blood more precisely regulated.
(C) it can support high metabolic activity.
(D) All of the above.

PART - 4 : DOUBLE CIRCULATION

Q.97 Double circulation is
(A) passage of blood twice in heart through the same way.
(B) passage of blood twice in heart through the unique way.
(C) passage of blood twice in heart through the separate way.
(D) None of the above

Q.98 Pulmonary circulation is
(A) Left auricle $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Lungs $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Right ventricle
(B) Left auricle $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Lungs $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Right ventricle
(C) Right ventricle $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Lungs $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Left auricle
(D) Right ventricle $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Lungs $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Left auricle

Q.99 Hepatic portal system is a
(A) vascular connection between the digestive tract and liver.
(B) vascular connection between the liver and lungs.
(C) vascular connection between the spleen and liver.
(D) vascular connection between the digestive tract and spleen.

Q.100 Systemic circulation is –
(A) Left ventricle $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Tissues $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Right ventricle
(B) Right ventricle $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Tissues $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Right auricle
(C) Left ventricle $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Tissues $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Right auricle
(D) Left ventricle $\xrightarrow[\text{blood}]{\text{Oxygenated}}$ Tissues $\xrightarrow[\text{blood}]{\text{Deoxygenated}}$ Right auricle

PART - 5 : REGULATION OF CARDIAC ACTIVITY

Q.101 Heart beat increases by
(A) adrenal hormones
(B) sympathetic nerves
(C) Both (A) and (B)
(D) parasympathetic nerve

Q.102 Neural signals through the sympathetic nerves (ANS) can increase the rate of heart beat by –
(A) increasing heart output.
(B) increasing the strength of ventricular contraction.
(C) Both (A) and (B)
(D) increasing the contraction of atrium

Q.103 Normal activities of the heart are regulated
(A) extrinsically (B) intrinsically
(C) Both (A) and (B) (D) None of these

Q.104 Neural centre in medulla oblongata can moderate the cardiac function through
(A) ANS (Autonomic Nervous System)
(B) sympathetic nervous system
(C) parasympathetic nervous system
(D) somatic nervous system

Q.105 Cardiac centre is present in
(A) medulla oblongata (B) cerebrum
(C) pons (D) epithalamus

Q.106 Cardiac activity could be moderated by the autonomous neural system. Choose the correct option
(A) The parasympathetic system stimulates heart rate and stroke volume.
(B) The sympathetic system stimulates heart rate and stroke volume.
(C) The parasympathetic system decreases the heart rate but increases stroke volume.
(D) The sympathetic system decreases the heart rate but increases stroke volume.

Q.107 Parasympathetic neural signal decreases the cardiac output by
(A) decreasing the speed of conduction of action potential.
(B) slowing down the rate of heart beat.
(C) increasing the speed of blood in veins.
(D) Both (A) and (B)

PART - 6 : DISORDERS OF CIRCULATORY SYSTEM

Q.108 Angina occurs due to –
(A) when enough oxygen is reaching to heart muscle.
(B) when not enough oxygen is reaching to heart muscle.
(C) the deposition of carbohydrates in artery.
(D) the deposition of protein in artery.

Q.109 Tachycardia is –
(A) fast heart rate (B) slow heart rate
(C) stop heart rate (D) normal heart rate

Q.110 Which one indicates hypertension or high blood pressure (BP)?
(A) 120/80 (B) 110/70
(C) 130/80 (D) 140/90

Q.111 Atherosclerosis is caused by deposition of –
(A) calcium
(B) fat and cholesterol
(C) deposition of fibrous tissue
(D) All of the above

Q.112 Blood pressure is controlled by (in emergency condition)
(A) corpus luteum (B) thyroid
(C) adrenal (D) thymus

Q.113 Atherosclerosis is called –
(A) coronary artery disease
(B) angina
(C) heart failure
(D) hypertension

Q.114 Coronary heart disease is due to the inadequate blood supply to
(A) heart ventricle (B) heart auricle
(C) heart volume (D) heart muscles

EXERCISE - 2 (LEVEL-2)

Choose one correct response for each question.

Q.1 The fluid-filled space that surrounds organs of animals with an open circulatory system.
(A) coelom (B) lymphocoel
(C) atracoel (D) sinus

Q.2 Very small vessels that supply blood to capillary beds.
(A) arterioles (B) venules
(C) arteries (D) veins

Q.3 Three-chambered hearts generally consist of the following numbers of atria/ventricles:
(A) 2/1 (B) 1/2
(C) 1/1 (D) 0/3

Q.4 In general, the path of blood in the systemic circulation in a vertebrate occurs in the following order:
(A) veins, venules, capillaries, arterioles, arteries.
(B) arterioles, capillaries, arteries, venules, veins.
(C) venules, veins, capillaries, arteries, arterioles.
(D) veins, arteries, arterioles, venules, capillaries.

Q.5 Which is necessary to start clotting of blood –
(A) Heparin
(B) Serotonin
(C) Thromboplastin & Ca^{++}
(D) Fibrinogen & prothrombin

Q.6 An open circulatory system –
(A) is found in flatworms.
(B) typically includes a hemocoel.
(C) has a continuous circuit of vessels with openings in the capillaries.
(D) is characteristic of vertebrates.

Q.7 Which of the following is not a function of the vertebrate circulatory system?
(A) helps maintain appropriate pH.
(B) transports nutrients, oxygen, and metabolic wastes.
(C) helps maintain fluid balance.
(D) produces hemocyanin.

Q.8 Lipoproteins –
(A) are mainly transported in granular leukocytes.
(B) transport cholesterol.
(C) have been linked to clotting disorders.
(D) are associated with platelets.

Q.9 In blood clotting –
(A) thrombin → prothrombin; fibrinogen → fibrin
(B) prothrombin → thrombin; fibrin → fibrinogen
(C) prothrombin → thrombin; fibrinogen → fibrin
(D) clotting factors → platelets; thrombin → fibrinogen.

Q.10 Arterioles –
(A) help regulate blood pressure
(B) help regulate distribution of blood to the tissues
(C) deliver blood to arteries
(D) answers A and B only

Q.11 The blood-filled cavity of an open circulatory system is called the –
(A) lymphocoel (B) hemocoel
(C) atracoel (D) sinus

Q.12 Which choice most accurately describes one sequence of blood flow?
(A) right atrium → right ventricle → pulmonary artery
(B) right atrium → left atrium → left ventricle → aorta
(C) left atrium → left ventricle → pulmonary artery
(D) left ventricle → left atrium → aorta

Q.13 Which choice most accurately describes one sequence of blood flow?
(A) pulmonary vein → pulmonary artery → right atrium.
(B) pulmonary artery → left atrium → left ventricle.

(C) pulmonary artery → pulmonary capillaries → pulmonary vein → left atrium.
(D) left ventricle → aorta → pulmonary artery.

Q.14 A cardiac cycle –
(A) consists of one ventricular heartbeat
(B) includes a systole
(C) equals stroke volume times heart rate
(D) includes a systole and a diastole

Q.15 Blood pressure is determined by –
(A) cardiac output.
(B) peripheral resistance.
(C) blood volume.
(D) answers A, B & C are correct.

Q.16 Lymph forms from –
(A) interstitial fluid
(B) blood serum
(C) plasma combined with protein
(D) fluid released by lymph nodes

Q.17 The valve between the right atrium and right ventricle is the –
(A) mitral valve (B) semilunar valve
(C) tricuspid valve (D) pulmonary valve

Q.18 Which of the following shows the thickness of the walls of blood vessels in ascending order?
(A) Capillaries, veins, arteries
(B) Arteries, veins, capillaries
(C) Veins, arteries, capillaries
(D) Arteries, capillaries, veins

Q.19 What is the function of blood plasma?
(A) Formation of clots
(B) Transport of oxygen
(C) Production of antibodies
(D) Transport of dissolved nutrients and waste products.

Q.20 The diagrams show the cross-sections of three different types of blood vessels P, Q and R.

Which shows the correct type of blood vessels?
(A) P-Artery, Q-Vein, R-Capillary
(B) P-Artery, Q-Capillary, R-Vein
(C) P-Vein, Q-Capillary, R-Artery
(D) P-Capillary, Q-Artery, R-Vein

Q.21 The deflection waves of an ECG include
(A) the P-wave, which is only present in a person who had a heart attack.
(B) the Q-T interval, which indicates the time of atrial contraction.
(C) the PQRS complex, which immediately follows ventricular contraction.
(D) the T-wave,which indicates ventricular repolarization.

