Cambridge Assessment International Education

Cambridge International AS & A Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2295025156

BIOLOGY **9700/22**

Paper 2 AS Level Structured Questions **October/November 2020**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Blank pages are indicated.

Answer **all** questions.

1 Fig. 1.1 is a diagram drawn from a photomicrograph of a transverse section through part of a leaf.

The arrows in Fig. 1.1 show the movement of water through the cells of the leaf after it has left the xylem.

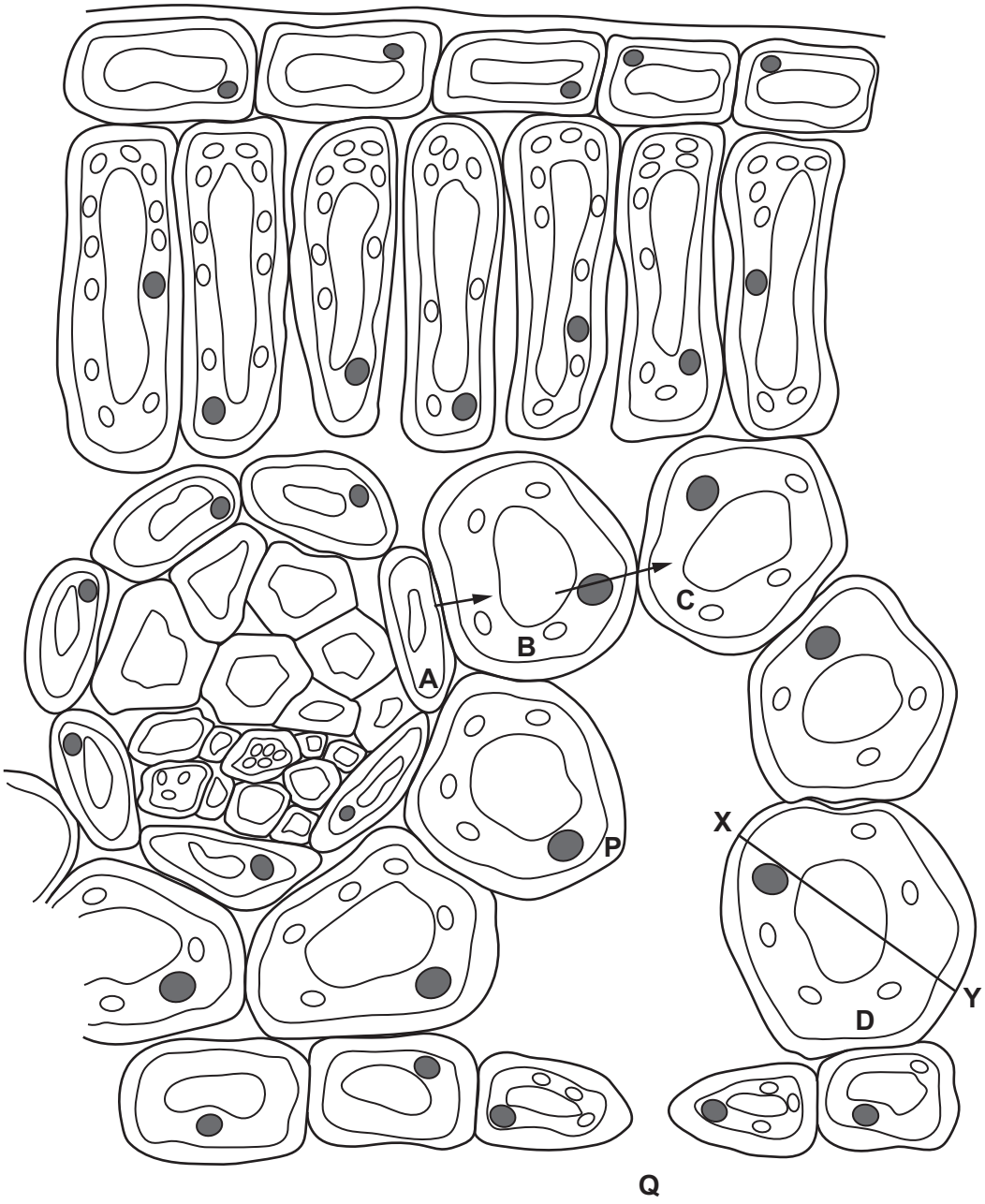

Fig. 1.1

(a) Water from the xylem can enter cell **A** and then moves to cells **B** and **C** without crossing their cell walls.

