

Body Fluid and Circulation

Introduction

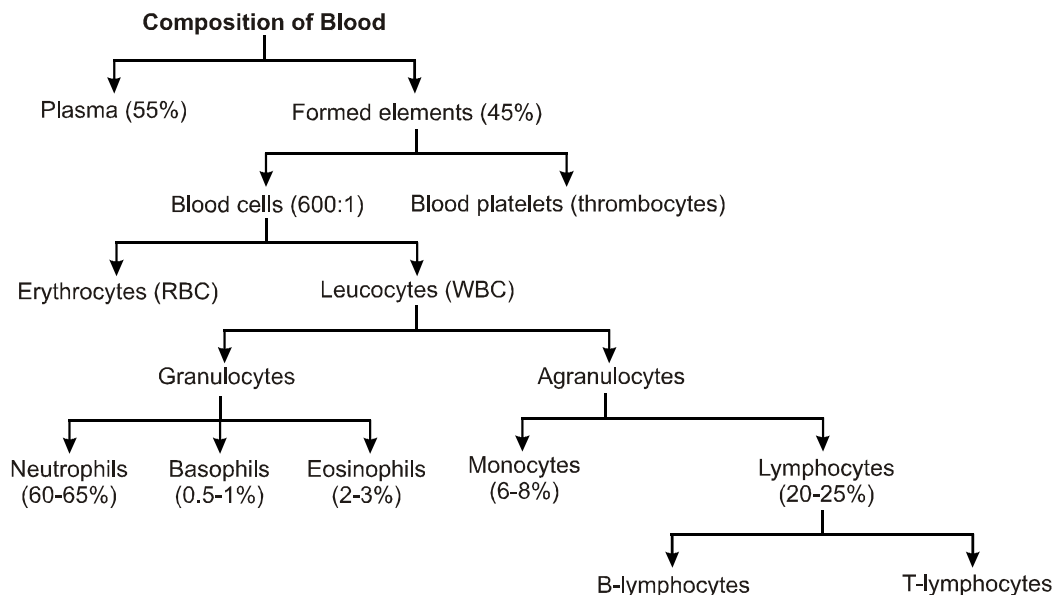
- All living cells have to be provided with nutrients, O_2 and other essential substances. Also, the waste or harmful substances produced, have to be removed continuously for healthy functioning of tissues. It is therefore, essential to have efficient mechanisms for the movement of these substances to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

Blood is the most commonly used body fluid by most of the higher organisms including humans for this purpose. Another body fluid, **lymph**, also helps in the transport of certain substances.

Blood:

Blood is a special connective tissue consisting of a fluid matrix, plasma, and cellular portion called formed elements. The plasma constitutes approximately 55% of the blood and the formed elements account for the remaining 45%.

- Study of blood - **Haematology**
- Process of blood formation **Haemopoiesis** (in bone marrow).
- Colour – Red
- pH – 7.4 (Slightly alkaline)
- By weight – 7 to 8% of body weight
- By volume – 5 – 6 litres in male and 4 – 5 litres in female.
- Blood is a false connective tissue because: –
 - a. Fibres are completely absent in blood.
 - b. Matrix of blood is produced & synthesized by liver and lymphoid organs.



Plasma

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

Composition of Plasma:

1. **Water:** 90% – 92%
2. **Proteins:** They constitute about 6-8 percent of it. **Fibrinogens, globulins** and **albumins** are the major plasma proteins.
 - (A) **Albumin:** It help in osmotic balance. They maintain the blood colloidal osmotic pressure (BCOP). It is produced & synthesized by liver. It is smallest plasma protein.
 - (B) **Globulin:** They are primarily involved in the Defense mechanism of the body. It is produced and secreted by liver and lymphoid organs.
The ratio of albumin & globulin is 2: 1.
 - (C) **Prothrombin and Fibrinogen:** They are produced by liver. They are largest plasma protein. They are needed for blood clotting or coagulation.
3. **Minerals:** Plasma contains small amounts of minerals like Na^+ , Ca^{++} , Mg^{++} , HCO_3^- , Cl^- etc.
4. **Other Substances:** Glucose, amino acids, lipids, urea, hormones etc. are also present in the plasma. They are being carried by the plasma from one place to another.
5. **Clotting Factors:** In plasma clotting factors present in inactive form. They help in blood coagulation.
Plasma without the clotting factors is called **serum**.

Formed Elements:

1. Erythrocytes (Red Blood Corpuscles):

- The erythrocytes are the most abundant of all cells in blood.
- Mammalian RBCs are biconcave, circular & non-nucleated.
- A healthy adult man has, on an average, 5 million to 5.5 million of RBCs mm^{-3} of blood.
- At the time of origin nucleus is present in the RBC but it degenerates during maturation process.
- Biconcave shape of RBC increases surface area.
- Due to absence of nucleus & presence of biconcave shape more Haemoglobin can be filled in RBC.

Exception: Camel & Lama are mammals with biconvex, oval shaped RBC.

- Plasma membrane of RBC is called **Donnan's membrane**.
In RBC, higher cell organelles like mitochondria & Golgi complex are absent.
- Due to absence of mitochondria, anaerobic respiration takes place in RBC and they do not take up any of the oxygen they carry.
- In RBC, carbonic anhydrase enzyme is present.
- Antigen of blood group is present on the surface of RBC.
- If Rh Antigen is present then it is also found on the surface of RBC.
- Single RBC is pale yellow in colour while group of RBC appear red in colour.
- In RBC, red coloured iron containing respiratory pigment **haemoglobin** is present.
- A healthy individual has 12-16 gm of haemoglobin in every 100 ml of blood.
- RBCs have an average life span of 120 days after which they are destroyed in the spleen (graveyard of RBCs).

Haemoglobin:

It is composed of two components

1. Haem – 5%
2. Globin – 95% (Protein part)

Haem (Iron and Porphyrin)

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

Globin: Each molecule of globin protein is composed of 4 polypeptide chains (α , β , γ and δ).
(Oxygen binding capacity of foetal Hb is more than adult Hb).

RBC Count:

Number of RBC in per cubic mm of blood is called RBC count.

Human (Male)	5.5 million] ± 1 Million/ mm^3
Human (Female)	4.5 million	
Newly born baby	6.8 million	

- Increases in RBC count condition is called **Polycythemia**. This condition occurs at hill station.
- Change in the size of RBC is called as **Anisocytosis** and change in shape is called **poikilocytosis**.
- Decrease in RBC count condition is called **Anaemia**.
- Process of formation of RBC is called **Erythropoiesis**.
- Organs which produce RBC's called **Erythropoietic organs**.
- Hormone which stimulate Erythropoiesis is called **erythropoietin** synthesized by Kidney & little quantity by liver.
- 1st RBC produced by yolk sac.
- During embryonic life RBC are produced by Liver, Spleen, Placenta, Thymus gland.
- In adult stage RBC is produced by **Red Bone Marrow** which filled in between trabeculae of spongy bones.
- Spleen stores excess blood corpuscles so it is called **Blood Bank of body**.
- Maturation of RBC's occurs by Vit. B_{12} & folic acid.

2. Leucocytes (White Blood Corpuscles):

- They are colourless due to the lack of haemoglobin.
- **TLC** - (Total leucocyte count). Number of WBC / $\text{mm}^3 \rightarrow 6000 - 8000 / \text{mm}^3 (\pm 2000 - 3000)$ of blood.

Leucocytosis: Increase in TLC. This condition occurs in bacterial & viral infection.

Leucocytopenia: Decrease in TLC. Normally TLC increases in bacterial & viral infection but in typhoid & AIDS, TLC decreases.

Leukemia: Abnormal increase in TLC (more than 1 Lakh) it is called as blood cancer.

- **Shape and Structure:** Leucocytes possess nuclei and other cell organelles and can move in an amoeboid fashion. Due to this ability, leucocytes can squeeze through pores in capillary wall and move to a site of infection (erythrocytes usually remain confined within blood vessels). The movement of leucocytes through capillary walls is referred to as **diapedesis**.
On the basis of nucleus & nature of cytoplasm, Leucocyte are of two types:

(i) Granulocytes

- In their cytoplasm granules are present which can be stained by specific dye.
- Nucleus is multilobed and lobes are interconnected by protoplasmic strand.
- Due to presence of lobed nucleus they are called as polymorphonuclear WBC.
- Produced in Bone marrow -
They are (A) Acidophils, (B) Basophils & (C) Neutrophils.

(ii) Agranulocytes

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

They are of 2 types (i) Monocytes (ii) Lymphocytes.

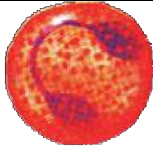
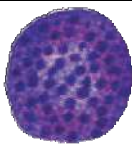
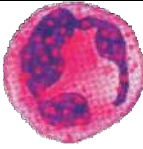

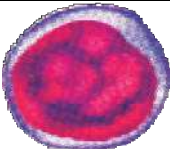
3. Thrombocytes (Platelets):

- Size 2 - 3 μm in diameter.
- Life span - 2-4/5 days.
- Number - 1.5 - 3.5 lakh/ mm^3 of blood.
- They are non nucleated and are cell fragments produced from **megakaryocyte** cells of bone marrow.
- In shape platelets are disc like, oval shaped or biconvex.
- Decrease in number of blood platelets is called **Thrombocytopenia**. It can lead to clotting disorders which will lead to excessive loss of blood from the body.

Function:

1. Repair endothelium of blood vascular system by the formation of platelet plug.
2. Synthesize thromboplastin which help in blood clotting.

LEUCOCYTES (WBCs)

Characteristics	Acidophils/ Eosinophils	Basophils	Neutrophils	Monocytes	Lymphocytes
Stain with	Acidic dye like eosin	Basic dye like methylene blue	any dye (acidic/basic/neutral)	—	—
Shape of nucleus	Bilobed	2 or 3 lobed, S-shaped	3 to 5 lobed	Kidney or Bean shaped	Large, due to which cytoplasm becomes peripheral
Function/s	They protect body against allergy and parasitic infections.	Secrete and transport heparin, histamine and serotonin	Phagocytic in nature Destroy bacteria and viruses by phagocytosis	Also called scavengers of blood because they engulf damaged or dead and minute bits of blood corpuscles	<ul style="list-style-type: none">• T-Killer – direct kill microbes• T-Helper – Stimulate B-Lymphocytes to produce antibody• T-suppressor – Suppresses T-Killer and protect immune system.• B-lymphocyte-Produce and transport antibodies.
Number	2-3% of TLC	0.5 – 1% of TLC (minimum in no.)	60-65% of TLC (maximum in no.)	6-8% of TLC	20-25% of TLC
Special point	Acidophils \uparrow called Eosinophilia occurs during taeniasis, Ascariasis, Hay fever	These cells are involved in inflammatory reactions.	Due to their smaller size and phagocytic nature they are called micropoliceman of blood	—	—
Diagram					

Blood Clotting (Coagulation of Blood)

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

Mechanism of Blood Clotting (Enzyme Cascade theory):

- Proposed by **Macfarlane & Co-workers**.
 - According to this theory there are 3 steps in blood clotting:
 - 1. Releasing of Thromboplastin:**
 - Injured tissue synthesizes exothromboplastin and platelets synthesize endothromboplastin.
 - Both these thromboplastins react with plasma proteins in the presence of Ca^{++} ions to form **prothrombinase enzymes**. (Thrombokinase)
 - This enzyme inactivates heparin. (Antiheparin)
 - 2. Conversion of Prothrombin into Thrombin:**
 - Prothrombinase enzyme converts inactive prothrombin into active thrombin in the presence of Ca^{++} ion.
 - 3. Conversion of Fibrinogen into Fibrin:**
 - Fibrinogen is a soluble protein of plasma. Thrombin protein polymerizes monomers of fibrinogen to form insoluble fibrous protein fibrin.
 - Fibrin fibres form a network on cut or wound in which blood corpuscles get trapped. This forms a clot of blood.
 - After clotting a pale yellow liquid oozes from the clot called **Serum**. In which antibodies are found.

$\text{Blood} - \text{Corpuscles} = \text{Plasma}$
 $\text{Plasma} - \text{Fibrinogen and clotting factors} = \text{Serum}$
- Clotting time of lymph is slower than blood.

