The Circulatory System (8.1): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

22 questions · 48 marks · about 58 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · Paper 2 · October/November 2022 (22) · Q1(a) · 3 marks

1 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

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- the main vein returning deoxygenated blood to the heart.

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[3]

Question 2 · Paper 2 · October/November 2022 (22) · Q1(b) · 1 mark

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

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

Question 3 · Paper 2 · May/June 2021 (22) · Q4(e) · 2 marks

(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.

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Question 4 · Paper 2 · May/June 2022 (22) · Q3(c) · 1 mark

(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.

Question 5 · Paper 2 · May/June 2022 (22) · Q3(e) · 3 marks

(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]

Question 6 · Paper 2 · October/November 2023 (22) · Q3(a) · 1 mark

3 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.

(a) The hepatic artery branches from the main artery that transports blood from the heart.

Name the main artery that transports blood to the hepatic artery.

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Question 7 · Paper 2 · May/June 2024 (21) · Q2(b)(i) · 1 mark

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

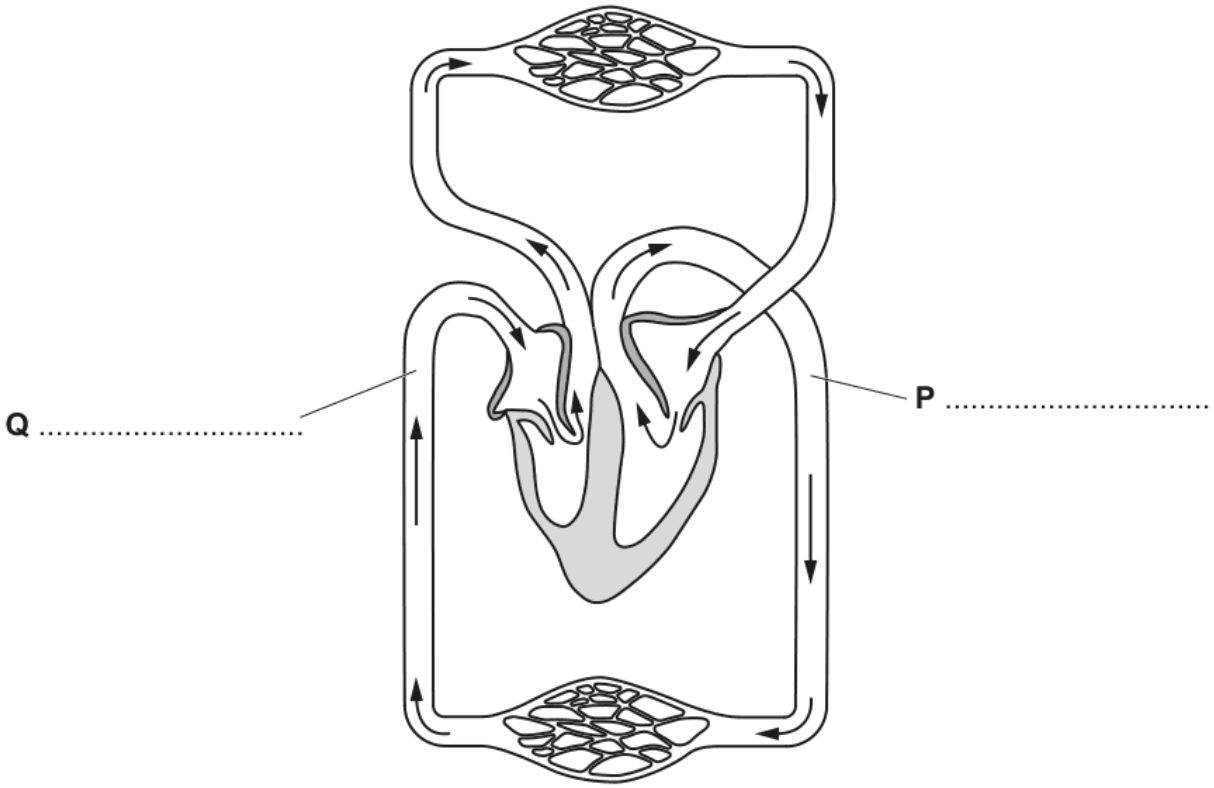


Fig. 2.1

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

Question 8 · Paper 2 · May/June 2024 (21) · Q2(b)(ii) · 2 marks

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

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Question 9 · information from earlier in the question

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

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Question 9 · Paper 2 · May/June 2024 (22) · Q1(c)(i) · 2 marks

(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.

