30 Which statement correctly compares blood plasma and tissue fluid in a healthy person?

A Blood plasma contains more protein than tissue fluid.

B Both blood plasma and tissue fluid contain red blood cells.

C Tissue fluid contains white blood cells whereas blood plasma does **not** contain lymphocytes.

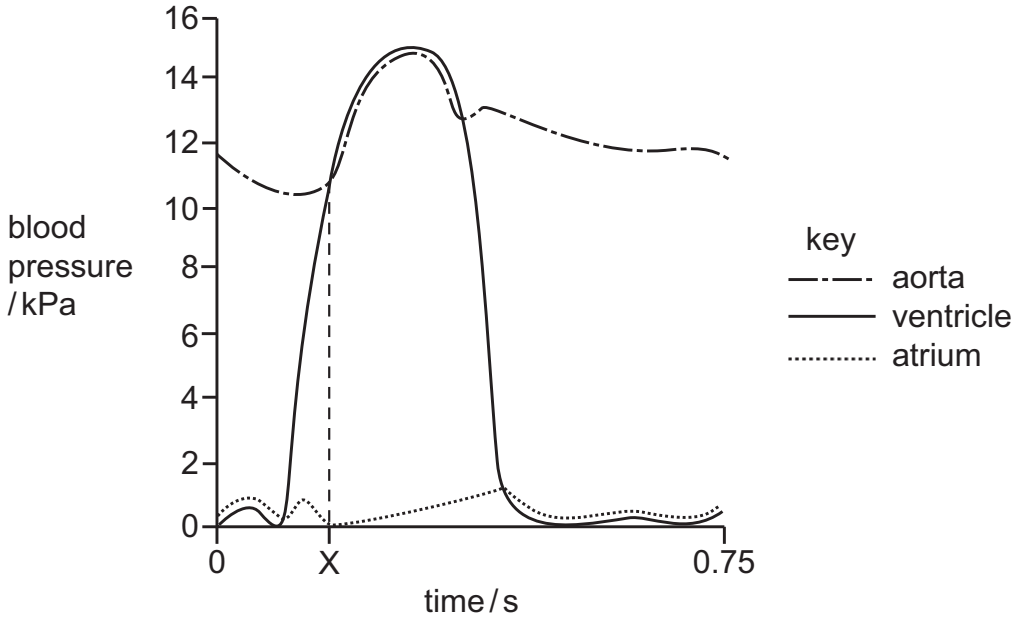
D Tissue fluid is formed from blood plasma and is **not** returned to blood plasma.

31 The body maintains an average normal blood pH of 7.4.

Which row describes the conditions that would increase the dissociation rate of haemoglobin the most during periods of intense exercise?

	blood pH	blood CO_2 partial pressure / kPa
A	7.2	5.6
B	7.2	9.5
C	7.6	5.6
D	7.6	9.5

32 The graph shows changes in blood pressure during one cardiac cycle.



What is happening at time X?

	aortic semilunar valve	atrium
A	closing	emptying
B	closing	filling
C	opening	emptying
D	opening	filling

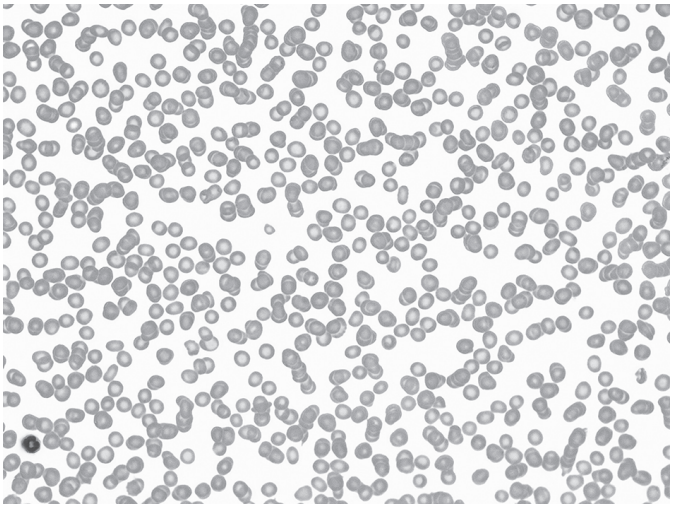
33 How many times must a carbon dioxide molecule pass through a cell surface membrane to travel from the tissue fluid into the blood plasma?