Blood Groups

- Antigen of blood groups is present on the surface of RBC also called as **agglutinin**.
 - Antibody for blood group antigen is present in serum (plasma) called **agglutinin**.
 - Blood grouping Antigen & Antibody are special type of **glycoproteins**.
- 1. ABO Grouping:**
 - Blood groups are of 4 types A, B, AB, O.
 - A, B and O blood group discovered by **Landsteiner**.

BLOOD GROUPS AND DONOR COMPATIBILITY

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

- Blood group **O⁻** is universal donor & Blood group **AB⁺** is universal acceptor.

2. Rh Grouping:

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

% Ratio of Rh		
	Rh ⁺	Rh ⁻
In India	97%	3%
In World	80%	20%

- In Rh⁺ antibody is absent for this antigen.
- Rh antibody is also absent in Rh⁻ blood.

But

1. If Rh⁺ blood is transfused to Rh⁻ then 1st blood transfusion is complete successfully but during 1st blood transfusion Rh antibodies are formed in receiver's blood. So in next blood transfusion, agglutination of blood takes place.
2. If mother is Rh⁻ & father is **Rh⁺** then offspring may be Rh⁺. In this case 1st pregnancy is completely successful but at the time of 1st delivery Rh antibody is formed in mother's blood due to damaged blood vessel. So in next pregnancy death of foetus or could cause severe anemia and Jaundice in the earlier stage due to agglutination of blood called **erythroblastosis foetalis**.

Anti-Rh antibodies are given to mother within 72 hrs after the delivery of first child, to destroy foetal RBC which prevent Rh-antibodies formation in mother.

Lymphatic System

Lymphatic Circulatory System: It is comprises by following parts: -

- (1) Lymph
- (2) Lymph vessels
- (3) Lymph nodes

(1) Lymph = Blood - (RBC + platelets) or (Plasma + WBC)

- Lymph is a colourless fluid containing specialised lymphocytes. Which is present in the lymphatic system is called the 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.
- It has the same mineral distribution as that in plasma. Exchange of nutrients, gases, etc., between the blood and the cells always occur through this fluid.

- An elaborate network of vessels called the lymphatic system collects this fluid and drains it back to the major veins. The fluid present in the lymphatic system is called lymph. Lymph is 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.

Concept Builder



- Which formed element of blood involved in inflammatory reaction?
(1) Eosinophil (2) Erythrocyte (3) Basophil (4) Megakaryocyte
- Which smallest plasma protein maintain the blood colloidal osmotic pressure and help in osmotic balance?
(1) Globulin (2) Albumin (3) Fibrinogen (4) Both (1) and (2)
- In coagulation of blood, cascade process is required to form:
(1) Prothrombin (2) Fibrinogen (3) Fibrin (4) Thrombokinase
- The most abundant cell present in blood are:
(1) RBC (2) Lymphocyte (3) Monocyte (4) Platelet
- Globulin protein of blood plasma mainly involved in the:
(1) Clotting (2) Osmotic balance
(3) Defence mechanism (4) None
- Smallest blood corpuscles are:
(1) RBC (2) WBC (3) Platelets (4) Basophils
- A reduction in platelets number causes:
(1) Clotting disorder (2) Immuno disorder (3) Digestive disorder (4) Respiratory disorder

Concept Builder (Answer-Key)

Que.	1	2	3	4	5	6	7
Ans.	3	2	4	1	3	3	1

Circulation

- Circulatory Pathways:** The circulatory pathways are of two types:

Open Type		Closed Type	
(1)	Blood is pumped by heart passes through large vessels into open spaces or body cavities called blood sinuses.	(1)	Blood is pumped by heart into closed network of blood vessels.
(2)	Tissues are in direct contact with circulating fluid. Eg. Arthropods, molluscs.	(2)	Tissues are not in direct contact with circulating fluid. Eg. Annelids, Chordates.

In human beings (**on the basis of circulating fluid**) two types of circulatory system are observed:-

(1) Blood Circulatory System: It consist of: Blood, Blood vessels, Heart.

(2) Lymphatic System: It consist of lymph, lymph vessels, lymph nodes.

Type of Blood Circulation and Heart in Vertebrates:

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

Evolutionary sequence is present in vertebrates heart:

(1) Fishes have **“Venous-Heart”** In their heart, deoxygenated blood enters from one side and from the other side sent to the gills for oxygenation. This is called the **“Single Heart Circuit”**.

(2) In **amphibians** and **Reptiles** the auricles are divided into right and left. Right auricle gets deoxygenated and left auricle gets oxygenated blood from the body. But only 1 ventricle is present or is incompletely divided. So after coming here the oxygenated and deoxygenated blood mix up. This is called **Incomplete double circulation**.

(3) In some reptiles (Crocodile, Gavialis and Alligator) and in **all birds and mammals** the heart is divided into 2 auricles and 2 ventricles. So while circulating inside the heart the oxygenated and deoxygenated blood remain separated. The right portion of the heart collects deoxygenated blood from the body and sends it to the lungs for oxygenation, while the left portion takes oxygenated blood from the lungs and distributes it to the whole body. This is called **Double circulation**.

The right portion of the heart is called as the **“Pulmonary-Heart”** and the left portion is termed as the **“Systemic-heart”**. This is termed as **“Double Circulation of Heart”**, because the blood has to pass through the heart twice before being delivered to systemic organs.

Systemic heart:

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

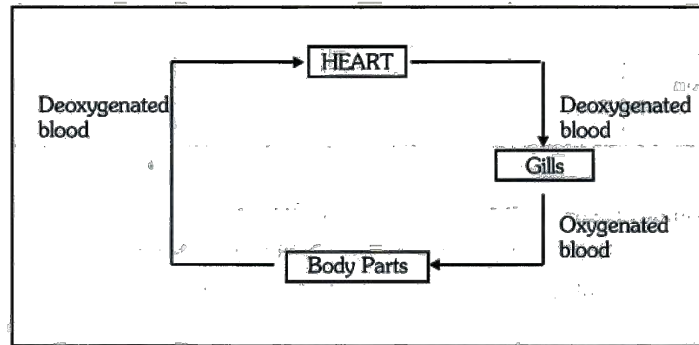
Pulmonary heart:

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

Types of Circulation of Blood

1. Single Circulation:

ex.: Fishes.

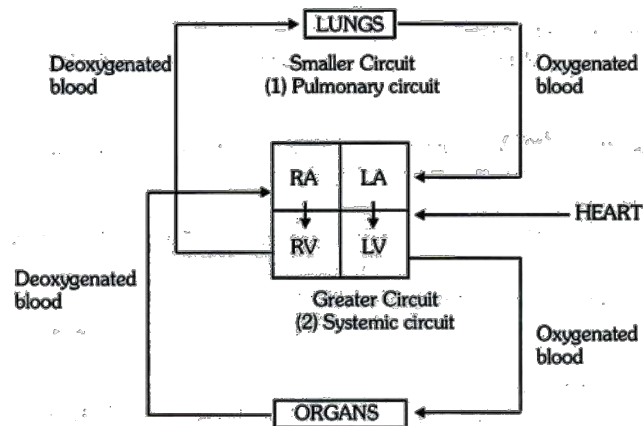


2. Incomplete Double Circulation: Two circuits are not completely separate.

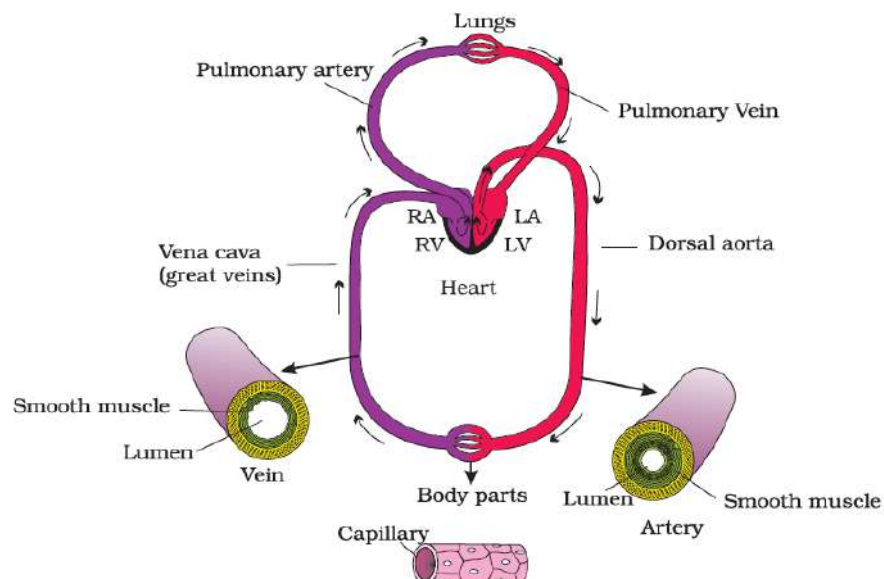
ex.: Amphibia, Reptiles.

3. Double Circulation:

ex.: Birds, Mammals



Human Circulatory System:



Schematic plan of blood circulation in human

Structure of Heart

- Heart is **mesodermally** derived organ, is situated in thoracic cavity in between the lungs, slightly tilted to the left.
- Heart is 5 × 3.5 inches in size, weight 300 gm. Its triangular superior-broad portion is tilted slightly towards right (dorsal) side. Its lower narrow portion is tilted towards left side.
- Heart is protected by a double layered bag called pericardium. The narrow space in between these two membranes is called **pericardial cavity** in which pericardial fluid is present. Pericardial fluid provide moisture to heart and reduces frictions. It is secreted by the pericardium.
- Pericardial cavity is a true coelom (as it lies between two layers of mesoderm).

Wall of Heart: The wall of heart is made of three layers:-

- (i) **Epicardium** - outermost layer, Made of simple squamous epithelium.
- (ii) **Myocardium** - middle layer, thickest, Made of cardiac muscle which are striated but involuntary.
- (iii) **Endocardium** - innermost layer, Made of simple squamous epithelium.
- Thickness of wall of Heart depends on Myocardium.
- The heart of man is four chambered. Two relatively small upper chambers called Atria and two larger lower chambers called ventricles.
- The atrium and the ventricle of the same side are separated by a thick fibrous tissue called the atrio-ventricular septum.
- The right and left atria are separated by a thin muscular wall called **Inter atrial septum**. Which is shifted slightly towards left. So right atrium is slightly bigger than left atrium.

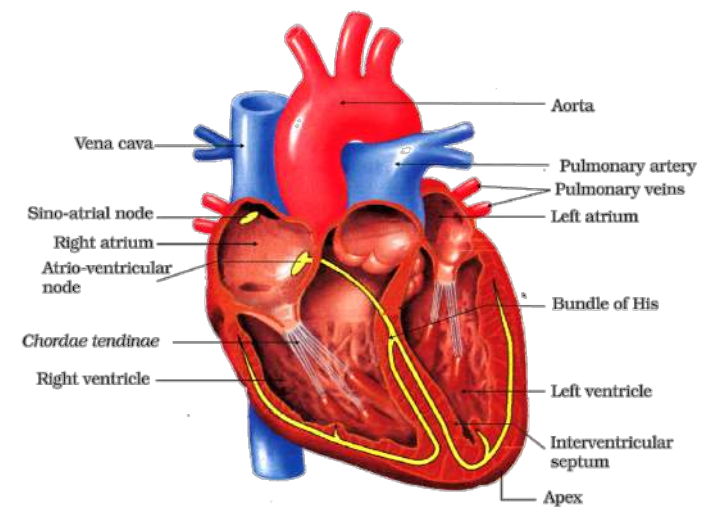
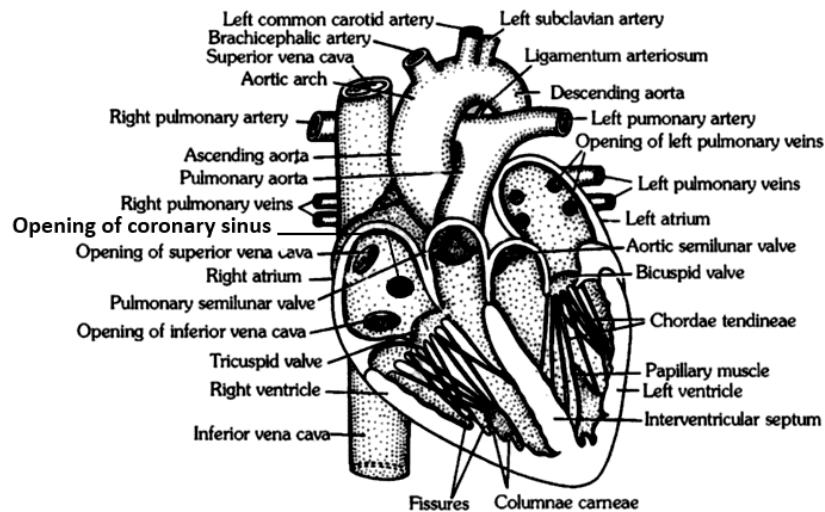


Fig. Section of a human heart

- Ventricular part is broad, muscular and light colour. Ventricles have thicker walls than auricles. The septa which divide the two ventricles are termed as **Inter-ventricular septum**. It is oblique or tilted toward Right. It does not reach till the tip or apex of the heart, So the right ventricle is smaller than the left ventricle.
- Left ventricle is more muscular and thick walled then right because it has to pump blood into those arteries which distribute blood throughout the body while right ventricle has to pump blood only to the lungs.
- Left ventricle is the largest chamber of heart.