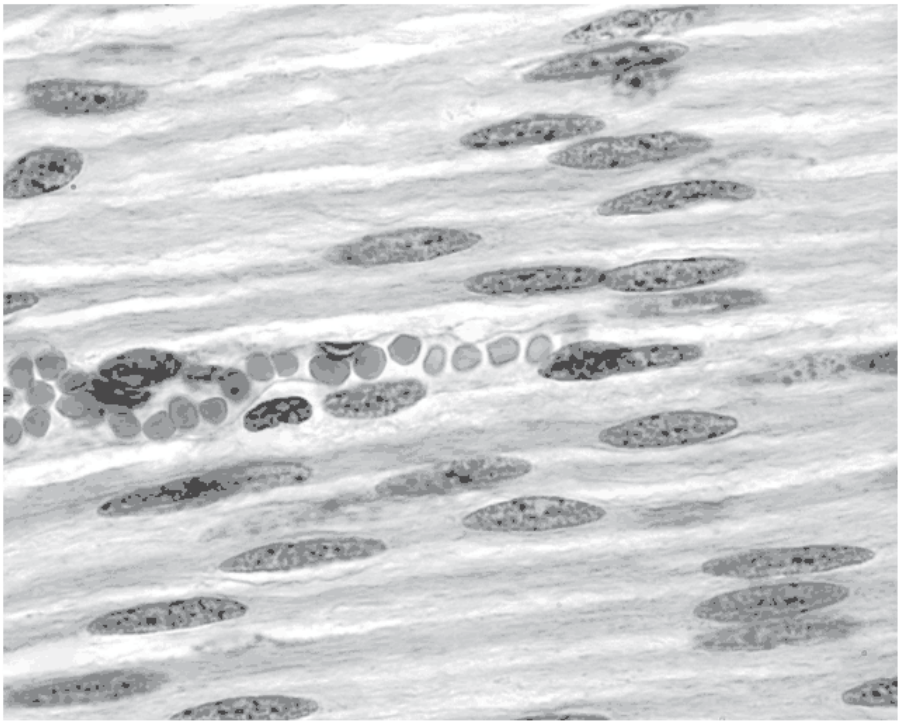


Fig. 1.2

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

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Question 10 · Paper 2 · May/June 2024 (22) · Q1(c)(ii) · 3 marks

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

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(c) Fig. 5.2 is a photomicrograph showing a transverse section of part of the human aorta.

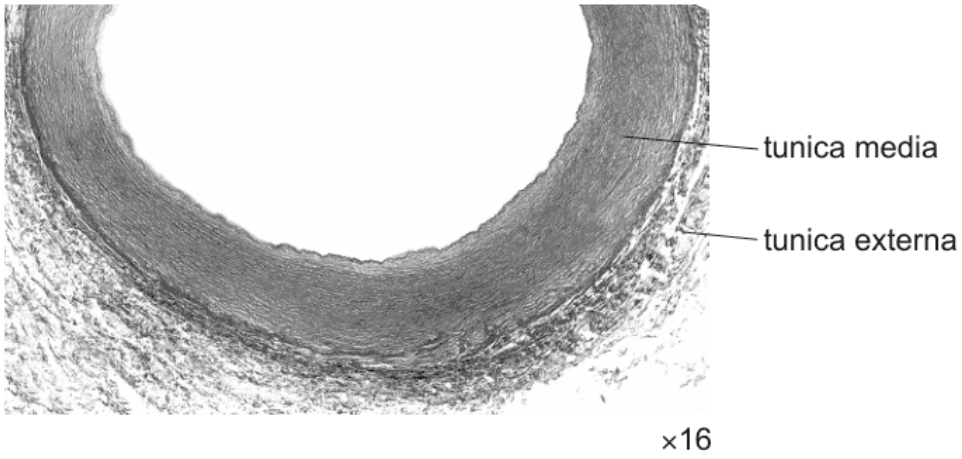


Fig. 5.2

Explain how the structure of the tunica media in Fig. 5.2 is different from the structure of the tunica media in a muscular artery **and** relate the difference to the function of the aorta.

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Question 12 · Paper 2 · October/November 2023 (22) · Q5(e) · 3 marks

(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.

