The Gas Exchange System (9.1): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

22 questions · 50 marks · about 60 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · Paper 2 · May/June 2023 (22) · Q6(a) · 1 mark

6 The Weibel Lung model was developed after an extensive study of the gas exchange system. The model includes detailed measurements of airway diameters (lumen diameters of the airways). In the model, different parts of the gas exchange system are identified with a generation number, as outlined in Fig. 6.1.

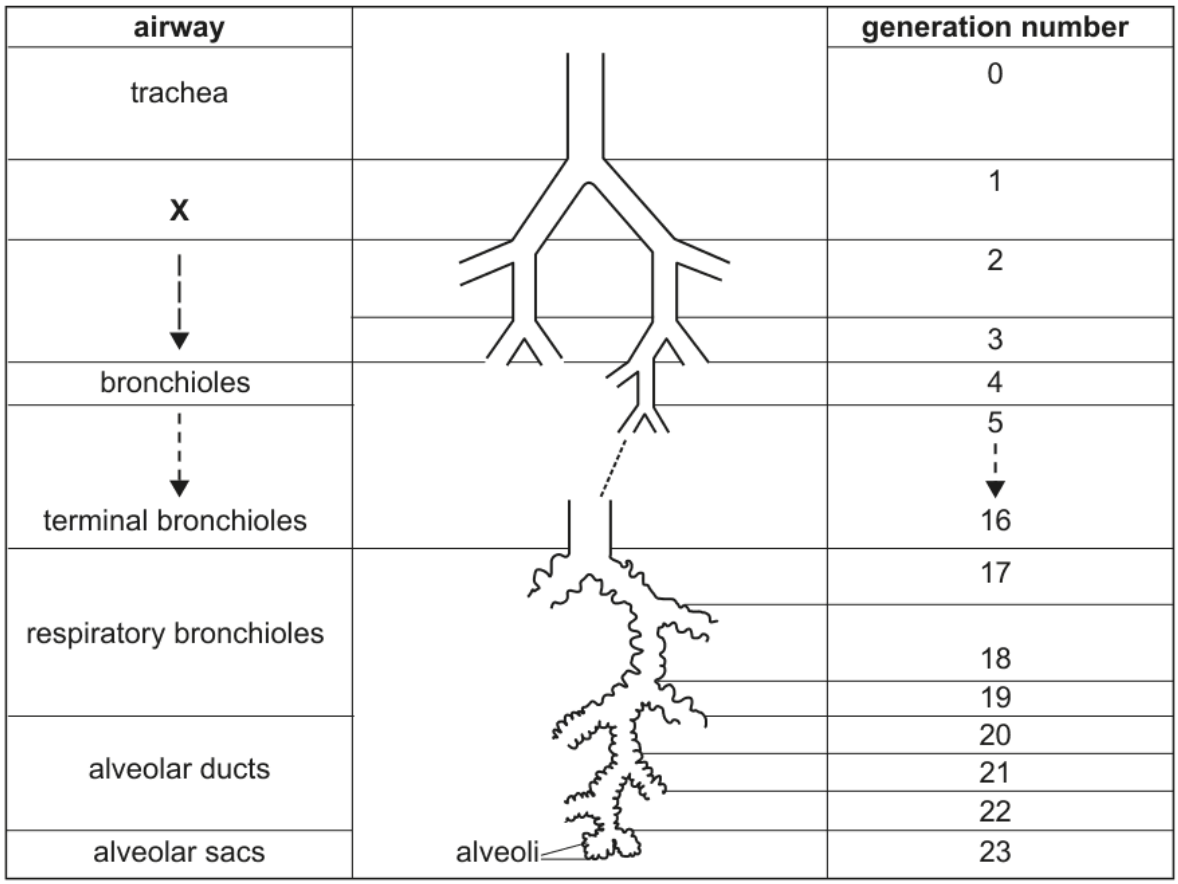


Fig. 6.1

(a) The Weibel Lung model describes how each airway divides into two.

Name the airways in generation 1, labelled **X** in Fig. 6.1, that branch from generation 0.

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Question 2 · Paper 2 · May/June 2023 (23) · Q2(c)(ii) · 3 marks

(ii) Table 2.1 shows four types of cell and three structures found in the gas exchange system.

Complete Table 2.1 to show the distribution of cell types in each structure of the gas exchange system.

Use a tick (✓) if the cell type is present in the structure and a cross (✗) if the cell type is **not** present.

Put a tick (✓) or a cross (✗) in every box.

Table 2.1

cell type	alveolus	bronchus	trachea
ciliated epithelial cell			
goblet cell			
smooth muscle cell			
squamous epithelial cell			

[3]

Question 3 · Paper 2 · February/March 2021 (22) · Q1(c) · 1 mark

(c) Some structures in the gas exchange system are listed in alphabetical order in Table 1.1.

- Write **YES** in the box provided if the structure contains smooth muscle.
- Write **NO** in the box provided if the structure does **not** contain smooth muscle.

Table 1.1

alveolus	
bronchiole	
bronchus	
trachea	

[1]

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Question 4 · Paper 2 · February/March 2020 (22) · Q4(a) · 3 marks

4 **(a)** When a section of lung tissue is viewed using a light microscope, it is possible to identify the trachea, the bronchus, the bronchioles and the alveoli.

Other than differences in their diameters, describe **one** structural difference visible between:

- the trachea and a bronchus

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- a bronchus and a bronchiole

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- a bronchiole and an alveolus.

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[3]

Question 5 · information from earlier in the question

4 The airways of the gas exchange system are lined with epithelium. Gradual changes in the structural features of this epithelium occur as the airways branch and become increasingly narrow.

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(b) Fig. 4.1 is a photomicrograph of a section through a bronchiole, which is surrounded by alveoli.

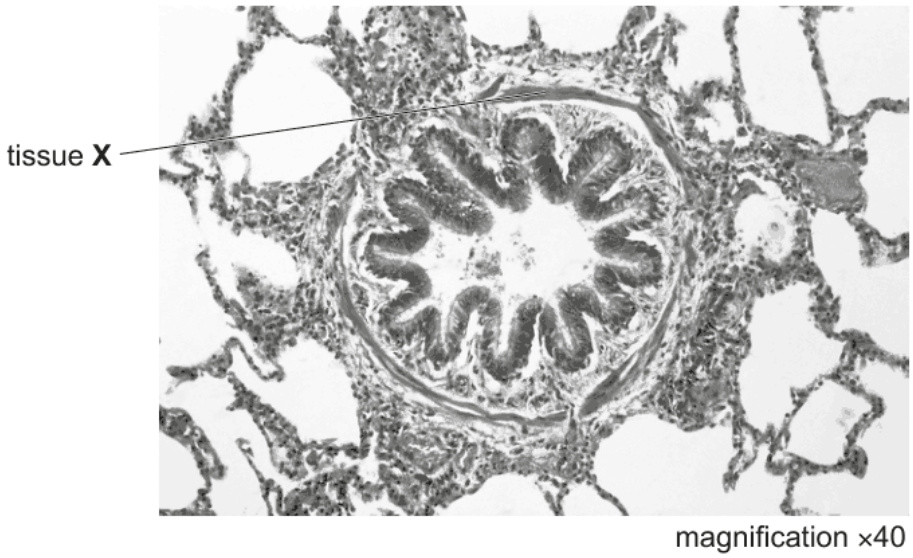


Fig. 4.1

(i) There are structural differences between the epithelium of the bronchiole and the epithelium of an alveolus.