Vessels:

- **Right Atrium:** Receives one **S.V.C.**, one **I.V.C.** and one opening of **coronary sinus** in man. **SVC** = superior vena cava; **IVC** = inferior vena cava. The SVC & IVC bring deoxygenated blood from the upper and lower body parts respectively. The **Coronary sinus** receives deoxygenated blood from the Rt. & Lf. Coronary veins and drains it in the right atrium.
- **Right Ventricle:** Receives deoxygenated blood through right AV foramen from right atrium. Drains the deoxygenated blood into pulmonary artery through which it reaches lungs for oxygenation.
- **Left Atrium:** Receives oxygenated blood from lungs via pulmonary vein. This oxygenated blood is drained into left ventricle through left AV foramen. **In human four pulmonary veins** open into LA through separate openings.
- **Left Ventricle:** Drains pure blood into the Aorta from where it is supplied to systemic organs.

Walls:

- **Atrium:** The inner wall surface here presents a series of transverse muscular ridges called **musculi pectinati**. They run forwards and downwards towards AV foramen, giving appearance of the teeth of a comb (combed muscles).
- **Ventricles:** The inner wall is rough due to presence of muscular ridges **trabeculae carnae** or **columnae carnae**. These continue as **papillary muscles**, whose one end is attached to the ventricular wall and the other end connected to the cusps of AV valves by **chordae tendinae**. These chorda tendinae are **collagenous and inelastic chords**, one end of which is inserted in the papillary muscles and other end is connected to the flaps of AV valves. These are meant for preventing the pushing of flaps into atrium during ventricular contraction.

Valves:

- **Rt. Atrium:** Its inlets are guarded with valves to prevent backflow of the blood. The IVC which opens below this has its opening guarded by a valve called **Eustachian valve** (during embryonic life the valve guides the inferior vena caval blood to the left atrium through foramen ovale). The opening of coronary sinus in Rt Atrium is guarded by **Thebesian valve**.
- **Lf. Atrium:** At its inlet is pulmonary vein (four veins in man and two in rabbit), these have no **guarding valve**.
- **AV Foramen:** The right AV foramen has a unidirectional valve called **tricuspid valve** (made of three flaps or cusps) which allows entry of Blood from Rt. Atrium to Rt ventricle and prevents its backflow. The unidirectional valve present on left AV foramen is made of two cusps only, hence called **bicuspid valve**. (also called as the **Mitral valve**).
- **Rt. Ventricle:** Its outlet is in the pulmonary artery, it is guarded by a **pulmonary semilunar valve**.

- **Lf. Ventricle:** Its outlet is in the systemic aorta. This opening is guarded by an **aortic semilunar valve**. Both these semilunar valves are made of **three cusps** each and are unidirectional in nature.

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

- **Blood Supply of Heart (Coronary Circulation):**

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

Golden Key Points

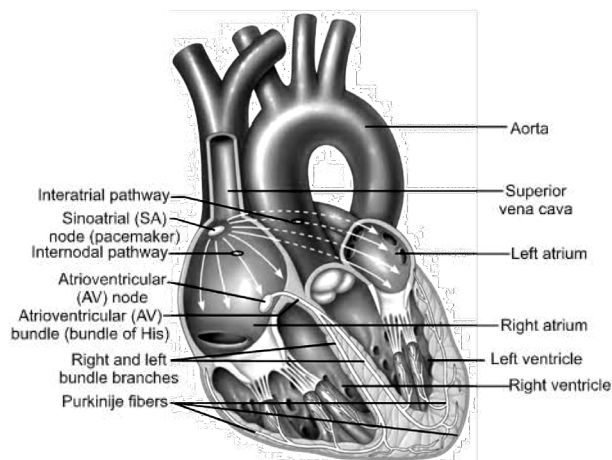
1. Total number of valves in human embryonic heart are six - Tricuspid, bicuspid, pulmonary semilunar, aortic semilunar, Thebasian and Eustachian. **Thebasian** and **Eustachian valves** merge into the musculature of their respective veins after birth.
2. In embryonic heart small opening, **Foramen ovale** is present at interatrial septum which after birth is modified to **Fossa ovalis**.
3. In embryonic heart a small duct, **Ductus arteriosus** is present which connect pulmonary artery and aorta, which after birth is modified to **Ligamentum arteriosum**.

Heart Beat

Differences between Neurogenic and Myogenic Hearts

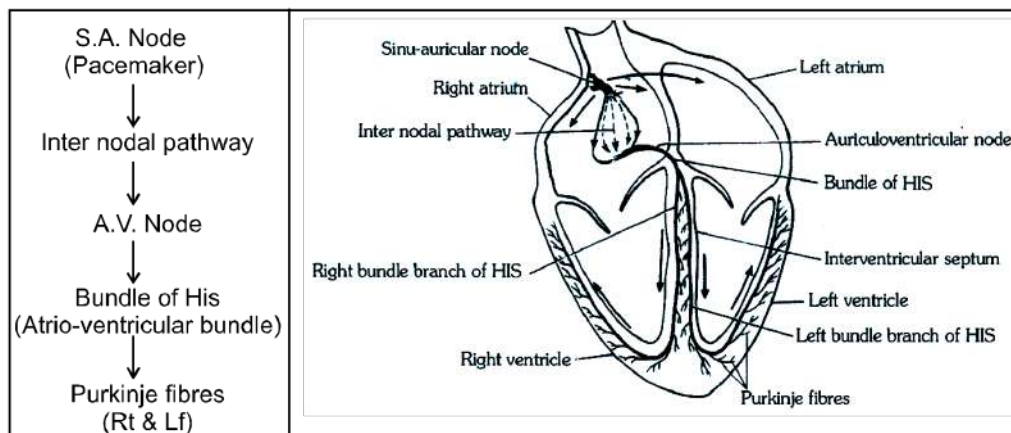
Neurogenic Heart	Myogenic Heart
(1) Impulse of heart beat comes from outside the heart.	(1) The impulse of heart beat develops within the heart.
(2) Impulse is generated by nervous system.	(2) Impulse is generated by a special muscular tissue.
e.g. Arthropods and some annelids.	e.g. Molluscs and vertebrates

The Conducting System of Myogenic Heart:



It is made of myocardium that is specialised for initiation and conduction of the cardiac impulse. Its fibres are finer than other myocardial fibres, these are completely cross striated and possess special nerve like properties (= self excitatory **neuromuscular pathway**).

The conducting system has the following parts:



- **Speed of conduction is fastest in Purkinje fibres and slowest in AV node.**

(1) Sinuatrial node (SA node). It is known as the “pacemaker” of the heart. It is present in right upper corner of the right atrium. It generates impulses at the rate of about 70 – 75 per minute and initiates heart beat.

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

(3) Atrioventricular node (AV Node). It is situated in the lower left corner of the right atrium close to the atrioventricular septum.

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

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

(5) The Purkinje fibres. These are distributed through the endocardium of the ventricles and propagate the impulse in the entire ventricle musculature.

- The SAN can generate the maximum number of action potentials, i.e., $70\text{--}75\text{ min}^{-1}$, 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}).
- Rhythmic contraction and the relaxation of heart is called heart beat. Actually, contraction and relaxation occur separately in atria and ventricles. However, ventricular movements are quite prominent and forceful. Therefore, each heart beat is synonym with **ventricular** or **apex beat**. It increases temporarily with activity and disease. In animals heart beat is connected with size. In mammals, smaller animals have higher heart beat.

Adult human	:	72 per min.
Rabbit	:	210 per min.
New born	:	120 - 140 per min.

Note: Heart rate is higher in women, children and infants and lower in aged persons.

Concept Builder



1. Exchange of nutrients, gases etc. between the blood and the cells always occurs through:
(1) Plasma (2) Tissue fluid (3) Interstitial fluid (4) Both (2) and (3)
2. Which of the following is incorrect about lymph?
(1) Lymph is an important carrier for nutrients, hormones etc.
(2) Fats are absorbed through lymph in the lacteals
(3) Lymph is a colourless fluid containing erythrocytes
(4) All are correct
3. In which of the following, two separate circulatory pathways are present?
(1) Amphibians & fishes (2) Fishes & reptiles (3) Reptiles & birds (4) Birds & mammals
4. Find out the incorrect statement:-
(1) Atrial systole increases the flow of blood into the ventricles by about 30 %
(2) During ventricular diastole, closure of semilunar valves prevent the backflow of blood into the atrium
(3) Cardiac output of an athlete will be much higher than that of an ordinary man
(4) Heart sounds are of clinical diagnostic significance.
5. During joint diastole:-
(1) Tricuspid and bicuspid valves are open
(2) Semilunar valves are closed
(3) All the four chambers of heart are in a relaxed state.
(4) All of the above
6. Open circulatory system is present in:
(1) Annelids and Chordates (2) Annelids and Arthropods
(3) Arthropods and Chordates (4) Arthropods and Molluscs
7. During ventricular systole:
(1) Semilunar valves are closed
(2) About 30 percent blood is pumped into aorta from ventricles.
(3) Tricuspid and Bicuspid valves are closed
(4) Ventricular pressure declines
8. Which of the following is not represented in normal human ECG?
(1) Depolarisation of atria (2) Depolarisation of ventricles
(3) Repolarisation of atria (4) Repolarisation of ventricles

Concept Builder (Answer-Key)

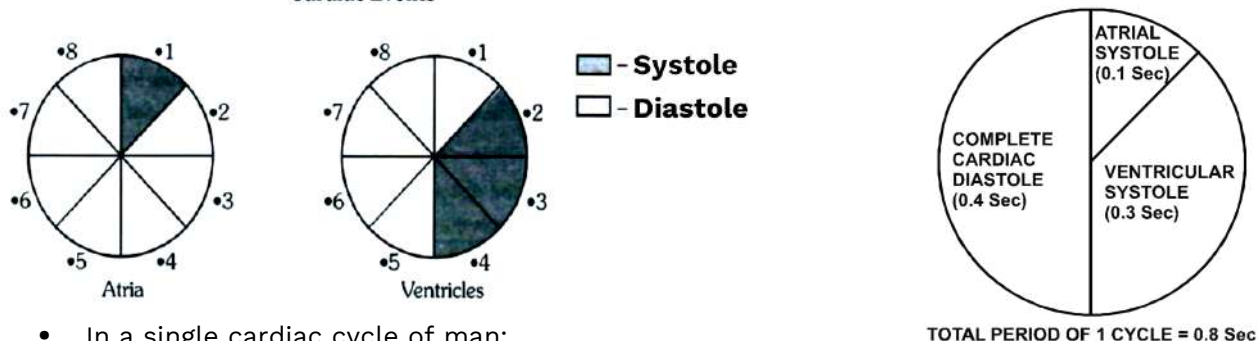
Que.	1	2	3	4	5	6	7	8
Ans.	4	3	4	2	4	4	3	3

Cardiac Cycle

- To begin with, all the four chambers of heart are in a relaxed state, i.e., they are in joint diastole. As the tricuspid and bicuspid valves are open, blood from the pulmonary veins and vena cava flows into the left and the right ventricle respectively through the left and right atria. The semilunar valves are closed at this stage.