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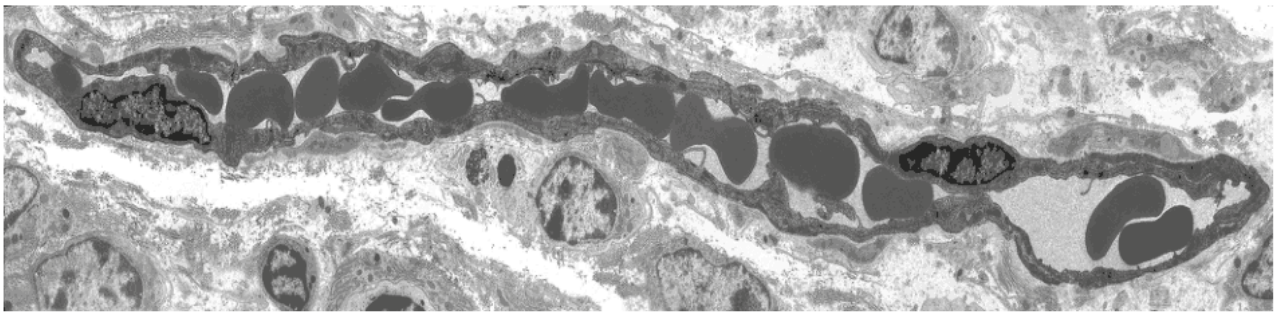
Space for diagram

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Question 13 · Paper 2 · May/June 2023 (21) · Q5(a) · 2 marks

Question 5 is on page 16.

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.

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Question 14 · Paper 2 · May/June 2023 (21) · Q5(b) · 3 marks

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

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Question 15 · Paper 2 · May/June 2019 (22) · Q3(a) · 3 marks

3 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.

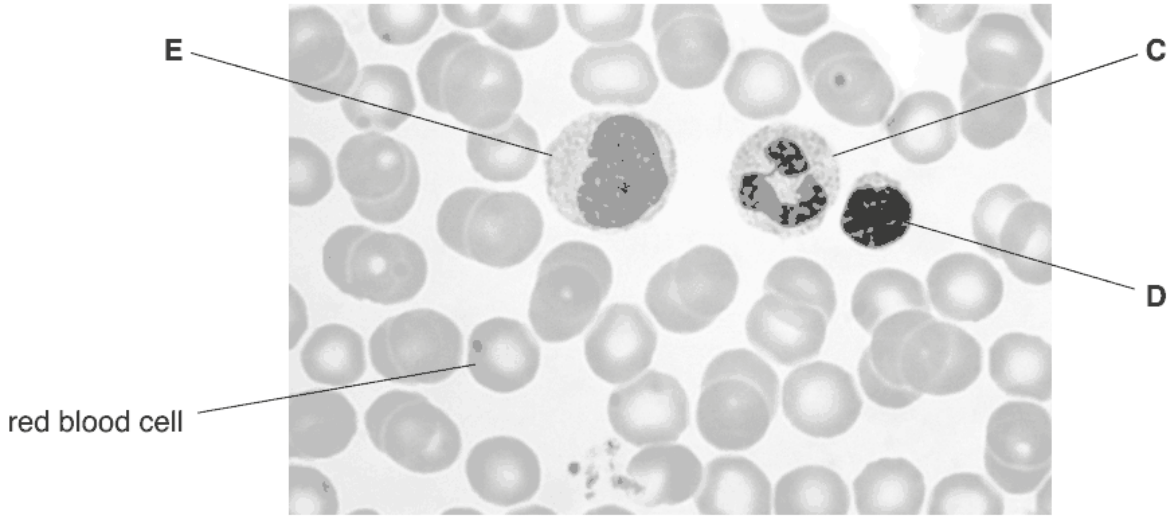


Fig. 3.1

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

C .....

D .....

E ..... [3]

Question 16 · Paper 2 · May/June 2024 (21) · Q2(a) · 3 marks

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

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

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Question 17 · information from earlier in the question

1 The wall of the small intestine is highly folded to form villi. Between the villi are infoldings known as crypts of Lieberkühn.

Fig. 1.1 is a diagram of a section through a single villus and a crypt of Lieberkühn.

