9. Gas Exchange

9.1 The gas exchange system

Paper 1

Question Paper

1 How are alveoli adapted to their function?

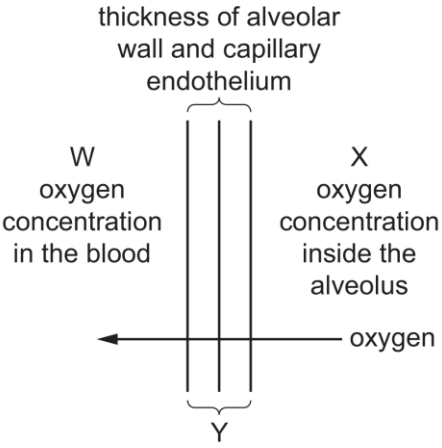
A They contain squamous epithelium for a short diffusion distance.

B They contain goblet cells to produce mucus.

C They contain ciliated epithelium to move mucus.

D They contain cartilage to prevent alveolar collapse.

2 The diagram shows oxygen diffusing from the space inside an alveolus into the blood through the gaseous exchange surface.



What would increase the rate of diffusion of oxygen from the alveolus to the blood?

	increase	decrease	keep the same
A	W	X	Y
B	W	Y	X
C	Y	X	W
D	X	Y	W

3 Which tissues are present in a bronchus?

	cartilage	ciliated epithelium	smooth muscle
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✓

key
✓ = present
✗ = not present

4 Steep concentration gradients must be maintained for efficient gaseous exchange to occur in the human lungs.

Which row correctly describes how steep concentration gradients can be maintained?

	elastic fibres in the walls of the alveoli recoil when breathing out	continual supply of deoxygenated blood by the pulmonary artery
A	✓	✓
B	✗	✓
C	✓	✗
D	✗	✗

key
✓ = helps maintain
✗ = does not help maintain

5 In the lungs, movement of dissolved carbon dioxide out of the capillaries occurs in one of two ways:

- by diffusion through the endothelial cells of the capillaries
- by leakage through pores in the endothelial cells of the capillaries.

What is the **minimum** number of times that a carbon dioxide molecule that has been transported to the lungs in a red blood cell must cross a cell surface membrane to reach an air space in an alveolus?

A 2 **B** 3 **C** 4 **D** 5

6 What maintains the steep concentration gradients needed for successful gas exchange in the lungs?

1 Air flow in the alveoli is in the opposite direction to blood flow in the capillaries.

2 Blood arrives in the lungs with a lower oxygen concentration and a higher carbon dioxide concentration than the air in the alveoli.

3 Blood is constantly flowing through and out of the lungs, bringing a fresh supply of red blood cells.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

7 Where is cartilage tissue always found in the human gas exchange system?

A in the trachea only

B in the bronchi only

C in the bronchioles and trachea

D in the bronchi and trachea

8 Scientists compared the density of goblet cells in the lungs and the density of mucus in the lungs of three groups of people:

- people who do not smoke and do not have lung disease
- people who smoke tobacco but do not have lung disease
- people who smoke tobacco and have lung disease.

The results are shown in the table.

group	goblet cell density / cells per mm^2	mucus density / arbitrary units
non-smokers	19	6
smokers who do not have lung disease	54	26
smokers with lung disease	37	15

What is indicated by these data?

1 There is a positive correlation (relationship) between density of goblet cells and density of mucus.

2 Lung disease results in an increase in goblet cell density.

3 There is an association between tobacco smoking and an increase in mucus density.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