- The SAN now generates an action potential which stimulates both the atria to undergo a simultaneous contraction – the atrial systole. This increases the flow of blood into the ventricles by about 30 per cent. The action potential is conducted to the ventricular side by the AVN and AV bundle from where the bundle of His transmits it through the entire ventricular musculature. This causes the ventricular muscles to contract, (ventricular systole), the atria undergoes relaxation (diastole), coinciding with the ventricular systole. Ventricular systole increases the ventricular pressure causing the closure of tricuspid and bicuspid valves due to attempted backflow of blood into the atria.
- As the ventricular pressure increases further, the semilunar valves guarding the pulmonary artery (right side) and the aorta (left side) are forced open, allowing the blood in the ventricles to flow through these vessels into the circulatory pathways. The ventricles now relax (ventricular diastole) and the ventricular pressure falls causing the closure of semilunar valves which prevents the backflow of blood into the ventricles. As the ventricular pressure declines further, the tricuspid and bicuspid valves are pushed open by the pressure in the atria exerted by the blood which was being emptied into them by the veins. The blood now once again moves freely to the ventricles. The ventricles and atria are now again in a relaxed (joint diastole) state, as earlier. Soon the SAN generates a new action potential and the events described above are repeated in that sequence and the process continues.
- This sequential event in the heart which is cyclically repeated is called the cardiac cycle and it consists of systole and diastole of both the atria and ventricles. As mentioned earlier, the heart beats 72 times per minute, i.e., that many cardiac cycles are performed per minute. From this it could be deduced that the duration of a cardiac cycle is 0.8 seconds. During a cardiac cycle, each ventricle pumps out approximately 70 mL of blood which is called the stroke volume. The stroke volume multiplied by the heart rate (no. of beats per min.) gives the cardiac output. Therefore, the cardiac output can be defined as the volume of blood pumped out by each ventricle per minute and averages 5000 mL or 5 litres in a healthy individual. The body has the ability to alter the stroke volume as well as the heart rate and thereby the cardiac output. For example, the cardiac output of an athlete will be much higher than that of an ordinary man.
- 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. These sounds are of clinical diagnostic significance.

Cardiac Events



- In a single cardiac cycle of man:

(1) Atrial systole	= 0.1 sec	} 0.8 sec
(2) Atrial diastole	= 0.7 sec.	
(3) Ventricular systole	= 0.3 sec	} 0.8 sec
(4) Ventricular diastole	= 0.5 sec	

Volumes of Blood Related with Cardiac Cycle:

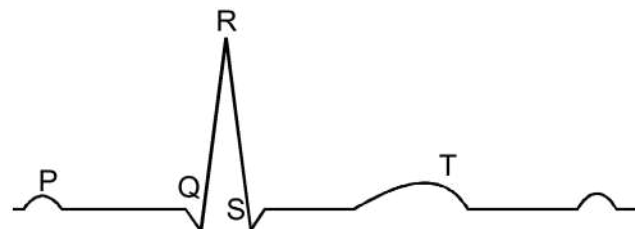
- During diastole, filling of the ventricles normally increases the volume of each ventricle to about 120 millilitres. This volume is known as **End Diastolic Volume (EDV)**.
- **Stroke volume**. i.e. the volume of blood pumped by each ventricle in the aorta in one heart beat or one cardiac cycle. Its value is 70 ml.
- The remaining volume in each ventricle is now about 50 millilitres is called **End Systolic Volume (ESV)**.
- $\text{Stroke Volume} = \text{EDV} - \text{ESV} = 70 \text{ ml}$ (approx).
- The fraction of the end diastolic volume which is ejected out is called the **Ejection Fraction**. (usually around 60% or 7/12). $\text{EF} = \text{SV}/\text{EDV}$
- **Cardiac output** it is the amount of blood pumped by the each ventricle per minute. Its value in a normal adult is about 5 litre/minute.
 $\text{Cardiac output} = \text{stroke volume} \times \text{heart rate.}$
 $= 70 \times 72 \approx 5 \text{ lit.}$
- The body is able to alter the stroke volume as well as the heart rate and thereby the cardiac output. As for example, the cardiac output of an athlete will be much higher than that of an ordinary man.

Heart Sounds:

- During each cardiac cycle two prominent sounds are produced.
- These “Lubb” and “Dub” sounds of the heart can be heard with the help of an instrument called **”Stethoscope”**
- Due to defects in heart valves an abnormal heart sound is produced called **HEART MURMUR**.

Electrocardiogram (ECG)

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



Standard ECG

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

Peaks and their Interpretations:

- **P wave:** Depolarisation in atria (Beginning of atrial systole).
- **QRS Complex:** Depolarisation in ventricles (Beginning of ventricular systole).
- **T waves:** Repolarisation in ventricle (Beginning of ventricular diastole and joint diastole).

- By counting the numbers of QRS complexes that occur in a given time period, heart beat rate can be determined.
- Since ECG obtained from different individuals have roughly the same shape for same lead configuration, any deviation in the shape indicates a possible abnormality or disease, which is why it is of a great clinical significance.

Regulation of Heart Beat:

Centre for heart beat Regulation is located in medulla oblongata. (Brain stem).

(a) Nervous Control:

- The “Cardiac-centre” (neural centre) which regulates heart-beat is found in Medulla-oblongata of the brain it can moderate the cardiac function through ANS. This cardiac-centre has two units.
 - (i) Cardio-accelerator centre.
 - (ii) Cardio-inhibitory centre.
- From the cardio-accelerator centre, a pair of sympathetic nerves go into the S.A. node, Neural signals through the sympathetic nerves can increase the rate of heart beat, the strength of ventricular contraction and thereby cardiac output.
- While the cardio-inhibitory centre sends impulses to the S.A. node through cardiac branch of Vagus-nerve. From the parasympathetic nerve-fibres, hormone Acetyl-choline is secreted which decrease the heart rate, speed of conduction of action potential and the cardiac output.

(b) Hormonal control: Adrenal medulla hormone (Adrenaline, nor adrenaline) and Thyroxine hormone of thyroid gland increase heart rate and the cardiac output.

Key Points

Hormonal control	Adrenaline	–	↑	Rate
	Nor adrenaline	–	↑	Rate
	Thyroxine	–	↑	Rate
Autonomic Nervous System	Sympathetic	–	↑	Rate
	Parasympathetic	–	↓	Rate
	Vagal stimulation releases Acetyl choline	–	↓	Rate

Tachycardia		Bradycardia	
It is the condition where heart rate exceeds 90 per minute in an average adult.		It is the condition where the heart rate falls below 60 per minute in an average adult.	
Common causes of tachycardia :		Common causes of bradycardia :	
(i)	Temperature	(i)	Temperature
(ii)	Stimulation by sympathetic nerves	(ii)	Stimulation by parasympathetic Vagus
(iii)	Weak condition of the heart	(iii)	Stronger condition of the heart.
(iv)	Shock/loss of blood	(iv)	
(v)	Exercise	(v)	

Blood Pressure:

- Blood pressure is the pressure exerted by the flowing blood on the elastic walls of arteries. Blood pressure is measured in two stages.
- (1) **Systolic Pressure (Pumping Pressure):** It is the higher limit of blood pressure that shows the state of heart (systole) contraction. for man this limit is 120 mm Hg (normal).
- (2) **Diastolic Pressure (Resting Pressure):** It is the lower limit of B.P. that shows the state of heart relaxation (expansion = Diastole). For man this limit is 80 mm Hg (normal).
- The instrument by which we can measure B.P. is called **sphygmomanometer**.
- In man B.P. is measured in the brachial artery of arm. or in radial artery.
[Normal B.P. of a healthy person is **120/80 mm Hg**]
Age: B.P. increases as the age advances.
- **Pulse:** The pulse is felt in the radial artery present in the wrist of a man. It is also felt in the artery of neck region. The graph of pulse of an artery is marked by an instrument that is called **sphygmograph**.
- **Pulse pressure** is the Pressure difference which generates a pulse.
Pulse Pressure = Systolic Pressure - Diastolic Pressure.

Disorders Related to the Circulatory System:

- **High Blood Pressure (Hypertension):** Hypertension is the term for blood pressure that is higher than normal. A blood pressure of **120/80** is considered normal. In this measurement, 120 mm Hg (millimetres of mercury) is the **systolic**, or pumping, pressure and 80 mm Hg is the diastolic, or resting, pressure. If repeated checks of blood pressure of an individual is 140/90 or higher, it shows hypertension which leads to heart diseases and also affects vital organs like brain and kidney.
- **Coronary Artery Disease (CAD):** Coronary Artery Disease, often referred to as **atherosclerosis**, affects the vessels that supply blood to the heart muscle. It is caused due to the depositions of calcium, fat, cholesterol and fibrous tissues in the arteries supplying the heart musculature. These depositions make the lumen of arteries narrower.
- **Angina Pectoris:** A symptom of acute chest pain appears when no enough oxygen is reaching the heart muscle. The term **angina pectoris** means chest pain. It can occur both in men and women of any age but is more common among the middle aged and elderly people. It occurs due to conditions that affect the blood flow.
- **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).
- **Heart Attack (Myocardial Infarction):** Heart attack occurs when the heart muscles are suddenly damaged by an inadequate blood supply.
- **Heart - Block:** When A.V. Node gets damaged, so contractions do not reach up to ventricles this event is called heart block.

- **Cardiac Arrest:** Cardiac arrest means complete stoppage of the heart beat i.e., when the heart stops beating.

Blood Vessels:

In closed type of blood vascular system blood vessels are of 3 types:

(1) Arteries (2) Veins (3) Capillaries

- Capillaries are present in the organs, and these are the vessels through which exchange takes place.

Anatomy of Arteries and Veins: Normally there are three layers are found in the walls of blood vessels.

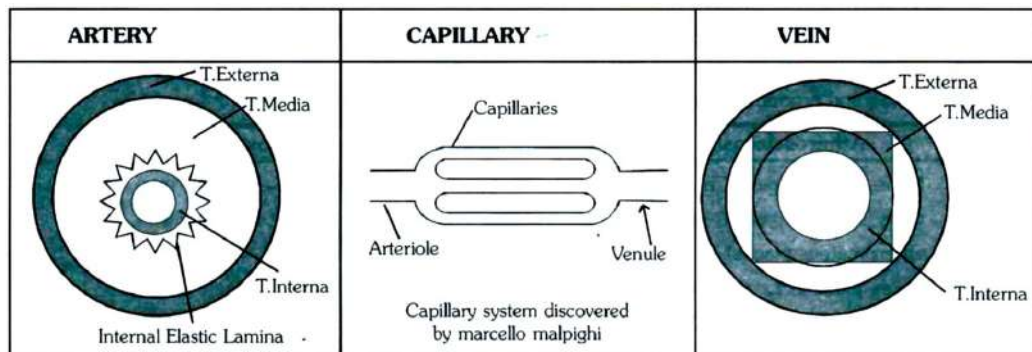
(i) Tunica Externa: It is the outer most layer. It is formed of loose connective tissue in which many collagen fibres, elastin fibres and longitudinal muscles are found.

(ii) Tunica Media: It is a thick layer of circular non striated muscles and a network of elastin fibres.

(iii) Tunica Interna: This layer is made up of squamous epithelium. It is also known as Endothelium.

- In the walls of blood capillaries only endothelium layer is found. Its cells are flat and squamous. Their walls are perforated. These blood capillaries join the arteries with the veins.

Main differences in arteries and veins:



Artery		Vein	
(1)	It carries blood from the heart to the organs.	(1)	It carries blood from organs to the heart.
(2)	All the arteries carry pure blood except pulmonary artery which carries impure blood.	(2)	All the veins carry impure blood except pulmonary vein which carries pure blood.
(3)	Blood flows with a high pressure & speed.	(3)	In the vein, blood flows with a low pressure & speed.
(4)	Arteries are deeply situated in the body.	(4)	Veins are superficial just below the skin.
(5)	Their lumen is constricted.	(5)	Their lumen is wide.
(6)	Valves are absent in the walls of arteries.	(6)	Walls of veins contain valves.
(7)	Their tunica media layer is much thicker as compared to veins.	(7)	Their tunica media layer of wall is thinner as compared to arteries.

