8. Transport in Mammals

8.1 The Circulatory System

Paper 2

Question Paper

1 **(a)** Water is the main component of blood.

Explain how the properties of water make it suitable as the main component of blood.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Fig. 2.1 is a diagram of the circulation in a mammal.

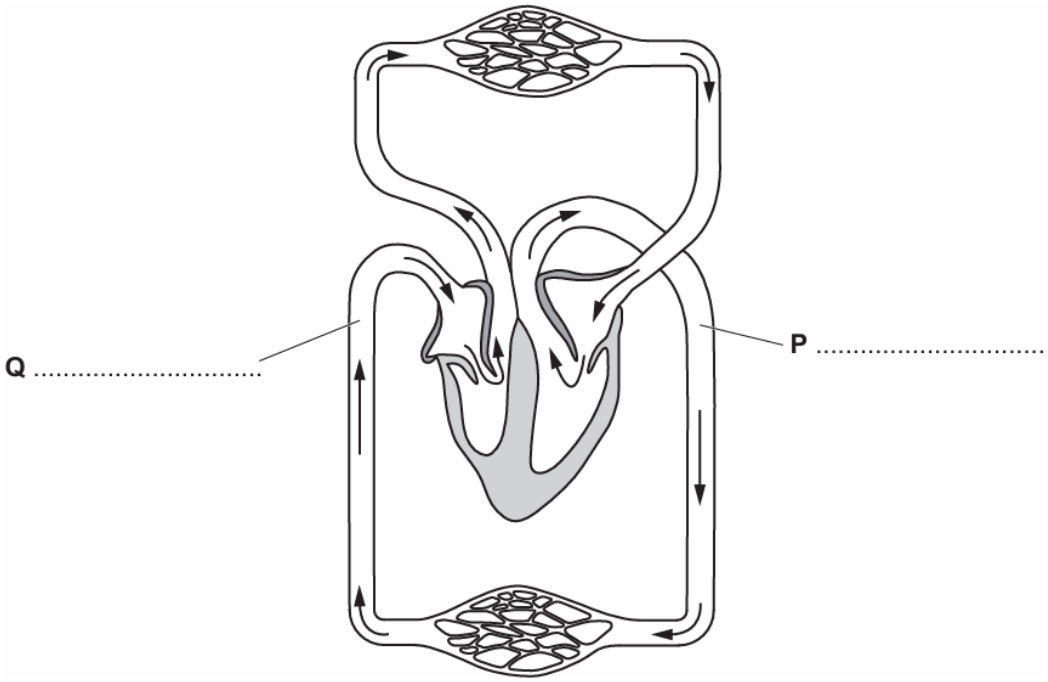


Fig. 2.1

(i) Complete Fig. 2.1 by naming **P** and **Q**. Write your answers on Fig. 2.1. [1]

(ii) Describe the functions of **P** and **Q**.

.....

.....

.....

.....

.....

..... [2]

(iii) Explain why the mammalian circulation is described as a closed, double circulation.

.....

.....

.....

.....

..... [2]

(c) Fig. 2.2 is a transmission electron micrograph of a cross-section of an arteriole. Blood flows from muscular arteries through arterioles into capillary networks.

The lining of the arteriole is folded because the arteriole has constricted. This constriction causes the blood pressure to decrease from 12.7 kPa in the muscular artery to 2.7 kPa at the end of the arteriole.



magnification ×2000

Fig. 2.2

(i) Explain why it is important that the pressure of blood decreases as it passes through arterioles.

.....

.....

.....

.....

..... [2]

(ii) Compare the structure of a muscular artery with the structure of the arteriole shown in Fig. 2.2.

.....

.....

.....

.....

.....

.....

..... [3]

2 Smooth muscle is a tissue composed of smooth muscle cells. The cells contain cytoplasm packed with proteins that are involved in contraction and relaxation.

(c) Fig. 1.2 is a photomicrograph of smooth muscle tissue in the wall of the intestines. A capillary is visible in addition to smooth muscle cells.

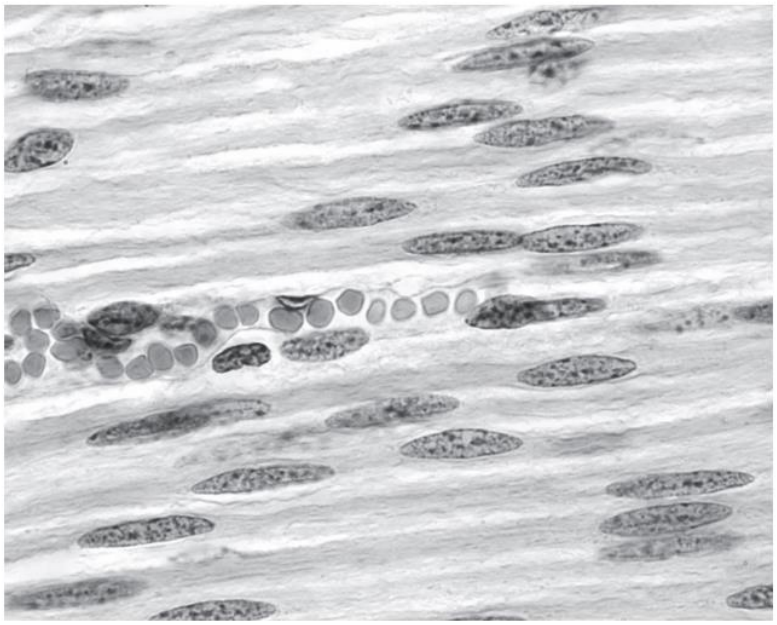


Fig. 1.2

(i) Outline the features that help to identify the blood vessel in Fig. 1.2 as a capillary.

