AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.3.1 SURFACE AREA TO VOLUME RATIO

SCORE	PERCENTAGE
/314	%

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Q1.

(a) Describe the relationship between size and surface area to volume ratio of organisms.

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_____

_____

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_____

(1)

(b) A scientist calculated the surface area of a large number of frog eggs. He found that the mean surface area was 9.73 mm^2. Frog eggs are spherical.

The surface area of a sphere is calculated using this equation

$$\text{Surface area} = 4\pi r^2$$

where r is the radius of a sphere

$$\pi = 3.14$$

Use this equation to calculate the mean diameter of a frog egg.

Show your working.

Diameter = _____ mm

(2)

The scientist calculated the ratio of surface area to mass for eggs, tadpoles and frogs. He also determined the mean rate of oxygen uptake by tadpoles and frogs.

His results are shown in the table.

Stage of frog development	Ratio of surface area to mass	Mean rate of oxygen uptake / µmol g^{-1} h^{-1}
Egg	2904 : 1	no information

Tadpole	336 : 1	5.7
Adult	166 : 1	1.3

(c) The scientist used units of μmol g^{-1} h^{-1} for the rate of oxygen uptake.

Suggest why he used μmol in these units.

_____

_____

_____

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_____

(1)

(d) The scientist decided to use the ratio of surface area to mass, rather than the ratio of surface area to volume. He made this decision for practical reasons.

Suggest **one** practical advantage of measuring the masses of frog eggs, tadpoles and adults, compared with measuring their volumes.

_____

_____

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(1)

(e) Explain why oxygen uptake is a measure of metabolic rate in organisms.

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(1)

(f) A student who looked at these results said that they could not make a conclusion about the relationship between stage of development and metabolic rate.

Use information in the table to explain reasons why they were unable to make a conclusion.

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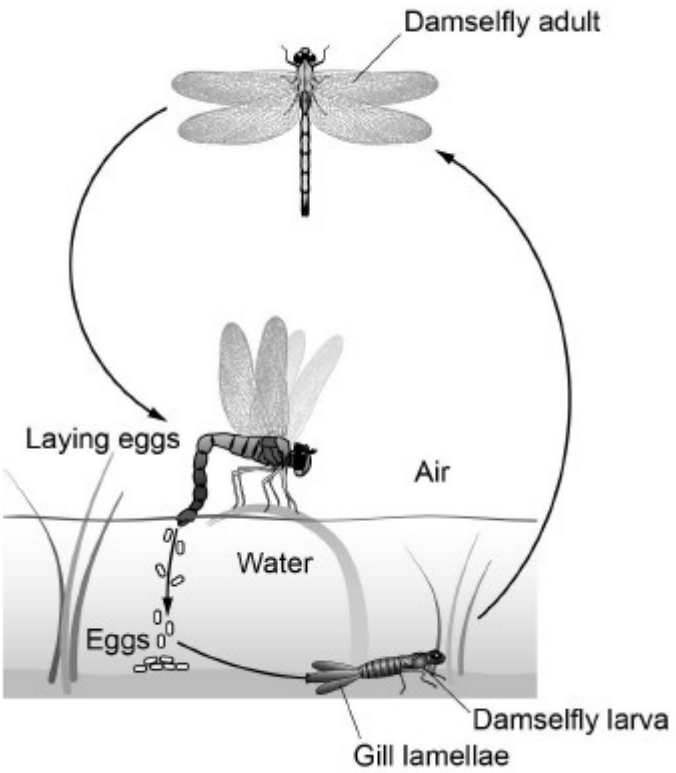
(3)

(Total 9 marks)

Q2.

Figure 1 shows the stages of development of an insect called a damselfly.

Figure 1



(a) The adult damselfly uses a tracheal system for gas exchange.

Explain **three** ways in which an insect's tracheal system is adapted for efficient gas exchange.

1. _____

_____

_____

2. _____

_____

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3. _____

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(3)

(b) The damselfly larva is a carnivore that actively hunts prey. It has gills to obtain oxygen from water.

Some other species of insect have larvae that are a similar size and shape to damselfly larvae and also live in water. These larvae do **not** actively hunt prey and do **not** have gills.

Explain how the presence of gills adapts the damselfly to its way of life.

_____

_____

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(2)

(c) A scientist measured the size of each gill lamella of the gills of 40 damselfly larvae. His results are shown in the table.

Mean width / mm (± uncertainty / mm)	1.61 (± 0.19)
Mean width / mm (± uncertainty / mm)	6.12 (± 0.41)

Calculate the mean surface area of **one side** of one gill lamella. Assume that a gill lamella is rectangular and give your answer to an **appropriate number of significant figures**.

Include the percentage error (uncertainty) of surface area in your answer.
Show your working.

Mean surface area = _____

Percentage error (uncertainty) of surface area = _____

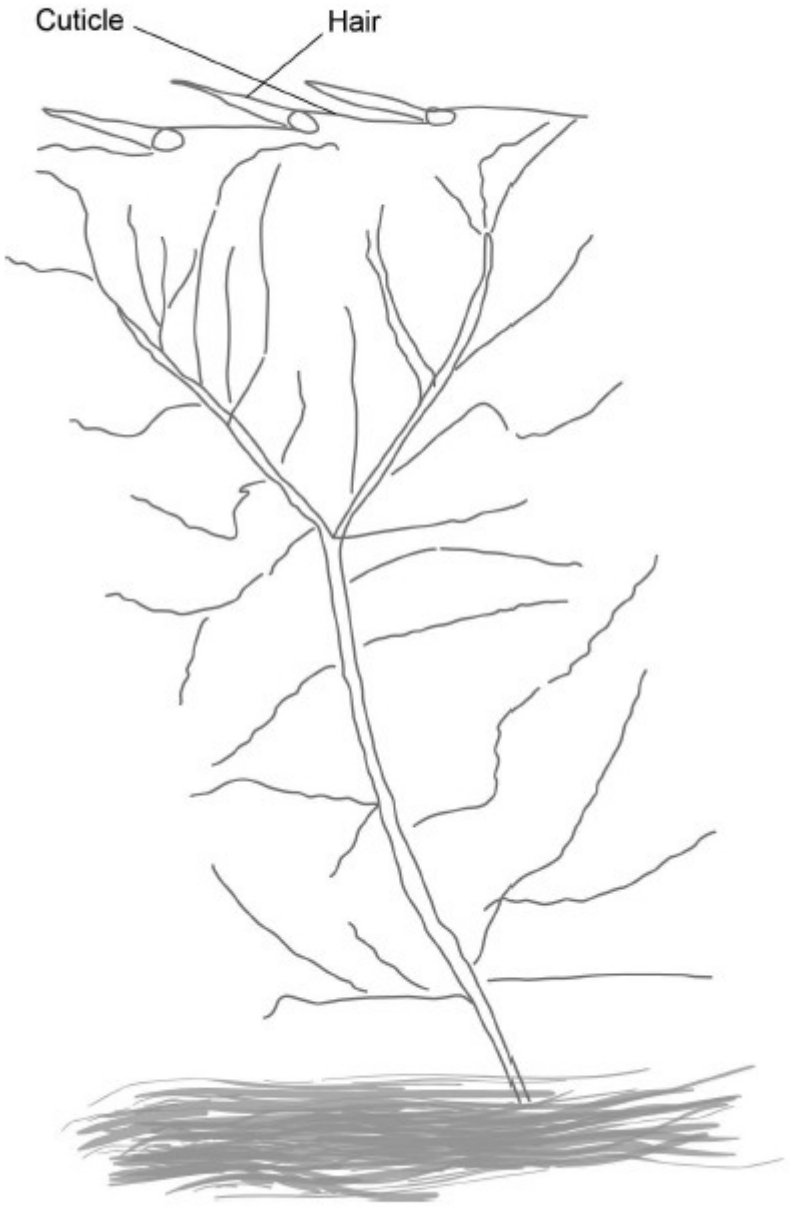
(3)

(d) A student used an optical microscope to observe part of a damselfly larva gill.

Figure 2 shows the drawing the student produced.

Figure 2

Part of a damselfly larva's gill



Suggest **two** ways the student could improve the quality of her scientific drawing of this gill.

1. _____

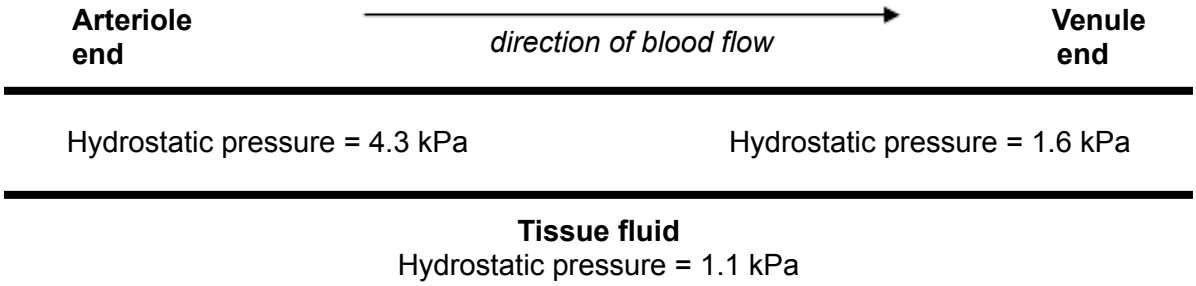
2. _____

(2)

(Total 10 marks)

Q3.

The figure below represents a capillary surrounded by tissue fluid.
The values of the hydrostatic pressure are shown.



(a) Use the information in the figure above to explain how tissue fluid is formed.