9 What is the function of cilia in the gas exchange system?

A to increase the surface area

B to move mucus

C to produce mucus

D to trap dust and pathogens

10 Which tissues are present in the walls of a trachea and an alveolus?

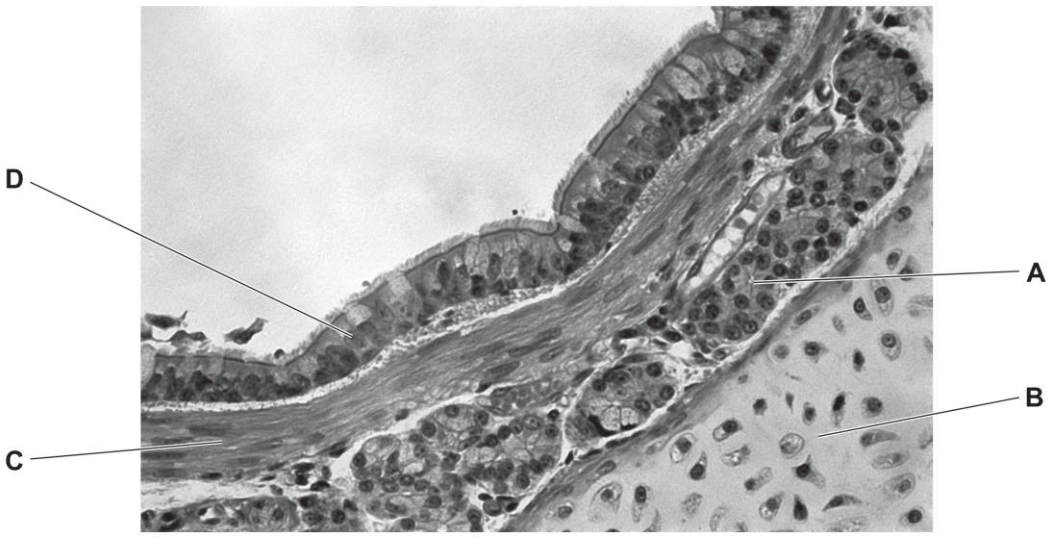
		tissue	
		epithelium with goblet cells	smooth muscle
A	trachea	✓	✓
	alveolus	✗	✗
B	trachea	✓	✓
	alveolus	✗	✓
C	trachea	✓	✗
	alveolus	✓	✓
D	trachea	✗	✓
	alveolus	✗	✗

key

✓ = present
✗ = **not** present

11 The photomicrograph shows part of a bronchus.

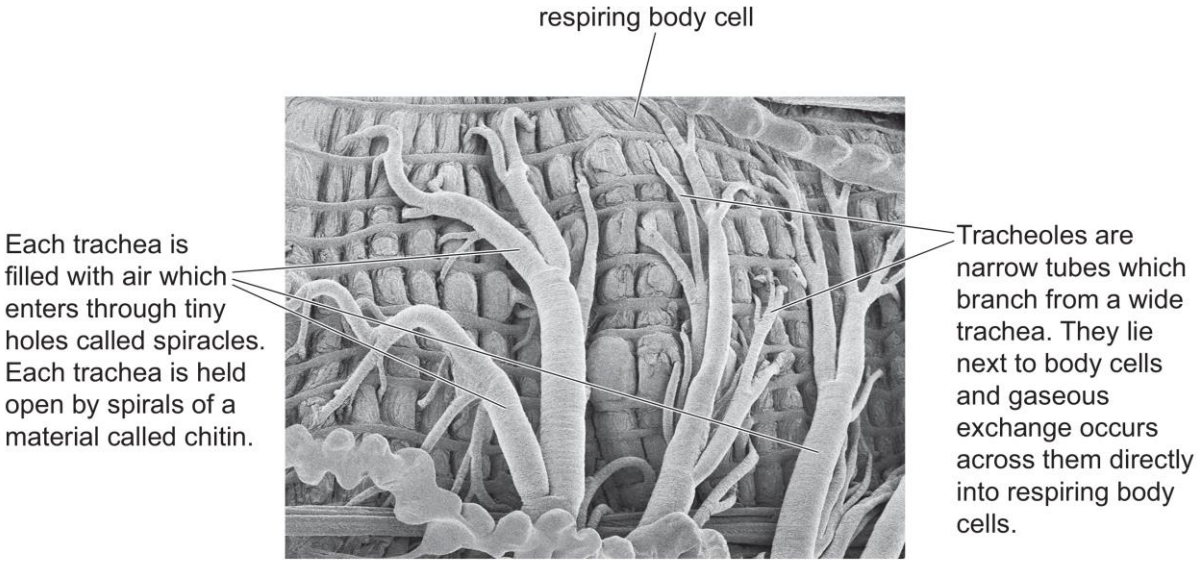
Which label identifies cartilage?



