Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2682797581

BIOLOGY **9700/22**

Paper 2 AS Level Structured Questions **May/June 2022**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **16** pages.

DC (CE/SG) 302736/1

1 Epithelial cells in the small intestine have cell structures known as microvilli. The microvilli of these cells are found only on the surface that borders the gut lumen.

Fig. 1.1 shows images of microvilli of intestinal epithelial cells. These images have been obtained using a scanning electron microscope and a transmission electron microscope.

Fig. 1.1**A** is at a different magnification to Fig. 1.1**B**.

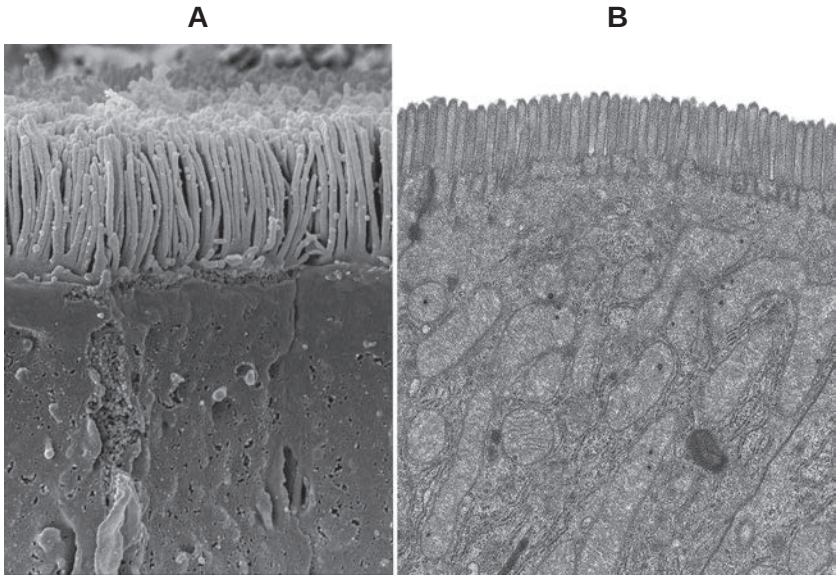

Fig. 1.1

(a) With reference to Fig. 1.1, state how it is possible to distinguish between a scanning electron micrograph and a transmission electron micrograph.

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..... [1]

(b) The approximate length of a microvillus is 1 μm.

Outline the method you would use to estimate the magnifications of the images shown in Fig. 1.1.

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..... [2]

(c) One role of an intestinal epithelial cell is the absorption of glucose from the gut lumen into the circulatory system. This involves different membrane transport proteins.

The events occurring in an intestinal epithelial cell during the absorption of glucose are summarised in Fig. 1.2.