Portal System:

When the vein of any organ of the body does not open in the caval vein or heart but it divides into capillaries in any other organ and its blood is transported by vein of that other organs to the heart, then this type of system is termed as **portal system**.

It is of following types:

- (i) Renal portal system
- (ii) Hepatic portal system
- (iii) Hypophysial portal system

(i) Renal Portal System:

Veins which collect blood from posterior parts of the body and legs combine to form a renal portal vein. This vein goes into **kidney** and divides into capillaries kidneys separate nitrogenous wastes from this blood.

- In mammals, renal portal system is absent.
- In Frog both the portal systems; renal portal system and hepatic portal system are present.

(ii) Hepatic Portal System:

It is a portal system which brings venous blood directly from digestive tract, spleen, pancreas and gall bladder to **liver** for extraction of nutrients and other metabolites by breaking up into single celled thick capillaries and sinusoids.

(iii) Hypophysial Portal System:

It is portal system formed by a vein from hypothalamus which breaks up into capillaries in ant. lobe of pituitary gland (Adenohypophysis). The Vein is called **hypophysial portal vein**. Hypothalamus produces a number of hormones for controlling endocrine activity of adenohypophysis.

Spleen:

- Spleen is known to be the largest lymph node of body. It is the **blood bank of the body**.
- Spleen is also called **“Graveyard of RBC”**.
- Spleen originates from embryonal **mesoderm**.
- Spleen is red-coloured lymph node, it is found attached by mesentery to the lateral side of stomach.

Functions of Spleen:

1. Its macrophages engulf or phagocytize and destroy worn-out blood cells, pathogens, cell debris etc.
2. In the embryonal stage it produces RBCs.
3. Some antibodies are synthesised here.
4. Spleen stores iron.
5. [Spleen + liver + kidneys] These three are called **blood filter apparatus** of blood.
6. Dead – **RBC filtering** apparatus = Spleen + liver.

Concept Builder



1. Normal activities of the heart are:
(1) Regulated extrinsically (2) Auto regulated
(3) regulated by specialised nodal nerves (4) All are correct
2. If heart receive parasympathetic neural signals, It will:-
(1) Increase the rate of heart beat
(2) Increase the speed of conduction of action potential
(3) decrease the cardiac output
(4) Increase strength of ventricular contraction
3. Which of the following disorder of circulatory system affects the vessels that supply blood to the heart muscle?
(1) Hypertension (2) Heart failure
(3) Coronary artery disease (4) Cardiac arrhythmia
4. Narrow lumen of arteries with deposition of calcium, fat & cholesterol is significant with which disorder:-
(1) High blood pressure (2) Atherosclerosis
(3) Heart attack (4) Congestive heart failure
5. If parasympathetic nerve of the Human is cut then heart beat will:
(1) Unaffected (2) Decreases (3) Increases (4) Stop
6. Systemic heart refers to:
(1) The heart that contracts under stimulation from nervous system
(2) Left auricle and left ventricle in higher vertebrates
(3) Entire heart in lower vertebrates
(4) The two ventricles together in humans
7. Hepatic portal system connects:
(1) Digestive system to liver (2) Kidney to liver
(3) Liver to heart (4) Liver to kidney
8. Which one indicates the hypertension?
(1) 90/60 mm of Hg (2) 120/85 mm of Hg
(3) 110/70 mm of Hg (4) 140/100 mm of Hg

Concept Builder (Answer-Key)								
Que.	1	2	3	4	5	6	7	8
Ans.	2	3	3	2	3	2	1	4

Exercise – I

1. Component of blood responsible for producing antibodies is:
 (1) Thrombocytes (2) Monocytes
 (3) Erythrocytes (4) Lymphocytes
2. Serum is:
 (1) Plasma without clotting factors
 (2) Blood without blood cells
 (3) Blood without clotting factors
 (4) Blood without RBC
3. If 'A' antigen is present on RBCs then the blood group of a person is:
 (1) A (2) B (3) AB (4) O
4. The normal Albumin/Globulin ratio in blood is:
 (1) 2: 1 (2) 1: 2
 (3) 1: 4 (4) 1: 5
5. Blood group Antigen are:
 (1) Found in Hb molecule
 (2) Found in Plasma protein
 (3) Found on RBC
 (4) Found on WBC
6. Life span of platelets is:
 (1) 4 days (2) 9 - 12 days
 (3) 20 - 30 days (4) 90 days
7. Blood colloidal osmotic pressure mainly maintained by which plasma protein:
 (1) Globulin (2) Albumin
 (3) Fibrinogen (4) Prothrombin
8. Mammalian RBC are:
 (1) Biconcave, circular, non-nucleated
 (2) Biconcave, Nucleated, circular
 (3) Biconvex, circular, Nucleated
 (4) Biconvex, circular, Non-nucleated
9. Persons with and blood group are called universal recipients & universal donors respectively:
 (1) AB⁻, O⁺ (2) O⁺, AB⁻
 (3) O⁻, AB⁺ (4) AB⁺, O⁻
10. ABO blood grouping is based on:
 (1) Surface antibodies on RBC
 (2) Surface antigen on WBC
 (3) Surface antigen on RBC
 (4) Plasma antigens
11. Which leucocyte has kidney shaped nucleus:
 (1) Basophil (2) Monocyte
 (3) Neutrophil (4) Lymphocyte
12. Blood clotting requires:
 (1) Na⁺ + K⁺
 (2) Na⁺ + Prothrombin
 (3) Na⁺ + Thromboplastin
 (4) Ca⁺⁺ + Thromboplastin
13. Lymph differ from blood in possessing:
 (1) Only WBC
 (2) More RBC & WBC
 (3) More RBC & few WBC
 (4) More WBC & few RBC
14. Diapedesis means:
 (1) Formation of WBC
 (2) Formation of RBC
 (3) Process by certain WBCs squeeze through thin capillary wall
 (4) Movement of food in gut
15. Which of following act as middleman of body?
 (1) WBC (2) Lymph
 (3) Plasma (4) Blood
16. Process by which blood cells are formed in bone marrow:
 (1) Haemopoiesis
 (2) Haemolysis
 (3) Thrombopoiesis
 (4) Erythroblastosis
17. Content of haemoglobin/100 ml of Blood:
 (1) 15 gm (2) 20 gm
 (3) 10 gm (4) 5 gm
18. Which of following has least consistency in shape:
 (1) RBC (2) WBC
 (3) Mast cell (4) Bone cells
19. Ratio of WBC / RBC in human blood:
 (1) 1: 100 (2) 1: 200
 (3) 500: 1 (4) 1: 500

- 20.** In comparison to WBC, RBC have:
 (1) Antigen (Agglutinin) on surface of RBC
 (2) Carbonic anhydrase
 (3) Donnan's membrane
 (4) All of above
- 21.** Which one is more in lymph than blood:
 (1) RBC (2) Nutrients
 (3) Lipids (4) Oxygen
- 22.** Blood bank of body is:
 (1) Liver (2) Spleen
 (3) Heart (4) Bone marrow
- 23.** Worn out RBC are destroyed by:
 (1) Spleen (2) Bone cells
 (3) Mast cells (4) Kidney
- 24.** Blood differs from real connective tissue because:
 (1) Plasma of blood is not entirely secreted by blood cells
 (2) Blood corpuscles are not formed in blood
 (3) Fibres are absent in blood
 (4) All of above
- 25.** 1st site of RBC production is:
 (1) Bone marrow (2) Spleen
 (3) Liver (4) Yolk sac
- 26.** Which WBC has maximum lobes of nucleus:
 (1) Neutrophil (2) Acidophil
 (3) Basophil (4) Lymphocyte
- 27.** Which WBC increase in Allergy.
 (1) Acidophil (2) Basophil
 (3) Lymphocyte (4) Neutrophil
- 28.** Thromboplastin is secreted by:
 (1) Kidney (2) Platelets
 (3) Leucocyte (4) Erythrocyte
- 29.** T-lymphocyte differentiates in:
 (1) Bone marrow (2) Liver
 (3) Thymus gland (4) Kidney
- 30.** Antibody are absent in which blood group:
 (1) A (2) B (3) AB (4) O
- 31.** Blood group 'A' can receive blood from which group:
 (1) A, AB, O (2) A, O
 (3) O (4) B, AB
- 32.** Which is not a plasma protein:
 (1) Heparin (2) Albumin
 (3) Prothrombin (4) Fibrinogen
- 33.** Megakaryocyte cell is:
 (1) RBC producer
 (2) Thrombocyte producer
 (3) WBC producer
 (4) Protein producer
- 34.** In which pair erythroblastosis foetalis occur:
 (1) Rh⁺ male & Rh⁻ female
 (2) Rh⁻ male & Rh⁻ female
 (3) Rh⁺ male & Rh⁺ female
 (4) Rh⁻ male & Rh⁺ female
- 35.** Blood of AB blood group can transfer blood to:
 (1) A (2) B (3) AB (4) O
- 36.** Agranulocytes are:
 (1) Eosinophils and neutrophils
 (2) Monocytes and lymphocytes
 (3) Eosinophils and lymphocytes
 (4) Lymphocytes and basophils
- 37.** Which is unrelated to blood coagulation?
 (1) Fibrinogen (2) Fibrin
 (3) Bilirubin (4) Calcium
- 38.** Maximum number of white blood corpuscles is that of:
 (1) Basophils (2) Neutrophils
 (3) Monocytes (4) Eosinophils
- 39.** Which of the following are involved in body defence:
 (1) Neutrophils (2) Lymphocytes
 (3) Macrophages (4) All the above
- 40.** Prothrombin, albumin and fibrinogen are synthesised by:
 (1) Pancreas (2) Bone marrow
 (3) Spleen (4) Liver

- 41.** Which one is a factor for maturation of erythrocytes:
 (1) Vitamin B₁₂ (2) Vitamin A
 (3) Vitamin D (4) Vitamin C
- 42.** Immature RBCs of mammals have:
 (1) No nucleus
 (2) Single beaded nucleus
 (3) Many nuclei
 (4) Single nucleus
- 43.** Number of erythrocytes per mm³ of human blood is:
 (1) 2 million (2) 5 million
 (3) 6 million (4) 0.5 million
- 44.** Number of WBCs per mm³ of human blood is:
 (1) 8000 (2) 4000
 (3) 3000 (4) 16000
- 45.** RBCs are nucleated in:
 (1) Man (2) Rabbit
 (3) Rat (4) Frog
- 46.** An anticoagulant is:
 (1) Heparin (2) Hirudin
 (3) EDTA (4) All the above
- 47.** The minimum number of leucocyte of human blood is:
 (1) Basophil (2) Monocyte
 (3) Neutrophil (4) Eosinophil
- 48.** Blood has a pH of:
 (1) 7.4 (2) 7.8 (3) 6.9 (4) 6.3
- 49.** Bilirubin and biliverdin are derived from:
 (1) Globin (2) Haem
 (3) Iron (4) Fat
- 50.** Continuous bleeding from an injured part of body is due to deficiency of:
 (1) Vitamin-A (2) Vitamin-B
 (3) Vitamin-K (4) Vitamin-E
- 51.** Abnormal increase in number of WBC in blood is called:
 (1) Anaemia (2) Polycythaemia
 (3) Leukaemia (4) Sarcoma
- 52.** Liquid which remain after clotting of blood is called as:
 (1) Serum (2) Plasma
 (3) Lymph (4) Blood
- 53.** Deoxygenated blood is pumped by the heart in:
 (1) Reptiles (2) Birds
 (3) Mammals (4) Fishes
- 54.** Closed circulatory system occurs in:
 (1) Cockroach (2) Tadpole/Fish
 (3) Mosquito (4) Housefly
- 55.** Where is the pace maker situated:
 (1) In left auricle near opening of pulmonary vein
 (2) In right auricle near opening of superior vena cava
 (3) On inter-auricular septum
 (4) On inter-ventricular septum
- 56.** Papillary muscles are found in:
 (1) Haemocoel of cockroach
 (2) Auricles of heart
 (3) Ventricles of heart
 (4) Ventricles of brain
- 57.** To reach the left side of heart the blood must pass through:
 (1) Sinus venosus (2) Kidneys
 (3) Liver (4) Lungs
- 58.** Characteristics of cardiac muscles are that they:
 (1) Contract quickly and get fatigued
 (2) Contract quickly and do not get fatigued
 (3) Contract slowly and get fatigued
 (4) Contract slowly and do not get fatigued
- 59.** In heart of Human bicuspid valve is situated in:
 (1) Right auricle and pulmonary aorta
 (2) Post caval and auricle
 (3) Left auricle and left ventricle
 (4) Right auricle and right ventricle
- 60.** When the right ventricle contracts the blood pumps in to:
 (1) Superior vena cava
 (2) Dorsal aorta
 (3) Pulmonary aorta
 (4) Pulmonary veins

