

Human Biology

Unit F221: Molecules, Blood and Gas Exchange

Introduction

OCR has produced these candidate style answers to support teachers in interpreting the assessment criteria for the new GCE specifications and to bridge the gap between new specification release and availability of exemplar candidate work.

This content has been produced by senior OCR examiners, with the input of Chairs of Examiners, to illustrate how the sample assessment questions might be answered and provide some commentary on what factors contribute to an overall grading. The candidate style answers are not written in a way that is intended to replicate student work but to demonstrate what a “good” or “excellent” response might include, supported by examiner commentary and conclusions.

As these responses have not been through full moderation and do not replicate student work, they have not been graded and are instead, banded “medium” or “high” to give an indication of the level of each response.

Please note that this resource is provided for advice and guidance only and does not in any way constitute an indication of grade boundaries or endorsed answers.

1 Human blood contains erythrocytes and leucocytes. These cells are specialised to perform specific functions.

Fig. 1.1 shows a photomicrograph of blood cells.

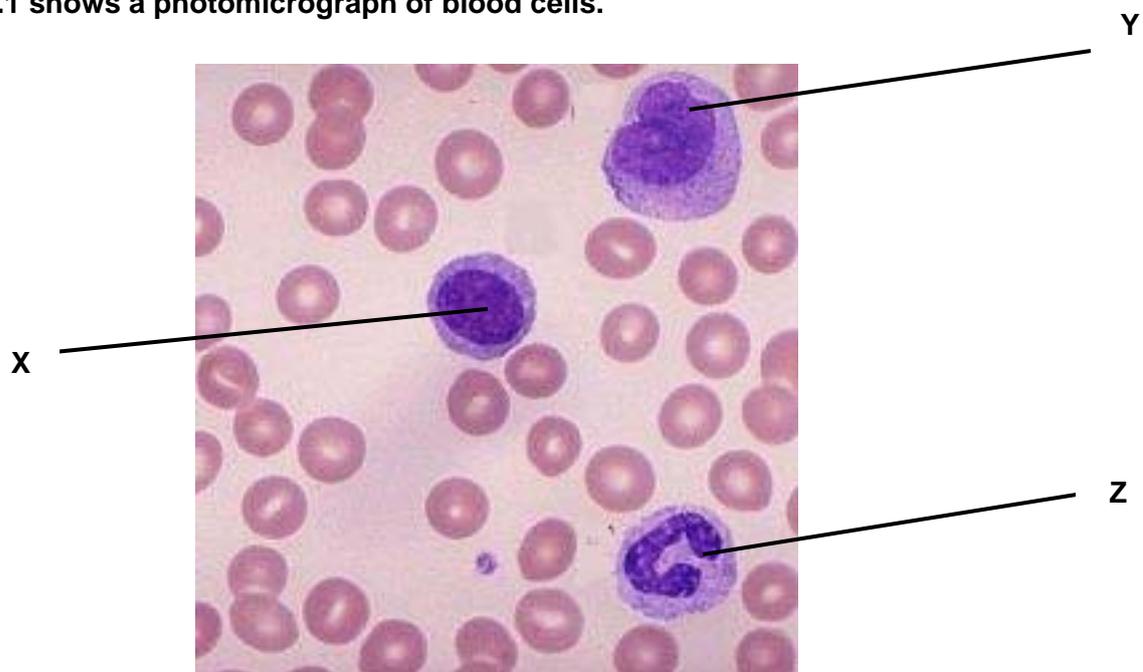


Fig. 1.1

(a) Name the leucocytes X, Y and Z.

[3]

<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p>X lymphocyte Y monocyte Z neutrophil</p>	<p>(a) The candidate would score full marks in this question.</p>

(b) The difference in composition between blood plasma and tissue fluid depends on the permeability of capillaries to different substances.

Table 1.1 shows the relative permeability of capillaries to substances found in blood plasma. Water is given a value of 1.

Table 1.1

substance	relative molecular mass	permeability
water	18	1
sodium ions	23	0.96
urea	60	0.8
glucose	180	0.6
albumin (a plasma protein)	69 000	0.000 01

Using the information in Table 1.1,

(i) describe the relationship between relative molecular mass and permeability

[1]

<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<i>As the molecular mass increases the permeability decreases</i>	This candidate would score some marks in this question. Although the answer is clear, there is no reference to the capillary <i>walls</i> being impermeable to the albumin.

(ii) predict with reasons which of the above substances you would not expect to be present in tissue fluid.

[2]

<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<i>Plasma proteins will not be in the tissue fluid as they are too large to pass out of the pores in the capillaries. Any molecule with a large molecular mass will not be able</i>	Correct response

(c) Saline is used medically in a variety of ways. Saline also contains sodium ions.	
(i) Give one common medical use of saline. [1]	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<i>to use in drips</i>	The language is too colloquial and lacks detail. Whilst it is likely that the candidate is meaning the use of <i>intravenous</i> drips, this is ambiguous for the examiner.