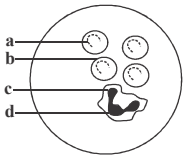
Q.22 Which statements about arteries is/are correct?
(i) All arteries do not contain any valves.
(ii) All arteries transport blood away from the heart.
(iii) All arteries transport blood under high pressure.
(iv) All arteries transport oxygenated blood.
(A) (ii) only (B) (iii) only
(C) (i) and (ii) only (D) (ii) and (iii) only

Q.23 The heart's electrical conduction network found within the ventricular myocardium is termed –
(A) sinoatrial node
(B) atrioventricular node
(C) bundle of His/atrioventricular bundle
(D) Purkinje fibers.

Q.24 The diagram shows a section of the human heart. Which chambers contain deoxygenated blood?

(A) P and Q (B) P and S
(C) Q and R (D) R and S

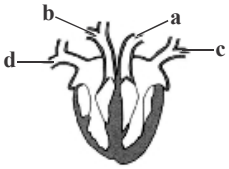
Q.25 The diagram shows a human blood sample in a blood vessel. Where is carbon dioxide found?



(A) a (B) b
(C) c (D) d

Q.26 Select the incorrect match.
(A) Heart attack - Death of heart muscle
(B) Brachycardia - Slow heart beat
(C) Thrombosis-Decreased blood flow to brain
(D) Tachycardia - Fast heart beat

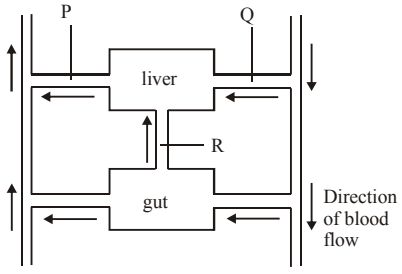
Q.27 The diagram shows a section through the mammalian heart. Which two labelled blood vessels carry oxygenated blood?



(A) a and b (B) a and d
(C) a and c (D) c and d

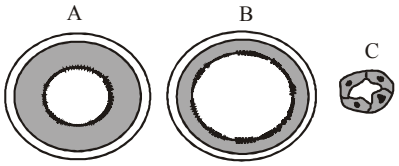
Q.28 If vagal nerves to the heart were severed,the result should be that
(A) the heart would stop contracting.
(B) the heart rate would increase.
(C) the atrioventricular node would take-over as the heart's pacemaker.
(D) parasympathetic stimulation to the heart would increase.

Q.29 The diagram shows the blood supply to the liver and gut.



What are the identities of the blood vessels P, Q and R?
(A) P-Hepatic artery, Q-Hepatic vein, R-Hepatic portal vein
(B) P-Hepatic vein, Q-Hepatic portal vein, R-Hepatic artery
(C) P-Hepatic vein, Q-Hepatic artery, R-Hepatic portal vein
(D) P-Hepatic portal vein, Q-Hepatic artery, R-Hepatic vein

Q.30 The diagram shows three types of blood vessels, 1, 2 and 3 (not drawn to scale).

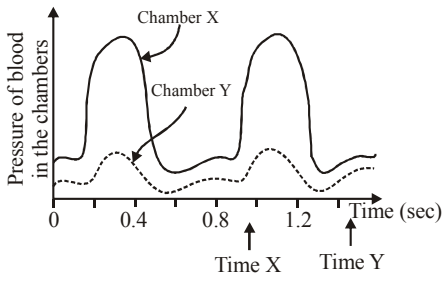


Which describes features of each vessel?

	Blood passes through wall	High pressure blood flow	Presence of valves
(A)	B	A	C
(B)	B	C	A
(C)	C	A	B
(D)	C	B	A

Q.31 Which of the following correctly shows the route of a red blood cell from the lung to the liver?
(A) Lung → Pulmonary vein → Left atrium → Left ventricle → Aorta → Liver
(B) Lung → Pulmonary vein → Right atrium → Right ventricle → Aorta → Liver
(C) Lung → Pulmonary artery → Left atrium → Left ventricle → Hepatic artery → Liver
(D) Lung → Pulmonary artery → Right atrium → Right ventricle → Hepatic artery → Liver

Q.32 The graph shows the pressure changes that occur in the two chambers of a mammalian heart in two cardiac cycles.



Which of the following occurs at time X?
(A) Blood is filling the ventricles.
(B) The atria are contracting.
(C) The bicuspid valves are closed.
(D) The tricuspid valves are open.

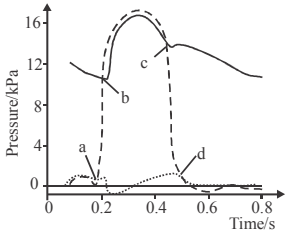
Q.33 Carotid artery supplies –
(A) oxygenated blood to lungs.
(B) oxygenated blood to intestine.
(C) oxygenated blood to brain.
(D) none of these.

Q.34 Mark the pair of substances among the following which is essential for coagulation of blood.
(A) Heparin and calcium ions
(B) Calcium ions and platelet factors
(C) Oxalates and citrates
(D) Platelet factors and heparin

Q.35 The first heart sound, 'lub' is most valuable in diagnosing
(A) semilunar valve dysfunctions
(B) atrioventricular valve dysfunctions
(C) pulmonary trunk wall dysfunctions
(D) ascending aortic wall dysfunctions.

Q.36 Which of the following is not a cause for the increase in blood flow to the skeletal muscle during exercise?
(A) Increase in heart rate
(B) Increase in blood temperature
(C) Increase in blood pressure
(D) Dilation of arterioles in the muscle

Q.37 The diagram gives information about blood pressures in various parts of the circulatory system during the cardiac cycle. At which point does the semi-lunar valve of the aorta close?



(A) a (B) b
(C) c (D) d

Q.38 Which of the following occurs as a result of the recoil action of arterial walls?
(A) Blood flow is at high velocity.
(B) Blood is kept flowing in one direction.
(C) Blood flow is at high pressure.
(D) Blood flow moves by peristalsis.

Q.39 Which of the following is the best explanation for the reduction of pressure as blood flows from an arteriole to a capillary network?
(A) The walls of a capillary are only one cell thick.
(B) The velocity of blood decreases.
(C) The cross-sectional area of capillaries in a network is smaller than that of an arteriole.
(D) The cross-sectional area of capillaries in a network is greater than that of an arteriole.

Q.40 Antigen A and B are not found in which of the following blood groups?
(A) AB (B) A
(C) O (D) B

Q.41 In which of the following steps is vitamin K essential for blood clotting to be successful?
(a) Damaged tissue & platelets produce thrombokinase
(b) Conversion of prothrombin to thrombin
(c) Conversion of fibrinogen to insoluble fibrin thread
(A) b only (B) c only
(C) a only (D) a and b only

Q.42 Where in the body does blood flow travel the fastest?
(A) Capillaries (B) Cerebral arteries
(C) Coronary arteries (D) Aorta

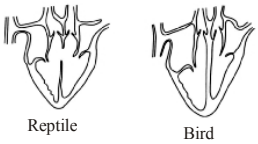
Q.43 Which is found in blood plasma but not in lymph?
(A) Salt (B) Urea
(C) Oxygen (D) Platelets

Q.44 Blood flow to the skin
(A) is regulated mainly by a decreasing pH.
(B) increases when external environmental temperature rises

(C) increases when internal body temperature decreases so that the skin does not freeze.
(D) is not an important source of nutrients and oxygen for skin cells.

Q.45 The left ventricle's myocardium is thicker than the right ventricle's myocardium in order to –
(A) accommodate a greater volume of blood.
(B) increase the size of the thoracic cavity during diastole.
(C) contract with a greater pressure.
(D) force blood through a smaller semilunar valve.

Q.46 Hearts of a reptile & a bird are shown



Choose the correct statement –
(A) The reptile heart is more efficient as the two ventricles contribute to pumping blood around the body.
(B) The aorta of the reptile carries less oxygen than that of the bird.
(C) Both hearts are equally efficient and successful in these life forms.
(D) The pulmonary vein carries less oxygen in the reptile.