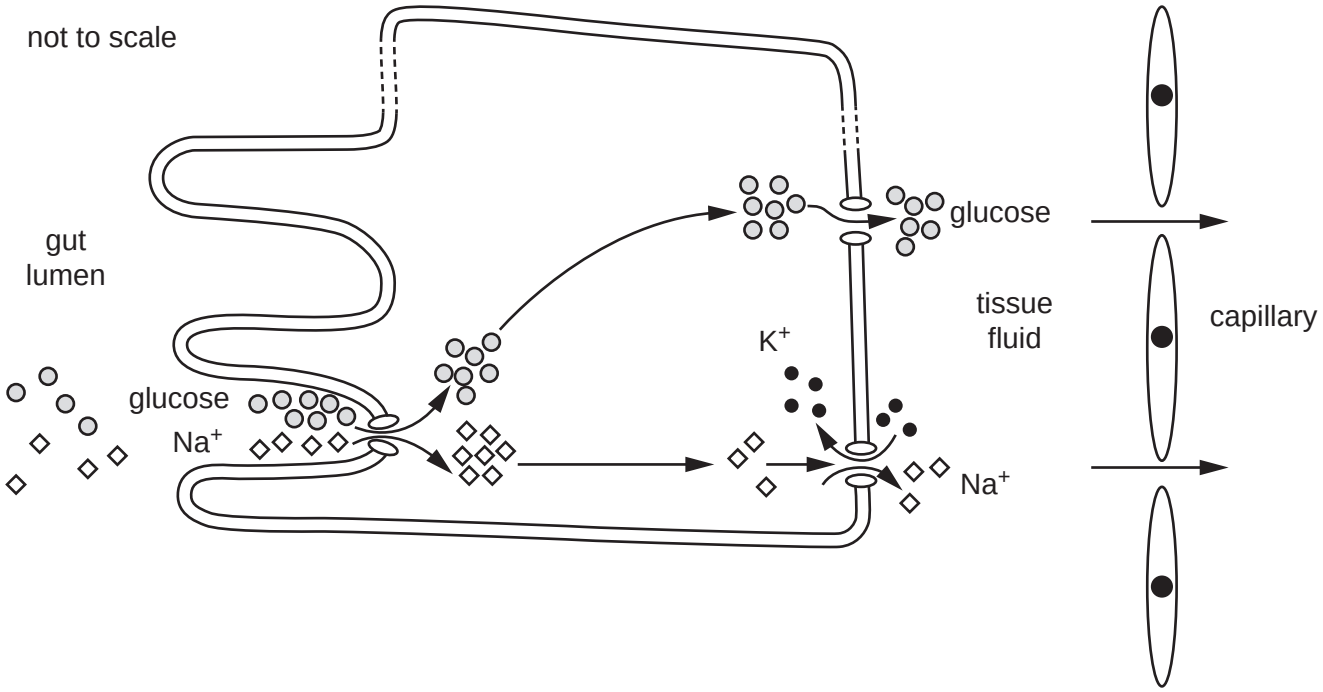

Fig. 1.2

- Sodium ions (Na^+) are removed from the cell by active transport through a transport protein known as a sodium-potassium (Na^+/K^+) pump.
- This decreases the concentration of Na^+ in the cell compared to the gut lumen.
- Glucose molecules are cotransported with Na^+ into the cell from the gut lumen.
- Glucose molecules are transported out of the cell into the tissue fluid down a concentration gradient.

(i) Active transport involves water-soluble substances, such as Na^+ and K^+, and the use of ATP to provide the energy needed for their transport through carrier proteins.

Outline **other** features of active transport.

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..... [2]

(ii) Glucose molecules enter the cell through a membrane protein.

Suggest why glucose molecules need to be cotransported with Na^+ when it enters the cell through the membrane protein.

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(iii) Explain how microvilli increase the uptake of glucose into an intestinal epithelial cell.

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(d) Stem cells are also located in the wall of the small intestine. These cells divide by mitosis continuously.

Suggest **and** explain the importance of mitosis by stem cells in the small intestine.

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..... [4]

[Total: 13]

2 Cholera is a life-threatening and infectious disease caused by the bacterium *Vibrio cholerae*. One of the symptoms of the disease is severe diarrhoea.

V. cholerae O1 and *V. cholerae* O139 are the two forms of the pathogen that are associated with cholera epidemics (large outbreaks). These two forms have different antigens that can be detected.

(a) If an outbreak of cholera is suspected but not confirmed, a standard home treatment for diarrhoeal diseases can be used immediately to help prevent severe illness as a result of dehydration. If cholera is the cause of the disease, this standard treatment also helps to prevent a larger outbreak of the disease.

(i) Outline the standard treatment that can be used for suspected cholera cases.

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(ii) Suggest **and** explain why this treatment can help to prevent a larger outbreak of cholera.

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(b) Rapid diagnostic testing (RDT) can be used to diagnose cholera by detecting the presence of *V. cholerae*. One type of RDT involves using a dipstick that contains mobile and immobilised monoclonal antibodies.

Monoclonal antibodies (mAbs) are specific in their action.

Fig. 2.1 shows a simplified diagram of an RDT dipstick that can be used to distinguish between *V. cholerae* O1 and *V. cholerae* O139. A faecal sample from a person with suspected cholera is collected and added to a reagent solution to form the test mixture.