The cell structures through which water passes from cell **A** to cell **B** are **not** visible in Fig. 1.1.

(i) Name the cell structures through which water passes from cell **A** to cell **B** without crossing their cell walls.

..... [1]

(ii) Explain what causes water to move from cell **B** to cell **C**.

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..... [1]

(iii) Name the pathway taken by water between cell **A** and cell **C**.

..... [1]

(b) Most of the water that arrives at the leaf passes to the external atmosphere.

With reference to Fig. 1.1, describe **and** explain the sequence of events occurring between point **P** and point **Q**.

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..... [4]

(c) The actual diameter of cell **D** in Fig. 1.1 along the length **X**–**Y** is 25 μm.

Calculate the magnification of the image.

Write down the formula used to make your calculation. Show your working.

formula

answer = × ..... [3]

[Total: 10]

2 The treatment for people with active tuberculosis (TB) lasts six months and involves a combination of antibiotics. This is usually very effective if the person has a susceptible (non-resistant) strain of *Mycobacterium tuberculosis*, the causative organism of TB.

Table 2.1 summarises one recommended treatment strategy that involves a combination of antibiotics.

Table 2.1

antibiotic	length of treatment	mode of action of antibiotic
rifampicin (R)	6 months	enters bacterial cells and inhibits protein synthesis
isoniazid (H)	6 months	prevents the synthesis of cell wall components known as mycolic acids
ethambutol (E)	first two months	prevents mycolic acids from being added to the cell wall
pyrazinamide (Z)	first two months	prevents the synthesis of fatty acids

(a) Susceptible strains of *M. tuberculosis* will be killed using any one of the antibiotics listed in Table 2.1. However, combination treatment is preferred as it is one method that can be used to reduce the impact to society of antibiotic resistance.

With reference to Table 2.1, explain how combination treatment for TB can help to reduce the impact of antibiotic resistance compared to single antibiotic treatment.

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..... [4]

Rifampicin binds tightly to an RNA polymerase molecule close to its active site. This affects the activity of the enzyme.

(b) (i) RNA polymerase catalyses the formation of messenger RNA (mRNA) from DNA.

State the term for this process.

..... [1]

(ii) During the formation of RNA, a number of events occur that involve the action of RNA polymerase.

Suggest ways in which rifampicin can affect the activity of RNA polymerase.

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..... [3]

(c) RNA polymerase is composed of five different polypeptides. Gene *rpoB* codes for one of these polypeptides known as the β-subunit.

One or more mutations in a specific region of *rpoB* result in strains of *M. tuberculosis* that are resistant to rifampicin. In these strains, mutations often occur in two DNA triplets in this region, in positions 526 and 531.

Table 2.2 summarises the results of an investigation into seven rifampicin-resistant strains, **A** to **G**, that have amino acid changes for positions 526 and 531.

Table 2.2 includes:

- the change in the **mRNA codon** for position 526 or position 531
- the amino acid change that has occurred as a result of the mutation
- the minimum concentration of rifampicin required to inhibit growth of the bacterial strain (MIC)
- the number of **other** mutations occurring within the specific region of *rpoB*.

Table 2.2

Key
≈ approximately ⩾ greater than or equal to ⩽ less than or equal to

strain	codon involved	mRNA codon change	amino acid change	MIC / $\mu g\,cm^{-3}$	number of other mutations in the specific region
A	526	CAC ⟶ UAC	His ⟶ Tyr	⩽50	0
B	526	CAC ⟶ AAC	His ⟶ Asn	⩾100	1
C	526	CAC ⟶ CGC	His ⟶ Arg	≈50–75	2
D	526	CAC ⟶ CGC	His ⟶ Arg	⩾100	3
E	526	CAC ⟶ CGC	His ⟶ Arg	≈50	3
F	526	CAC ⟶ UUC	His ⟶	⩾100	3
	531	UCG ⟶ UUG	Ser ⟶ Leu		
G	526	CAC ⟶ UAC	His ⟶	⩾100	3
	531	UCG ⟶ UUC	Ser ⟶ Phe		

(i) Complete Table 2.2 to show the amino acid changes that have occurred in strains **F** and **G**.