Describe the differences between the epithelium of bronchioles and the epithelium of alveoli, **other than** differences in the number of goblet cells.

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Question 6 · Paper 2 · May/June 2022 (22) · Q5(a) · 1 mark

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.

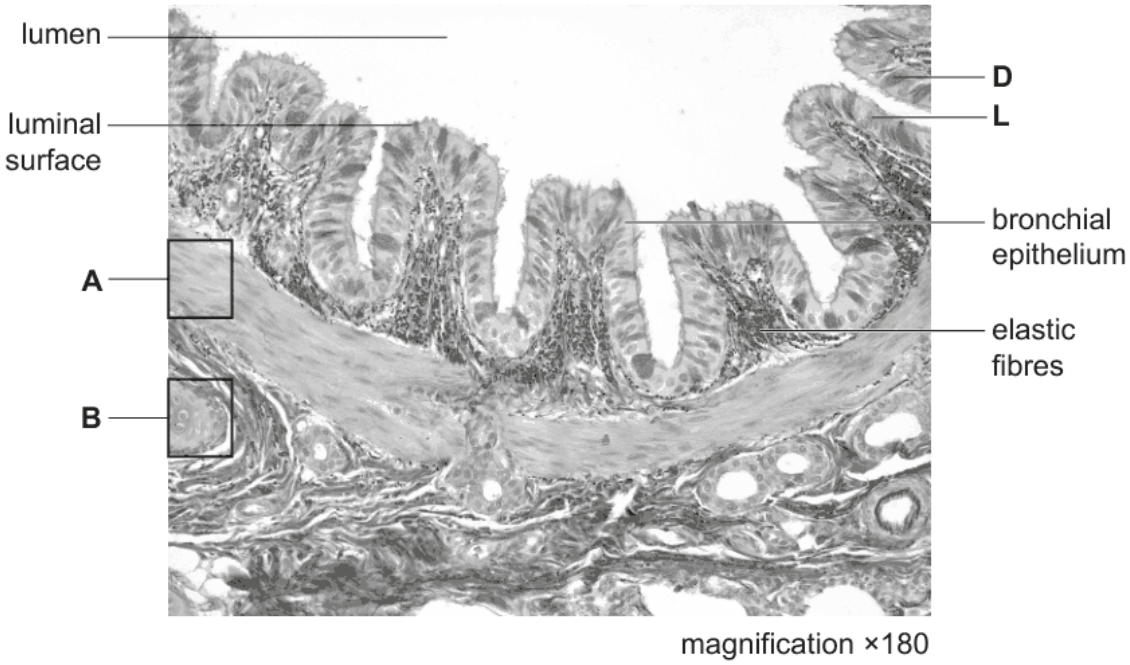


Fig. 5.1

(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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Question 7 · Paper 2 · May/June 2022 (22) · Q5(b) · 2 marks

(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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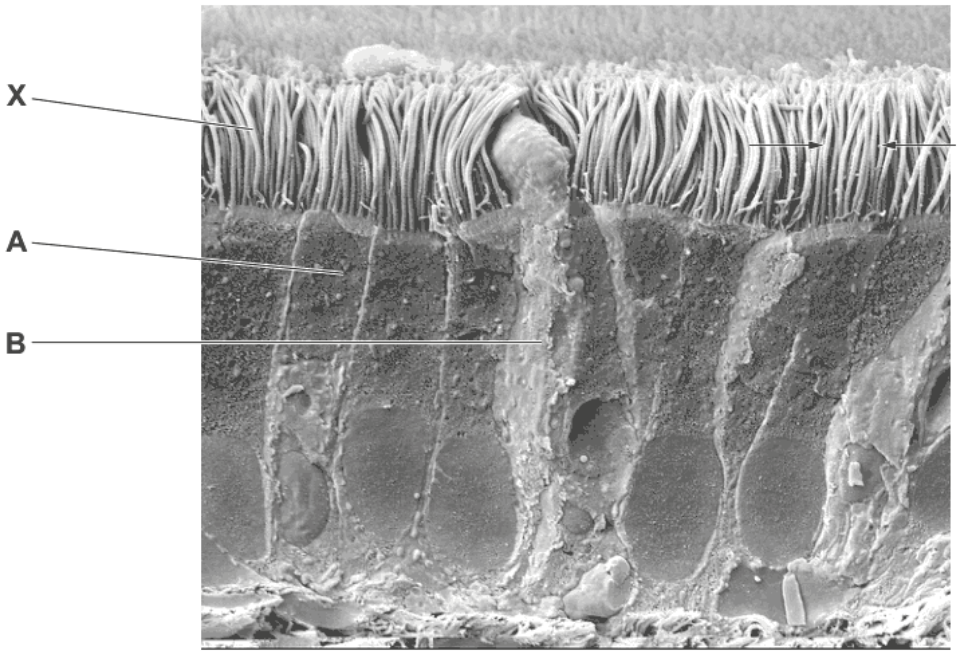
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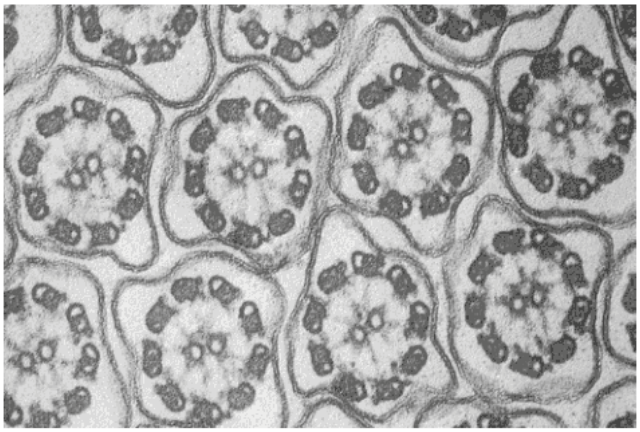
4 Fig. 4.1 is a scanning electron micrograph showing the tissue that lines the bronchi in the gas exchange system.