.....

.....

.....

.....

..... [2]

(ii) Explain how the structure of a capillary is related to its function in smooth muscle.

.....

.....

.....

.....

.....

.....

..... [3]

3 Some people who are infected with HIV have HIV/AIDS.

(c) Studies suggest that people who are infected with HIV may be at a higher risk of heart disease. One cause of heart disease is the narrowing of the lumen of one or both of the main coronary arteries.

A coronary artery bypass graft (bypass graft) is a surgical operation that uses healthy blood vessels to divert blood around diseased sections of coronary arteries. The main choice of blood vessel to use for a bypass graft is known as the internal thoracic artery.

Fig. 6.1 is a diagram of an external view of the heart to show a **double** bypass graft.

The blood vessels used in the bypass graft shown in Fig. 6.1 are the great saphenous vein from the leg and the internal thoracic artery.

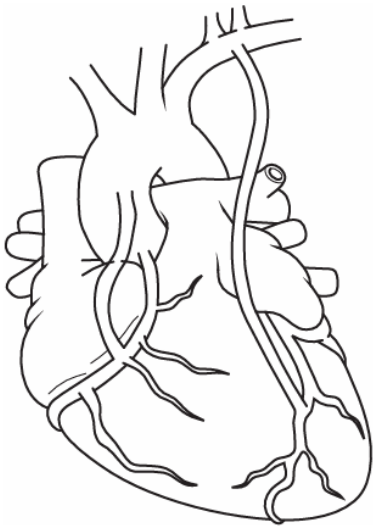


Fig. 6.1

(ii) After surgery, the wall of the great saphenous vein becomes thicker.

Suggest **and** explain why it is important for the wall of the vein to become thicker after surgery.

.....

.....

.....

.....

..... [2]

4 **(a)** In the mammalian circulatory system, red blood cells travel through different types of blood vessel as they pass from the heart to respiring tissues and back to the heart.

Fig. 2.1 shows the types of blood vessels through which red blood cells travel in the circulatory system.

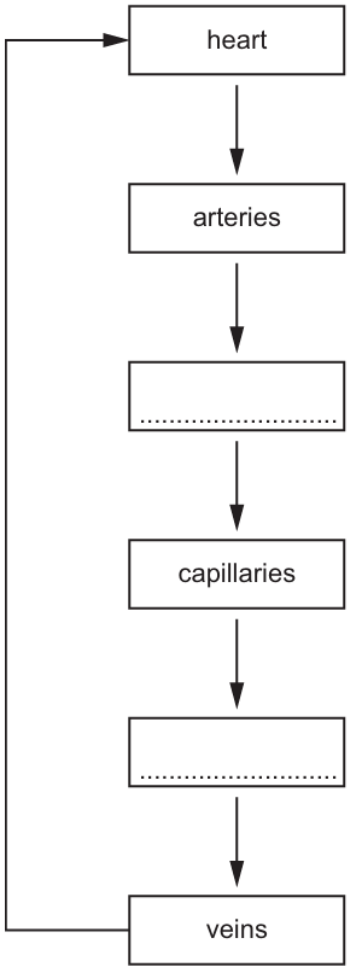
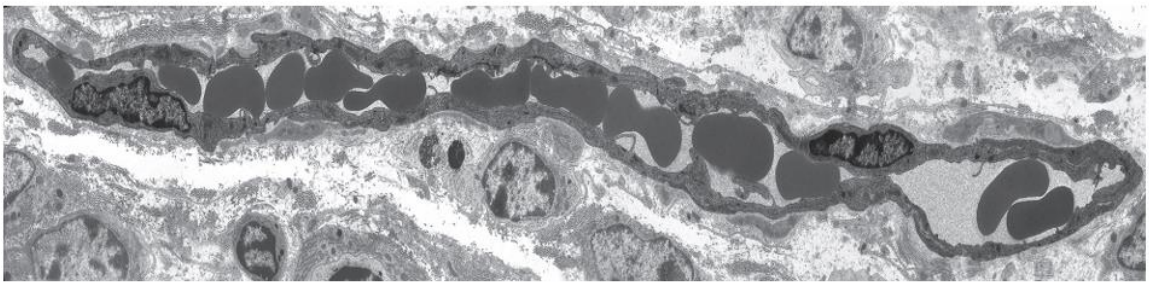


Fig. 2.1

Complete Fig. 2.1 by writing the names of the missing types of blood vessels through which red blood cells travel. [2]

5 Fig. 5.1 is a longitudinal section of a capillary in muscle tissue as viewed with a transmission electron microscope.



magnification ×2000

Fig. 5.1

(a) State the evidence, **visible in Fig. 5.1**, that identifies the cells inside the capillary as red blood cells.

