

Body Fluids and Circulation



Multiple Choice Questions (MCQs)

- Which of the following leucocytes have multilobed nucleus?
(a) Eosinophils (b) Lymphocytes
(c) Neutrophils (d) Monocytes
- The number of which cells increase during allergy?
(a) Monocytes (b) Eosinophils
(c) Erythrocytes (d) Thrombocytes
- Lymph is colourless because
(a) WBCs are absent
(b) WBCs are present
(c) RBCs are present
(d) RBCs are absent.
- Blood capillaries are made of
(a) endothelium and thin coat of connective tissue
(b) endothelium and thin coat of muscle fibres
(c) endothelium and thin coat of connective tissue and muscle fibres
(d) only endothelium.
- The heart sound “dub” is caused by the
(a) opening of mitral valve
(b) closing of mitral valve
(c) closing of semilunar valve
(d) opening of tricuspid valve.
- Select an incorrect statement for arteries.
(a) They are thick walled.
(b) They are elastic and muscular.
(c) They have valves.
(d) None of these
- Ventricular systole lasts for
(a) 0.1 second (b) 0.3 seconds
(c) 0.4 seconds (d) 0.6 seconds.
- Characteristics of cardiac muscles are that they
(a) contract quickly and get fatigued
(b) contract quickly and do not get fatigued
(c) contract slowly and get fatigued
(d) contract slowly and do not get fatigued.
- Chordae tendinae are found in
(a) ventricles of brain
(b) ventricles of heart
(c) auricles of heart
(d) connection between bone.
- Vasoconstriction causes
(a) increase in heart beat
(b) decrease in heart beat
(c) increase in blood pressure
(d) decrease in blood pressure.
- Heart beats are decelerated by
(a) cranial nerve
(b) sympathetic nerve
(c) parasympathetic nerve
(d) sympathetic ganglion.
- Anticoagulants like streptokinase is useful in treatment of
(a) hypertension
(b) angina pectoris
(c) coronary thrombosis
(d) fibrillation.
- Arteriosclerosis is mainly due to
(a) intake of protein rich diet
(b) inelasticity of arteries
(c) malfunctioning of heart
(d) deposition of potassium salts.
- Globulins contained in human blood plasma are primarily involved in
(a) osmotic balance of body fluids
(b) oxygen transport in the blood
(c) clotting of blood
(d) defence mechanisms of body.
- Match the types of WBC listed under Column I with the shape of nucleus given under Column II and select the correct option from codes given below.

Column I	Column II
A. Neutrophils	(i) Bean-shaped
B. Eosinophils	(ii) 3 lobed
C. Basophils	(iii) Multiple lobed
D. Monocytes	(iv) 2 lobed
	(v) Disc-shaped

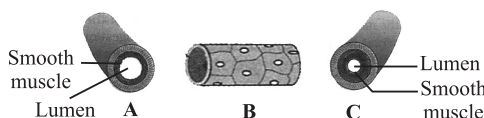
- (a) A - (iii), B - (v), C - (i), D - (ii)
 (b) A - (v), B - (iii), C - (i), D - (iv)
 (c) A - (ii), B - (i), C - (v), D - (iii)
 (d) A - (iii), B - (iv), C - (ii), D - (i)

16. Identify the given figure and select the correct option.



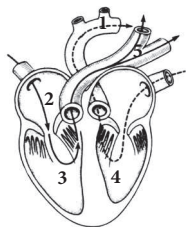
- (a) Neutrophil - phagocytic cell which destroys foreign organisms entering the body
 (b) Eosinophil - their number increases during allergic infection
 (c) Lymphocyte - small sized non-motile and non-phagocytic
 (d) Monocyte - motile and phagocytic in nature

17. Given below are the figures of blood vessels. Identify them and select the correct option.



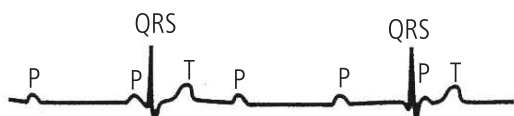
- | A | B | C |
|---------------|-----------|-----------|
| (a) Capillary | Vein | Artery |
| (b) Artery | Capillary | Vein |
| (c) Vein | Capillary | Artery |
| (d) Vein | Artery | Capillary |

18. In the given figure of the heart which of the marked structure (1, 2, 3, 4, 5) carrying oxygenated blood?



- (a) 1, 2, 3 and 4 (b) 1 and 5
 (c) 1 and 4 (d) 3 and 5

19. Refer to the given electrocardiogram and select the correct statement.



- (a) It shows electrocardiogram of a healthy person.

- (b) It shows partial blockage due to damaged AV nodes.
 (c) It shows complete blockage and there is no synchrony between atrial and ventricular activities.
 (d) It shows that muscles of the heart are weak.

20. Which of the following sequences is truly a systemic circulation pathway?

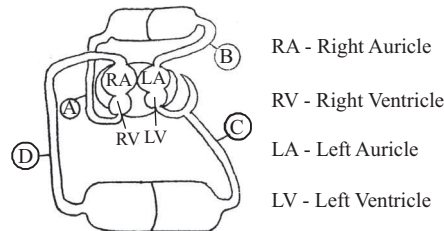
- (a) Right ventricle → Pulmonary aorta → Tissues → Pulmonary veins → Left auricle
 (b) Right auricle → Left ventricle → Aorta → Tissues → Veins → Right auricle
 (c) Left auricle → Left ventricle → Pulmonary aorta → Tissues → Right auricle
 (d) Left auricle → Left ventricle → Aorta → Arteries → Tissues → Veins → Right atrium

21. Match the columns and choose correct one.

Column I	Column II
A. Myocardial infarction	1. Chronic heart valve damage
B. Myocardial ischemia	2. Blood flow to myocardium is restricted
C. Heart failure	3. Blood clot causes heart attack
D. Rheumatic heart disease	4. Inadequate pumping by heart

- (a) A-4, B-1, C-2, D-3
 (b) A-4, B-3, C-1, D-2
 (c) A-2, B-1, C-4, D-3
 (d) A-3, B-2, C-4, D-1

22.



In the above given diagram which blood vessel represents vena cava?

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

23. In veins, valves are present to check backward flow of blood flowing at

- (a) atmospheric pressure
 (b) high pressure
 (c) low pressure
 (d) all of these.

