7(a) **Describe the circulatory system as a system of tubes with a pump and valves to ensure one-way flow of blood**

Right Atrium receives deoxygenated blood from the body through vena cava where as left atrium receives oxygenated blood from the lungs through pulmonary veins. When atria contract the blood moves to ventricles. After that ventricles contract which forces bicuspid and tricuspid valve to close. It prevents back flow of blood from ventricles to atria. Ventricular contraction also opens semilunar valves so blood goes out of the ventricles. Oxygenated blood from left ventricle is carried to the body through aorta where as pulmonary arteries carry deoxygenated blood to the lungs from right ventricle

7(b) **Describe the double circulation in terms of a low pressure circulation to the lungs and a high pressure circulation to the body tissues and relate these differences to the different functions of the two circuits**

Right ventricle has less thicker walls than left ventricle so the contraction of right ventricle generates low pressure in pulmonary arterie. Pulmonary arteries carry blood to the lungs at low pressure as high pressure can damage capillaries around alveoli. Also low pressure in the pulmonary artery allows more gases exchange between the alveoli and the blood capillaries surrounding them. Aorta on the other hand has higher pressure due to the thicker walls of the left ventricle. Aorta carries blood to far apart distances in the body so need to be at higher pressure,

1. The components of the circulatory system are the heart, blood vessels and blood.
2. Blood passes through the heart twice in a complete circuit. This is termed double circulation.
3. Double circulation consists of:

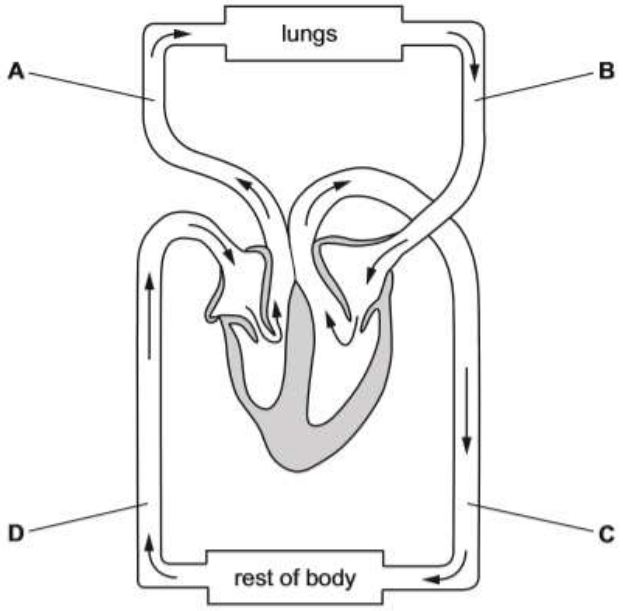
(a) Systemic circulation – Carries oxygenated blood (oxygen-rich) from the heart to all body organs and returns oxygen-poor blood to the heart

(b) Pulmonary circulation – Carries deoxygenated blood (oxygen-poor) from the heart to the lungs for gaseous exchange before returning blood to the heart for transport to the body organs via systemic circulation

Question 83

The diagram shows the circulatory system.

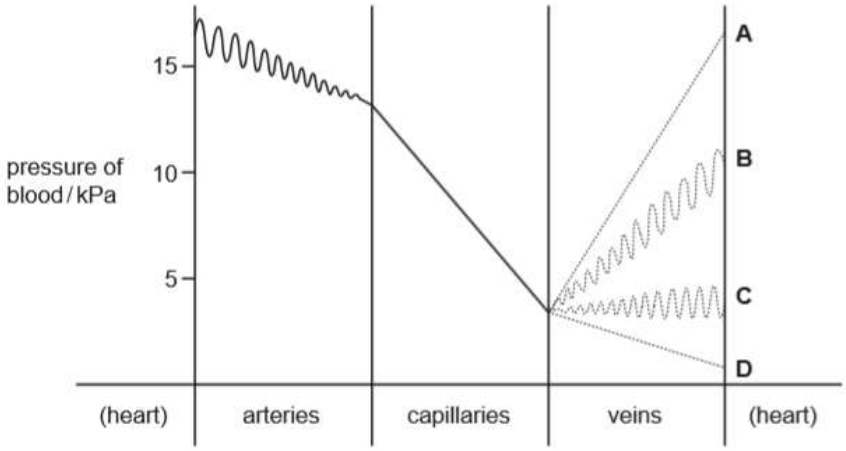
In which vessel is the blood pressure highest?



Question 84

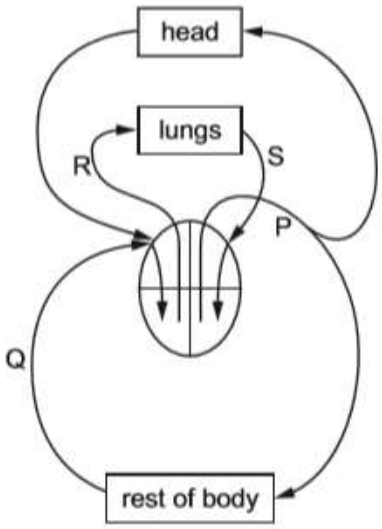
The diagram shows the blood pressure of a person at rest as the blood leaves the heart and passes through arteries and then capillaries.

Which line shows the pressure of blood as it flows through veins before returning to the heart?



