



A-Level Biology

Insect and Fish Gas Exchange

Question Paper

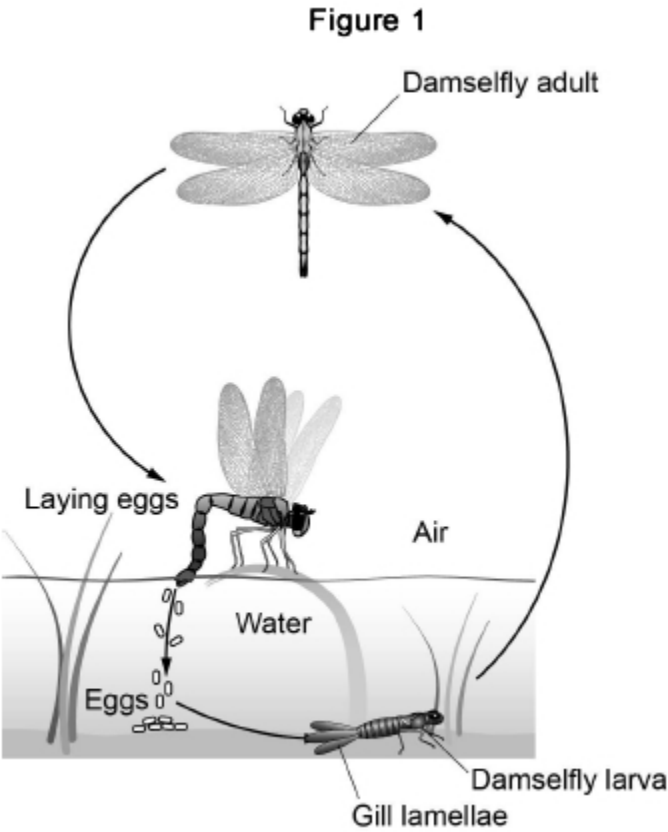
Time available: 78 minutes

Marks available: 62 marks

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1.

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



(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. _____

- 3. _____

(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.

(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 (\pm uncertainty / mm)	1.61 (\pm 0.19)
Mean width / mm (\pm uncertainty / mm)	6.12 (\pm 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.