Q.47 Right atrium receives blood from –
(A) Sinus venosus
(B) Pulmonary veins
(C) Inferior vena cava
(D) Superior and inferior venae cavae

Q.48 In the mammalian heart, ventricular filling of blood takes place due to –
(A) Relaxation of right ventricle
(B) A higher blood pressure in right auricle
(C) adequate blood in the right auricle
(D) All the above actions

Q.49 Properties of human RBCs are
I. devoid of nucleus
II. formed in bone marrow
III. possess healing properties
IV. biconcave in shape
V. help in blood clotting.
Choose the option with correct properties.
(A) I, II and III (B) I, II and IV
(C) III, IV and V (D) III, II and IV

Q.50 Pulse pressure is –
(A) Difference between systolic and diastolic pressure
(B) Systolic pressure
(C) Pressure in the great veins
(D) Diastolic pressure

Q.51 Heart wall is made of –
(A) Myocardium (B) Epicardium
(C) Endocardium (D) All the above

Q.52 If vagus/parasympathetic nerve to heart is cut, the heart beat will –
(A) Decrease (B) Increase
(C) Remain normal (D) Stop

Q.53 In aquatic mammals –
(A) Heart will be small (B) Heart will be large
(C) Lungs will be small (D) Lungs will be large

Q.54 Oxygenated blood is found in –
(A) Pulmonary veins (B) Pulmonary arteries
(C) Right atrium (D) Right ventricle

Q.55 The valves in the heart allows the blood flow in which direction?
I. From atria to ventricles.
II. From ventricles to pulmonary artery.
III. From pulmonary artery to aorta.
(A) I and II (B) II and III
(C) III and I (D) All of these

Q.56 What is the correct order of events occurring in blood clotting?
I. Conversion of fibrinogen to fibrin.
II. Formation of clot
III. Thromboplastin formation.
IV. Conversion of prothrombin to thrombin.
Choose the correct option.
(A) III, II, I and IV (B) III, IV, I and II
(C) III, IV, II and I (D) IV, I, III and II

Q.57 Heart beats originate from –
(A) Left atrium (B) Right ventricle
(C) Cardiac muscles (D) Pace maker

Q.58 Example of Rh incompatibility is
(A) mother Rh –ve and father Rh +ve
(B) father Rh –ve and mother Rh +ve
(C) Both Rh –ve
(D) Both Rh +ve

Q.59 Which of the following statement is incorrect about the lymph.
I. Lymph is colourful as it has haemoglobin but no RBC.
II. The fluid present in the lymphatic system is called lymph.
III. It contains specialised lymphocytes which are responsible for the immunity of the body.
IV. Lymph is an important carrier for nutrients and hormones.
V. Fats are absorbed through the lymph in the lacteals present in the intestinal villi.
Choose the correct option.
(A) Only I (B) III and IV
(C) II and III (D) Only IV

Q.60 Right auricle of the mammalian heart release blood through
(A) Tricuspid valve (B) Vena cava
(C) Pulmonary aorta (D) Mitral valve

Q.61 Purkinje fibers are present in –
(A) Mammalian heart
(B) Voluntary muscles
(C) Cerebral cortex
(D) Ampullae of semi-circular canal of internal ear.

Q.62 Glucose is carried from digestive tract to liver by
(A) Hepatic artery (B) Hepatic portal vein
(C) Pulmonary vein (D) None of the above

Q.63 Haemoglobin has maximum affinity for –
(A) CO_2 (B) CO
(C) O (D) NH_3

Q.64 Lymph is colourless because –
(A) WBC are absent
(B) WBC are present
(C) Haemoglobin is absent
(D) RBC are absent

Q.65 Open vascular system is found in –
(A) Man (B) Fish
(C) Cockroach (D) Earthworm

Q.66 In which of the following reptiles four chambered heart is present –
(A) Lizard (B) Snake
(C) Scorpion (D) Crocodile

Q.67 Heart sound "DUB" is caused due to closing of–
(A) Valve (B) Tricuspid valve
(C) Semilunar valve (D) None of these

Q.68 Formed elements present in the human blood are
I. erythrocytes II. leucocytes III. platelets
IV. plasma V. lymph
(A) I, II and III (B) II, III and IV
(C) III, IV and V (D) I, II, III, IV and V

Q.69 Grouping of ABO blood is based on the –
(A) surface antigens present on RBCs.
(B) surface lipids present on the cell membrane.
(C) nature of all constituents.
(D) nature of RBC and WBC.

Q.70 Incomplete circulation is found in
I. reptiles II. amphibians
III. birds IV. mammals
(A) I and II (B) III and IV
(C) III and II (D) I and IV

Q.71 Which one of the following blood cells is involved in antibody production.
(A) B-Lymphocytes (B) T-Lymphocytes
(C) RBC (D) Neutrophils

Q.72 When thromboplastin is released in humans?
(A) During hypertension.
(B) By the traumatised cell at the place of injury.
(C) In the condition of erythroblastosis foetalis.
(D) During anaemia.

EXERCISE - 3 (LEVEL-3)

Choose one correct response for each question.

Q.1 Erythrocytes are –
(i) also called red blood cells.
(ii) spherical shaped.
(iii) produced in bone marrow.
(iv) a kind of white blood cell.
(v) specialized to transport O_2.
Choose the correct option –
(A) (i), (ii), (v) (B) (i), (iii), (v)
(C) (ii), (iii), (v) (D) (i), (ii), (iii)

Q.2 In mammals, blood enters the right atrium from the –
(i) right ventricle (ii) superior vena cava
(iii) inferior vena cave (iv) pulmonary artery
(v) jugular vein
Choose the correct option –
(A) (i), (ii), (v) (B) (i), (iii)
(C) (iii), (v) (D) (ii), (iii)

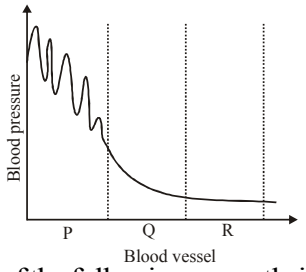
Q.3 Pulmonary arteries carry blood that is
(i) low in O_2 (ii) low in CO_2
(iii) high in O_2 (iv) high in CO_2
(v) on its way to the lungs.
Choose the correct option –
(A) (i), (ii), (v) (B) (i), (iii), (v)
(C) (i), (iv), (v) (D) (i), (ii), (iii)

Q.4 Fibrinogen is –
(i) a plasma lipids (ii) a gamma globulin
(iii) a protein (iv) a precursor to fibrin
(v) involved in the clotting mechanism
Choose the correct option –
(A) (i), (ii), (v) (B) (i), (iii), (v)
(C) (i), (iv), (v) (D) (iii), (iv), (v)

Q.5 In mammals, a semilunar valve is found between a ventricle and __
(i) an atrium (ii) another ventricle
(iii) the aorta (iv) a pulmonary artery
(v) a pulmonary vein
Choose the correct option –
(A) (i), (ii), (v) (B) (i), (iii)
(C) (iii), (iv) (D) (ii), (iii)

Q.6 The pericardium surrounds –
(A) atria only (B) ventricles only
(C) blood vessels (D) the heart

Q.7 The diagram below shows the blood pressure in three different blood vessels.



Which of the following correctly identifies blood vessels Q and R?
(A) P-Arteriole, Q-Venule
(B) P-Capillary, Q-Arteriole
(C) P-Capillary, Q-Venule
(D) P-Arteriole, Q-Capillary

Q.8 Which of the following exerts the highest pressure during the beating of the mammalian heart?
(A) Left atrium (B) Left ventricle
(C) Right atrium (D) Right ventricle

Q.9 Cholesterol plaque is formed by the accumulation of cholesterol on the wall of arteries. Which of the following is the reason why a heart attack may occur if the coronary artery is blocked by cholesterol plaque?
(A) The rate of heartbeat increases.
(B) Less blood is pumped out from the heart.
(C) The heart muscle breaks down.
(D) Less blood is supplied to the heart muscle.

Q.10 The table shows the characteristics of the blood in one blood vessel in the body.

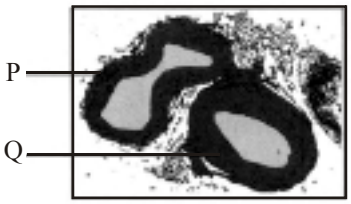
Oxygen concentration	Carbon dioxide concentration	Pressure
Low	High	High

Which blood vessel contains blood with these characteristics?
(A) Aorta (B) Pulmonary artery
(C) Pulmonary vein (D) Vena cava

Q.11 Which of the following components of the blood can destroy bacteria that have entered the body?
(a) Antibodies (b) Phagocytes
(c) Blood platelets
(A) (a) and (b) only (B) (a) and (c) only
(C) (b) and (c) only (D) (a), (b) and (c)

Q.12 Which statements about cardiac output is correct?
(A) Stroke volume can increase when the end diastolic volume decreases.
(B) If a semilunar valve was partially obstructed, then the end systolic volume in the affected ventricle would decrease.
(C) A decreased venous return will cause an increased end diastolic volume.
(D) A decreased heart rate will cause an increased end diastolic volume.

Q.13 The photomicrograph shows the transverse section of two blood vessels connecting the heart and the lungs.