Question 85

The diagram represents the heart and some major blood vessels.



What are possible blood pressures (in kPa) for the vessels shown on the diagram?

	P	Q	R	S
A	1	4	2	16
B	4	16	2	1
C	16	2	4	1
D	16	4	1	2

7(c) Name the main blood vessels that carry blood to and from the heart, lungs, liver and kidneys

The main vessels of the human circulatory system are:

(a) Pulmonary arteries that supply oxygen-poor blood from the heart to the lungs

(b) Pulmonary veins that bring oxygen-rich blood from the lungs to the heart

(c) Aorta that supplies oxygen-rich blood from the heart to the rest of the body. The aorta branches into: coronary arteries which supply cardiac tissue, an anterior branch leading to the head and arms and a posterior branch (dorsal aorta) leading to abdominal organs and legs.

(d) Branches of the dorsal aorta include:

(i) **Hepatic artery** from the heart to the liver

(ii) **Mesentric Arteries** to the alimentary canal

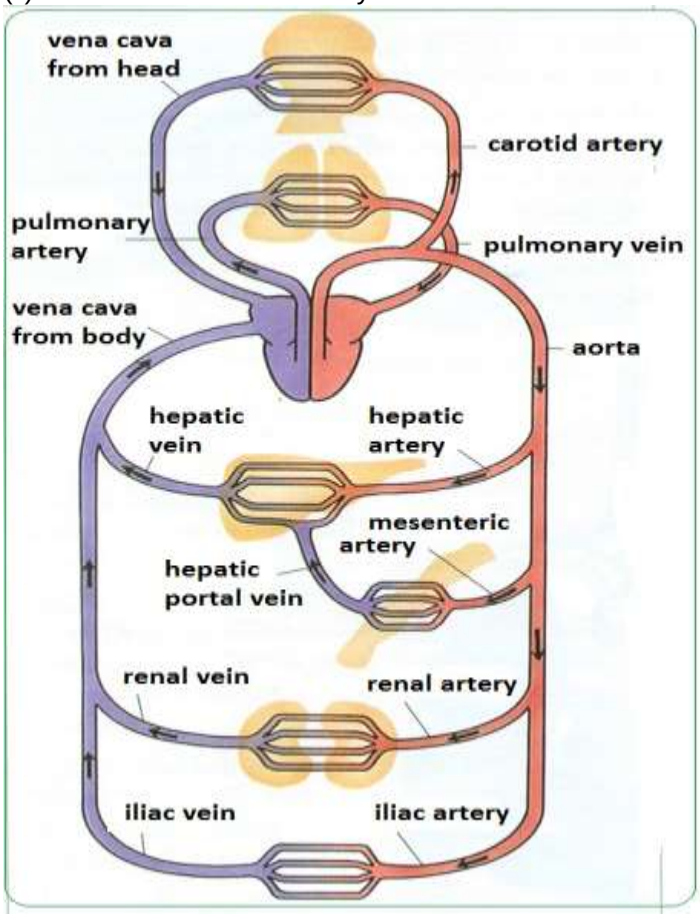
(iii) **Renal arteries** from the heart to the kidneys

(e) **Vena cava** consists of an anterior branch which returns blood from the head and arms to the heart and a posterior branch.

(f) Posterior vena cava collects blood from the posterior parts of the body, such as from:

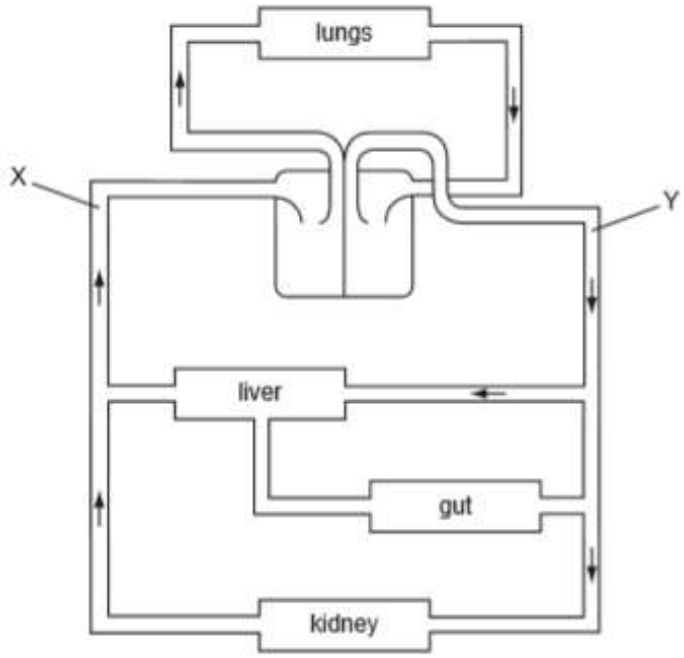
(i) Hepatic veins from the liver to the heart

(ii) Renal veins from the kidneys to the heart



Question 86

The diagram shows a plan of part of the circulatory system.



Which vessel **must** the blood pass through in flowing from X to Y?