[1]

(ii) With reference to Table 2.2, list the strains of *M. tuberculosis* that show the greatest resistance to rifampicin.

..... [1]

(iii) Suggest reasons to explain why strains **C**, **D** and **E** show:

- resistance to rifampicin
- different levels of resistances to rifampicin.

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..... [3]

[Total: 13]

3 Fig. 3.1 is a photomicrograph of a section through lung tissue.

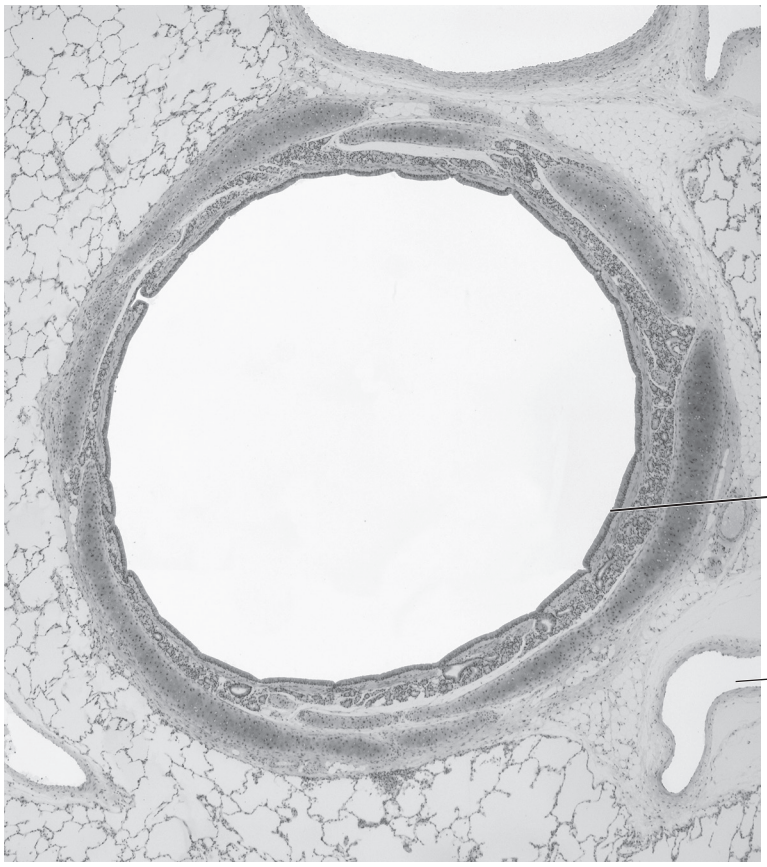

Fig. 3.1

(a) State the feature visible in Fig. 3.1 that identifies the structure in the centre of the image as the bronchus **and** list other visible features that help to confirm this identification.

feature to identify the bronchus .....

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other features .....

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[3]

(b) Identify the structure labelled **J** in Fig. 3.1.

State the evidence visible in Fig. 3.1 that supports your answer.

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[2]

(c) The ciliated epithelium labelled in Fig. 3.1 consists of goblet cells and ciliated epithelial cells.

Outline how goblet cells and cilia work together to maintain healthy lung tissue.

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..... [2]

[Total: 7]

4 In the immune system, a plasma cell develops from an activated B-lymphocyte. Mature plasma cells synthesise and secrete antibody molecules.

(a) Fig. 4.1 is a diagram of a transmission electron micrograph of a plasma cell.

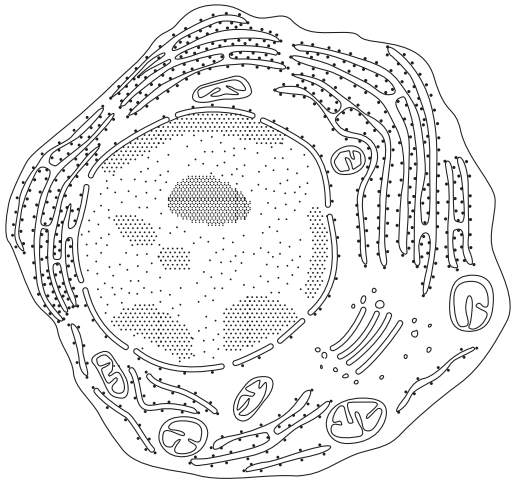

Fig. 4.1

The plasma cell can be seen in greater detail using an electron microscope compared with using a light microscope.

