EXAM PAPERS PRACTICE

Gas Exchange

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

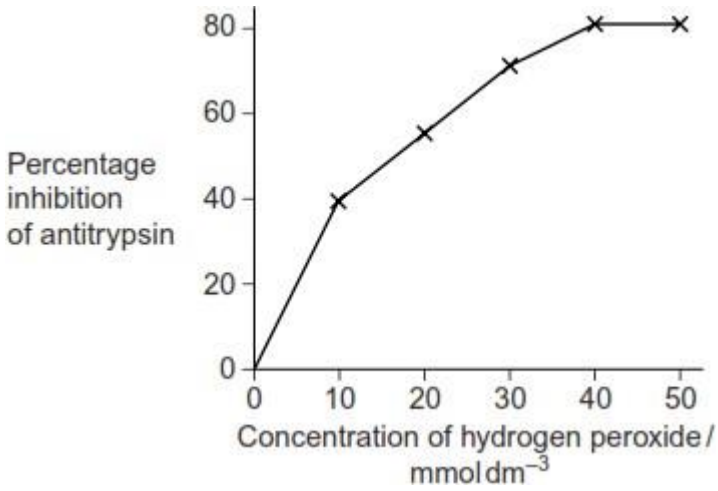
Level: AQA A LEVEL 7402

Subject: Biology

Exam Board: AQA A Level 7402

Topic: Gas Exchange

1 Alpha-1-antitrypsin is a protein that reduces the activity of enzymes that can damage lung tissue. Cigarette smoke contains hydrogen peroxide. Hydrogen peroxide reduces the activity of alpha-1-antitrypsin. Scientists investigated the effect of different concentrations of hydrogen peroxide on the activity of alpha-1-antitrypsin. The graph shows their results.



(a) (i) Hydrogen peroxide reacts with two amino acids in alpha-1-antitrypsin. Explain how this reduces activity of the protein.

(2)

(ii) Explain the results shown in the graph.

(2)

(b) Long-term smokers are often short of breath. Use this information to explain why.

(2)

(Total 6 marks)

2 (a) Describe **two** differences between active transport and facilitated diffusion.

1. _____

_____

2. _____

_____

(2)

(b) Explain why molecules of oxygen and carbon dioxide are able to diffuse across membranes.

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(2)

(c) Explain why ventilation of the lungs increases the efficiency of gas exchange.

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(2)

(Total 6 marks)

3 This question should be written in continuous prose, where appropriate.
Quality of Written Communication will be assessed in the answer.

(a) Explain how the ventilation mechanism of a fish and the structure of its gills result in the efficient uptake of oxygen from water.

(6)

Table 1 compares some features of water and air.

Feature	Water	Air
Relative density	1000	1
Maximum concentration of oxygen / cm^3 dm^{-3}	9	130

Table 1

Table 2 shows some features of gas exchange in a fish and in a mammal.

Feature	Fish	Mammal
Percentage of oxygen extracted from water or air	80	25
Oxygen consumption at rest / $cm^3\ kg^{-1}\ hour^{-1}$	100	200

Table 2

(b) (i) The fish has a body mass of 0.2 kg. Calculate the volume of water it will need to pass over its gills each hour to supply the oxygen required when resting. Show your working.

Answer _____ dm^3 / $hour^{-1}$

(2)

(ii) Ventilation in mammals involves movement of air to and from the gas exchange surface in a tidal pattern. Using information in the tables, explain why it is easier to move water over the gas exchange surface of a fish in one direction rather than in a tidal pattern.

_____

_____

_____

_____

(2)

(c) A rise in the temperature of water decreases the amount of oxygen dissolved in the water. As the water temperature rises, the rate of ventilation in a fish also rises. Explain the advantage of this.

(2)

(Total 12 marks)

4 (a) Describe and explain how fish maintain a flow of water over their gills.

(4)

(b) Describe and explain how the structure of the mammalian breathing system enables efficient uptake of oxygen into the blood.

(6)

(Total 10 marks)

5 (a) When first hatched, the young of some species of fish are less than 2 mm long. Explain how these young fish get enough oxygen to their cells without having gills.

(2)

(b) Mackerel are fast swimming fish whereas toadfish only swim slowly. The table shows some features of the gills of these fish.

	Thickness of lamellae / µm	Number of lamellae per mm of gill length
Mackerel	5	32
Toadfish	35	8

Use evidence from the table to explain how mackerel are able to swim faster than toadfish.

_____

_____

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_____

(3)

(Total 5 marks)

6 (a) Describe how air is taken into the lungs.

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_____

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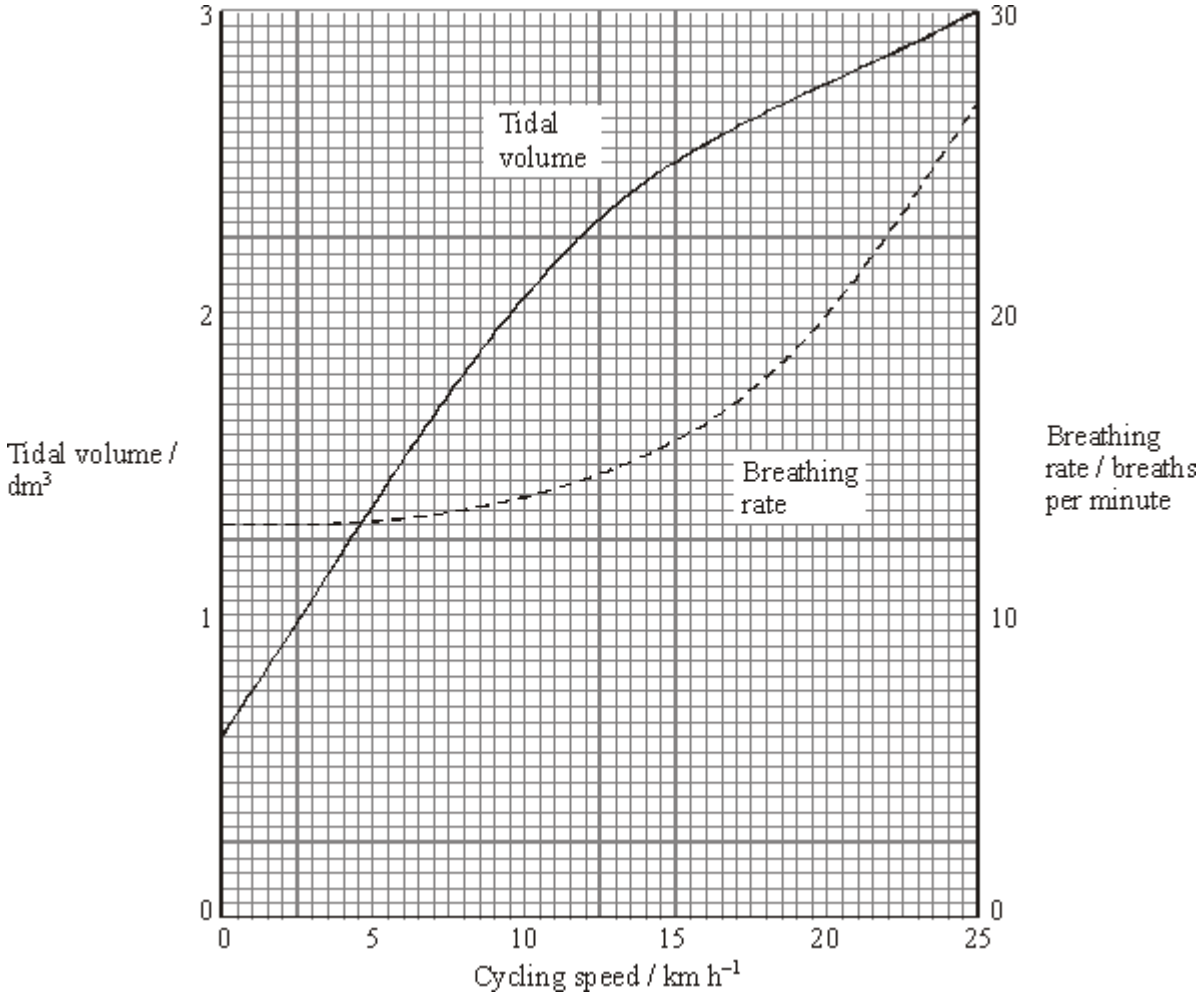
(3)

The volume of air breathed in and out of the lungs during each breath is called the tidal volume. The breathing rate and tidal volume were measured for a cyclist pedalling at different speeds. The graph shows the results.



