



CHEMISTRY ONLINE
— **TUITION** —

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BIOLOGY

ORGANISMS EXCHANGE SUBSTANCES

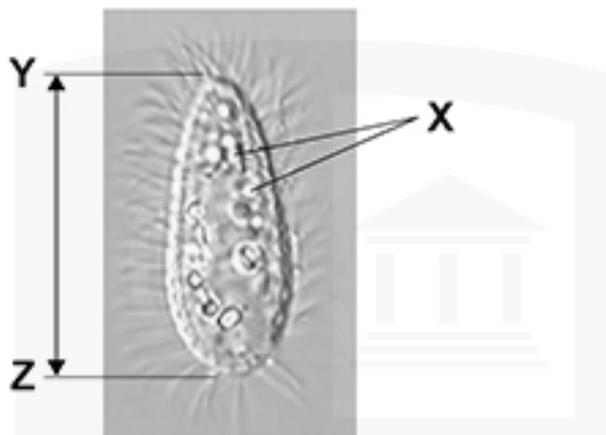
Level & Board	AQA (A-LEVEL)
TOPIC:	SURFACE AREA VOLUME RATIO
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	5
TOTAL MARKS	26

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Surface Area to Volume Ratio - 1

1.

Urinoma marinum is a eukaryotic single-celled organism. An optical microscope image of U. marinum is shown in the diagram below.



(a) The majority of mitochondria in U. marinum large cells are located in close proximity to the cell-surface membrane. The mitochondria are evenly spaced throughout the cytoplasm of smaller cells. Oxygen is used by mitochondria during aerobic respiration.

Utilizing this data and your understanding of surface area to volume ratios, propose a hypothesis regarding the location of mitochondria in large U. marineum cells. **(2)**

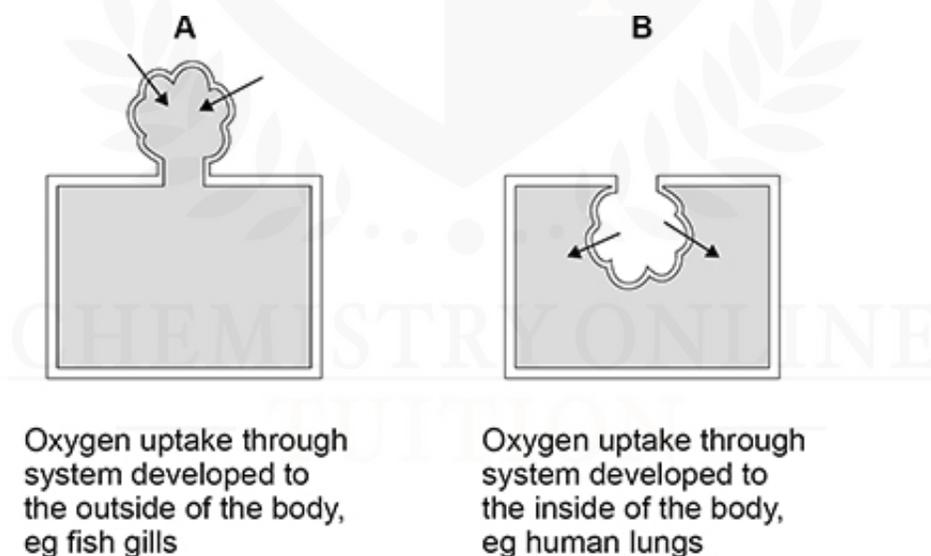
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2.

(a) Describe the benefit of having a specialized system that makes it easier for larger animals to absorb oxygen. (2)

Two animal models of oxygen uptake are displayed in Figure 1.



(b) Use Model A instead of Model B to suggest how environmental conditions have led to system adaptations. (2)

(c) Two mammals' features are displayed in the table below.

Shrews are ground-living mammals, whereas bats are soaring mammals.

Mammal	Mean body mass / kg	Mean lung volume / cm ³
Bat	0.096	12.48
Shrew	0.024	0.72

Determine the number of times the bat lung volume per unit of body mass is higher than the shrews.

Assign a suitable number of significant figures to your response.

Provide a hypothesis to account for this discrepancy. **(3)**

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Answer -----

Explanation

3.

A researcher looked into the oxygen affinity of mouse and horse hemoglobin. The table displays a portion of their findings.

Animal	Partial pressure of oxygen when hemoglobin is 50% saturated / kPa	Partial pressure of oxygen when hemoglobin is 25% saturated / kPa	Body mass of one animal / g
Horse	3.5	1.9	550 000
Mouse	6.5	3.3	23

(a) To calculate an animal metabolic rate, use the following formula.

$$\text{Metabolic rate} = 63 \times 10^{-0.27}$$

BM = body mass in grams

Determine the number of times a mouse metabolic rate is faster than a horse using this equation. (2)

Answer = _____ times faster

(b) Mice and horses are two examples of mammals that can keep their body temperature steady.

Make use of your understanding of the surface area to volume ratio to provide an explanation for why mice have higher metabolic rates than horse.

(3)



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(a) Explain the connection between an organism's size, surface area, and volume ratio. **(1)**

(b) A large number of frog eggs surface areas were calculated by a scientist. He discovered that the surface area had a mean of 9.73 mm^2 . The frog ovum is spherical.

This formula is used to find a sphere's surface area.

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

where r is a sphere radius and

$$\pi = 3.14$$

To find the mean diameter of a frog egg, use this formula.

Display your work. **(2)**

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Diameter = _____ mm

The scientist determined the frog, tadpole, and egg surface area to mass ratios. He also ascertained the average rate at which frogs and tadpoles absorb oxygen.

His findings are displayed in the table.

Stage of frog development	Ratio of surface area to mass	Mean rate of oxygen uptake / $\mu\text{mol g}^{-1} \text{h}^{-1}$
Egg	2904 : 1	No information
Tadpole	336 : 1	5.7
Adult	166 : 1	1.3

(c) The rate of oxygen uptake was measured in units of $\mu\text{mol g}^{-1} \text{h}^{-1}$.

Explain his choice of μmol for these units. (1)

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(d) Instead of using the ratio of surface area to volume, the scientist chose to use the ratio of surface area to mass. He took this action for pragmatic considerations.

Give an example of a useful benefit of weighing frog eggs, tadpoles, and adults instead of just their volumes. (1)

(e) Describe the relationship between oxygen uptake and an organism's metabolic rate. **(1)**

(f) A student who examined these data stated that they were unable to draw any conclusions regarding the connection between metabolic rate and developmental stage.

To explain why they were unable to come to a conclusion, use the data in the table. **(3)**

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5.

Small slender creature called tubifex worms inhabit water. They lack a specialized circulatory system and gas exchange.

Below is a figure of a tubifex worm.



(a) Identify the mechanism through which oxygen enters a tubifex worm internal cells. **(1)**

(b) Using the information given, describe how two characteristics of the tubifex worm body enable effective gas exchange. **(2)**

1.

2.



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