24. Pulmonary artery is different from pulmonary vein in

- (a) its broad lumen
- (b) its thick wall
- (c) presence of valves
- (d) absence of endothelium.

25. Select the incorrect difference between open and closed circulatory system.

Open circulatory system	Closed circulatory system
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- | | |
|-------------------------------------|---|
| (a) Blood flows at high pressure. | Blood flows at low pressure. |
| (b) Exchange of material is direct. | Exchange of material occurs through tissue fluid. |
| (c) It is less efficient. | It is more efficient |
| (d) Found in leech, prawns, etc. | Found in earthworm, squids, etc. |

26. The important function of lymph is to

- (a) transport oxygen to the brain
- (b) transport carbon dioxide to the lungs
- (c) return RBCs to the lymph nodes
- (d) return interstitial fluid to the blood.

27. Which of the following cytoplasmic granules contain histamine?

- (a) Basophils
- (b) Eosinophils
- (c) Acidophils
- (d) Neutrophils

28. Select the correct statement about WBC.

- (a) Do not have cell organelles including nucleus.
- (b) Its formation is called erythropoiesis.
- (c) Vitamin B₁₂ and folic acid stimulate the maturation of WBC.
- (d) Can squeeze through blood capillaries

29. pH of blood

- (a) is greater than 9
- (b) ranges between 7-8
- (c) is less than 7
- (d) none of these.

30. Polymorphism is exhibited by _____ and they can squeeze out of the blood capillaries into the tissues by the process of _____ .

- (a) WBCs, diapedesis
- (b) RBCs, phagocytosis
- (c) blood platelets, phagocytosis
- (d) RBCs, diapedesis

31. Both RBC and WBC are formed in the

- (a) thymus
- (b) adrenal
- (c) thyroid
- (d) bone marrow.

32. _____ is phagocytic in nature.

- (a) Monocyte
- (b) RBC
- (c) Eosinophil
- (d) Basophil

33. If one litre of blood is drawn out of 5 litres from the body of man, how much blood would be left by the next day?

- (a) 5 litres
- (b) 4 litres
- (c) 4.5 litres
- (d) 3.0 litres

34. Anaemia refers to

- (a) lack of Hb
- (b) lack of WBCs
- (c) lack of blood
- (d) lack of thrombocytes.

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

- A. Human heart is an ectodermal derivative.
 - B. Mitral valve guards the opening between the right atrium and left ventricle.
 - C. SAN is located on the left upper corner of the right atrium.
 - D. Stroke volume \times Heart rate = Cardiac output
- (a) Only A is correct.
 - (b) A and B are correct.
 - (c) B and D are correct.
 - (d) Only D is correct.

36. Select the correct statement.

- (a) Capillaries are made up of three layers.
- (b) The walls of the arteries are thick and muscular.
- (c) In veins, flow of blood is fast.
- (d) All of these

37. Blood pressure increases due to

- (a) hypertension
- (b) angina
- (c) glucosuria
- (d) hypotension.

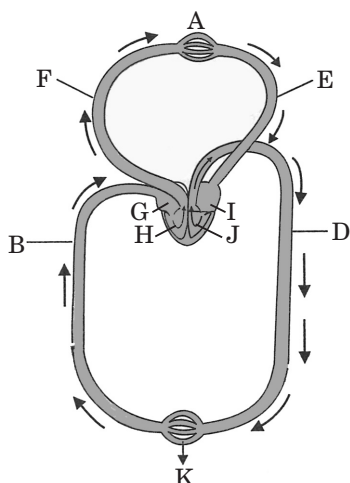


Case Based MCQs

Case I : Read the following passage and answer questions from 38 to 42 given below:
The schematic plan of complete double circulation

in humans is shown in the figure. The blood flows through arteries and veins which consist of three layers-tunica intima, tunica media and tunica

externa. Left and right atrium passes oxygenated and deoxygenated blood into the left and right ventricles. Ventricles then pump it out without mixing into aorta and pulmonary artery. The volume of blood pumped out by each ventricle of heart per minute is called cardiac output.



38. Which of the following carries oxygenated blood during circulation ?

- (a) F (b) E
(c) D (d) Both (b) and (c)

39. Tunica externa is made up of

- (a) connective tissue
(b) squamous epithelium
(c) smooth muscle
(d) endothelium.

40. Select the correct sequence of pulmonary circulation.

- (a) G → H → A → I (b) A → E → D → F
(c) G → H → B → E (d) F → A → G → B

41. Following are the significance of double circulation.

- A. It checks the mixing of oxygenated and deoxygenated blood.
B. Oxygenated blood carries more oxygen.
C. Deoxygenated blood carries less carbon-dioxide for removal.
(a) A and B are correct.
(b) A is correct.
(c) B is correct.
(d) B and C are correct.

42. Calculate the cardiac output of athlete having a beats 75 times/minutes and pumps out about 75 mL of blood per beat.

- (a) 5040 mL (b) 5625 mL
(c) 4000 mL (d) 6000 mL

Case II : Read the following passage and answer questions from 43 to 47 given below:

Blood is a special connective tissue which comprises of a fluid matrix, plasma and formed elements. 55 percent of blood is plasma which contains fibrinogen, globulins and albumin and 45 percent constitute formed elements which comprises of erythrocytes, leucocytes and platelets. Erythrocytes being most abundant play role in transport of respiratory gases. Leucocytes lack haemoglobin and comprises of neutrophils, eosinophils, basophils, lymphocytes and monocytes which play a role in immune system. Platelets help in clotting of blood.

43. Read the given statements and identify them.

- (I) X is involved in defense mechanism.
(II) Y helps in osmotic balance.
(III) Z is required for clotting of blood.

X	Y	Z
(a) Albumin	Globulin	Fibrinogen
(b) Globulin	Albumin	Fibrinogen
(c) Fibrinogen	Globulin	Albumin
(d) Albumin	Fibrinogen	Globulin

44. Which of the following is an essential factor for maturation of erythrocytes?

- (a) Vitamin B₁₂ (b) Globulin
(c) Haemoglobin (d) Both (a) and (c)

45. Histamine is secreted by

- (a) mast cells (b) macrophage
(c) basophils (d) both (a) and (c).

