Unit 1

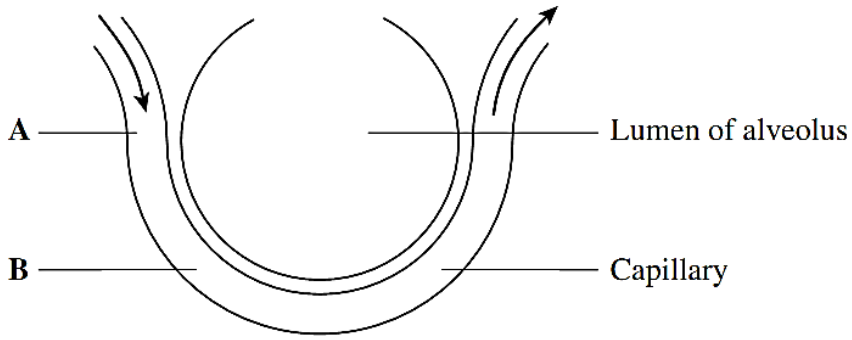
Biology and Disease

The Lungs

Practice Exam Questions

1.

The diagram shows part of an alveolus and a capillary.



10 µm

(a) The rate of blood flow in the capillary is 0.2 mm s^{-1}.
Calculate the time it would take for blood in the capillary to flow from point **A** to point **B**. Show your working.

Answer ..... seconds
(2 marks)

(b) The rate of diffusion of oxygen is affected by the difference between its concentration in the alveolus and its concentration in the blood.

(b) (i) Circulation of the blood helps to maintain this difference in oxygen concentration. Explain how.

.....

.....

.....

(1 mark)

(b) (ii) During an asthma attack, less oxygen diffuses into the blood from the alveoli. Explain why.

.....

.....

.....

.....

(2 marks)

(c) Scientists investigated a new drug to treat asthma. People with asthma took part in a trial. They were divided into two groups, an experimental group and a control group.

(c) (i) It was important to have a control group in this trial. Explain why.

.....

.....

.....

(1 mark)

(c) (ii) People in the experimental group were given the drug in an inhaler. Describe how the control group should have been treated.

.....

.....

.....

.....

2 Miner's lung is a disease caused by breathing in dust in coal mines. The dust causes the alveolar epithelium to become thicker. People with miner's lung have a lower concentration of oxygen in their blood than healthy people.

(a) (i) Describe the path by which oxygen goes from an alveolus to the blood.

.....

.....

.....

.....

.....

(2 marks)

(ii) Explain why people with miner's lung have a lower concentration of oxygen in their blood.

.....

.....

(1 mark)

(b) In healthy lungs, a gradient is maintained between the concentration of oxygen in the alveoli and the concentration of oxygen in the lung capillaries.

(i) Describe how ventilation helps to maintain this difference in oxygen concentration.

.....

.....

.....

.....

.....

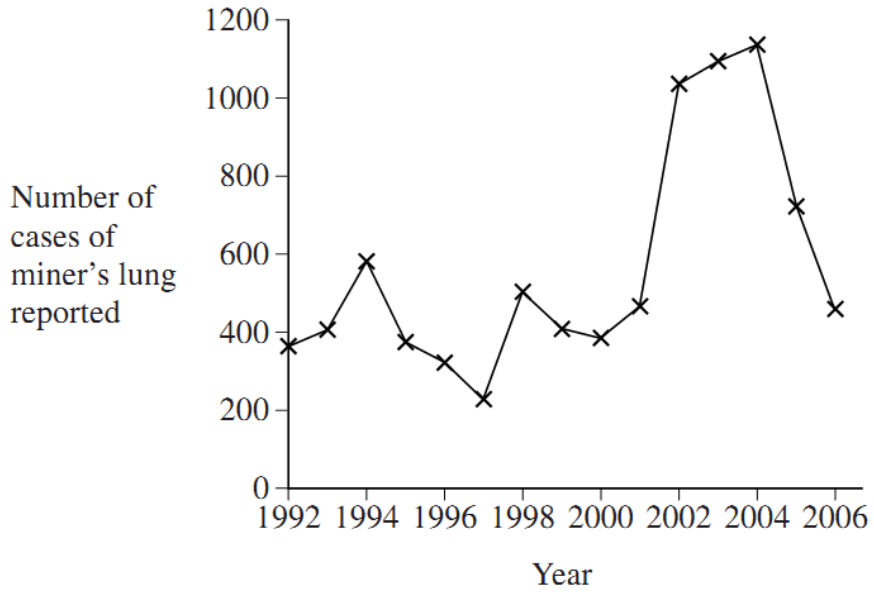
(2 marks)

(ii) Give **one** other way that helps to maintain the difference in oxygen concentration.