(b) Describe the **two** curves.

(i) Tidal volume

_____

_____

_____

(ii) Breathing rate

_____

_____

_____

(2)

(c) Calculate the total volume of air breathed in and out per minute when the cyclist is cycling at 20 km h^{-1}. Show your working.

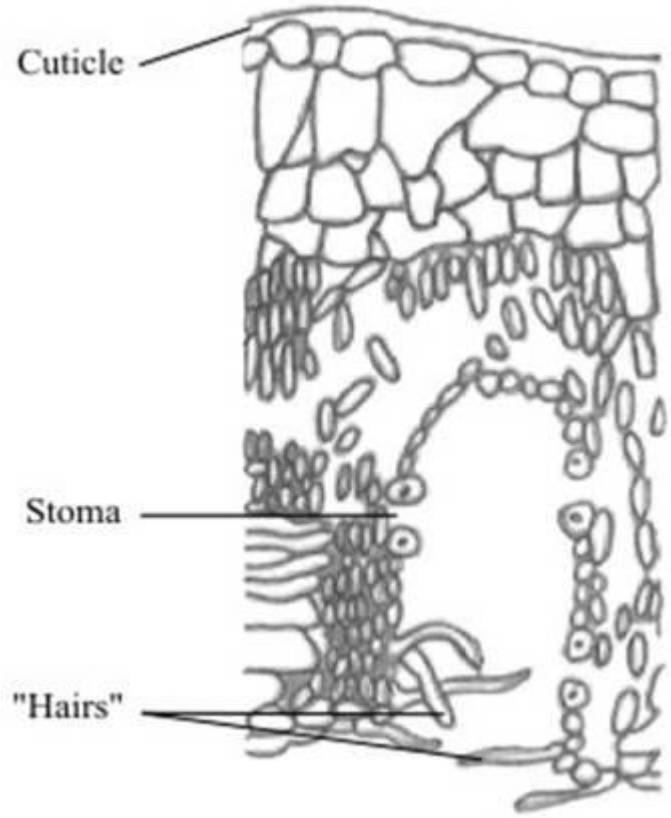
_____ dm^3

(2)

(Total 7 marks)

7 **Figure 2** shows a single stoma and surrounding cells from the leaf of a xerophytic plant.

Figure 2



(i) Explain how the cuticle reduces water loss.

_____

_____

(1)

(ii) Explain how **one** of the other labelled parts reduces water loss.

_____

_____

_____

_____

(2)
(Total 3 marks)

8 (a) The photograph shows part of the gill of a fish as seen through a light microscope. It is magnified × 400.

(i) Explain how the structure of the gill makes oxygen uptake efficient.

_____

_____

_____

_____

(2)

(ii) Water containing dissolved oxygen flows over the gill in the opposite direction to the blood flow inside. Explain why this arrangement is important for efficient oxygen uptake.

_____

_____

_____

_____

(2)

(b) There is a one-way flow of water over the gills of a fish whereas there is a two-way flow of air in the lungs of a mammal. Suggest **one** advantage to a fish of this one-way flow of water over its gills.

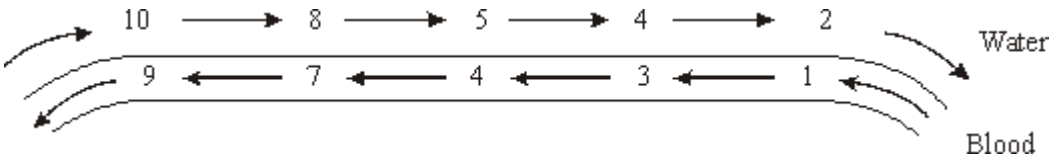
_____

_____

(1)

(Total 5 marks)

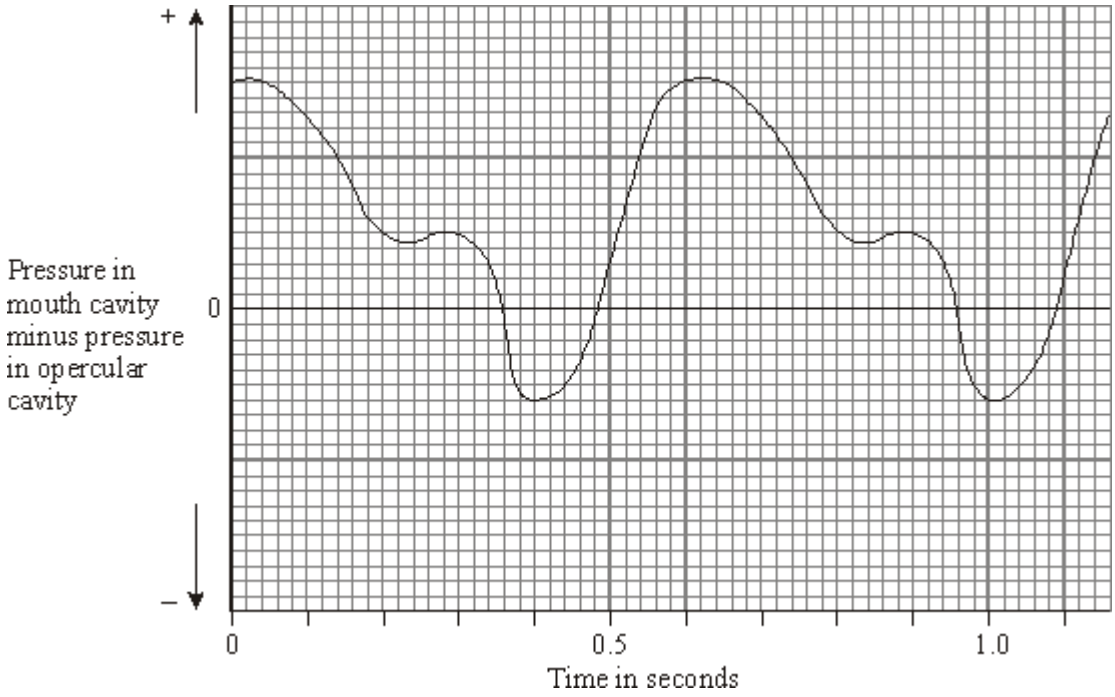
9 (a) The diagram represents the flow of water and blood through the gills of a fish. The figures give relative oxygen concentrations.



Use the information in diagram to explain the advantage of the countercurrent flow.

(2)

(b) In the ventilation cycle of a fish, water enters the mouth cavity and then passes through the gills into the opercular cavity. The graph shows the difference in pressure between the mouth cavity and the opercular cavity.



Calculate the number of ventilation cycles per minute of the fish. Show your working.

Answer _____

(2)

(Total 4 marks)

10 Lung cancer, chronic bronchitis and coronary heart disease (CHD) are associated with smoking. **Tables 1** and **2** give the total numbers of deaths from these diseases in the UK in 1974.

Table 1 Men

Age/years	**Number of deaths (in thousands)**		
	lung cancer	chronic bronchitis	coronary heart disease
35 - 64	11.5	4.2	31.7
65 - 74	12.6	8.5	33.3

75+	5.8	8.1	29.1
Total (35 - 75+)	29.9	20.8	94.1

Table 2 Women

Age/years	Number of deaths (in thousands)		
	lung cancer	chronic bronchitis	coronary heart disease
35 – 64	3.2	1.3	8.4
65 – 74	2.6	1.9	18.2
75+	1.8	3.5	42.3
Total (35 – 75+)	7.6	6.7	68.9

(i) Using an example from the tables, explain why it is useful to give data for men and women separately.

_____

_____

_____

(2)

(ii) Data like these are often given as percentages of people dying from each cause.

Explain the advantage of giving these data as percentages.

_____

_____

_____

_____

(2)

(Total 4 marks)

11 (a) Describe the features of fish gills that give them a large surface area.