46. Which of the following is true for plasma proteins ?

- (a) Helps in uniform distribution of heat all over the body.
(b) Some may act as enzymes.
(c) Maintenance of pH.
(d) All of these

47. Cells which lack nucleus is/are

- (a) erythrocytes (b) leucocytes
(c) thrombocytes (d) both (a) and (c).



Assertion & Reasoning Based MCQs

For question numbers 48-57, two statements are given—one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

- (a) Both assertion and reason are true and reason is the correct explanation of assertion.
- (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
- (c) Assertion is true but reason is false.
- (d) Assertion is false but reason is true.

48. Assertion : The open circulatory system is less efficient than the closed circulatory system.

Reason : The blood flows far more rapidly in open circulatory system than in the closed one.

49. Assertion : The cardiac impulse is said to be myogenic.

Reason : Rate of formation and conduction of cardiac impulse can be changed by the action of nerves.

50. Assertion : AV bundle is essential for the conduction of cardiac impulse.

Reason : There is no continuity between the cardiac muscle fibres of the auricles and the ventricles.

51. Assertion : Hypertension is observed in arteriosclerotic patients.

Reason : In the condition of arteriosclerosis, the arteries lose their elasticity and get stiffened.

52. Assertion : An artificial pacemaker can replace the sinoatrial node of heart.

Reason : An artificial pacemaker is capable of stimulating the heart electrically to maintain its beats.

53. Assertion : The normal heart rate is 75 beats/min and cardiac cycle is 0.8 sec.

Reason : Cardiac cycle is inversely proportional to the heart rate.

54. Assertion : Cardiac output rises during exercise.

Reason : Cardiac output helps in less oxygen consumption.

55. Assertion : Cardiac output is the volume of blood pumped by left or right ventricle in one minute.

Reason : Cardiac output is calculated by multiplying the heart rate by the stroke volume.

56. Assertion : Walls of ventricles are thicker than the auricles.

Reason : This helps in preventing the back flow of the blood.

57. Assertion : Pulmonary circulation consists of flow of deoxygenated blood from right ventricle to the lungs and flow of oxygenated blood from lungs to the left atrium.

Reason : Systemic circulation consists of flow of oxygenated blood from the left ventricle to all parts of the body and deoxygenated blood from different parts of body to right atrium.

SUBJECTIVE TYPE QUESTIONS



Very Short Answer Type Questions (VSA)

1. A person with blood group O can be transferred blood of only O group. Why?
2. What is the life span of
 - (a) Granulocytes
 - (b) Thrombocytes?
3. Why is blood group identification not needed for serum transfusion?
4. Name the blood component which is viscous and straw coloured fluid.
5. Name the embryonic/germ layer from where human heart develops.
6. Name one animal whose heart pumps only deoxygenated blood. How many chambers does its heart have?
7. A cardiologist observed an enlarged QRS wave in the ECG of a patient. What does it indicate?
8. Which blood vessel in mammals would normally carry the largest amount of urea?

9. How parasympathetic nervous system effects on heartbeat?

10. Heart failure is sometimes called congestive heart failure. Why?

Short Answer Type Questions (SA-I)

11. Define erythropoiesis.

12. Name the condition in which a Rh positive fetus suffers in a Rh negative mother's body. How can it be avoided?

13. What is the average number of thrombocytes in human blood? Write their function.

14. What is the composition of lymph?

15. What is pericardium? How is it helpful to humans?

16. Purkinje fibres arise from which region of the heart?

17. What is the significance of P-wave and T-wave in the ECG?

18. What happens to the mitral valve and the respective blood flow during ventricular systole?

19. What is a portal vein? Give an example.

20. Differentiate between heart failure and cardiac arrest.

Short Answer Type Questions (SA-II)

21. What is the importance of body fluids?

22. Draw a well labelled diagram of:

- (a) Basophil
- (b) Eosinophil
- (c) Neutrophil.

23. (a) State the functions of the following:

- (i) Fibrinogen (ii) Globulin
- (b) Which factors are activated by thrombin during the clotting mechanism?
- (c) What is a haemocytometer?

24. Give differences between erythrocytes and leucocytes.

25. Explain the functional significance of lymphatic system.

26. Enlist the important functions of the circulatory system.

27. Explain the advantage of the complete partition of ventricle among birds and mammals and hence leading to double circulation.

28. What is meant by double circulation? What is its significance?

29. What is the role of hormones in regulating the cardiac activity?

30. What is the effect of the following on the heart rate?

- (a) Sympathetic nervous system
- (b) Noradrenaline
- (c) Fever

31. Differentiate between arteriosclerosis and atherosclerosis.

32. Differentiate between arteries and veins.

33. What are the factors that affect pulse rate?

34. Explain the different steps involved in the process of blood clotting.

35. Draw a neatly labelled diagram of an artery and a vein.

Long Answer Type Questions (LA)

36. Explain different types of blood groups and donor compatibility by making a table.

37. (a) What is blood pressure?

(b) How is it measured and what is its normal value?

38. (a) Draw a neatly labelled diagram of human heart.

(b) Explain the structure of right and left ventricles of heart.

39. (a) Briefly describe the three types of blood vessels found in the circulatory system.

(b) Give a brief description of the layers found in blood vessels.