12 Which row shows the features of the gas exchange surface that increase diffusion of carbon dioxide and oxygen?

	concentration gradient	diffusion distance
A	steep	long
B	steep	short
C	shallow	long
D	shallow	short

13 The electron micrograph shows some of the airways in the gaseous exchange system of an insect and the respiring body cells that surround them.



Which statements describe correct differences between the insect gas exchange system shown in the electron micrograph and the human gas exchange system?

1 Gas exchange occurs through the walls of the airways directly into respiring body cells in insects but this does **not** occur in humans.

2 There are spirals of chitin in the walls of a trachea in insects to hold it open but **not** in humans.

3 There is more than one trachea in the gas exchange system of the insect but only one in humans.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 3 only

14 Which row is correct for the wall of the trachea **and** the wall of the bronchus?

	cartilage	smooth muscle	goblet cells
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✗

key
✓ = present
✗ = **not** present

15 A person with no breathing conditions rests for an hour. Their breathing in this time is shallow and slow, so little air from outside the body reaches the alveoli. The person's heart rate remains constant.

Which statement is correct?

A The carbon dioxide concentration in the blood in the pulmonary vein will be higher than in the pulmonary artery.

B Carbon dioxide molecules in the air of the alveoli move out of the blood by active transport.

C The air in the alveoli has a lower concentration of oxygen than the blood in the pulmonary vein.

D Oxygen molecules diffuse from the air in the alveoli into the blood at a slower rate than when the person is active.

16 Which statements about **all** bronchioles are correct?

1 They have epithelium.

2 They have goblet cells.

3 They have muscle tissue.

A 1, 2 and 3 **B** 1 and 3 only **C** 2 only **D** 3 only

17 Where are squamous epithelial cells found in the human gas exchange system?

	trachea	bronchus	alveolus
A	✓	✓	✓
B	✓	✗	✓
C	✗	✓	✗
D	✗	✗	✓

key
✓ = found
✗ = not found

18 Which statement about gas exchange between air in the alveoli and blood in the pulmonary capillaries is correct?

A The oxygen concentration in the capillaries leaving the pulmonary artery is higher than the oxygen concentration in the alveoli.

B Gases must diffuse across the endothelium of the pulmonary capillaries and the endothelium of the alveoli.

C The elastic fibres in the alveoli walls allow the alveoli to expand to increase the surface area available for diffusion into the pulmonary capillaries.

D Breathing out reduces the carbon dioxide concentration gradient between the blood in the pulmonary capillaries and the air in the alveoli.

19 The average thicknesses for some structures in the human respiratory system are shown.

structure	average thickness of structure / nm
human cell membrane	5
cytoplasm of alveolar wall cells	190
cytoplasm of capillary wall cells	90
tissues between alveolar wall and capillary wall	300

A molecule of oxygen is in the alveolar air space next to the wall of the alveolus.

What is the shortest distance that the molecule needs to diffuse from its current position to the haemoglobin that completely fills a red blood cell in the nearest capillary?

(Assume that the red blood cells touch the walls of a capillary.)

A 595 nm **B** 600 nm **C** 605 nm **D** 610 nm

20 Which statements about **all** bronchioles are correct?

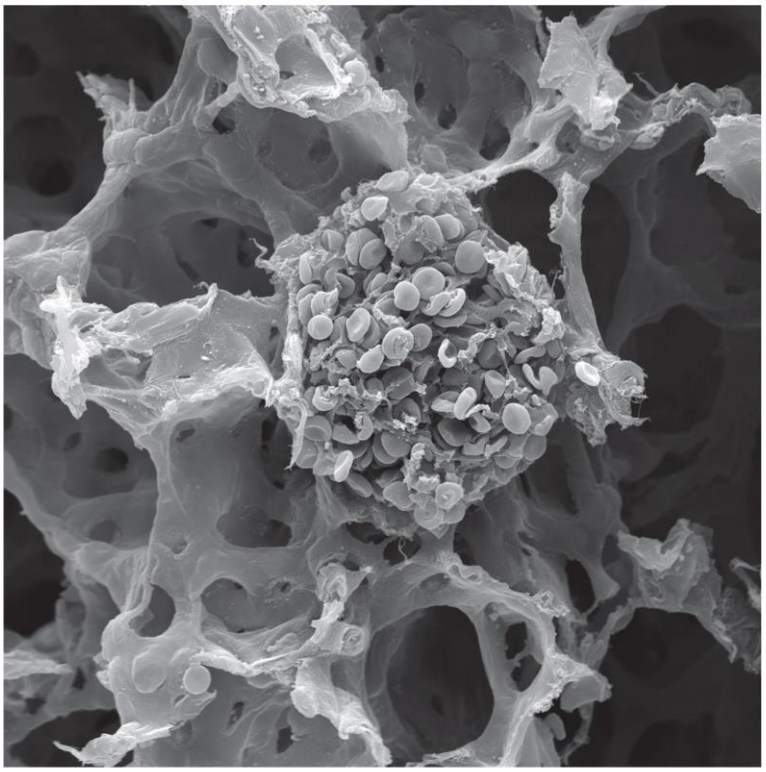
1 They have goblet cells.