(Assume there are no pores between the cells the carbon dioxide molecule must pass through.)

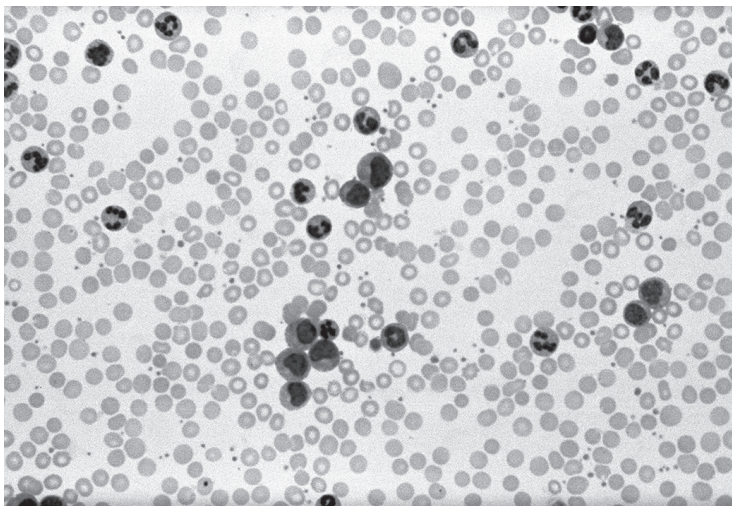
A 1 **B** 2 **C** 3 **D** 4

32 The photomicrographs show blood smears from two different people. Person J does **not** have a disorder that affects their blood. Person K does have a disorder that affects their blood.

person J



person K



The table shows some disorders that increase or decrease the number of neutrophils, red blood cells or lymphocytes.

	disorders related to blood count changes	
	increase	decrease
neutrophil	chronic inflammation	autoimmune neutropenia
red blood cell	heart failure	anaemia
lymphocyte	chronic leukaemia	sepsis

Which disorder does person K have?

A autoimmune neutropenia

B heart failure

C sepsis

D chronic leukaemia

2 **(a)** Haemoglobin is a globular protein containing haem groups.

Explain how the presence of haem groups allows the haemoglobin molecule to transport oxygen.

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(b) In certain situations, such as during intense exercise, a person may breathe very quickly and deeply. This is known as hyperventilation.

This hyperventilation causes more carbon dioxide to be exhaled. As a result, there is a lower concentration of carbon dioxide in the blood that passes through the capillary network in respiring tissues. This increases the affinity of haemoglobin for oxygen so that there is a decrease in the release of oxygen from red blood cells.

Explain why a decrease in the concentration of carbon dioxide in the blood passing through respiring tissues leads to a decrease in the release of oxygen from red blood cells.

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(c) Fig. 2.1 is a diagram of a section through the heart.