40. How is the heart activity regulated in the human body?

ANSWERS

OBJECTIVE TYPE QUESTIONS

1. (c) : Neutrophils have multilobed nucleus, approximately 3-5 lobed.
2. (b) : The number of eosinophils increases in people with allergic conditions such as asthma or hay fever.
3. (d) : Lymph is colourless due to absence of RBCs.
4. (d) : The wall of blood capillaries consists of thin cell layer endothelium surrounded by thin layer called basement membrane.
5. (c) : At the end of ventricular systole "dub" sound is produced by vibrations associated with closure of the aortic and pulmonary semilunar valves.
6. (c) : Arteries do not have valves in their walls.
7. (b) : Ventricular systole lasts for 0.3 seconds.
8. (b) : Cardiac muscles are autorhythmic, hence contracts quickly and do not get fatigued.
9. (b) : The fibrous cords attached to the flaps of the bicuspid and tricuspid valves are called chordae tendineae. Chordae tendineae are present in ventricles.
10. (c) : Vasconstriction is narrowing of blood vessels by smooth muscles in their walls. When blood vessels constrict, blood flow is slowed or blocked and this causes higher blood pressure.
11. (c) : The parasympathetic nerve fibres travel through vagus cranial nerve. It slows down the heart beat as it dilates arteries and lowers blood pressure.
12. (c) : Anticoagulants like streptokinase helps to dissolve blood clots that have formed in the blood vessels. It is used immediately after symptoms of heart attack occur to improve patient survival.
13. (b) : Due to deposition of calcium salts and cholesterol, the walls of arteries lose their property of distension which may lead to heart attack or even death.
14. (d) : Globulins in human blood plasma are primarily involved in defence mechanisms of body. Globulins like immunoglobulins act as antibodies that destroys bacteria, viruses and toxic substances that may enter into the blood from outside.
15. (d)
16. (a)
17. (c)
18. (c) : The marked structures 1 and 4 are pulmonary vein and left ventricle respectively, which carry oxygenated blood.
19. (c) : In case of complete A-V block (third degree block), the condition in the AV bundle causes complete block of the impulse from the atria into the ventricles. The ventricles spontaneously establish their own signal usually originating in the AV node or AV bundle. Therefore, the P waves become dissociated from QRS-T complexes and there is no relation between the rhythm of the P waves and that of the QRS-T complexes. The rate of rhythm of the atria in this electrocardiogram is about 100 beats per minute, whereas the rate of ventricular beat is less than 40 per minute.
20. (d)
21. (d)
22. (b) : In the given diagram 'D' represent the vena cava. Vena cava is either of the two large veins that carry deoxygenated blood into the right atrium.
23. (c) : Veins collect blood from the different parts of the body and pour it into the heart. As each vein carries blood of individual organ, the blood pressure is low in vein in comparison to artery (which carry oxygenated blood from heart for the various body organs).
24. (b) : Pulmonary veins are four in number, two from each lung. They bring oxygenated blood to left atrium. Pulmonary arteries carry deoxygenated blood to the lungs. Pulmonary arteries are thick walled than pulmonary vein.
25. (a)
26. (d) : An important function of lymph is to return interstitial fluid back to the blood. This interstitial fluid also called extracellular fluid is filtered form of blood without the cellular component.
27. (a) : The basophils constitute less than one per cent of the WBCs circulating in the blood. Their cytoplasmic granules contain histamine, which initiates the inflammatory response.
28. (d) : The leucocytes or WBCs are rounded or irregular in shape. They can change their shape like *Amoeba* and are thus, capable of amoeboid movement. This enables them to squeeze out of blood capillaries into the tissues (extra vascular regions). This process is called diapedesis.
29. (b)
30. (a) : WBCs exhibit polymorphism. WBCs are of many shapes. They can squeeze out of the blood capillaries into the tissues by the process of diapedesis.
31. (d) : RBCs and WBCs both are formed in the bone marrow.
32. (a)

33. (a) : The blood volume (e.g., in blood donation) can be recovered within 24 hours and the haemoglobin count returns to normal within 2 weeks.

34. (a) : Anaemia is lower than normal number of red blood cells (erythrocytes) in the blood, usually measured by a decrease in the amount of hemoglobin. Hemoglobin is the red pigment in red blood cells that transports oxygen. Most anaemias are caused by the lack of nutrients required for normal erythrocyte synthesis, principally iron, vitamin B₁₂ and folic acid.

35. (d) : Human heart is mesodermal derivative. The opening between the right atrium and right ventricle is guarded by tricuspid valve whereas bicuspid or mitral valve guards the opening between left atrium and left ventricle.

SAN or sino-atrial node is a patch of tissue present in the right upper corner of right atrium.

36. (b) : Capillaries are made of a single layer of endothelial cells that is surrounded by another thin layer called basement membrane. The flow of blood through veins is slow.

37. (a) : Hypertension is the most common disease affecting the heart and blood vessels. It is the main cause of high blood pressure. A blood pressure of 120/80 is considered normal. But the increase in blood pressure beyond 140 mm Hg (systolic) and 90 mm Hg (diastolic) is called high blood pressure (hypertension). High blood pressure can harm heart, brain, kidneys and eyes. When blood pressure is high, the heart uses more energy in pumping.

38. (d) : F is pulmonary artery carries deoxygenated blood from heart to lungs. D and E are dorsal aorta and pulmonary vein carries oxygenated blood from heart to body parts and lungs to heart respectively.

39. (a) : Tunica externa is the outermost layer of arteries and veins formed of connective tissue.

40. (a) : Sequence of pulmonary circulation:

Right atrium → Right ventricle → Pulmonary artery
(G) (H) (F)
→ Lungs → Pulmonary vein → Left atrium
(A) (E) (I)

41. (a) : Significance of double circulation are:

- (i) It checks the mixing of oxygenated and deoxygenated blood.
- (ii) Oxygenated blood carries more oxygen.
- (iii) Deoxygenated blood carries more carbon dioxide for removal.

42. (b) : The number of beats of athlete = 75 times/min.
Volume of blood pumped by each ventricle (stroke volume) = 75 mL

Cardiac output = Stroke volume × No. of beats per minute
= 75 × 75 = 5625 mL

43. (b) : X is globulin primarily involved in defence mechanism of body. Y is albumin which helps in osmotic balance. Z is fibrinogen needed for clotting or coagulation of blood.

44. (a) : Vitamin B₁₂ is an essential factor that stimulates the maturation of RBC's.

45. (d) : Histamine is a chemical substance released by mast cells and basophils. It is involved in allergic and inflammatory reactions.

46. (d) : Plasma proteins are involved in:

- (i) retention of blood fluid volume
- (ii) body immunity
- (iii) maintenance of pH
- (iv) transport of certain materials
- (v) distribution of heat
- (vi) enzymatic reactions.

47. (d) : RBC (Red blood corpuscle) and thrombocytes (Cell fragments) are enucleated formed elements found in blood plasma.

48. (d) : The closed circulatory system is more efficient than the open circulatory system because in open circulatory system, the blood flows through open spaces and channels whereas in closed circulatory system, the blood flows through proper blood vessels. The closed circulatory system considerably enhances the speed, precision and efficiency of circulation because the blood flows far more rapidly in closed blood vessels than in wide and open channels and body cavities. Thus blood takes much shorter time to circulate through the closed system and return to the heart. This quickens the supply and removal of materials to and from the tissues by the blood.