.....

.....

.....

.....

..... [2]

(b) Explain how the structure of the capillary wall is related to its functions.

.....

.....

.....

.....

.....

.....

..... [3]

6 The liver receives blood from the hepatic artery and from the hepatic portal vein. The hepatic portal vein transports blood from the digestive system.

Hepatocytes are the main cell type of the liver. They have a wide range of functions, including:

- the synthesis of triglycerides and plasma proteins
- detoxifying waste
- energy storage.

(b) Blood arriving at the liver enters specialised blood vessels known as sinusoids.

Fig. 3.1 is a diagram of part of a sinusoid and surrounding hepatocytes. A second type of cell found in the liver, a Kupffer cell, is also shown.

Kupffer cells are phagocytic cells of the immune system.

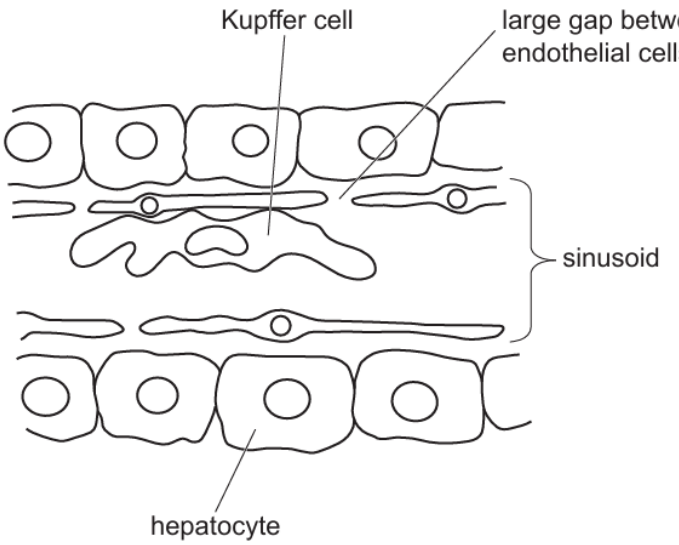


Fig. 3.1

(i) Suggest **one** advantage of having large gaps between the endothelial cells of the sinusoid, as shown in Fig. 3.1.

.....

.....

..... [1]

7 Tuberculosis (TB) is an infectious disease caused by a bacterium. In the majority of people, only the lungs are affected.

In most cases, the transmission of TB from an infected person to an uninfected person involves *Mycobacterium tuberculosis*. A different species of bacterium is involved in the transmission of TB from cattle, such as dairy cows, to humans.

(e) *M. tuberculosis* can spread in the blood and lymph to other organs in the body.

In very rare cases, a disease known as mycotic aneurysm can be caused by infection of the arterial wall, particularly in elastic arteries. The damage caused by the pathogen can lead to a rupture (bursting) of the artery.

With reference to the structure of the wall of **elastic** arteries, suggest how damage caused by *M. tuberculosis* infection can lead to the rupture of the artery.

You may draw a diagram if you wish.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Space for diagram

[3]

8 Hummingbirds are the smallest of birds and are found in the Americas. Some species migrate hundreds of kilometres between warmer overwintering areas and summer breeding grounds. Like mammals, birds maintain a constant body temperature.

Hummingbirds have a high requirement for sugars because they have a very high metabolic rate. Fig. 3.1 shows a hummingbird feeding on nectar, one of their main food sources.



Fig. 3.1

(c) In birds such as hummingbirds:
- blood is kept within vessels
- for each complete circuit of the body, blood passes through the heart twice.

State the term used to describe this type of circulatory system.

..... [1]

(e) Complete Table 3.1 to show the names and functions of the main blood vessels associated with the heart of mammals.

Table 3.1

function of blood vessel	name of blood vessel
carries blood from the heart to the lungs	
carries blood to the heart from the lungs	
carries blood from the heart to the rest of the body	
carries blood to the heart from the rest of the body	

[3]

9 The mammalian circulatory system is adapted for the long-distance transport of the respiratory gases, oxygen and carbon dioxide.

The system is described as a closed double circulation.

(a) Name:

- the two different circulations of the double circulatory system of mammals

  .....

  .....

- the main vein returning deoxygenated blood to the heart.

  .....

[3]

(b) In a closed circulation, blood is kept within vessels at all times.

Name the type of blood vessel that connects capillaries and veins.

..... [1]