.....

(1 mark)

(c) Scientists investigated the number of cases of miner's lung reported in Britain between 1992 and 2006.



Coal mining in Britain had been dramatically reduced by 1990.

Some scientists concluded that the rise in reported cases of miner's lung after 1992 shows that the disease takes a long time to develop.

Evaluate this conclusion.

.....

.....

.....

.....

.....

(2 marks)

3.

(a) Pulmonary tuberculosis is a disease of the lungs.
Describe the transmission and course of infection of pulmonary tuberculosis.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5 marks)

(b) Emphysema is another disease of the lungs. People with emphysema may feel weak and tired. Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5 marks)

4.

Read the following passage.

Several diseases are caused by inhaling asbestos fibres. Most of these diseases result from the build up of these tiny asbestos fibres in the lungs.

One of these diseases is asbestosis. The asbestos fibres are very small and enter the bronchioles and alveoli. They cause the destruction of phagocytes and the surrounding lung tissue becomes scarred and fibrous. The fibrous tissue reduces the elasticity of the lungs and causes the alveolar walls to thicken. One of the main symptoms of asbestosis is shortness of breath caused by reduced gas exchange.

People with asbestosis are at a greater risk of developing lung cancer. The time between exposure to asbestos and the occurrence of lung cancer is 20–30 years.

Use information in the passage and your own knowledge to answer the following questions.

(a) Destruction of phagocytes (lines 4–5) causes the lungs to be more susceptible to infections. Explain why.

.....

.....

.....

.....

(2 marks)

(b) (i) The reduced elasticity of the lungs (lines 6–7) causes breathing difficulty. Explain how.

.....

.....

.....

.....

(2 marks)

(ii) Apart from reduced elasticity, explain how changes to the lung tissue reduce the efficiency of gas exchange.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

(c) (i) Doctors did not make the link between exposure to asbestos and an increased risk of developing lung cancer for many years. Use information in the passage to explain why.

.....

.....

(1 mark)

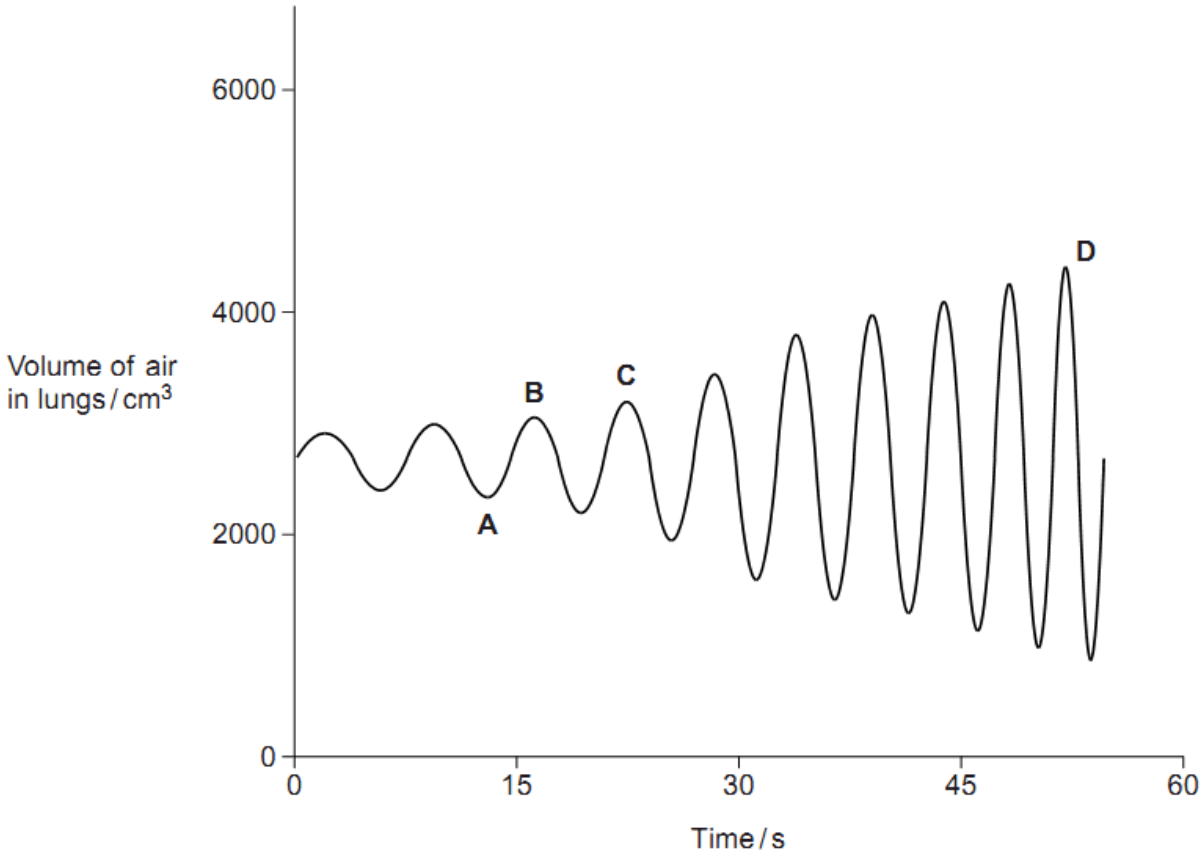
(ii) Give **one** factor, other than asbestos, which increases the risk of developing lung cancer.