49. (b) : Cardiac impulse is a wave of electrical potential (originating from sinoatrial node) which is responsible for the beating of the heart. It is conducted along cardiac muscle fibres to reach the different heart chambers. The cardiac impulse is said to be myogenic in origin because it originates in cardiac muscle fibres and is not brought to the heart by any nerve fibre [myo = muscle; genic = originating from].

Although the cardiac impulse has a myogenic origin, the rate of its formation and conduction by cardiac muscle fibres may be changed by the action of nerves. For example, the vagus nerve reduces the rate of impulse formation from the SA node and its conduction along the conducting system of the heart; this slows the heart and may even stop it in diastole. The sympathetic nerve fibres increase the activity of the SA node to enhance the heart rate.

50. (a)

51. (a) : A rise in blood cholesterol may lead to a deposition of cholesterol on the walls of blood vessels which causes the arteries to lose their elasticity and get stiffened. This condition is called arteriosclerosis or hardening of arteries. The elasticity of the arterial wall moderates and reduces the rise in the arterial blood pressure. The stiffened arterial wall fails to exert this moderating effect on blood pressure. This results in hypertension (an abnormal rise in the arterial blood pressure) in arteriosclerotic patients.

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

53. (b) : The human heart beats at the rate of about 75 per minute in the resting condition. Thus normal heart rate is 75 beats/min. On the other hand two phases - systole and diastole are togetherly called cardiac cycle. In human being the cardiac cycle is 0.8 sec (0.1 sec + 0.7 sec).

Heart rate 75/min means 75 times in 60 Sec.

$$1 \text{ times} = \frac{60}{75} \text{ sec} = 0.8 \text{ sec.}$$

Assume, cardiac cycle increases from 0.8 sec to 1 sec.

In 60 sec, total number of cardiac cycle is 60.

Heart rate would be 60/60 sec or 60/min.

Thus, with the increase of the cardiac cycle, heart rate decreases and vice versa. So, cardiac cycle is inversely proportional to the heart rate.

54. (c) : Cardiac output is the volume of blood ejected by either ventricle into the arterial system over a given period of time. The cardiac output rises during exercise. In very severe exercise, it may rise to even 20 liters per minute, about four to five fold the normal resting value of about 5 litres. per minute. The rise in the cardiac output helps the body in exercise by enhancing manifold the supply of nutrients and oxygen to the contracting muscles.

55. (b) : Cardiac output, also called minute volume, is the amount of blood ejected from the heart in the aorta in one minute. It depends upon the volume of blood pumped out

of the heart at each beat, the stroke volume and the heart rate (no. of beats/min).

Cardiac output = Stroke volume \times rate of heart beat.

It is about 5 litre of blood and is important variable in supplying blood to the body. One way of controlling cardiac output is to control the heart rate.

56. (c) : The walls of the ventricles is thicker than the auricle because unlike auricles, it has to pump the blood to all the parts of the body during its contraction. To counter act the backward pressure exerted by the blood, the walls of both the ventricles have to be thicker otherwise it may lead to bursting of heart.

Backflow of the blood is prevented by the presence of valves in the heart. The AV valves (tricuspid and bicuspid valves) are found at the auriculo-ventricular aperture on the right and left side of the heart. The semilunar valves guard the openings of great arteries in the ventricles. The AV valves allow the flow of blood only in one direction *i.e.* from auricles to ventricles and not in the backward direction. Similarly, semilunar valves allow blood to enter the arteries from the ventricles but prevent blood flow in the reverse direction.

57. (b)

SUBJECTIVE TYPE QUESTIONS

1. Since blood group O has both anti-*a* and anti-*b* antibodies, no other blood group with any antigen can be accepted by it. Only blood group O which lacks any antigen can be transferred.

2. (a) Granulocytes - 4 to 8 hours in blood, 4 to 5 days in tissue.

(b) Thrombocytes - around 7 days.

3. Blood group identification is not needed for serum transfusion because serum does not have the coagulation/ clotting factors.

4. Plasma is straw coloured, viscous fluid, slightly alkaline and aqueous solution which constitutes about 55% of the blood.

5. Mesoderm develops human heart.

6. Heart of fish has only two chambers and it pumps deoxygenated blood.

7. Enlarged QRS wave in ECG indicates about the ventricular contraction of the heart that may be normal or abnormal.

8. Hepatic portal vein

9. Parasympathetic nervous system slows the heart rates by dilating arteries and lowering the blood pressure.

10. Heart failure is sometimes called congestive heart failure because congestion of lungs is the main symptom of this disease.

11. Erythropoiesis is the process by which red blood cells (erythrocytes) are produced. In human adults, this usually occurs within the bone marrow. In the early fetus, erythropoiesis takes place in the mesodermal cells of the yolk sac. By the third or fourth month, erythropoiesis moves to the spleen and liver. In humans with certain diseases and in some animals, erythropoiesis also occurs outside the bone marrow, within the spleen or liver termed as extramedullary erythropoiesis.

12. The condition in which a Rh positive fetus suffers in Rh negative mother's body is called erythroblastosis fetalis. It can be avoided by administering anti-Rh antibodies immediately after first delivery.

13. Average number of thrombocytes is 1,50,000 to 4,50,000/mm³ in human blood. Their function is to release substances that are concerned with the clotting of blood.

14. The composition of lymph is as follows:

(i) Lymph plasma is similar to blood but has fewer blood proteins, less calcium and phosphorus and high glucose concentration. Mainly globulin proteins are present which are actually antibodies. Other components are organic, inorganic substances, water, etc.

(ii) Lymph corpuscles are floating amoeboid cells, the leucocytes (WBCs) which are mostly lymphocytes. RBCs and thrombocytes are absent in lymph.

15. Pericardium is the two layered covering of the heart. It consists of outer parietal pericardium and inner visceral pericardium. In between the two layers, a space called pericardial cavity is present, which is filled with pericardial fluid. The pericardium protects the heart from shocks and mechanical injuries and also allows free movement of the heart.

16. A mass of specialised fibres, the bundle of His originates from AV node within myocardium of ventricles and passes downwards into the inter-ventricular septum. This bundle then divides into left and right bundle branches one going to each ventricle. In the walls of the ventricles, these two branches divide into a network of fine fibres called Purkinje fibres.