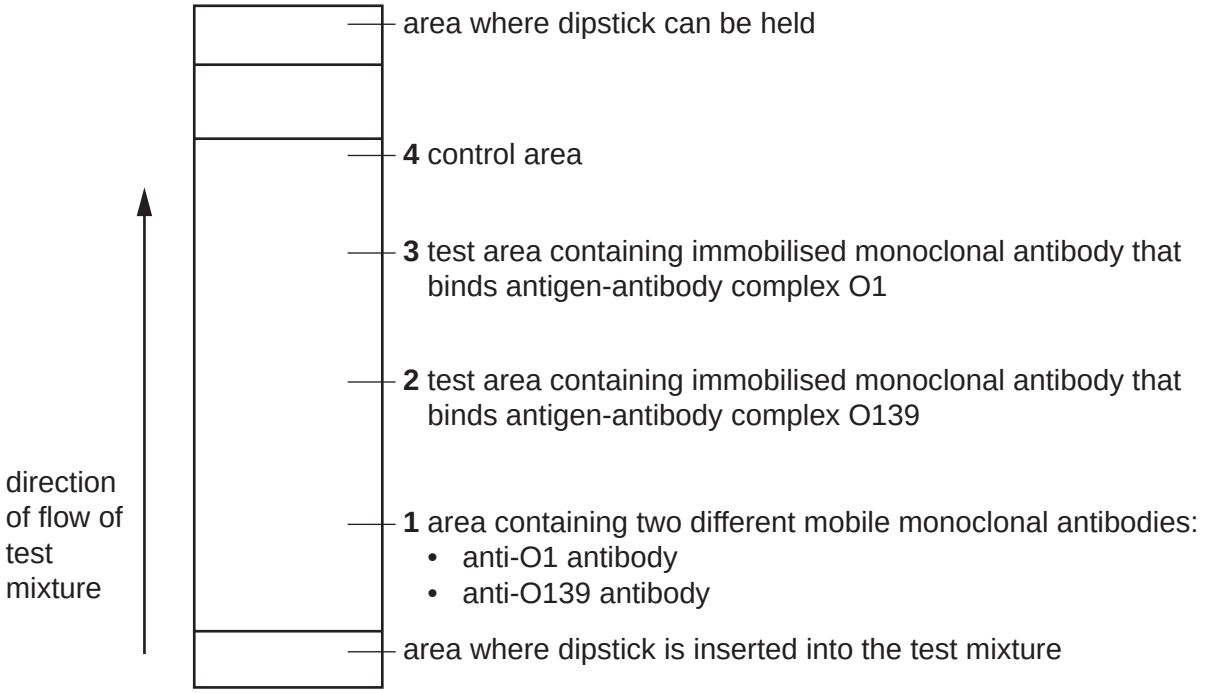

Fig. 2.1

The test mixture moves up the dipstick through area **1**. The mobile monoclonal antibodies are attached to tiny gold particles. If these antibodies collect in test area **2** or **3**, a coloured band becomes visible.

A coloured band that becomes visible in area **4** confirms that the test strip is working and that the results are valid.

(i) Explain how the structure of the monoclonal antibodies in the dipstick allows them to be specific in their action.

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..... [2]

(ii) Fig. 2.2 shows the results for samples taken from two different people, **A** and **B**, who are suspected of having cholera.