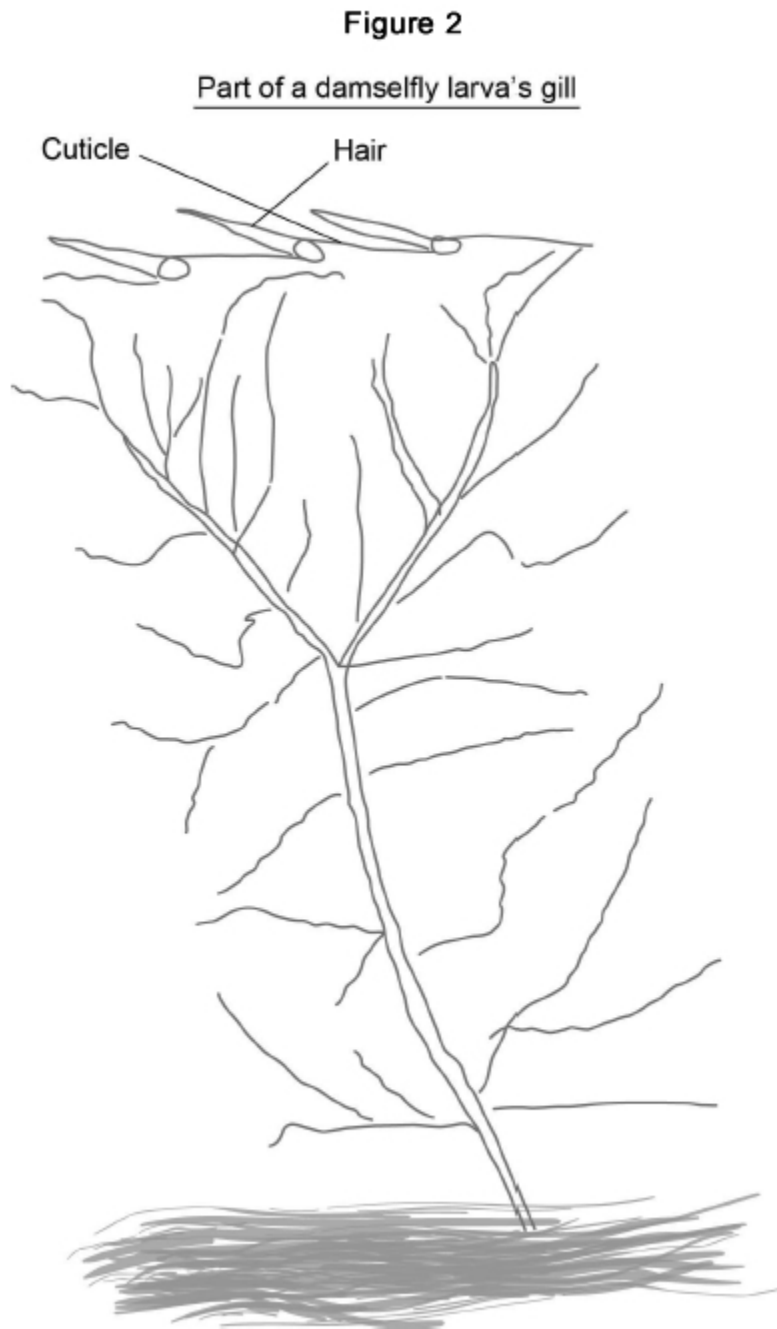
Mean surface area = _____

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.



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

1. _____

2. _____

(2)

(Total 10 marks)

2.

(a) (i) Name the structure through which gases enter and leave the body of an insect.

(1)

(ii) Name the small tubes that carry gases directly to and from the cells of an insect.

(1)

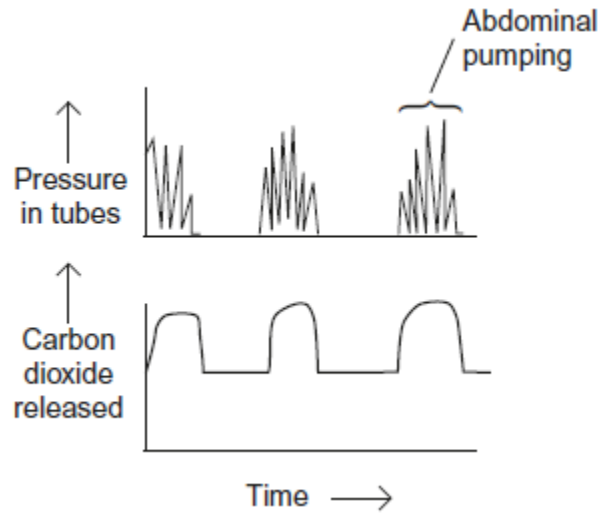
(b) Explain the movement of oxygen into the gas exchange system of an insect when it is at rest.

(3)

- (c) Abdominal pumping takes place during vigorous activity in insects. This causes regular squeezing of the tubes of the gas exchange system.

A scientist investigated the effect of abdominal pumping on the pressure in the tubes and the volume of carbon dioxide released by the insect.

Her results are shown below.

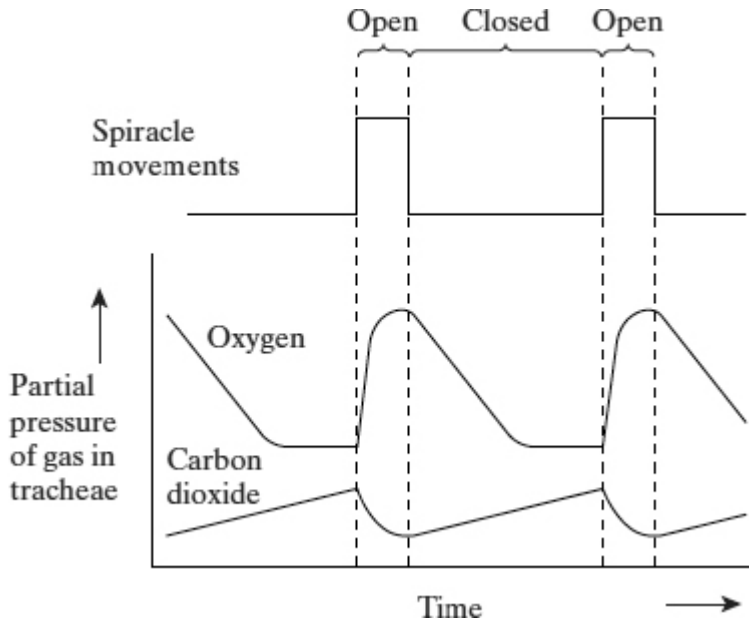


Describe and explain these results.

(3)
(Total 8 marks)

3.

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.

(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)

4.

(a) Describe how the structure of the insect gas exchange system:

- provides cells with sufficient oxygen
- limits water loss.

Explain your answers.

(5)

(b) Describe how humans breathe in and out.

(5)

(Total 10 marks)

5.

(a) Describe and explain how the countercurrent system leads to efficient gas exchange across the gills of a fish.

(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 / $\text{cm}^3 \text{ kg}^{-1} \text{ hour}^{-1}$	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)

6.

