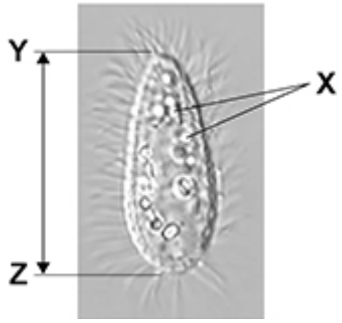
Q1.

Uronema marinum is a single-celled eukaryotic organism. The diagram below is a photograph of *U. marinum* taken through an optical microscope.



(d) In large cells of *U. marinum*, most mitochondria are found close to the cell-surface membrane. In smaller cells, the mitochondria are distributed evenly throughout the cytoplasm. Mitochondria use oxygen during aerobic respiration.

Use this information and your knowledge of surface area to volume ratios to suggest an explanation for the position of mitochondria in **large** *U. marinum* cells.

(2)

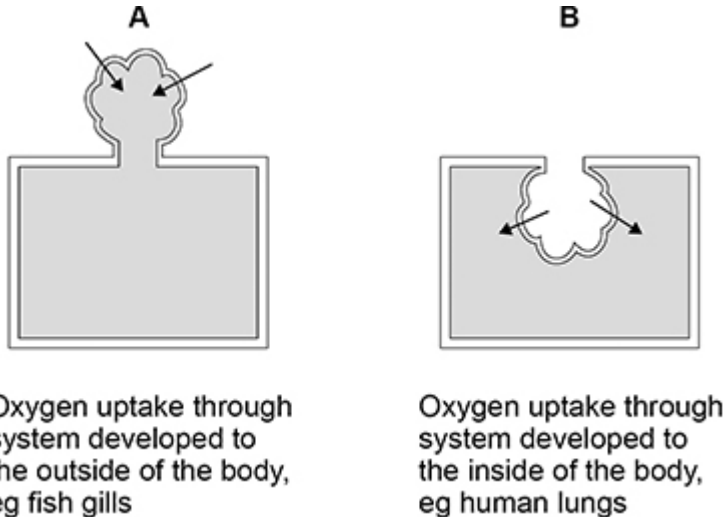
Q2.

(a) Explain the advantage for larger animals of having a specialised system that facilitates oxygen uptake.

(2)

Figure 1 shows two models of oxygen uptake found in animals.

Figure 1



(b) Suggest how the environmental conditions have resulted in adaptations of systems using **Model A** rather than **Model B**.

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(2)

(e) The table below shows features of two mammals.

Bats are flying mammals; shrews are ground-living mammals.

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

Calculate how many times the lung volume per unit of body mass of the bat is greater than that of the shrew.

Give your answer to an appropriate number of significant figures.

Give **one** suggestion to explain this difference.

Answer _____

Explanation _____

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(3)

Q3.

A scientist investigated the affinity for oxygen of horse haemoglobin and mouse haemoglobin.

Some of their results are shown in the table.

Animal	**Partial pressure of oxygen when haemoglobin is 50% saturated / kPa**	**Partial pressure of oxygen when haemoglobin is 25% saturated / kPa**	**Body mass of one animal / g**
Horse	3.2	1.9	550 000
Mouse	6.5	3.3	23

(b) The following equation can be used to estimate the metabolic rate of an animal.

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

BM = body mass in grams

Use this equation to calculate how many times faster the metabolic rate of a mouse is than the metabolic rate of a horse.

Answer = _____ times faster

(2)

(d) Mammals such as a mouse and a horse are able to maintain a constant body temperature.

Use your knowledge of surface area to volume ratio to explain the higher metabolic rate of a mouse compared to a horse.

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(3)

Q4.

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

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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.

(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.

(3)

(Total 9 marks)

Q5.

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.

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(1)

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

1. _____

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2. _____

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(2)