CHAPTER 18

Body Fluids and Circulation

EXAM DRILL

ANSWERS

1. **(c) :** Myocardial infarction (MI) commonly known as a heart attack occurs when blood flow stops to part of the heart causing damage to the heart muscle.

2. **(a) :** Coronary arteries bring oxygen-rich blood to the hardworking heart muscle. The blockage of these arteries, as well as others in the body most often arises from a condition known as atherosclerosis. With this disease, calcified fatty deposits (specially cholesterol and triglycerides) build up to form so-called plaques in the inner lining of these arteries, which results in narrowing of lumen of arteries that reduces the blood flow.

3. **(c) :** Haemoglobin is a conjugated protein made up of protein called globin and a non protein group heme. A mammalian haemoglobin molecule is a complex of 4 haeme molecules joined with 4 globin molecules. A molecule of haemoglobin binds with 4 molecules of oxygen.

OR

(b)

4. **(a) :** Injections of factor IX also called Christmas factor or plasma thromboplastin component is used to treat haemophilia-B, so it is also known as anti-haemophilic factor -B.

5. **(b) :** T and B lymphocytes are involved in the specific immune response. They produce antibodies to destroy microbes and their toxins reject grafts and kill tumour cells.

6. **(b)**

7. Mature human RBCs have a biconcave shape that provides more surface area for gas exchange and are enucleated.

8. The formed elements include erythrocytes, leucocytes and platelets. Platelets are not true cells but are cell fragments due to their lack of genetic material and are formed from megakaryocytes.

9. Pulse pressure = Systolic pressure – Diastolic pressure. It is measured in millimetres of mercury (mmHg). It represents the force that the heart generates each time it contracts.

10. X shows atrial systole and Y is ventricular systole of cardiac cycle.

11. **(c) :** Person with 'O' blood group lacks both antigens but have both antibodies.

12. **(a)** **13.** **(b)**

14. **(d) :** Serum is plasma minus clotting factors.

15. **(i)** The given graph shows the electrocardiograph (ECG), a graphic record of the electric current produced by the excitation of the cardiac muscles. A normal ECG is composed of a P wave, QRS wave (complex) and a T wave.

(ii) The importance of the given graph (ECG) is that it records the electrical activity of our heart at rest and also provides information about our heart rate and rhythm.

(iii) **(a) :** Point A represent P wave. It shows atrial depolarisation, caused by activation of SA node. The impulse of contraction starts from SA node and spreads throughout the atria.

(iv) **(c) :** By counting number of QRS complexes (point B), pulse rate can be determined.

(v) **(d) :** Point C shows T wave which represents ventricular repolarisation.

16. **(i)** In this figure, A is an artery and B is a vein.

(ii) X, Y and Z represent the coats (wall) of blood vessels:

X is tunica externa

Y is tunica media

Z is tunica interna

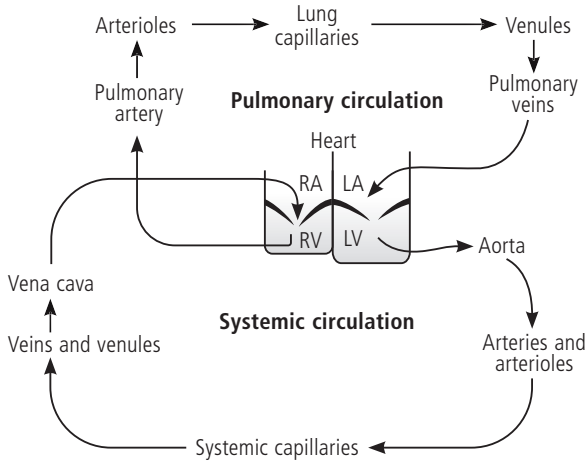
(iii) Artery (A) is a blood vessel that carries oxygen rich blood away from the heart to the all body's tissues. The flow of blood is fast and under high pressure.

Veins (B) collect blood from different parts of the body and pour it into the heart. The flow of blood in veins is under low pressure.

(iv) **(d)**

17. Cardiac arrest, heart attack and heart failure are the diseases of the cardiovascular system. Cardiac arrest happens when the heart stops beating. A heart attack happens when the heart muscle is suddenly damaged due to the inadequate blood supply. Heart failure is a condition where the heart does not pump enough blood to meet the needs of the body.

18. Diagrammatic representation of the double circulation in human is given in the following flow chart.



Significance : Double circulation of blood helps to keep oxygenated blood (rich in oxygen) separate from deoxygenated blood (rich in carbon dioxide). This results in more efficient circulation of blood because a greater amount of oxygen-rich blood can be delivered to the tissues. It also maintains constant body temperature.