(a) Explain **two** ways in which the structure of fish gills is adapted for efficient gas exchange.

- 1. _____
- _____
- 2. _____
- _____

(2)

(b) Explain how the counter current mechanism in fish gills ensures the maximum amount of the oxygen passes into the blood flowing through the gills.

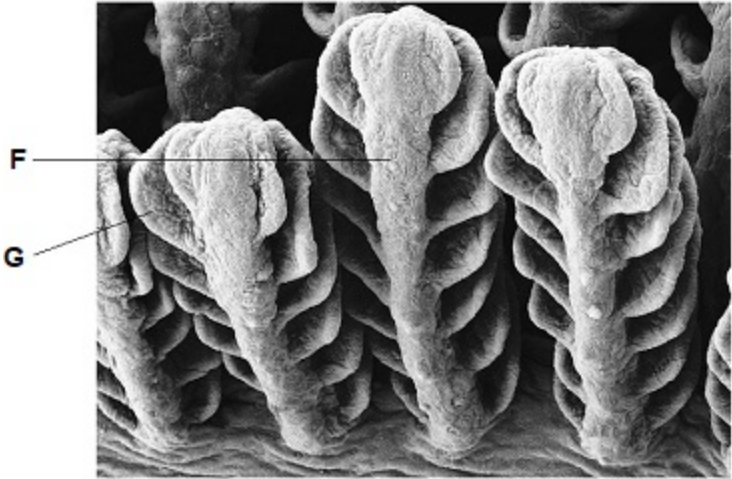
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____
- _____

(3)

(Total 5 marks)

7.

Below is an image of a fish gill taken using a scanning electron microscope.



(a) Identify structures labelled **F** and **G**.

F _____

G _____

(1)

(b) Describe and explain the advantage of the counter-current principle in gas exchange across a fish gill.

(3)

(Total 4 marks)

8.

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

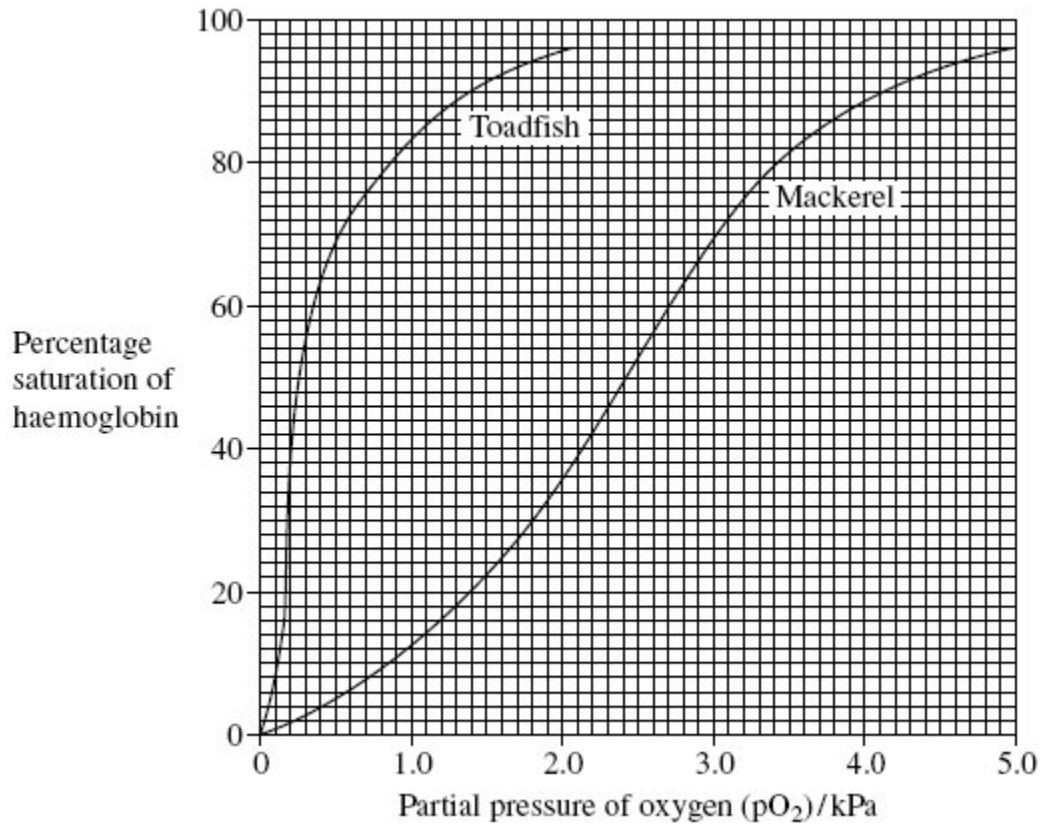
(6)

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)