10 Fig. 2.1 is a simplified diagram of the human circulatory system.

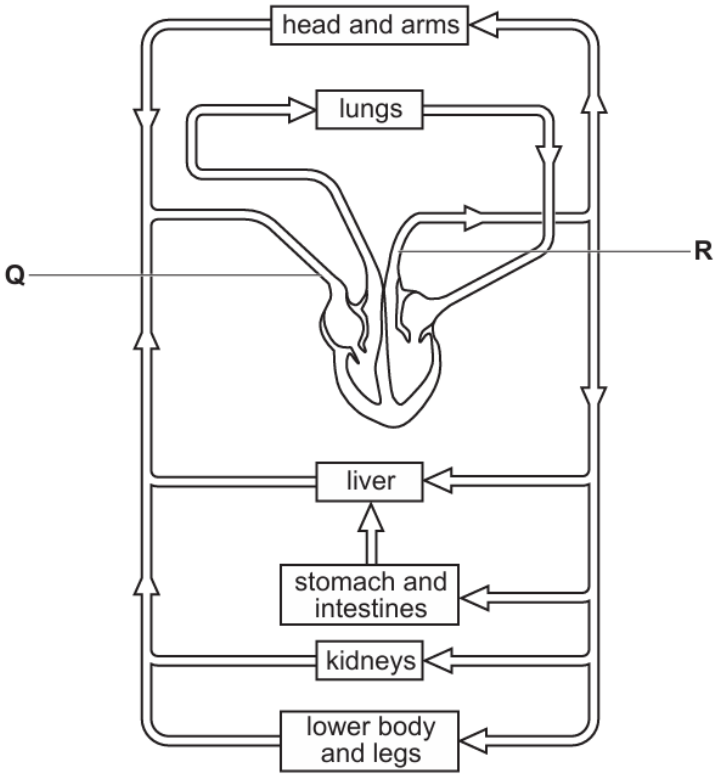


Fig. 2.1

(a) (i) State why the human circulatory system is described as a closed, double circulation.

.....

.....

.....

.....

..... [2]

(ii) Identify blood vessel **Q** and blood vessel **R**, shown in Fig. 2.1.

Q .....

R .....

[1]

(iii) Blood leaving the heart passes through valves before it enters blood vessel **R**.

Describe the differences between the structure of blood vessel **Q** and the structure of blood vessel **R**. Do **not** refer to valves in your answer.

.....

.....

.....

.....

.....

.....

..... [3]

11 In mammals, some cell signalling molecules are steroid (lipid) hormones. These hormones are transported in the bloodstream to reach capillary networks.

At a capillary network, hormones pass out of the blood into tissue fluid.

(a) Fig. 3.1 is a diagram of a capillary network.

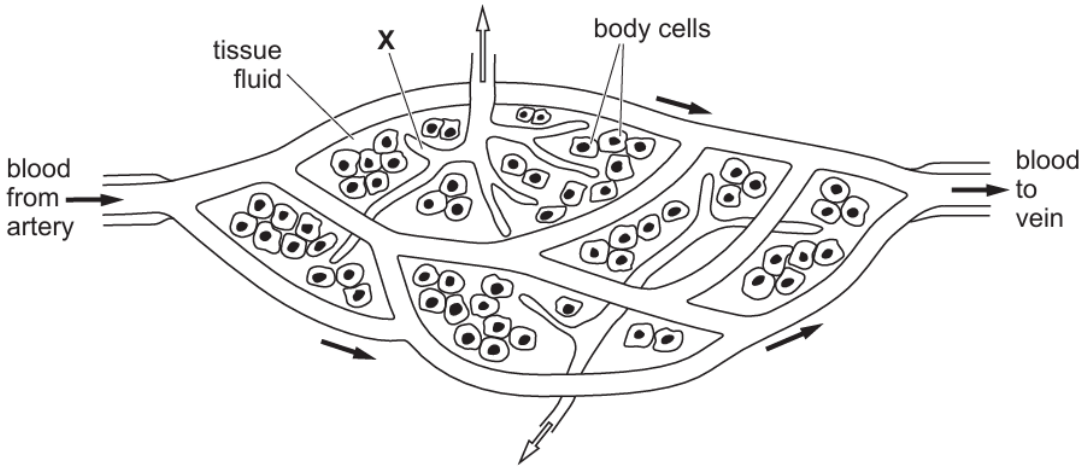


Fig. 3.1

(i) Describe the **differences** between the blood arriving at the arterial end of the capillary network and the tissue fluid surrounding the body cells.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) Not all the tissue fluid passes back into the blood capillaries to enter the bloodstream. Some of the tissue fluid drains into blind-ended vessels, such as vessel **X** shown in Fig. 3.1.

Name the fluid that is formed in vessel **X**.

..... [1]

12 A person who is exposed to tobacco smoke is at greater risk of lung cancer and chronic obstructive pulmonary disease (COPD).

Many people with COPD have both chronic bronchitis and emphysema. These diseases cause changes in the gas exchange system. For example, changes occur in the total lung surface area to volume ratio (SA:V).

(e) In humans, blood that becomes oxygenated in the lungs reaches body tissues without coming into contact with blood that is deoxygenated.

Explain how the blood that becomes oxygenated in the lungs is kept separate from blood that is deoxygenated.

.....

.....

.....

.....

..... [2]

13 The high blood pressure at the arterial end of a capillary network results in some components of blood leaving the capillaries and forming tissue fluid. At the venous end, the presence of plasma proteins allows movement of water by osmosis back into the capillaries.

Fig. 2.1 is a diagram showing a capillary network. The lymph vessels and the blood vessels at the arterial and venous ends of the network are also shown.