.....

(1 mark)

5.

The graph shows changes in the volume of air in a person's lungs during breathing.



(a) The person was breathing in between times **A** and **B** on the graph.

(i) Explain how the graph shows that the person was breathing in between times **A** and **B**.

.....

.....

(1 mark)

(ii) Describe and explain what happens to the shape of the diaphragm between times **A** and **B**.

.....

.....

.....

.....

(2 marks)

(b) The person's pulmonary ventilation changed between times **C** and **D**.
Describe how the graph shows that the pulmonary ventilation changed.

.....

.....

.....

.....

.....

.....

(3 marks)

(c)

Describe and explain how the lungs are adapted to allow rapid exchange of oxygen between air in the alveoli and blood in the capillaries around them.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5 marks)

6.

A doctor measured the volume of air in the lungs of two people over a period of 7 seconds. Both people were resting. One person was healthy. The other had emphysema. The results are shown in the table.

Time / s	Volume of air in lungs / dm^3	
	Person **A**	Person **B**
0	6.5	7.0
1	3.8	6.0
2	3.0	5.6
3	2.3	5.1
4	2.0	4.8
5	1.7	4.5
6	1.6	4.2
7	1.6	3.9

(a) The two people were breathing out during the time shown. What evidence in the table supports this statement?

.....

.....

(1 mark)

(b) Calculate the rate at which person **A** breathed air out of his lungs between 0 and 3 seconds. Show your working.

Answer ..... $dm^3\,s^{-1}$

(2 marks)

(c) Person **B** has emphysema. Give **one** piece of evidence from the table that shows this.

.....

.....

(1 mark)

(d) Emphysema reduces the efficiency of gas exchange in the lungs. Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

7.

Fig. 2.1 shows a drawing of a part of the lung.

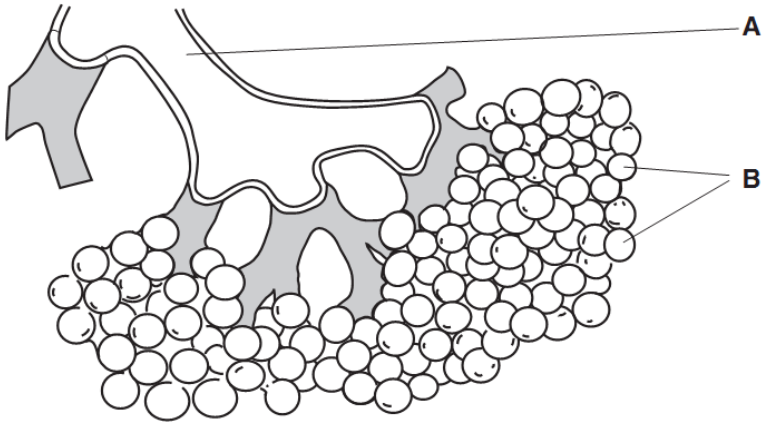


Fig. 2.1

(a) Name the structures labelled **A** and **B**.

