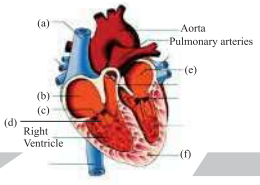


Chapter - 18

Body Fluids and Circulation

Points To Remember

Blood : A special connective tissue that circulates in principal vascular system of man and other vertebrates consisting of fluid matrix, plasma and formed elements (Blood = Plasma + All blood cells).

Plasma : (Blood – All blood cells = Plasma) The liquid part of blood which is straw coloured, viscous fluid and contains about 90-92% of water and 6-8% proteins.

Lymph : A clear yellowish, slightly alkaline, coagulable tissue fluid, containing white blood cells (Only lymphocytes), a liquid resembling blood plasma.

Serum : Blood plasma from which fibrinogen and other clotting factors have been removed. [Plasma– (fibrinogen & other clotting factor)] = blood serum.

Heart Beat : The rhythmic contraction and relaxation of the heart, which includes one systole (contraction phase) and one diastole (relaxation phase) of the heart. Heart beat count of healthy person is 72 times per minute.

Stroke Volume : The volume of blood pumped out by the heart during a systole. It is approximately 70 ml.

Cardiac output : The amount of blood pumped by heart per minute is called cardiac or heart output. The value of cardiac output of a normal person is about $72 \times 70 = 5040$ mL or about 5L per minutes.

Cardiac Cycle : The rhythmic contraction and dilation of different parts of heart in one beat.

Systole : Contraction of heart muscles.

Diastole : Relaxation of heart muscles

Formed Elements : Erythrocytes, leukocytes and platelets are called blood corpuscles or formed elements.

TYPES OF BLOOD CELLS THEIR NUMBER, STRUCTURE & FUNCTIONS

Name and Number/ Percentage	Structure	Life Span and Formation	Function
(A) Erythrocytes RBCs - 4.5 to 5.5 million per cubic millimetre of blood	Red colour Circular, biconcave denucleated, elastic lack of cell organelles like ER, ribosomes, mitochondria etc.	Formed from birth onward by red bone marrow Life-120 days excess RBCs are stored in spleen	Transport of oxygen and some amount of carbon dioxide through haemoglobin
(B) Leucocytes (WBCs) 6000-8000 per cubic mm of blood	Colourless rounded or irregular, nucleated 12 to 20mm wide	Formed in red bone marrow, Lymph nodes, spleen and thymus, life-1-4 days	Acts as soldiers scavenger and some help in healing
(i) Agranulocytes (a) Lymphocytes 20-45% of leucocytes (B and T)	Large rounded nucleus, 6-10 mm	Lymph nodes, spleen, thymus red bone marrow, life few days to months or even years	Non Phagocytic secrete antibodies
(b) Monocytes 6-8% of leucocytes,	Largest of all (12-15 mm) bean shaped nucleus	Red Bone marrow, life 10-20 hours	phagocytic, very motiles engulf germs
(ii) Granulocytes (a) Eosinophils 2-3% of leucocytes	bilobed nucleus, granules in cytoplasm	Red Bone marrow, life 4 to 8 hrs. in blood	Resist infectious and allergic reactious
(b) Basophils 0-5% of leucocytes	Three lobed nucleus (s-shaped)	Red Bone marrow, life 4 to 8 hours in blood	release heparin and histamine
(c) Neutrophils 60-65% of leucocytes	Many lobed nucleus fine granules	Red Bone marrow, life 4 to 8 hours in blood	phagocytic, engulf germ and dead cells
(C) Platelets thrombocytes 1,50,000-3,50,000 per cubic mm of blood	Colourless, rounded or oval, or irregular non-nucleated fragments	Red Bone marrow worn out ones phagocytized in blood	help in blood clotting

Blood Pressure—The resistance offered by the lumen of the artery to the flow of Blood.

Hypertension : The condition when blood pressure is higher than normal (120/80 mmHg)

Electrocardiograph : (ECG) the machine used to record electrocardiogram.