A hepatic artery

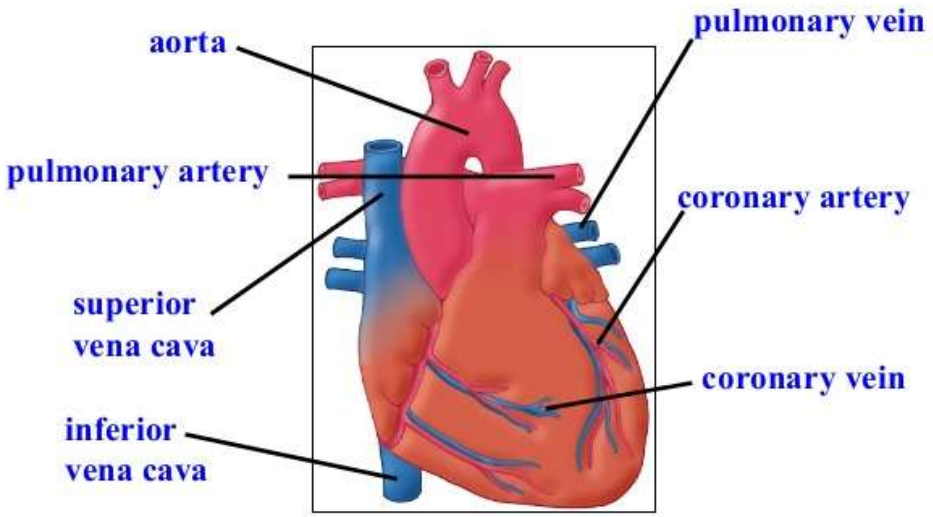
B hepatic portal vein

C pulmonary artery

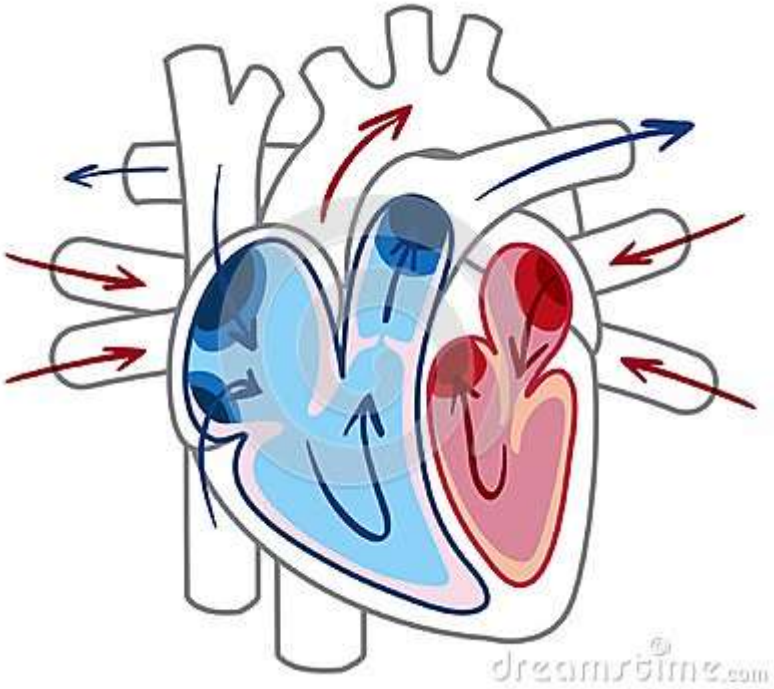
D renal vein

7(d) Describe the structure and function of the heart in terms of muscular contraction and the working of valves