- 61.** The blood leaving the lungs is richer than the blood entering the lung in:
 (1) Oxygen (2) CO₂
 (3) Hydrogen (4) Moisture
- 62.** Purkinje fibres are found in:
 (1) Brain (2) Liver
 (3) Eyes (4) Heart
- 63.** In children, heart rate is:
 (1) More than adult (2) Less than adult
 (3) Equal to adult (4) None of these
- 64.** The wall of Human heart is thick due to presence of:
 (1) Inner layer endocardium
 (2) Middle layer myocardium
 (3) Outer most layer pericardium
 (4) Outer layer epicardium
- 65.** Bundle of His originates from:
 (1) Sinu-auricular node
 (2) Auriculo-ventricular node
 (3) Pulmonary aorta
 (4) Systemic aorta
- 66.** Purkinje fibres mainly help in contraction of:
 (1) Right auricle (2) Left ventricle
 (3) Ventricles (4) Aorta
- 67.** The valves of the heart are attached to papillary muscles by:
 (1) Columnae carnae
 (2) Chordae tendinae
 (3) Tendinae
 (4) Pectinate muscles
- 68.** The rate of heart beat per minute is highest in case of:
 (1) Elephant (2) Whale
 (3) Man (4) Mouse
- 69.** The largest and the thickest heart chamber is:
 (1) Left ventricle (2) Left atrium
 (3) Right atrium (4) Right ventricle
- 70.** Pace maker is:
 (1) Instrument for measuring heart beat
 (2) Instrument for measuring pulse rate
 (3) Auriculo-ventricular node that provides impulse for heart beat
 (4) Sinu-auricular node that provides impulse for heart beat.
- 71.** Origin of heart beat and its conduction is represented by:
 (1) Av node → Bundle of His → SA node → Purkinje fibres
 (2) SA node → Purkinje fibres → AV node → Bundle of His
 (3) Purkinje fibres → AV node → AV node → Bundle of His
 (4) SA node → AV node → Bundle of His → Purkinje fibres
- 72.** The hormone that stimulates heart beat is:
 (1) Insulin (2) Adrenaline
 (3) Glucagon (4) Gastrin
- 73.** Heart beat is accelerated by:
 (1) Sympathetic nerves and noradrenaline
 (2) Cranial nerves and adrenaline
 (3) Cranial nerves and acetylcholine
 (4) Sympathetic nerves and acetylcholine
- 74.** Neurogenic heart is characteristic of:
 (1) Humans (2) Invertebrates
 (3) Rat (4) Rabbit
- 75.** In circulatory system, valves occur in:
 (1) Heart and blood vessels of both vertebrates and invertebrates as well as vertebrate lymphatics
 (2) Both vertebrate and invertebrate hearts
 (3) Vertebrate heart only
 (4) Both vertebrate and invertebrate hearts and their blood vessels.
- 76.** Heart wall is made of:
 (1) Myocardium
 (2) Epicardium
 (3) Endocardium
 (4) All the above

77. Match the columns:

Column-I

- a. Superior Vena Cava
- b. Inferior Vena Cava
- c. Pulmonary Artery
- d. Pulmonary Vein

Column-II

- p. Carries deoxygenated blood to lungs
- q. Carries oxygenated blood from lungs
- r. Brings deoxygenated blood from lower parts of body to right atrium
- t. Brings deoxygenated blood from upper parts of body into right atrium

- (1) a-q, b-t, c-r, d-p (2) a-t, b-p, c-q, d-r
(3) a-t, b-r, c-p, d-q (4) a-t, b-p, c-r, d-q

78. Blood vessel which brings oxygenated blood to left auricle is:

- (1) Precaval vein (2) Post caval vein
(3) Pulmonary vein (4) Pulmonary artery

79. Ventricular contraction takes place in command of:

- (1) S.A. Node (2) A.V. Node
(3) Purkinje fibers (4) Papillary muscles

80. Bundle of His is network of:

- (1) Muscle fibres distributed throughout the heart walls
(2) Muscle fibres found only in the inter ventricular septum
(3) Nerve fibres distributed in ventricles
(4) Nerve fibres found throughout the heart

81. During exercise:

- (1) Heart beat faster
(2) Heart beat stronger
(3) Increase in cardiac output
(4) All of these

82. The heartbeat of which animal is myogenic in nature:

- (1) Cockroach (2) Leech
(3) Elephant (4) All of these

83. The heart sound "DUP" is Produced when:

- (1) Mitral valve opens
(2) Mitral valve closes
(3) Semilunar valve at the base of aorta closes
(4) Tricuspid valve opens

84. Which of the following is mismatched?

- (1) Lubb: First heart sound associated with closer of heart valves
(2) Cardiac output: Stroke volume multiplied by heart rate
(3) Dub: Second heart sound, due to opening of heart valves
(4) Duration of cardiac cycle: 0.8 second

85. Purkinje fibres arise from:

- (1) Apex of ventricles
(2) Middle of ventricles
(3) Anterior part of atria
(4) Posterior part of atria

86. Which one is the first heart sound?

- (1) 'Lubb' during closure of semilunar valves
(2) 'Lubb' during closure of atrioventricular valves
(3) 'Dup' during closure of atrioventricular valves
(4) 'Dup' during closure of semilunar valves

87. Normal Cardiac output is:

- (1) 15 Litres/min.
(2) 5 Litres \times 72/min.
(3) 5 Litres/min.
(4) 5/72 Litres/min.

88. 1st Heart sound is:

- (1) 'LUBB' at end of systole
(2) 'DUB' at end of systole
(3) 'LUBB' at beginning of Ventricular systole
(4) 'DUB' at beginning of Ventricular systole

89. The sound of lubb is produced during closure of:

- (1) Bicuspid valve
(2) Tricuspid valve
(3) Semilunar valves
(4) Both (1) and (2)

90. Cardiac output is blood:

- (1) Received by heart per minute
(2) Pumped by ventricles per sec
(3) Pumped by left ventricle per minute
(4) Pumped by left ventricle per hour

- 91.** In human, oxygenated blood flows from:
 (1) Left auricle to left ventricle during auricular systole
 (2) Right auricle to right ventricle during ventricular systole
 (3) Right ventricle to aorta during ventricular systole
 (4) Pulmonary vein to left auricle during auricular systole
- 92.** How many of the statements are true for platelets?
 (i) They are cell fragments from megakaryocytes.
 (ii) Life span is 8–10 days.
 (iii) Present in non-mammalian vertebrates in the form of spindle corpuscles.
 (iv) Very less number i.e. below critical count, causes Purpura disease.
 (1) One (2) Three (3) Two (4) Four
- 93.** Blood enters into the heart because muscles of:
 (1) Atria relax (2) Ventricle contract
 (3) Ventricle relax (4) Atria contract
- 94.** Blood Capillaries are made of:
 (1) Endothelium and thin coat of connective tissue
 (2) Endothelium and thin coat of muscle fibres
 (3) Endothelium and thin coat of connective tissue and muscle fibres
 (4) Only endothelium
- 95.** Pulmonary veins are those which:
 (1) Carry deoxygenated blood from lungs to heart
 (2) Carrying oxygenated blood from lungs to heart
 (3) Carry deoxygenated blood from heart to lung
 (4) Carry oxygenated blood from heart to lungs
- 96.** Lymph can be defined as:
 (1) Blood minus corpuscles
 (2) Blood minus Plasma
 (3) Blood minus WBC
 (4) Blood minus RBC & Platelets
- 97.** Sphygmomanometer measures:
 (1) Blood pressure (2) Pulse rate
 (3) Rate of heart beat (4) All
- 98.** Which has no muscular walls:
 (1) Capillary (2) Arteriole
 (3) Veins (4) Artery
- 99.** Pulse beat is measured from:
 (1) Veins (2) Artery (Radial)
 (3) Nerve (4) Capillary
- 100.** In a normal man, blood pressure is:
 (1) 120/80 mm of Hg
 (2) 80/100 mm of Hg
 (3) 80/120 mm of Hg
 (4) 100/80 mm of Hg
- 101.** Systolic pressure is higher than diastolic pressure due to:
 (1) Volume of blood in the heart is greater during systole
 (2) Arteries contract during systole
 (3) Blood vessels offer resistance to flowing blood during systole
 (4) Blood is forced into arteries during systole.
- 102.** Which heart sound is produced at the beginning of joint diastole?
 (1) S_2 (2) S_1 (3) S_3 (4) S_4
- 103.** A renal portal system is found in:
 (1) Rabbit (2) Mouse
 (3) Horse (4) Frog
- 104.** All arteries carry oxygenated blood except:
 (1) Systemic (2) Hepatic
 (3) Pulmonary (4) Cardiac
- 105.** When there is a sudden loss of blood from the body the organ which supplies blood is:
 (1) Spleen (2) Heart
 (3) Liver (4) Lung
- 106.** Coagulation of lymph is:
 (1) Faster than blood (2) Not possible
 (3) Slower than blood (4) A passive process
- 107.** An artery can be distinguished from a vein in having:
 (1) Thicker wall (2) Lesser lumen
 (3) No valves (4) All of the above
- 108.** The most important center of lymph formation is:
 (1) Liver
 (2) Spleen
 (3) Bone marrow
 (4) Mucosa of ileum

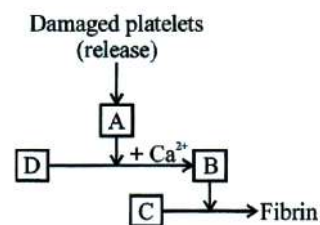
- 109.** The renal portal system of vertebrates is significant for:
 (1) Elimination of excess fats by kidneys
 (2) Removing nitrogenous wastes in kidneys
 (3) Supplying food to the kidneys
 (4) Draining blood from the kidney
- 110.** _____ is composed of just one cell layer.
 (1) Capillary (2) Arteriole
 (3) Venule (4) Vein
- 111.** Narrowing of lumen of artery due of deposition of fats is called:
 (1) Angina pectoris
 (2) Cardiac arrest
 (3) Heart failure
 (4) Atherosclerosis
- 112.** Which one of the following is the main graveyard of RBC:
 (1) Bone marrow (2) Spleen
 (3) Liver (4) Kidney
- 113.** Largest lymphoid organ of body is:
 (1) Liver (2) Kidney
 (3) Spleen (4) Pancrease
- 114.** A portal system is that in which:
 (1) A vein begins from an organ and ends in heart
 (2) An artery breaks up in an organ & restarts by the union of its capillaries
 (3) The blood from gut is brought in to kidneys before it is poured in to heart
 (4) A vein breaks up in an organ in to capillaries & restarts by their union as a new vein in the same organ.
- 115.** Indicate **correct** statement for Human:
 (1) Arteries always carry oxygenated blood while veins always carry deoxygenated blood
 (2) Venous blood is returned to left auricle
 (3) Arteries are provided with valves while veins are devoid to valves.
 (4) Arteries always carry blood away from the heart, while veins always carry blood towards the heart.
- 116.** What is true about vein:
 (1) All veins carry deoxygenated blood
 (2) All veins carry oxygenated blood
 (3) They carry blood from organs towards heart
 (4) They carry blood from heart towards organs
- 117.** Which of the following is valve less:
 (1) Arteries (2) Veins
 (3) Lymphatics (4) Chambers in Heart
- 118.** Which of the following carries deoxygenated blood:
 (1) Carotid artery (2) Pulmonary artery
 (3) Pulmonary vein (4) Aorta
- 119.** In a Portal system (Man):
 (1) A vein starts from an organ & ends in Heart
 (2) A vein enters into organ other than heart & breaks in Capillaries
 (3) An artery breaks in an organ & restarts by union of its Capillaries
 (4) Blood from intestine is brought in kidneys then in IV C.
- 120.** Lymph:
 (1) Transports O₂ to brain
 (2) Transports CO₂ to lungs
 (3) Returns interstitial fluid to blood
 (4) Returns RBCs and WBCs to lymph nodes
- 121.** Pulmonary artery differs from pulmonary vein in having:
 (1) Thick wall (2) Thin wall
 (3) Valves (4) Both (2) and (3)
- 122.** Normal pulse pressure is:
 (1) 80 mm Hg (2) 120 mm Hg
 (3) 40 mm Hg (4) 320 mm Hg
- 123.** Fully digested food reaches to liver by:
 (1) Hepatic portal vein (2) Hepatic artery
 (3) Hepatic vein (4) All the above
- 124.** Which of the following statement is true for Lymph:
 (1) WBC and serum
 (2) All components of blood except RBCs, Platelets and some proteins
 (3) RBCs, WBCs and Plasma
 (4) RBCs, Proteins and Platelets