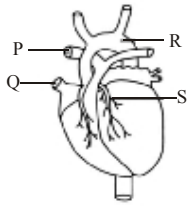


Which heart chamber is connected to vessel Q?
(A) Left atrium (B) Left ventricle
(C) Right atrium (D) Right ventricle

Q.14 Clotting of blood is a primary function of
(A) plasma (B) platelets.
(C) red blood cells. (D) white blood cells

Q.15 Which of the following statement(s) regarding the cardiac system is/are correct?
(i) Human heart is an ectodermal derivative.
(ii) Mitral valve guards the opening between the right atrium and left ventricle.
(iii) SAN is located on the left upper corner of the right atrium.
(iv) Stroke volume × Heart rate = Cardiac output.
(A) (i) only (B) (i) and (ii)
(C) (ii) and (iii) (D) (iv) only

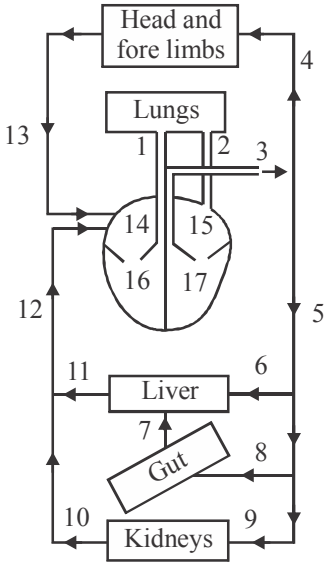
Q.16 For the human heart shown. Which of the following correctly describes the conditions of the blood in the different vessels?



	P	Q	R	S
(A)	Oxygenated, high pressure	Deoxygenated, low pressure	Deoxygenated, high pressure	Oxygenated, high pressure
(B)	Oxygenated, high pressure	Oxygenated, high pressure	Deoxygenated, low pressure	Deoxygenated, low pressure
(C)	Deoxygenated, low pressure	Deoxygenated, low pressure	Oxygenated, high pressure	Oxygenated, high pressure
(D)	Deoxygenated, high pressure	Deoxygenated, low pressure	Oxygenated, high pressure	Oxygenated, high pressure

Q.17 Properties of leucocytes are
I. they are nucleated.
II. they are denucleated like RBC
III. they are 6000-8000 mm^{-3} of blood.
IV. they are long lived.
V. they are short lived.
(A) I, III and V (B) II, IV and V
(C) I, IV and V (D) I, III and IV

For Q.18 and Q.19 : Diagram shows the general blood circulation of a man.



Q.18 Which of the following gives the correct identities of the blood vessels?
(A) Vessel 1-Aorta, Vessel 2-Vena cava, Vessel 3-Pulmonary vein, Vessel 12-Pulmonary artery

(B) Vessel 1-Pulmonary vein, Vessel 2-Pulmonary artery, Vessel 3-Aorta, Vessel 12-Vena cava
(C) Vessel 1-Pulmonary artery, Vessel 2-Pulmonary vein, Vessel 3-Aorta, Vessel 12-Vena cava
(D) Vessel 1-Vena cava, Vessel 2- Aorta, Vessel 3-Pulmonary artery, Vessel 12-Pulmonary vein

Q.19 Which of the following describes the relative blood glucose level in blood vessels 7 and 11 of a healthy man, half an hour after a meal rich in starch?
(A) Blood vessel 7 will have a higher blood glucose level than blood vessel 11.
(B) Blood vessel 11 will have a higher blood glucose level than blood vessel 7.
(C) Blood vessels 7 and 11 will have the same blood glucose level.
(D) Blood vessels 7 and 11 will have low blood glucose level.

Q.20 In human heart, identify the correct statements,
I. Volume of both the atria is the greater than the volume and both ventricles.
II. Volume of both the ventricle is greater than the volume of both the atria.
III. Inter-ventricular septum separates the right and the left atria.
IV. Atrio ventricular septum don't separates the atrium and ventricle.
Choose the correct option accordingly .
(A) All except I (B) All except II
(C) All except III (D) All except IV

Q.21 I. Neutrophils II. Eosinophils
III. Basophils IV. Lymphocytes
V. Monocytes
Identfy wheather the given cell types are granulocytes (a) and agranulocytes (b)and choose the correct option accordingly.
(A) a - I, II, III ; b - IV, V
(B) a - I, III, IV ; b - II, V
(C) a - IV, V ; b - I, II, III
(D) a - II, V ; b - I, III, IV

Q.22 Which of the following statements are incorrect?
(i) Leucocytes do not show diapedesis.
(ii) RBCs, WBCs and blood platelets are produced by bone marrow.
(iii) Neutrophils bring about destruction and detoxification of toxins of protein origin.
(iv) Important function of lymphocytes is to produce antibodies.
(A) (i) and (ii) (B) (i) and (iv)
(C) (i) and (iii) (D) (ii) and (iii)

Q.23 Which of the following enables the maintenance of high pressure blood flow in arteries?
(A) The recoil action of the muscular walls
(B) Thick muscular walls
(C) Narrow lumen
(D) Absence of valves

Q.24 Match the column –

Column-I	**Column-II**
a. Neutrophils	(i) Kidney-shaped
b. Eosinophils	(ii) S-shaped
c. Basophils	(iii) Multiple lobes
d. Monocytes	(iv) 2 lobes
	(v) Disc-shaped

(A) a - (iii), b - (v), c - (i), d - (ii)
(B) a - (v), b - (iii), c - (i), d - (iv)
(C) a - (ii), b - (i), c - (v), d - (iii)
(D) a - (iii), b - (iv), c - (ii), d - (i)

Q.25 Which of the following statements are correct?
(i) Ca^{+2} is necessary for blood coagulation.
(ii) Coagulation in blood vessel is prevented during normal condition by heparin.
(iii) Clotting of blood involves changes of fibrinogen to fibrin by thrombin.
(iv) Blood clotting involves cascading process involving a number of factors present in the active form always.
(A) (i), (iii) and (iv) (B) (ii) and (iv)
(C) (i), (ii) and (iii) (D) (iii) and (iv)

Note (Q.26-Q.33) :
(A) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement -1.

(B) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement -1.
(C) Statement - 1 is True, Statement- 2 is False.
(D) Statement -1 is False, Statement -2 is False.

Q.26 **Statement 1:** Lymph capillaries are free and blind at one end.
Statement 2: Lymph does not flow in a circular manner.

Q.27 **Statement 1 :** Atria receive blood from all parts of the body which subsequently flows to ventricles.
Statement 2: Action potential generated at sino-atrial node passes from atria to ventricles.

Q.28 **Statement 1 :** Closed circulatory system is more effective than open type.
Statement 2 : The closed circulatory system considerably enhances the speed, precision and efficiency of circulation.

Q.29 **Statement 1 :** An artificial pacemaker can replace the sinoatrial node of heart.
Statement 2 : This is because, an artificial pacemaker is capable of stimulating the heart electrically to maintain its beats.

Q.30 **Statement 1 :** Heart of fish contains only deoxygenated blood.
Statement 2 : Oxygenated blood do not return back to the heart in fishes.

Q.31 **Statement 1 :** The increased permeability of the lymph capillaries is easily altered.
Statement 2 : The increased permeability of the capillary walls leads to oedema or swelling.

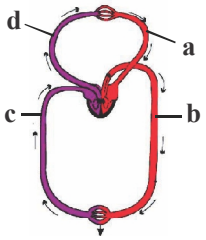
Q.32 **Statement 1 :** Electorcardiogram is record or electrical activity of the heart which shows certain waves called P, Q, R, S and T waves.
Statement 2 : It gives important information concerning the spread of excitation to the different parts of heart and it is of value in the diagnosis of cases of abnormal cardiac rhythm and myocardial damage.

Q.33 **Statement 1 :** WBCs accumulate at the site of wounds by diapedesis.
Statement 2 : It is the sqeezing of leucocytes from the endothelium.

EXERCISE - 4 (PREVIOUS YEARS AIPMT/NEET EXAM QUESTIONS)

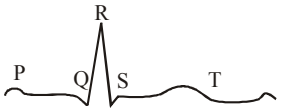
Choose one correct response for each question.

Q.1 Figure shows schematic plan of blood circulation in humans with labels a to d, Identify the label and give its functions. **[NEET 2013]**



(A) d-Dorsal aorta-takes blood from heart to body parts, $pO_2 = 95$ mm Hg.
(B) a-Pulmonary vein-takes impure blood from body parts, $pO_2 = 60$ mm Hg.
(C) b-Pulmonary artery-takes blood from heart to lungs, $pO_2 = 90$ mm Hg.
(D) c-Vena Cava-takes blood from body parts the right auricle, $pCO_2 = 45$ mm Hg.

Q.2 The diagram given here is the standard ECG of a normal person. The P- wave represents the : **[NEET 2013]**



(A) End of systole
(B) Contraction of both the atria
(C) Initiation of the ventricular contraction
(D) Beginning of the systole

Q.3 Person with blood group AB is considered as universal recipient because he has **[AIPMT 2014]**
(A) Both A and B antigens on RBC but no antibodies in the plasma.
(B) Both A and B antibodies in the plasma.
(C) No antigen on RBC and no antibody in the plasma.
(D) Both A and B antigens in the plasma but no antibodies.