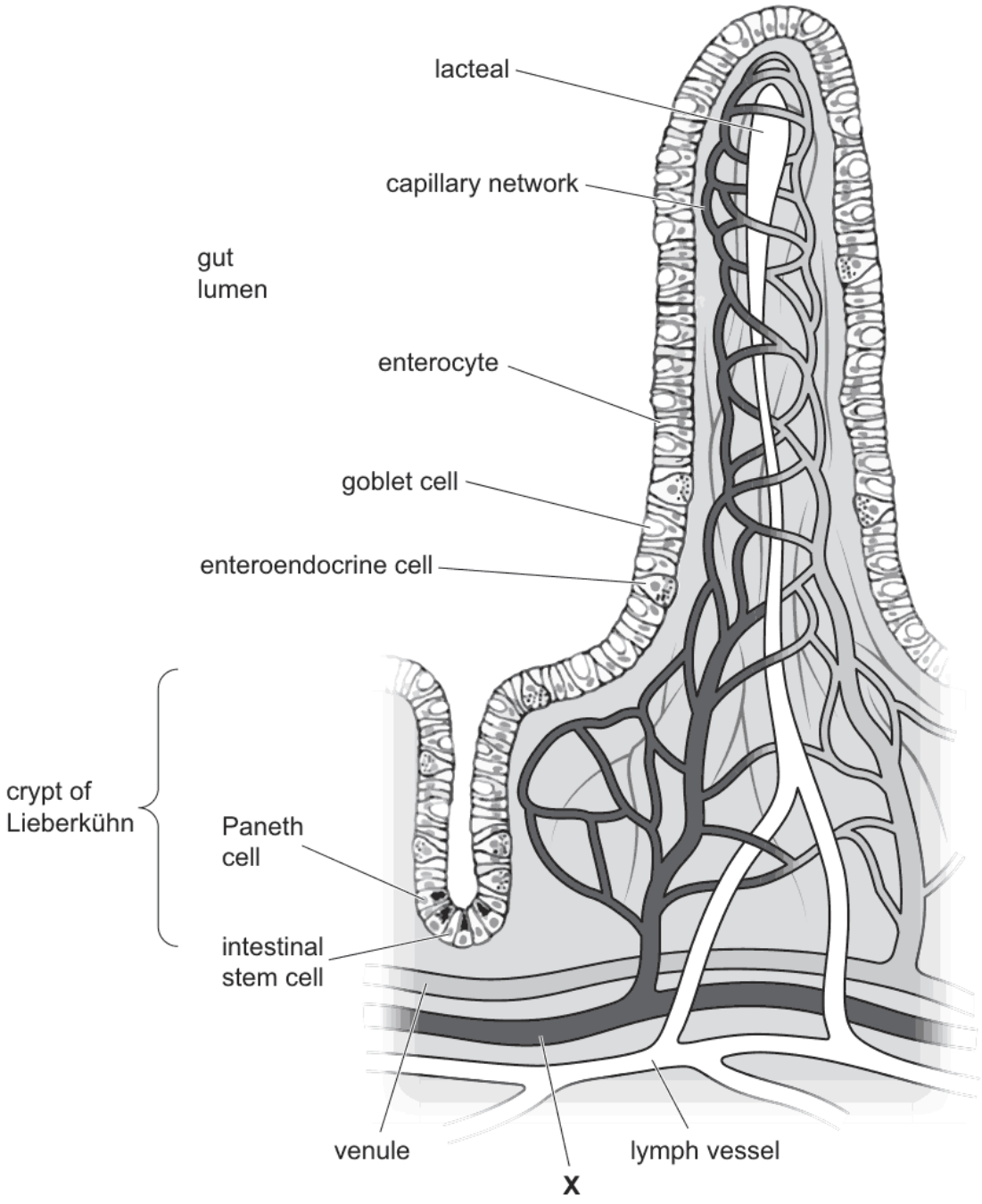


Fig. 1.1

Fig. 1.1 shows that the epithelium of the villus contains mainly goblet cells and cells known as enterocytes. Both cell types have microvilli on the apical surface (surface facing the gut lumen).

Goblet cells are involved in the production of mucus.

Enterocytes are adapted for the absorption of the soluble products of digestion. These products

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Question 17 · Paper 2 · October/November 2025 (22) · Q1(c)(i) · 1 mark

(c) In Fig. 1.1, blood vessel **X** delivers blood to the capillary network of the villus, where tissue fluid is formed. Some of the fluid passes back into the capillaries and then into the venule.

(i) Blood vessel **X** receives blood from an artery.

Name the type of blood vessel represented by **X**.

Question 18 · Paper 2 · October/November 2025 (22) · Q1(c)(ii) · 2 marks

(ii) Describe the formation of tissue fluid in the capillary network of the villus.

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2 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.

