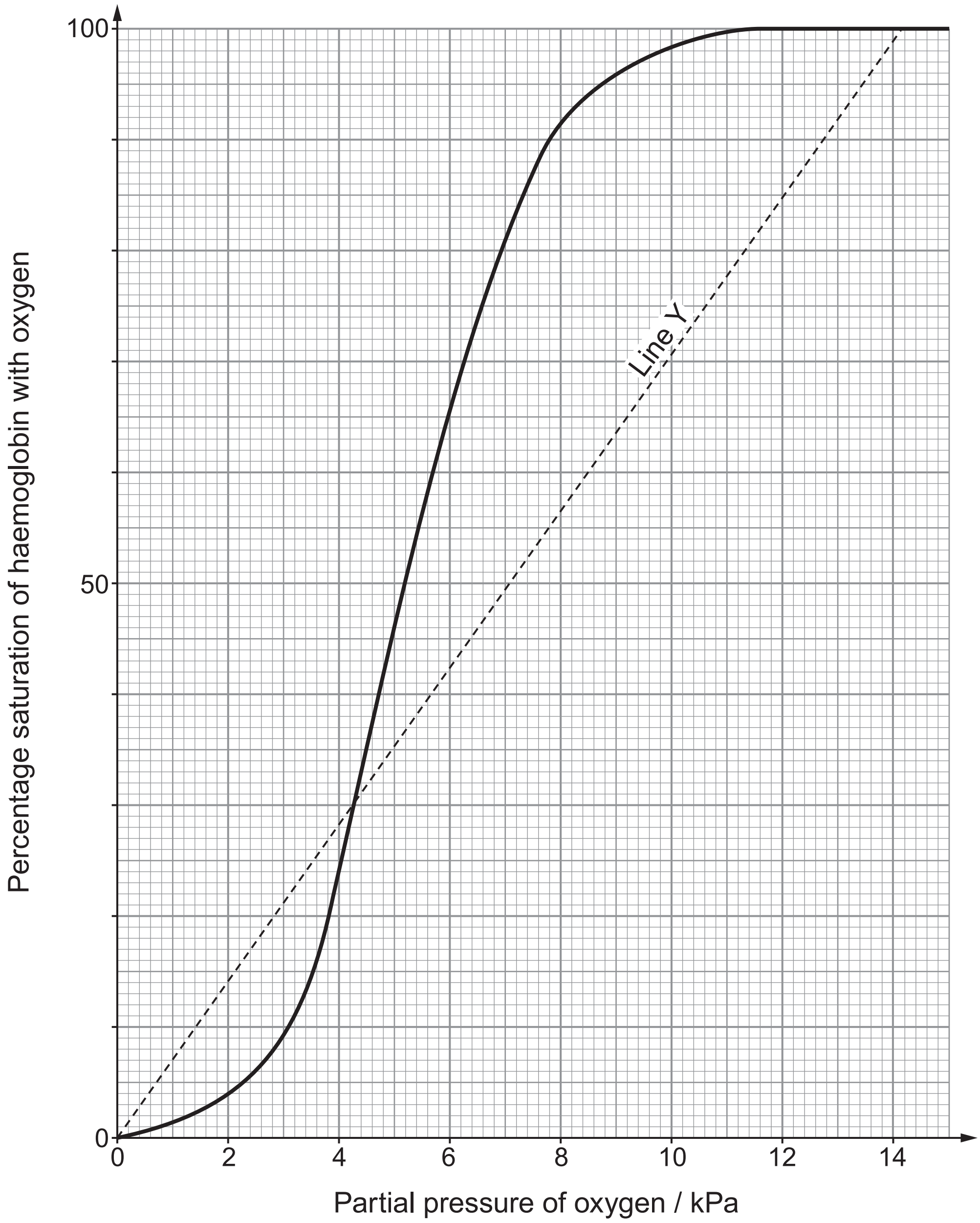
GCE AS Level Biology

S21-B400U20-1

Assessment Resource 10

Biodiversity and Physiology of Body Systems Resource D

1. The diagram below shows the oxygen dissociation curve for adult human haemoglobin.



(a) The curve shows a sigmoid (S-shaped) relationship between partial pressure of oxygen and saturation of haemoglobin with oxygen. Line Y shows the theoretical linear relationship.