2 They have epithelial cells.

3 They have muscle tissue.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

21 What is shown in the electron micrograph?



×850

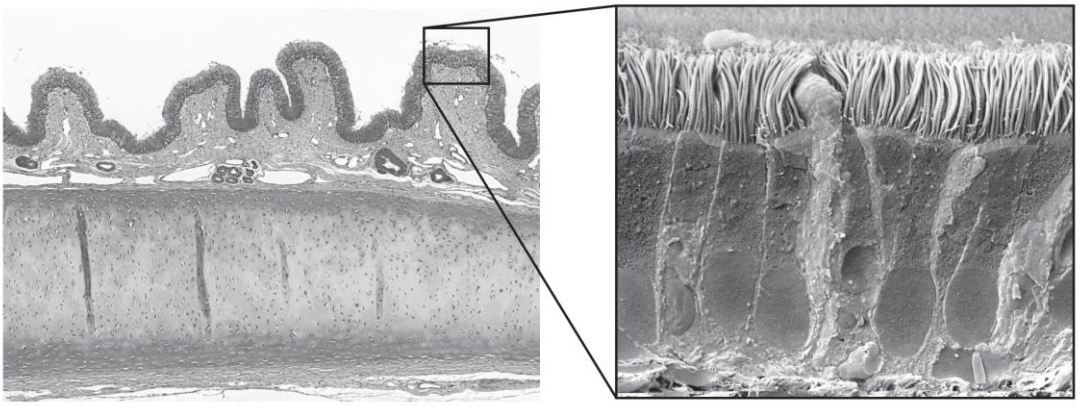
A scanning electron micrograph of bronchial epithelium and lymphocytes

B scanning electron micrograph of lung squamous epithelium and red blood cells

C transmission electron micrograph of bronchial epithelium and lymphocytes

D transmission electron micrograph of lung squamous epithelium and red blood cells

22 The photomicrographs show a cross-section through the lining of part of the respiratory system.



Which statements about the photomicrographs are correct?

1 Goblet cells are visible between squamous epithelium cells.

2 Smooth muscle is visible.

3 The section cannot be from a bronchiole as cartilage is visible.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

23 The surface tension of the layer of liquid lining the alveoli tends to pull the walls inwards so alveoli could collapse.

Which statements could explain how this is prevented?

1 Alveolar fluid is moved around by cilia.

2 Elastic fibres keep the alveoli open.

3 Epithelial cells secrete a chemical that reduces the cohesion in water.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 3 only

24 Which statements about the human gas exchange system are correct?

1 The absence of cartilage in small bronchioles allows them to expand.

2 The walls of the alveoli are made of cuboidal epithelium.

3 Alveoli secrete a substance which reduces surface tension.

4 The trachea and bronchi are supported by rings of cartilage.

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

25 Four types of cell in the gas exchange system are listed.

J alveolus epithelium cell

K ciliated cell

L goblet cell

M smooth muscle cell

The ticks (✓) in the table show specialised features of three of these types of cell.