ANSWER KEY																									
Que.	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
Ans.	4	1	1	1	3	1	2	1	4	3	2	4	1	3	2	1	1	2	4	4	3	2	1	4	4
Que.	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
Ans.	1	1	1	2	3	3	2	1	2	1	3	2	3	2	4	4	1	4	2	1	4	4	1	1	2
Que.	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Ans.	3	3	1	4	2	2	3	4	2	3	3	1	4	1	2	2	3	2	4	1	4	4	2	1	2
Que.	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	4	3	3	1	2	4	3	3	3	1	2	3	3	4	3	1	2	1	4	2	4	1	1	2
Que.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
Ans.	1	1	4	3	1	3	4	4	2	1	4	2	3	4	4	3	1	2	2	3	1	3	1	2	4
Que.	126	127	128	129																					
Ans.	3	1	3	2																					

Exercise - II

1. Erythroblastosis foetalis occurs when a factor from mother passes into the foetus through the placenta, it is:
 (1) Rh antigen (2) Rh antibodies
 (3) Agglutinins (4) ABO antibodies
2. Rise in heart beat, increase in the cardiac output, blood pressure and blood sugar occurs during emergency, by the hormone:
 (1) Aldosterone
 (2) Antidiuretic hormone
 (3) Epinephrine
 (4) Oxytocin
3. _____ supply/supplies oxygenated blood to heart musculature.
 (1) Coronary artery (2) Carotid artery
 (3) Hepatic artery (4) Coronary sinus
4. Which of the following generates the action potential in the heart?
 (1) Right atrium (2) SA node
 (3) Papillary muscles (4) Chordae tendinea
5. A symptom of acute chest pain when enough oxygen is not reaching the heart muscle is called:
 (1) Heart attack
 (2) Angina
 (3) Cardiac arrest
 (4) Coronary artery disease
6. High blood pressure can potentially harm the vital organs like:
 A - Heart B - Brain
 C - Kidneys D - Lungs
 (1) A and B only (2) B and C only
 (3) A, B and C (4) A, B, C and D
7. Which of the following WBCs are phagocytic cells:
 (a) Monocytes (b) Neutrophils
 (c) Basophils (d) Eosinophils
 (1) Only (a) (2) (a) and (b)
 (3) (a) and (c) (4) (c) and (d)

8. Identify A, B and C in the given below blood clotting process.



Options:

	A	B	C
(1)	Thrombo-plastin	Prothrombin	Fibrinogen
(2)	Thrombin	Fibrinogen	Thrombo-Kinase
(3)	Thrombo-plastin	Thrombin	Fibrinogen
(4)	Prothrombin	Thrombin	Fibrinogen

9. Read the following statements (A-D):
 A. RBCs are the most abundant of all the cells in blood
 B. A healthy adult man has on an average 5 millions to 5.5 millions of RBCs mm^{-3} of blood
 C. RBCs are formed in liver in the adults
 D. RBCs are devoid of nucleus in most of the mammals and are biconcave in shape
 How many of the above statements are incorrect:
 (1) Four (2) Three
 (3) Two (4) One
10. Erythroblastosis fetalis can be avoided by administering to the mother immediately after the delivery of first child:
 (1) Vitamins
 (2) Antibiotics
 (3) Anti-Rh antibodies
 (4) Rh-antigen

11. Read the following (A - D) Statements:
 (A) Plasma is a straw coloured, viscous fluid constituting 55 percent of the blood.
 (B) 90-92 percent of plasma is water and proteins contribute 6-8 percent of it.
 (C) Globulins are needed for clotting or coagulation of Blood
 (D) Fibrinogens are primarily involved in defence mechanism of the body.
 How many of the above statements are **correct**:
 (1) Four (2) Three
 (3) Two (4) One
12. Which of the following is **incorrect** match of WBCs with its functions:
 (1) Neutrophils = Phagocytic cells
 (2) Eosinophils = Resist infections and are also associated with allergic reactions
 (3) Basophils = Secrete histamine, serotonin and heparin
 (4) T-Lymphocytes = Produce antibodies
13. Incomplete double circulation is found in:
 (1) Reptiles and Birds
 (2) Amphibia and Reptiles
 (3) Birds and Mammals
 (4) Fish and Amphibia
14. Correctly match column-I with column-II

Column-I	Column-II
A-Cardiac arrest (i)	Heart not pumping blood effectively
B-Heart Failure (ii)	Heart muscle is suddenly damaged
C- Heart attack (iii)	Acute chest pain
D- Angina (iv)	Heart stops beating

 (1) A→(i), B→(ii), C→(iii), D→(iv)
 (2) A→(iv), B→(ii), C→(i), D→(iii)
 (3) A→(iv), B→(i), C→(ii), D→(iii)
 (4) A→(ii), B→(iii), C→(i), D→(iv)

15. Match the Column-I with Column-II.

Column-I	Column-II
(A) Fish	(i) 3-chambered heart
(B) Amphibia	(ii) Incomplete double circulation
(C) Birds	(iii) 4-chambered heart
	(iv) Single circulation
	(v) 2-chambered heart
	(vi) Double circulation

 (1) A→(i), (ii) B→(iii), (vi) C→(iv), (v)
 (2) A→ (i), (iv) B→(v), (ii) C→(iii), (vi)
 (3) A→(v), (iv) B→(i), (ii) C→(iii), (vi)
 (4) A→(iii), (ii) B→(i), (iv) C→(v), (vi)
16. In which of the following can decrease the rate of heart beat?
 (A) Sympathetic neural signals.
 (B) Parasympathetic neural signals.
 (C) Adrenal medullary hormones.
 (D) Vagus nerve.
 (E) Thyroxine hormone
 (F) Acetylcholine
 (1) A, C, E (2) D, E, F
 (3) A, C, D (4) B, D, F
17. Which is responsible for initiating and maintaining the rhythmic contractile activity of the heart?
 (1) Sino-atrial node (SAN)
 (2) Atrio-ventricular node (AVN)
 (3) Purkinje fibres
 (4) Bundle of his
18. In which the following has the ability to generate action potentials without any external stimuli?
 (1) Sino-atrial node (SAN)
 (2) Atrio-ventricular node (AVN)
 (3) Purkinje fibres
 (4) All of the above
19. Which information is **incorrect** about cardiac output?
 (1) It's average value is 5000 ml
 (2) The stroke volume multiplied by the heart rate, gives the cardiac output.
 (3) It is the volume of blood pumped out by each ventricle per minute.
 (4) The body has no ability to alter the cardiac output.

- 20.** Birds and Mammals have:
- (1) Single and closed type circulation
 - (2) Double and open type circulation
 - (3) Double and closed type circulation
 - (4) Single and open type circulation
- 21.** Identify the **correct** sequence of events in a cardiac cycle:
- (1) Joint diastole → Atrial systole
→ Ventricular systole
 - (2) Joint diastole → Atrial diastole
→ Ventricular systole
 - (3) Ventricular systole → Atrial systole
→ Joint diastole
 - (4) Atrial systole → Joint diastole
→ Ventricular systole
- 22.** Match the terms given under Column 'I' with their functions given under Column 'II' and select the answer from the options given below:
- | Column-I | Column-II |
|---------------------|--|
| A. Lymphatic System | (i) Carries oxygenated blood |
| B. Pulmonary vein | (ii) Immune Response |
| C. Thrombocytes | (iii) To drain back the tissue fluid to the circulatory system |
| D. Lymphocytes | (iv) Coagulation of blood |
- (1) A→(i), B→(ii), C→(iii), D→(iv)
 - (2) A→(iii), B→(i), C→(iv), D→(ii)
 - (3) A→(iii), B→(i), C→(ii), D→(iv)
 - (4) A→(ii), B→(i), C→(iii), D→(iv)
- 23.** Cardiac activity could be moderated by the autonomous neural system. Tick the correct answer:
- (1) The parasympathetic system stimulates heart rate and stroke volume
 - (2) The sympathetic system stimulates heart rate and stroke volume
 - (3) The parasympathetic system decreases the heart rate but increase stroke volume
 - (4) The sympathetic system decreases the heart rate but increase stroke volume.

- 24.** Which among the following is **correct** during each cardiac cycle?
- (1) The volume of blood pumped out by the Rt and Lf ventricles is same.
 - (2) The volume of blood pumped out by the Rt and Lf ventricles is different
 - (3) The volume of blood received by each atrium is different
 - (4) The volume of blood received by the aorta and pulmonary artery is different.
- 25.** After examining the blood group of husband and wife, the doctor advised them not to have more than one child. The blood groups of the couple are likely to be:
- (1) Male Rh⁻ and female Rh⁺
 - (2) Female Rh⁻ and male Rh⁺
 - (3) Male Rh⁺ and female Rh⁺
 - (4) Male Rh⁻ and female Rh⁻
- 26.** Prothrombin is found in:
- (1) Intestine and helps in cellulose digestion
 - (2) Liver and helps in production of bile
 - (3) Blood and gives red colour
 - (4) Blood and helps in blood clotting
- 27.** Which of the following is an anticoagulant and checks blood coagulation in blood vessels?
- (1) Prothrombin
 - (2) Globulin
 - (3) Thromboplastin
 - (4) Heparin
- 28.** In normal healthy female, the number of RBC/mm³ of blood is:
- (1) 6.5 - 7.0 million
 - (2) 5.5 - 6.0 billion
 - (3) 4.5 - 5.0 million
 - (4) 3.5 - 4.0 million
- 29.** The following are needed for blood clotting:
- (1) Ca⁺⁺ and Vitamin E
 - (2) Ca⁺⁺ and Vitamin K
 - (3) Ca⁺⁺ and Vitamin A
 - (4) K⁺ and Vitamin K

30. Read the following statements and choose the correct option.

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 Through AV node.

- (1) Action mentioned in statement-1 is dependent on action mentioned in statement-2.
- (2) Action mentioned in statement-2 is dependent on action mentioned in statement-1.
- (3) Action mentioned in statement-1 and 2 are independent of each other.
- (4) Action mentioned in statement-1 and 2 are synchronous.

31. Mark the pair of substances among the following which is essential for coagulation of blood.

- (1) Heparin and calcium ions
- (2) Calcium ions and platelet factors
- (3) Oxalates and citrates
- (4) Platelet factors and heparin

ANSWER KEY

Que.	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
Ans.	2	3	1	2	2	3	2	3	4	3	3	4	2	3	3	4	1	4	4	3	1	2	2	1	2
Que.	26	27	28	29	30	31																			
Ans.	4	4	3	2	3	2																			

Exercise – III (Previous Year Questions)

[AIPMT 2006]

1. Examination of blood of a person suspected of having anaemia, shows large, immature, nucleated erythrocytes without haemoglobin. Supplementing his diet with which of the following is likely to alleviate his symptoms?
- (1) Thiamine
 - (2) Folic acid and cobalamin
 - (3) Riboflavin
 - (4) Iron compounds

[AIPMT 2007]

2. Which one of the following mammalian cells is not capable of metabolising glucose to carbon-dioxide aerobically?
- (1) Red blood cells
 - (2) White blood cells
 - (3) Unstriated muscle cells
 - (4) Liver cells
3. A drop of each of the following, is placed separately on four slides. Which of them will not coagulate?
- (1) Whole blood from pulmonary vein
 - (2) Blood plasma
 - (3) Blood serum
 - (4) Sample from the thoracic duct of lymphatic system.