19. The heart is made up of cardiac muscles. A specialised nodal tissue called the sinoatrial node is present in the upper part of the right atrium. This nodal musculature has the ability to generate electrical impulses, without any external stimuli. The electrical impulse then triggers a sequence of events leading to the rhythmic beating of the heart. The sinoatrial node is responsible for initiating and maintaining the rhythmic beats of the heart. It is called the natural pacemaker of human body.

20. The pulmonary circuit consists of blood flowing to and from the lungs, whereas the systemic circuit carries blood to and from the entire body. The systemic circuit is far more extensive, consisting of far more vessels and offers much greater resistance to the flow of blood, so the heart must generate a higher pressure to overcome this resistance. This can be seen in the thickness of the myocardium in the ventricles.

21. Haemolytic disease of the newborn is caused during subsequent pregnancies if mother is Rh–ve and fetus is Rh+ve. During the first pregnancy, Rh+ve blood of fetus stimulates the formation of anti Rh factors or antibodies in the mother's blood but the child does not suffer as enough anti–Rh factors are not produced in the mother's blood to harm the fetus. But in subsequent pregnancies with Rh+ve fetuses, the anti–Rh factors of the mother's blood destroy the fetal red blood corpuscles because her immune system will make antibodies to attack her baby. This results in haemolytic disease of newborn. It is called erythroblastosis fetalis (destruction of the erythrocytes of fetus).

22. Differences between serum and blood plasma:

S.No.	Serum	Blood plasma
(i)	The clear yellow fluid separated when blood is allowed to clot freely.	Yellowish and slightly alkaline fluid minus blood corpuscles.
(ii)	It is the watery fluid from blood without the clotting factors.	It is the blood fluid that contains blood-clotting agents.
(iii)	Human serum is usually used for the purpose of diagnostic testing. Other animal serums are used as antivenom, antitoxins and vaccinations. They are also used in humans for therapeutic purposes.	Plasma is given to the patients who lack blood cells. It is also transferred to patients who suffer from haemophilia, shocks, burns and other clotting problems.

OR

Differences between red blood cells and white blood cells:

S.No.	Red Blood cells or erythrocytes	White blood cells or leucocytes
(i)	In embryonic phase, they are formed in liver and spleen and after birth, they are formed in red bone marrow.	They are formed in red bone marrow, lymph nodes, spleen, etc.
(ii)	These are 4-5 million/mm^3 and are most abundant cells in blood accounting for 40-45 per cent of its volume.	They account for about 1 per cent volume of blood, *i.e*, about 8000/mm^3.
(iii)	Biconcave and disc shaped.	Irregular or round shape.
(iv)	Nucleus is absent (enucleate).	Nucleus present and may be bilobed, irregular or round.

23. The continuous process of blood cell including formation, development and differentiation is known as haematopoiesis or erythropoiesis. It takes place in haematopoietic tissue. In the developing embryo, the first site of blood formation is the yolk sac. Later in embryonic life, the liver and spleen become the important red blood cell-forming organ, but are soon succeeded by the bone marrow, which in adult life is

the only source of both red cells and the granulocytes. In young children, haematopoietic bone marrow fills most of the skeleton, whereas in adults the marrow is located mainly in the central bones (ribs, sternum, vertebrae and pelvic bones).

24. In a blood transfusion, blood types of recipient and donor must be matched, else, the recipient's immune system will produce antibodies that cause agglutination of the transfused cells and block blood circulation through capillaries. For example, if someone with Type O blood (blood with no A or B antigens on the surface of red blood cells) received red blood cells donated from someone with Type B blood (blood containing B antigens), the recipient's immune system would immediately identify the new blood cells as foreign and seek to destroy them. Antibodies attack by binding to the foreign antigens on the surface of red blood cells. This ultimately causes those red blood cells to rupture, destroying them entirely. In small amounts, rejected blood can be filtered out by the kidneys, but larger transfusion amounts could cause kidney failure and, potentially leads to death.

25. Differences between lymphocytes and neutrophils are:

S.No.	Lymphocytes	Neutrophils
(i)	These are agranular leucocytes.	These are granular leucocytes.
(ii)	They are non-motile and nonphagocytic.	They are phagocytic in nature.
(iii)	Lymphocytes produce antibodies to destroy microbes and their toxins reject grafts.	They can eat harmful germs or digest foreign materials.
(iv)	They are 20-25 per cent of leucocytes.	They are 60-65 per cent of leucocytes.