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_____

_____

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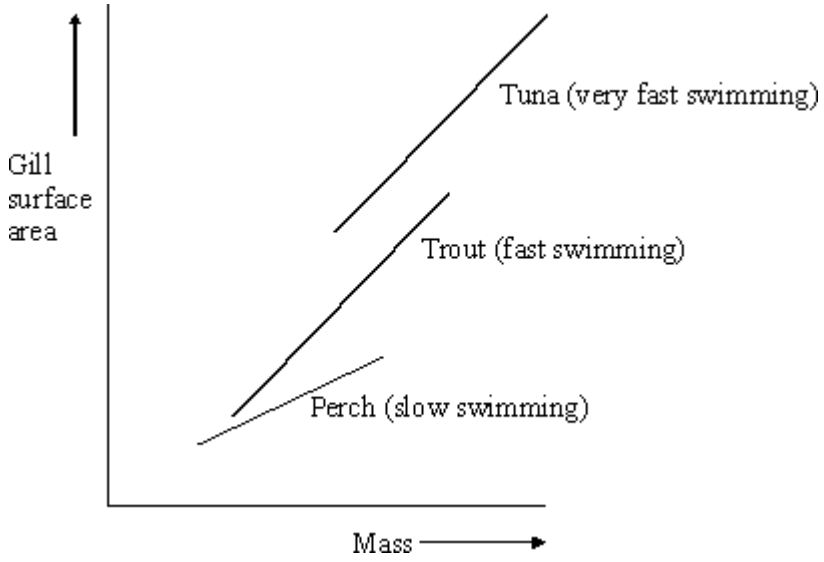
(2)

The graph shows the relationship between gill surface area and body mass for three species of fish.



(b) (i) Describe the relationships between gill surface area, mass and swimming speed shown in the diagram.

_____

_____

(1)

(ii) Explain the relationship between gill surface area and swimming speed.

_____

_____

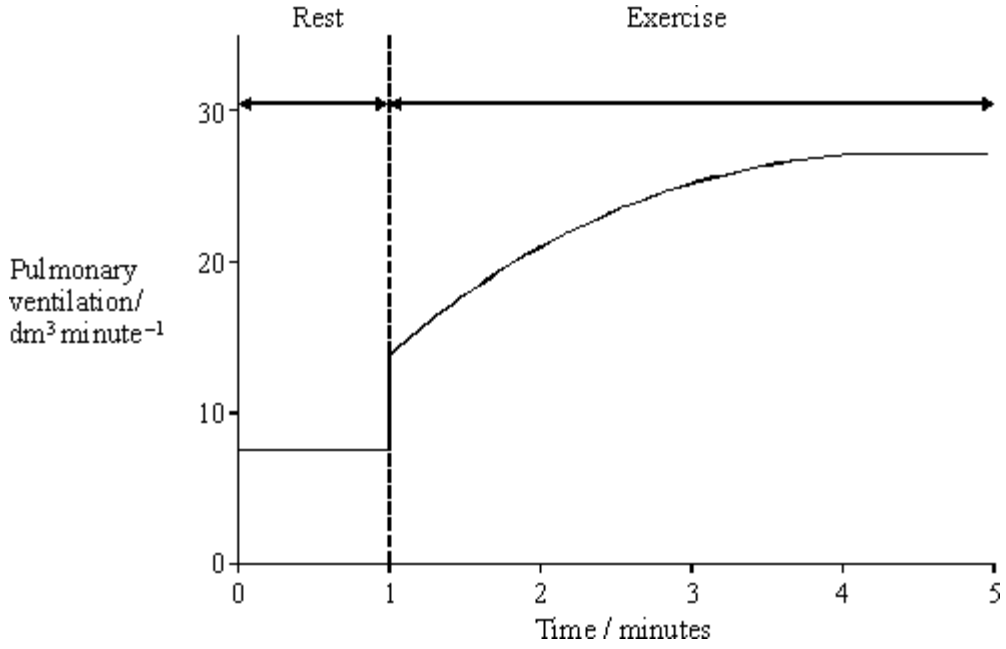
_____

_____

(2)

(Total 5 marks)

12 The graph shows how pulmonary ventilation changes during a period of exercise.



(a) Describe how pulmonary ventilation changed during the period of exercise.

_____

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_____

(1)

(b) After 4 minutes of exercise, the breathing rate was 20 breaths per minute. Explain how you could use this information and the graph to calculate tidal volume.

_____

_____

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(2)

(c) When a person starts to breathe out, the percentage of oxygen in the air first exhaled is the same as the percentage of oxygen in the atmospheric air. Explain why.

_____

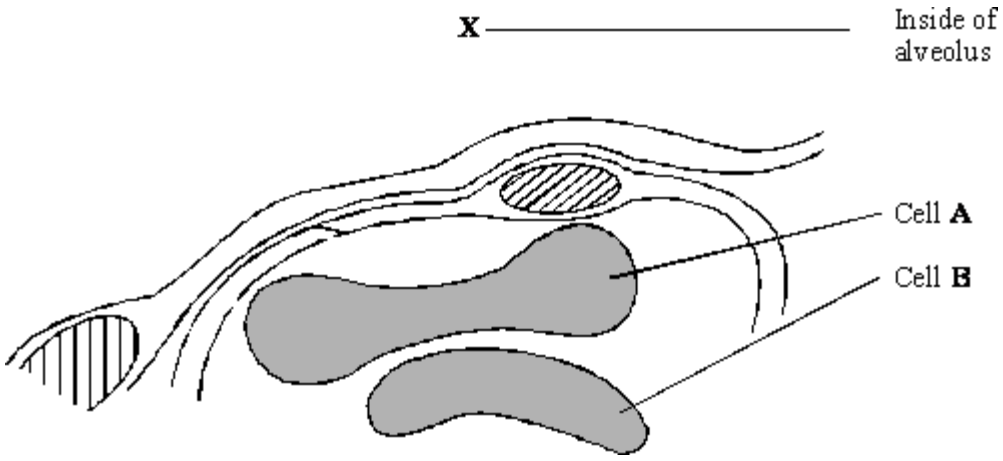
_____

_____

(2)

(Total 5 marks)

13 The drawing shows an electron micrograph of a section through part of an alveolus from a lung.



(a) Describe the path of a molecule of oxygen from the air in the alveolus at **X** to the plasma membrane of cell **A**.

_____

_____

(1)

(b) Cell **A** is a eukaryotic cell. Give **two** features that may be found in a prokaryotic cell which are not found in cell **A**.

1. _____

_____

2. _____

_____

(2)

(c) Cells **A** and **B** are biconcave discs. Explain **one** advantage of a biconcave disc over a spherical cell of the same volume in transporting oxygen.

_____

_____

_____

_____

(2)

(d) The diameter of a human red blood cell is 7 µm.

(i) Calculate the magnification of the drawing. Show your working.

Magnification = _____

(2)

(ii) In calculating the magnification, what assumption did you have to make about how the section was cut?

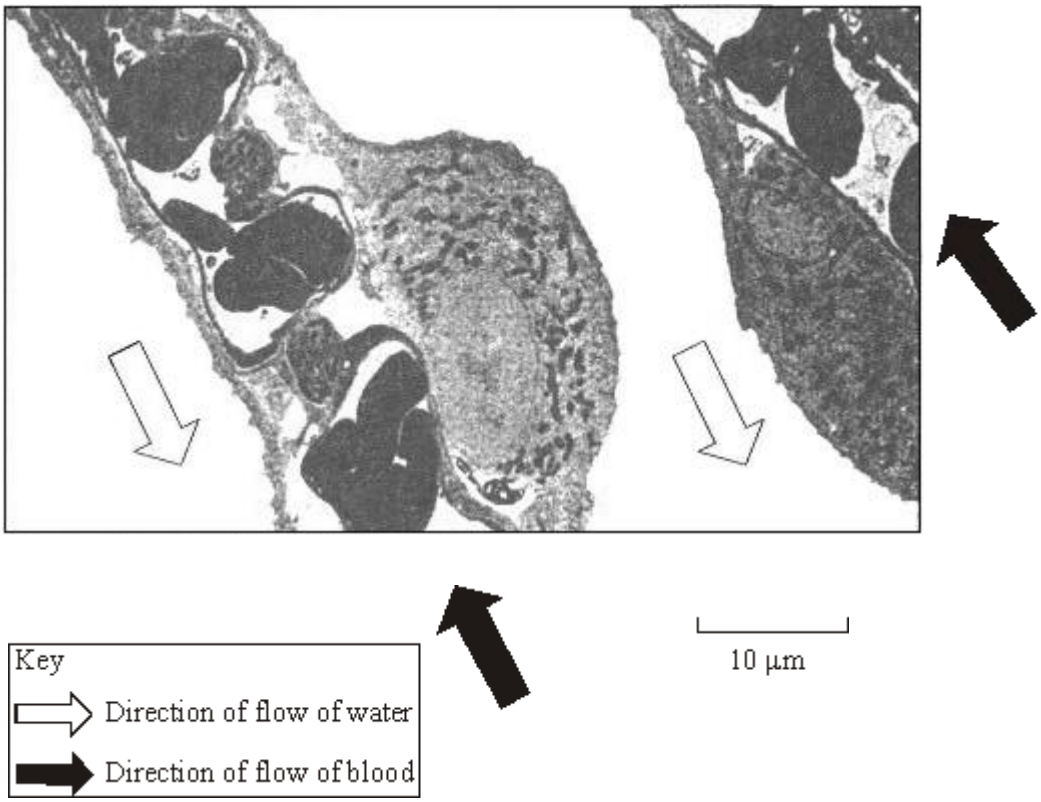
_____

_____

(1)

(Total 8 marks)

14 The electron micrograph shows a section through a fish gill. The directions of flow of water and of blood are indicated by arrows.