Fig. 4.2 is a transmission electron micrograph of a horizontal section made at the position indicated by the two arrows in Fig. 4.1.



magnification ×3000

Fig. 4.1



magnification ×80 000

Fig. 4.2

(a) (i) Name the cells labelled **A** and **B** in Fig. 4.1.

A .....

B .....

[2]

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3 Fig. 3.1 is a photomicrograph of a section through lung tissue.

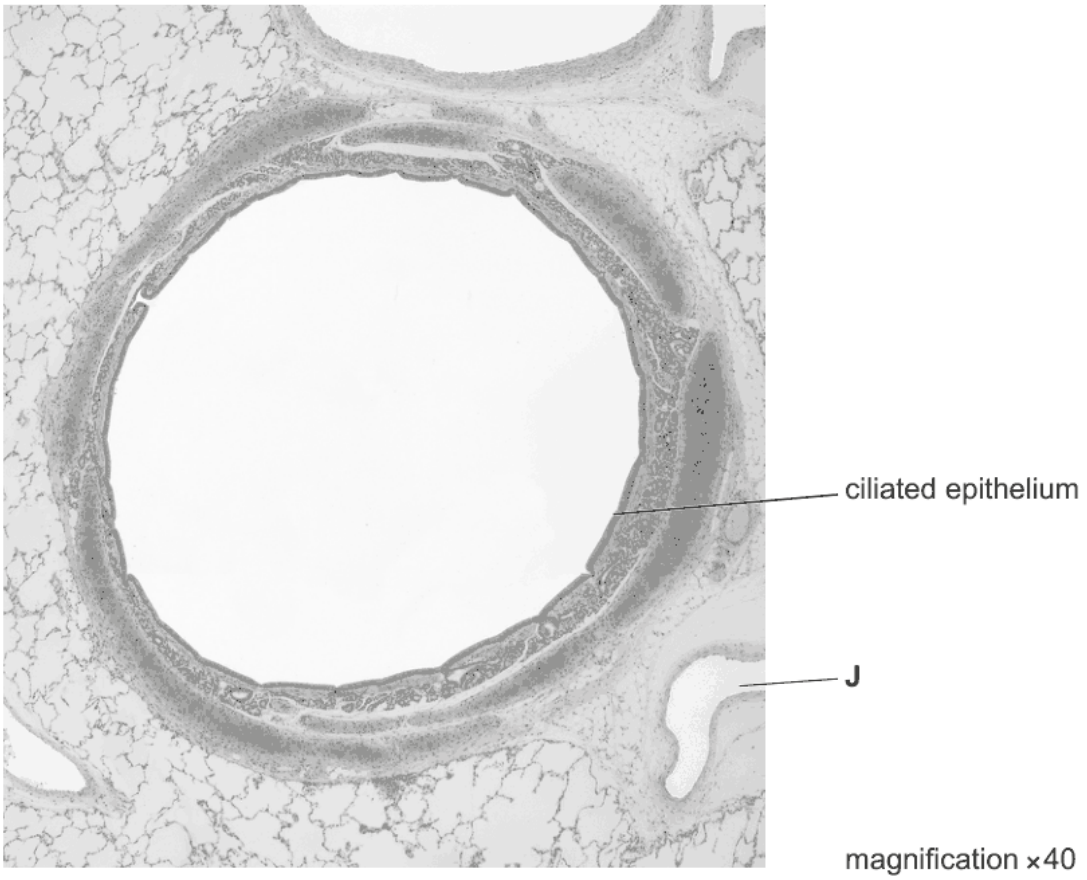


Fig. 3.1

(a) State the feature visible in Fig. 3.1 that identifies the structure in the centre of the image as the bronchus **and** list other visible features that help to confirm this identification.

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other features .....

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[3]

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(d) Fig. 4.1 is a photomicrograph of a section of lung tissue taken from a person who has **not** been infected with the bacterial pathogen and who does **not** have TB.