(i) Describe the **extra** detail of the nucleus that can be seen using an electron microscope.

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..... [3]

(ii) Explain why cell structures, such as ribosomes and the rough and smooth endoplasmic reticulum, cannot be seen using a light microscope.

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..... [2]

(b) The transition from the activated B-lymphocyte to the fully mature plasma cell requires a number of mitotic cell cycles to occur. This process, which is known as clonal expansion, results in a large number of genetically identical plasma cells.

Fig. 4.2 describes events, **A** to **F**, that occur during the mitotic cell cycle of the B-lymphocyte.

A centrioles replicate
B DNA polymerase catalyses the formation of phosphodiester bonds
C condensation of chromosomes
D nuclear envelope reassembles around each set of daughter chromosomes
E centromeres move towards poles
F chromosomes line up at spindle equator

Fig. 4.2

Table 4.1 lists the stages occurring during one cell cycle of the B-lymphocyte. These stages are not in the correct order.

Table 4.1

stage of cell cycle	**correct letter from Fig. 4.2**
G_2 phase	
metaphase	**F**
cytokinesis	
prophase	
S phase	
anaphase	
G_1 phase	
telophase	

Complete Table 4.1 by writing the letter of the event described in Fig. 4.2 that correctly matches the stage of the cell cycle listed.

Leave a **blank space** if there is **no** matching description for the stage in the list. Use each letter **once** only.

One of the letters in Table 4.1 has already been added for you.

[5]

[Turn over

(c) Clonal expansion also results in the production of memory B-lymphocytes.

Explain the importance of clonal expansion **and** the production of memory B-lymphocytes in providing protection for a person against an infectious disease.

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..... [3]

(d) Myasthenia gravis is an example of a disease where the immune system fails to distinguish between self and non-self.

Explain what is meant by this statement.

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..... [2]

[Total: 15]

5 Sucrose phosphorylase is an enzyme found in some species of bacteria. One function of this enzyme is for the production of compounds that help to protect the cell from harmful osmotic changes in the external environment.

Fig. 5.1 shows the reversible reaction that takes place within the bacterial cell.

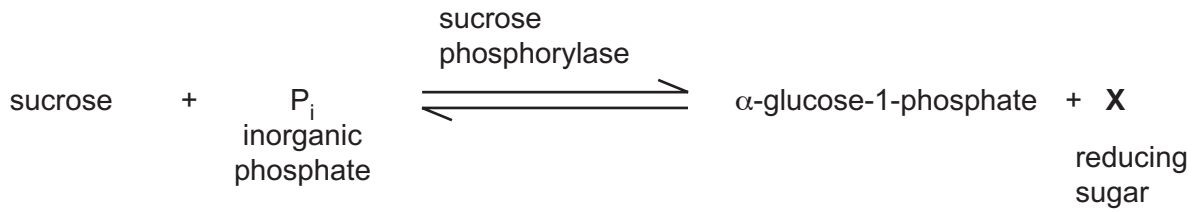

Fig. 5.1

(a) Name reducing sugar **X** in Fig. 5.1.

..... [1]

(b) In the absence of sucrose phosphorylase as a catalyst, the reaction shown in Fig. 5.1 would take too long to occur to allow the bacterial cell to function efficiently.

Explain why the reaction shown in Fig. 5.1 proceeds at a much faster rate in the presence of the enzyme.