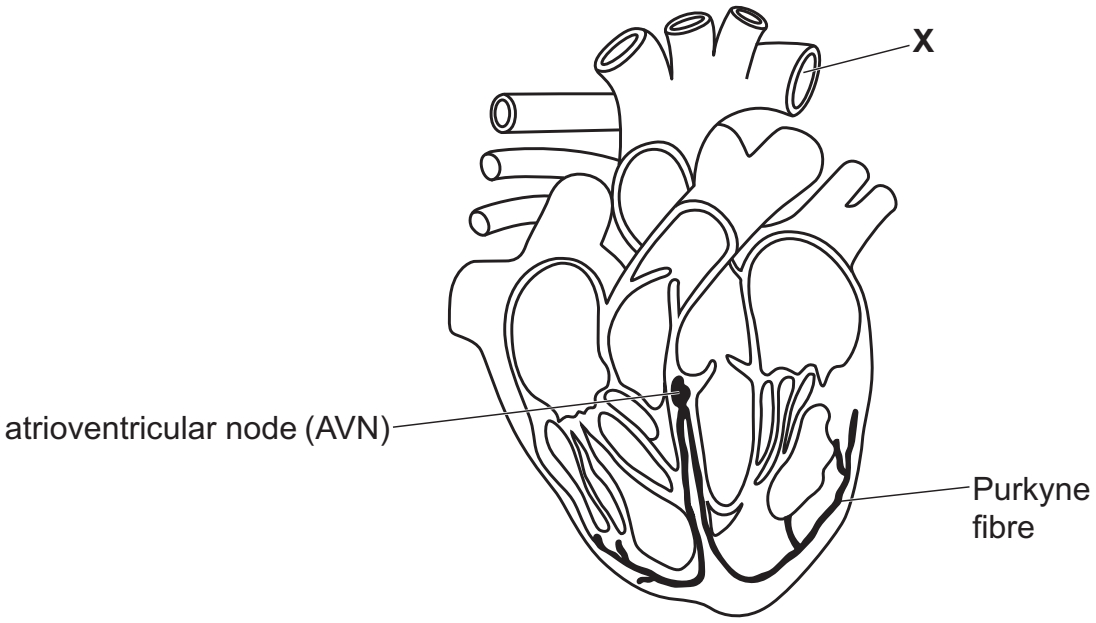

Fig. 2.1

(i) Describe and explain how the tunica media (middle layer of the wall) of blood vessel **X** adapts the blood vessel for its function.

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(ii) Describe the role of the atrioventricular node (AVN) and the Purkyne tissue in the cardiac cycle.

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[Total: 12]

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.