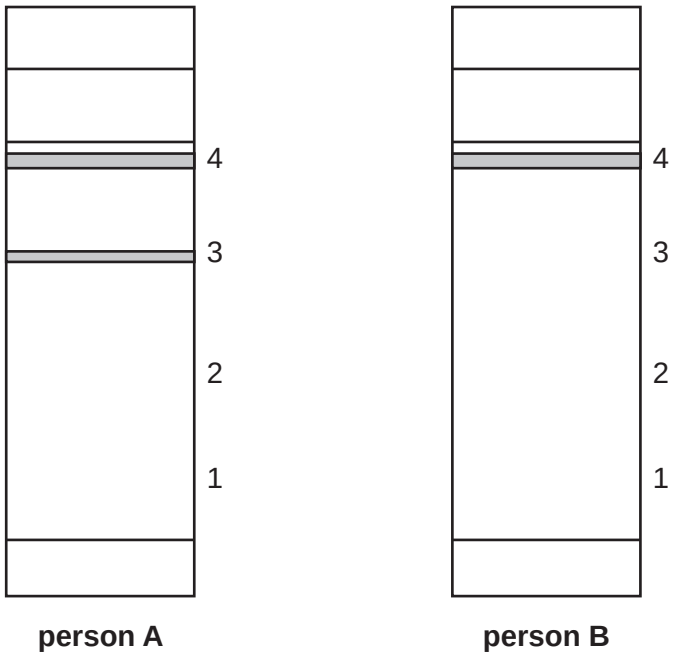

Fig. 2.2

With reference to Fig. 2.2, state **and** explain the conclusions that can be drawn from the results of the RDT dipsticks for each person.

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(c) Table 2.1 shows the results of an investigation to evaluate the effectiveness of an RDT dipstick in diagnosing cholera.

Samples taken from 156 people were tested using a dipstick and compared to the results obtained by culturing the pathogen in a laboratory for accurate identification.

Table 2.1

	number of test results		
	using culture techniques (to obtain accurate identification)	**using dipstick**	
		correct diagnosis	**incorrect diagnosis**
positive results for cholera	102	97	5
negative results for cholera	54	32	22

(i) With reference to Table 2.1, calculate the percentage chance of an RDT dipstick correctly confirming that a person with cholera has the disease.

[1]

(ii) Using an RDT dipstick to diagnose cholera is much cheaper than culturing the pathogen and requires less technical skill.

Suggest **one** additional advantage of using an RDT dipstick, rather than culture techniques, to diagnose cholera.

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..... [1]

[Total: 11]

3 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

(a) Nectar is a sugary liquid containing mainly sucrose, fructose and glucose.
Sucrose has the molecular formula $C_{12}H_{22}O_{11}$. Fructose and glucose each have the molecular formula $C_6H_{12}O_6$.

State **two** differences between sucrose and fructose, other than the number of carbon, hydrogen and oxygen atoms present.

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..... [2]

(b) In preparation for migration, sugars need to be converted to triglycerides to function as energy reserves. Hummingbirds can double their body mass during this time.

(i) Fig. 3.2 shows the structural formula of one type of storage triglyceride. The triglyceride has two types of fatty acid residue, palmitate and oleate.

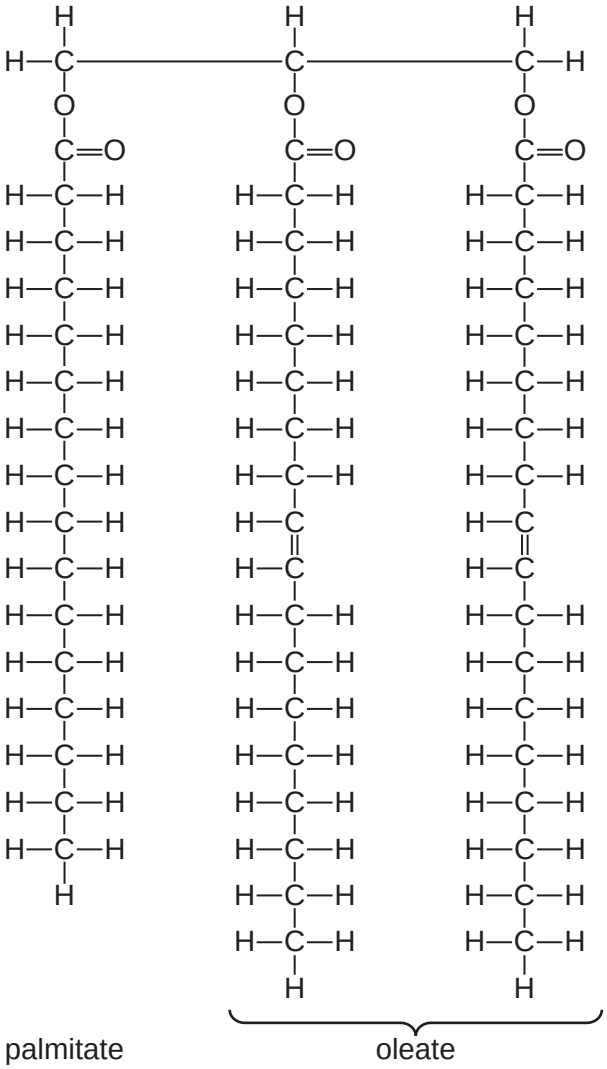

Fig. 3.2

Outline the features of the molecular structure of the triglyceride shown in Fig. 3.2.