Electrocardiogram ECG : The print out of pattern of heart beat taken on a graph paper from Electrocardiograph. (ECG machine)

Lymph (Tissue Fluid)

The colourless mobile fluid connective tissue drains into the lymphatic capillaries from the intercellular spaces. It is formed by squeezing of blood through capillaries, within tissues. Its flow is unidirectional *i.e.,* from tissues to heart.

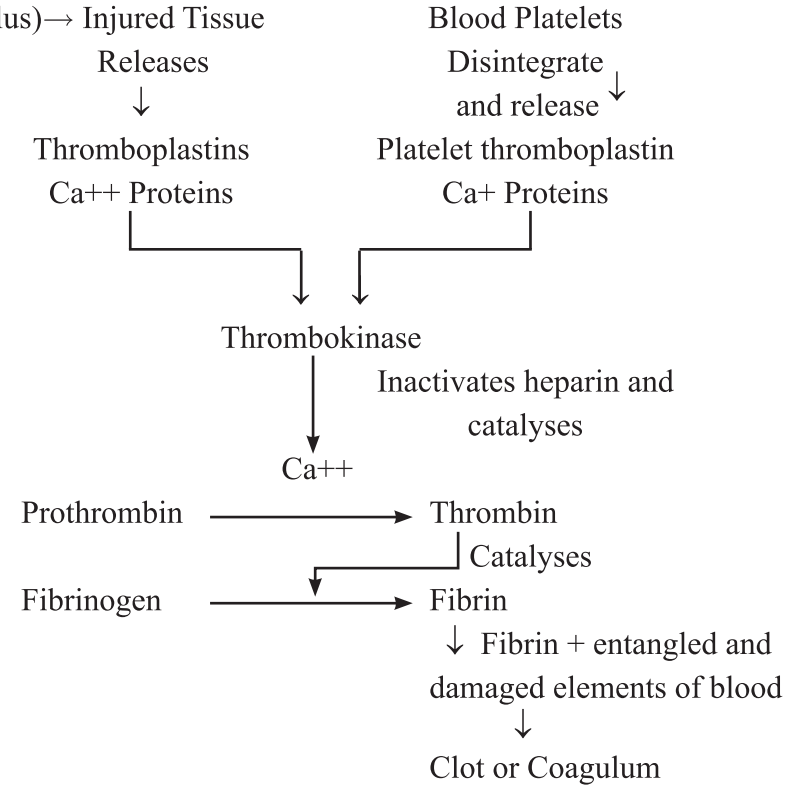
Composition : It is composed of fluid matrix, plasma having only lymphocytes of white blood corpuscles or leucocytes.

Functions : (i) It drains excess of tissue fluid from extra cellular spaces back into the blood.

(ii) It contain lymphocytes and antibodies.

(iii) It transport digested fats.

Blood Clotting : Coagulation of Blood : (Cascade process)



Functions of Blood

Transport, of food, respiratory gases (O_2 and CO_2), hormones, metabolic intermediates, waste products, supply of raw materials, regulation of water balance, regulation of pH and body temperature, and provides immunity.

Blood Groups : Based on presence of Antigens and Antibodies in blood.

Blood Group	Antigen (on the Surface of R.B.Cs)	Anti body : (in plasma)	Possible recipients having blood group	Possible donors having blood group	Remarks
A	A	Anti B	A, AB	O, A	—
B	B	Anti A	B, AB	O, B,	—
AB	A and B	None	AB	O, A, B, AB	Universal recipient
O	None	Anti A and Anti B	O, A, B, AB	O	Universal Donor

Rh (Rhesus) Group :

- Rh positive (Rh + ve) – Rh antigen similar one present in rhesus monkey. Observed on the surface of RBCs (nearly 80% of humans)
- Rh negative (Rh–ve) – those in whom this antigen is absent.
- Compatibility is crucial during transfusion and pregnancy because if Rh -ve person is exposed to Rh +ve blood it forms specific antibodies against Rh antigens.