A .....

B ..... **[2]**

(b) State **two** features of the structures labelled **B** that enable efficient gaseous exchange.

.....

.....

.....

..... **[2]**

(c) (i) Explain what is meant by the term *tissue*.

.....

.....

.....

..... **[2]**

(ii) Explain why the lungs can be considered to be an organ.

.....

.....

..... **[2]**

8.

(a) Explain, using the term **surface area to volume ratio**, why large, active organisms need a specialised surface for gaseous exchange.

.....

.....

.....

.....

.....

..... **[2]**

(b) Table 4.1 describes some of the features of the mammalian gas exchange system.

Complete the table by explaining how each feature improves the efficiency of gaseous exchange. The first one has been completed for you.

Table 4.1

feature of gas exchange system	how feature improves efficiency of gaseous exchange
many alveoli	this increases the surface across which oxygen and carbon dioxide can diffuse
the epithelium of the alveoli is very thin	
there are capillaries running over the surface of the alveoli	
the lungs are surrounded by the diaphragm and intercostal muscles	

[3]

(c) Outline how the diaphragm **and** intercostal muscles cause **inspiration**.

.....

.....

.....

.....

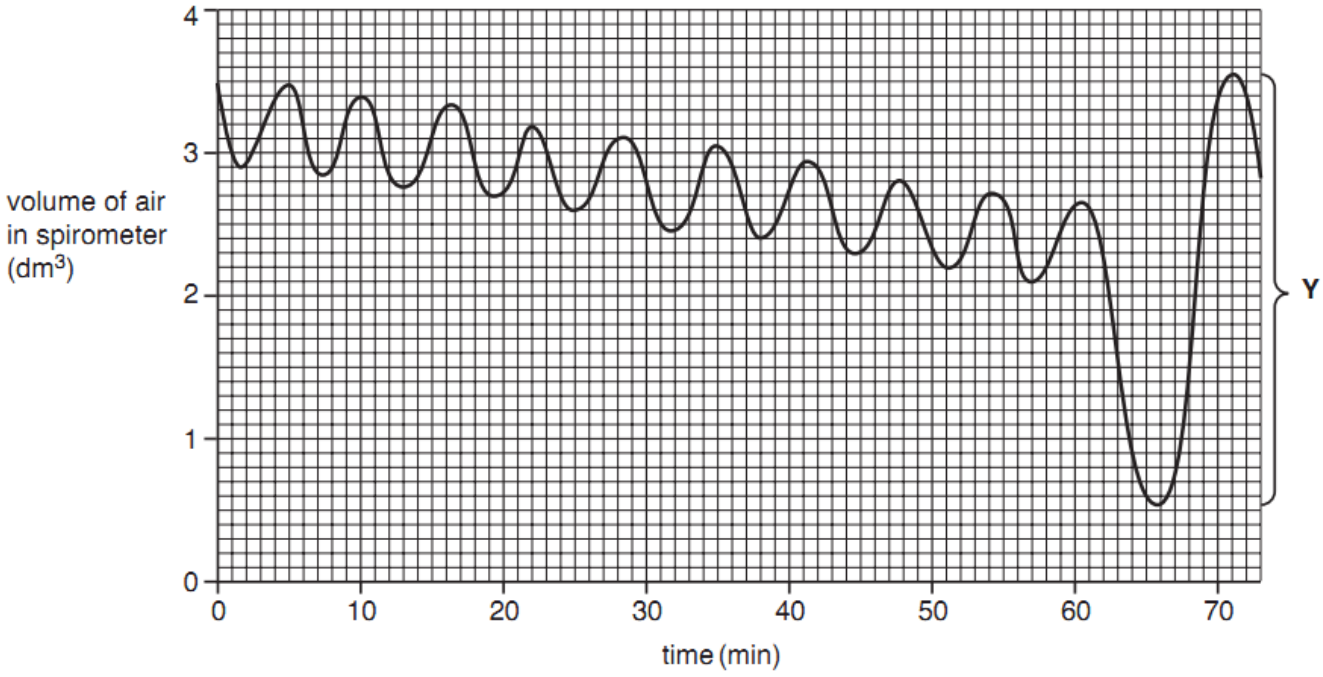
.....