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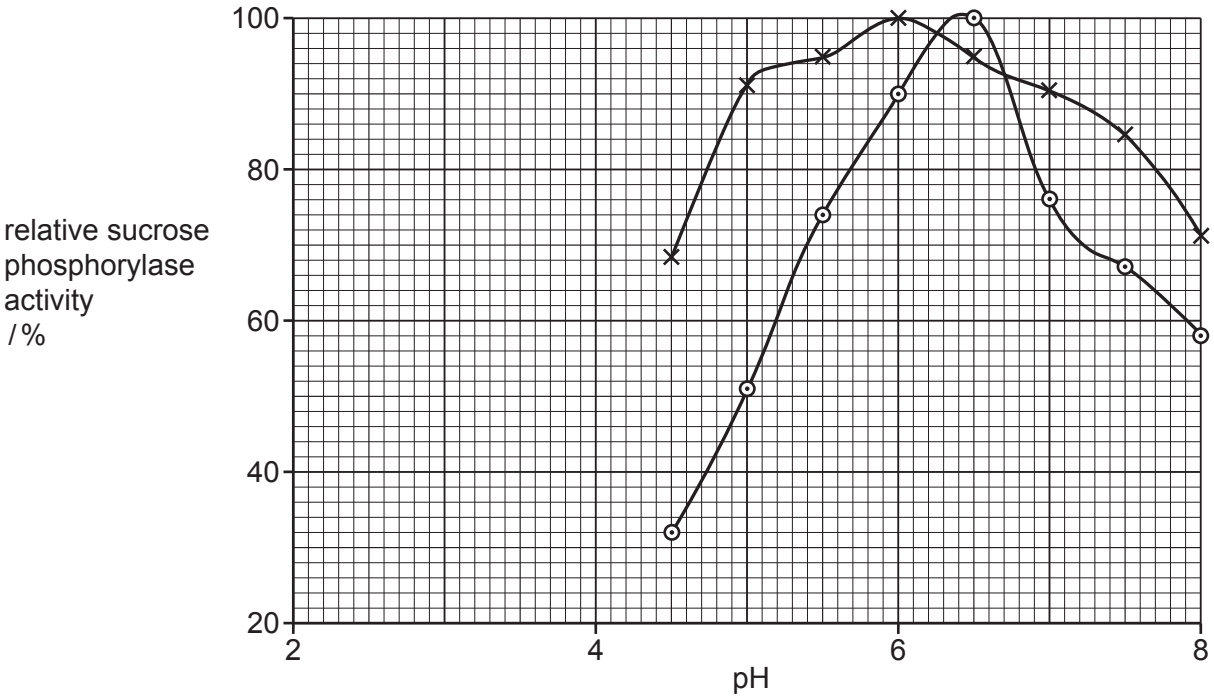
..... [2]

(c) An enzyme that catalyses a reaction of commercial interest needs to be investigated to see if it is suitable for use in industry.
For example:

- immobilised enzymes may be used as they have a longer shelf-life than the enzyme free in solution
- many industrial reactions are carried out at higher temperatures to minimise contamination of products by microorganisms.

Fig. 5.2 shows the results of an investigation to compare the activity of sucrose phosphorylase free in solution (free enzyme) with immobilised sucrose phosphorylase (immobilised enzyme) at different pHs.