Q.4 How do parasympathetic neural signals affect the working of the heart? **[AIPMT 2014]**
(A) Reduce both heart rate and cardiac output.
(B) Heart rate is increased without affecting the cardiac output.
(C) Both heart rate and cardiac output increase.
(D) Heart rate decreases but cardiac output increases.

Q.5 Erythropoiesis starts in : **[AIPMT 2015]**
(A) Liver (B) Spleen
(C) Red bone marrow (D) Kidney

Q.6 Which one of the following is correct ? **[AIPMT 2015]**
(A) Serum = Blood + Fibrinogen
(B) Lymph = Plasma + RBC + WBC
(C) Blood = Plasma + RBC + WBC + Platelets
(D) Plasma = Blood – Lymphocytes

Q.7 Blood pressure in the mammalian aorta is maximum during: **[AIPMT 2015]**
(A) Diastole of the right ventricle.
(B) Systole of the left ventricle.
(C) Diastole of the right atrium.
(D) Systole of the left atrium.

Q.8 Which one of the following animals has two separate circulatory pathways? **[RE-AIPMT 2015]**
(A) Lizard (B) Whale
(C) Shark (D) Frog

Q.9 Doctors use stethoscope to hear the sounds produced during each cardiac cycle. The second sound is heard when: **[RE-AIPMT 2015]**
(A) Ventricular walls vibrate due to gushing in of blood from atria.
(B) Semilunar valves close down after the blood flows into vesels from ventricles.
(C) AV node receives signal from SA node.
(D) AV valves open up.

Q.10 In mammals, which blood vessel would normally carry largest amount of urea? **[NEET 2016 PHASE 1]**
(A) Renal Vein (B) Dorsal Aorta
(C) Hepatic Vein (D) Hepatic Portal Vein

Q.11 Blood pressure in the pulmonary artery is **[NEET 2016 PHASE 1]**
(A) Same as that in the aorta
(B) More than that in the carotid
(C) More than that in the pulmonary vein
(D) Less than that in the venae cavae

Q.12 Name the blood cells, whose reduction in number can cause clotting disorder, leading to excessive loss of blood from the body. **[NEET 2016 PHASE 2]**
(A) Erythrocytes (B) Leucocytes
(C) Neutrophils (D) Thrombocytes

Q.13 Serum differs from blood in **[NEET 2016 PHASE 2]**
(A) Lacking globulins
(B) Lacking albumins
(C) Lacking clotting factors
(D) Lacking antibodies

Q.14 The hepatic portal vein drains blood to liver from **[NEET 2017]**
(A) Heart (B) Stomach
(C) Kidneys (D) Intestine

Q.15 Adult human RBCs are enucleate. Which of the following statement(s) is/are most appropriate explanation for this feature? **[NEET 2017]**
(a) They do not need to reproduce
(b) They are somatic cells
(c) They do not metabolize
(d) All their internal space is available for oxygen transport
(A) Only (d) (B) Only (a)
(C) (a), (c) and (d) (D) (b) and (c)

Q.16 Match the items given in Column I with those in Column II and select the correct option given below **[NEET 2018]**

Column I	Column II
a. Tricuspid valve	i. Between left atrium and left ventricle.
b. Bicuspid valve	ii. Between right ventricle and pulmonary artery.
c. Semilunar valve	iii. Between right atrium and right ventricle

(A) a-i, b-ii, c-iii (B) a-i, b-iii, c-ii
(C) a-iii, b-i, c-ii (D) a-ii, b-i, c-iii

Q.17 Match the items given in Column I with those in Column II and select the correct option given below **[NEET 2018]**

Column I	Column II
a. Fibrinogen	(i) Osmotic balance
b. Globulin	(ii) Blood clotting
c. Albumin	(iii) Defence mechanism

(A) a-i, b-iii, c-ii (B) a-i, b-ii, c-iii
(C) a-iii, b-ii, c-i (D) a-ii, b-iii, c-i

Q.18 Match the Column-I with Column-II **[NEET 2019]**

Column-I	Column-II
(a) P - wave	(i) Depolarisation of ventricles
(b) QRS complex	(ii) Repolarisation of ventricles
(c) T - wave	(iii) Coronary ischemia
(d) Reduction in the size of T-wave	(iv) Depolarisation of atria
	(v) Repolarisation of atria

Select the correct option.
(A) a-(iv), b-(i), c-(ii), d-(iii)
(B) a-(iv), b-(i), c-(ii), d-(v)
(C) a-(ii), b-(i), c-(v), d-(iii)
(D) a-(ii), b-(iii), c-(v), d-(iv)

Q.19 What would be the heart rate of a person if the cardiac output is 5 L, blood volume in the ventricles at the end of diastole is 100 mL and at the end of ventricular systole is 50 mL? **[NEET 2019]**

(A) 50 beats per minute
(B) 75 beats per minute
(C) 100 beats per minute
(D) 125 beats per minute

ANSWER KEY

EXERCISE-1 (SECTION-1&2)

(1) (D) **(2)** (B) **(3)** (A) **(4)** (C)
(5) (B) **(6)** (A)
(7) Clotting **(8)** Neutrophils
(9) Allergic **(10)** Calcium
(11) QRS complex **(12)** 55, 90-92, 6-8
(13) Right, pulmonary, left, aorta
(14) Purkinje fibre
(15) Muscular chambered heart, 2, 3, 4
(16) 12-16, 6-100, respiratory
(17) Deoxygenated, oxygenated
(18) Atria, asterial systole, 30
(19) Left atria, right atria
(20) Nodal tissue, SAN, AVN
(21) Left, right, deoxygenated
(22) Semilunar; Dub
(23) Nodal musculature
(24) Interstitial fluid
(25) O_2, tissue, CO_2
(26) Plasma, inactive, serum

EXERCISE - 1 [SECTION-3 & 4]

Q	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
A	A	B	A	B	C	C	D	C	C	D	C	A	C	D	C	D	C	B	B	B	D	A	C	D	C
Q	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76
A	B	A	C	C	B	B	A	D	B	C	D	B	C	A	B	A	C	B	C	C	A	A	A	B	C
Q	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101
A	D	C	B	B	B	B	C	C	A	B	A	A	D	B	A	A	D	B	C	D	C	C	A	D	A
Q	102	103	104	105	106	107	108	109	110	111	112	113	114												
A	C	B	A	A	B	D	B	A	D	D	C	A	D												

EXERCISE - 2

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	D	A	A	A	C	B	D	B	C	D	B	A	C	D	D	A	C	A	D	C	D	B	D	D	B
Q	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
A	C	C	B	C	C	A	C	C	B	B	B	C	A	D	C	D	D	D	B	C	B	D	D	B	A
Q	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72			
A	D	B	B	A	A	B	D	A	A	A	A	B	B	D	C	D	C	A	A	A	A	B			

EXERCISE - 3

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
A	B	D	C	D	C	D	D	B	D	B	A	A	D	B	D	D	A	C	A	B	A	C	C	D	C
Q	26	27	28	29	30	31	32	33																	
A	A	B	A	A	A	B	A	B																	

EXERCISE - 4

Q	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
A	D	B	A	A	A	C	B	B	B	C	C	D	C	D	A	C	D	A	C

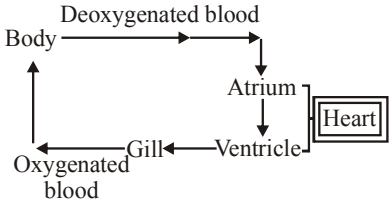
SOLUTIONS

EXERCISE-1

(1) (D) **(2)** (B) **(3)** (A) **(4)** (C)
(5) (B) **(6)** (A)
(7) Clotting **(8)** Neutrophils
(9) Allergic **(10)** Calcium
(11) QRS complex **(12)** 55, 90-92, 6-8
(13) Right, pulmonary, left, aorta
(14) Purkinje fibre
(15) Muscular chambered heart, 2, 3, 4
(16) 12-16, 6-100, respiratory
(17) Deoxygenated, oxygenated
(18) Atria, asterial systole, 30
(19) **Left atria, right atria.** In crocodiles, birds and mammals left atria receives oxygenated blood and right atria deoxygenated blood.
(20) Nodal tissue, SAN, AVN
(21) Left, right, deoxygenated
(22) **Semilunar; Dub.**
Lub : The first heart sound is associated with the closure of tricuspid and bicuspid valves.
Dub : The second heart sound is associated with the closure of semilunar valves.
(23) Nodal musculature
(24) **Interstitial fluid.** This interstitial fluid is called the tissue fluid or lymph, which plays an important role in immunity against diseases. It has the same mineral distribution as that of the plasma.
(25) O_2, tissue, CO_2
(26) **Plasma, inactive, serum.**

S.N.	Blood Plasma	Blood Serum
1.	Fluid portion of the blood in the form of matrix.	Fluid collected after the clot reaction.
2.	Has fibrinogen and other clotting material.	Does not have fibrinogen and other clotting material.
3.	Takes part in blood clotting.	Don't take part in blood clotting.
4.	It is straw coloured clear liquid.	It is pale yellow in colour.