Rh incompatibility in pregnancy

1st PREGNANCY

Rh+ve (Father)
Rh-ve (Mother)
Rh+ve (Foetus)

→ No mixing of two bloods due to placenta
Foetal maternal blood mixes during delivery

First newborn Rh +ve (safe)
But mother (Rh-ve) prepares antibodies against Rh factor

2nd PREGNANCY

Rh+ve (Father)
Rh-ve (Mother)
Rh+ve (Foetus)

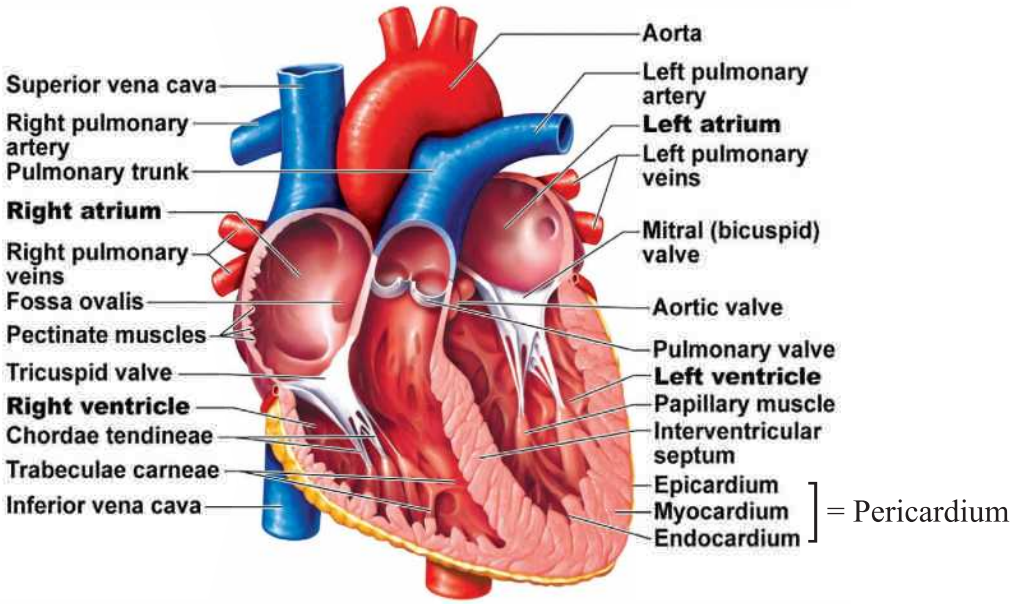
→ Antibodies leak into the blood of foetus

Destroy foetal RBCs
Leads to erythroblastosis foetalis

→ **SAN (Sino-atrial node) :** A patch of tissues present in the right upper corner of the right atrium, acts as pacemaker due to having a unique property of self excitation.

→ **AVN (Atrio Ventricular Node) :** A mass of tissues seen in the lower left corner of the right atrium close to the atrio-ventricular septum. Fresh wave of contraction generated here, passes over both the ventricles simultaneously along the bundle of HIS.

Human Heart



Human Heart

- It is the mesodermally derived organ situated in thoracic cavity in between the two lungs. Protected by a double membrane covering called Pericardium.
- Four chambers–two (left and right) atria, and two ventricles (left and right)
- Inter-atrial septum separates the two atria and inter ventricular septum separates the two ventricles, while the atria and ventricles are separated by atrioventricular septum.
- The valves between right atrium and right ventricle is tricuspid while between left atrium and left ventricle is bicuspid or mitral value.
- The opening of the right ventricle into the pulmonary artery and the opening of left ventricle in to aorta are guarded by semilunar values.

- The valves allow the flow of blood only in one direction, *i.e.,* from atria to ventricles and from ventricles to pulmonary artery or aorta.

Heart Valves

Tricuspid Valve : The valves formed of three muscular flaps or cups, which guard the opening between the right atrium and the right ventricle.

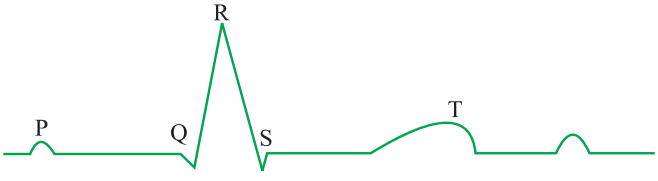
Bicuspid Valve (Mitral Valve) : The valves which guard the opening between the left atrium and the left ventricle, made up of two flaps.

Semilunar Valves : The valves present at the opening of the right and the left ventricles and allow the entry of blood into pulmonary artery and the aorta respectively.