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..... [3]

(ii) In hummingbirds, glycogen is the long-term carbohydrate energy store.

Suggest **one** reason why hummingbirds build up a greater energy store in the form of triglyceride, rather than a greater energy store of glycogen, in preparation for migration.

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..... [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]

(d) The heart of birds has the same structure as the heart of mammals. Compared with the heart of mammals, the heart of birds is larger in proportion to their body size.

Suggest why the heart of birds is larger in proportion to their body size.

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..... [2]

(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]

[Total: 12]

4 The enzyme carbonic anhydrase has been found in a wide range of organisms and acts as a catalyst in many tissues.

Studies have shown that there are differences in the protein structure of the enzyme and differences in the number and organisation of introns and exons of the gene coding for the enzyme.

All carbonic anhydrase enzymes catalyse the same reversible reaction, shown in Fig. 4.1.

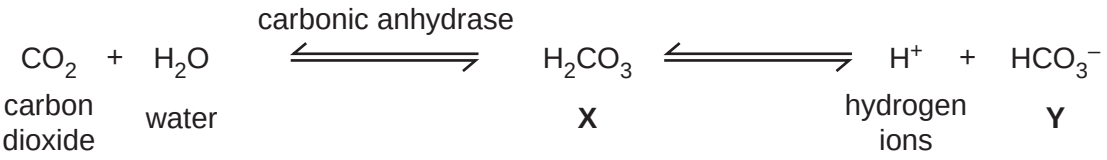

Fig. 4.1

(a) With reference to Fig. 4.1, name **X** and **Y**.

X .....

Y .....
[2]

(b) Carbonic anhydrase enzymes can have different primary structures.

Suggest how all carbonic anhydrase enzymes can catalyse the same reaction, even though they have different primary structures.

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..... [1]

(c) Genes coding for proteins in eukaryotes consist of introns and exons.

Outline the similarities and differences between the introns and the exons of genes coding for proteins such as carbonic anhydrase.

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..... [3]

All mammals have the same type of carbonic anhydrase, known as α-carbonic anhydrase. Many different forms, or isoforms, of α-carbonic anhydrase have been identified in mammals.

There are 15 isoforms of α-carbonic anhydrase (CA) in humans. Cells of different tissues have one or more isoforms. Within cells the isoforms may be in different locations.

(d) Red blood cells contain two isoforms, CA1 and CA2.

Suggest the location of CA1 and CA2 in red blood cells **and** give a reason for your answer.

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(e) Isoform CA6 forms part of human breast milk. Mammary gland cells package CA6 in Golgi vesicles for release from the cells.

Name the transport mechanism associated with CA6 secretion.

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(f) Human CA isoforms in some epithelial cells in the eye have a role in the formation of the clear fluid of the eye known as aqueous humour. Overactivity of the enzyme may lead to a harmful increase of pressure within the eye and cause a condition known as glaucoma.

Acetazolamide is a therapeutic drug that can be used in the treatment of glaucoma. It acts as a reversible non-competitive inhibitor.

Describe the mechanism of action of acetazolamide as a reversible non-competitive inhibitor of carbonic anhydrase.

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[Total: 12]

5 Fig. 5.1 is a photomicrograph of a transverse section through part of the bronchus of the human gas exchange system. The image is of a good resolution for a light microscope.

The bronchial epithelium is a single layer of cells lining the lumen of the bronchus.