(i) Using the sigmoid curve the percentage decrease in the haemoglobin saturation between 6 kPa and 2 kPa is 15.5 % per kPa.

Calculate the equivalent **percentage decrease per kPa** for the linear relationship shown in the graph. [2]

Decrease = ... % per kPa

(ii) Explain why the sigmoid curve is more efficient for a respiratory pigment than the linear relationship. [2]

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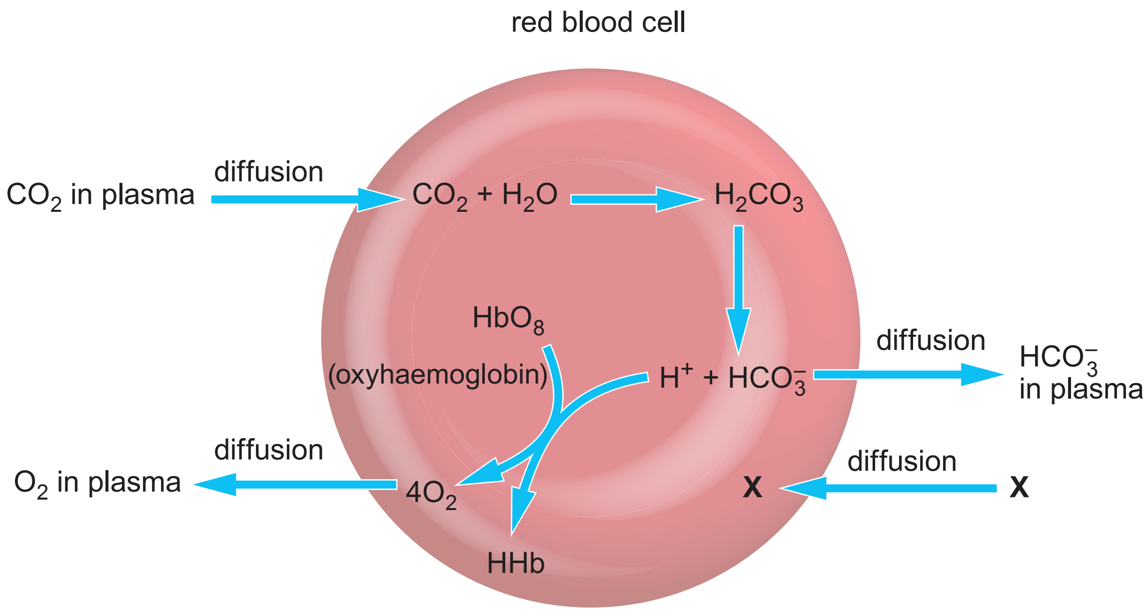
(b) The diagram below shows the process by which a red blood cell located in a capillary of actively respiring tissue is involved in the transport of carbon dioxide.



(i) Carbon dioxide normally dissolves slowly in water.

Explain why carbon dioxide dissolves much more quickly within red blood cells. [1]

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(ii) Name ion **X** and explain why it enters red blood cells. [2]

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(iii) Use the diagram to explain why an increase in the rate of respiration would lead to more oxygen being released from oxyhaemoglobin. [4]