ECG

Electrocardiogram ECG : The graphic record of the electric current produced by the excitation of the cardiac muscles. It is composed of a 'P' wave, 'QRS' wave. (complex) and 'T' wave.

Standard ECG and Reading of ECG : 'P' Wave represents the electrical excitation (or depolarisation) of the atria and leads to the contraction of both the atria.

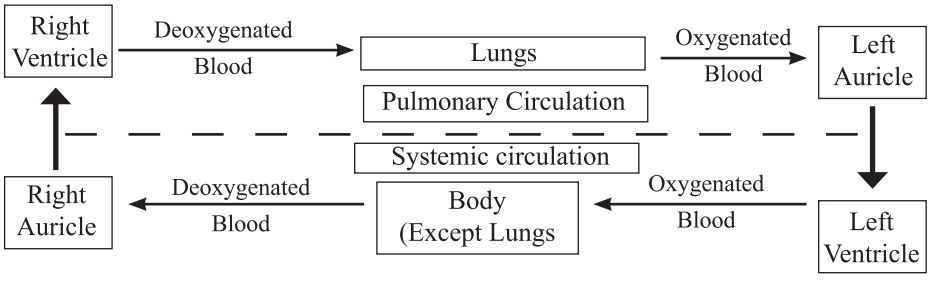


Diagrammatic presentation of a standard ECG.

'QRS' complex : represents the depolarisation of the ventricles, which initiates the ventricular contraction.

'T' Wave : represents the return of the ventricles from excited to normal state (repolarisation). The end of T-wave marks the end of sytole.

Double circulation :



CARDIAC CYCLE : The rhythmic contraction and dilation of different parts of heart in one beat.

Systole : contraction of heart muscles.

Diastole : relaxation of heart muscles.

- ❑ Joint diastole :-All chambers of heart in relaxed state.
  - Tricuspid and bicuspid valves– open
  - Blood from pulmonary vein and vena cava flows into left and right atrium respectively.
- ❑ Atrial systole :- contraction of atrias
  - SAN generates action potential to stimulate atrias to contract simultaneously
  - Blood flows to respective ventricles
- ❑ Ventricular systole : contraction of ventricles
  - AV node and AV bundle conduct the wave of contraction to the ventricles via bundle of HIS.
  - Ventricles contract as a closed chamber (as AV valves and semilunar valves are close).
  - Pressure of blood opens the semilunar valves and blood flows to respective arteries.
- ❑ Joint diastole : Relaxation of all chambers.

HEART SOUNDS

- Closure of bicuspid and tricuspid valves produces first heart sound 'lub'
- Closure of semilunar valves produces second heart sound 'dub'

Disorders of circulatory System

Hypertension (High blood Pressure) : It results from narrowing of arterial lumen and reduced elasticity of arterial walls in old age. It can cause rupturing of capillaries. It is a silent killer.

Coronary Artery Disease : (CAD) Atherosclerosis. The supply of the blood to heart muscles is affected. It is caused by deposits of Calcium, fat, cholesterol and fibrous tissues to make the lumen of arteries narrower.

Angina Pectoris : Caused due to arteriosclerosis, when not enough oxygen is reaching the heart muscle due to which the person experiences acute chest pain.

Heart attack : Caused when the heart muscle is suddenly damaged by an inadequate blood supply.

Cardiac arrest : The state in which the heart stops beating.

Arteriosclerosis : The state of hardening of arteries and arterioles due to thickening of the fibrous tissue and consequent loss of elasticity. It causes hypertension.

Questions

(SRT) Select Response Type Question (1 mark each)

1. Which instrument is used to measure blood pressure?
   (a) Barometer (b) Sphygmomanometer
   (c) BOD meter (d) none of these
2. State true or false
   "A lymph node is specialized structure in lymphatic vessel concerned with filtration of foreign bodies by the lymphocytes."
3. QRS complex of Electron cardio gram represents
   (a) Ventricular systole (b) Joint diastole
   (c) Joint systole (d) Ventricular diastole
4. The carbonic acid in RBCs is synthesised by the enzyme
   (a) RUBISCO (b) Lipase
   (b) Carbonic anhydrase (d) Acetyl co transferase.