.....

.....

..... **[4]**

(d) Fig. 4.1 shows the trace from a spirometer recorded from a 16-year-old student.



At the end of the trace the student measured his vital capacity. This is indicated by the letter **Y**.

State the vital capacity of the student.

..... **[1]**

Lungs; answers & markscheme

1.

Part	Sub Part	Marking Guidance	Mark	Comments
(a)		Two marks for a correct answer of 0.1s;; One mark for an incorrect answer where attempt has been made to divide distance by rate of blood flow;	2	**Q** Other answers can be accepted if distance clearly estimated as differing from 20µm. Credit is for method, not measuring ability. Mark can only be awarded if approach is clearly shown
(b)	(i)	Replaces it with blood with a low oxygen concentration / removes blood with high oxygen concentration;	1	
(b)	(ii)	Asthma attack narrows airways; Air in alveoli not replaced (as efficiently) /less air/oxygen to alveoli; Difference in concentration lower so rate of diffusion lower;	2 max	Ignore trachea and aveoli
(c)	(i)	To make sure that nothing else might have produced the results / that patients didn't improve anyway /to allow comparison (with expt group);	1	
(c)	(ii)	Inhaler with dummy drug / placebo / with old drug / with no drug; Otherwise treated exactly the same;	2	**Q** No need for phrase "dummy drug" as long as idea conveyed.

2	(a)	(i)	Through alveolar epithelium; Through capillary epithelium/endothelium;	2	Accept: Through lining / wall of alveolus and capillary for 1 mark Accept: squamous epithelial cells for 'epithelium' Neutral: alveolar endothelium Neutral: references to diffusion **Q** Correct use of terminology;
2	(a)	(ii)	(Thicker alveolar wall) – no mark (So) Longer diffusion pathway / slower diffusion;	1	Neutral: less diffusion Neutral: references to surface area
2	(b)	(i)	(In alveolus) Brings in air containing a high(er) oxygen concentration; Removes air with a low(er) oxygen concentration;	2	Need the idea of air moving and oxygen concentration Neutral: reference to carbon dioxide concentration
2	(b)	(ii)	Circulation of blood / moving blood;	1	Neutral: blood Neutral: short diffusion pathway
2	(c)		Long time between decrease in mining and increase in cases; Graph shows fluctuations; Correlation does not prove causation / there may be other causes of miner's lung; Improved diagnosis methods; Do not know number of cases / baseline before 1990; Not all cases reported / not all individuals with miner's lung visit a doctor;	2 max	*Accept*: correct use of figures from graph for the first marking point: e.g. cases do not increase until after 2000 / 2001-2004 / 10 years later.

3.

(a)	1	(Bacteria transmitted in) droplets / aerosol;	5 max	1	Accept: TB / 'it' / the disease / air droplets
	2	(Bacteria) engulfed / ingested by phagocytes / macrophages;		1	Neutral: spread through the air / coughs / sneezes
	3	(Bacteria) encased in named structure e.g. wall / tubercle / granuloma / nodule;		1	Reject: virus
				2	Neutral: 'destroyed by';
	4	(Bacteria) are dormant / not active / not replicating;		2	Accept: white blood cells
				3	Neutral: bacteria contained
	5	If immunosuppressed, bacteria activate / replicate / released;		5	Accept: reference to HIV / old age / stress
				7	Accept: fibrous tissue
	6	Bacteria destroy alveoli / capillary / epithelial cells;		8	Neutral: reduced gas exchange
				8	Accept: reduced SA:VOL
	7	(Leads to) fibrosis / scar tissue / cavities /calcification;			
	8	(Damage) leads to less diffusion /less surface area / increases diffusion distance;			
	9	(Activation / damage allows bacteria) to enter blood / spreads (to other organs);			

