Unit 2

The Variety of Living Organisms

Gas Exchange

Practice Exam Questions

1

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

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2 .....

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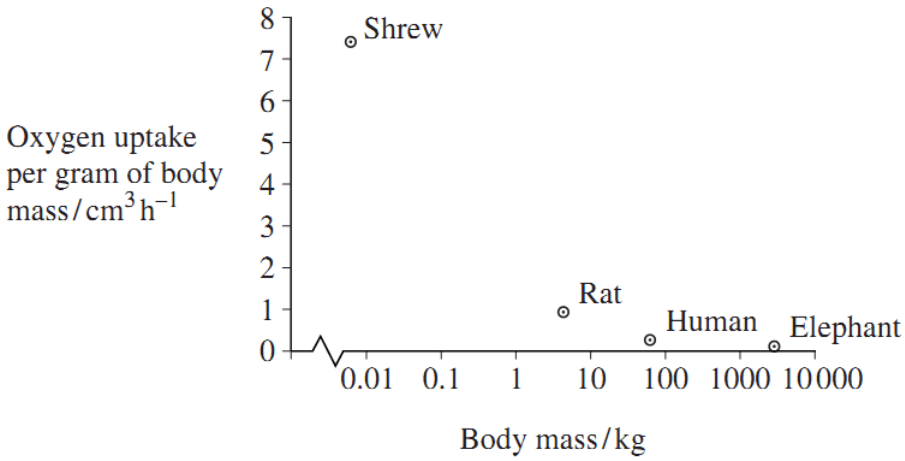
(2 marks)

(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.



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

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(1 mark)

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

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(1 mark)

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

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(2 marks)

(b) (iv) Heat from respiration helps mammals to maintain a constant body temperature. Use this information to explain the relationship between body mass and oxygen uptake shown in the graph.

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(3 marks)

2

Very small organisms such as the amoeba do not have specialised gas exchange systems. Mammals are large, multicellular organisms and have a complex gas exchange system. Explain why the mammal needs such a system when the amoeba does not. (4 marks)

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3

Bony fish rely on gills for gas exchange.

(a) Why does the highly folded structure of the gills increase the efficiency of gas exchange? (2 marks)

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(b) Suggest why gill lamellae would not provide an efficient gas exchange surface on land. (2 marks)

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(c) Name two similarities and two differences between the gas exchange of an insect and that of a mammal. (4 marks)

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

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

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

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

Table 4.1

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

5

A student was told by a teacher that the surface area to volume ratio (SA:V ratio) of an organism varies according to its size. The student decided to investigate this using two spheres, **A** and **B**, as models of organisms of different sizes. These are shown in Table 1.1. The surface area and volume of each sphere were calculated.

Table 1.1

	sphere **A**	sphere **B**
		
diameter / cm	1	3
surface area / cm^2	3.14	28.27
volume / cm^3	0.52	14.14

(a) (i) The student calculated the SA:V ratio of sphere **B** as 2:1. Calculate the SA:V ratio of sphere **A**. Show your working.

Answer = ... [2]

(ii) Describe how the SA:V ratio changes as the size of the sphere increases.

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6. Outline how the counter-current flow of blood and water results in efficient gas exchange in fish

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(3 marks)

Gas Exchange Answers & Markscheme

Question 1

Part	Marking Guidance	Mark	Comments
(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;	2 max	**Q** Do not credit thin cell walls/membranes
(b)(i)	Large/wide range of values (so can fit on graph);	1	
(b)(ii)	Decrease in uptake with increase in mass / negative correlation;	1	
(b)(iii)	Enables comparison; As animals differ in size/mass;	2	
(b)(iv)	Smaller animals have larger surface area to volume ratio; Lose more heat per gram of tissue; Respire more/faster (relative to body mass); Oxygen used in respiration;	3 max	Allow converse for larger animals. Allow appropriately named animal as an alternative to smaller or larger animals.

Question 2

amoeba has a large surface area to volume ratio/and a short diffusion pathway to all parts of the organism; therefore diffusion is efficient;

mammals have a small surface area to volume ratio/and a long diffusion pathway;
they have skin which is waterproof and gastight;
they need an internalised system so that the gas exchange surface can be kept moist;
the folded surface of the lungs provides a large surface area; 4

Question 3

(a) Increases surface area;
over which diffusion may take place; ***2***

(b) The gills may dry out;
thus preventing oxygen dissolving on the surface of the gills;
they are no longer supported by water/folds may stick together with surface tension/not open as easily; ***2***

(c) Similarities:
large surface area;
moist gas exchange surface;
thin gas exchange surface;
concentration gradient achieved by ventilation (in some species of insects); 2

Differences:
Transport (circulatory) system in mammals but not in insects;
the respiratory surface in mammals is the alveoli, in insects it is the junction between the tracheoles and the respiring tissues; 2

4 max

Total 8

Question 4

<table>
<tr><td>4</td><td>(a)</td><td></td><td>large / active, organisms have high(er), demand for oxygen / need to remove CO_2 ;
small(er), <u>surface area to volume ratio / SA:V / surface area:volume</u> ;
surface area too small / distance too large / diffusion takes too long (to supply needs) ;</td><td>2 max</td><td>ACCEPT ORA throughout
IGNORE ref to nutrients

ACCEPT diffusion too slow
look for reason why diffusion not good enough</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>(b)</td><td></td><td>create / maintain, (steep), diffusion / concentration, gradient ;
<table><tr><td></td><td></td></tr><tr><td>epithelium</td><td>short (diffusion) distance ;</td></tr><tr><td>capillaries</td><td>delivers carbon dioxide (to be removed from blood) / carries oxygen away (from alveoli) ;
short (diffusion) distance ;</td></tr><tr><td>diaphragm / intercostal muscles</td><td>ventilation / supply of oxygen (to alveoli) / removal of carbon dioxide (from alveoli) ;</td></tr></table></td><td>3 max</td><td>could give mark in any row as an additional mark – but only once

DO NOT ACCEPT any vague reference to ‘gases’ throughout

ACCEPT short diffusion distance here even if given above

ACCEPT breathing in and out / AW</td></tr>
</table>

Question 5

(i) 6:1 ; ;
working. 3.14 divided by 0.52 **2**

(ii) ratio for B is smaller / decreased / AW ; *ora*
by two thirds / AW ;
volume increases more rapidly than area / AW ; *ora*

ecf if wrong calculation in (a) (i) **2 max**

Question 6

The blood flows in the opposite direction to the water across the gills;

as a result, highly oxygenated water comes into contact with poorly oxygenated blood;

this maintains (an oxygen) concentration gradient across the whole of the gill plate/maximises diffusion;

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