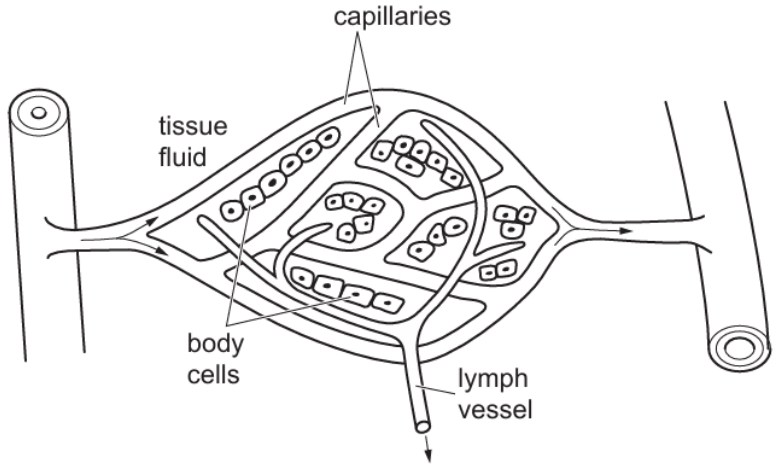


Fig. 2.1

(a) Red blood cells and plasma proteins, such as albumin, remain in the capillaries and are not found in tissue fluid.

Explain why red blood cells and albumin do not leave the capillary.

.....

.....

.....

..... [2]

(d) A low blood albumin concentration can lead to a condition known as oedema.

Oedema is a swelling of tissues caused by the accumulation of tissue fluid surrounding the body cells in the capillary network.

Suggest **and** explain how a low blood albumin concentration can lead to oedema.

.....

.....

.....

.....

.....

.....

..... [3]

14 **(a)** Fig. 2.1 is a transmission electron micrograph of a transverse section through a blood capillary that is surrounded by actively respiring cells.

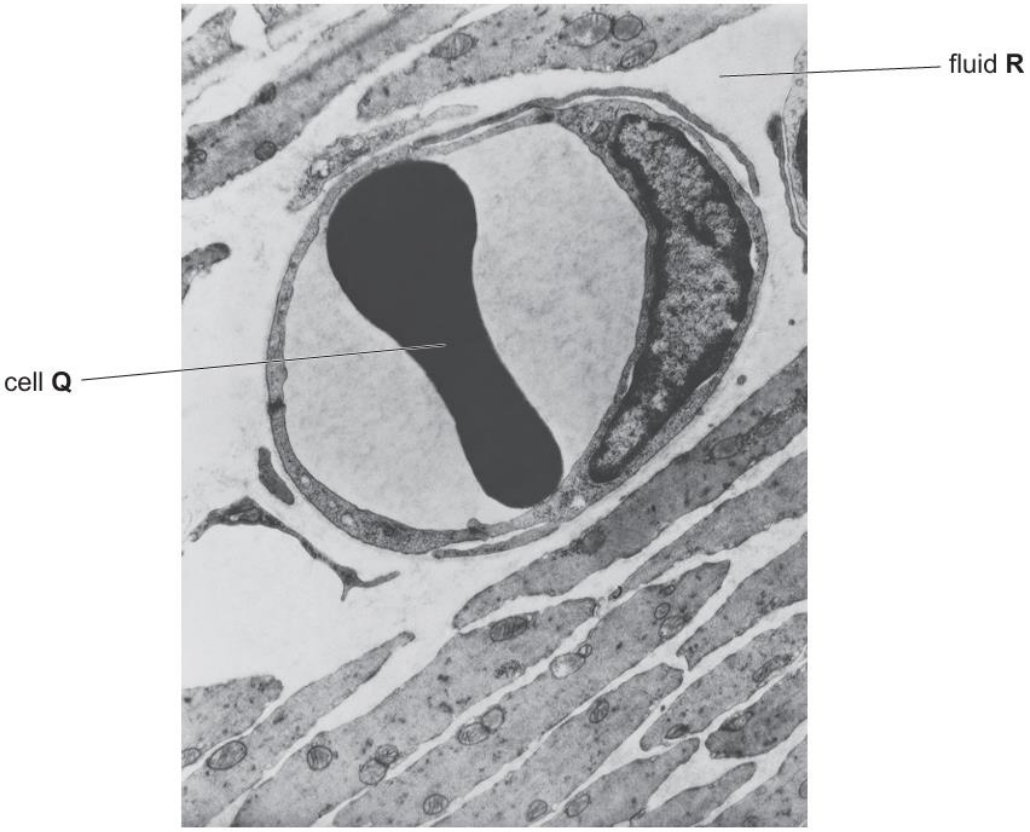


Fig. 2.1

(i) Identify cell **Q** shown in Fig. 2.1.

..... [1]

(ii) Fluid **R** is formed from blood in the blood capillary.

State **and** explain **one** difference between the composition of fluid **R** and the composition of the blood in the capillary.

difference .....

explanation .....

.....

.....

.....

..... [3]

(c) Nicotine is one of the components of tobacco smoke. Nicotine can cross cell surface membranes and enter the bloodstream.

(i) Describe the short-term effects of nicotine on the cardiovascular system.

.....

.....

.....

.....

.....