(b)	1	Alveoli break down / collapse / rupture / walls thicken;	5 max	1	Neutral: alveoli damaged
	2	Less surface area / increases diffusion distance / less diffusion;		2	Accept: references to a lack of alpha-1-antitrypsin
	3	Loss of elastin / elastic tissue / elastase involved;		3	This mark is for a structure. Accept: elastin permanently stretched
	4	(Alveoli / lungs) cannot recoil / spring back / have reduced elasticity / more difficult to expel air;		4	This mark is for a mechanism. Do **not** award reduced elasticity for 3.
	5	Reduced diffusion gradient / air not replenished / less air leaves lungs;		4	Neutral: more difficult to inhale air
				5	This mark is for a consequence
	6	Less oxygen enters blood / tissues;			Accept: reduced concentration gradient;
	7	Less respiration / less energy released / less ATP produced;			Neutral: less air enters lungs
				7	**Q** Reject: 'less energy produced' / anaerobic respiration
				7	Accept: 'less energy produced in the form of ATP' / less oxygen for respiration

4.

Part	Sub Part	Marking Guidance	Mark	Comments
(a)		Phagocytes engulf/ingest pathogens/microorganisms/bacteria/viruses; Phagocytes destroy pathogens/microorganisms/bacteria/viruses; Lung diseases are caused by pathogens/microorganisms/bacteria/viruses;	2 max	**Q** Allow description of process of engulfing;
(b)	(i)	Alveoli/lungs will not inflate/deflate fully/reduced lung capacity; Breathing out particularly affected/no longer passive; Concentration/diffusion gradient / rate of diffusion reduced;	2 max	
(b)	(ii)	Alveolar walls thicken; Longer diffusion pathway; Scarred/fibrous tissue; Reduces surface area (for gaseous exchange);	4	**Q** Diffusion is essential for 2nd point and surface area for 4th point.
(c)	(i)	Cancer develops 20 – 30 years after exposure (to asbestos);	1	
(c)	(ii)	Smoking / air pollution / specified industrial source;	1	

5.

(a)(i)	(Lung volume) increases / reaches a maximum (at **B**);	1	Do not negate mark for 'breathing out' if qualified e.g. when (lung volume) decreases
(a)(ii)	Flattens / lowers / moves down; (Diaphragm / muscle) contracts;	2	 *Reject:* second mark only if intercostal muscles cause the diaphragm to flatten
(b)	Pulmonary ventilation = tidal volume × breathing rate; Breathing rate increases / more breaths per min (between **C** and **D**) / peaks get closer; Tidal volume / volume of air (inhaled) per breath increases (between **C** and **D**) / deeper breaths; (Tidal volume increase) qualified by data from graph e.g. approximate three-fold increase / appropriate calculation;	3 max	*Accept:* ventilation rate instead of breathing rate *Neutral:* breathing increases *Accept:* breathe quicker *Neutral:* volume in lungs increases *Accept:* distance from bottom to top of peak increases for 'tidal volume increases' *Neutral:* higher peaks for 'tidal volume increases'

(c)

1	Many alveoli / alveoli walls folded provide a large surface area;	5 max	*Neutral:* alveoli provide a large surface area
2	Many capillaries provide a large surface area;		*Neutral:* greater / better diffusion *Neutral:* fast gas exchange
3	(So) fast diffusion;		Allow 'fast diffusion' only once
4	Alveoli or capillary walls / epithelium / lining are thin / short distance between alveoli and blood;		*Reject*: thin membranes / cell walls *Accept:* one cell thick for 'thin'
5	Flattened / squamous epithelium;		*Accept*: endothelial
6	(So) short diffusion distance / pathway;		
7	(So) fast diffusion;		
8	Ventilation / circulation;		*Accept:* descriptions for ventilation / circulation
9	Maintains a diffusion / concentration gradient;		Do not double penalise if description lacks detail e.g. thin membranes so a short diffusion distance = 1 mark
10	(So) fast diffusion;		

6.

(a)	Volume (of air in lungs) decreases;	1	Accept: Results decrease
(b)	Correct answer 1.4;; Incorrect answer showing (vol. air breathed out =) 6.5 – 2.3 / 4.2 (dm^3);	2	
(c)	Reduced flow rates / less air breathed out / more air left in lungs (after breathing out);	1	Insufficient: More air in lungs / high volume of air in lungs
(d)	1. Alveoli break down / collapse / rupture / fewer alveoli / larger alveoli or alveolar wall/epithelium walls thicken; 2. Reduced surface area / increased diffusion pathway; 3. (So) less diffusion; 4. Less elastin / elastic (tissue) / not recoiling / loss of elasticity / elastin permanently stretched; 5. Reduced flow rate / less air expelled; 6. So small / reduced diffusion or concentration gradient;	4 max	1. Neutral: Damage. Accept alveoli burst Less surface area for diffusion = 2 marks (mark points 2 and 3) 3. Accept diffusion less efficient. Reject diffusion of air. 4. Elastic tissue must be in context of lungs. 6. Accept: Not maintaining a steep diffusion/ concentration gradient.