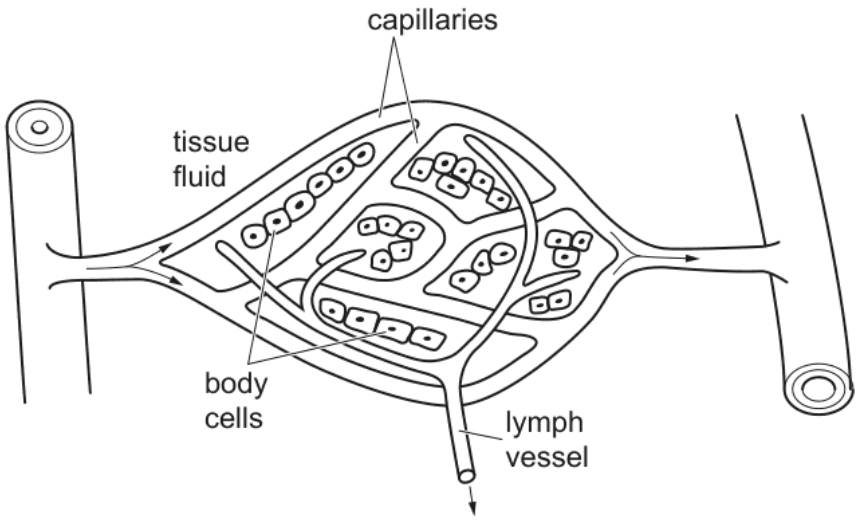


Fig. 2.1

(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.

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Question 20 · Paper 2 · October/November 2021 (22) · Q2(d) · 3 marks

(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.

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Question 21 · Paper 2 · May/June 2021 (22) · Q3(a)(i) · 3 marks

3 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.

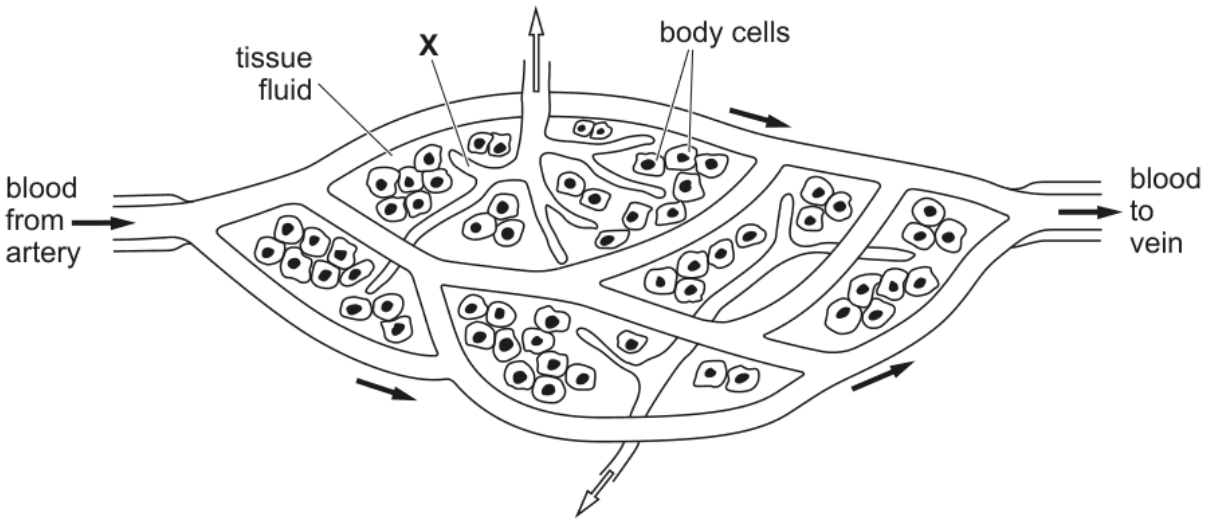


Fig. 3.1

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

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Question 22 · information from earlier in the question

(b) People with sickle cell anaemia may need a blood transfusion.

One risk associated with a blood transfusion is a condition known as transfusion-associated circulatory overload (TACO). TACO is caused by a large increase in blood volume over a short period of time. This increase in blood volume can be harmful.

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Question 22 · Paper 4 (A level) · February/March 2022 (42) · Q3(b)(ii) · 1 mark

(ii) One feature of TACO is an increase in fluid entering the alveoli, which makes it difficult to breathe. This increase in fluid can be caused by an increase in blood pressure in the pulmonary capillaries that surround the alveoli.

Suggest how an increase in blood pressure in the pulmonary capillaries can cause fluid to enter the alveoli.