..... [2]

15 Fig. 4.1 shows the site of gas exchange in the mammalian lung.

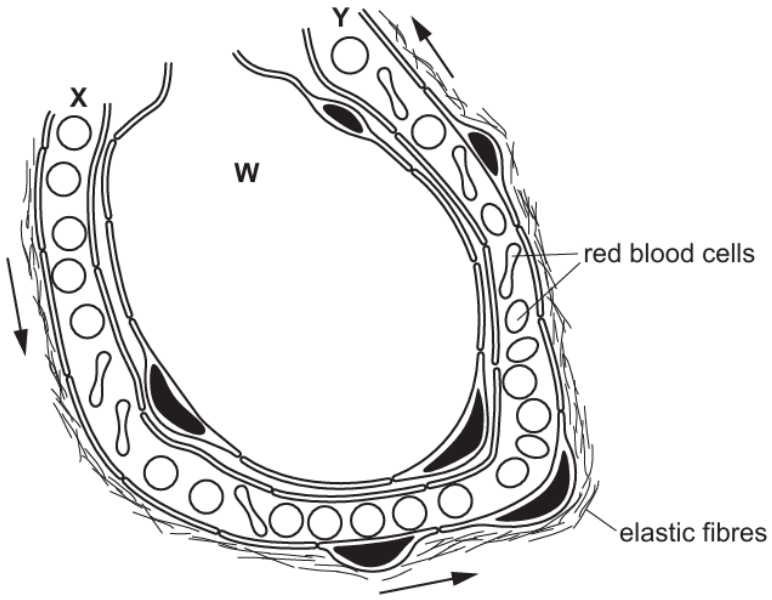


Fig. 4.1

(c) Elastic fibres are present in tissues at the site of gas exchange in the lungs.

Describe the roles of elastic fibres in the gas exchange system **and** in the cardiovascular system.

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [4]

(d) Scientists in Peru investigated the effect of moving from sea level to high altitude on the composition of blood. The scientists studied 10 students. Each student had lived at sea level since birth and then moved to live in the Andes at a height of 4500 metres above sea level.

The scientists took samples of blood from each student before they moved to live at high altitude. The scientists took further blood samples at intervals after the students had moved to high altitude.

The relative proportions of red blood cells and plasma in each sample were determined.

The total volume of blood for each student was also determined at each sampling time. As the students were all of different body mass, the total volumes were converted to a volume per kg of body mass ($cm^3\,kg^{-1}$).

Fig. 4.2 shows for each sampling time:

- the mean volume of blood per kg of body mass
- the proportions of red blood cells and plasma.