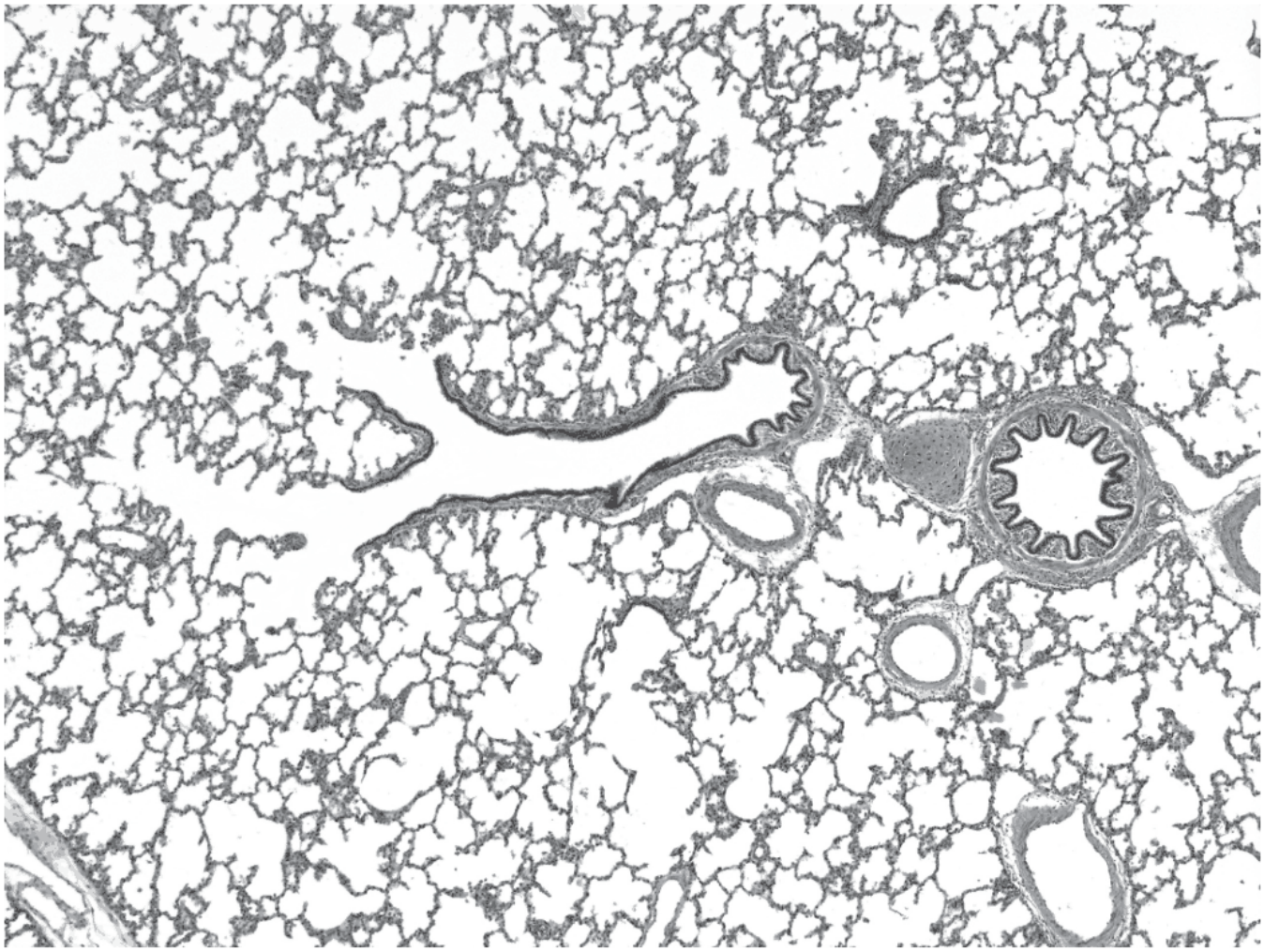


Fig. 4.1

Blood vessels and some structures of the gas exchange system are visible in Fig. 4.1.

On Fig. 4.1, use a label line and label:

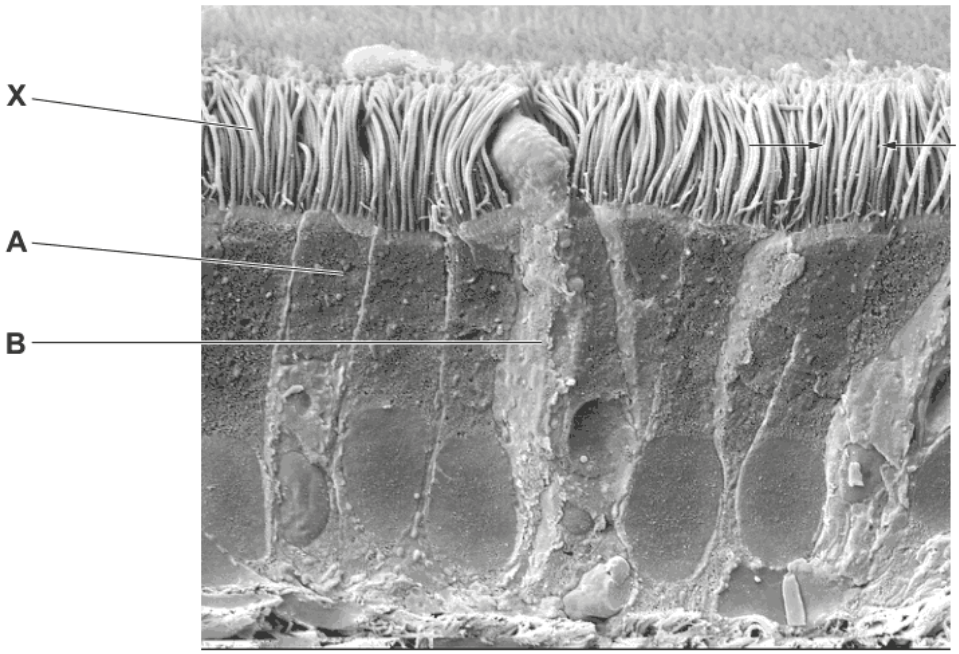
- a bronchus
- a bronchiole
- a blood vessel.

[3]

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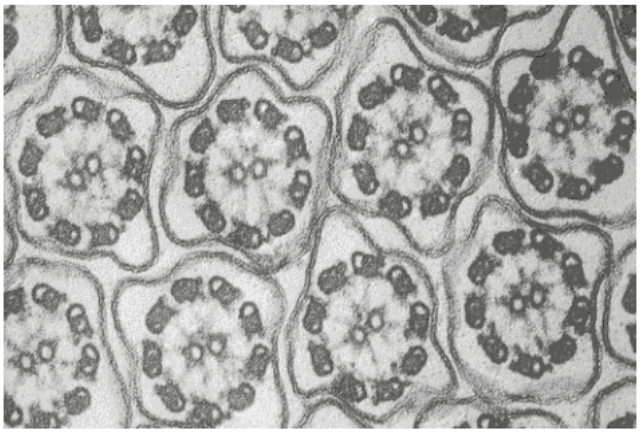
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Fig. 4.2 is a transmission electron micrograph of a horizontal section made at the position indicated by the two arrows in Fig. 4.1.



magnification ×3000

Fig. 4.1



magnification ×80 000

Fig. 4.2

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Question 11 · Paper 2 · May/June 2024 (21) · Q4(a)(ii) · 3 marks

(ii) Describe how the tissue shown in Fig. 4.1 is adapted to its function in the gas exchange system.

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Question 12 · information from earlier in the question