17. P-wave represents the electrical depolarisation of the atrial musculature. It coincides with the blood being pumped into the ventricle.

T-wave represents the repolarisation of the ventricular muscles. It coincides with blood being received by the auricles.

18. At the start of the ventricular systole, the mitral valve closes to prevent the back flow of blood into the atrium. As systole continues, blood from the right ventricle enters the pulmonary artery and blood from the left ventricle enters the aorta.

19. A vein which collects blood from one organ by one set of capillaries and distributes blood to some other organ by another set of capillaries instead of sending it to the heart is called a portal vein. For example, hepatic portal vein.

20. Differences between heart failure and cardiac arrest are as follows:

	Heart failure	Cardiac arrest
(i)	It is the state of heart, when it is not pumping effectively enough blood to meet the needs of the body.	It is the state of heart when it stops beating completely.
(ii)	May lead to death only in severe cases.	Leads to death.

21. Significance of body fluids are as follows :

(i) Homeostasis : The maintenance of internal environment is called homeostasis. Water forms not only the essential constituent of internal environment but also plays important role in homeostasis.

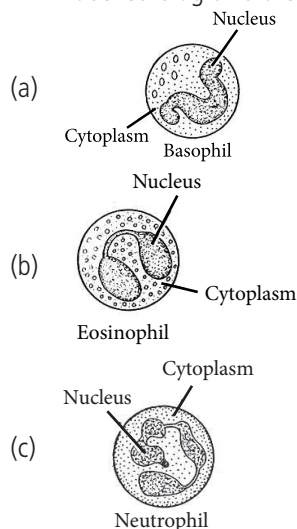
(ii) Transport mechanism : Body water forms the transport medium by which nutrients and other essential substances enter the cells and unwanted substances come out of the cells.

(iii) Metabolic reactions : Water inside the cells is necessary for the growth and functional activities of the cells.

(iv) Texture of tissues : Water inside the cells is necessary for the characteristic form and texture of various tissues.

(v) Temperature regulation : Water plays an essential role in the maintenance of normal body temperature.

22. Labelled diagrams are as follows:



23. (a) (i) Fibrinogen - It is present in blood plasma and helps in blood clotting.

(ii) Globulin - It is a plasma protein which helps in defence mechanism.

(b) Thrombin converts fibrinogen to an active form that assembles into fibrin. Thrombin also activates factor XI, factor V and factor VIII. This positive feedback accelerates the production of thrombin.

(c) Haemocytometer is a device used to estimate the concentration of cells in blood samples.

24. Differences between erythrocytes and leucocytes of man are as follows:

	Erythrocytes (RBCs)	Leucocytes (WBCs)
(i)	They are smaller, more numerous and longer lived cells than the WBCs.	They are larger, fewer, shorter-lived cells than RBCs.
(ii)	They have a fixed form. RBCs of man are circular, biconcave and enucleated.	WBCs are rounded but can change their shape.
(iii)	They occur only in blood vessels.	They can escape from capillaries into the tissues (diapedesis).
(iv)	RBCs lose cell organelles (ER, mitochondria, ribosomes, centrioles) during development.	WBCs retain cell organelles (ER, mitochondria, ribosomes, centrioles).
(v)	They have haemoglobin.	They lack haemoglobin.
(vi)	RBCs are yellowish when seen singly and red when viewed in bulk.	WBCs are colourless.
(vii)	These play important role in transport of O_2 and CO_2 .	These play important role in defence against infections, <i>i.e.</i> , role of soldiers and scavengers.
(viii)	These are produced by yolk sac, liver, spleen and bone marrow.	These are produced by bone marrow, lymph nodes, spleen, tonsils and Peyer's patches.

25. Lymphatic system is an elaborate network of vessels, which collects the interstitial fluid (tissue fluid), along with some protein molecules and drains it back into the major veins. The lymphatic vessels are present in all tissues (except the central nervous system and cornea). It comprises of lymph, lymphatic capillaries, lymphatic vessels, lymphatic ducts and lymphatic nodes. Lymph performs the following important functions:

(i) It acts as an important carrier of nutrients, hormones, etc.

(ii) Absorption of fats also occurs through lymph in the lacteals present in the intestinal villi.

(iii) It helps in the renewal of extracellular fluid (ECF).

(iv) Maturation of lymphocytes, *i.e.*, B-cells and T-cells occur with the help of lymph nodes, releasing them into the lymph.

(v) It helps in keeping tissue cells moist.

26. The important functions of the circulatory system are as follows:

(i) The circulatory system supplies food, oxygen, enzymes, hormones and other substances to the different cells of the body.

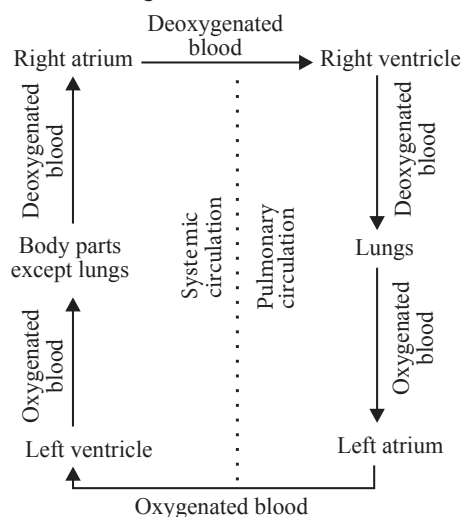
(ii) It carries the end products of metabolism to the excretory organs.

(iii) It provides a strong defence to the body in prevention against invasion of infectious microorganisms.

(iv) It maintains body temperature, homeostasis of the tissue fluids and acid base balance.

27. Birds and mammals have four chambered heart, with two atria and two ventricles. The inter-atrial septum separates left and right atria and left and right ventricles are separated by inter-ventricular septum. In four chambered heart, oxygenated and deoxygenated blood received by left and right atria respectively passes into left and right ventricles without getting mixed. Thus, birds and mammals have two separate circulatory pathways; systemic circulation and pulmonary circulation, therefore, known as double circulation.

28. The type of blood circulation in which oxygenated blood and deoxygenated blood do not get mixed is termed double circulation. It includes systemic circulation and pulmonary circulation. The circulatory pathway of double circulation is given in the following flow chart.