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Mark schemes

Question 1 · Paper 2 · October/November 2022 (22) · Q1(a) · 3 marks

1(a)	pulmonary (circulation) ; systemic (circulation) ; **R** systematic vena cava / inferior vena cava / superior vena cava ; **A** venae cavae	**3**

Question 2 · Paper 2 · October/November 2022 (22) · Q1(b) · 1 mark

1(b)	venule / venules ;	**1**

Question 3 · Paper 2 · May/June 2021 (22) · Q4(e) · 2 marks

4(e)	*any two from* 1 <u>only</u> oxygenated blood passes through left side of heart **ora** **or** oxygenated blood in left side and deoxygenated blood in right side of heart ; 2 septum in heart separates (oxygenated and deoxygenated) blood ; 3 oxygenated blood is in pulmonary, venules / veins <u>and</u> deoxygenated blood is in, pulmonary arteries / arterioles ; 4 (because mixing prevented by) double circulation / double circulatory system / pulmonary and systemic circulations ;	**2**

Question 4 · Paper 2 · May/June 2022 (22) · Q3(c) · 1 mark

3(c)	<u>closed, double</u> (circulation / circulatory system) ;	**1**

Question 5 · Paper 2 · May/June 2022 (22) · Q3(e) · 3 marks

3(e) *note: only one mark for both pulmonary vessels* **3**

function of blood vessel	name of blood vessel
carries blood from the heart to the lungs	pulmonary, artery / arteries ; pulmonary, vein / veins
carries blood to the heart from the lungs	
carries blood from the heart to the rest of body	<u>aorta</u> ; **I** artery
carries blood to the heart from the rest of body	**I** superior and inferior or anterior and posterior **I** vein venae cavae / vena cava ;

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Question 6 · Paper 2 · October/November 2023 (22) · Q3(a) · 1 mark

3(a)	aorta / dorsal aorta ; *correct spelling needed*	1

Question 7 · Paper 2 · May/June 2024 (21) · Q2(b)(i) · 1 mark

2(b)(i)	**P** - aorta **A** dorsal aorta **Q** - vena cava ; **I** superior and inferior	1

Question 8 · Paper 2 · May/June 2024 (21) · Q2(b)(ii) · 2 marks

2(b)(ii)	**1** aorta / **P**, transports / delivers / AW, oxygenated blood to the, organs / body / respiring tissues / systemic circulation **or** aorta / **P**, transports / AW, blood at high pressure to, organs / body / respiring tissues / systemic circulation ; **2** vena cava / **Q**, transports / returns / AW, deoxygenated blood to the, right atrium / heart (from systemic circulation) **or** vena cava / **Q**, transports / AW, blood at low pressure to the, right atrium / heart ; **A** vena cava / **Q**, collects blood from, veins / systemic circulation *alternative* **3** aorta / **P**, transports oxygenated blood and, vena cava / **Q**, transports deoxygenated blood ; **4** blood in aorta to, organs / body / respiring tissues / systemic circulation, and blood in vena cava to, right atrium / heart ;	2

Question 9 · Paper 2 · May/June 2024 (22) · Q1(c)(i) · 2 marks

1(c)(i)	*any **two** from:* wall, of one layer / is one cell thick ; **I** capillary is one cell thick **A** thin wall / endothelial cells are a single layer **A** endothelium is, a single layer (of cells) / one cell thick *idea that* red blood cells transported in single file ; *idea that* red blood cells diameter (approximately), as large / same, as capillary (lumen) ; **A** if diameter (e.g. 7μm) stated as being similar to capillary size *idea of* diameter of capillary narrower than smooth muscle cell ; AVP ; e.g. no muscle and elastic layer muscle fibres / elastic fibres / collagen, not present *ref. to* different shapes of red blood cell / red blood cell showing flexibility, to pass through (narrow) capillary	2

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Question 10 · Paper 2 · May/June 2024 (22) · Q1(c)(ii) · 3 marks