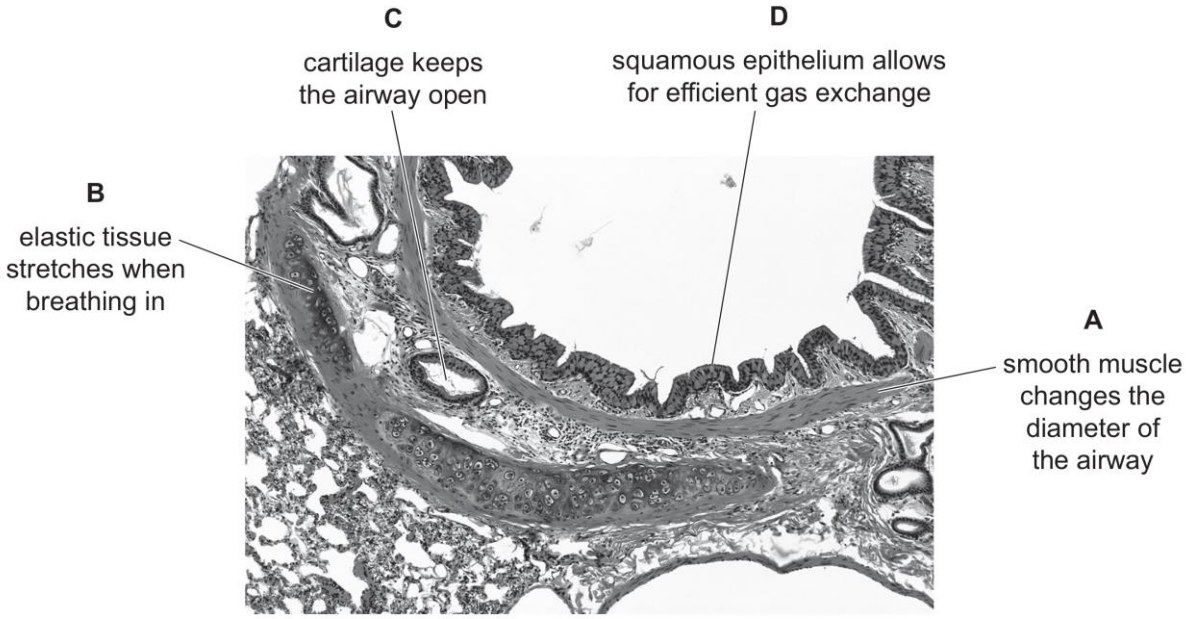
	many mitochondria	lots of endoplasmic reticulum	many Golgi bodies
1	✓		
2	✓		
3	✓	✓	✓

Which row correctly matches the specialised feature with the correct cell?

	1	2	3
A	J	M	K
B	K	J	M
C	K	M	L
D	M	L	J

26 The photomicrograph shows a section through a bronchus.

Which annotated label is correct?



27 What can be found in the wall of an alveolus in the lungs of a human?

	cartilage	cilia	elastic fibres
A	✓	✓	✗
B	✗	✗	✓
C	✓	✗	✗
D	✗	✓	✓

key

✓ = present

✗ = not present

28 What are the functions of cilia in the gas exchange system?

1 to move mucus

2 to trap pathogens and dust

3 to increase the surface area

	1	2	3
A	✓	✗	✗
B	✓	✓	✗
C	✗	✓	✓
D	✗	✗	✓

key

✓ = a function

✗ = not a function

29 The table shows the partial pressure of carbon dioxide and oxygen in two blood vessels.

	partial pressure of gas in pulmonary artery / kPa	partial pressure of gas in pulmonary vein / kPa
carbon dioxide	6	5
oxygen	5	15

What explains the difference in the partial pressures of oxygen in the pulmonary artery and pulmonary vein?

A Oxygen diffuses from the alveoli into the blood in the capillaries.

B Carbon dioxide diffuses into the alveoli from the blood in the capillaries.

C Oxygen diffuses from the body cells into the blood in the capillaries.

D Carbon dioxide diffuses into the body cells from the blood in the capillaries.

30 Which row shows the tissues that are present in the wall of the trachea **and** in the wall of the bronchus?

	cartilage	squamous epithelium	goblet cells
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✗

key

✓ = present

✗ = not present

31 In some cases where a person has lung disease, the partial pressure of oxygen in the pulmonary veins is less than the partial pressure of oxygen in the alveoli.

What could explain the difference in partial pressure of oxygen?