26. Blood exhibits coagulation or clotting in response to an injury or trauma. This is a mechanism to prevent excessive loss of blood from the body.

Blood clotting occurs in the following steps:

(i) At the site of an injury, the blood platelets disintegrate and release a phospholipid, called platelet factor-3 or platelet thromboplastin. Injured tissues also release a lipoprotein factor called thromboplastin. These two factors combine with calcium ions and certain proteins of the blood plasma to form an enzyme called prothrombinase.

(ii) The prothrombinase inactivates heparin or antiprothrombin-anticoagulant in the presence of calcium. Prothrombinase catalyses breakdown of prothrombin (inactive plasma protein) into an active protein called thrombin and some small peptide fragments.

(iii) Thrombin acts as an enzyme and first brings about depolymerisation of fibrinogen (a soluble plasma protein) into its monomers. Later, thrombin stimulates repolymerisation of these monomers into long insoluble fibre-like polymers called fibrin. The thin, long and solid fibres of fibrin form a dense network upon the wound and trap blood corpuscles (RBCs, WBCs and platelets) to form a clot. The clot seals the wound and stops bleeding. Soon after the clot starts contracting and a pale yellow fluid, the serum, starts oozing out. This serum is blood plasma minus fibrinogen and blood corpuscles. Vitamin K is essential for blood clotting as it is necessary for the synthesis of prothrombin in the liver.

27. Following are some differences between pacemaker and pacesetter:

S.No.	Pacemaker	Pacesetter
(i)	It is called the SA node of the heart.	It is the atrioventricular node (AV node) of the heart.
(ii)	It is present in the right atrium near the opening of superior vena cava.	It is present in the right atrium near the base of the interatrial septum.
(iii)	It's muscle fibres have the highest rhythmicity among all cardiac muscle fibres.	It's rhythmicity is low than pacemaker.
(iv)	It is regulated by the cardiac centres present in the medulla oblongata of the brain.	It is stimulated by cardiac impulses originated in the SA node.

28. Human heart is myogenic, *i.e.*, heartbeat is initiated by a patch of modified heart muscle. The heartbeat originated from SA node, pacemaker, which lies in the wall of the right atrium near the opening of the superior vena cava. The SA node is a mass of neuromuscular tissue.

Another mass of neuromuscular tissue, the atrioventricular node (AV node) is situated in the wall of the right atrium. The AV node picks up the wave of contraction propagated by sinoatrial (SA node). A mass of specialised fibres, the bundle of His, originates from the AV node. The bundle of His divides into two branches, one going to each ventricle. Within the mycocardium of the ventricles the branches of bundle of His divide into a network of fine fibres called the Purkinje fibres. The bundle of His and the Purkinje fibres convey impulse of contraction from the AV node to the myocardium of the ventricles.

OR

Human heart consists of four chambers; two atria and two ventricles.

Atria : The two thin walled atria are separated from each other by the interatrial septum. The right atrium receives the openings of superior vena cava, inferior vena cava and coronary sinus. The opening of inferior vena cava is guarded by Eustachian valve. The opening of the coronary sinus has coronary or Thebesian valve. In the right atrium adjoining the interatrial septum, an oval depression, the fossa ovalis is present. It marks the position of an opening, the foramen ovale, between the two atria in the fetus, but in the adult it persists only as a depression. The left artrium receives four openings of pulmonary veins.

Ventricles : There are present left and right ventricles with thick walls. The walls of the left ventricle are about three times thicker than the right ventricle. The left ventricle is longer and narrower than the right ventricle. Attached to the flaps of the bicuspid and tricuspid valves are special fibrous cords, the chordae tendineae, which are joined to the other ends with the special muscles of the ventricular wall, the papillary muscles. The chordae tendineae prevent the bicuspid and tricuspid valves from collapsing back into the atria during powerful ventricular contractions. The chordae tendineae can be seen extending from the valves to the columnae carneae, which are the muscular ridges or projections on the walls of the ventricles. The columnae carneae divide the cavity of the ventricles into smaller spaces, known as fissures. The walls of the ventricles are thicker than the atria. The thickest portion of the human heart is the wall of the left ventricle.

29. Angioplasty or balloon catheterisation is a technique to remove the atherosclerotic plaques from the coronary arteries through ballooning. The plaques can block the lumen of the arteries partially or even totally. Therefore, it is necessary to remove the plaques to clear the passage. A very small balloon-tipped catheter is inserted into the coronary artery under X-ray observation. Then the balloon is inflated with air to squash the plaques against the blood vessel wall, thereby clearing the lumen of the vessel for blood. It increases the blood flow through the vessel.