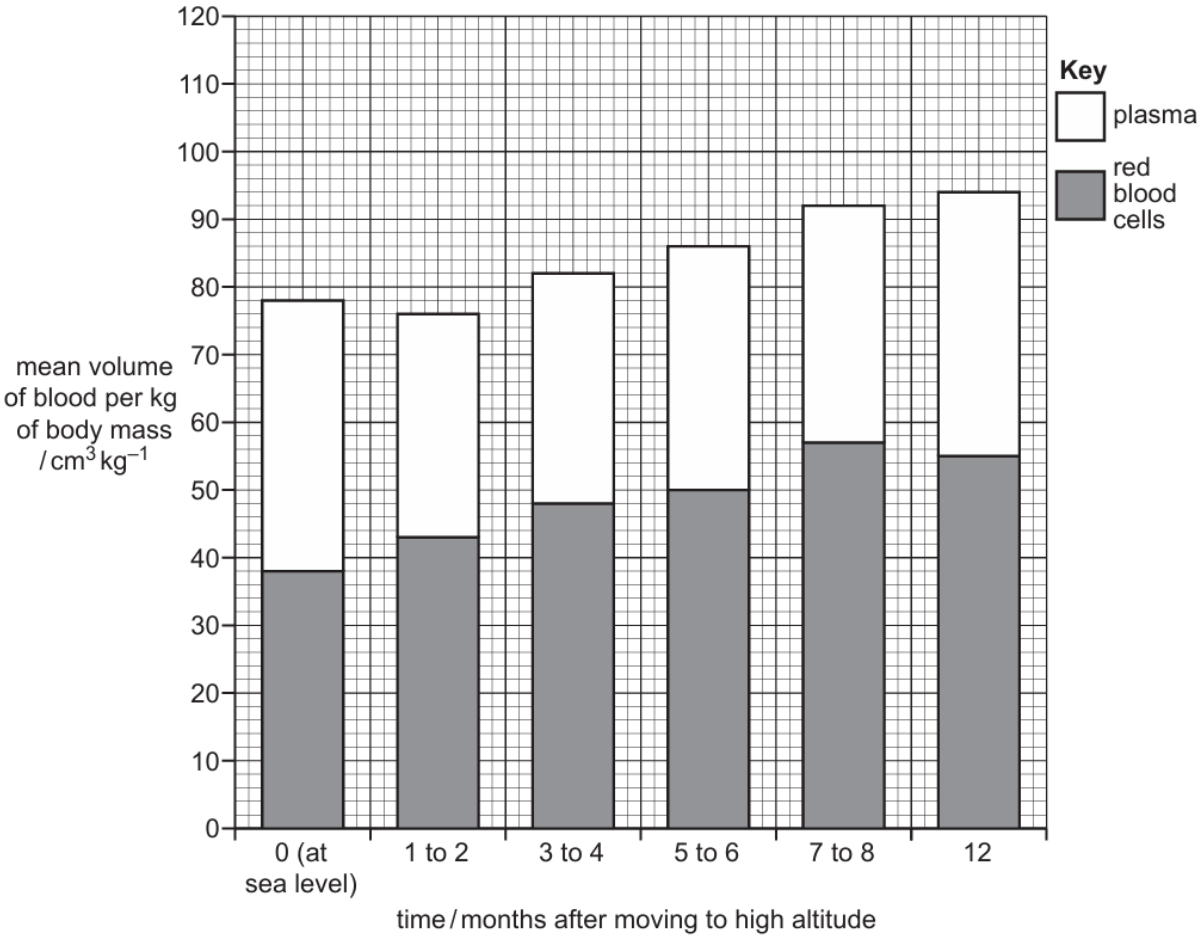


Fig. 4.2

(i) The percentage of mean blood volume that is represented by red blood cells for the samples taken at sea level is 48%.

Calculate the percentage of mean blood volume that is represented by red blood cells at 5 to 6 months after living at high altitude.

Show your working and give your answer to the nearest whole number.

answer = ...% [2]

16 **(a)** The circulatory system of mammals is a double circulation.

(i) Explain what is meant by the term double circulation.

.....

.....

..... [1]

17 **(a)** Fig. 4.1 is a photomicrograph of a human blood smear.

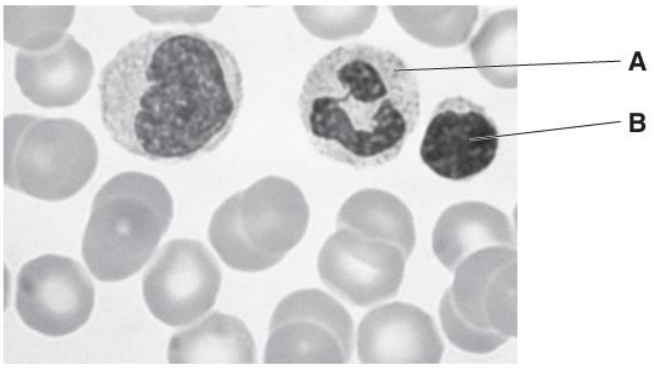


Fig. 4.1

Name the cells labelled **A** and **B** in Fig. 4.1.

A .....

B .....

[2]

(b) Blood and lymph are both fluids that transport substances within the human body.

(i) Table 4.1 shows components found in both blood and lymph.

Complete Table 4.1 to show whether the concentration of each of these components is **higher** or **lower** or the **same** in the lymph, when compared with the concentration in the blood in the aorta.

You may use the words **higher** or **lower** or **same** once, more than once or not at all.

Table 4.1

component	concentration **in lymph** compared to the concentration in blood in the aorta
oxygen	
carbon dioxide	
red blood cells	

[2]

18 People who smoke tobacco are at an increased risk of developing non-infectious diseases of the gas exchange system and the cardiovascular system.

In 2004, a study was carried out on the most popular brands of filter cigarettes from each of the six World Health Organization (WHO) regions.

In this study, the smoke passing through the filter was analysed for the tar, nicotine and carbon monoxide (CO) content for each brand of cigarette. For each WHO region, the mean content of tar, nicotine and carbon monoxide of the different brands of cigarette was calculated.

The results are shown in Fig. 2.1.

Key to WHO regions

AFRO = African Region
AMRO = Region of the Americas
EMRO = Eastern Mediterranean Region
EURO = European Region
SEARO = South-East Asia Region
WRPO = Western Pacific Region