1 A high proportion of alveoli are collapsed and do not have enough alveolar capillaries.

2 The partial pressure of oxygen in the pulmonary arteries is lower than in the alveolar air.

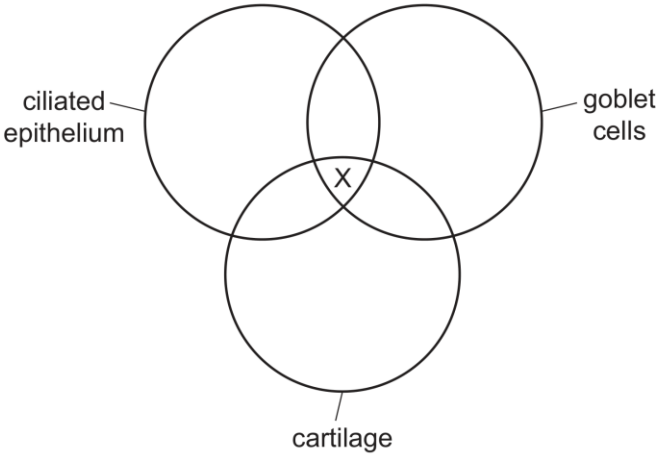
3 The rate of diffusion of oxygen from the alveolar air to the surrounding alveolar capillaries is too slow.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

32 How many times must a molecule of carbon dioxide pass through a cell surface membrane as it diffuses from the plasma, through a cell in the capillary wall, into an alveolus?

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

33 The diagram shows three features found in the mammalian gas exchange system.



Which structures of the gas exchange system could be represented by X in the diagram?

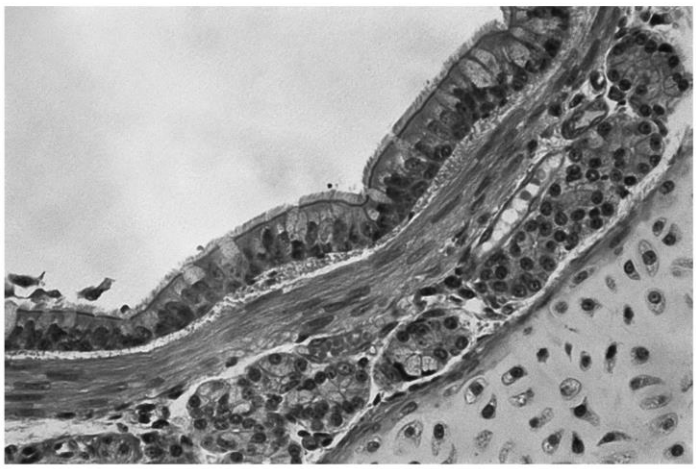
A small bronchiole only

B small bronchiole and bronchus

C trachea only

D trachea and bronchus

34 The image shown is a photomicrograph of a transverse section of part of the gas exchange system.



What describes the image?

A a thin inner layer of ciliated epithelial cells on top of a layer containing cartilage, supported by elastic fibres

B a very thin epithelial lining with walls containing elastic fibres, surrounded by many blood vessels

C an inner layer of ciliated epithelial and goblet cells on top of elastic fibres, supported by an outer layer consisting of cartilage

D an inner layer of ciliated epithelial and goblet cells on top of loose tissue with mucous glands, supported by a continuous ring of cartilage

35 Which row shows the tissues that are present in the wall of the trachea and the wall of the bronchus?

	smooth muscle	squamous epithelium	goblet cells
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✗

key

✓ = present

✗ = not present

36 When a person suffers an asthma attack, the tubes of the gas exchange system narrow and extra mucus is produced.

Which changes occur during an asthma attack?

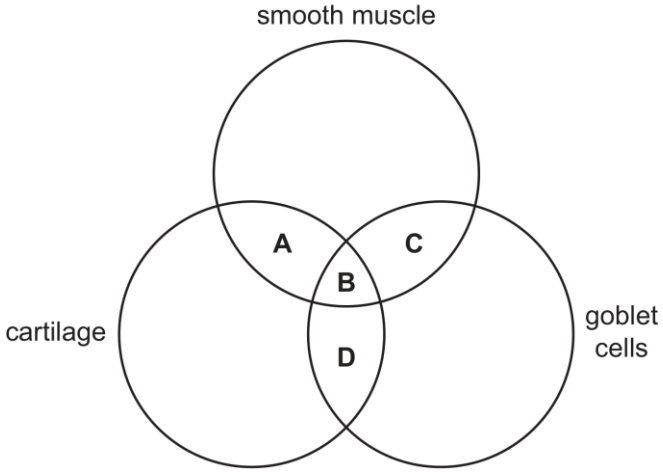
1 Activity of ciliated epithelium increases.