Source: www.ucdavis.edu/mjguinan

(a) Calculate the minimum distance that a molecule of oxygen would have to travel from the water to a red blood cell. Give your answer in micrometres and show your working.

Answer _____ µm.

(2)

(b) Explain how the relationship between the direction of flow of water and of blood shown in the micrograph is useful to a fish.

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(3)

(Total 5 marks)

15 (a) Describe the part played by the diaphragm in causing air to enter the lungs during breathing.

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_____

(3)

Seals are mammals. They have lungs and must breathe air. They can dive and remain under water for a long time. The table shows the flow of blood to the lungs and to the diaphragm in a seal when it is on land and when it is under water.

Organ	Blood flow / $cm^3\ min^{-1}\ g^{-1}$	
	On land	Under water
Lungs	0.88	0.52
Diaphragm	0.21	0.02

(b) Explain why the figures in the table are given per gram of tissue.

_____

_____

_____

_____

(2)

(c) Calculate the percentage by which blood flow to the lungs is reduced when a seal is swimming under water. Show your working.

Answer _____

(2)

(d) There is a greater percentage reduction in blood flow to the diaphragm than to the lungs during a dive. Explain the advantage to a diving seal of

(i) blood continuing to flow to the lungs;

_____

_____

(1)

(ii) a large reduction in blood flow to the diaphragm.

_____

_____

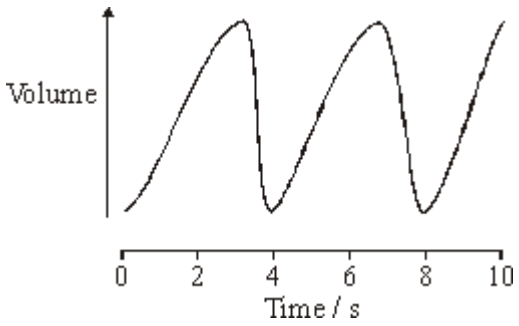
_____

_____

(2)

(Total 10 marks)

16 A person was sitting at rest and breathing normally. A recording was made of the changes in the volume of air in his lungs over a ten-second period. The diagram shows this recording.



(a) Describe the part played by muscles in bringing about the change between 3 and 4 seconds.

_____

_____

(1)

(b) Describe how an increase in lung volume leads to air entering the lungs.

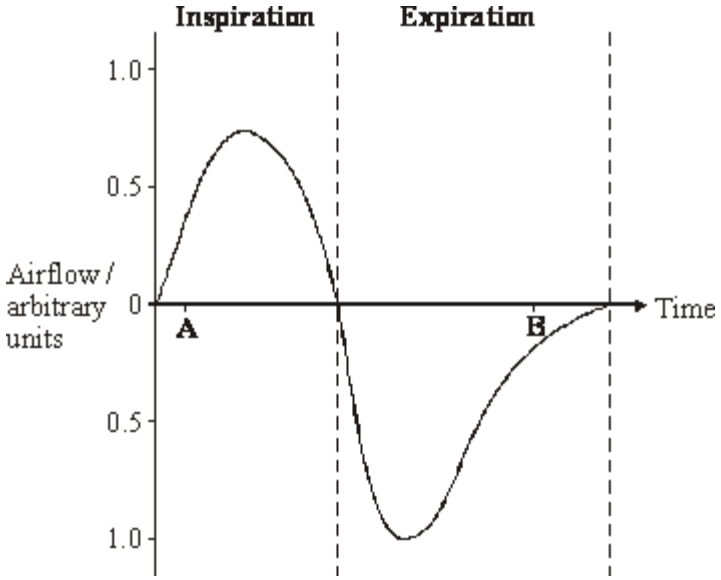
_____

_____

(1)

(Total 2 marks)

17 The graph shows airflow into and out of the lungs during a normal breath.



(a) (i) How will the concentration of carbon dioxide in the airflow differ at times **A** and **B**?

_____

_____

(1)

(ii) Describe the role of diffusion in producing this difference.

_____

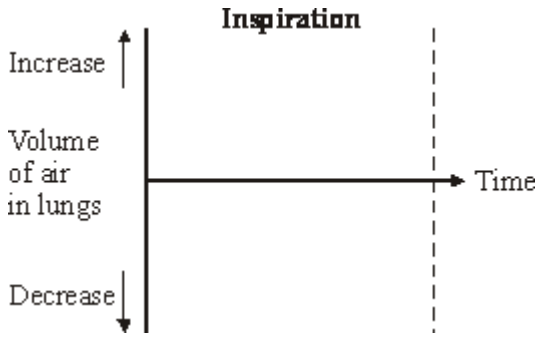
_____

_____

_____

(2)

(b) Use information from the graph to sketch a curve on the axes below to show how the volume of air in the lungs changes during inspiration.



(2)

(c) The intercostal muscles are between the ribs. In normal breathing, describe the part played by the intercostal muscles

(i) during inspiration;

_____

_____

_____

_____

_____

_____

(3)

(ii) during expiration.

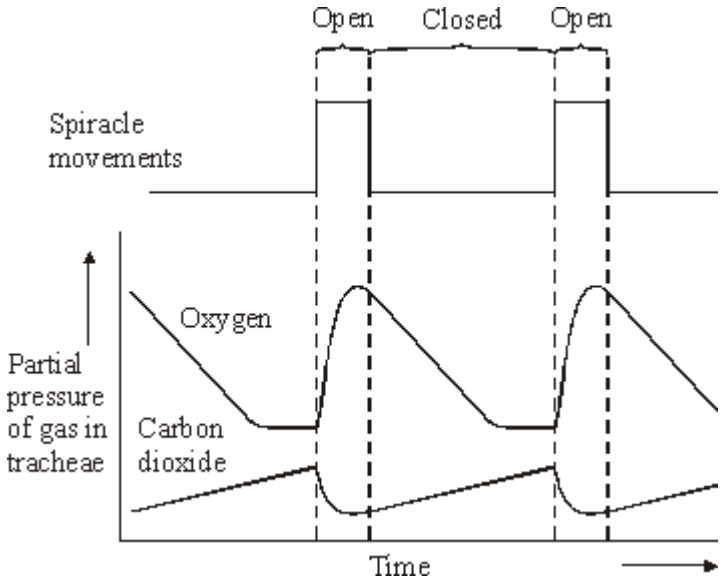
_____

_____

(1)

(Total 9 marks)

18 Many insects release carbon dioxide in short bursts even though they produce it at a constant rate. The diagram shows how this is achieved in one particular insect.



(a) Using information from the diagram, suggest what stimulates the spiracles to open.

_____

_____

(1)

(b) Explain what causes the oxygen concentration in the tracheae to fall when the spiracles are closed.

_____

_____

_____

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(2)

(c) The insect lives in dry conditions. Suggest an advantage of the pattern of spiracle movements shown in the diagram.

_____

_____

_____

_____

(2)

(Total 5 marks)

19 In the lungs, the alveoli are the site of gas exchange.

(a) A large number of small alveoli is more efficient in gas exchange than a smaller number of larger alveoli. Explain why.