Structure of heart



Internal structure of heart

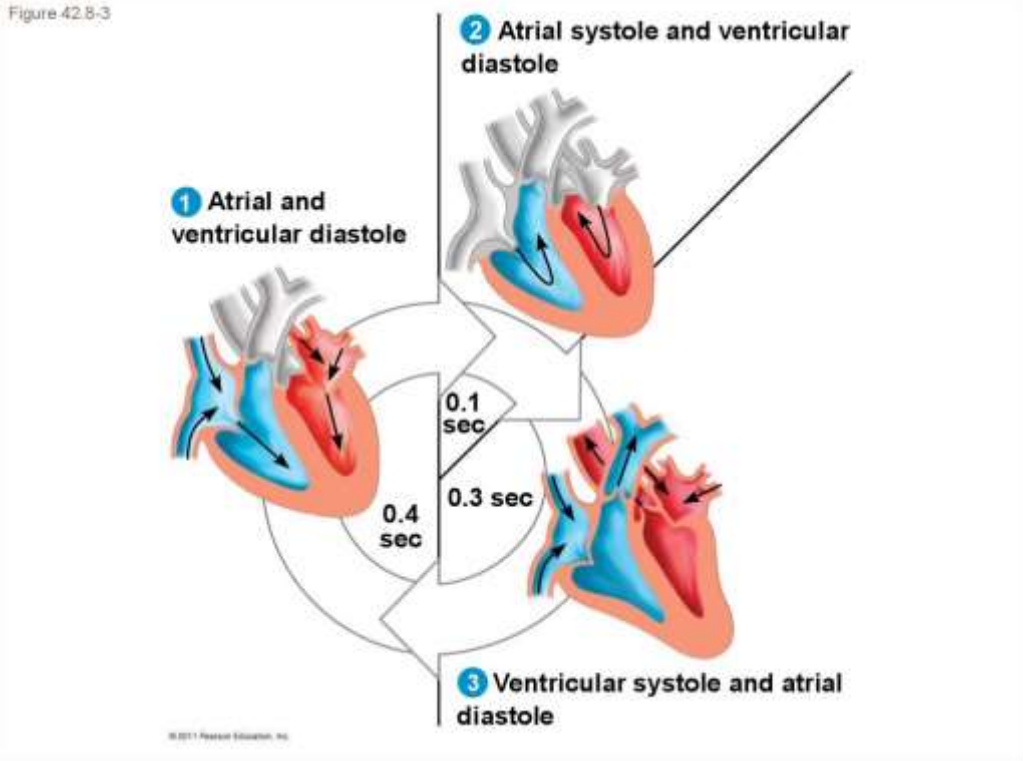


The heart is mainly made up of cardiac muscle tissue surrounded by a double-walled sac called a pericardium. The inner membrane of the pericardium is connected to the outer layer of the cardiac muscle. Between the two layers is the pericardial fluid, which reduces friction when the heart is beating.
3. The four chambers of the heart are the right and left atria and ventricles.
4. The atria are the upper chambers of the heart, with relatively thin walls. They collect blood returning to the heart and pump it into the ventricles.
5. The ventricles have thick, muscular walls. The left ventricle has thicker walls than the right ventricle, as it has to pump blood to the rest of the body.
6. The right side of the heart pumps deoxygenated blood and the left side pumps oxygenated blood. The septum separating the right and left sides prevent the blood from mixing, so that the maximum amount of oxygen can be carried to the tissues.
7. Between the right atrium and ventricle is a valve called the tricuspid valve which consists of three flaps attached to the walls of the right ventricle by cord-like tendons called cordae tendineae.
8.Between the left atrium and left ventricle is a bicuspid valve (mitral valve) which consists of two flaps, also attached by cordae tendineae.
9. The bicuspid and tricuspid valves are collectively known as atrioventricular valves.
10. Vessels associated with the heart are the anterior and posterior venae cavae, pulmonary veins and artery, aorta and coronary arteries. The coronary arteries are found on the heart surface itself, and supply blood to the heart muscles.
11. Located at the start of the aorta and pulmonary arteries are semi-lunar valves.

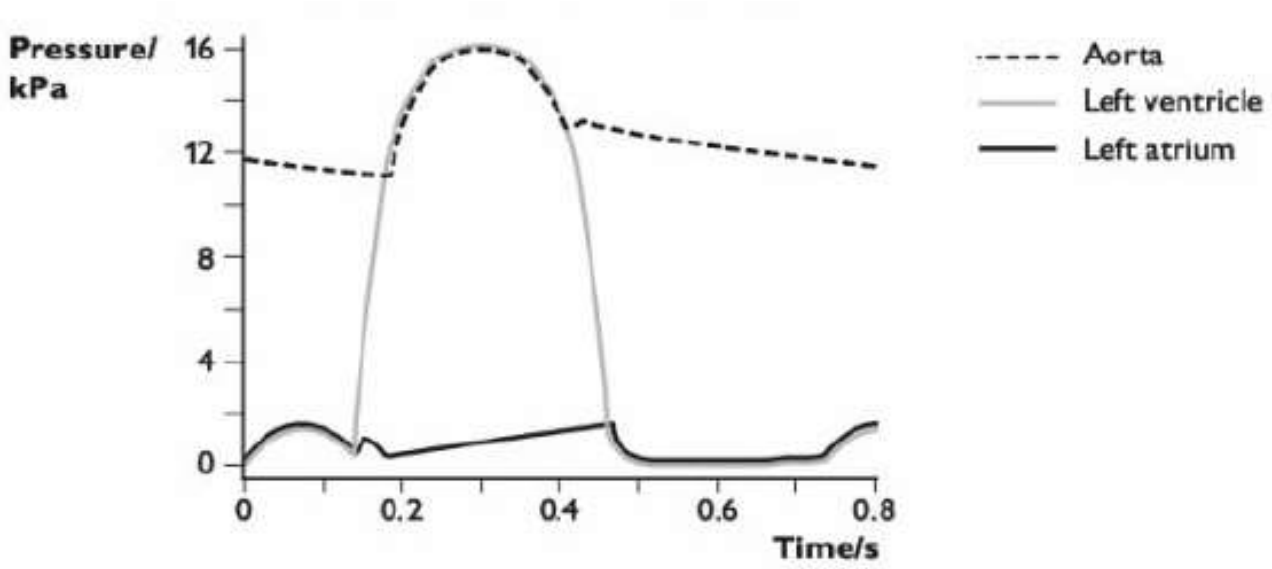
Cardiac cycle

1. One complete sequence of pumping and filling of the heart is called the cardiac cycle.
2. The contraction phase is called systole and the relaxation phase is called diastole.
3. The cycle starts when the whole heart is relaxed. The right atrium receives blood from the venae cavae and the left atrium receives blood from the pulmonary veins.
4. The next stage is atrial systole. When the atria contract, atrioventricular valves open and blood flows into the ventricles.
5. Next, the ventricles contract and atrioventricular valves close, producing the ‘lub’ sound of the heartbeat. This is called ventricular systole. The pressure in the ventricles increases, causing the semi-lunar valves in the pulmonary

artery and aorta to open. Blood flows into the aorta and pulmonary artery. While the ventricles are contracting, the atria relax in atrial diastole.
6. Finally, the ventricles relax. This is called ventricular diastole. The semi-lunar valves shut because the ventricles are at a lower blood pressure than the aorta and pulmonary arteries. This causes the 'dub' sound of the heartbeat. The atrioventricular valves open due to the drop in ventricular pressure.