1(c)(ii)	*allow tissue fluid / fluid surrounding cells, instead of (smooth muscle) cells* *allow, blood / plasma, for capillary* *allow O_2 for oxygen and CO_2 for carbon dioxide* *any **three** from:* *capillary function* **1** named, substance / type of substance, that is supplied to smooth muscle cells or is a product removed from the cells **;** e.g. (supply) oxygen / nutrients / glucose / amino acids / cell-signalling molecule e.g. (removes) carbon dioxide / lactic acid / waste **A** exchange of respiratory gases (between capillary and cells) **I** plasma proteins into tissue fluid *structure to function* **2** thin wall / AW, so short distance **;** **R** capillary is thin **3** endothelial pores / fenestrations, for more efficient passage / AW **;** **A** gaps, between / within, (endothelial) cells (of capillary wall) **A** increases, quantity / rate of supply (of substances) **A** endothelial pores for formation of tissue fluid (around cells) **R** if blood leaves to make tissue fluid **4** (endothelial) pores / AW, for passage of, phagocytes / monocytes / macrophages / neutrophils **;** **5** small (size) / narrow diameter, to reach cells / so (all) cells are close **;** **A** value in range 5–10 μm **A** small size / narrow lumen, slows (rate of) blood flow **6** detail about red blood cell and, respiratory gases / gas exchange / oxygen / carbon dioxide **;** e.g. narrow lumen slows red blood cell movement for uptake of oxygen slows red blood cell movement to increase time for exchange of gases only one red blood cell fits (at a time) so short diffusion distance red blood cells are close to (muscle) cells for gas exchange red blood cells squeeze through, (so) distance for oxygen to reach cells is minimised	**3**

Question 11 · Paper 2 · February/March 2023 (22) · Q5(c) · 3 marks

5(c)	(the tunica media of aorta) contains, more elastin / more elastic fibres / more elastic tissue / less smooth muscle, than the muscular artery **; ora** *plus any **two** from:* allows the aorta to stretch / aorta less likely to burst (as a result of high blood pressure) **;** during ventricular contraction / systole **;** (after stretching) the aorta recoils **;** maintains high blood pressure **;** evens out the flow of blood / AW **;**	**3**

Question 12 · Paper 2 · October/November 2023 (22) · Q5(e) · 3 marks

5(e)	*any **three** from:* *allow elastic tissue for elastic fibres* 1 loss of / damage to, elastic fibres (and smooth muscle) from tunica media **;** **A** scar tissue replaces, elastic fibres / smooth muscle, in tunica media **A** middle layer for tunica media 2 loss of / damage to, collagen (fibres), in / damage to, tunica, externa / adventitia **;** **A** outer layer for tunica, externa / adventitia *mp1 and mp2 if layers not named, use diagram to confirm location of elastic fibres in (thicker) middle layer and collagen fibres in (thinner) outer layer* *any **two** from mp3-5* **;** 3 cannot withstand, high pressure / increase in pressure / pressure of blood **;** 4 overstretching / over-expansion / described **; A** cannot, stretch / expand 5 impaired / poor / no / AW, recoil **;** *in context of loss of elastic fibres*	**3**

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Question 13 · Paper 2 · May/June 2023 (21) · Q5(a) · 2 marks

5(a)	*any **two** from:* no nucleus ; no organelles / uniform appearance / homogenous cytoplasm ; (some are) biconcave shape / described ; **A** cells have different shapes same, width / size, as the lumen of the capillary ; **A** same width as capillary / diameter of cells is 6 - 7 μm **R** colour / shading / AW	**2**

Question 14 · Paper 2 · May/June 2023 (21) · Q5(b) · 3 marks

5(b)	*any **three** from:* **1** (wall is) thin / one cell thick / 1–2 μm in thickness ; **R** 'thin cell wall' ***I*** tunica intima **2** *ref. to*, endothelial cells / endothelium ; ***I*** squamous / epithelium **3** short distance for diffusion ; **4** endothelial pores / fenestrations **or** pores / gaps, between / within, (endothelial) cells of the wall ; **5** for passage of, (named) small molecules / AW, from / to, plasma / blood / tissue fluid ; **A** phagocytes **A** ultrafiltration **6** AVP ; *ref. to* pinocytosis across endothelial cells	**3**

Question 15 · Paper 2 · May/June 2019 (22) · Q3(a) · 3 marks

3(a)	**C** =neutrophil ; **A** polymorphonuclear leucocyte **A** basophil **A** eosinophil **D** = lymphocyte ; B / T *is neutral* **E** = monocyte ; **A** macrophage ***I*** *leucocyte / white blood cell, throughout*	**3**

Question 16 · Paper 2 · May/June 2024 (21) · Q2(a) · 3 marks

2(a)	*any **three** from:* **1** water is a, good / universal / AW, solvent ; **A** dissolves many substances / description of solvent action **A** solvent for / dissolves, (named) ions **and** (named) polar molecules **2** transport of one named substance for a correct reason ; e.g. urea for excretion **3** high specific heat capacity ; **A** a full description e.g. the amount of heat that must be added to, one unit of mass of the substance / 1 gram *or* 1 cm^3 of water, to increase the temperature by, one unit / 1 °C **4** so temperature of blood remains (fairly) constant / heat is dispersed throughout the body ; *must be linked to mp**3*** **I** temperature of water is constant AVP ; e.g. water is (di)polar	**3**