(2)

(b) The hydrostatic pressure falls from the arteriole end of the capillary to the venule end of the capillary. Explain why.

(1)

(c) High blood pressure leads to an accumulation of tissue fluid. Explain how.

_____

(3)

(d) The water potential of the blood plasma is more negative at the venule end of the capillary than at the arteriole end of the capillary. Explain why.

_____

_____

_____

_____

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_____

(3)

(Total 9 marks)

Q4.

Breathing out as hard as you can is called forced expiration.

(a) Describe and explain the mechanism that causes forced expiration.

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_____

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(4)

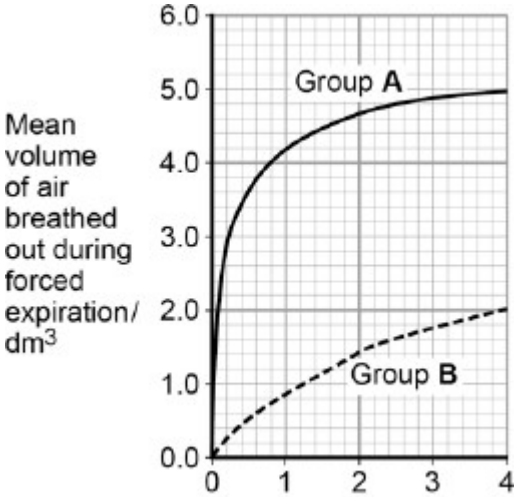
Two groups of people volunteered to take part in an experiment.

- People in group **A** were healthy.
- People in group **B** were recovering from an asthma attack.

Each person breathed in as deeply as they could. They then breathed out by forced expiration.

A scientist measured the volume of air breathed out during forced expiration by each person.

The graph below shows the results.



(b) Forced expiration volume (FEV) is the volume of air a person can breathe out in1 second.

Using data from the first second of forced expiration, calculate the percentage decrease in the FEV for group **B** compared with group **A**.

Answer = _____ %

(1)

(c) The people in group **B** were recovering from an asthma attack.
Explain how an asthma attack caused the drop in the mean FEV shown in the figure above.

_____

_____

_____

_____

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(4)

(Total 9 marks)

Q5.

Organic compounds synthesised in the leaves of a plant can be transported to the plant's

roots.
This transport is called translocation and occurs in the phloem tissue of the plant.

(a) One theory of translocation states that organic substances are pushed from a high pressure in the leaves to a lower pressure in the roots.

Describe how a high pressure is produced in the leaves.

_____

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_____

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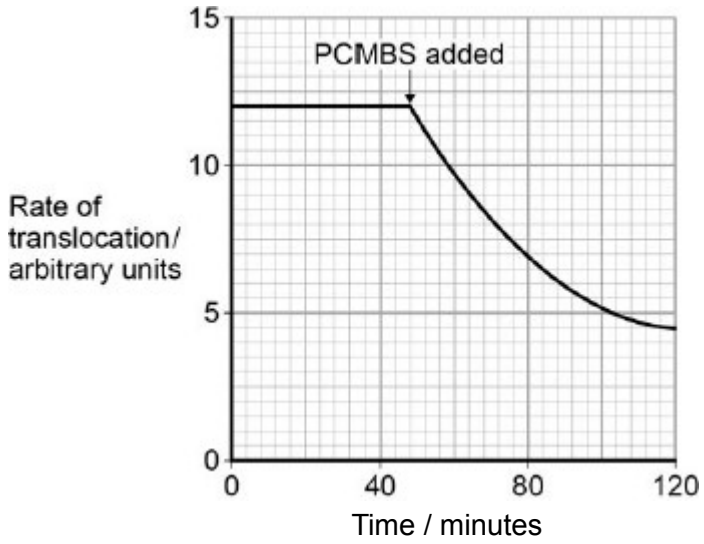
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(3)

PCMBS is a substance that inhibits the uptake of sucrose by plant cells.

Scientists investigated the effect of PCMBS on the rate of translocation in sugar beet.
The figure below shows their results.



(b) During their experiment, the scientists ensured that the rate of photosynthesis of their plants remained constant.
Explain why this was important.

_____

_____

_____

_____

(2)

(c) The scientists concluded that some translocation must occur in the spaces in the cell walls.

Explain how the information in the figure above supports this conclusion.

_____

_____

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_____

_____

(2)

(Total 7 marks)

Q6.

(a) Describe how oxygen in the air reaches capillaries surrounding alveoli in the lungs. Details of breathing are **not** required.

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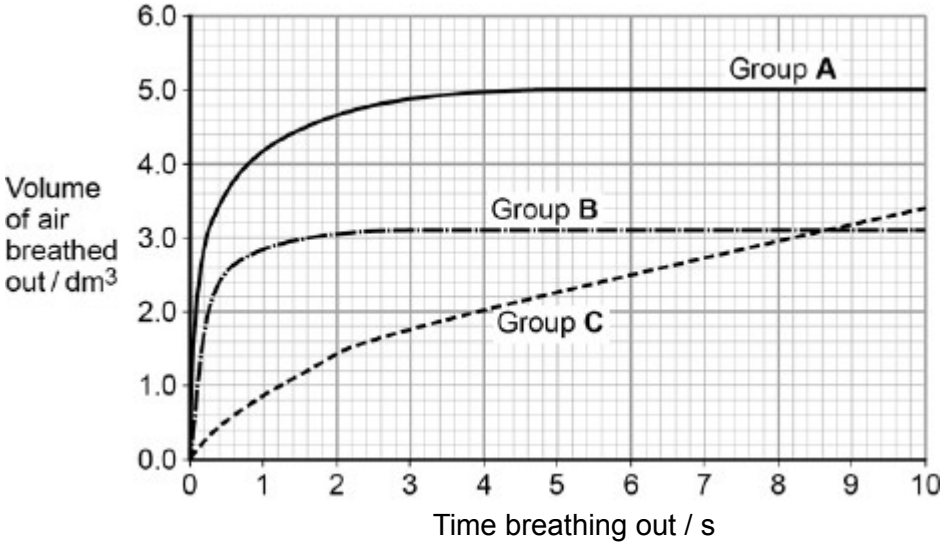
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(4)

Forced expiratory volume (FEV) is the greatest volume of air a person can breathe out in 1 second.

Forced vital capacity (FVC) is the greatest volume of air a person can breathe out in a single breath.

The figure below shows results for the volume of air breathed out by three groups of people, **A**, **B** and **C**. Group **A** had healthy lungs. Groups **B** and **C** had different lung conditions that affect breathing.



(b) Calculate the percentage drop in FEV for group **C** compared with the healthy people.

Answer = _____

(1)

(c) Asthma affects bronchioles and reduces flow of air in and out of the lungs. Fibrosis does not affect bronchioles; it reduces the volume of the lungs.

Which group, **B** or **C**, was the one containing people with fibrosis of their lungs? Use the information provided and evidence from the figure above to explain your answer.

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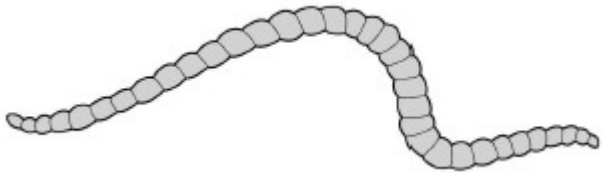
(3)

(Total 8 marks)

Q7.

Tubifex worms are small, thin animals that live in water. They have no specialised gas exchange or circulatory system.

The figure below shows a tubifex worm.



(a) Name the process by which oxygen reaches the cells inside the body of a tubifex worm.

_____

(1)

(b) Using the information provided, explain how **two** features of the body of the tubifex worm allow efficient gas exchange.

1. _____

_____

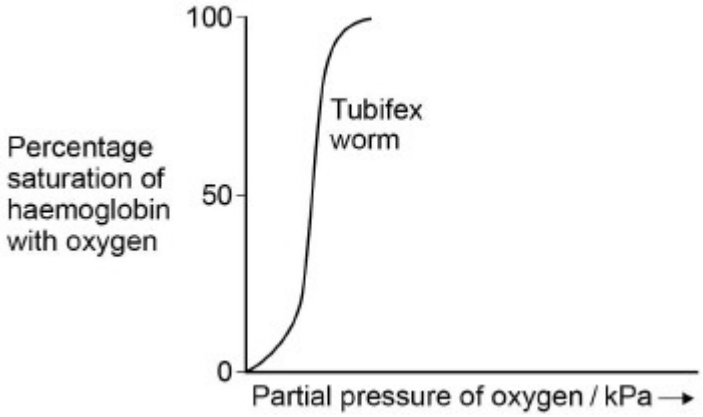
2. _____

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(2)

(c) Most species of tubifex worms live at the bottom of ponds, lakes and rivers where the partial pressure of oxygen is low. Pollution of water by sewage can cause the partial pressure of oxygen to fall below 0.2 kPa.

The graph shows the oxyhaemoglobin dissociation curve for a species of tubifex worm found in a river polluted with sewage.



The species of tubifex worm in the graph has 50% saturation of their haemoglobin with oxygen at 0.08 kPa.

Explain how this enables this species to survive in water polluted with sewage.

_____

_____

_____

_____

_____

(2)

(d) Species of tubifex worm that live in ponds, lakes and rivers **cannot** survive in seawater.

Use your knowledge of water potential to explain why they cannot survive in seawater.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q8.

(a) The oxygen dissociation curve for haemoglobin shifts to the right during vigorous exercise. Explain the advantage of this shift.