CONSTRUCTED RESPONSE TYPE (CRT)

Very Short Answer Questions (1 mark each)

5. What is systemic circulation ?
6. Give two examples of extra-cellular fluids.
7. What name is given to the blood vessels which generally bring blood to an organ ?
8. Which adrenal hormone accelerates heart beat under normal conditions ?

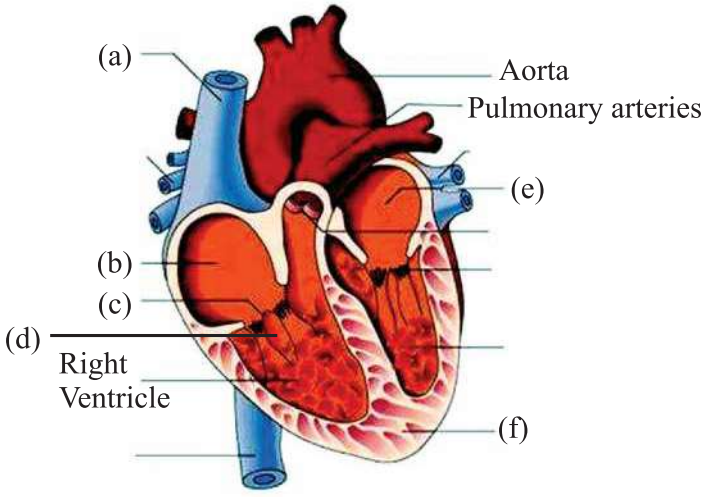
9. Name the blood vessel that carries blood from the intestine to liver.
10. Define cardiac cycle.
11. Name the protein found in RBCs.
12. What happens to a person suffering from hemophilia ?

Short Answer Questions-I (2 marks each)

13. Explain when and how the two sounds of heart are produced.
14. Define joint diastole. What are constituents of the conducting system of human heart ?
15. Give the names of various types of formed elements present in the blood.

Short Answer Questions-II (3 marks each)

16. Why is the SA node called pacemaker of the heart ? Write its full from.
17. Draw a diagram showing schematic plan of blood circulation in human.
18. In the following diagram of section of a human heart, label a, b, c, d, e and f.



19. What is lymph ? Describe its circulation in brief.
20. What is stroke volume ? What is its relation with cardiac output ?
21. A person suffering from fever is advised to take blood test. What may happen to his WBC count and why ?

Long Answer Questions (5 marks each)

22. Neena is having blood group A-ve while her husband's blood group is O +ve. Their first child is having blood gp. A +ve. Her second child was born with severe anemia and jaundice. What could be the reason ? How this situation could have been avoided ?
23. Draw a diagram to show the internal structure of human heart. Lable any two heart chambers, any two heart valves and chordae tendinae in it.
24. Describe the structure of human heart.
25. What is cardiac cycle ? Describe the event that occur during it.
26. Explain Rh grouping and its incompatibility in humans.

Case Based/Competency Based Questions (5 marks each)

27. Blood is a fluid connective tissue made up of fluid matrix plasma, and formed elements, Red blood cells, (erythrocytes) white blood cells (leukocytes), and platelets (thrombocytes) constitute the formed elements. The blood of humans is grouped into A, B, AB and O systems based on the presence or absence of two surface antigens A, B on the RBCs. Another blood grouping is also done based on the presence or absence of another antigen called Rhesus factor (Rh) on the surface of RBCs. The spaces between cells in the tissues contain a fluid derived from the blood called tissue fluid this fluid called lymph is almost similar to blood except for the protein content and the formed elements.