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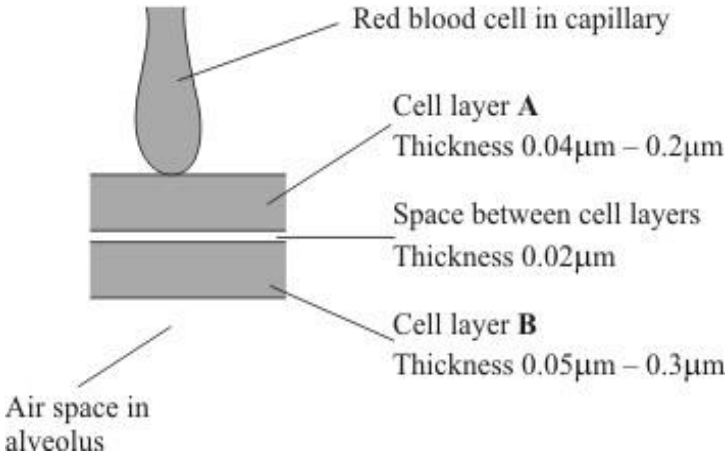
_____

_____

_____

(2)

(b) The diagram shows part of an alveolus and a capillary.



(i) Name the type of cells in layer **B**.

_____

(1)

(ii) What is the minimum distance a molecule of carbon dioxide diffuses from the blood plasma to the air space in the alveolus?

_____

(1)

(c) Just before a person starts to exhale, the composition of the air in an alveolus differs from the composition of the air in the trachea.

(i) Give **two** ways in which the composition would differ.

1. _____

2. _____

(1)

(ii) Explain what causes this difference in composition between the air in the alveolus and the air in the trachea.

_____

_____

(1)

(d) The partial pressure of a gas is a measure of the amount of gas that is present.
The partial pressure of carbon dioxide in blood going to the lungs is 6.3 kPa.
The partial pressure of carbon dioxide in an alveolus is 5.3 kPa.

(i) Through which vessel does blood leave the heart to go to the lungs?

_____

(1)

(ii) Suggest why blood returning to the heart from the lungs contains some carbon dioxide.

_____

_____

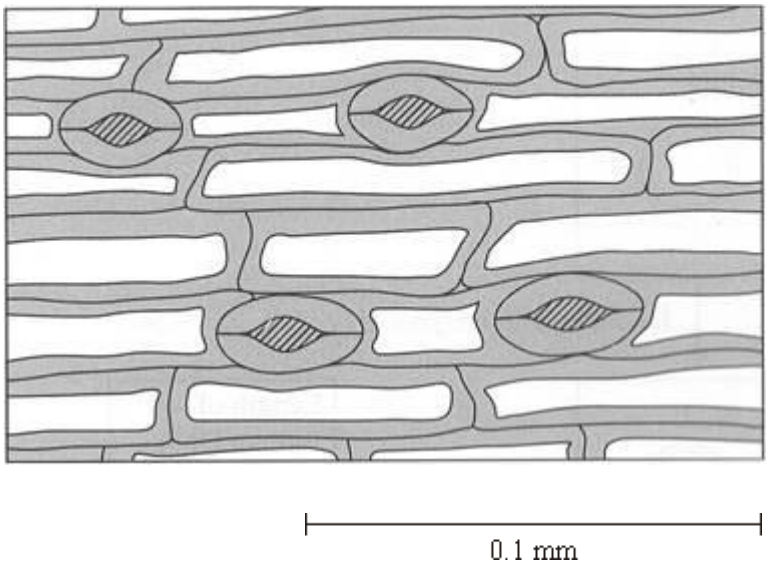
_____

_____

(2)

(Total 9 marks)

20 The drawing shows part of the lower leaf epidermis of sorghum.



(a) Calculate the number of stomata per mm^2 of the leaf surface. Show your working.

Answer _____ stomata per mm^2

(2)

(b) Sorghum has few stomata per mm^2 of leaf surface area. Explain how this is an adaptation to the conditions in which sorghum grows.

_____

_____

_____

_____

_____

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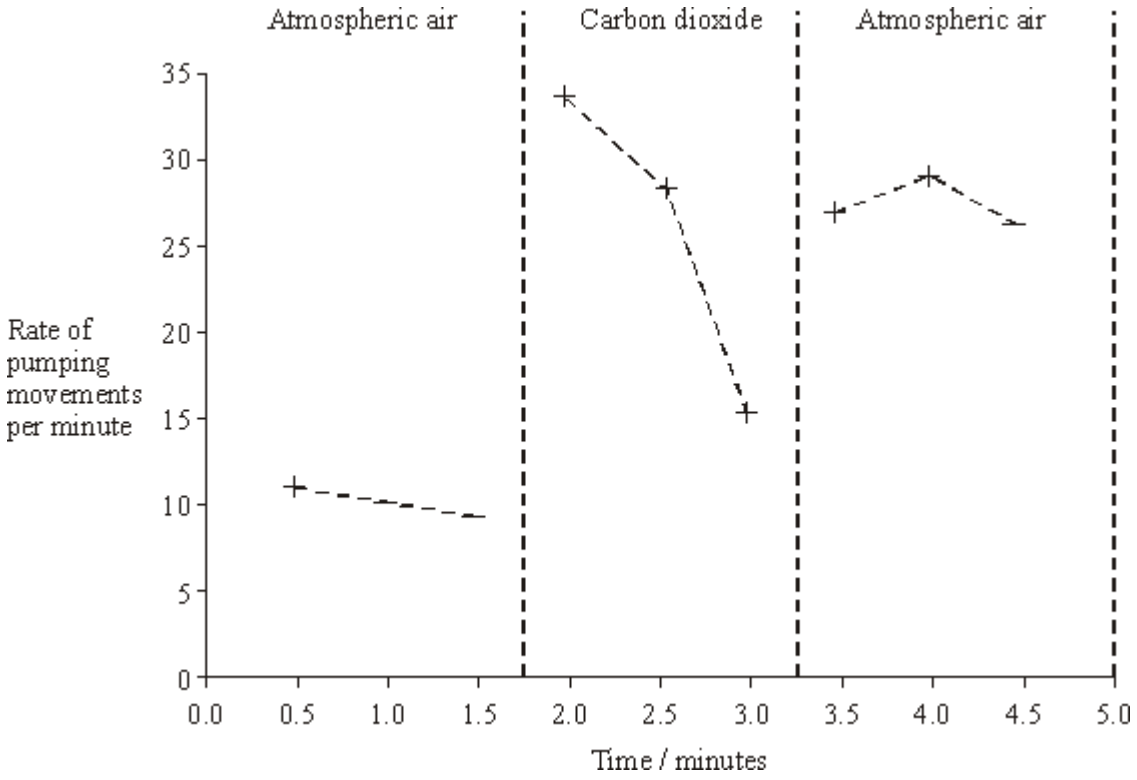
(3)

(Total 5 marks)

21 In an investigation, a locust was given alternating supplies of atmospheric air and pure carbon dioxide. The rate of pumping movements of the insect's abdomen was measured.

The graph shows the results.



(a) Explain what caused

(i) the rise in the rate of abdominal pumping movements between 1.5 and 2.0 minutes,

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_____

(1)

(ii) the fall in the rate of abdominal pumping movements between 2.0 and 3.0 minutes.

_____

_____

_____

_____

(2)

(b) The rate of abdominal pumping movements increases between 3.0 and 3.5 minutes. Suggest the advantage of this change to the locust.

_____

_____

(1)

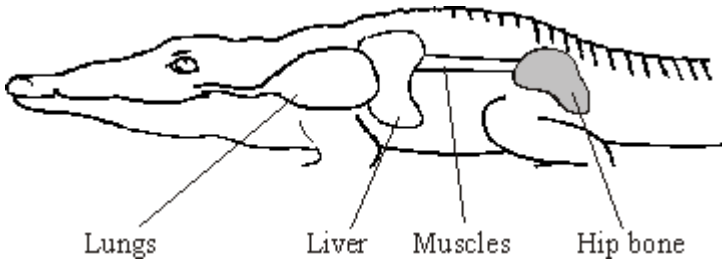
(Total 4 marks)

22 Read the following passage.

When a person breathes in, the diaphragm muscle contracts and the diaphragm flattens. This, together with movement of the ribs, leads to air being drawn into the lungs. Breathing out is generally passive and results from the relaxation of the diaphragm muscle and the elastic recoil of the lung tissue.

Two sets of intercostal muscles also play an important part in breathing in humans. Contraction of the external intercostal muscles is associated with breathing in. During strenuous exercise, contraction of the internal intercostal muscles helps force air out of the lungs. In this case, breathing out is active.