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_____

_____

_____

(3)

(b) Weddell seals are diving mammals that live in cold environments. A Weddell seal is shown in **Figure 1**.

Figure 1



By Jerzystrzelecki (own work)
[CC BY 3.0] via Wikimedia Commons

(i) Explain how the body shape of a Weddell seal is an adaptation to living in a cold environment.

_____

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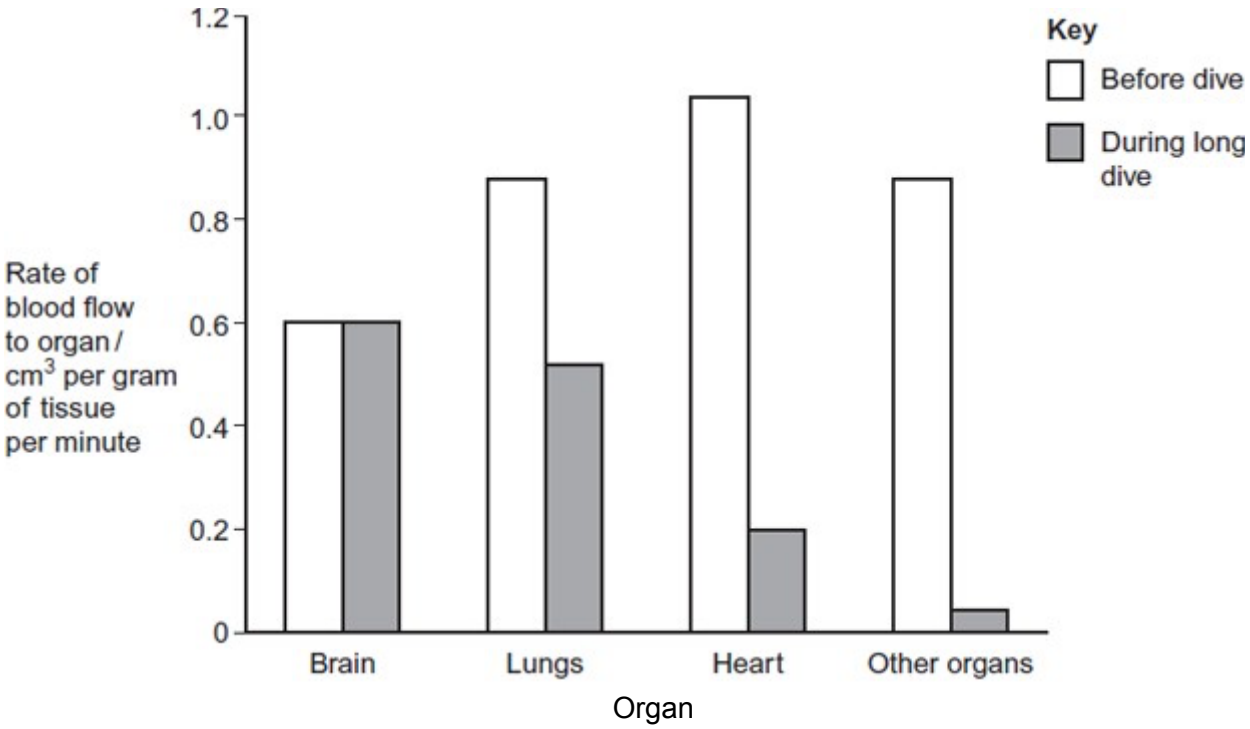
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(2)

(ii) Weddell seals can remain underwater for long periods of time. **Figure 2** shows the rate of blood flow to different organs of a Weddell seal before a dive and during a long dive.

Figure 2



Describe and explain the changes in the rate of blood flow to the different organs during a long dive.

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(3)

(Total 8 marks)

Q9.

(a) Describe and explain how the countercurrent system leads to efficient gas exchange

across the gills of a fish.

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_____

_____

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_____

_____

(3)

(b) Amoebic gill disease (AGD) is caused by a parasite that lives on the gills of some species of fish. The disease causes the lamellae to become thicker and to fuse together.

AGD reduces the efficiency of gas exchange in fish. Give **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(c) The table below shows some features of gas exchange of a fish at rest.

Volume of oxygen absorbed by the gills from each dm^3 of water / cm^3	7
Mass of fish / kg	0.4
Oxygen required by fish / $cm^3\ kg^{-1}\ hour^{-1}$	90

(i) Calculate the volume of water that would have to pass over the gills each hour to supply the oxygen required by the fish. Show your working.

_____ dm^3

(2)

(ii) The volume of water passing over the gills increases if the temperature of the water increases. Suggest why.

_____

_____

_____

(1)

(Total 8 marks)

Q10.

(a) (i) Name the process by which oxygen passes from an alveolus in the lungs into the blood.

_____

(1)

(ii) Describe **two** adaptations of the structure of alveoli for efficient gas exchange.

1. _____

_____

2. _____

_____

(2)

(b)



© iStock/Thinkstock

The photograph shows a fire-breather creating a ball of fire. Fire-breathers do this by blowing a fine mist of paraffin oil onto a flame. Some of this mist can be inhaled and may eventually lead to fibrosis.

People who have been fire-breathers for many years often find they cannot breathe out properly. Explain why.

_____

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(2)
(Total 5 marks)

Q11.

Doctors investigated the effect of the smoking habits of men on their non-smoking wives.

The doctors recruited 540 non-smoking women aged 40 or older. They divided these women into groups according to the smoking habits of their husbands.
After 14 years, the doctors recorded how many of the wives had died and their cause of death.

They used these data to determine the relative risk of a wife dying from a particular disease according to her husband's smoking habit.

In this comparison, they gave the relative risk to the wife of a non-smoker as 1.00. A value greater than 1.00 shows an increased risk compared to the wife of a non-smoker.

The results are shown in the table below.

Cause of death	**Relative risk of wife dying**		
	Husband non-smoker	**Husband smokes 1 to 19 cigarettes /day**	**Husband smokes more than 19 cigarettes / day**
Lung cancer	1.00	1.61	2.08
Emphysema	1.00	1.29	1.49
Cervical cancer	1.00	1.15	1.14
Stomach cancer	1.00	1.02	0.99
Heart disease	1.00	0.97	1.03

A journalist concluded from these data that if a husband smoked, it greatly increased the risk of his wife dying of certain diseases. Evaluate this statement.

_____

_____

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(Total 4 marks)

Q12.

(a) There are ethical and economic arguments for maintaining biodiversity.

(i) Suggest **one** ethical argument for maintaining biodiversity.

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_____

_____

(1)

(ii) Suggest **one** economic argument for maintaining biodiversity.

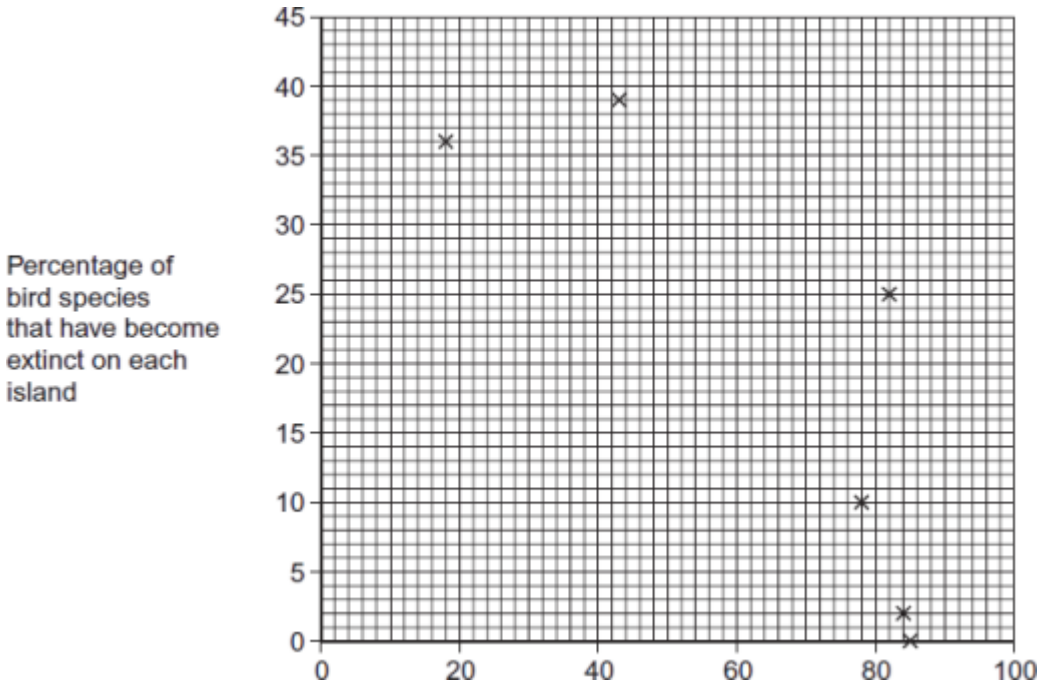
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(1)

Ecologists calculated the percentage of bird species that have become extinct on six islands in the last one hundred years. They also calculated the percentage of original forest area remaining on each island after the same time period. The graph shows their results.



(b) Explain the relationship between the percentage of original forest area remaining

and the percentage of bird species that have become extinct.

_____

_____

_____

_____

_____

(2)

(c) What **two** measurements would the ecologists have needed to obtain to calculate the index of diversity of birds on each island?

1. _____

2. _____

(2)

(d) The ecologists noted that the species of birds surviving on the coldest islands had a larger body size than those surviving on warmer islands.

Explain how a larger body size is an adaptation to a colder climate

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q13.