(27) **(A).**



This circulation clearly indicates that there is single atrium and ventricle. So it is the circulation of fishes.

(28) (B) **(29)** (A) **(30)** (B)
(31) **(C).** 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. Different group of animals have evolved different method for this transport. Simple organism like sponges and coelenterates circulate water from their surroundings through their body cavities to facilitate the cells to exchange these substances.
(32) **(C).** More than 20 different blood group systems are recognised in medicine. Out of which, the best known are ABO system and Rh system. In 1900, Dr. Karl Landsteiner discovered the ABO blood groups and 1902 Rh was found by Decastello & Sturll.
(33) **(D).**
(34) **(C).** The term graveyard of RBC is used for spleen.
(35) **(C).** Agranulocytes are of two types :
Lymphocytes (about 30%) : They are smaller with large rounded nucleus. They are non-motile and non-phagocytic. They exists in two major forms: B and T lymphocytes. They produce antibodies, which are the key cells of immune response.
Monocytes (about 4%) : They are the largest among all the type of leucocytes. They are motile and phagocytic in nature.
(36) **(D).** Rh negative person if exposed to Rh positive blood, the person will form specific antibodies against the Rh antigens. Therefore, Rh group should also be matched before transfusion.

(37) **(C).** Mature mammalian RBCs (or erythrocytes) do not have nucleus and some cell organelles. This increases the surface area of RBCs and enables them to contain more haemoglobin which is required for transport of gases.

(38) **(A).** Blood Platelets occur only in mammals. They are non-nucleated and colourless. They bud off from the megakaryocytic cells of red bone marrow. That's why they are called blood platelets or cell fragments. They have thromboplastin necessary for blood clotting.

(39) **(C).** Erythrocytes or RBC are the most abundant of the three types of blood cells. They have a count of about 5-5.5 million per cubic mm of the blood in an adult male and 4.5-5 million/mm in females. They are formed in the red bone marrow in the adults.

(40) **(D).** Fibrinogen, globulin and albumin are the major proteins present in the human blood. Fibrinogens are needed for clotting or coagulation of the blood. Globulin is primarily involved in the defense mechanism of the body and albumin helps in maintaining the osmotic balance.

(41) **(C).** At the site of injury, blood platelets disintegrates and release thromboplastin.

(42) **(D).** Clotting disorders occurs mainly due to the reduction in the number of the platelets as platelets releases variety of substances which are involved in clotting.

(43) **(C).** Thrombocytopenia i.e., decrease in platelet count is one of the common symptoms observed in people infected with dengue fever.

(44) **(B).** Fluid part of the blood after the removal of corpuscles is called plasma. Blood plasma minus clot results in the formation of serum which is a pale yellow fluid.

(45) **(B).** Leucocytes or white blood corpuscles which are without haemoglobin and therefore, they are colourless and considerably larger than RBC. The normal WBC count is 6000-8000 per cubic mm of blood. Lower count is called leukopenia and high WBC count is termed as leukaemia or leucocytosis. The life span of WBC in man is about 10-13 days.

(46) **(B).** Individuals having Rh antigen are called Rh positive (Rh +ve).

(47) (D) **(48)** (A)

(49) **(C).** Basophils have less number of coarse granules. They release heparin, serotonin and histamine. They are probably like mast cells of connective tissue and are not phagocytic in nature. Macrophages are cells produced by the differentiation of monocytes in the tissues and are phagocytic in nature. Monocytes are the largest of all types of leucocytes. They are motile and phagocytic in nature and engulf bacteria and cellular debris. Neutrophils have fine granules. Neutrophils are the most numerous of all leucocytes. They eat harmful germs and are, therefore, phagocytic in nature.

(50) **(D).** Blood platelets occur only in mammals. They are non-nucleated, round or oval biconvex and bud from megakaryocytes. They are much smaller than RBC. Blood platelets are the source of thromboplastin, necessary for blood clotting.

(51) **(C).** ABO blood groups in human beings are designated on the basis of presence and absence of antigens and antibodies because different persons have different antigenic and immune properties as antibodies (in the plasma) of one person react with the antigens (present on the surface of RBCs) of other person. Human ABO Blood groups and their compatibility is shown as:

Blood group	Geno-type	Antigens in Red Blood Corpuscles	Anti-bodies in blood plasma	Can give blood to	Can get blood from
A	I^AI^A or I^AI^O	A	b	A, AB	A, O
B	I^AI^A or I^BI^O	B	a	B, AB	B, O
AB	I^AI^B	AB	None	AB	All
O	I^OI^O	None	a, b	al	O

(52) **(B).** Another antigen, the Rh antigen is similar to the one present in Rhesus monkey (Hence,

Rh). It is also observed on the surface of RBCs of majority (nearly 80%) of humans. Such individuals are called Rh positive (Rh^+) and those in whom this antigen is absent are called Rh negative (Rh^-).

(53) **(A).** Blood is slightly alkaline having average pH 7.4. It is made up of blood cells (RBCs, WBCs, etc) and blood plasma.

(54) **(C).** Blood is a liquid, mobile connective tissue consisting of fluid matrix, plasma and formed elements.

(55) **(C).** Average life of RBC is 120 days after which they are broken down in spleen or liver. Product of breakdown of haemoglobin is a pigment (yellow colour) called bilirubin which is normally disposed off through the bile. Whereas, haeme is transferred to bone marrow. Retention of bilirubin leads to jaundice.

(56) **(B).** Universal Donor = O blood group.
Universal receipient = AB blood group.

(57) **(B).** Granulocytes and agranulocyte are the categories of WBC.

(58) **(A).** An elaborate network of vessels called the lymphatic system collects the interstitial fluid and drains it back to the major vein. This network is called lymphatic system and the process is called lymphatic circulation.

(59) **(D).** Lymphocytes are the agranulocytes involved in immune response of the body.

(60) **(B).** Lymph is a colourless fluid containing specialised lymphocytes (B and T cells) which are responsible for the immune response of the body. Lymph is also an important carrier for nutrients and hormones, etc. Fats are absorbed by the lymph in the lacteals present in the intestinal villi.

(61) (C) **(62)** (D)

(63) **(B).** Lymph can be defined as blood minus RBCs and some proteins. The main site of lymph formation is the interstitial space and normally, the rate of lymph formation is equal to the rate of its return to the blood stream.

(64) (C) **(65)** (A)

(66) **(B).** Lymph acts as the middle man of the body because the interstitial fluid comes to the blood by lymphatic system through the complex network of capillaries.

(67) **(A).** In open circulatory system instead of capillaries, blood vessels join directly with the open sinuses. Blood is actually a combination of blood and interstitial fluid called haemolymph which is forced from the blood vessels into the large sinuses, where it actually, baths the internal organs.

(68) **(C).** **Ventricular Systole:** When the contraction of the ventricles occurs immediately after atrial systole, the pressure in the ventricles rises and closes the atrioventricular valves, preventing blood from returning to the atria. Then the pressure opens the semilunar valves (three half moon shaped pockets) of aorta and pulmonary artery (the great artery) to make entry of blood into these vessels (ejection).
This lead to reduced volume of blood into the ventricles (about 40 to 50 mL). The closing of atrioventricular valves during ventricular systole produces the first heart sound lub.

(69) **(B).**

(70) **(C).** Atrial diastole takes place when both the atria are filled with blood (having deoxygenated in right and oxygenated in left).

(71) **(C).** Electrocardiograph is a type of machine used to obtain an ECG (electrocardiogram).

(72) **(A).** The wall of ventricles are much thicker than the atrium because ventricles have to pump the blood to pulmonary artery and aorta. Due to that functioning, the ventricles are thicker than atrium. Atrium only has to receive the blood so it is thinner than the ventricles.

(73) **(A).** During a cardiac cycle, each ventricle pumps out approximately 70 ml of blood, thus, both the ventricles pumpout same volume of blood in each cardiac cycle.

(74) **(A).**

(75) **(B).** All reptiles have three-chambered heart containing two atrium (left and right) and

one ventricle. There is a single ventricle and so mixing of oxygenated and deoxygenated blood occurs. But in crocodile, which is an exception have four-chambered heart.