3 Fig. 3.1 is a photomicrograph of a section through lung tissue.

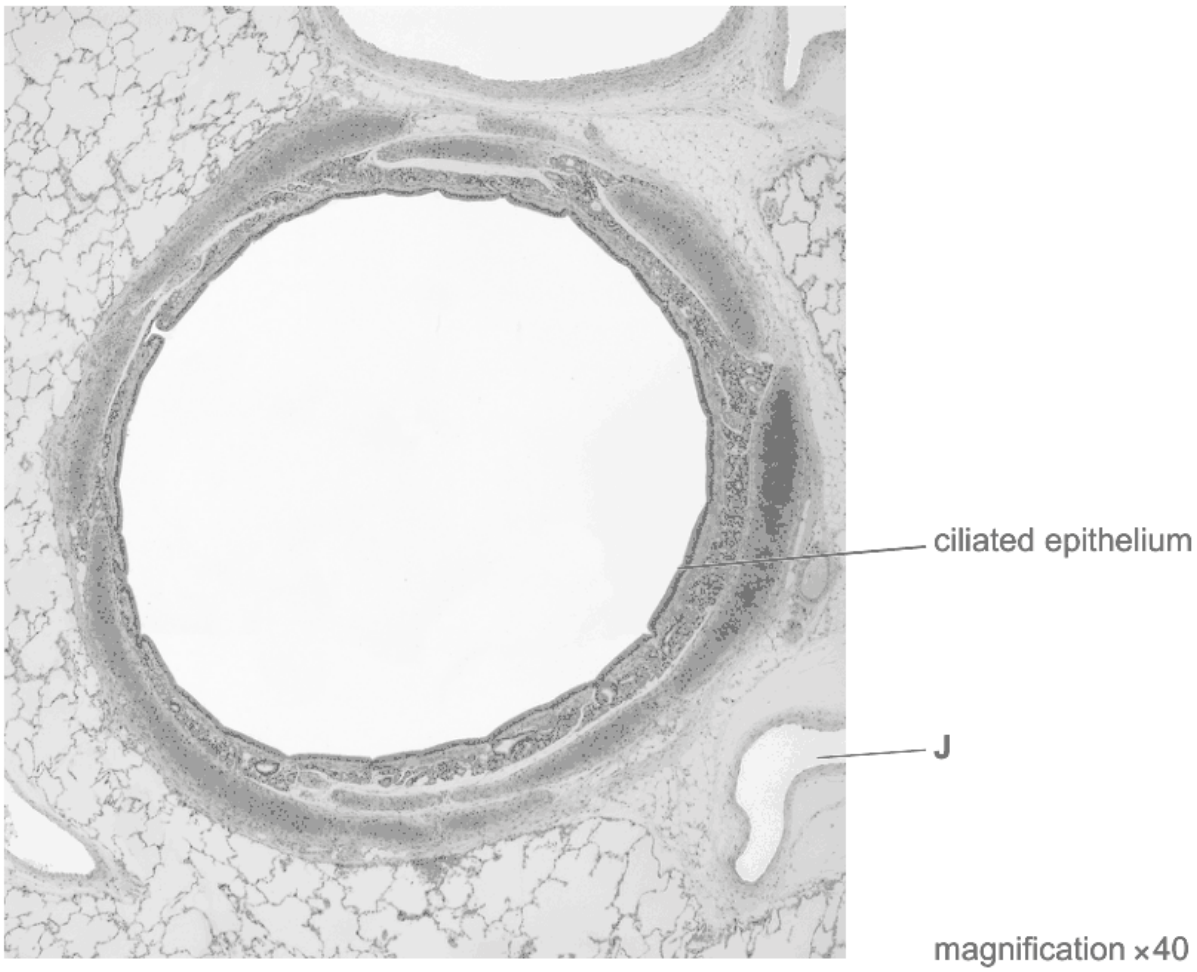


Fig. 3.1

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 12 · Paper 2 · October/November 2020 (22) · Q3(c) · 2 marks

(c) The ciliated epithelium labelled in Fig. 3.1 consists of goblet cells and ciliated epithelial cells.

Outline how goblet cells and cilia work together to maintain healthy lung tissue.

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Question 13 · Paper 2 · February/March 2023 (22) · Q2(c) · 2 marks

Cystic fibrosis is a genetic disease caused by a mutation in the human *CFTR* gene. This results in mucus that is thicker than normal.

(c) Suggest how thicker mucus interferes with the maintenance of healthy gas exchange surfaces in the lungs.

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Question 14 · Paper 2 · February/March 2022 (22) · Q5(e) · 3 marks

(e) Oxygen and carbon dioxide are also exchanged between blood capillaries and alveoli in the lungs.

The gas exchange system has specialised cells to prevent harmful microscopic particles that are present in inhaled air from reaching the alveoli.

These particles are associated with many respiratory diseases.

Explain how specialised cells in the gas exchange system prevent harmful microscopic particles from reaching the alveoli.

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Question 15 · Paper 2 · May/June 2024 (22) · Q1(a) · 2 marks

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.

(a) Smooth muscle is present in the airways of the gas exchange system.

Explain how smooth muscle cells in the walls of the **bronchioles** contribute to the function of these airways.

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Question 16 · information from earlier in the question

4 The airways of the gas exchange system are lined with epithelium. Gradual changes in the structural features of this epithelium occur as the airways branch and become increasingly narrow.

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(b) Fig. 4.1 is a photomicrograph of a section through a bronchiole, which is surrounded by alveoli.

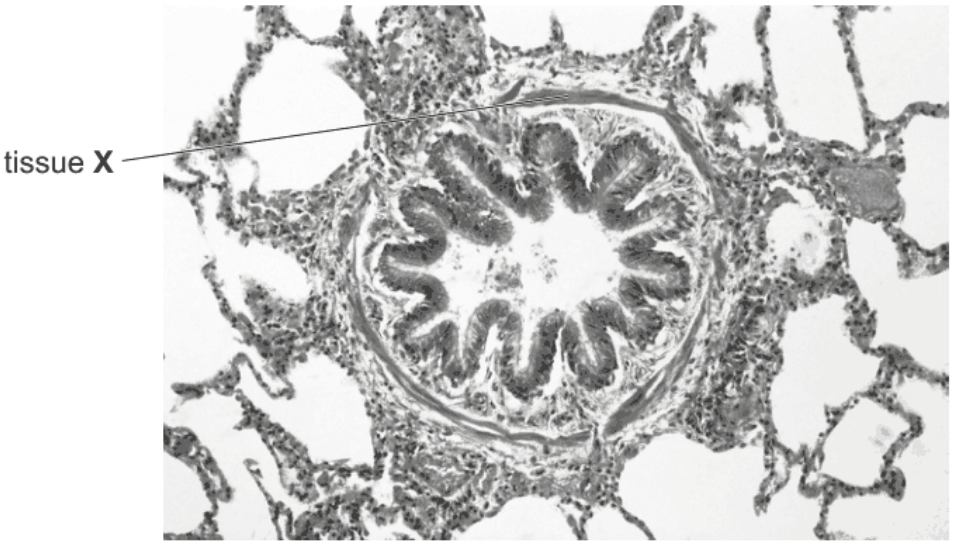


Fig. 4.1

Question 16 · Paper 2 · October/November 2022 (22) · Q4(b)(ii) · 3 marks

(ii) Tissue **X**, shown in Fig. 4.1, is located in the wall of the bronchiole.

Name tissue **X and** outline the function of tissue **X** in the bronchiole.

tissue **X** = ...

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Question 17 · information from earlier in the question

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.