Read the following passage.

Gluten is a protein found in wheat. When gluten is digested in the small intestine, the products include peptides. Peptides are short chains of amino acids. These peptides cannot be absorbed by facilitated diffusion and leave the gut in faeces

Some people have coeliac disease. The epithelial cells of people with coeliac disease do not absorb the products of digestion very well. In these people, some of the

peptides from gluten can pass between the epithelial cells lining the small intestine and enter the intestine wall. Here, the peptides cause an immune response that leads to the destruction of microvilli on the epithelial cells.

Scientists have identified a drug which might help people with coeliac disease. It reduces the movement of peptides between epithelial cells. They have carried out trials of the drug with patients with coeliac disease.

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

(a) Name the type of chemical reaction which produces amino acids from proteins.

_____

(1)

(b) The peptides released when gluten is digested cannot be absorbed by facilitated diffusion (lines 2 – 3). Suggest why.

_____

_____

_____

_____

_____

_____

(3)

(c) Explain why the peptides cause an immune response (lines 7 – 8).

_____

_____

_____

(1)

(d) Scientists have carried out trials of a drug to treat coeliac disease (lines 10 – 11). Suggest **two** factors that should be considered before the drug can be used on patients with the disease.

1. _____

_____

2. _____

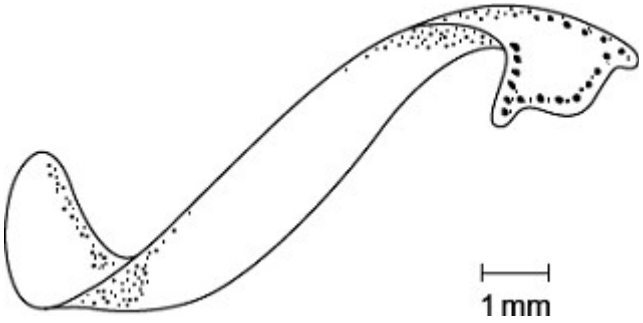
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(2)

(Total 7 marks)

Q14.

(a) Flatworms are small animals that live in water. They have no specialised gas exchange or circulatory systems.
The drawing shows one type of flatworm.



(i) Name the process by which oxygen reaches the cells inside the body of this flatworm.

_____

(1)

(ii) The body of a flatworm is adapted for efficient gas exchange between the water and the cells inside the body.
Using the diagram, explain how **two** features of the flatworm's body allow efficient gas exchange.

1. _____

_____

2. _____

_____

(2)

(b) (i) A leaf is an organ. What is an organ?

_____

_____

_____

(1)

(ii) Describe how carbon dioxide in the air outside a leaf reaches mesophyll cells inside the leaf.

_____

_____

_____

_____

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(3)

(Total 7 marks)

Q15.

Different cells in the body have different functions.

(a) Some white blood cells are phagocytic. Describe how these phagocytic white blood cells destroy bacteria.

(4)

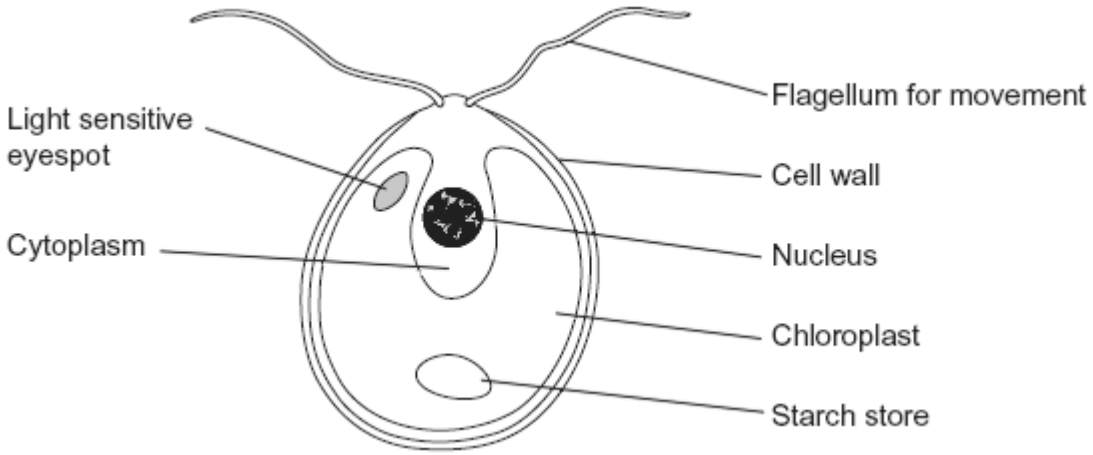
(b) The epithelial cells that line the small intestine are adapted for the absorption of glucose. Explain how.

(6)

(Total 10 marks)

Q16.

The diagram shows an organism called *Chlamydomonas*.



(a) Name **two** structures shown in the diagram that are present in plant cells but are **not** present in animal cells.

1. _____

_____

2. _____

_____

(2)

(b) *Chlamydomonas* lives in fresh water ponds. Use your knowledge of osmosis to suggest an advantage of using starch as a carbohydrate store.

_____

_____

_____

_____

_____

(2)

(c) *Chlamydomonas* has adaptations that help it to maintain a high rate of photosynthesis.

Use information in the diagram to explain what these adaptations are.

_____

_____

_____

_____

_____

(3)

(Total 7 marks)

Q17.

(a) Many different substances enter and leave a cell by crossing its cell surface membrane. Describe how substances can cross a cell surface membrane.

(5)

(b) 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.

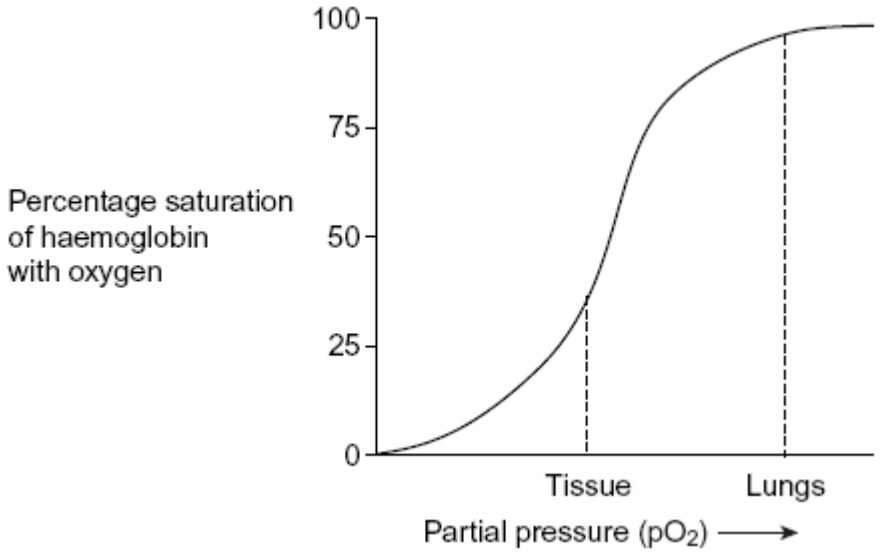
(5)

(Total 10 marks)

Q18.

(a) **Figure 1** shows the oxygen dissociation curve for human haemoglobin.

Figure 1



Use **Figure 1** to describe how haemoglobin loads and unloads oxygen in the body.

_____

_____

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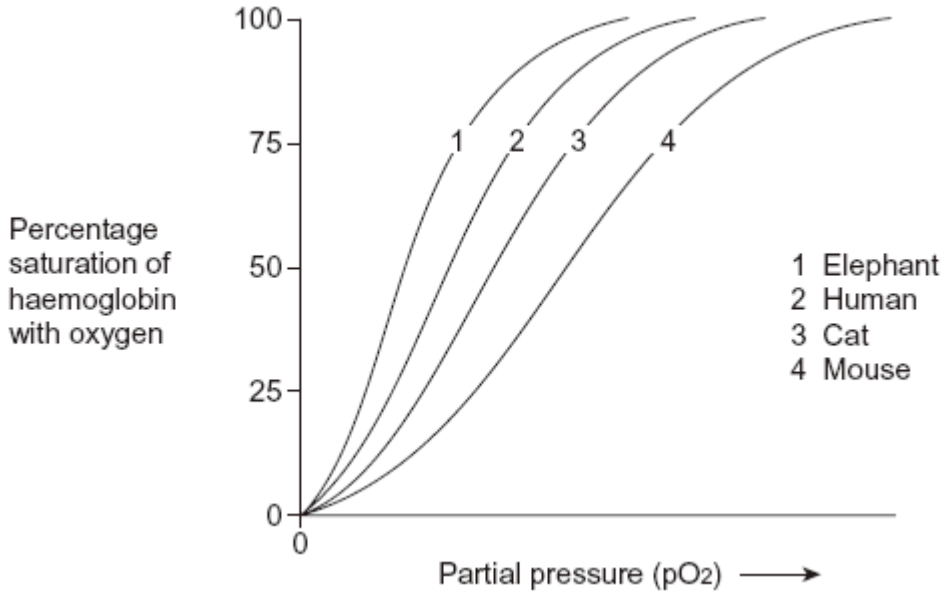
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(3)

(b) **Figure 2** shows oxygen dissociation curves from mammals of different size.

Figure 2



(i) Describe the relationship between the size of mammals and the oxygen dissociation curves of their haemoglobins.

_____

_____

(1)

(ii) Heat from respiration helps mammals to maintain a constant body temperature.

Use this information to explain the relationship between the surface area to volume ratio of mammals and the oxygen dissociation curves of their haemoglobins.