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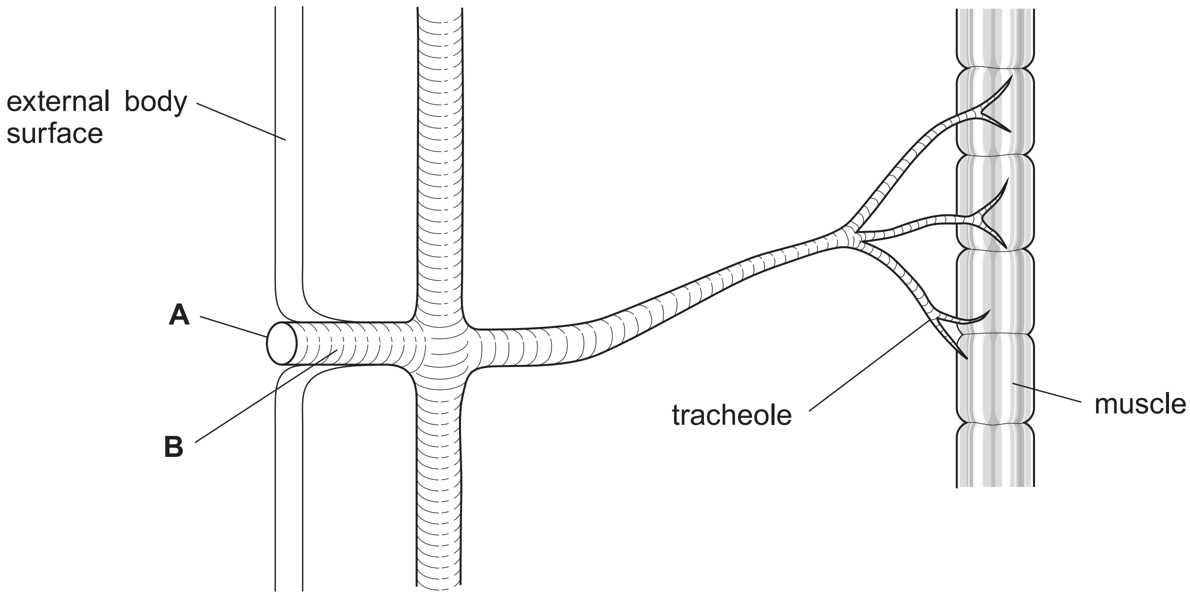
2. Insects have evolved an internal gas exchange system as an adaptation to a terrestrial environment. The diagram below shows part of an insect's gas exchange system.



(a) Name the structures labelled **A** and **B**. [1]

A: ....

B: ....

(b) Many small animals such as earthworms have a circulatory system with a respiratory pigment such as haemoglobin.

(i) Explain why earthworms need a respiratory pigment, but insects do not. [2]

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(ii) Suggest why having the type of gas exchange system shown in the diagram means that insects are not able to grow as large as animals which have a circulatory system and haemoglobin. [1]

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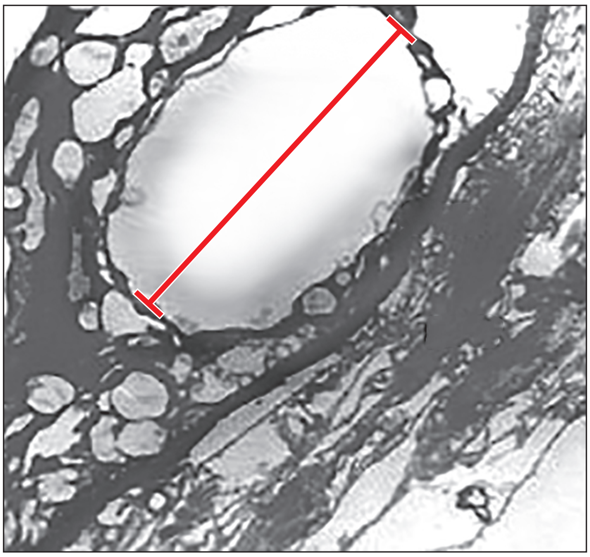
The electron micrograph below shows a transverse section of an insect tracheole.



(c) Using the line provided on the electron micrograph, calculate the diameter of the insect tracheole in the electron micrograph, given that the magnification of the image is × 10 000.

Give your answer in μm to 2 significant figures. [2]

Diameter = ... μm

Albacore tuna (*Thunnus alalonga*) is a fast-swimming predatory fish which can swim at speeds of up to 80 km hr^{-1} and often performs very deep dives into colder water in pursuit of prey. The tuna has a very high rate of respiration and has several adaptations which help it maximise its rate of gas exchange:

- gills have a surface area up to 30 times greater than other fish of comparable size
- gas exchange surface is much thinner than that of other fish
- higher blood pressure than other fish
- counter-current flow in its gills

However, it has lost the ability to pump water over its gill surface, relying instead on a process known as ram ventilation. In this process, the fish keeps its mouth open as it swims and water is forced over the gill surface as it moves through the water.

(d) (i) Explain how a thin gas exchange surface and high blood pressure help a tuna to maximise its rate of gas exchange. [3]

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(ii) Tuna must swim continuously. Explain why this is essential. [3]

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Another adaptation found in tuna is that they are able to maintain a core body temperature several degrees above that of the surrounding water. They achieve this by means of a counter-current heat exchanger located deep within their muscle. Cool blood in arteries from the gills passes very close to warm blood in the veins flowing in the opposite direction. This allows heat from the warm blood to raise the temperature of the cooler blood before it reaches the muscle capillaries.