Crocodiles also have lungs and breathe air. They have well developed intercostal muscles but do not appear to use these during breathing. They also lack a diaphragm. Breathing in, in crocodiles, is brought about by contraction of muscles attaching the liver to the hip bones (see diagram). This pulls the liver back and causes air to enter the lungs. Breathing out results from the contraction of abdominal muscles which move the liver forwards.



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

(a) Describe the movement of the ribs when a person breathes in (line 2).

_____

_____

(1)

(b) (i) Explain what is meant by passive (line 3).

_____

_____

(1)

(ii) Is breathing out in crocodiles active or passive? Explain your answer.

_____

_____

(1)

(c) Explain how movement of the liver causes air to enter a crocodile's lungs.

_____

_____

_____

_____

_____

_____

(3)

(d) Describe the difference in the composition of gases in inhaled and exhaled air. Explain how these differences are caused.

(6)

(Total 12 marks)

23 (a) A fish uses its gills to absorb oxygen from water. Explain how the gills of a fish are adapted for efficient gas exchange.

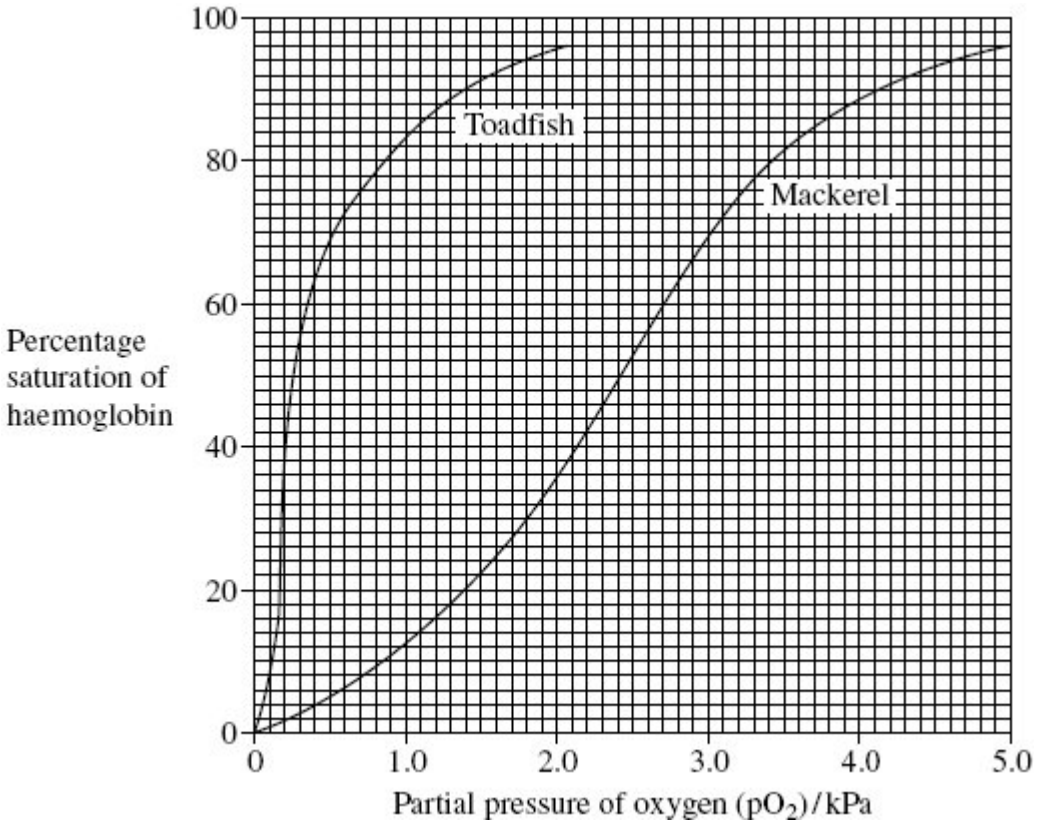
(6)

Mackerel live in the surface waters of the sea. Toadfish live on the seabed in deep water.

(b) The concentration of oxygen is higher in the surface waters than it is in water close to the seabed. Suggest why.

(2)

(c) The graph shows oxygen dissociation curves for toadfish haemoglobin and for mackerel haemoglobin.



Explain how the shape of the curve for toadfish haemoglobin is related to where the toadfish is normally found.

(2)

(d) Scientists analysed the sequence of amino acids in one polypeptide chain in the haemoglobin of four different species of ape. The only difference they found affected the amino acids at three positions in the polypeptide chain. Their results are shown in the table. The letters are abbreviations for particular amino acids.

Species	Position 87	Position 104	Position 125
Chimpanzee	T	R	P
Bonobo	T	R	P
Gorilla	T	K	P
Orang utan	K	R	Q

What information do the data in the table suggest about the relationships between the chimpanzee, the bonobo and the gorilla? Explain your answer.

_____

_____

_____

_____

(2)

(Total 12 marks)

24 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)

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

_____

_____

_____

_____

(2)

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

(4)

(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)

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

(1)

(Total 10 marks)

25 Read the following passage.

Campylobacter jejuni is a bacterium. It is one of the commonest causes of diarrhoea in humans. The illness that it causes does not usually last very long and many sufferers do not even go to the doctor. The only treatment required is the use of oral rehydration solutions to replace the water lost by diarrhoea. In 1998, laboratory tests confirmed 60 000 cases of diarrhoea caused by this bacterium in the UK. The bacterium was more frequently found in males than in females with a ratio of 1.5 : 1.

In rare cases, the nervous system may be affected. Scientists are now beginning to understand the cause of this. Sugars in the antigens on the surface of the bacteria are identical to some of the sugars on the surface of nerve cells. Antibodies produced against the bacteria may therefore attack the body's nerve cells. There can be serious problems if this leads to paralysis of the diaphragm. Breathing difficulties result and the patient may die.

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

(a) (i) The number of cases of diarrhoea confirmed as being caused by *Campylobacter jejuni* in the UK in 1998 was 60 000 (lines 4–5). Explain why the true number of cases is thought to be more than this.

_____

_____

_____

(1)

(ii) Calculate the number of cases of diarrhoea confirmed as being caused by *Campylobacter jejuni* in men in 1998.

Answer _____

(1)

(b) Explain why antibodies produced against *Campylobacter jejuni* also attack nerve cells (lines 9 –10).

_____

_____

_____

_____

_____

_____

(3)

(c) Explain how paralysis of the diaphragm leads to breathing difficulties (line 11).

(2)

(Total 7 marks)

26 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)

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

(1)

(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.

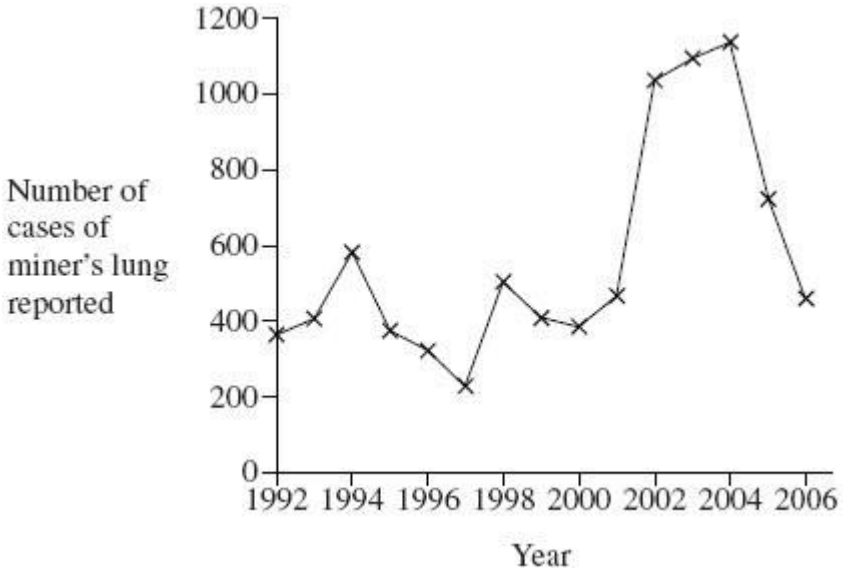
(2)

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

_____

(1)

(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)

(Total 8 marks)

27 (a) Gas exchange in fish takes place in gills. Explain how **two** features of gills allow efficient gas exchange.