_____

_____

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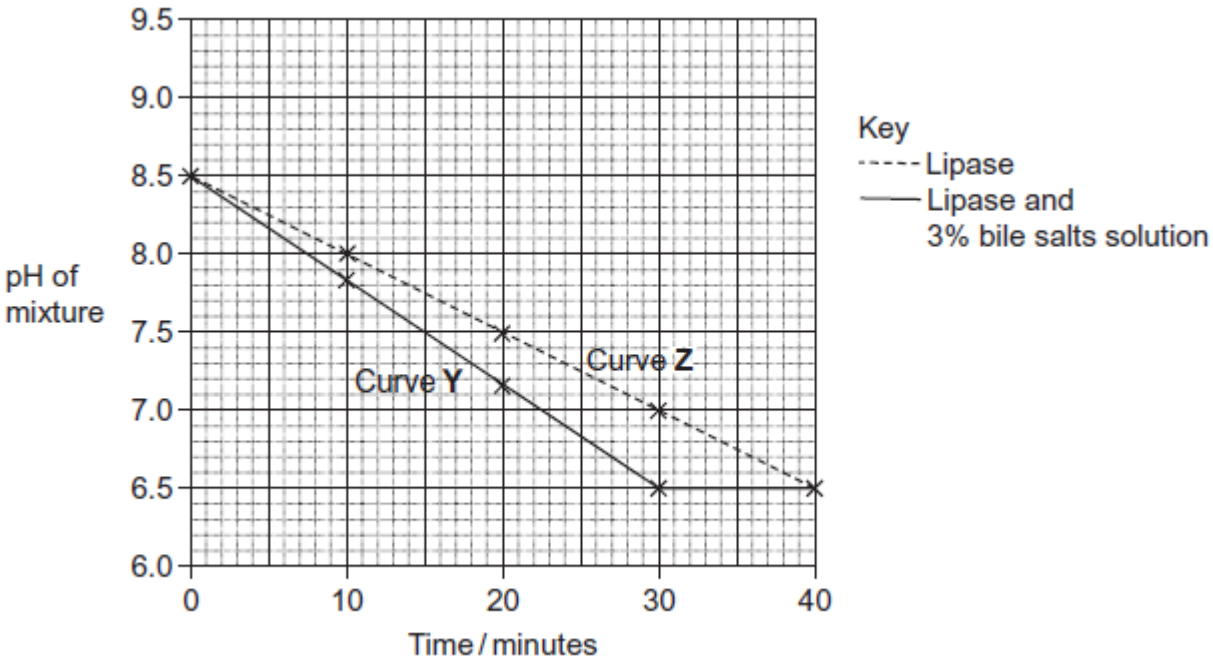
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(4)

(Total 8 marks)

Q19.

Scientists investigated the effect of lipase and a 3% bile salts solution on the digestion of triglycerides. The graph below shows their results.



The scientists also incubated triglycerides with different concentrations of bile salts. After 30 minutes they measured the diameter of the triglyceride droplets. They used the results to calculate the mean radius of the droplets at each concentration. The table below shows their results.

Concentration of bile salts /%	0	1	2	3	4	5
Mean radius of triglyceride droplet / μm	6	5	4	3	2	1

(a) Describe how you would use a microscope to find the mean diameter of triglyceride droplets on a slide.

_____

_____

_____

_____

_____

_____

(3)

(b) (i) The ratio of mean radius of triglyceride droplets in bile salts at a concentration of 0% to the mean radius in bile salts at a concentration of 3% is 2 : 1.

What is the ratio of their surface areas? Show your working.

You can calculate the surface area of a droplet from the formula

$$A = 4\pi r^2$$

Where A = surface area
r = radius
π = 3.14

(2)

(ii) Use the data in the table to explain the difference between curves **Y** and **Z** in the graph.

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

Q20.

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.

_____

_____

_____

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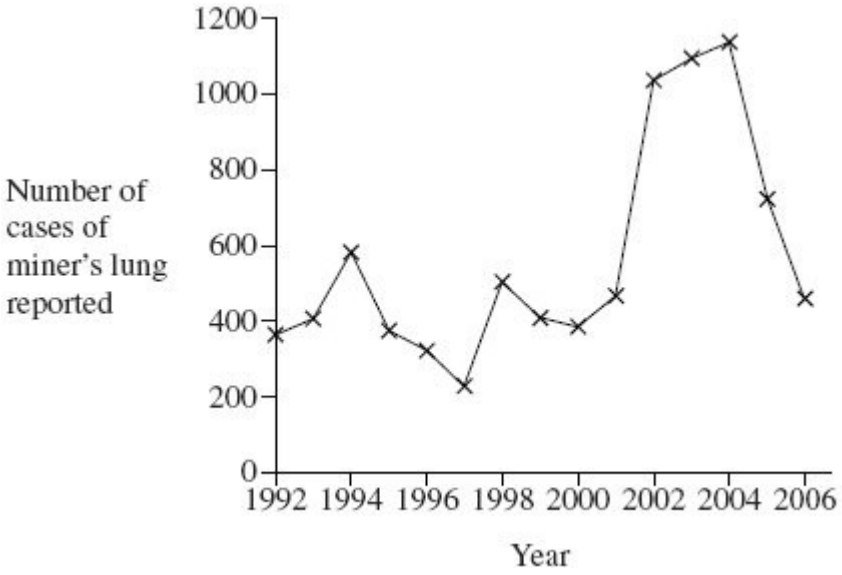
(2)

(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.

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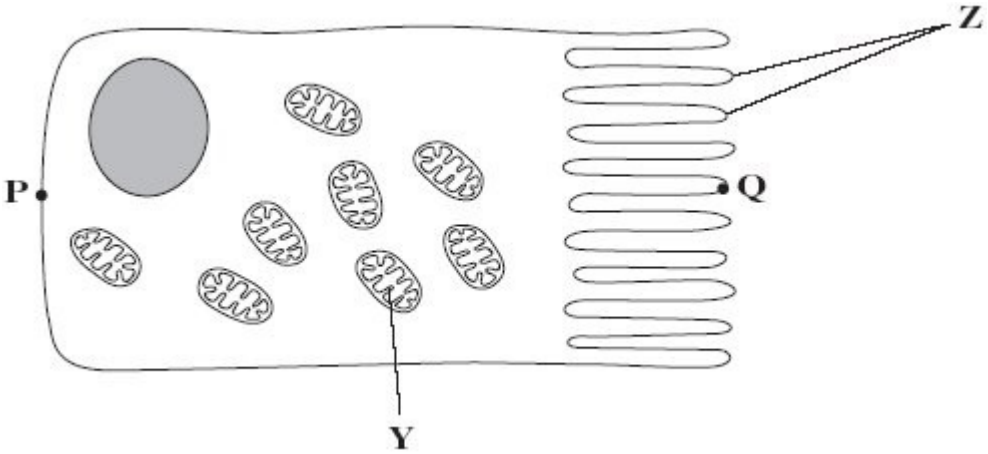
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(2)

(Total 8 marks)

Q21.

The diagram shows an epithelial cell from the small intestine.



(a) (i) Name organelle **Y**.

_____

(1)

(ii) There are large numbers of organelle **Y** in this cell. Explain how these organelles help the cell to absorb the products of digestion.

_____

_____

_____

_____

_____

(2)

(b) This diagram shows the cell magnified 1000 times. Calculate the actual length of the cell between points **P** and **Q**. Give your answer in µm. Show your working.

Answer _____ µm

(2)

(c) Coeliac disease is a disease of the human digestive system. In coeliac disease, the structures labelled **Z** are damaged.

Although people with coeliac disease can digest proteins they have low concentrations of amino acids in their blood.

Explain why they have low concentrations of amino acids in their blood.

_____

_____

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(2)

(Total 7 marks)

Q22.

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

1. _____

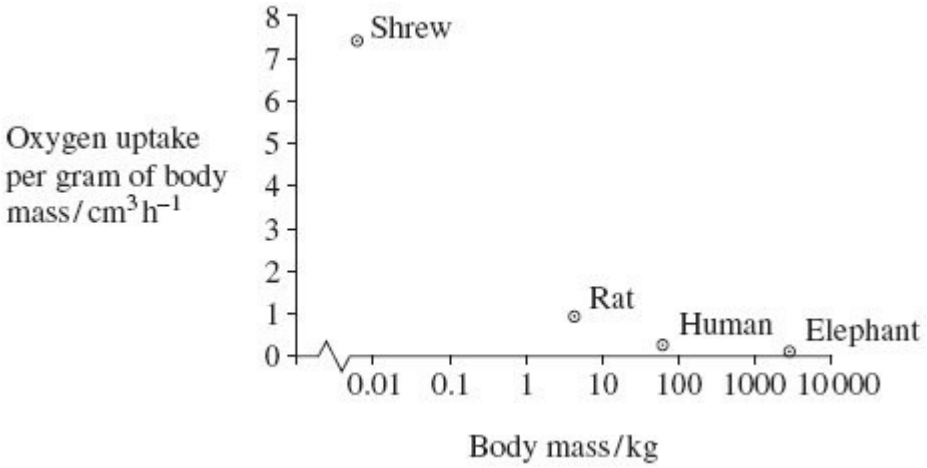
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2. _____

_____

(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)

Q23.

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.

_____

_____

_____

_____

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_____

_____

(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)

Q24.

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

_____

_____

_____

_____

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_____

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_____

(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.