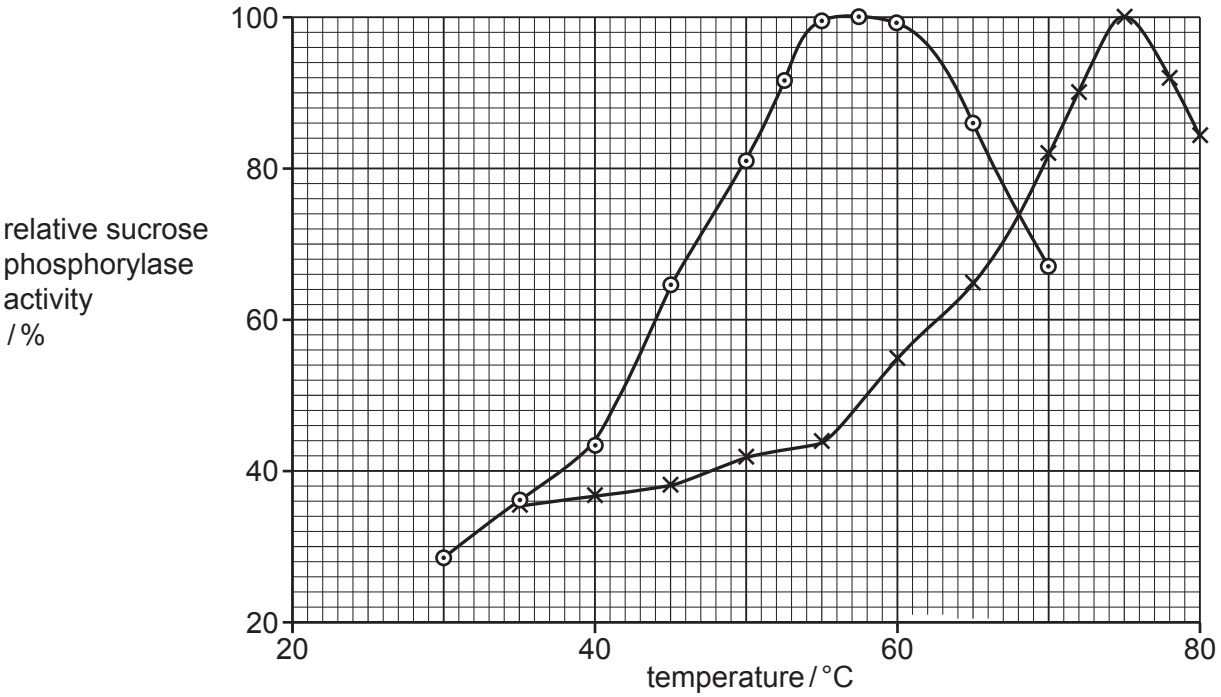
Fig. 5.3 shows the activity of the free enzyme and immobilised enzyme at different temperatures.



Key

⊙ free enzyme
× immobilised enzyme

Fig. 5.2



Key

⊙ free enzyme

× immobilised enzyme

Fig. 5.3

With reference to the results shown in Fig. 5.2 and Fig. 5.3, discuss which sucrose phosphorylase enzyme, free or immobilised, is better for use in industrial reactions.

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[Total: 7]

6 **(a)** Fig. 6.1 shows an oxygen dissociation curve for adult human haemoglobin.

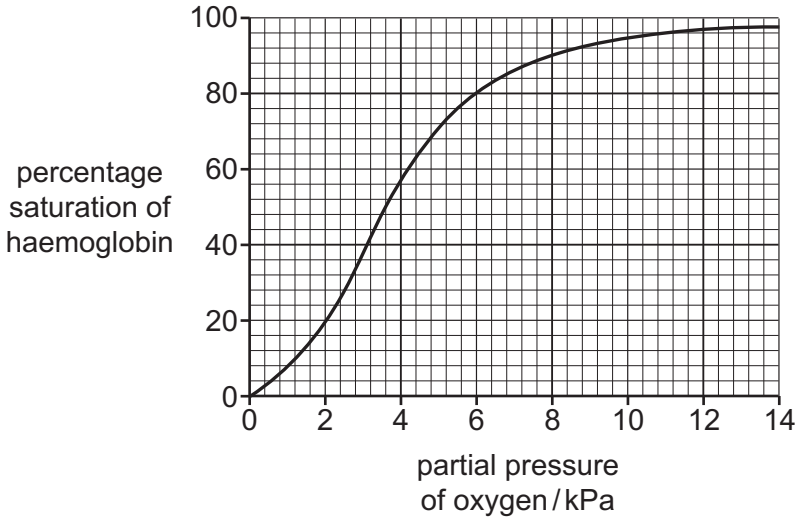

Fig. 6.1

An increase in the partial pressure of carbon dioxide (pCO_2) in respiring tissue causes the Bohr effect.

(i) Sketch on Fig. 6.1 to show how the Bohr effect changes the oxygen dissociation curve. [1]

(ii) Explain how an increase in pCO_2 produces the Bohr effect **and** state the benefit of this effect for the tissue.

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..... [3]

(b) Carbon dioxide (CO_2) is transported across the cell surface membrane of the red blood cell using a different mechanism to the transport of hydrogen carbonate ions (HCO_3^-).

Name the different mechanisms of transport used for CO_2 and for HCO_3^- **and** explain why they are transported across the membrane by different mechanisms.

CO_2 .....

HCO_3^- .....

explanation .....

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[4]

[Total: 8]

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