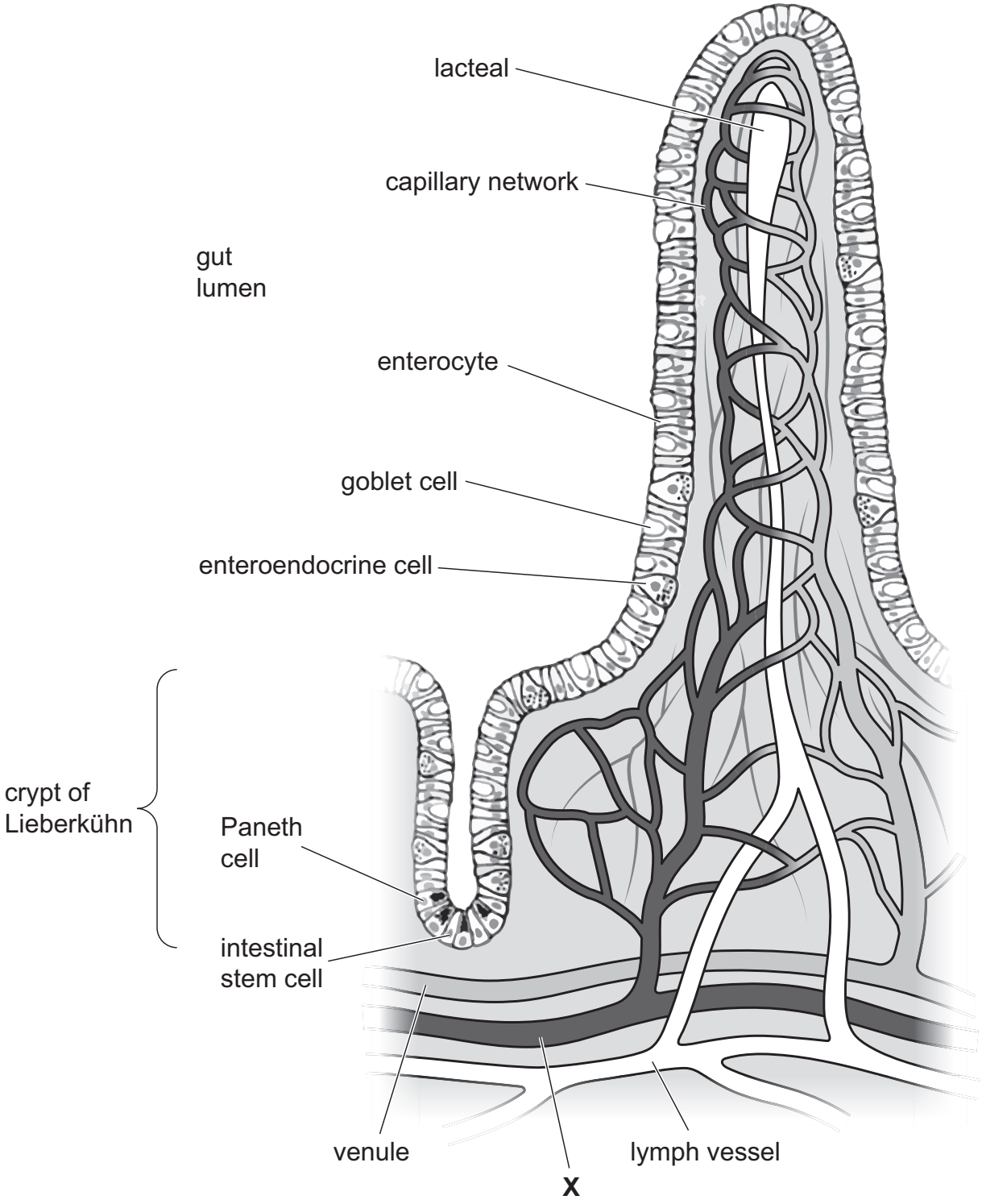

Fig. 1.1

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 enter the circulatory system.

(a) A student incorrectly stated that an enterocyte has many **cilia** on its apical surface.

Explain the difference between a cilium and a microvillus.

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(b) Suggest **one** role of the mucus produced by the goblet cells of the villus.

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(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**.

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

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(d) In response to the presence of compounds in the gut lumen, enteroendocrine cells synthesise and release peptides (short chains of amino acids) that are cell-signalling molecules. One of these cell-signalling molecules is known as GLP-1.

GLP-1 initiates a number of responses in different body cells. Some of these responses include:

- the increase in release of the hormone insulin from cells in the pancreas
- the decrease in release of acid from cells in the stomach.

Outline, **in sequence**, the main stages involved in the process of cell signalling by GLP-1.

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(e) Paneth cells, which are secretory cells, are located between intestinal stem cells at the base of the crypt of Lieberkühn, as shown in Fig. 1.1.

A Paneth cell has a very different appearance to an intestinal stem cell.

Fig. 1.2 is a transmission electron micrograph of a Paneth cell.

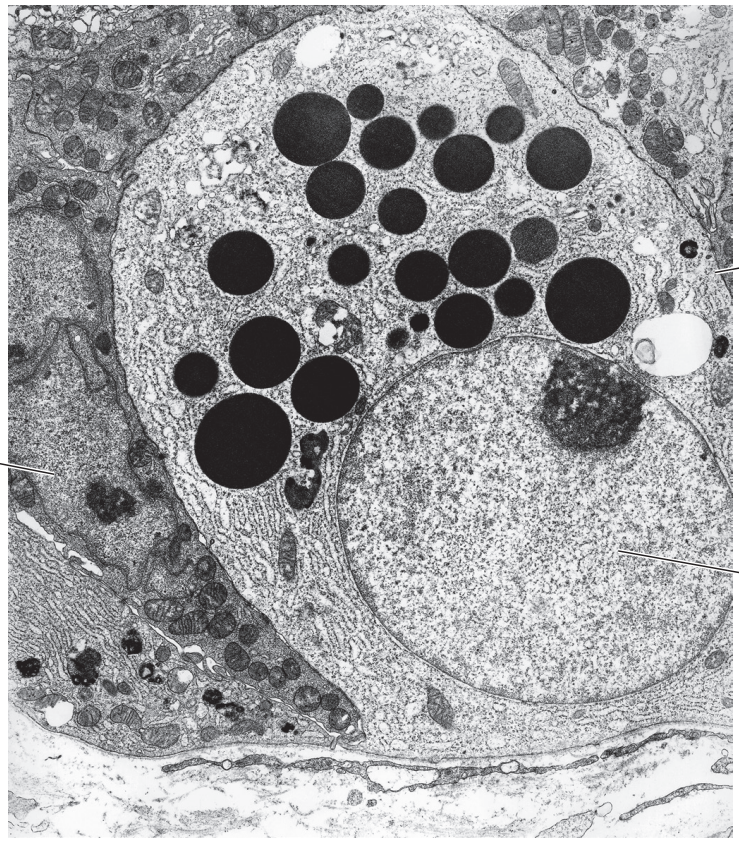

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Fig. 1.2

(i) Paneth cells are formed following the mitotic division of an intestinal stem cell during a cell cycle.

Complete the cell cycle shown in Fig. 1.3 by naming, **in sequence**, the stages of mitosis.