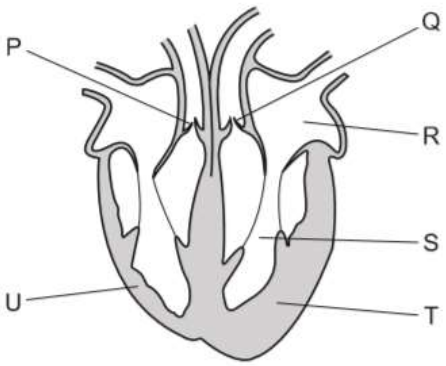


Pressure changes in the left side of the heart during cardiac cycle



Question 87

The diagram shows a section through the human heart.



Which labelled features suggest that blood leaves the heart at different pressures, when going to the lungs and to the body?

A Chambers R and S have different volumes.

B The walls of the atria are thinner than the walls of the ventricles.

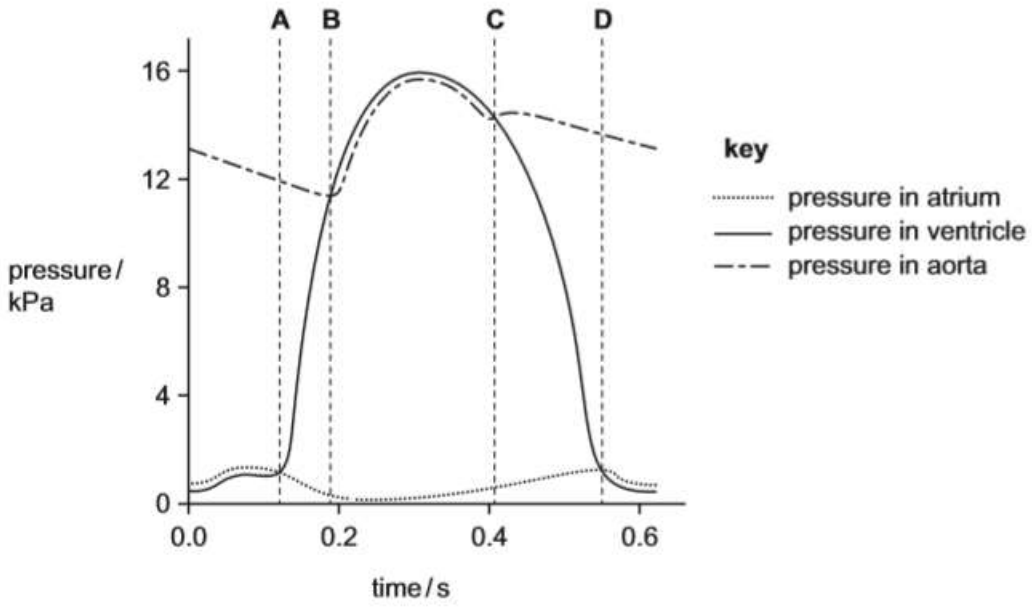
C Valve P is stronger than valve Q.

D Wall T is more muscular than wall U.

Question 88

The graph shows pressure changes in the left side of the heart, during a single heart beat.

At which point does the semi-lunar valve open?



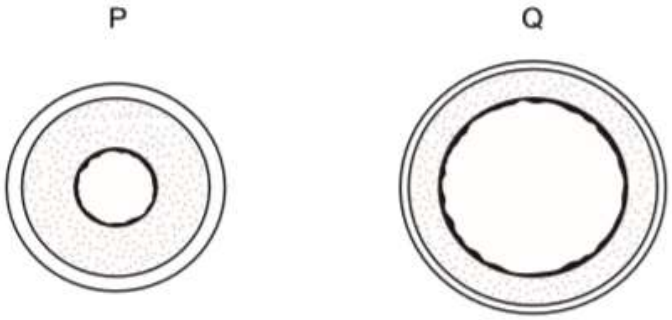
7(e) **Compare the structure and function of arteries, veins and capillaries**

Blood vessels and their functions
1. Arteries are blood vessels which carry blood away from the heart.
2. They have thick, muscular and elastic walls that can withstand the surge of the high pressure blood pumped out of the heart.
3. The arterial wall is divided into three layers. The outer layer is a protective layer consisting of connective tissue and elastic fibre. The middle layer consists of smooth muscle and more elastic fibres and the innermost layer next to the lumen consists of the endothelium, a single layer of flattened cells.
4. All arteries carry oxygenated blood with the exception of the pulmonary arteries.
5. Arteries split up into arterioles which are structurally similar to arteries but smaller in diameter.
6. Arterioles control blood flow into capillary beds by:
(a) Contracting the smooth muscle layer in the arteriole wall.
(b) Using sphincters, which are bands of smooth muscle located where arterioles branch into capillaries. Contraction prevents blood flow into capillary beds.
7. Capillaries are microscopic vessels with walls that are only one-cell thick. Their walls consist of a layer of flattened cells called endothelial cells.
8. The endothelium is partially permeable, allowing diffusion to occur.
9. Capillaries branch to form networks called capillary beds, which infiltrate almost all tissues, allowing exchange of substances to take place.
10. The extensive branching increases the total cross-sectional area of the vessels, lowering the blood pressure in the capillaries and hence the rate of blood flow, giving more time for the exchange of substances.
11. Capillaries converge into venules which are small vessels structurally similar to veins.
12. Venules converge to form veins.
13. Similar to arterial walls, the walls of veins consist of three layers.
14. However, the middle wall contains much less smooth muscle and elastic fibres. Hence they are not as thick, muscular or elastic as arteries. Therefore, a vein has a larger lumen as compared to an artery with the same external diameter.
15. The blood pressure in the veins is much lower than that of the arteries. Blood flows more slowly and smoothly so there is no need for thick, muscular and elastic walls.
16. Blood flow through the veins is assisted by the presence of semi-lunar valves and skeletal muscle action.
17. When we move, our skeletal muscles pinch the veins and move blood through them.
18. Blood is prevented from flowing backwards by the semi-lunar valves. Blood moving backwards causes the valves to close.
19. Veins carry blood back to the heart. The exceptions are portal veins, which carry blood between two capillary beds, e.g. the hepatic portal vein.
20. Veins carry deoxygenated blood with the exception of the pulmonary veins.