[AIPMT 2008]

4. Which type of white blood cells are concerned with the release of histamine and the natural anticoagulant heparin?
- (1) Eosinophils
 - (2) Monocytes
 - (3) Neutrophils
 - (4) Basophils
5. In humans, blood passes from the post caval to the diastolic right atrium of heart due to:
- (1) Stimulation of the sino auricular node.
 - (2) Pressure difference between the post caval and atrium.
 - (3) Pushing open of the venous valves.
 - (4) Suction pull

6. The most active phagocytic white blood cells are:

- (1) Eosinophils and lymphocytes
- (2) Neutrophils and monocytes
- (3) Neutrophils and eosinophils
- (4) Lymphocytes and macrophages

[AIPMT 2009]

7. The most popularly known blood grouping is the ABO grouping. It is named ABO and not ABC, because "O" in it refers to having:
- (1) No antigens A and B on RBCs
 - (2) Other antigens besides A and B on RBCs
 - (3) Overdominance of this type on the genes for A and B types
 - (4) One antibody only - either anti-A or anti-B on the RBCs
8. The letter T in T-lymphocyte refers to:
- (1) Thymus
 - (2) Thyroid
 - (3) Thalamus
 - (4) Tonsil
9. Globulins contained in human blood plasma are primarily involved in:
- (1) Clotting of blood
 - (2) Defence mechanisms of body
 - (3) Osmotic balance of body fluids
 - (4) Oxygen transport in the blood

[AIPMT-2010]

10. Fastest distribution of some injectable material/medicine and with no risk of any kind can be achieved by injecting it into the:
- (1) Arteries
 - (2) Veins
 - (3) Lymph vessels
 - (4) Muscles

11. Given below are four statement (a-d) regarding human blood circulatory system:

- (a) Arteries are thick-walled and have narrow lumen as compared to veins.
- (b) Angina is acute chest pain when the blood circulation to the brain is reduced
- (c) Persons with blood group AB can donate blood to any person with any blood group under ABO system.
- (d) Calcium ions play a very important role in blood clotting.

Which two of the above statements are correct?

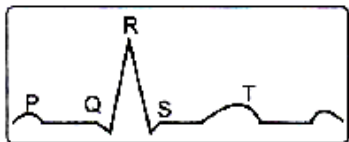
- (1) (a) and (b) (2) (b) and (c)
(3) (c) and (d) (4) (a) and (d)

- 12.** If due to some injury the chordae tendinae of the tricuspid valve of the human heart is partially non-functional, what will be the immediate effect?

- (1) The flow of blood into the pulmonary artery will be reduced
- (2) The flow of blood into the aorta will be slowed down
- (3) The 'pacemaker' will stop working
- (4) The blood will tend to flow back into the left atrium

[AIPMT-2011]

- 13.** Given below is the ECG of a normal human. Which one of its components is correctly interpreted below?



- (1) Peak P – Initiation of left atrial contraction only
- (2) Complex QRS – One complete pulse
- (3) Peak T – Initiation of total cardiac contraction
- (4) Peak P and Peak R together – Systolic and diastolic blood pressures.

- 14.** Which one of the following statements is correct regarding blood pressure?

- (1) 130/90 mm Hg is considered high and required treatment
- (2) 100/55 mm Hg is considered an ideal blood pressure
- (3) 105/50 mm Hg makes one very active
- (4) 190/110 mm Hg may harm vital organs like brain and kidney

- 15.** Arteries are best defined as the vessels which:

- (1) Supply oxygenated blood to the different organs
- (2) Carry blood away from the heart to different organs
- (3) Break up into capillaries which reunite to form a vein
- (4) Carry blood from one visceral organ to another visceral organ

- 16.** Bundle of His is a part of which one of the following organs in humans?

- (1) Brain (2) Heart
(3) Kidney (4) Pancreas

17. Which one of the following plasma proteins is involved in the coagulation of blood

- (1) Albumin (2) Serum amylase
(3) Globulin (4) Fibrinogen

[AIPMT-2012]

18. Which one of the following human organ is often called the **"Graveyard of RBCs"**?

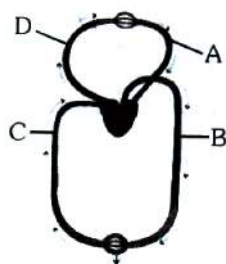
- (1) Spleen (2) Liver
(3) Gall bladder (4) Kidney

- 19.** A patient brought to a hospital with myocardial infarction is normally immediately given:

- (1) Cyclosporine- A (2) Statins
(3) Penicillin (4) Streptokinase

[NEET-UG 2013]

20. Figure shows schematic plan of blood circulation in humans with labels A to D. Identify the label and give its function/s:



- (1) **D**-Dorsal aorta-takes blood from heart to body parts, $PO_2 = 95$ mm Hg.
- (2) **A**-Pulmonary vein-takes impure blood from body parts, $PO_2 = 60$ mm Hg.
- (3) **B**-Pulmonary artery-takes blood from heart to lungs, $PO_2 = 90$ mm Hg
- (4) **C**-Vena Cava-takes blood from body parts of the right auricle, $PCO_2 = 45$ mm Hg.

[AIPMT 2014]

21. How do parasympathetic neural signals affect the working of the heart?
- (1) Reduce both heart rate and cardiac output.
 - (2) Heart rate is increased without affecting the cardiac output.
 - (3) Both heart rate and cardiac output increase.
 - (4) Heart rate decreases but cardiac output increases.

[NEET UG-2014]

22. Person with blood group AB is considered as universal recipient because he has:
- (1) Both A and B antigens on RBC but no antibodies in the plasma.
 - (2) Both A and B antibodies in the plasma.
 - (3) No antigen on RBC and no antibody in the plasma
 - (4) Both A and B antigens in the plasma but no antibodies.

[AIPMT 2015]

23. Blood pressure in the mammalian aorta is maximum during:
- (1) Diastole of the right ventricle
 - (2) Systole of the left ventricle
 - (3) Diastole of the right atrium
 - (4) Systole of the left atrium.

[RE-AIPMT 2015]

24. Which one of the following animals has two separate circulatory pathways?
- (1) Shark
 - (2) Frog
 - (3) Lizard
 - (4) Whale
25. Doctors use stethoscope to hear the sound produced during each cardiac cycle. The second sound is heard when:
- (1) AV node receives signal from SA node
 - (2) AV valves open up.
 - (3) Ventricular walls vibrate due to gushing of blood from atria.
 - (4) Semilunar valves close down after the blood flows into vessels from ventricles.

[NEET-I 2016]

26. Blood pressure in the pulmonary artery is:
- (1) Same as that in the aorta
 - (2) More than that in the carotid
 - (3) More than that in the pulmonary vein
 - (4) Less than that in the venae cavae

[NEET-II 2016]

27. Name the blood cells, whose reduction in number can cause clotting disorder, leading to excessive loss of blood from the body:
- (1) Leucocytes
 - (2) Neutrophils
 - (3) Thrombocytes
 - (4) Erythrocytes
28. Serum differs from blood in:
- (1) Lacking albumins
 - (2) Lacking clotting factors
 - (3) Lacking antibodies
 - (4) Lacking globulins

[NEET 2017]

- 29.** Adult human RBCs are enucleate. Which of the following statement(s) is/are most appropriate explanation for this feature?
- (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

Options:

- (1) Only (d) (2) Only (a)
- (3) (a), (c) and (d) (4) (b) and (c)

- 30.** Frog's heart when taken out of the body continues to beat for sometimes. Select the best option from the following statements:
- (a) Frog is a poikilotherm
 - (b) Frog does not have any coronary circulation
 - (c) Heart is "myogenic" in nature
 - (d) Heart is auto excitable

Options:

- (1) Only (c) (2) Only (d)
- (3) (a) and (b) (4) (c) and (d)

[NEET 2018]

- 31.** Match the items given in Column-I with those in Column-II and select the **correct** option given below:

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

a	b	c
(1) ii	iii	i
(2) iii	ii	i
(3) i	iii	ii
(4) i	ii	iii

- 32.** Match the items given in Column I with those in column-II and select the **correct** option given below:

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	b	c
(1) ii	i	iii
(2) iii	i	ii
(3) i	ii	iii
(4) i	iii	ii

[NEET 2019]

- 33.** Match the Column-I with Column-II:

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 of T - wave	iv. Depolarisation size of atria
	v. Repolarisation of atria

Select the **correct** option.

	(a)	(b)	(c)	(d)
(1)	(ii)	(i)	(v)	(iii)
(2)	(ii)	(iii)	(v)	(iv)
(3)	(iv)	(i)	(ii)	(iii)
(4)	(iv)	(i)	(ii)	(v)

[NEET 2019 (Odisha)]

- 34.** All the components of the nodal tissue are autoexcitable. Why does the SA node act as the normal pacemaker?
- (1) SA node has the lowest rate of depolarisation.
 - (2) SA node is the only component to generate the threshold potential.
 - (3) Only SA node can convey the action potential to the other components.
 - (4) SA node has the highest rate of depolarisation.
- 35.** A specialised nodal tissue embedded in the lower corner of the right atrium, close to Atrio-ventricular septum, delays the spreading of impulses to heart apex for about 0.1 sec. The delay allows.
- (1) Blood to enter aorta.
 - (2) The ventricles to empty completely.
 - (3) Blood to enter pulmonary arteries.
 - (4) The atria to empty completely.

[NEET 2020]

- 36.** The QRS complex in a standard ECG represents:
- (1) Depolarisation of auricles
 - (2) Depolarisation of ventricles
 - (3) Repolarisation of ventricles
 - (4) Repolarisation of auricles
- 37.** Match the following columns and select the **correct** option.

Column-I		Column-II	
(a)	Eosinophils	(i)	Immune response
(b)	Basophils	(ii)	Phagocytosis
(c)	Neutrophils	(iii)	Release histaminase, destructive enzymes
(d)	Lymphocytes	(iv)	Release granules containing histamine

- | | | | | |
|-----|------------|------------|------------|------------|
| | (a) | (b) | (c) | (d) |
| (1) | (iv) | (i) | (ii) | (iii) |
| (2) | (i) | (ii) | (iv) | (iii) |
| (3) | (ii) | (i) | (iii) | (iv) |
| (4) | (iii) | (iv) | (ii) | (i) |

[NEET 2021]

- 38.** Persons with 'AB' blood group are called as "Universal recipients". This is due to:
- (1) Absence of antigens A and B on the surface of RBCs
 - (2) Absence of antigens A and B in plasma
 - (3) Presence of antibodies, anti-A and anti-B, on RBCs
 - (4) Absence of antibodies, anti-A and anti-B, in plasma
- 39.** Which enzyme is responsible for the conversion of inactive fibrinogens to fibrins?
- (1) Thrombin
 - (2) Renin
 - (3) Epinephrine
 - (4) Thrombokinase

[NEET 2022]

- 40.** Given below are two statements:
- Statement I:**
The coagulum is formed of network of threads called thrombins.
- Statement II:**
Spleen is the graveyard of erythrocytes. In the light of the above statement, choose the **most appropriate** answer from the options given below:
- (1) Both **Statement I** and **Statement II** are correct
 - (2) Both **Statement I** and **Statement II** are incorrect
 - (3) **Statement I** is correct but **Statement II** is incorrect
 - (4) **Statement I** is incorrect but **Statement II** is correct
- 41.** Which one of the following statement is **correct** ?
- (1) The atrio-ventricular node (AVN) generates an action potential to stimulate atrial contraction
 - (2) The tricuspid and the bicuspid valves open due to the pressure exerted by the simultaneous contraction of the atria
 - (3) Blood moves freely from atrium to the ventricle during joint diastole.
 - (4) Increased ventricular pressure causes closing of the semilunar valves.

ANSWER KEY

Que.	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
Ans.	2	1	3	4	2	2	1	1	2	2	4	1	2	4	2	2	4	1	4	4	1	1	2	4	4
Que.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41									
Ans.	3	3	2	1	4	1	2	3	4	4	2	4	4	1	4	3									