_____

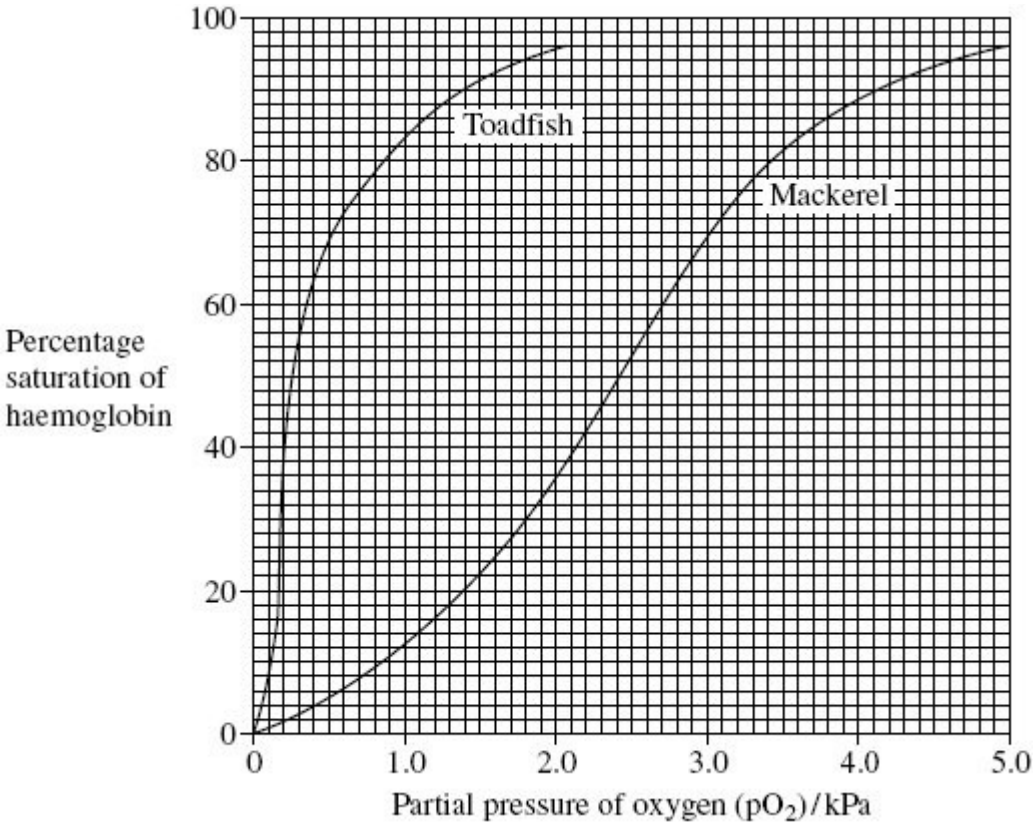
_____

_____

_____

(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.

_____

_____

_____

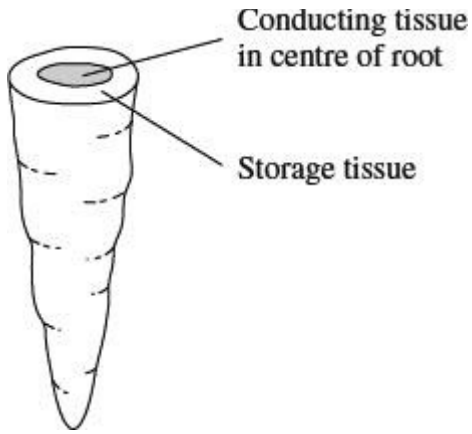
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(2)

(Total 12 marks)

Q25.

The diagram shows a carrot.



A group of students investigated the effect of sucrose concentration on the length of cylinders cut from a carrot.

(a) The students used a cork borer to cut cylinders from the carrot. Describe how the students should cut these cylinders to make sure that this was a fair test and would produce reliable results.

_____

_____

_____

_____

(2)

(b) They measured the initial length of each cylinder then placed the cylinders into test tubes containing different concentrations of sucrose solution. Bungs were placed in the tubes and the tubes were left overnight. Explain why the bungs were placed in the tubes.

_____

_____

_____

_____

(2)

(c) The students then measured the final lengths of the carrot cylinders. Their results are shown in the table.

Concentration of sucrose / mol dm^{-3}	$\frac{\text{Final length}}{\text{Initial length}}$
0.0	1.4
0.2	1.4
0.4	1.2
0.6	1.1
0.8	0.9

(i) The students used these results to find the concentration of sucrose that has the same water potential as the carrot cylinders. Describe how they could have done this.

_____

_____

_____

_____

(2)

(ii) Was it important in this investigation that the carrot cylinders had the same initial length? Explain your answer.

_____

_____

_____

(1)

(Total 7 marks)

Q26.

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)

Q27.

Heat and many different substances are transferred within the body and between the body and the environment. Write an essay to explain how surface area is linked to this transfer.

(Total 25 marks)

Q28.

(a) Dietary recommendations are that lipid intake should make up 30% of energy intake. The recommended energy intake for most women aged 19-49 is 8100 kJ day^{-1}.The energy content of lipid is 37.8 kJ g^{-1}. Calculate the recommended lipid intake per day for these women. Show your working.

Answer _____ g

(2)

In humans, triglycerides are the main form of dietary lipids. They are digested in the gut and the products of digestion are absorbed by the small intestine.

(b) Describe a biochemical test that could be performed on a sample of food to determine whether it contained triglycerides.

_____

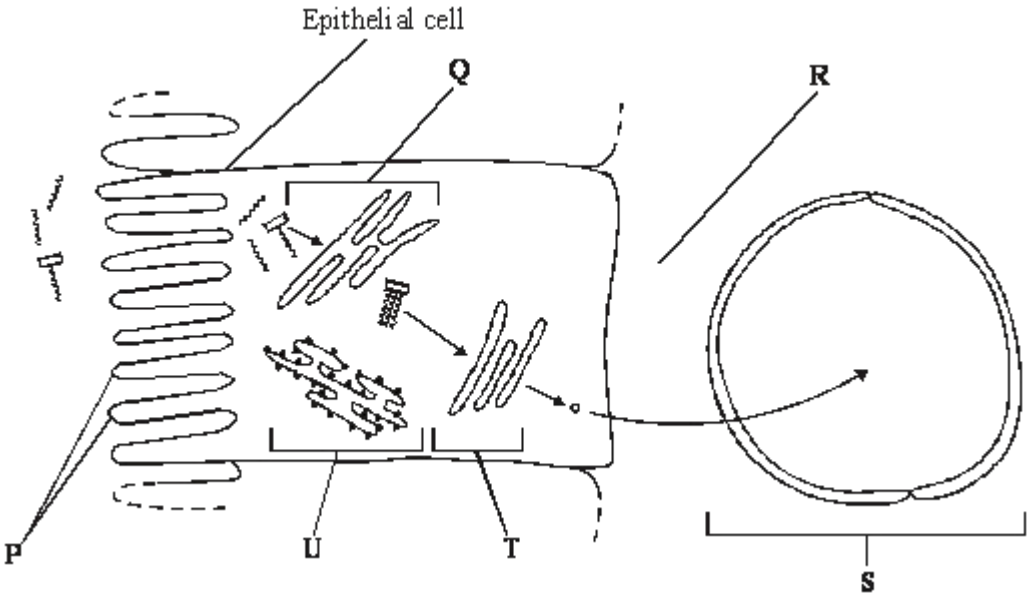
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(2)

(c) The diagram shows the events that occur in the absorption of monoglycerides and fatty acids. These molecules enter the epithelial cells of the small intestine by diffusion. Once inside they are reassembled into triglycerides in organelle **Q**. The triglyceride molecules are formed into chylomicrons in organelle **T**. Chylomicrons are made from many triglyceride molecules surrounded with protein molecules. The chylomicrons leave the cell and enter vessel **S**.



(i) Explain the importance of the structures labelled **P**.

_____

_____

(1)

(ii) Name

R; _____

S. _____

(2)

(iii) Describe the role played by organelle **U** in the formation of chylomicrons.

_____

_____

_____

_____

(2)

(iv) Suggest how the chylomicrons leave the epithelial cell. Give a reason for your answer.

_____

_____

_____

_____

(2)

(Total 11 marks)

Q29.

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.

_____

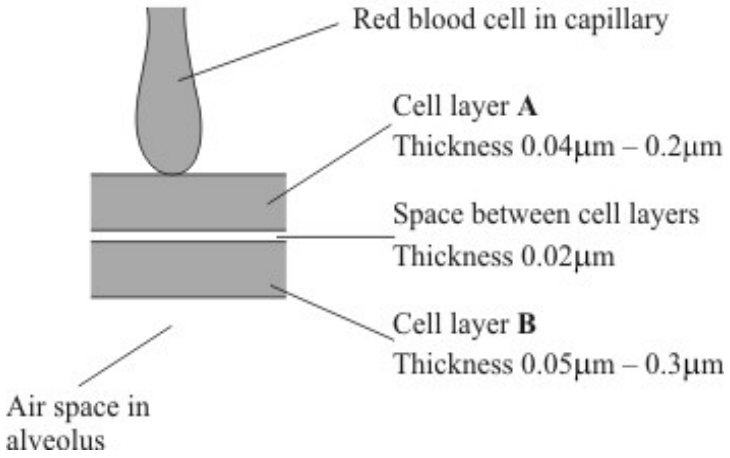
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(2)

(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.