Aspect	Artery	Vein	Capillary
Cross section	 Lumen	 Lumen	 Lumen
Function	To carry blood away from the heart to other parts of the body	To carry blood to the heart	To connect the artery and the vein
Size of lumen	Small	Large	Very small
Wall thickness	Thick, elastic and muscular	Thinner and less elastic	Very thin (one-cell thick)
Blood flow	Very fast, high pressure	Slow, low pressure	Very slow, very low pressure
Type of blood carried	Oxygenated blood (except pulmonary artery)	Deoxygenated blood (except pulmonary vein)	Carries oxygenated blood to cell body; bring deoxygenated blood out of cell body
Presence of valve	× (except pulmonary artery)	✓ (except pulmonary vein)	×

Question 89

The diagram shows cross-sections of two blood vessels, P and Q.



What types of blood vessel are they?

	P	Q
A	artery	capillary
B	artery	vein
C	vein	artery
D	vein	capillary

7(f) Investigate and state the effect of physical activity on pulse rate
Take two students of same age gender and body mass
Make sure they take the same food two hours before experiment
Ask one boy to make 15 push ups
And ask other to sit still for the same time
Record pulse rate by placing index finger on the wrist of each student
Repeat this experiment three times and take mean pulse rate
Physical activity increases the pulse rate.

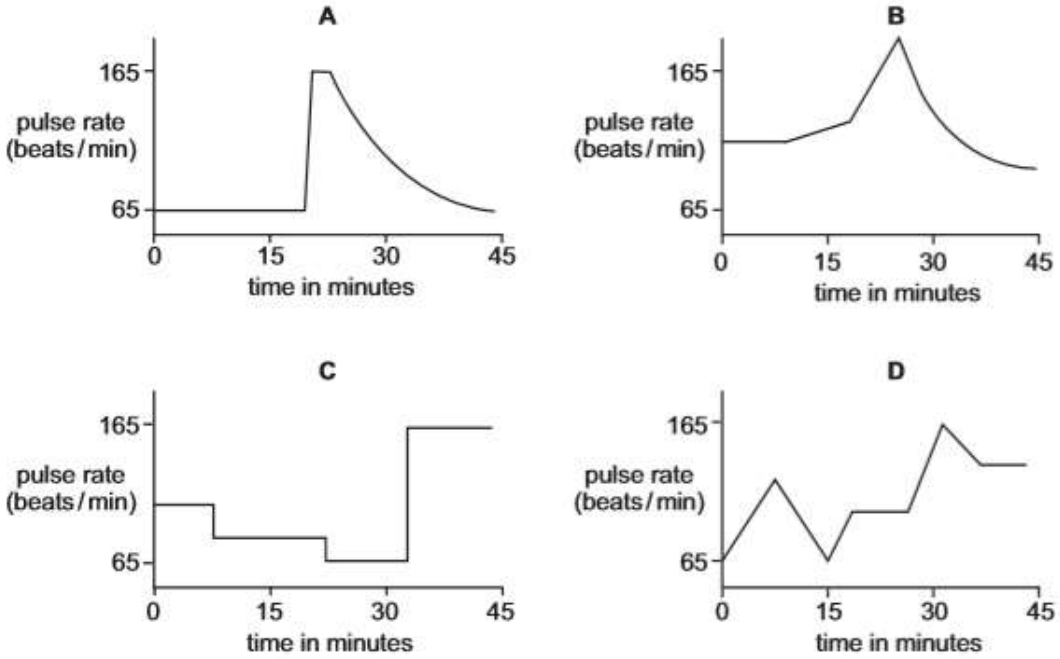
Question 90

5 The graph shows changes in a person's pulse rate over a period of 45 minutes.

The sequence of events involves:

- waiting in a queue
- entering a sports stadium
- seeing a goal scored
- relaxing during half time.

Which graph shows this sequence of events?



7(g) Describe coronary heart disease in terms of the occlusion of coronary arteries and state the possible causes (diet, stress and smoking) and preventive measures

Coronary heart disease

1. Coronary heart disease occurs when the coronary arteries become blocked (occluded) or narrowed.
2. The heart muscles will no longer be able to receive sufficient oxygen and nutrients.
3. This can cause a heart attack. During a heart attack, blood supply to part of the heart muscle is completely cut off due to blockage in the coronary arteries.
The affected part dies, which can affect the heart's ability to pump and lead to heart failure.