(76) **(C).**

(77) **(D).** The closing of atrioventricular valves during ventricular systole produces the first heart sound, lub.
During ventricular diastole, the semilunar valves are closed and blood is forced back into the ventricles. Due to the high pressure developed in the vessels, this causes the second heart sound, dub.

(78) **(C).**

(79) **(B).** Cardiac output
= Heart beats/min × stroke volume
= 72 beats/min × 50 ml/beat
= 3600 ml/min.

(80) **(B).** As the two atria contract simultaneously (Stimulated by SA node, blood is pumped into ventricles. This is called arterial systole.

(81) **(B).**

(82) **(B).** By counting the numbers of QRS complexes that occur in a given time period, one can determine the heart beat rate of an individual. Since the ECGs is obtained from different individuals have roughly the same shape for a given lead configuration, any deviation from this shape indicates a possible abnormality or disease. Hence it is of great clinical significance.

(83) **(C).** Semilunar valve are of two types :
Pulmonary Valve : Controls the flow from the right ventricles into the pulmonary artery which carry the blood to the lungs for oxygenation.
Aortic Valve : It opens on the left side and opens the way for the oxygenated blood to pass from the left ventricles into aorta (Body's largest artery).

(84) **(C).** Duration of a cardiac cycle is 0.8 sec out of which atrial systole takes 0.1 sec, ventricular systole takes 0.3 sec and complete cardiac systole occurs in 0.4 sec.

(85) **(A).** Heart is mesodermal in origin.

(86) **(B).** Joint relaxation happens in the isometric relaxation. In this phase, all the valves are closed and atria and ventricles are in relaxed state.

(87) **(A).**

(88) **(A).** The cycle of events which occur in a single heart beat is called cardiac cycle. It involves contraction and relaxation of the heart muscle.
Systole : When blood is ejected from the heart contraction.
Diastole : When chambers of the heart are filled with the blood. It is also called relaxation.

(89) **(D).** To obtain a standard ECG a patient is connected to a machine with three electrical leads (one to each wrist and one to left ankle) that continuously monitor the heart activity. For detailed evaluation of the heart's function, multiple leads are attached to the chest region.

(90) **(B).** During beginning of ventricular diastole the ventricles relax and the semilunar valves are closed. This causes the second heart sound (dubb).

(91) **(A).**

(92) **(A).** Sequential events in the heart, which is cyclically repeated is called the cardiac cycle. It consists of systole and diastole of both the atria and ventricle.

(93) **(D).** SA node is known as the pacemaker of heart because the cells in SA node contract the most number of times per minute and because each wave of excitation begins here and acts as the stimulus for the next wave of excitation. In a diseased heart, the AV node can act as a pacemaker though it beats at comparatively less frequency (around 40-50 per min).

(94) (B) **(95)** (C) **(96)** (D)

(97) **(C).** Double circulation is the passage of the blood twice in the heart through the separate pathways for completing one cycle. It consists of two parts (i) Pulmonary pathway (ii) Systemic pathway.

(98) **(C).** Double circulation consists of two parts
(i) **Pulmonary circulation :** In this the movement of blood take place from heart to lung and then from lung to heart.

(ii) **Systemic Circulation :** In this the movement of blood take place between heart and different part of body except lungs. It has arterial and venous system.

(99) **(A).** A unique vascular connection exists between the digestive tract and liver called hepatic portal system. The hepatic portal vein carries the blood from the intestine to liver before it is delivered to systemic circulation. A special coronary system of blood vessels is present in our body exclusively for circulation of the blood to and from the cardiac musculature.

(100) **(D).**

(101) **(A).** Adrenal gland (a gland present on the medullary region of kidney) secretes emergency hormone like epinephrine, nor epinephrine, which increases the heart rate.

(102) **(C).** Neural signals through the sympathetic nerves (part of ANS) can increase the rate of heartbeat by the strength of the ventricular contraction and cardiac output.

(103) **(B).** Normal activities of heart are regulated intrinsically. i.e., auto regulated by specialised muscle (nodal tissue). Hence, the heart is called myogenic.

(104) **(A).**

(105) **(A).** A special neural centre in medulla oblongata can moderate the cardiac function through Autonomic Nervous System (ANS). Medulla oblongata is called the cardiac centre.

(106) **(B).** A specialised neural centre in the medulla oblongata 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.

(107) **(D).** Parasympathetic neural signals (another component of ANS) decreases the rate of heartbeat, speed of conduction of action potential and thereby cardiac output.

(108) (B)

(109) **(A).** Tachycardia is characterized by increased heart rate due to fast beating of the heart.

(110) **(D).** If repeated checks of blood pressure of an individual is 140/90 (140 over 90) or higher, it shows hypertension. High blood pressure leads to heart diseases and also affects the vital organs like brain and kidney.

(111) **(D).**

(112) **(C).** In emergency condition, the hormones released by adrenal gland, adrenaline and noradrenaline increases the cardiac output and increases the blood pressure.

(113) **(A).**

(114) **(D).** Circulation of the blood in the heart muscle is called coronary circulation. Coronary heart diseases occur due to the insufficient blood supply to the heart muscles.

EXERCISE-2

(1) (D)

(2) **(A).** An arteriole is a small diameter blood vessel in the microcirculation that extends and branches out from an artery and leads to capillaries. Arterioles have muscular walls (usually only one to two layers of smooth muscle) and are the primary site of vascular resistance.

(3) (A) **(4)** (A) **(5)** (C) **(6)** (B)

(7) (D)

(8) **(B).** Lipoprotein:any of a group of soluble proteins that combine with and transport fat or other lipids in the blood plasma.

(9) (C) **(10)** (D)

(11) **(B).** Haemocoel : The primary body cavity of most invertebrates, containing circulatory fluid.

(12) **(A).** The heart consists of four chambers in which blood flows. Blood enters the right atrium and passes through the right ventricle. The right ventricle pumps the blood to the lungs where it becomes oxygenated. The oxygenated blood is brought back to the heart by the pulmonary veins which enter the left atrium.

(13) (C) **(14)** (D) **(15)** (D) **(16)** (A)

(17) **(C).** The tricuspid valve, or right atrioventricular valve, is on the right dorsal side of the mammalian heart, between the right atrium and the right ventricle. The function of the valve is to prevent back flow of blood into the right atrium.

(18) (A)

(19) **(D).** Blood plasma: It's mainly made of water and surrounds the blood cells, carrying them around the body. Plasma helps maintain blood pressure and regulates body temperature. It contains a complex mix of substances used by the body to perform important functions. These substances include minerals, salts, hormones and proteins.

(20) (C) **(21)** (D) **(22)** (B) **(23)** (D)

(24) (D) **(25)** (B) **(26)** (C) **(27)** (C)

(28) (B) **(29)** (C) **(30)** (C) **(31)** (A)

(32) (C)

(33) **(C).** Carotid arteries are the major blood vessels that deliver blood to brain.

(34) **(B).** Certain factors released by the tissues at the site of injury initiate coagulation. Calcium ions play a very important role in clotting. Blood clotting can also be prevented in a test tube by adding a little oxalate or citrate. Oxalateor Citrate reacts with calcium to form an insoluble compound, so free calcium ions necessary for clotting are not available.

(35) **(B).** In healthy adults, there are two normal heart sounds often described as a lub and a dub (or dup), that occur in sequence with each heartbeat. These are the first heart sound (S1) and second heart sound (S2), produced by the closing of the atrioventricular valves and semilunar valves, respectively.

(36) (B) **(37)** (C) **(38)** (A) **(39)** (D)

(40) (C) **(41)** (D) **(42)** (D) **(43)** (D)

(44) (B) **(45)** (C) **(46)** (B)

(47) **(D).** Deoxygenated blood enters the right atrium through three major veins: the superior and inferior vena cava and the coronary sinus. The superior vena cava returns all of the blood to the heart from tissues superior to the heart in the head, neck, arms and upper thorax.

(48) (D)

(49) **(B).** RBCs are circular, biconcave and enucleated in mammals (except camel where they are oval and nucleated). It is biconcave so as to increase the surface area (For transfer) and allows easy passage through blood vessel.

(50) (A) **(51)** (D) **(52)** (B) **(53)** (B)

(54) (A) **(55)** (A) **(56)** (B)

(57) **(D).** The heart beat starts in a tiny island of tissues present in the upper region of right auricle, called the sino-auricular node or sino-atrial node (S.A.). It is located near the opening of large vein. S.A. acts as the pace maker of the heart.

(58) **(A).** A special case of Rh incompatibility has been observed between Rh –ve blood of pregnant mother with Rh +ve blood of foetus. During the delivery of the first child there is a possibility of exposure of the maternal blood to small amount of Rh +ve blood from foetus.