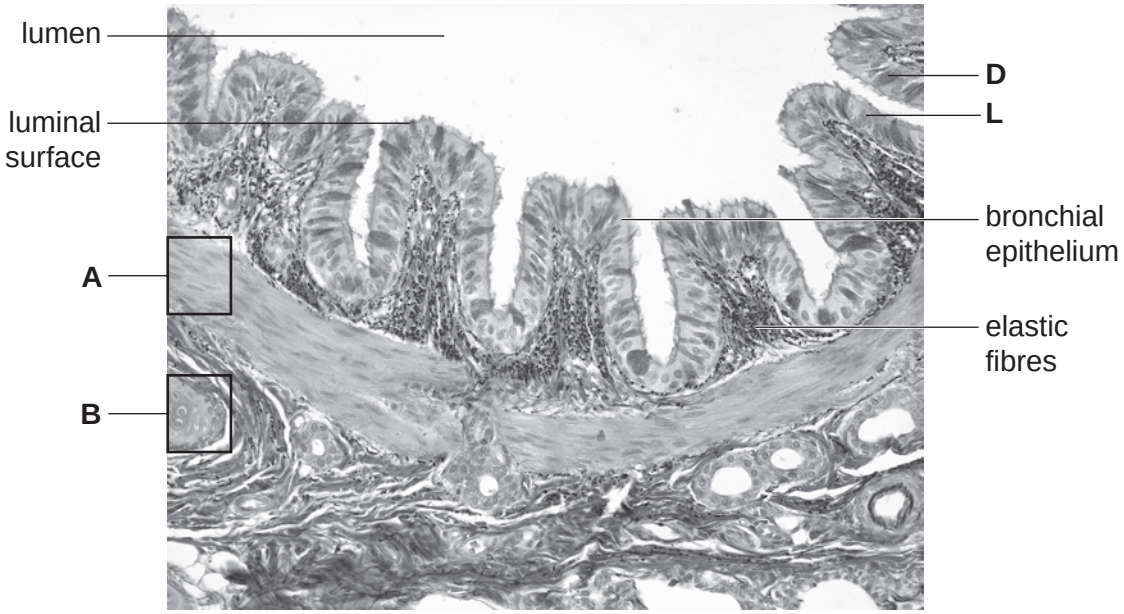

Fig. 5.1

(a) The luminal surface shown in Fig. 5.1 is not clearly defined and appears slightly blurred.

State why the luminal surface of the bronchial epithelium appears slightly blurred, even though the resolution of the image is good.

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..... [1]

(b) Some cells of the bronchial epithelium shown in Fig. 5.1 appear darker than others. For example, cell **D** appears darker than cell **L**.

With reference to the bronchial epithelium shown in Fig. 5.1, explain why some cells, such as cell **D**, appear darker and other cells, such as cell **L**, appear lighter.

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..... [2]

(c) In Fig. 5.1 the tissue in box **B** is cartilage.

The tissue shown in box **A** is different from the tissue in box **B**.

Outline the differences in the structure **and** function of tissue **A** compared with tissue **B**.

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..... [3]

[Total: 6]

6 The transport tissues of plants are phloem and xylem.

The role of xylem is the transport of water and mineral ions from the soil solution to the different parts of the plant body.

The role of phloem is the translocation of assimilates and other substances from sources to sinks.

(a) The source of mineral ions for the plant is the soil solution. These mineral ions are transported from the roots in the xylem. Mineral ions are also found in the phloem sap within phloem sieve tubes.

Suggest why mineral ions are found within phloem sieve tubes **and** state how they are transported within phloem sieve tubes.

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..... [3]

(b) Phloem tissue consists of different cell types.

Complete the passage using the most appropriate terms to summarise some of the features of phloem tissue.

The end walls of sieve tube elements are modified to allow efficient flow of phloem sap by the formation of ..... . These structures also prevent the cells from bursting under pressure. The cytoplasm of sieve tube elements is very much reduced and is found at the ..... of the cells. Most of the organelles in the cell are absent. Adjacent to sieve tube elements are ..... cells that carry out the metabolic processes of the missing organelles, allowing the sieve tube elements to function. [3]

[Total: 6]