1. Why is blood called a fluid connective tissue?
   (a) Because of fluid matrix plasma
   (b) Because of osteocytes
   (c) Because of the solid matrix
   (d) None of the above
2. Name the formed elements of blood.
   (a) RBCs, WBCs only (b) Platelets only
   (c) Plasma only (d) RBCs, WBCs and Platelets
3. Which blood group is considered a universal donor and why?
   (a) A (b) B
   (c) AB (d) O

4. Name the complication which arises when a Rh+foetus is developing the womb of a Rh-mother.
   (a) Erythroblastosis foetalis
   (b) Angina
   (c) Cardiac arrest
   (d) None of the above
5. Give the basic difference between tissue fluid and blood.
   (a) Tissue fluid has no proteins
   (b) Tissue fluid has no RBCs
   (c) Tissue fluid has no WBCs and platelets
   (d) All of the above

Assertion & Reason Question (SRT) (1 marks each)

DIRECTIONS : In the following questions, a statement of assertion (A) is followed by a statement of the reason (R). Mark the correct choice as :

(a) If both (A) and (R) are correct and (R) is the correct explanation of (A)

(b) If both (A) and (R) true, but (R) is not the correct explanation of (A)

(c) If (A) is true but (R) is false

(d) If both (A) and (R) are false

28. **Assertion :** Blood coagulates in uninjured blood vessels.

    Reason : Uninjured Blood vessels release an anticoagulant Heparin.

29. **Assertion :** Left atrium possess the thickest muscles.

    Reason : Left atrium receives blood from the lungs.

30. **Assertion :** In the human heart there is no mixing of oxygenated and deoxygenated blood.

    Reason : The presence of valves in the heart allows the movement of blood in one direction.

Answers

(SRT) Select Response Type Question (1 mark each)

1. (b) Sphygmomanometer. 2. True

3. (a) QRS waves denotes ventricular systole.
4. (c) Carbonic anhydrase.

Very Short Answer (1 mark each)

5. The kind of blood circulation that is concerned with the supply of oxygenated blood from the left ventrical to all body parts and return of deoxygenated blood to the right atrium of heart.
6. Interstitial fluid and blood plasma.
7. Afferent blood vessel.
8. Noradrenalin.
9. Hepatic portal vein.
10. A regular sequence of three events (i) Joint diastole during the completion of one heart beat (ii) auricular systole and (iii) ventricular systole.
11. Haemoglobin.
12. The person suffering from haemophilia lacks clotting factors in blood, which result the defective clotting mechanism. In case of injury the person is at a risk of blood loss.

Short Answer-I (2 mark each)

13. (i) 'Lubb' the first sound which is low pitched, is caused by the closure of bicuspid and tricuspid valves.
    (ii) 'Dub' the second sound which is high pitched, is caused by the closure or semilunar valves.
14. In a cardiac cycle when both atria and ventricles are in a diastole and are relaxed simultaneously is called a joint diastole.
    Conducting system constitutes : SA node → AV node → Bundle of His → Purkinje fibres.
15. Erythrocytes, lymphocytes, (monocytes, neutrophils, eosinophils, basophils), and platelets.

Short Answer-II (3 marks each)

16. SA node being self excitatory initiate a wave of contraction in the heart.
    SA node — Sino–Atrial Node.
17. Refer Support material Points to remember.

18. Refer Support material Points to remember.
19. Refer Points to remember of support material.
20. During one cardiac cycle or one heart beat the volume of blood pumped by the heart is called stroke volume. This is normally 70 mL.

    In one minute the heart beats about 72 times and the amount of blood pumped per minute is called cardiac output. This is usually 4900 mL. or 5 litres.
21. The WBC count of this person may show an increase from the normal range. As pathogens may be present in his body, so the body is producing more WBCs to fight against those pathogens. WBC count is a good tool to asses the presence of infection in a sick person.

Long Answer (5 marks each)

22. During her first pregnancy after exposure with blood of her first Rh +ve child, her body prepared antibodies against Rh antigen in her blood. In second pregnancy these Rh antibodies from mother leaked into the blood of foetus (Rh +ve) and destroyed foetus RBCs. It could cause of severe anemia and Jaundice could be fetal to the foetus.

    This situation could have been avoided if she had got herself administered anti Rh antibodies, immediately after first delivery to kill Rh antibodies entered in mother's blood from foetus.
23. Refer Points to remember.
24. Refer Points to remember.
25. Refer Points to remember.
26. Refer Points to remember.

Case Based Question (4 marks each)

27. 1. (a) 2. (d) 3. (d)
    4. (a) 5. (d)

Assertion & Reason Question (SRT) (1 marks each)

28. (d)
29. (c)
30. (b)