4. A cause of coronary heart disease is atherosclerosis, in which an artery wall thickens and hardens due to the deposition of plaque, which causes the lumen of the artery to become narrower.
5. The narrowing of the lumen of the arteries causes an increase in blood pressure.
This causes arteries to develop rough linings, which increases the likelihood of formation of blood clots inside the arteries. This is known as thrombosis.
6. This obstructs blood flow in the afflicted artery. If it occurs in a coronary artery, a heart attack takes place.
7. Factors that contribute to atherosclerosis include:
(a) High intake of cholesterol and saturated fats
(b) Stress
(c) Smoking
8. Preventive measures include:
(a) Healthy diet – low in cholesterol and saturated fats
(b) Not smoking – nicotine increases blood pressure
(c) Exercising – lowers stress and strengthens the heart

Question 91

Some factors associated with coronary heart disease are listed.

1 high blood pressure

2 high intake of fruit and vegetables

3 high intake of saturated fats

4 low blood cholesterol

5 low intake of processed foods

Which factors **decrease** the risk of coronary heart disease?

A 1, 2 and 3 **B** 1, 3 and 5 **C** 2, 3 and 4 **D** 2, 4 and 5

Question 92

Which row shows what may cause coronary heart disease?

	diet high in saturated fats	diet low in salt	regular exercise
A	✓	✓	✗
B	✓	✗	✗
C	✗	✓	✓
D	✗	✗	✓

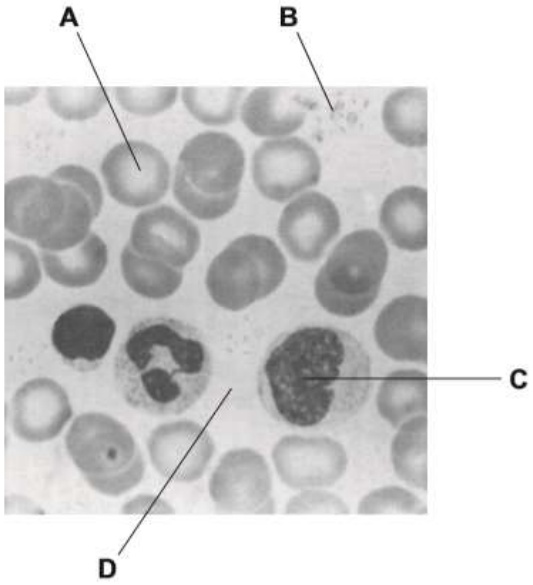
key
✓ = yes
✗ = no

7(h) Identify red and white blood cells as seen under the light microscope on prepared slides, and in diagrams and photomicrographs

Question 93

The photomicrograph shows human blood.

Which component cannot function effectively if a person's diet lacks iron?



magnification ×1000

7(i) List the components of blood as red blood cells, white blood cells, platelets and plasma

Components of blood

1. Blood is a connective tissue consisting of 45% cells suspended in 55% plasma.
2. Plasma is a clear yellowish liquid consisting mostly of water. It contains soluble proteins such as albumin and fibrinogen, as well as dissolved substances such as nutrients, waste products and ions.
3. Cellular elements in blood include:

(a) Red blood cells (erythrocytes) which function to transport oxygen.

Adaptations to this function are:

(i) Flattened, biconcave shape without nucleus or organelles at maturity, increasing the surface area to volume ratio for faster diffusion of oxygen

(ii) Contains haemoglobin, an iron-containing protein which is able to bind reversibly with oxygen

(iii) Flexibility to turn bell-shaped in order to pass through the narrow lumen of the capillaries

(b) White blood cells (leukocytes) are responsible for fighting infections in the body. There are two main types of white blood cells:

(i) Phagocytes have lobed (bi-lobed, tri-lobed, multi-lobed) nuclei and granular cytoplasm. They engulf and digest foreign particles such as bacteria.

(ii) Lymphocytes have a large rounded nucleus and a small amount of cytoplasm. They produce antibodies to protect the body from pathogens.

(c) Platelets (thrombocytes) are small cell fragments which have no nuclei.

They play a role in blood clotting.

Role of blood in transport

1**. Blood plasma transports:**

(a) Simple sugars, amino acids, fatty acids and glycerol from the capillaries in the small intestine

(b) Waste products of metabolism from tissues:

(i) Carbon dioxide in the form of bicarbonate ions. Carbon dioxide enters the blood from body tissues by diffusion into red blood cells, which contain the enzyme carbonic anhydrase to convert it to hydrogen carbonate. The hydrogen carbonate then diffuses out of red blood cells to be carried in plasma. In the lungs, the reverse occurs.
(ii) Nitrogenous waste products such as urea, uric acid and creatinine to the kidneys to be removed
(c) Hormones from the glands to target tissues
(d) Heat from muscles and liver throughout the body
2. Red blood cells transport:
(a) Oxygen as oxyhaemoglobin
(b) A small amount of carbon dioxide bound to haemoglobin

Transport of oxygen by red blood cells

1. As air enters the lungs, oxygen dissolves in the fluid covering the moist epithelium of the alveoli.
2. The oxygen diffuses into the capillaries of the lungs where they bind reversibly with haemoglobin in red blood cells to form oxyhaemoglobin.
3. When blood is transported to oxygen-poor respiring tissues, oxyhaemoglobin releases its oxygen which then diffuses into tissue cells.