Significance of double circulation : Double circulation or separation of systemic and pulmonary circulations provides a higher metabolic rate to the body and also allows the two circulations to have different blood pressures according to the need of the organs they supply.

29. Hormones play an important role in regulating the cardiac activity. The substance secreted at the end of the vasoconstrictor nerves is called norepinephrine (noradrenaline). It regulates the blood pressure under normal conditions. Norepinephrine causes constriction of essentially all the blood vessels of the body and thus increases the heart rate. Another hormone called epinephrine (adrenaline) is also secreted by the medulla of the adrenal endocrine gland. It also acts directly on the blood vessels, usually to cause vasoconstriction. Epinephrine has a greater effect on heart activity than norepinephrine. It also causes weak constriction of the blood vessels of the muscles in comparison with a much stronger constriction that results from norepinephrine. Thus adrenal medullary hormones increase the heart beat.

30. (a) Sympathetic nervous system accelerates the heart beat. It constricts arteries that raise blood pressure.

(b) Refer to answer 29.

(c) Fever causes an increase in heart rate as an increase of a single degree of temperature increases heart rate of about 10 beats per minute.

31. Differences between arteriosclerosis and atherosclerosis are as follows:

	Arteriosclerosis	Atherosclerosis
(i)	It refers to the hardening of the arteries due to deposition of cholesterol and calcification.	It refers to the deposition of lipids (cholesterol) on the wall lining the lumen of arteries.
(ii)	The artery loses the power of distension and its walls may rupture.	This results in the reduction of the lumen size of artery and flow of blood is reduced.
(iii)	The blood leaking from ruptured vessel may clot and block the pathway of blood.	This may cause proliferation of smooth muscles.

32. Differences between arteries and veins are as follows:

	Arteries	Veins
(i)	These carry blood away from the heart for distribution to the body.	They bring blood from the body back to the heart.

(ii)	They contain oxygenated blood, except the pulmonary arteries.	They contain deoxygenated blood, except the pulmonary veins.
(iii)	The flow of the blood is intermittent and fast due to the heart beats.	The flow of the blood is slow and steady.
(iv)	Their blood has considerable pressure.	Their blood has low pressure.
(v)	They have thick, elastic walls and narrow lumen.	They have thinner, scarcely elastic walls and wide lumen.
(vi)	They have no valves in them.	They have valves to prevent back flow of blood.
(vii)	In tunica interna, elastic membrane is thick and endothelial cells are more elongated.	In tunica interna, elastic membrane is thin and endothelial cells are less elongated.
(viii)	Tunica media is thick, having more muscle fibres and elastic fibres.	Tunica media is thin, having fewer muscle fibres and elastic fibres.

33. The factors that affect the pulse rate are as follows:

- (i) The pulse rate in children is more rapid than in adults.
- (ii) The pulse rate is more rapid in the females than in the males.

(iii) When the person is in standing position the pulse rate is more rapid than when he/she is lying down.

(iv) When any strong emotion is experienced the pulse rate is increased, for example, anger, excitement, fear, etc.

(v) Any exercise increases the rate of the pulse.

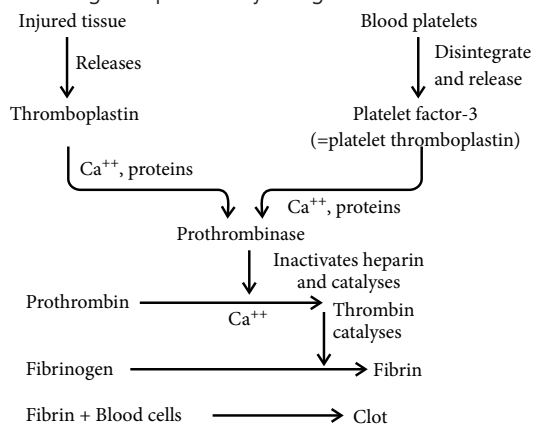
(vi) A temperature increase of just 1°C raises the heart rate by about 10 beats per minute. This is why pulse increases substantially in a person suffering from fever.

34. Blood clotting occurs in the following steps:

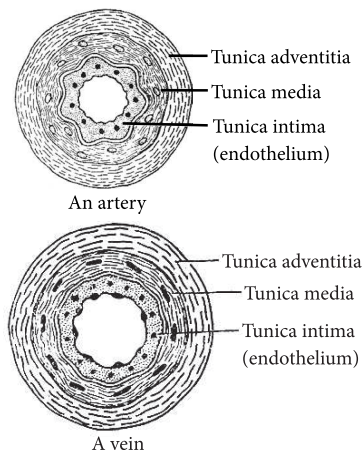
(i) At the site of an injury, the blood platelets disintegrate and release a phospholipid, called platelet factor-3 or platelet thromboplastin. Injured tissues also release a lipoprotein factor called thromboplastin. These two factors combine with calcium ions and certain proteins of the blood plasma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

(ii) The prothrombinase inactivates heparin or anti-prothrombin-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. The mechanism of blood clotting is explained by the given flow chart:



35. The labelled diagram of an artery and a vein are as follows:



36. ABO blood groups in human beings were reported for first time by Karl Landsteiner. ABO blood groups are determined by the gene *I* (isoagglutinin). There are three alleles, I^A , I^B and I^O of this gene. Proteins produced by the I^A and I^B alleles are called A antigen and B antigen respectively.

(i) People with blood group A have the A antigen on the surface of their RBCs, and antibodies to antigen B in their plasma.

(ii) Persons with blood group B have B antigen on their RBCs, and antibodies against A antigen in their plasma.

(iii) Individuals with AB blood group have both antigen A and antigen B on their RBCs, and no antibodies for either of the antigens in their plasma.

(iv) Type O individuals are without A and B antigens on their RBCs, but have antibodies for both antigens in their plasma. If a blood transfusion is made between an incompatible donor and recipient, reaction of antigens on the cells and antibodies in the plasma produces clots that clogs capillaries.

Blood groups with donor compatibility is given in the table:

Blood group	Genotype	Antigens on red blood corpuscles	Antibodies in blood plasma	Acceptor	Donor
A	$I^A I^A$ or $I^A I^O$	A	b	A, AB	A, O
B	$I^B I^B$ or $I^B I^O$	B	a	B, AB	B, O
AB	$I^A I^B$	AB	None	AB	AB, A, B, O
O	$I^O I^O$	None	a, b	AB, A, B, O	O

37. (a) Blood pressure is defined as the pressure that the blood exerts on the walls of the blood vessels produced by the discharge of blood into them by contractions of the left ventricle.