_____

_____

_____

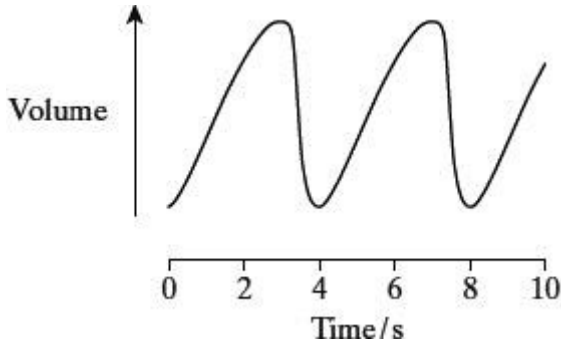
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(2)

(Total 9 marks)

Q30.

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)

Q31.

Read the following passage.

The plasma membrane plays a vital role in microorganisms. It forms a barrier between the cell and its environment, controlling the entry and exit of solutes.
This makes bacteria vulnerable to a range of antiseptics and antibiotics.

When bacteria are treated with antiseptics, the antiseptics bind to the proteins in the membrane and create tiny holes. Bacteria contain potassium ions at a concentration many times that outside the cell. Because of the small size of these ions and their concentration in the cell, the first observable sign of antiseptic damage to the plasma membrane is the leaking of potassium ions from the cell. Some antibiotics damage the plasma membrane in a similar way. One of these is tyrocidin. This is a cyclic polypeptide consisting of a ring of ten amino acids. Tyrocidin and other polypeptide antibiotics are of little use in medicine.

Other antibiotics also increase the rate of potassium movement from cells. It is thought that potassium ions are very important in energy release and protein synthesis, and a loss of potassium ions would lead to cell death. Gramicidin A coils to form a permanent pore passing through the plasma membrane. This pore enables potassium ions to be conducted from the inside of the cell into the surrounding medium. Vanilomycin also facilitates the passage of potassium ions from the cell.
A molecule of vanilomycin forms a complex with a potassium ion and transports it across the membrane. The potassium ion is released on the outside and the vanilomycin is free to return and pick up another potassium ion. Vanilomycin depends on the fluid nature of the plasma membrane in order to function.

Polyene antibiotics have flattened ring-shaped molecules. The two sides of the ring differ from each other. One side consists of an unsaturated carbon chain. This part is strongly hydrophobic and rigid. The opposite side is a flexible, strongly hydrophilic region. It has been shown that polyene antibiotics bind only to sterols. Sterols are lipids found in the membranes of eukaryotes but not in the membranes of prokaryotic organisms. It is thought that several sterol-polyene complexes come together.
The plasma membranes of eukaryotic cells treated with these polyene antibiotics lose the ability to act as selective barriers and small ions and molecules rapidly leak out.

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

(a) By what process do potassium ions normally enter a bacterial cell? Explain the evidence for your answer.

_____

_____

_____

_____

(2)

(b) (i) Draw a peptide bond showing how the COOH group of one amino acid joins to the NH_2 group of another.

(1)

(ii) How many peptide bonds are there in a molecule of tyrocidin (lines 9 - 10)?

_____

(1)

(c) Experiments have shown that vanilomycin is unable to transport potassium ions across a membrane when it is cooled. Gramicidin A continues to facilitate the movement of potassium ions at these low temperatures. Explain these results.

_____

_____

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_____

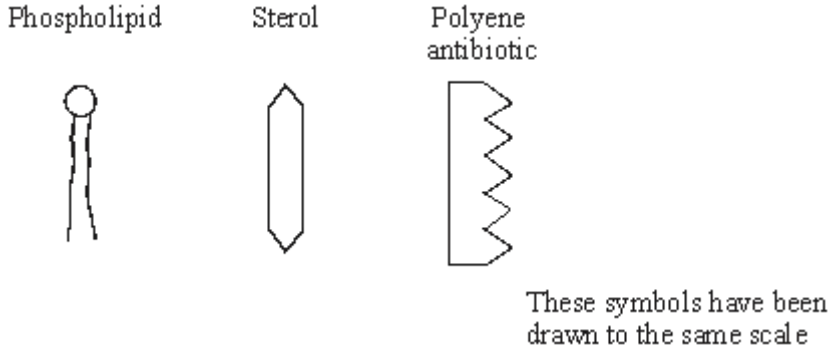
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(3)

(d) Draw a simple diagram of one of the phospholipid layers to show how polyene antibiotics allow small ions and molecules to leak rapidly through a plasma membrane. Use the following symbols to represent the different molecules.

Note that the zigzag line on the symbol for the polyene antibiotic represents its hydrophobic region.



(2)
(Total 9 marks)

Q32.

(a) Explain how the shape of a red blood cell allows it to take up a large amount of oxygen in a short time.

_____

_____

_____

_____

(2)

Samples of blood were mixed with equal volumes of different liquids. A drop of each mixture was put on a slide and examined with an optical microscope. The table shows the appearance of each slide.

Slide	Liquid added	Appearance of slide
A	Distilled water	No cells seen. Slide appears a uniform pale red colour
B	Sucrose solution	Cells are smaller in diameter than in an untreated sample of blood
C	Detergent (dissolves lipids)	No cells seen. Slide appears a uniform pale red colour

(b) (i) What does the appearance of slide **B** tell you about the plasma membrane surrounding a red blood cell?

_____

_____

(1)

(ii) Explain the appearance of slide **C**.

_____

_____

_____

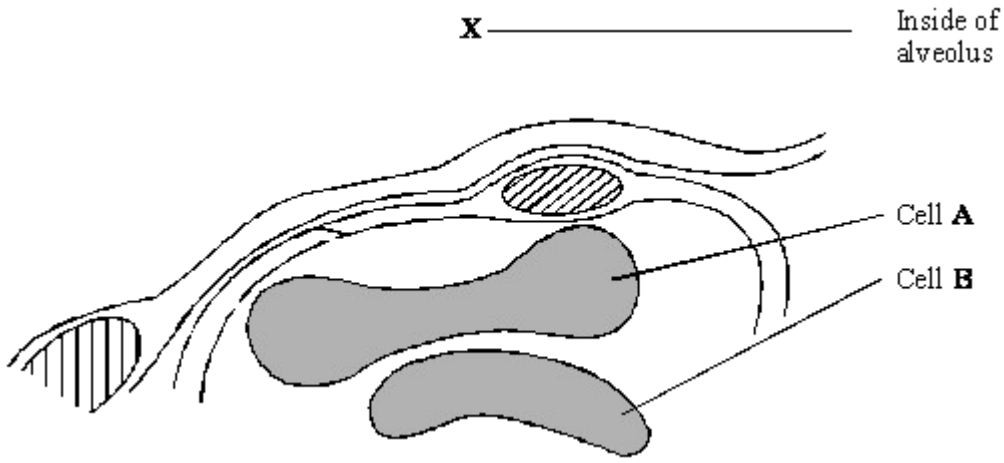
_____

(2)

(Total 5 marks)

Q33.

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)

Q34.

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

_____

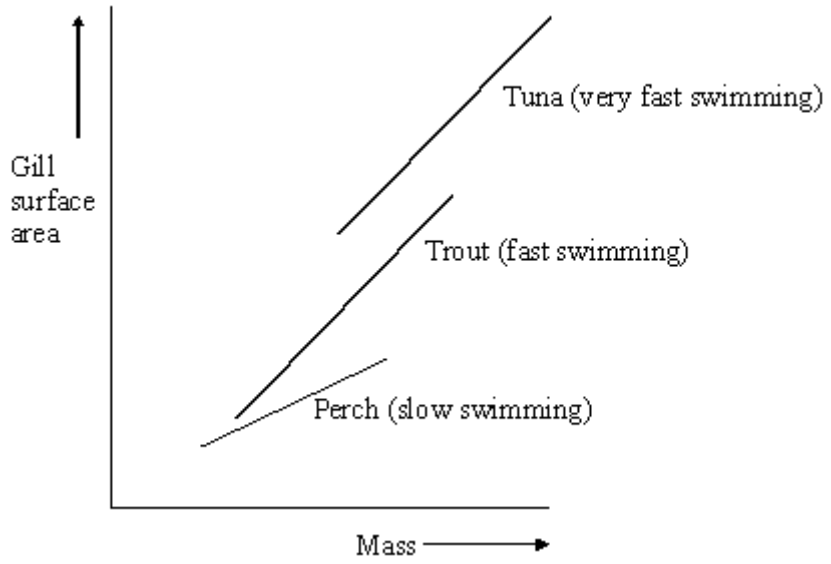
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(2)

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.