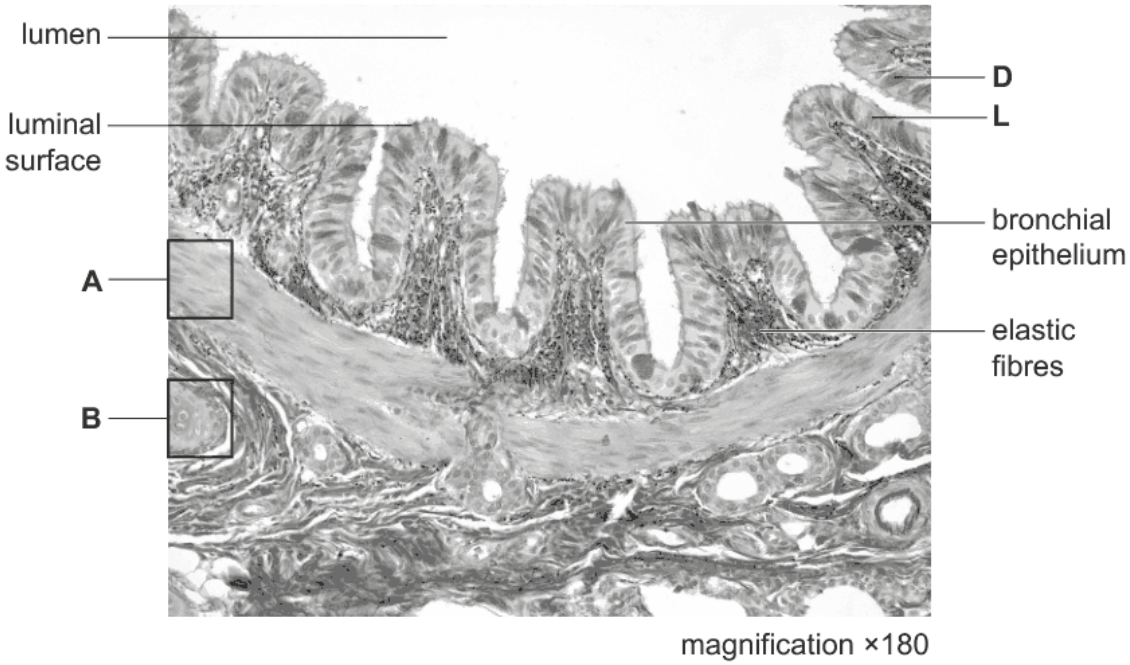


Fig. 5.1

Question 17 · Paper 2 · May/June 2022 (22) · Q5(c) · 3 marks

(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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Question 18 · Paper 2 · October/November 2023 (22) · Q4(a) · 2 marks

4 The alveoli of the lungs are the main gas exchange surface in humans.

(a) Explain how blood flow through the alveolar capillaries helps to maintain steep diffusion gradients for gas exchange.

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Question 19 · Paper 2 · October/November 2023 (22) · Q4(b) · 2 marks

(b) Ventilation of the lungs is the process of inhalation and exhalation. Ventilation helps to maintain steep diffusion gradients.

Explain the role of elastic fibres in the alveolar wall during ventilation.

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Question 20 · information from earlier in the question

6 The Weibel Lung model was developed after an extensive study of the gas exchange system. The model includes detailed measurements of airway diameters (lumen diameters of the airways). In the model, different parts of the gas exchange system are identified with a generation number, as outlined in Fig. 6.1.

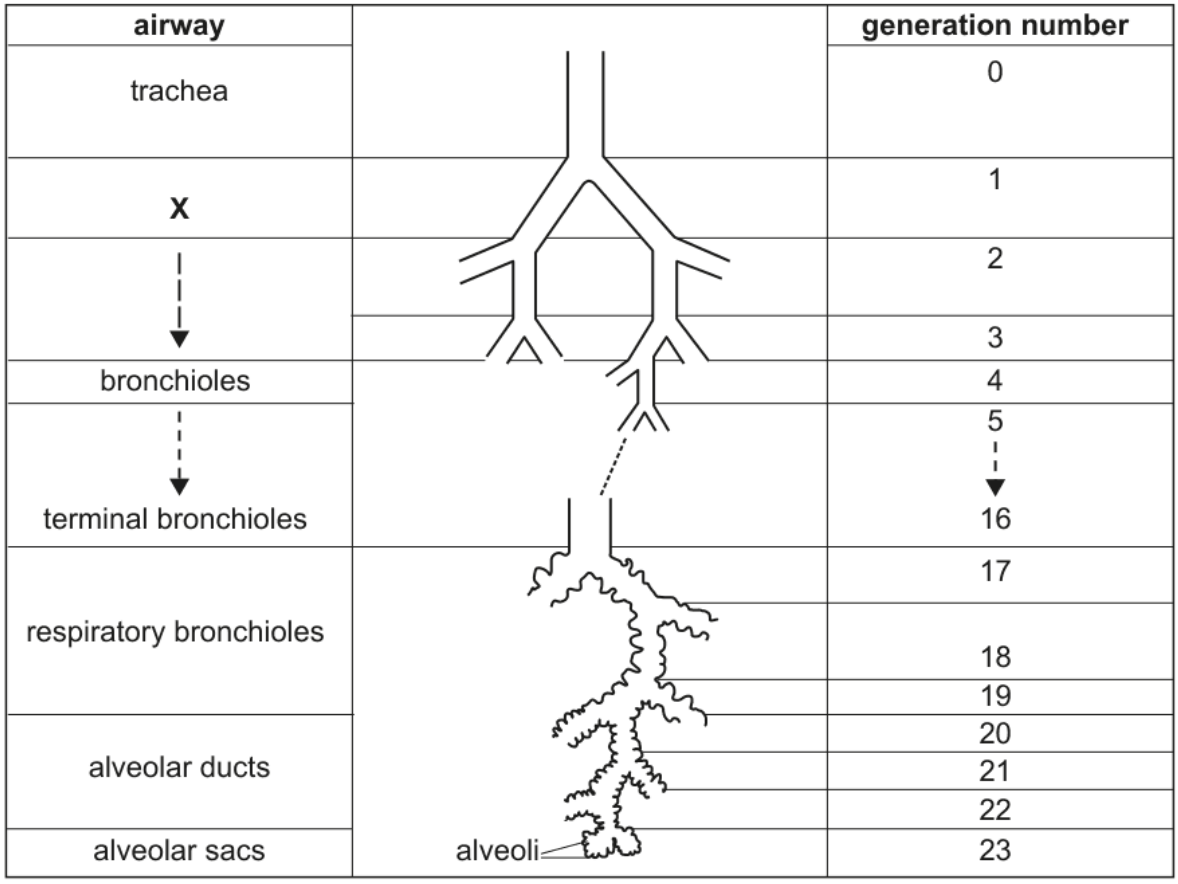


Fig. 6.1

Question 20 · Paper 2 · May/June 2023 (22) · Q6(b) · 2 marks

(b) The airways are well supplied with blood. However, the airways from generation 0 to generation 16, shown in Fig. 6.1, are **not** able to carry out gas exchange.

Suggest why the airways from generation 0 to generation 16 are **not** able to carry out gas exchange.

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Question 21 · information from earlier in the question

5 Pneumonia is a severe lung disease that can interfere with gas exchange. A person with pneumonia can be connected to an ECMO machine. This machine performs the gas exchange functions of the lungs.

A cannula (tube) is inserted into the right atrium and this takes blood to the ECMO machine. In the ECMO machine, blood is passed firstly to an artificial pump and then to an oxygenator, where gas exchange occurs. The blood is then warmed and returns by another cannula to the vena cava.