2 Endocytosis in goblet cells increases.

3 Smooth muscles are more active.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

37 Which structures are found in bronchi?



38 Which tissue in the respiratory system is correctly linked to its function?

	tissue	function
A	cartilage	stretch and recoil to force air out
B	ciliated epithelium	gives protection from suspended particles in the air
C	elastic fibres	contract and relax to adjust diameter of bronchioles
D	smooth muscle	keeps trachea and bronchi open

39 Which structures of the human gas exchange system are supported by cartilage?

	bronchus	bronchiole	trachea
A	✗	✓	✓
B	✗	✓	✗
C	✓	✓	✓
D	✓	✗	✓

key

✓ = cartilage present

✗ = cartilage not present

40 Which statements about all bronchioles are correct?

1 they have goblet cells

2 they have ciliated cells

3 they have muscle tissue

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

41 Which are present in bronchioles?

1 endothelium

2 ciliated cells

3 smooth muscle tissue

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

42 The partial pressure of oxygen in air inside alveoli is 14 kPa.

The partial pressure of oxygen in pulmonary capillaries is 6 kPa.

What will be the effect of these partial pressures on diffusion?

A Carbon dioxide will not diffuse in any direction.

B Oxygen will diffuse from alveoli into capillaries.

C Oxygen will diffuse from capillaries into alveoli.

D Oxygen will diffuse equally in both directions.

43 Which statements about bronchioles are correct?

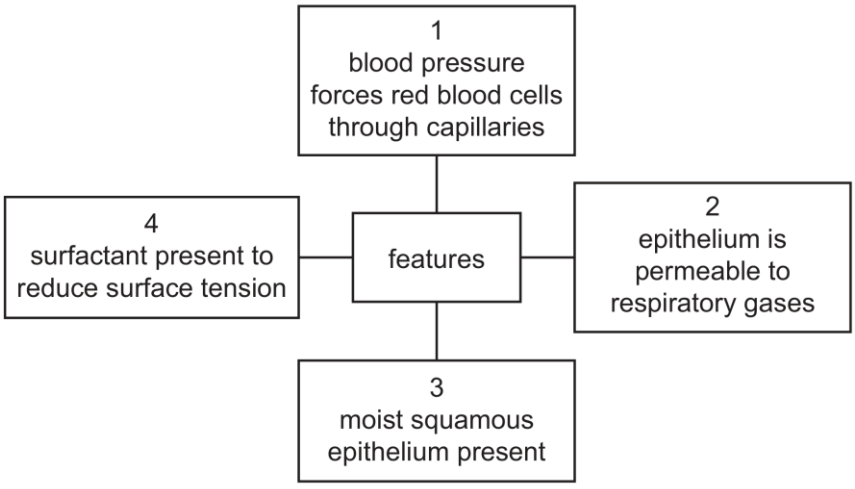
1 They have ciliated cells.

2 They have goblet cells.

3 They have muscle tissue.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

44 Which features are important for the diffusion of oxygen out of an alveolus?



A 1, 2 and 3 **B** 1, 3 and 4 **C** 1 and 3 only **D** 2 and 4 only

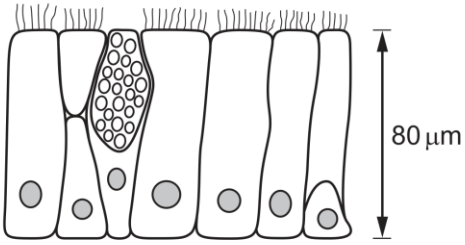
45 Which tissues are present in the walls of a trachea and an alveolus?

		tissue	
		epithelium with goblet cells	smooth muscle
A	trachea	✓	✓
	alveolus	✗	✗
B	trachea	✓	✓
	alveolus	✗	✓
C	trachea	✓	✗
	alveolus	✓	✓
D	trachea	✗	✓
	alveolus	✗	✗

key

✓ = present
✗ = absent

46 The diagram shows a section through a type of epithelium.



Where is this type of epithelium found in the respiratory system?

	trachea	bronchus	all bronchioles
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✓

key
✓ = present
✗ = not present

47 Which statement is correct?

A Alveoli have goblet cells to produce mucus to trap pathogens from the air.