7.

(a)		A = bronchiole ; B = alveolus / alveoli ;	**2**	**Mark the first answer for each letter.** If the first answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**. **DO NOT CREDIT** bronchus **ACCEPT** phonetic spelling of alveolus and bronchiole e.g. aveoli
(b)		**1** large, surface area / SA :VOL ; **2** (alveolar) wall / epithelium, one cell thick ; **3** (made of) squamous, cells / epithelium ; **4** ref to surfactant ; *idea of:* **5** (very) close to, capillaries / blood supply **OR** rich blood supply / many capillaries ;	**2 max**	**Mark the first <u>two</u> suggestions only. Read as prose unless candidate has indicated two points by bullets or numbers – in this case mark the first comment in each bullet.** **ACCEPT** large SA / VOL, (alveoli) are small **and** in large number **DO NOT CREDIT** large amounts of tiny alveoli **ACCEPT** thin wall / thin barrier **DO NOT CREDIT** ref to cell wall / lining **IGNORE** alveolus one cell thick **ACCEPT** correct description of squamous cells (e.g. thin flat cell layer) **ACCEPT** pavement epithelium **IGNORE** reference to moist **DO NOT CREDIT** endothelium **IGNORE** ref to elastic fibres

7[c]

(i)	collection / group, of cells (of one or more types) ;	**2 max**	**IGNORE** ref similar cells
	(cells), working together **OR** with, common / same, function ;		**ACCEPT** a group of cells with a function = 2 marks
	specialised (cells) ;		**DO NOT CREDIT** differentiated
(ii)	squamous / ciliated ;	**1**	**ACCEPT** endothelium / columnar **DO NOT ACCEPT** cilia, goblet cell, ciliated *cells*
	(organ is) a collection of tissues / named tissues ;	**2**	Look for idea of more than one tissue **ACCEPT** two or more correctly named tissues from: epithelium, elastic, glandular, smooth muscle, blood, nervous, cartilage, connective
	(working together) to enable gas exchange / AW ;		**DO NOT ACCEPT** perform a function unqualified – we want to know *what* function (can be named or described) **DO NOT ACCEPT** respiration **IGNORE** breathing

8.

(a)		large / active, organisms have high(er), demand for oxygen / need to remove CO_2 ; small(er), <u>surface area to volume ratio / SA:V / surface area:volume</u> ; surface area too small / distance too large / diffusion takes too long (to supply needs) ;	**2 max**	**ACCEPT ORA** throughout **IGNORE** ref to nutrients **ACCEPT** diffusion too slow *look for reason why diffusion not good enough*
(b)		create / maintain, (steep), diffusion / concentration, gradient ; *epithelium* — short (diffusion) distance ; *capillaries* — delivers carbon dioxide (to be removed from blood) / carries oxygen away (from alveoli) ; short (diffusion) distance ; *diaphragm / intercostal muscles* — ventilation / supply of oxygen (to alveoli) / removal of carbon dioxide (from alveoli) ;	**3 max**	*could give mark in any row as an additional mark – but only once* **DO NOT ACCEPT** any vague reference to 'gases' throughout **ACCEPT** short diffusion distance here even if given above **ACCEPT** breathing in **and** out / AW
(c)		diaphragm (contracts / flattens and) moves downwards ; intercostal muscles <u>contract</u> to move ribs, up / out ; increase <u>volume</u> of thorax ; reduce pressure inside thorax ; to below atmospheric pressure/creates pressure gradient / AW ;	**4 max**	**IGNORE** ref to internal / external **ACCEPT** increase volume of lungs / chest **ACCEPT** decrease pressure in lungs / chest must ensure the pressure gradient is in correct direction – lower in lungs
(d)		3 dm^3 ;	**1**	correct units **must** be given **ACCEPT** litres