(e) The tuna's heat exchanger employs a counter-current flow mechanism. Explain how such an arrangement helps to maximise the rate of heat exchange. [2]

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(f) Suggest why it is particularly important to the tuna to raise the temperature of blood before it reaches the muscle capillaries. [3]

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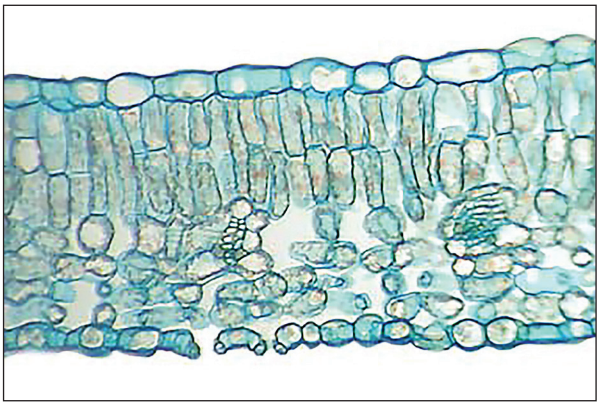
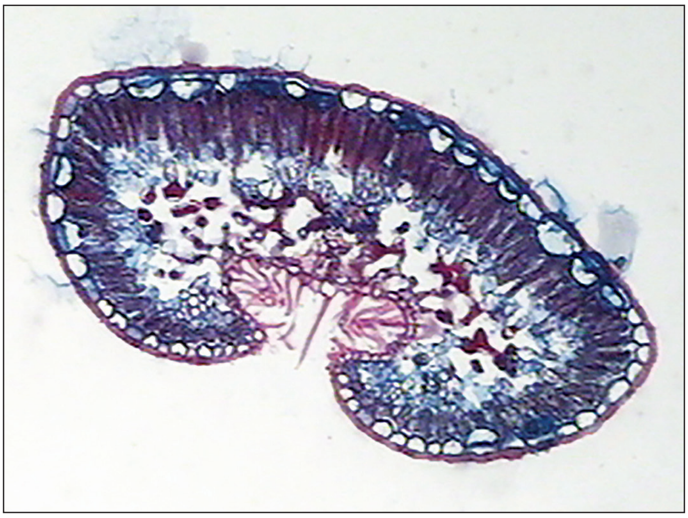
3. The three photomicrographs below show three types of angiosperm leaf adapted to different environmental conditions.

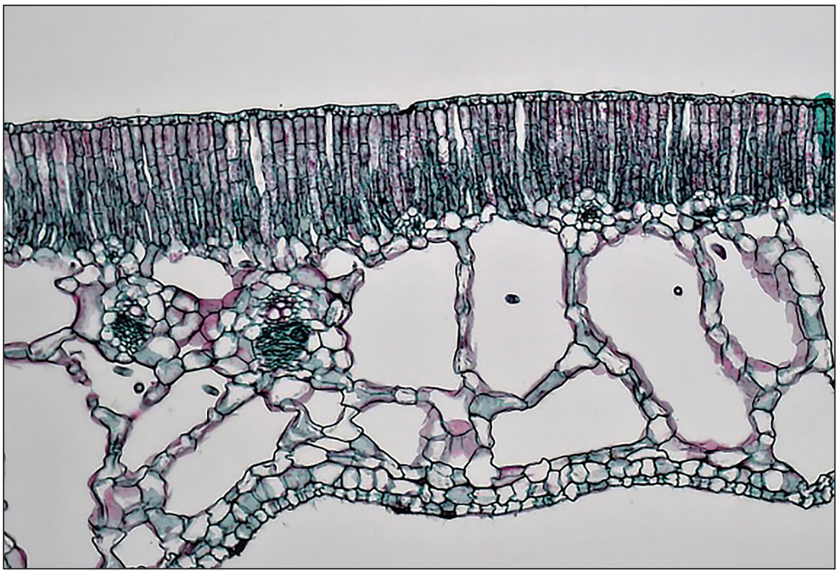
Photomicrograph **A**



Photomicrograph **B**



Photomicrograph **C**



Describe how the structures present in the leaf in photomicrograph **A** allow the plant to carry out photosynthesis and explain how the adaptations in the leaves in photomicrographs **B** and **C** enable the plants to survive in different environmental conditions. [9 QER]

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