In such cases, the mother starts preparing antibodies against Rh antigen in her blood. In the case of her subsequent pregnancies, the Rh antibody from the mother can leak to blood of foetus and destroy foetal RBC. This could be fatal to foetus or could cause severe anaemia and jaundice to the foetus. This condition in called erythroblastosis foetalis.

(59) (A) **(60)** (A)

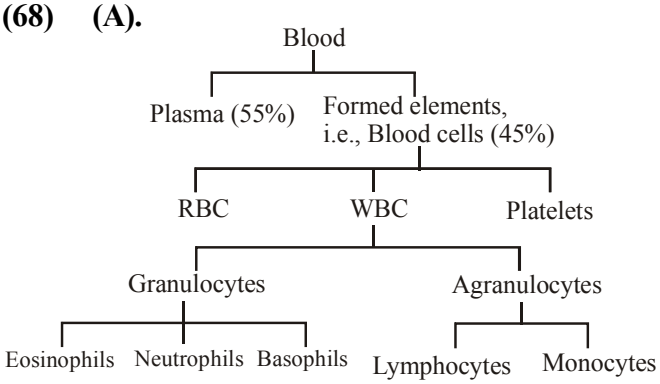
(61) **(A).** Purkinje fibers are a unique cardiac end-organ. Further histologic examination reveals that these fibers are split in atria and ventricles walls. The electrical origin of atrial Purkinje fibers arrives from the sinoatrial node.

(62) (B) **(63)** (B)

(64) **(D).** Lymph is watery clear fluid or colourless because it lacks red blood cells.

(65) (C) **(66)** (D) **(67)** (C)

(68) **(A).**



(69) **(A).** ABO blood grouping is based on the presence or absence of the surface antigens, A and B on RBCs.

(70) **(A).** **Complete circulation :** When there is complete separation of oxygenated and deoxygenated blood in the heart, it is called complete circulation. e.g., birds and mammals.

Incomplete circulation : When there is mixing of oxygenated and deoxygenated blood in the circulation via heart. This happens due to the absence of separate chambers in the heart for oxygenated and deoxygenated blood. e.g., amphibian, reptile and fishes.

(71) **(A).** Lymph nodes produce both B-cells and T-cells. B-cells change to plasma cells that produce antibodies against invading antigens.

(72) **(B).**

EXERCISE-3

(1) **(B).** (i) is correct because these cells are red in appearance due to the iron complexed to hemoglobin, which binds O_2 making (v) correct; (iii) is correct because RBCs are derived from stem cells in bone marrow; (ii) is not correct because RBC typically have a biconcave shape; (iv) is not correct because erythrocytes are not white blood cells.

(2) (D)

(3) **(C).** (i) and (v) are correct because the pulmonary artery carries deoxygenated blood from the right ventricle to the lungs to get oxygenated; (iv) is correct because this blood also carries relatively high levels of CO_2 to the lungs where it can be released into the air.

(4) (D) **(5)** (C) **(6)** (D) **(7)** (D)

(8) (B) **(9)** (D) **(10)** (B) **(11)** (A)

(12) (A) **(13)** (D) **(14)** (B) **(15)** (D)

(16) (D)

(17) **(A).** Leucocytes or white blood corpuscles which are without haemoglobin and therefore, they are colourless and considerably larger than RBC. The normal WBC count is 6000-8000 per cubic mm of blood. Lower count is called leukopenia and high WBC count is termed as leukaemia or leucocytosis. The life span of WBC in man is about 10-13 days.

(18) (C) **(19)** (A)

(20) **(B).** Volume of both atrium is less than the volume of both ventricles.

Interventricular septum separates the right and left ventricles.

Atrioventricular septum separates the atrium and ventricles.

(21) (A) **(22)** (C) **(23)** (C) **(24)** (D)

(25) (C) **(26)** (A) **(27)** (B) **(28)** (A)

(29) **(A).** An artificial pacemaker is a therapeutic instrument which is implanted in the heart of patients to generate the heart beat. A pacemaker is used when the normal heart rate of 72-80 drops down to abnormally low levels like 30-40 due to diseases or operations and threatens the life of the patient. Sometime, the SA node may become damaged or defective. It then fails to generate cardiac impulses at the normal rate. The heart beats become abnormally slow and irregular, and ventricles fail to pump the required amount of blood. This is remedied by the surgical grafting of artificial pacemaker instrument in the chest of the patient. The artificial pacemaker stimulates

the heart electrically at regular intervals to maintain its beats. Thus it replaces the SA node as the originator of the cardiac impulse.

(30) **(A).** The heart is a pumping organ for blood circulation which consists of chambers communicating with each other.

In fishes the heart is two-chambered, consisting of an auricle and a ventricle.

An accessory chamber called sinus venosus is also present which serves as a reservoir and opens anteriorly into auricle through the sino - atrial aperture. Fish heart contains and pumps only deoxygenated blood because after getting oxygenated from gills, the blood doesn't return back to the heart. Instead, it is supplied directly to the various parts of the body.

(31) **(B).** The permeability of the lymph capillaries is easily altered. It may be explained by giving examples. For instance in an infected wound, bacteria release chemicals which increase the permeability of the capillaries in the region, resulting in a local swelling. A swelling appears even in an uninfected injury because an injured tissue can somehow affect capillary permeability.

(32) (A) **(33)** (B)

EXERCISE-4

(1) **(D).** In the given figure (a) is pulmonary vein which brings pure blood from lungs to left aterium, (b) is dorsal aorta which carries blood from heart to body parts, (c) is vena cava which carries impure blood from body parts to right auricle, and (d) is pulmonary artery which takes impure blood from heart to lungs.

(2) **(B).** The P-wave represents the electrical excitation (or depolarisation) of the atria, which leads to the contraction of both the atria. The QRS complex represents the depolarisation of the ventricles, which initiates the ventricular contraction. The contraction starts shortly after Q & marks the beginning of the systole.

(3) **(A).** Person with blood group AB has both A and B antigens on RBC but no antibodies in the plasma.

(4) **(A).** Post-ganglionic fibers of parasympathetic nervous system secrete acetylcholine which decrease heart rate and cardiac output.

(5) **(A).** Liver can form proteins of blood too, so role of liver is more prominent.

(6) **(C).** Serum = Blood – fibrinogen

Lymph is devoid of RBC

Plasma is devoid of all the frame elements / Blood cells. So option (C) is correct which tells that blood is composed of plasma; RBC; WBC; platelets.

(7) **(B).** Upon systole of left ventricle blood is pushed in aorta, which creates systolic blood pressure which is 120mm Hg.

(8) **(B).** Whale is a mammal and has 4 chambered heart with 2 atria & 2 ventricles, oxygenated & deoxygenated blood flow on separate sides.

(9) **(B).** Second heart sound is 'DUP' which is produced during early ventricular diastole due to the sharp closure of semilunar valves.

(10) **(C).** Urea is synthesized in liver. So maximum amount of urea is present in hepatic vein and minimum in renal vein.

(11) **(C).** Blood pressure in different blood vessels:

Artery > Arteriole > Capillary > Venule > Vein (Vena cava)

(12) **(D).** Deduction in thrombocytes (platelets) can cause clotting disorder, leading to excessive loss of blood from the body.

(13) **(C).** Serum is plasma without clotting factors. It never clot.

(14) **(D).** In hepatic portal system, hepatic portal vein carries maximum amount of nutrients from intestine to liver.

(15) **(A).** In Human RBCs, nucleus degenerates during maturation which provide more space for oxygen carrying pigment (Haemoglobin). It lacks most of the cell organelles including mitochondria so respires anaerobically.

(16) **(C).** Tricuspid valves are AV valve present between right atrium and right ventricle. Bicuspid valves are AV valve present between left atrium and left ventricle. Semilunar valves are present at the openings of aortic and pulmonary aorta.

(17) **(D).** Fibrinogen forms fibrin strands during coagulation. These strands forms a network and the meshes of which are occupied by blood cells, this structure finally forms a clot. Antibodies are derived from γ-Globulin fraction of plasma proteins which means globulins are involved in defence mechanisms. Albumin is a plasma protein mainly responsible for BCOP.

(18) **(A).** In ECG P-wave represents depolarisation of atria. QRS complex represents depolarisation of ventricles. T-wave represents repolarisation of ventricle i.e. return from excited to normal state. Reduction in the size of T-wave i.e. if the T-wave represents insufficient supply of oxygen i.e. coronary ischaemia.

(19) **(C).** Cardiac output=stroke volume × Heart rate

Cardiac output = 5L or 5000 ml

Blood volume in ventricles at the end of diastole = 100 ml

Blood volume in ventricles at the end of systole = 50 ml

Stroke volume = 100 – 50 = 50 ml.

5000 ml = 50 ml × Heart rate

So, Heart rate = 100 beats per minute.