B Cartilage in the bronchi keeps the bronchi open and allows air to flow through freely.

C Complete rings of cartilage in the bronchioles make sure that air can reach the alveoli.

D During exercise, muscles in the bronchioles and alveoli relax to allow a greater flow of air.

48 Four types of cell in the gas exchange system are listed.

J alveolus epithelium cell

K ciliated cell

L goblet cell

M smooth muscle cell

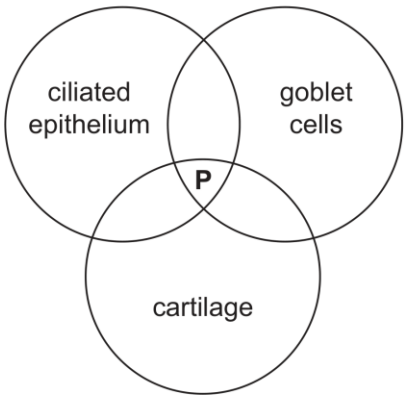
The ticks (✓) in the table show specialised features of three of these types of cell.

	many mitochondria	lots of endoplasmic reticulum	many Golgi bodies
1	✓		
2	✓		
3	✓	✓	✓

Which row correctly matches the specialised feature with the correct cell?

	1	2	3
A	J	M	K
B	K	J	M
C	K	M	L
D	M	K	J

49 The diagram shows three features found in tissues of the gas exchange system.



Which tubes of the gas exchange system could be represented at position **P** in the diagram?

	bronchus	bronchiole	trachea
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✓

key

✓ = yes

✗ = no

50 Which of these structures contain cartilage and cilia?

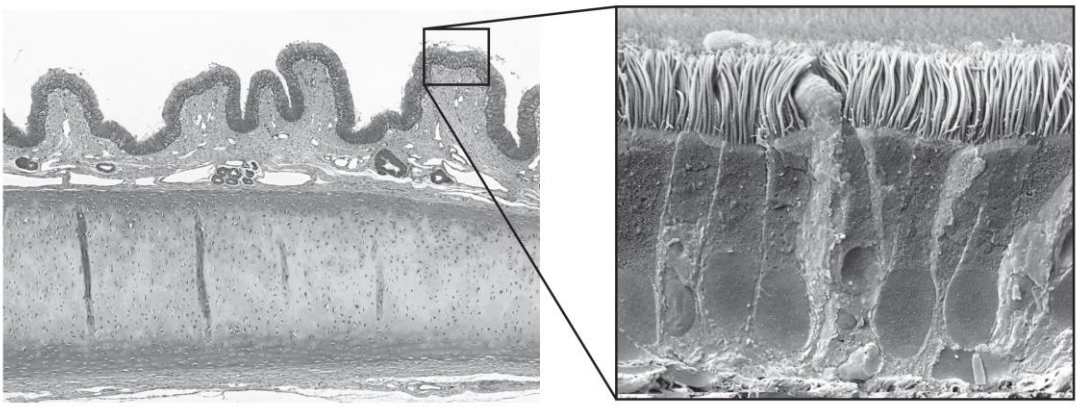
1 bronchi

2 bronchioles

3 trachea

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 3 only

51 The photomicrographs show a cross-section through the lining of part of the respiratory system.



Which statements are correct?

1 Goblet cells are visible between squamous epithelium cells.

2 Smooth muscle is visible.

3 The section cannot be from a bronchiole as cartilage is visible.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

52 In the lungs, oxygen and carbon dioxide pass through cell surface membranes by diffusion.

Which row is correct?

	number of cell surface membranes diffused through by	
	oxygen from air	carbon dioxide to air
A	3	2
B	3	2 or 3
C	5	4
D	5	4 or 5

53 Which tissues are present in a bronchus?

	cartilage	ciliated epithelium	smooth muscle
A	✓	✓	✓
B	✓	✓	✗
C	✓	✗	✓
D	✗	✓	✓

key

✓ = present

✗ = absent