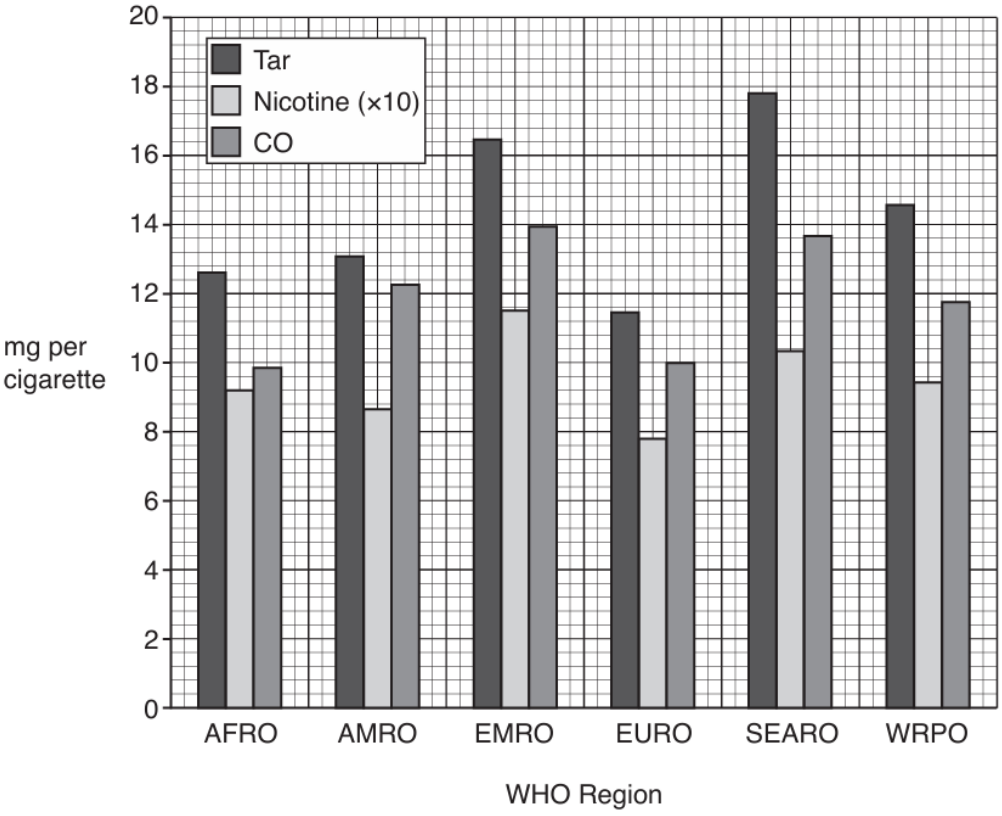


Fig. 2.1

(b) With reference to Fig. 2.1, explain why smoking a popular brand of cigarette from the AFRO region is more likely to increase the risk of blood clots forming than smoking a popular brand of cigarette from the EURO region.

.....

.....

.....

.....

..... [2]

19 A red blood cell goes through a number of stages in the bone marrow before it is released into the circulation to carry out its role of oxygen transport.

Fig. 3.1 is a transmission electron micrograph of developing red blood cells in the bone marrow. Each cell is known as an erythroblast.

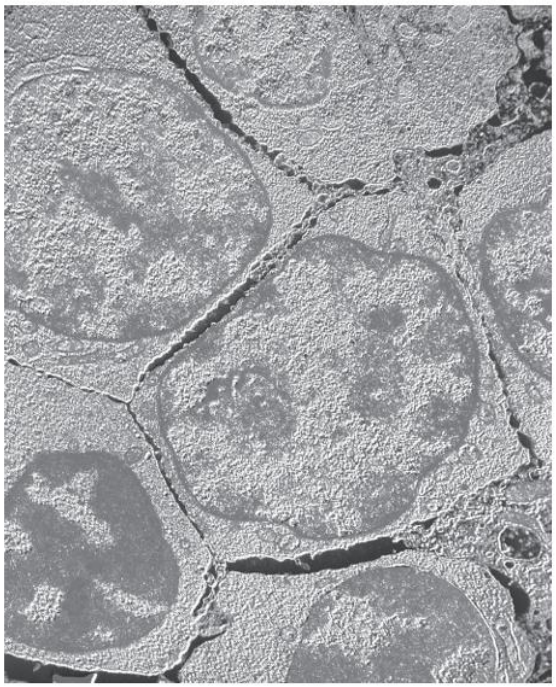


Fig. 3.1

(b) Describe the differences between an erythroblast and a mature red blood cell.

.....

.....

.....

.....

.....

.....

.....

..... [3]

20 **(a)** The mammalian circulatory system is described as a closed double circulation.

Explain why it is called a *closed* **and** *double* circulation.

closed .....

.....

double .....

..... [2]

21 Fig. 3.1 is a photomicrograph of human blood cells from a healthy individual who lives at sea level. The cells labelled **C**, **D** and **E** are white blood cells.

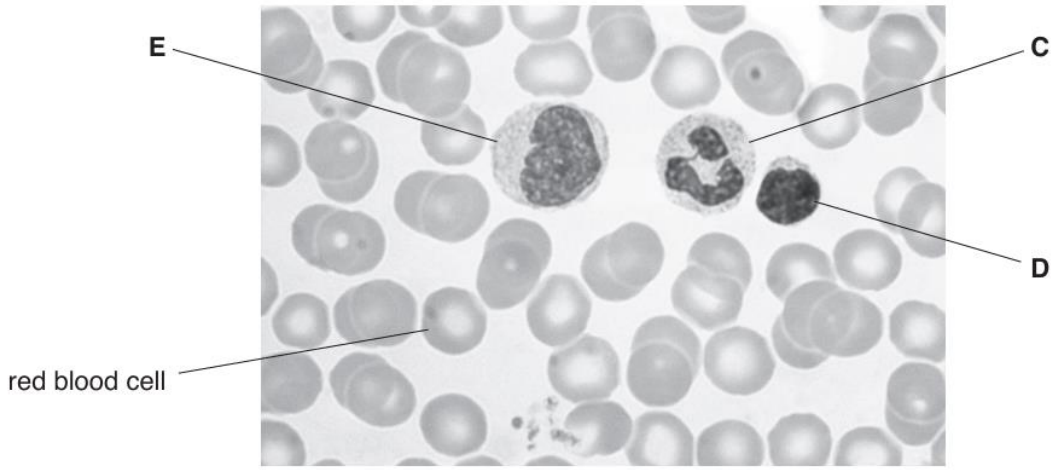


Fig. 3.1

(a) Name cells **C**, **D** and **E**.

C .....

D .....

E ..... [3]