30. Through coronary circulation, the heart gets its own blood supply. The flow of oxygenated blood from the ascending aorta to the heart muscle and the return of deoxygenated blood from the heart muscle to the right atrium is called coronary (cardiac) circulation. Although blood fills the chambers of the heart, the heart muscle tissue is so thick that it needs blood vessels to deliver oxygen and nutrients deep within it. The vessels that deliver oxygen-rich blood to the heart muscle are called coronary arteries; they branch directly from the aorta, just above the heart. During diastole, the increased aortic pressure above the valves forces blood into the coronary arteries and thence into the musculature of the heart. The vessels that remove the deoxygenated blood from the heart muscle are known as coronary veins, most of these converge to form the coronary venous sinus, which drains into the right atrium.

31. (a) Human heart has mainly four valves:

(i) Bicuspid valves : It is the atrioventricular opening between the left atrium and left ventricle. It is also called mitral valve and has two muscular flaps or cusps.

(ii) Tricuspid valve : This valve guards the atrioventricular opening between right atrium and right ventricle and has three muscular flaps.

(iii) Pulmonary semilunar valves : This valve is present at base of pulmonary trunk arising from the right ventricle.

(iv) Aortic semilunar valves : This valve is present at the base of aorta arising from the left ventricle, that carries oxygenated blood to all body tissues.

(b) Cardiac output is the amount of blood pumped by the heart per minute. Heart of normal person beats 72 times per minute and pumps out 70mL of blood per beat. Thus the cardiac output is 72 x 70 = 5040 mL or 5 litres per minute which is equivalent to the total body blood volume.

(c) Pulse is the rhythmic contraction and relaxation in the aorta and its main arteries. It is due to the flow of blood from the heart and is dependent on the rate of heartbeat. It is the regular jerk of an artery. Pulse is usually taken on the radial artery in the wrist but it can be taken on any artery that flows near enough to the surface of the body to be felt.

OR

The size of white blood cells (WBCs), also known as leucocytes, is from 12-20 μm. The leucocytes are rounded or irregular in shape. They can change their shape like *Amoeba*, which enables them to squeeze out of blood capillaries into the tissue. This process is called diapedesis. Two main categories of white blood cells are: agranulocytes and granulocytes.

(a) Agranulocytes : The granules are not found in cytoplasm of these cells. They are of two types:

(i) Lymphocytes : They are nonmotile and nonphagocytic cells with scant cytoplasm and large rounded nucleus. They are further divided into following types :

- B cells : They are also known as B-lymphocytes. These cells produce antibodies to help the immune system mount a response to infection.
- T cells : They are also known as T-lymphocytes. These white blood cells help recognize and remove infection-causing cells.
- Natural killer cells: These cells are responsible for attacking and killing viral cells, as well as cancer cells.

Lymphocytes produce antibodies to destroy microbes and their toxins reject grafts and kill tumour cells. They also help in healing injuries.

(ii) Monocytes : They are white blood cells that make up around 2-8% of the total white blood cell count in the body. These are the largest of all types of leucocytes and have bean-shaped nucleus. They change into macrophages after entering tissue spaces. They are motile and phagocytic in nature and engulf bacteria and cellular debris.

(b) Granulocytes : Granulocytes are those white blood cells that have small granules containing proteins. There are three types of granulocyte cells:

(i) Basophils : These represent less than 1% of white blood cells in the body and are typically present in increased numbers after an allergic reaction.Their nucleus is generally three lobed. Their granules take basic stain (*e.g.*, methylene blue) strongly. They release heparin, histamine and serotonin.

(ii) Eosinophils : They have coarse granules that take acidic stains (*e.g.*, eosin). The nucleus is two lobed. These are responsible for responding to infections that parasites cause. They also play a role in the general immune response, as well as the inflammatory response, in the body. They also help in dissolving blood clot.

(iii) Neutrophils : They have fine granules that stain weakly with both acid and basic stains. The nucleus is many lobed. These represent the majority of white blood cells in the body. They act as scavengers, helping surround and destroy bacteria and fungi that may be present in the body.