1. _____

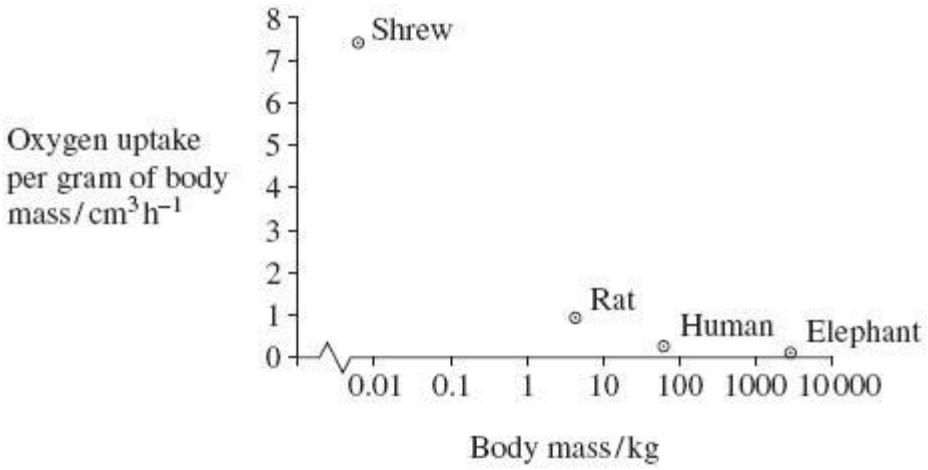
_____

2. _____

_____

(2)

(b) A zoologist investigated the relationship between body mass and rate of oxygen uptake in four species of mammal. The results are shown in the graph.



(i) The scale for plotting body mass is a logarithmic scale. Explain why a logarithmic scale was used to plot body mass.

_____

_____

(1)

(ii) Describe the relationship between body mass and oxygen uptake.

_____

_____

(1)

(iii) The zoologist measured oxygen uptake per gram of body mass. Explain why he measured oxygen uptake per gram of body mass.

_____

_____

_____

_____

(2)

(Total 6 marks)

Mark schemes

1

(a) (i) Changes shape of antitrypsin;
Reference to hydrogen/ionic/disulfide bonds;
No longer attaches to/interacts/ reacts with trypsin;

Accept protease

2

(ii) Higher the concentration of hydrogen peroxide, more amino acids/ proteins affected;
More antitrypsin molecules change shape;

2

(b) (Longterm smokers) inhale a lot of hydrogen peroxide;
Smokers have more active enzyme that damages lung tissue;
Reducing gas exchange surface;

2 max

[6]

2

(a) Active transport against / facilitated down with concentration gradient;

Accept answers in terms of water potentials

Active transport uses ATP/energy, /facilitated doesn't;

Reject along/across gradient

Active uses carrier (proteins), / facilitated (often) uses channel (proteins);

2 max

(b) Lipid/fatty acid part of membrane is non-polar/hydrophobic;

Accept lipid/fatty acid bilayer

Oxygen and carbon dioxide small/ non-polar (molecules);

Oxygen/carbon dioxide can diffuse through/dissolve in/ get between molecules in this layer;

Down a concentration gradient;

2 max

(c) Brings more oxygen/removes carbon dioxide;

Maintains diffusion/concentration gradients;

Between alveoli and blood/capillaries;

Reject references to surface area

2 max

[6]

3 (a) *(explanation must be linked to structures to gain second mark for each linked pair)*

filaments / lamellae ;	large SA;
gill plates or secondary lamellae;	
large number of capillaries;	to remove oxygen / to maintain a gradient;
thin epithelium;	short diffusion pathway;
pressure changes;	to bring in more water / to maintain gradient;
countercurrent flow (or description);	exchange / diffusion along whole length / concentration gradient maintained / equilibrium not achieved / blood always meets water with higher oxygen concentration;

6

(b) (i) requires 20 cm^3 of oxygen / extracts 7.2 cm^3 of oxygen /
reject if referring to volume of water

$\frac{20}{7.2}$;

2.7 / 2.8 (dm^3h^{-1});
(correct answer award 2 marks)

2

(ii) high (relative) density / heavy;
requires large input of energy as difficult to push back out;

2

(c) (*for each pair second point must be linked to first*)
to provide same amount of oxygen;
need to have more water flowing over gills;
OR
metabolic rate / respiration increases (with increase in temperature);
so more oxygen <u>required</u>;

2 max

[12]

QWC 1

4 (a)
1. mouth opens, operculum / opercular valve shuts;
2. floor of mouth lowered;
3. water enters due to decreased pressure / increased volume;
4. mouth closes, operculum / opercular valve opens;
5. floor raised results in increased pressure / decreased volume;
6. high / increased pressure forces / pushes water over gills;

4 max

(b) 1. alveoli provide a large surface area;
2. walls of alveoli thin to provide a short diffusion pathway;
3. walls of capillary thin / close to alveoli provides a short diffusion pathway;
4. walls (of capillaries / alveoli) have flattened cells;
5. cell membrane permeable to gases;
6. many blood capillaries provide a large surface area;
7. intercostal / chest muscles / diaphragm muscles / to ventilate lungs / maintain a diffusion / concentration gradient;
8. wide trachea / branching of bronchi / bronchioles for efficient flow of air;
9. cartilage rings keep airways open;
(*reject moist and thin membranes*)

6 max

[10]

5 (a) exchange / diffusion across body surface / skin;
short diffusion pathway / distance / large SA:V ratio;

2

(b) large numbers of lamellae so large SA;
lamellae thin so short (diffusion) pathway to blood / capillaries;
high rate of oxygen uptake for respiration / energy release;
(accept more oxygen)

3

[5]

6 (a) contraction of (diaphragm) muscles flattens diaphragm;
contraction of intercostal muscles raises ribcage;
increase in volume decreases pressure;

3

(b) (i) tidal volume increases steeply, then increase slows down after 10 to 15 km h^{-1};

1

(ii) breathing rate increases slowly then steeply after 10 to 15 km h^{-1};
(max 1 if no reference to speed where change occurs in either (i) or (ii))

1

(c) $20 \times 2.75 = 55\ dm^2$;
(award 1 mark for correct method i.e. tidal volume × rate);

2

[7]

7

(i) (waxy so) impermeable to water / waterproof / stops water passing through;

1

(ii) reference to hairs / position of stomata (sunken stomata / stomata in pits)
LINKED to reduced air movement / trap layer of air /
trap water vapour (*reject water)* / maintains humidity;

reduces diffusion gradient / concentration gradient of water / water potential gradient;

OR

stoma can close;
reduces area for evaporation or transpiration;

2

[3]

8

(a) (i) one feature;
then linked Explanation;

(many) filaments / lamellae / secondary lamellae;
so large surface area;

large number of capillaries; (NOT "good blood supply")
maintains a diffusion gradient / removes oxygen;

thin epithelium / lamellae wall;
short diffusion pathway;

2

(ii) maintains diffusion / concentration gradient / equilibrium not reached;
diffusion occurs across whole length (of lamellae / gill);

2

(b) less energy needed / continuous flow of water or O_2;

1

[5]

9

(a) (diffusion) gradient will be maintained all the way along the gill / the amount of oxygen in the water is always higher than in the blood / the numbers in the water are always higher than in the blood;
more oxygen will diffuse into the blood;

2

(b) 100 cycles per minute;

(principle of 60 / x or 0.6 seen gains one mark)

2

[4]

10 (i) Because there are big differences;
any correct named example e.g. lung cancer / bronchitis much lower in women than in men;

2

(ii) easier to compare if sample size effectively the same;
different numbers of people in each group;

2

[4]

11 (a) (gills have) lamellae on filaments;
lots of both;

2

(b) (i) all 3 go up;

Accept converse

1

(ii) more oxygen can be supplied;
for more respiration;

Accept answer relating to CO_2

2

[5]

12 (a) Immediate / rapid increase, steady rise and plateau clearly identified;

Ignore references to rest period if clearly identified as such

1

(b) Find value of pulmonary ventilation from graph / 26-28;
Divide by breathing rate / 20;

2

(c) Air is from nose / trachea / bronchi / not been in alveoli / dead space;
Gas exchange / diffusion only in alveoli / not in these structures;

2

[5]

13 (a) Epithelium of alveolus, capillary wall / epithelium / endothelium, plasma;

1

(b) Cell wall;
Capsule;
Flagellum;
Mesosomes;
Plasmid;
Genetic material / DNA / nucleoid;
Ribosomes;

Accept references to size only if some idea of range is given

max 2

(c) Large (surface) area;
For diffusion;
or
Short distance to centre of cell / to all haemoglobin;
For diffusion;