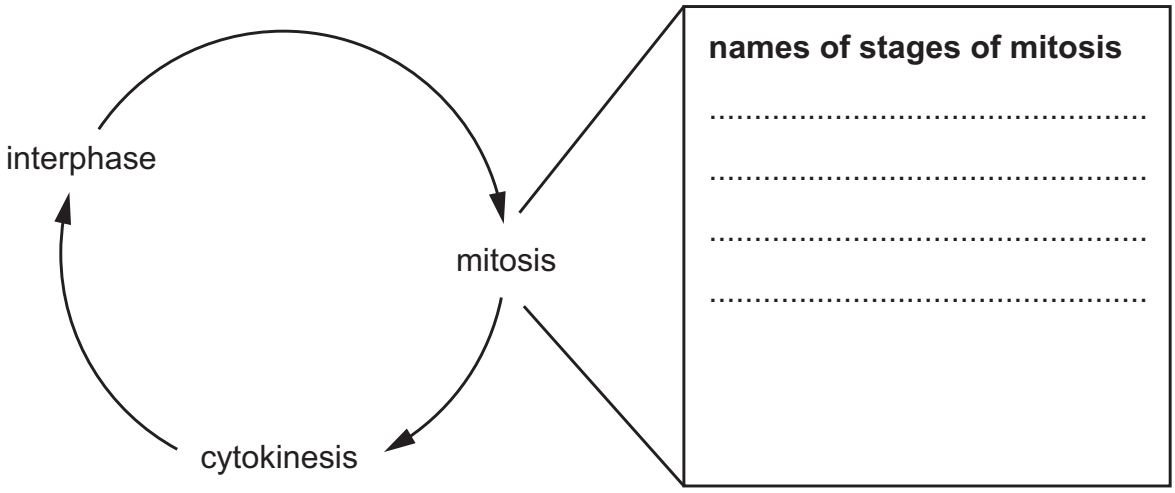

Fig. 1.3

[1]

(ii) One of the functions of a Paneth cell is to synthesise and secrete peptides and proteins that act against pathogens in the gut lumen.

State **and** explain the evidence, **visible in Fig. 1.2**, which suggests that a Paneth cell:

- is a secretory cell
- synthesises many peptides and proteins.

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(iii) Explain why a Paneth cell has a very different appearance to an intestinal stem cell.

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[Total: 14]

6 In the pulmonary circulation of a mammal, deoxygenated blood becomes oxygenated when red blood cells pass through alveolar capillaries and haemoglobin within the cells combines with oxygen.

The blood returns to the heart to be pumped around the systemic circulation.

(a) Describe the sequence of events occurring in the heart that allows blood returning in the pulmonary circulation to then enter the systemic circulation.

You should include in your description:

- the names of the relevant blood vessels of the pulmonary circulation and systemic circulation that are connected to the heart
- reference to blood pressure changes that cause the opening and closing of valves.

You **do not** need to include details of control of the cardiac cycle.

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(b) Fig. 6.1 is a drawing of a haemoglobin molecule to show its globular structure.

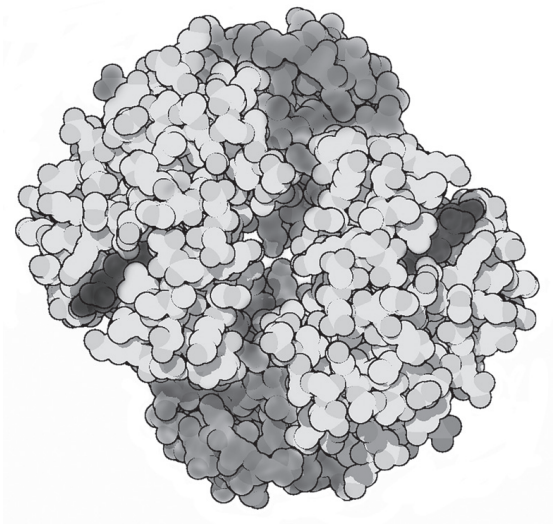

Fig. 6.1

(i) Describe the quaternary structure of a haemoglobin molecule.

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(ii) Outline how a haemoglobin molecule can become fully saturated with oxygen to form oxyhaemoglobin.

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[Total: 9]