_____

_____

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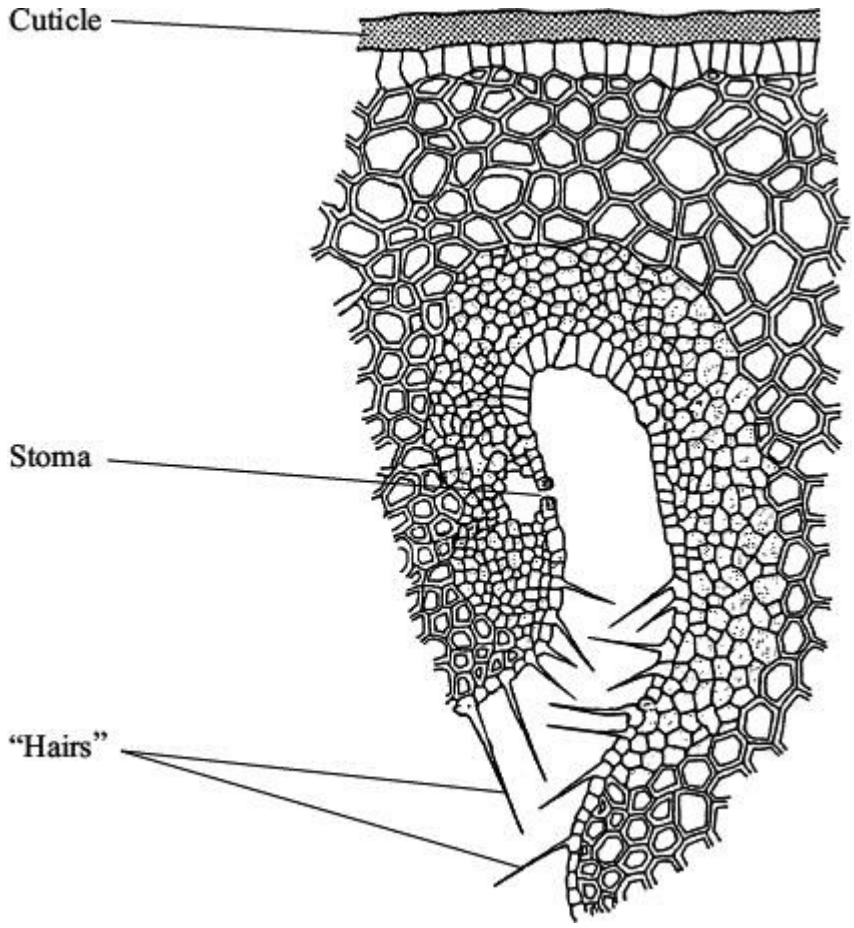
(2)

(Total 5 marks)

Q35.

Figure 1 shows a single stoma and surrounding cells from the leaf of a xerophytic plant.

Figure 1



(i) Explain how the cuticle reduces water loss.

_____

_____

(1)

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

_____

_____

_____

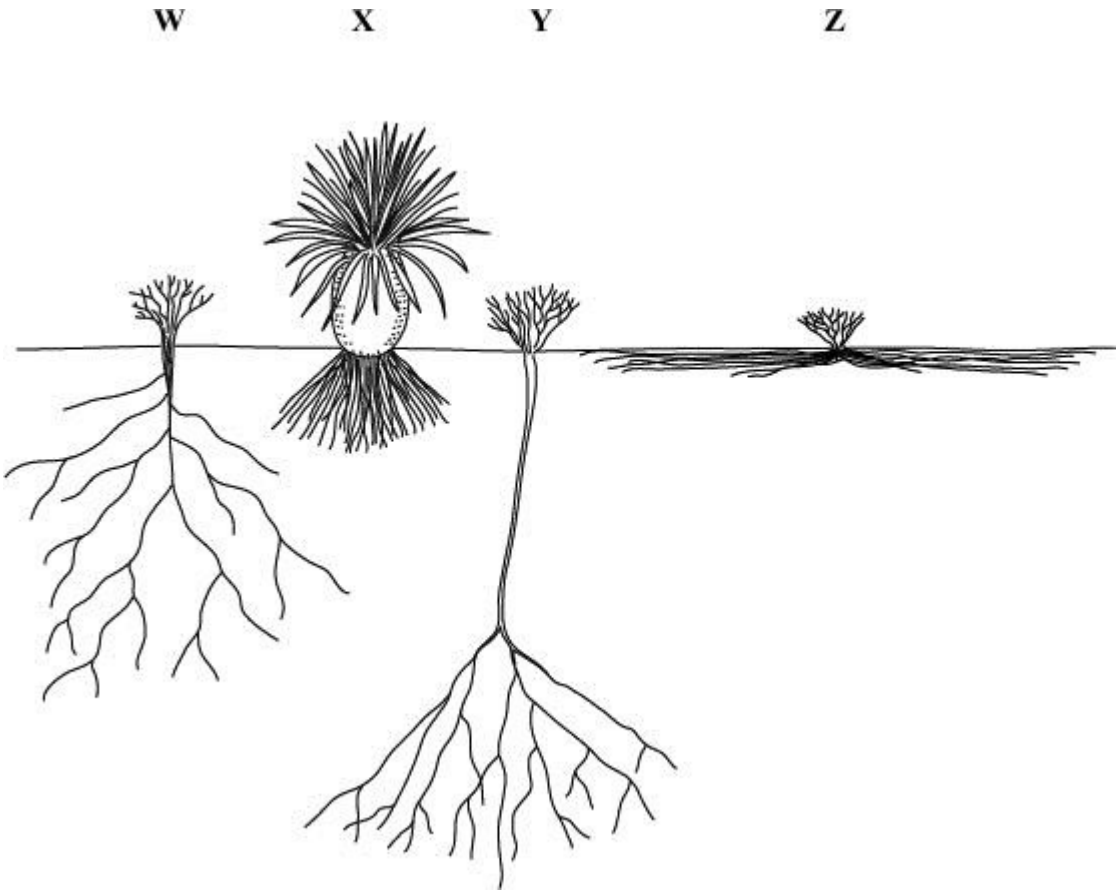
_____

(2)

(Total 3 marks)

Q36.

The drawing shows four common plants found in the Mojave Desert.



(a) Explain how **three** features of the plants shown in the drawing are adaptations to desert conditions.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(b) Resurrection plants can lose up to 95% of their water content without dying. They can survive for many years in this desiccated state and will revive within hours of rainfall. Suggest which of the plants **W** to **Z** is most likely to be a resurrection plant. Give a reason for your choice.

_____

_____

_____

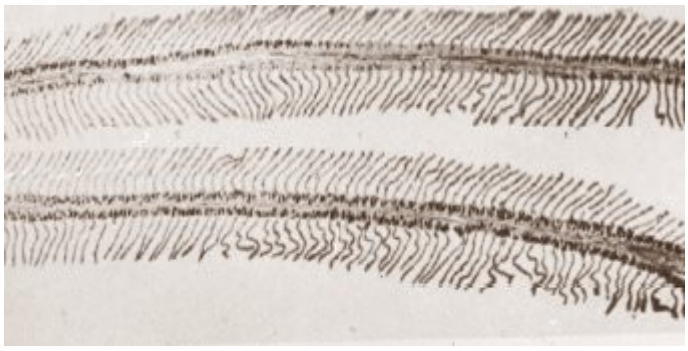
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(2)

(Total 5 marks)

Q37.

(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.

_____

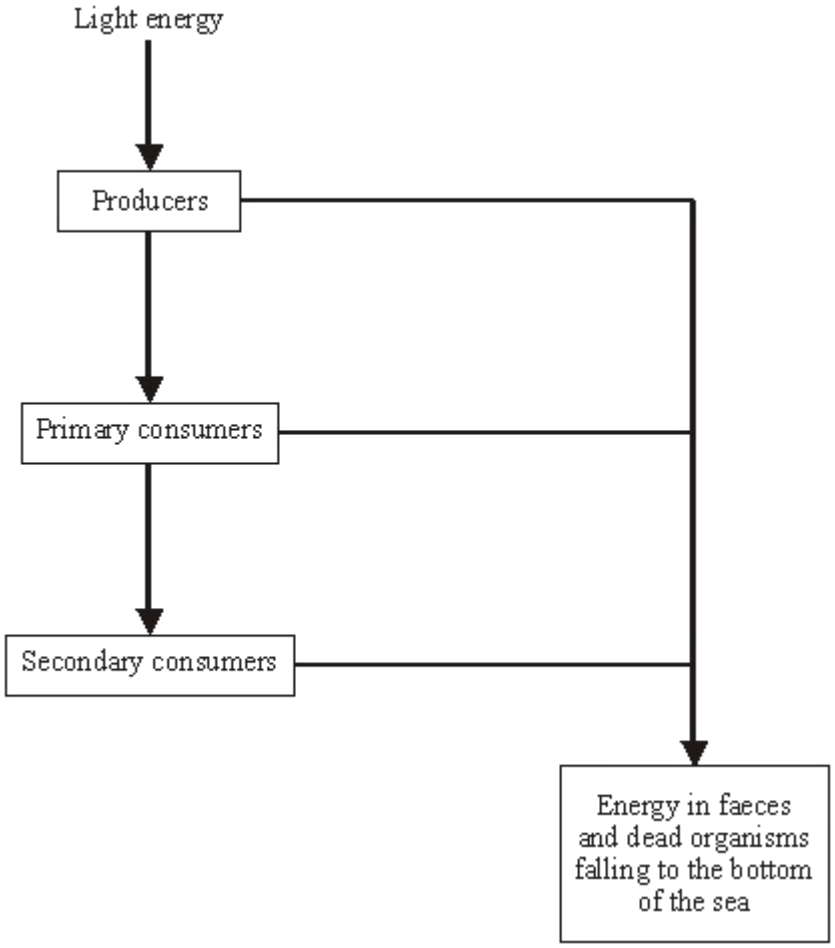
_____

(1)

(Total 5 marks)

Q38.

The diagram shows the flow of energy through a marine ecosystem.



(a) Give **one** reason why not all the light energy falling on the producers is used in photosynthesis.

_____

_____

(1)

(b) The producers in this ecosystem are seaweeds, which have a large surface area to volume ratio. Give **two** advantages to seaweeds of having a large surface area to

volume ratio.

1. _____

_____

2. _____

_____

(2)

(c) Some species of seaweed are submerged in water for most of the time. Explain how being under water might affect the rate of photosynthesis.

_____

_____

_____

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_____

(3)

(Total 6 marks)

Q39.

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

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_____

_____

_____

_____

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_____

(4)

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

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_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 10 marks)

Q40.

(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.

_____

_____

_____

_____

_____

(3)

(Total 5 marks)