2

(d) (i) Correct answer of approximately 7800 / 8000 = 2 marks
Incorrect answer but clearly derived by
dividing diameter of cell A by 7 = 1 mark

2

(ii) Idea of cut through maximum diameter / middle;

1

[8]

14

(a) $\frac{10}{20} \times$ *measurment* / $\frac{1}{2} \times$ *measurement*;

= 1.25 to 1.5;

allow 1 mark if correct working shown

max 2

(b) Maintains concentration gradient (over whole length of gill) / diffusion can occur over whole gill;
More oxygen enters blood (/ more CO_2 leaves);
More (aerobic) respiration / more energy release in muscle / for swimming; *'more' needed ONCE only*

3

[5]

15

(a) Diaphragm (muscle) contracts;
Flattens / Increases volume of chest;
Reduced pressure allows air to enter;

3

(b) Allows comparison;
As organs differ in size / as larger organs will need more blood;

2

(c) 2 marks for 40.91 / 40.9 / 41
1 mark for 59.09 / 59.1 / 59

2

(d) (i) Some oxygen still in lungs (which will enter the blood) /
removal of carbon dioxide (from blood);

1

(ii) More blood available for other organs;
Supplying oxygen / glucose / removing carbon dioxide;
OR
Diaphragm muscles not contracting (as not breathing);
Will not require (as much) oxygen / glucose;

2

[10]

16 (a) Muscles (associated with breathing) relax;

1

(b) Produces lower pressure (and air moves in down pressure gradient);

1

[2]

17 (a) (i) less at **A** / more at **B**;
(accept inspiration and expiration as equivalent to A and B)

1

(ii) carbon dioxide diffuses / passes / into alveoli / from blood;
as higher concentration in blood / low concentration in alveolus;
(first mark for site and direction, second for cause)

2

(b) curve increases;
(reject if decreases)
then levels out;

2

(c) (i) contract;
ribs move upwards / out;
increasing volume / decreasing pressure in chest / thorax / lungs;

3

(ii) intercostal muscles relax;
(if you can ignore ref to internal contracting, do so)

1

[9]

18 (a) increasing carbon dioxide concentration / partial pressure;
(decrease in oxygen negates)

1

(b) (oxygen is used in) respiration therefore diffuses (from tracheae) to tissues;
oxygen unable to enter organism;

2

(c) spiracles not open all the time;
therefore there is less water loss
(by diffusion through spiracles);

2

[5]

19

(a) (Small alveoli with) large surface area;
For diffusion;

2

(b) (i) Epithelium / epithelial / squamous / pavement cells;
Reject endothelium.

1

(ii) 0.11 µm;

1

(c) (i) Less oxygen / more carbon dioxide / more water vapour;
Two differences required, but only one mark for this part of the question.

1

(ii) Gas exchange takes place in alveoli / does not take place in trachea;

1

(d) (i) Pulmonary artery;

1

(ii) Concentrations reach equilibrium / become equal;
Diffusion occurs when there is a concentration gradient
(so some will remain in blood);
OR
Lung cells / vessel cells respire;
Add / produce carbon dioxide;

2

[9]

20

(a) 235–240;;
(one mark for an answer between 200-300
based on 2 - 3 stomata in 0.01mm^2
Alternatively, one mark for calculating the area of the
rectangle correctly as 0.016 – 0.017mm^2)

2

(b) grows in arid / dry conditions;
less surface area;
(rate of) transpiration / water loss would be reduced;

3

[5]

21 (a) (i) high / higher CO_2 concentration / lack of oxygen;

1

(ii) CO_2 asphyxiates / is toxic;
lack of oxygen for (aerobic) respiration;
OR
lack of energy / ATP (for pumping movements);
reduced <u>muscle</u> function / muscle fatigue

2 max

(b) removal of (excess) CO_2 / oxygen to break down lactate / to repay oxygen debt / to enable aerobic respiration;

1

[4]

22 (a) up and out;

1

(b) (i) does not require work / effort / involve muscle contraction / energy expenditure;

1

(ii) active as it involves contraction of muscles;

1

(c) liver moves back;
increases volume of lungs;
pressure lower (in lungs than outside);

3 max

(d) maximum of three marks for description, points 1 to 4

1 inhaled air contains more oxygen than exhaled air;

2 inhaled air contains less carbon dioxide than exhaled air;

3 inhaled air contains less water (vapour);

4 <u>relative amount / percentage</u> of nitrogen also changes;

5 respiration results in lower blood oxygen / higher blood carbon dioxide;

6 oxygen enters blood / carbon dioxide leaves blood in alveoli;

7 by diffusion;

8 water vapour diffuses from moist surface;

6 max

[12]

23 (a) 1. Large surface area provided by lamellae / filaments increases diffusion / makes diffusion efficient;;

Q *Candidates are required to refer to lamellae or filaments. Do not penalise for confusion between two*

2. Thin epithelium / distance between water and blood;

3. Water and blood flow in opposite directions / countercurrent;

4. (Point 4) maintains concentration gradient (along gill) / equilibrium not reached / as water always next to blood with lower concentration of oxygen;

5. Circulation replaces blood saturated with oxygen;

6. Ventilation replaces water (as oxygen removed);

6

(b) Mixing of air and water (at surface);

Air has higher concentration of oxygen than water;

Diffusion into water;

Plants / seaweeds near surface / in light;

Produce oxygen by photosynthesis;

2 max

(c) Not much oxygen near sea bed;

Toadfish haemoglobin (nearly) saturated / loads readily at / has higher affinity for oxygen at low <u>partial pressure</u> (of oxygen);

2

(d) The chimpanzee and the bonobo are more closely related (than to the gorilla);

They have identical amino acids / one of the amino acids is different in the gorilla;

2

[12]

24 (a) Phagocytes engulf / ingest pathogens / microorganisms / bacteria / viruses;

Phagocytes destroy pathogens / microorganisms / bacteria / viruses;

Lung diseases are caused by pathogens / microorganisms / bacteria / viruses;

Q *Allow description of process of engulfing*

2 max

(b) (i) Alveoli / lungs will not inflate / deflate fully / reduced lung capacity;

Breathing out particularly affected / no longer passive;

2

(ii) Alveolar walls thicken;

Longer diffusion pathway;

Scarred / fibrous tissue;

Reduces surface area (for gaseous exchange);

Q *Diffusion is essential for 2nd point and surface area for 4th point.*

(c) (i) Cancer develops 20 – 30 years after exposure (to asbestos);

(ii) Smoking / air pollution / specified industrial source;

25 (a) (i) Many people do not go to the doctor;

(ii) 36000;

No marks awarded for working here as calculation is very straightforward

(b) Same sugars / antigens on bacteria / nerve cells;

Do not accept references to same shape as equivalent to complementary.

Bind with antibody / form antigen-antibody complex;

Reject react

Have complementary shape / fit binding site;

Reject active site

(c) Diaphragm will not move down / flatten / contract;

Ignore references to breathing out

Thoracic cavity / lung volume not increased so cannot breathe in;

26 (a) (i) Through alveolar epithelium;

Through capillary epithelium / endothelium;

Accept: Through lining / wall of alveolus and capillary for 1 mark

Accept: squamous epithelial cells for 'epithelium'
Neutral: alveolar endothelium
Neutral: references to diffusion

4

1

1

[10]

1

1

3

2

[7]

2

(ii) (Thicker alveolar wall) – no mark

Neutral: less diffusion

(So) Longer diffusion pathway / slower diffusion;

Neutral: references to surface area

1

(b) (i) (In alveolus)

Need the idea of air moving and oxygen concentration

Brings in air containing a high(er) oxygen concentration;

Neutral: reference to carbon dioxide concentration

Removes air with a low(er) oxygen concentration;

2

(ii) Circulation of blood / moving blood;

Neutral: blood Neutral: short diffusion pathway

1

(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;

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.

2 max

[8]

27 (a) Filaments / lamellae provide large surface area;

Thin / flattened epithelium / one / two cell layers so short diffusion pathway (between water and blood);

Countercurrent / blood flow maintains concentration / diffusion gradient;

Q *Do not credit thin cell walls / membranes*

2 max

(b) (i) Large / wide range of values (so can fit on graph);

1

(ii) Decrease in uptake with increase in mass / negative correlation;

1

(iii) Enables <u>comparison</u>;

As animals differ in size / mass;

2

[6]