Question 21 · Paper 2 · February/March 2023 (22) · Q5(b)(i) · 1 mark

(b) In the oxygenator, a partially permeable membrane separates the blood from air that has been enriched with extra oxygen.

(i) State the name of a structure in the gas exchange system that has the same function as the partially permeable membrane of the oxygenator.

Question 22 · Paper 2 · February/March 2023 (22) · Q5(b)(ii) · 3 marks

(ii) In the oxygenator, blood and oxygen-enriched air flow in opposite directions.

Suggest **and** explain how the oxygenator carries out the functions of gas exchange that normally occur in the lungs.

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Mark schemes

Question 1 · Paper 2 · May/June 2023 (22) · Q6(a) · 1 mark

6(a)	bronchi / left and right bronchus ;	1

Question 2 · Paper 2 · May/June 2023 (23) · Q2(c)(ii) · 3 marks

2(c)(ii) one mark each correct column = 3 marks ;;; **3**
if 0 or 1 mark gained, check for correct row to max 2

In the whole table:
- *if only ticks are used, assume blanks are crosses*
- *if only crosses are used, assume blanks are ticks*

If there are ticks and crosses and blanks in the whole table, **R** the columns or rows with the blank(s)

cell type	alveolus	bronchus	trachea
ciliated epithelial cell	×	✓	✓
goblet cell	×	✓	✓
smooth muscle cell	×	✓	✓
squamous epithelial cell	✓	×	×

Question 3 · Paper 2 · February/March 2021 (22) · Q1(c) · 1 mark

1(c)	alveolus 'no' and all other boxes 'yes' ;	1

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Question 4 · Paper 2 · February/March 2020 (22) · Q4(a) · 3 marks

4(a)	*trachea and bronchus (max 1):* C-shaped cartilage rings in trachea vs, irregular / plates of, cartilage in bronchus ; more mucous glands in trachea / fewer mucous glands in bronchus ; pseudostratified / description, epithelium in trachea vs columnar epithelium in bronchus ; *bronchus and bronchiole (max 1):* cartilage in bronchus **or** no cartilage in bronchiole ; many goblet cells in bronchus vs few or no goblet cells in bronchiole / more goblet cells in bronchus / fewer goblet cells in bronchiole ; mucous glands in bronchus **or** no mucous glands in bronchiole ; more smooth muscle in bronchus / less smooth muscle in bronchiole ; *bronchiole and alveolus (max 1):* ciliated epithelium / ciliated cells / cilia / columnar epithelium / cuboidal epithelium, in bronchiole **or** squamous / pavement, epithelial cells in alveolus ; thick wall / wall of several layers, in bronchiole, vs, thin / single layered, wall in alveolus ; smooth muscle in bronchiole **or** no smooth muscle in alveolus ;	**3**

Question 5 · Paper 2 · October/November 2022 (22) · Q4(b)(i) · 3 marks

4(b)(i)	*any **three** from:* (bronchioles) have columnar, epithelium / cells ; **A** columnar and cuboidal, epithelium / cells (bronchioles) have ciliated, epithelium / (epithelial) cells ; **A** cilia (are present) **ora** (alveoli) have squamous, epithelium / cells ; **I** endothelium / endothelial cells detail ; e.g. (bronchiole epithelial cells) longer / wider / thicker **R** if, mucus makes it thicker / stated as more than one layer **or** (alveolar cells) flatter / thinner *allow ideas if stated as epithelium (rather than cells)* AVP ; e.g. ref. to alveolar type II cells / cells secreting surfactant	**3**

Question 6 · Paper 2 · May/June 2022 (22) · Q5(a) · 1 mark

5(a)	*any **one** from:* **I** too small presence of ciia ; **A** ciliated, cells / epithelial cells / epithelium AVP ; e.g. *suggestion that* mucus on surface makes detail not easily seen	**1**

Question 7 · Paper 2 · May/June 2022 (22) · Q5(b) · 2 marks

5(b)	epithelium has goblet cells and ciliated epithelial cells ; **A** ciliated cells **A** two different cell types present **I** *ref. to* cell division *ref. to* staining ; e.g. use of stains gives different, shades / colours differential staining one cell type more neutral / acidic different parts of cells stain differently *idea of* cells have different densities ; e.g. *idea of* more structures / larger nucleus, gives greater density / AW **R** no cell structures *for lighter cell* **I** *ref. to* number of cilia (sectioning may include) more of nucleus so, affects light penetration / makes cell darker ora AVP ; *idea of* different components in cells appearing, darker / lighter	**2**

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Question 8 · Paper 2 · May/June 2024 (21) · Q4(a)(i) · 2 marks

4(a)(i)	**A** – ciliated epithelial (cell) ; **R** ciliated epithelium **B** – goblet (cell) ;	**2**

Question 9 · Paper 2 · October/November 2020 (22) · Q3(a) · 3 marks

3(a)	irregular / plates / AW, of cartilage ; **A** cartilage not C-shaped rings *other features* *any **two** from:* smooth muscle ; elastic, tissue / fibres ; mucous glands ; thick wall / wall many layers ; large lumen (relative to thickness of wall) ; large size relative to surrounding alveoli ; **I** surrounded by alveoli	**3**

Question 10 · Paper 2 · May/June 2025 (22) · Q4(d) · 3 marks

4(d)	label line and label to: bronchus ; bronchiole ; blood vessel ; **R** if blood vessel is stated as a capillary	**3**

Question 11 · Paper 2 · May/June 2024 (21) · Q4(a)(ii) · 3 marks

4(a)(ii)	**1** goblet cells / **B**, secrete / produce / release, mucus / mucin ; **2** mucus, covers / AW, the (ciliated) epithelium to trap (named) particles ; **or** *idea that* mucus prevents (named) pathogens reaching, epithelial cells / alveoli / gas exchange surface ; **I** lungs **A** acts as a barrier to (named) pathogens **3** cilia / ciliated epithelial cells, move mucus (and trapped material), upwards / towards mouth / towards throat **or** pharynx / away from alveoli / away from gas exchange surface / away from lungs / out of the airways ; **I** 'out of the lungs' / 'to be swallowed' unqualified / out of the respiratory system / out of the gas exchange system	**3**

Question 12 · Paper 2 · October/November 2020 (22) · Q3(c) · 2 marks

3(c)	goblet cells, produce / secrete / AW, mucus to trap, pathogens / AW ; **A** dust / dirt / particles etc for AW cilia, waft / moves / carries / push, mucus, to back of throat / AW ;	**2**

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Question 13 · Paper 2 · February/March 2023 (22) · Q2(c) · 2 marks