32. The cardiac cycle comprises a complete relaxation and contraction of both the atria and ventricles, and lasts approximately 0.8 seconds. Beginning with all chambers in diastole, blood flows passively from the veins into the atria and past the atrioventricular valves into the ventricles. The atria begin to contract following depolarisation of the atria and pump blood into the ventricles. The ventricles begin to contract, raising pressure within the ventricles. When ventricular pressure rises above the pressure in the two major arteries, blood pushes open the two semilunar valves and moves into the pulmonary trunk and aorta in the ventricular ejection phase. Following ventricular repolarisation, the ventricles begin to relax and pressure within the ventricles drops. When the pressure falls below that of the atria, blood moves from the atria into the ventricles, opening the atrioventricular valves and marking one complete heart cycle.

OR

(a) The lab technician has not made any error. Blood type AB has both A and B surface antigens, and neither anti-A nor anti-B antibodies circulating in their plasma. When anti-A antibodies (added to the first well) contact A antigens on AB erythrocytes, they will cause agglutination. Similarly, when anti-B antibodies contact B antigens on AB erythrocytes, they will cause agglutination. It indicated that the blood type (group) of the person is AB.

(b) The cardiac centre lies in the medulla oblongata of the brain. It comprises of cardio-inhibitor and cardio-accelerator parts. The former decreases the rate of heart beat and the latter accelerates it. The cardio-inhibitor is connected with the heart through vagus nerve (it carries parasympathetic nerve fibres) and cardio-accelerator through sympathetic nerve fibres. Sensory fibres extend from the receptors present in the superior vena cava, aorta and carotid sinuses to the cardiovascular centre in the medulla oblongata. The impulses received from the aorta and carotid sinuses decrease the heart rate, whereas the impulses from the vena cava increase the heart rate.

33. **(a)** (i) Arteriosclerosis occurs when the blood vessels that carry oxygen and nutrients from the heart to the rest of the body (arteries) become thick and stiff, sometimes restricting blood flow to organs and tissues. Healthy arteries are flexible and elastic, but over time, the walls in arteries can harden, a condition commonly called hardening of the arteries. In arteriosclerosis, calcium salts precipitate with the cholesterol which forms plaques. Ultimately, this calcification of the plaques, makes the walls of the arteries stiff and rigid. Therefore, arteriosclerosis is referred to as the 'hardening of the arteries'. These affected arteries lose the property of elasticity and their walls may rupture. The blood which comes out from the ruptured wall may clot and block the path of blood flow. As a result, such a clot formation (thrombosis) in the coronary artery may lead to a heart attack.

(ii) Stents are a special device made of stainless steel, resembling a spring coil and can be permanently placed in an artery through a catheter (plastic tube). This is done to ensure proper blood circulation through the coronary artery that supplies blood to the heart.

(b) Blood pressure is set by following factors :

(i) Cardiac output - The amount of blood pumped by each ventricle in one minute; and (ii) peripheral resistance - the resistance that the heart has to overcome to make the blood flow through the blood vessels of our circulatory system.

OR

The hepatic portal system is a crucial part of the circulatory system and is characteristic feature of all vertebrates. An example of a portal venous system is the blood vessel network between the digestive tract and the liver. It delivers deoxygenated blood from parts of the gastrointestinal tract to the liver for purification before it is carried to the heart.

Nutrients that have been absorbed into the blood from the small intestine are taken to the liver for processing before being sent to the heart.

The hepatic portal vein is the largest vein in the abdominal cavity. It drains blood from the spleen and the gastrointestinal tract to the liver.

Important veins that open into the hepatic portal vein are:

(i) The superior mesenteric vein brings blood from the small intestine and portions of the large intestine, stomach, etc., through ilial, ileocolic, right colic, middle colic and right gastroepiploic veins.

(ii) The splenic vein drains blood from the stomach, pancreas and portions of the large intestine through left gastroepiploic, pancreatic and inferior mesenteric veins. The latter vein brings blood from the portions of the large intestine through the superior rectal, sigmoidal and left colic veins.

(iii) The left and right gastric veins open directly into the hepatic portal vein that brings blood from the stomach.

(iv) The cystic vein also opens directly into the hepatic portal vein and drains blood from the gall bladder.

Ultimately, blood leaves the liver through the hepatic veins which open into the inferior vena cava.

Significance of hepatic portal system are as follows :

(i) It supplies veins with metabolic substrates.

(ii) It also ensures that food ingested is processed by the liver first before entering the systemic circulation. This way, ingested toxins are detoxified by hepatocytes.

(iii) It also ensures that the liver is the first organ to absorb nutrients after intestines.

(iv) The portal venous system captures substances from digestive organs and directs it for metabolism.

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