(b) The blood pressure is measured from brachial artery by an instrument called sphygmomanometer in terms of height in millimeters of a column of mercury. When the left ventricle contracts pushing the blood into the aorta, the pressure produced is known as systolic blood pressure (120 mm Hg). When the complete diastole occurs and the heart is resting, the pressure within the blood vessels is called as the diastolic blood pressure (80 mm Hg). A sphygmomanometer consists of an inflatable cuff attached to a pressure gauge. The cuff is wrapped around the upper arm and rapidly inflated with a hand pump until no pulse is felt in the wrist. This shows that the blood supply to the forearm is stopped. A stethoscope is placed on the brachial artery just below the cuff, and the cuff is slowly deflated. The sound of blood flow is heard through the stethoscope. When thumping is heard, pressure on the gauge is noted. This sound is of the blood rushing through the arteries at peak pressure due to ventricular contraction. The reading on the gauge is the systolic blood pressure. The sound fades until it stops, the reading on the gauge now indicates the diastolic blood pressure. The systolic pressure shows the force with which the left ventricle pushes blood into the aortic arch. The diastolic pressure indicates the elasticity of the blood vessels, and is useful in diagnosing hardening of arteries or strain on their walls. The blood pressure is expressed as BP = 120/80 mm Hg.

38. (a) The structure of human heart is as follows:

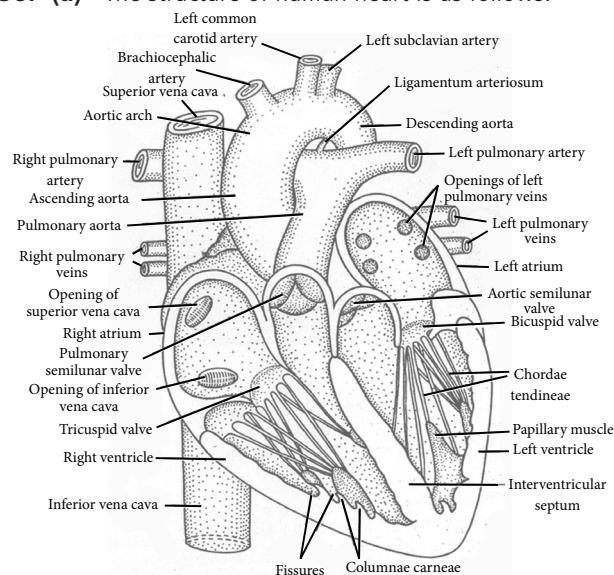


Fig.: Internal structure of human heart.

(b) The right ventricle of the heart receives blood from the right atrium. When the heart contracts the blood is forced out through the pulmonary semilunar valve into the pulmonary artery. The pulmonary semilunar valve is a three flap valve that stops the backflow of blood. The pulmonary arteries carry the blood from the right ventricle to both of the lungs. There the blood is oxygenated and sent to the left atrium in the heart. The wall of the right ventricle is a little thicker than the right atrium. The chamber of the left ventricle has walls that are three times the thickness of the right ventricle and this is the thickest portion of the human heart. This is so because the oxygenated blood that it receives from the left atrium has to be pumped throughout the body. When the heart muscle contracts the blood is forced through the aortic semilunar valve which has the same features as the pulmonary valve. The blood then passes through the aortic semilunar valve into the aorta.

Fine tendinous cords called chordae tendinae are attached to the ventricular surface of the valves. On the other end, the chordae tendinae are attached with the special muscles of the ventricular wall known as papillary muscles. During atrial systole, the blood flows from the atria to the ventricles. When the ventricles contract the valves close and the chordae tendinae support the valves preventing reflux of blood into the atria. The chordae tendinae 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.

39. (a) The blood vessels form a complex network of tubes throughout the body. The blood vessels carry blood between the heart, different tissues, and organs of the body. The three types of blood vessels are arteries, veins and capillaries.

The arteries are elastic, muscular tubes that carry the blood from the left ventricle of the heart to the tissues. The walls

of the arteries are thicker than the other vessels because of the high pressure. The wall thickness of the arteries prevent them from collapsing.

The veins carry blood from the tissues to the heart. The veins are more in number than arteries due to the draining of large areas when needed. Located within the veins are valves that allow blood to flow toward the heart but does not allow blood to flow backwards. The veins that are in the lower part of the body tend to have more valves to counteract the force of gravity. The capillaries are the smallest working unit in the blood vessels that connect the arterioles to the venules. The walls of the capillaries are only 1 cell thick, this allows for the exchange of nutrients and other substances like oxygen and carbon dioxide. The number of capillaries vary depending on the need for oxygen and other nutrients. The blood flow through the capillaries is regulated by a sphincter. This is important because there would not be enough blood to fill all the blood vessels at one time.

(b) Blood vessels consists of three layers. They are as follows:

- (i) Tunica adventitia or tunica externa is the outer layer of blood vessels. It is composed largely of collagen, but smooth muscle cells may be present, particularly in veins. The tunica adventitia is often the most prominent layer in the walls of veins.
- (ii) Tunica media is the middle layer in a blood vessel wall and is composed predominantly of smooth muscle reinforced by organised layers of elastic tissue which form elastic laminae. Tunica media is particularly prominent in arteries, being relatively indistinct in veins and virtually non-existent in very small vessels.
- (iii) Tunica intima or tunica interna is composed of a lining layer of highly specialised multifunctional flattened epithelial cells termed endothelium. This sits on a basal lamina; beneath this is a very thin layer of fibrocollagenous supporting tissue. It is continuous with the endocardial lining of the heart and is the only layer that is present in all blood vessels.

40. The rate of heart beat is regulated by two mechanisms : neural and hormonal regulation.

- (i) Neural regulation : The cardiac centre lies in the medulla oblongata of the brain. The cardiac centre is formed 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 (which 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.

- (ii) Hormonal regulation : Adrenaline (epinephrine) and noradrenaline (norepinephrine) hormones are secreted by the medulla of the adrenal glands. Noradrenaline accelerates the heart beat under normal conditions while adrenaline does this function at the time of emergency. These hormones directly influence the SA node.