2(c)	*any **two** from:* (because mucus is too thick) cilia, have difficulty / AW, moving the mucus (upwards) ; pathogens, build up / not removed / AW ; more chance of, infection / disease ; AVP ;	**2**

Question 14 · Paper 2 · February/March 2022 (22) · Q5(e) · 3 marks

5(e)	*any **three** from:* 1 production of mucus by, mucous glands / goblet cells ; 2 mucus (is sticky and) traps particles of dust ; **I** pathogens, microbes, bacteria, etc. 3 cilia on ciliated epithelial cells ; **A** ciliated epithelium 4 cilia, waft / move, mucus / AW ; 5 *idea of* mucus with, particles / dust, is moved away from lung tissue ;	**3**

Question 15 · Paper 2 · May/June 2024 (22) · Q1(a) · 2 marks

1(a)	*any **two** from:* **1** (by) contracts / contracting / contraction, and, relaxes / relaxing / relaxation ; *must be in context of bronchioles* **R** if includes *ref. to* stretch / expand / recoil **R** if in context of *bronchus or trachea (then ecf in subsequent mps)* **2** diameter / lumen size, can be, controlled / changed ; AW **A** contraction, decreases diameter (of lumen) / constricts **A** relaxation (after contraction) increases diameter (of lumen) / widens / dilates / expands **R** vasoconstriction / vasodilation **3** *idea of,* controls / regulates, flow of air / volume of air flowing ; AW **I** statements such as 'lets air in' / 'allows inhalation and exhalation' **A** oxygen in / carbon dioxide out, *instead of air flow* **R** oxygen out and carbon dioxide **4** AVP ; e.g. contract to, reduce air movement / prevent entry of contaminants *idea of* normally relaxed but can, contract / cause constriction, when needed *max 1 if response relates function to inhalation and exhalation* *0 marks if incorrectly stated as elastic tissue or elastic fibres*	**2**

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Question 16 · Paper 2 · October/November 2022 (22) · Q4(b)(ii) · 3 marks

4(b)(ii)	smooth muscle ; *plus any **two** from:* *max 1 for function if stretch and recoil **or** vasoconstriction / vasodilation stated* (muscle) contracts / contraction (and relaxation of bronchiole, lining / wall) ; **R** contraction of, bronchiole / lungs / other airways change / decrease, diameter of, bronchiole / lumen / airway ; **A** adjust size of airway **A** constriction of, bronchiole / airway control of air flow (to and from alveoli) / AW ; e.g. control volume of air, entering / leaving, alveoli *allow ecf **max two marks** if incorrectly stated as elastic fibres* stretch / expand, during inhalation ; **A** stretch and recoil prevents, overstretching / bursting, during inhalation ; recoils to help move air out during exhalation; *allow ecf to **max one mark** if incorrectly stated as cartilage* prevent collapse of, bronchiole / airway ; provides support / keeps airway open ;	**3**

Question 17 · Paper 2 · May/June 2022 (22) · Q5(c) · 3 marks

5(c) — **3**

*any **three** from:*

A		B / cartilage
max two for structure		
smooth muscle / composed of smooth muscle cells **or** no chondrocytes	**or**	no smooth muscle cells **or** has chondrocytes ;
cells close together	**or**	cells, (more) isolated / in gaps / in lacunae ;
cells, spindle shaped / elongated / AW	**or**	cells (more) rounded / AW ;
AVP structure e.g. not surrounded by, perichondrium / AW contains blood vessels	**or**	surrounded by, perichondrium / AW no blood vessels ;
function		
contractile / contracts (and relaxes) **I** recoil **A** bronchi walls contract **R** bronchi contract	**or**	non-contractile ;
changes diameter of airways **A** controls size of lumen	**or**	protective / support ; **A** described e.g. prevents collapse of, bronchus **or** keeps bronchus open

*if incorrectly quotes **A** as the cartilage, use right hand column to allow one mark max (ecf)*

Question 18 · Paper 2 · October/November 2023 (22) · Q4(a) · 2 marks

4(a)	*allow ideas from a diagram* 1 blood arriving, is deoxygenated / has low(er) partial pressure of oxygen **A** low, concentrations / levels, of oxygen **or** oxygen-poor **or** blood arriving has, high(er) partial pressure / AW, of carbon dioxide ; **A** carbon dioxide-rich 2 *idea that* newly oxygenated blood is, constantly / continually, removed ; **A** oxygenated blood passed to pulmonary vein **A** oxygen that diffuses, from alveoli / into blood, is transported away (by blood flow)	**2**

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Question 19 · Paper 2 · October/November 2023 (22) · Q4(b) · 2 marks

4(b)	*any **two** from:* allow alveoli to, expand / stretch, on, inhalation / inspiration / breathing in / AW **;** prevent alveoli from, overstretching / rupturing / bursting (on, inhalation / inspiration / breathing in) **; I** collapse recoil / recoiling, to help, exhalation / expiration / breathing out / force air out **;**	**2**

Question 20 · Paper 2 · May/June 2023 (22) · Q6(b) · 2 marks

6(b)	*any **two** from:* diffusion distance too great / AW **;** **A** walls too thick for (efficient) diffusion **I** *ref. to* surface area time taken for diffusion (to occur) too long / diffusion rate too slow **;** further detail **;** e.g. many cell layers / a number of tissues, to pass across named tissue type(s) to cross e.g. presence of smooth muscle *ref. to* ciliated epithelium / not squamous epithelium *ref. to* layer of mucus on lining of gas exchange system *idea that*, ventilation / fast air flow, reduces time for (correct gradient to be established for) diffusion to occur **;** *idea that* blood supply is, not from pulmonary artery / not pulmonary circulation / from a branch of the aorta / part of the systemic circulation **;** **I** not enough, blood / blood vessels detail **;** e.g. (systemic) blood supply to the gas exchange organs is, already oxygenated / not deoxygenated low / no, concentration gradient for, oxygen / carbon dioxide in (systemic) blood supply to the gas exchange organs	**2**

Question 21 · Paper 2 · February/March 2023 (22) · Q5(b)(i) · 1 mark

5(b)(i)	alveolar wall / alveolar epithelium **;** **A** alveolus / alveoli **A** wall of air sacs	**1**

Question 22 · Paper 2 · February/March 2023 (22) · Q5(b)(ii) · 3 marks

5(b)(ii)	*any **three** from:* oxygen moves (from the oxygen-enriched air) into the blood **and** carbon dioxide moves from the blood (into the oxygen-enriched air) / AW **;** by diffusion / down their concentration gradients **;** (opposite flow arrangement / counter current) maintains a steep diffusion gradient / ref. to equilibrium is not reached / AW **;** short diffusion pathway (across the membrane) **;** AVP **;** e.g. oxygenator membrane (will have a) large surface area	**3**

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