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Question 17 · Paper 2 · October/November 2025 (22) · Q1(c)(i) · 1 mark

1(c)(i)	arteriole ; **A** (small) artery	**1**

Question 18 · Paper 2 · October/November 2025 (22) · Q1(c)(ii) · 2 marks

1(c)(ii)	*any **two** from:* (at arteriole end of capillary) high, hydrostatic / blood, pressure ; **A** *ref. to* hydrostatic pressure gradient (ultra)filtration / described ; e.g. fluid / plasma / water and solutes, forced / comes out of, capillaries / blood glucose / amino acids / ions, leave (blood) **or** (large / plasma) proteins remain (in blood) ; **R** if stated, red blood cells / platelets, leave through, fenestrations / fenestrae / endothelial pores **or** pores / gaps / spaces, in, capillary wall / endothelium / between cells ;	**2**

Question 19 · Paper 2 · October/November 2021 (22) · Q2(a) · 2 marks

2(a)	too large / large size ; **A** not small enough cannot pass through endothelial, pores / gaps **I** holes **A** fenestrations / AW **or** cannot, pass across / cross the membranes of, endothelial cells ; **A** epithelial cells *in context of entering an endothelial cell and exiting to the tissue fluid*	**2**

Question 20 · Paper 2 · October/November 2021 (22) · Q2(d) · 3 marks

2(d)	*any **three** from:* **A** Ψ for water potential **A** plasma for blood *mp1 and mp2 = consequence in blood of lower blood albumin than normal* **1** *idea that* low blood albumin means, less / AW, solute ; **2** (so) higher water potential (in blood); *must be in context of blood context can be anywhere along the capillary* **A** high water potential *if ref. to low albumin is made* **A** steeper water potential gradient (than normally, at arterial end) *mp3 and mp4 = return of water to blood from tissue fluid (capillary venous end)* **3** less steep water potential gradient (than normal) / little difference in water potentials ; **4** less / little, water returns to, blood / capillary (from tissue fluid) ; **A** (tissue) fluid *for water* **R** plasma *for water* *additional ideas* **5** *idea that* more, water / plasma / fluid, enters tissue fluid (than normal) **R** tissue fluid *for fluid* **A** more, water / fluid, enters tissue fluid than exits (to the capillary or lymph system) ; *(compared to normal)* **6** AVP ; e.g. water can enter tissue fluid for a longer time than normal less albumin than normal to act as an osmotic force for return of water / AW too much excess, water / fluid / tissue fluid, to be taken up into lymph, capillaries / vessels / system	**3**

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Question 21 · Paper 2 · May/June 2021 (22) · Q3(a)(i) · 3 marks

3(a)(i) — **3**

accept from either column for mark and assume blood if not stated
any three from

blood	**tissue fluid**	
has red blood cells	has no red blood cells	;
more, white blood cells / leucocytes / named e.g. neutrophils, lymphocytes, monocytes **or** fewer macrophages	fewer white blood cells / leucocytes / named e.g. neutrophils, lymphocytes, monocytes **or** more macrophages	;
has platelets	has no platelets	;
has, more protein / large proteins **or** has, plasma proteins / named example e.g albumin / fibrinogen / globulin *these are large proteins*	has, fewer / no large, proteins **or** has no, plasma proteins / named example e.g. albumin / fibrinogen / globulin *only allow fewer plasma proteins if clear the proteins present are small enough to leave blood*	;
higher, concentration / AW, oxygen **A** more oxygenated	lower, concentration / AW, oxygen **A** less oxygenated	;
higher, concentration / AW, glucose / amino acids / fatty acids	lower, concentration / AW, glucose / amino acids / fatty acids	;
lower, concentration / AW, carbon dioxide **A** urea, in liver / muscles **I** waste	higher, concentration / AW, carbon dioxide **A** urea, in liver / muscles **I** waste	;
higher pressure	lower pressure	;

Question 22 · Paper 4 (A level) · February/March 2022 (42) · Q3(b)(ii) · 1 mark

3(b)(ii)	*idea that* fluid / water, is forced (from blood) into alveoli ; **R** diffusion / osmosis	**1**

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