Immune function of white blood cells

1. Phagocytosis refers to the ingestion of harmful foreign particles, bacteria and dead or dying cells by certain types of white blood cells called phagocytes.
2. When phagocytes detect a foreign particle, it engulfs it by stretching itself around the particle and enclosing it. It then digests the particle and kills it.
3. After phagocytosis, these cells die and form pus.
4. Antibodies are special proteins found in blood and other bodily fluids that help phagocytes identify and neutralise foreign particles. Antibodies also activate other immune responses.

5. When pathogens enter the blood, they stimulate lymphocytes to produce antibodies.
6. Antibodies may be present in the blood long after infection has been cured, conferring immunity to that particular infection.

7(j) State the functions of blood:

- red blood cells – haemoglobin and oxygen transport
- white blood cells – phagocytosis, antibody formation and tissue rejection
- platelets – fibrinogen to fibrin, causing clotting
- plasma – transport of blood cells, ions, soluble food substances, hormones, carbon dioxide, urea, vitamins and plasma proteins.

Question 94

Which row describes the functions of the blood components?

	plasma	platelets	white blood cells
A	antibody formation	clotting	transport of nutrients
B	clotting	transport of nutrients	antibody formation
C	clotting	antibody formation	transport of nutrients
D	transport of nutrients	clotting	antibody formation

Question 95

When the skin is cut the blood forms clots.

In which order would the components of the blood become involved?

	first → last			
A	fibrin	platelet	red blood cell	fibrinogen
B	fibrinogen	red blood cell	platelet	fibrin
C	platelet	fibrin	fibrinogen	red blood cell
D	platelet	fibrinogen	fibrin	red blood cell

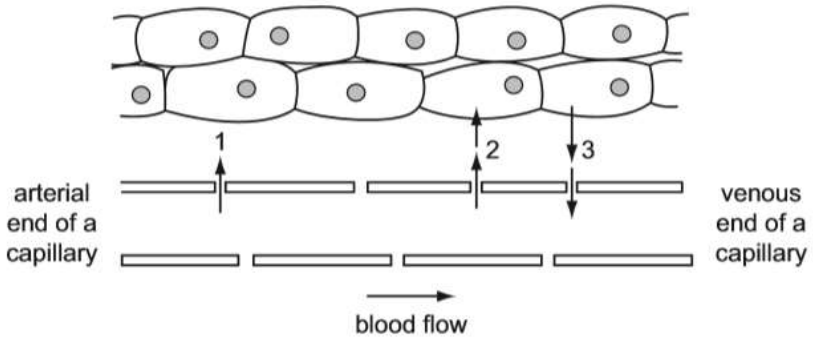
7(k) **Describe the transfer of materials between capillaries and tissue fluid**

Exchange of substances in capillaries

1. Capillaries are found between tissue cells.
2. As blood enters the capillaries, the narrow lumen of the capillaries forces red blood cells to travel in a single line.
3. Rate of blood flow decreases, allowing more time for the exchange of materials between tissue cells and red blood cells.
4. At the arterial end of capillaries, the blood pressure is high, forcing plasma through capillary walls into tissues. Plasma proteins are unable to pass through capillary walls.
5. The solution bathing tissue cells becomes known as tissue fluid, or interstitial fluid.
6. There is a higher concentration of nutrients and oxygen in blood than in the interstitial fluid. They diffuse across the endothelium of the capillary into the interstitial fluid, and from there, across the plasma membranes of tissue cells.
7. Waste materials from the tissue cells diffuse into the interstitial fluid, where they are present in higher concentrations than within the blood. They diffuse across the endothelium of the capillary into blood and are transported to excretory organs for removal.

Question 96

The diagram represents a tissue with an adjacent capillary.

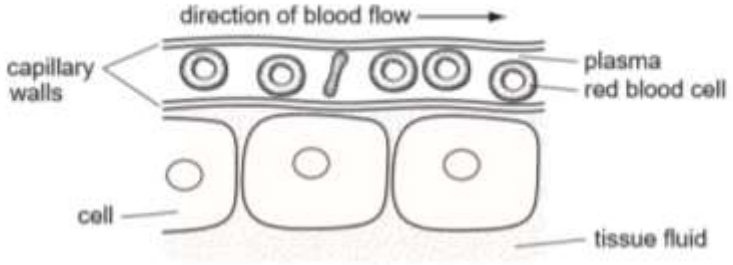


Which substances can 1, 2 and 3 represent?

	1	2	3
A	glucose	tissue fluid	carbon dioxide
B	oxygen	carbon dioxide	glucose
C	tissue fluid	glucose	oxygen
D	tissue fluid	oxygen	carbon dioxide

Question 97

The diagram shows a blood capillary close to some tissue cells bathed in tissue fluid. Exchange of nutrients takes place here.



Which row shows the type of nutrient in the plasma and in the tissue fluid and the method of transfer between the two?

	plasma	tissue fluid	method of transfer
A	amino acid	amino acid	diffusion
B	amino acid	protein	osmosis
C	protein	amino acid	digestion
D	protein	protein	active uptake