(ii) Explain why the concentration of sodium ions in saline used medically is the same as that in plasma. [3]

[Total: 10]

<i>Candidate style answer</i>	<i>Examiner's commentary</i>						
<i>The number of sodium ions present in the solution will effect the water potential of the solution and this can affect the blood cells. If there are more ions present in the cells than the saline solution then the water will move into the cells by osmosis. This will cause the cells to expand and explode. It is important that the saline and the plasma have the same number of sodium ions to ensure they are isotonic</i>	<p>This candidate has made good use of key terms and has demonstrated a good understanding of the topic of osmosis. The first sentence would gain no credit for the colloquial reference to osmosis but the last sentence has sufficient detail to gain marks.</p> <p>The use of the word 'explode' to describe what happens to the cells is not appropriate. Terms such as crenation or shrivel should be encouraged.</p> <p>A good teaching technique is to use homework time to set the following tasks to candidates to help reinforce key words to use in their answers:</p> <p><i>glossary of key terms</i> <i>simple flashcards of key terms with definitions on the reverse</i> <i>card sorts using 3 categories (term, definition and a sentence with the term used correctly)</i></p> <p>E.g.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Term</th> <th>Definition</th> <th>Correct use of the term</th> </tr> </thead> <tbody> <tr> <td>Osmosis</td> <td>The movement of water molecules from an area of high water potential to</td> <td>If erythrocytes are placed into a solution with a lower water potential then due to a process called water</td> </tr> </tbody> </table>	Term	Definition	Correct use of the term	Osmosis	The movement of water molecules from an area of high water potential to	If erythrocytes are placed into a solution with a lower water potential then due to a process called water
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Osmosis	The movement of water molecules from an area of high water potential to	If erythrocytes are placed into a solution with a lower water potential then due to a process called water					

		an area of low water potential down a water potential gradient.	molecules will leave the cells and the erythrocytes will become crenated.
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2 Proteins, polysaccharides and lipids are biological molecules present in the human body. These molecules all consist of smaller molecules that are joined together by different types of bond.

Fig. 2.1 shows three types of bond, labelled A to C, which occur in biological molecules.

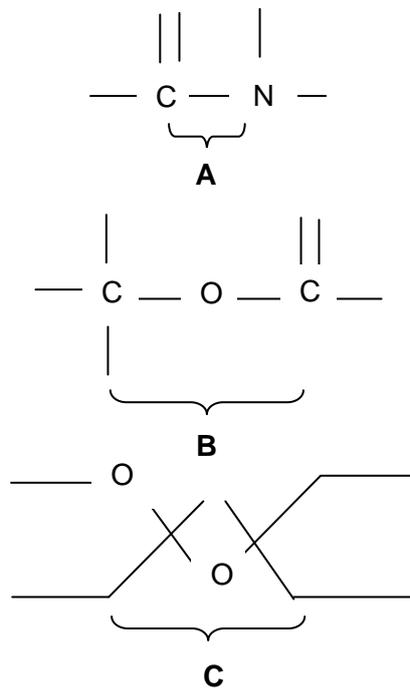


Fig. 2.1

(a) Give the letter of the bond that,

(i) joins together molecules of glucose in glycogen;

[1]

Candidate style answer	Examiner's commentary
C	The candidate scores marks in this question. Rote learning of molecular structures and bond names can be encouraged by the use of flash cards.

(ii) occurs in the primary structure of a protein such as insulin;

[1]

Candidate style answer	Examiner's commentary
A	Correct answer.

(iii) occurs in a lipid or phospholipid.

[1]

<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<i>B</i>	Correct answer.

<p>(b) Name the chemical process involved in breaking the bonds <u>A</u>, <u>B</u> and <u>C</u>.  In your answer, you should use an appropriate technical term spelled correctly. Explain how the properties and structure of glycogen adapt it to its function.</p> <p style="text-align: right;">[1]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<i>Hydrolysis reactions</i>	Correct answer.

<p>(c) Glycogen is an insoluble polysaccharide and consists of branched chains of glucose molecules</p> <p style="text-align: right;">[3] [Total: 7]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>Glycogen is formed by many condensation reactions joining together many glucose molecules to make a polysaccharide. This is a large molecule which is insoluble and this allows the cell to store it in the cytoplasm without upsetting the water potential of the cell. Glycogen is a good storage molecule as it has many branches which curl round each other and this means it can store lots of energy in one place. As there are lots of ends then many enzymes can work on it at the same time to release energy quickly.</i></p>	<p>The candidate has gained marks here. The last sentence gives the idea of enabling rapid breakdown. However, this candidate implied that the hydrolysis of glycogen to produce glucose molecules actually releases energy directly. This is a common misconception and the candidate should instead be encouraged to write a flow diagram similar to the one below to understand the concept:</p> <pre> graph TD A[Many α-glucose molecules] --> B[Many condensation reactions] B --> C[Production of glycogen (polysaccharide)] C --> D[Many hydrolysis reactions] D --> E[Release of many α-glucose molecules] E --> F["α-glucose molecules used in respiration (glycolysis)"] F --> G[production of ATP] G --> H["hydrolysis of ATP enables other chemical reactions to occur"] </pre>

**3 Airline passengers travelling on long haul flights are at risk of developing deep vein thrombosis (DVT).
A thrombus is a clot that develops inside a blood vessel. If a thrombus breaks away from the wall of the vessel, it becomes an embolus and may lead to an embolism.
(a) Suggest how an embolism may become life threatening.**

[4]

<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>If a clot travels in the blood stream as an embolism it may go anywhere in the body. If it reaches the heart it can cause a heart attack and if it reaches the brain it can cause a stroke. The cells past the clot will not get enough oxygen and so they will die as they will not be able to carry out respiration properly. This is because after the embolism there will be less blood flowing and it may stop altogether.</i></p>	<p>As per the glossary of command words in the specification, candidates are not expected to have been taught the content required to answer this question. The nature of a 'suggest' question is that the candidate has to provide a suitable and plausible idea based on their scientific knowledge and understanding.</p> <p>In this case the candidate would gain for showing a good understanding of the relationship between blood flow, oxygen delivery and cell death.</p>

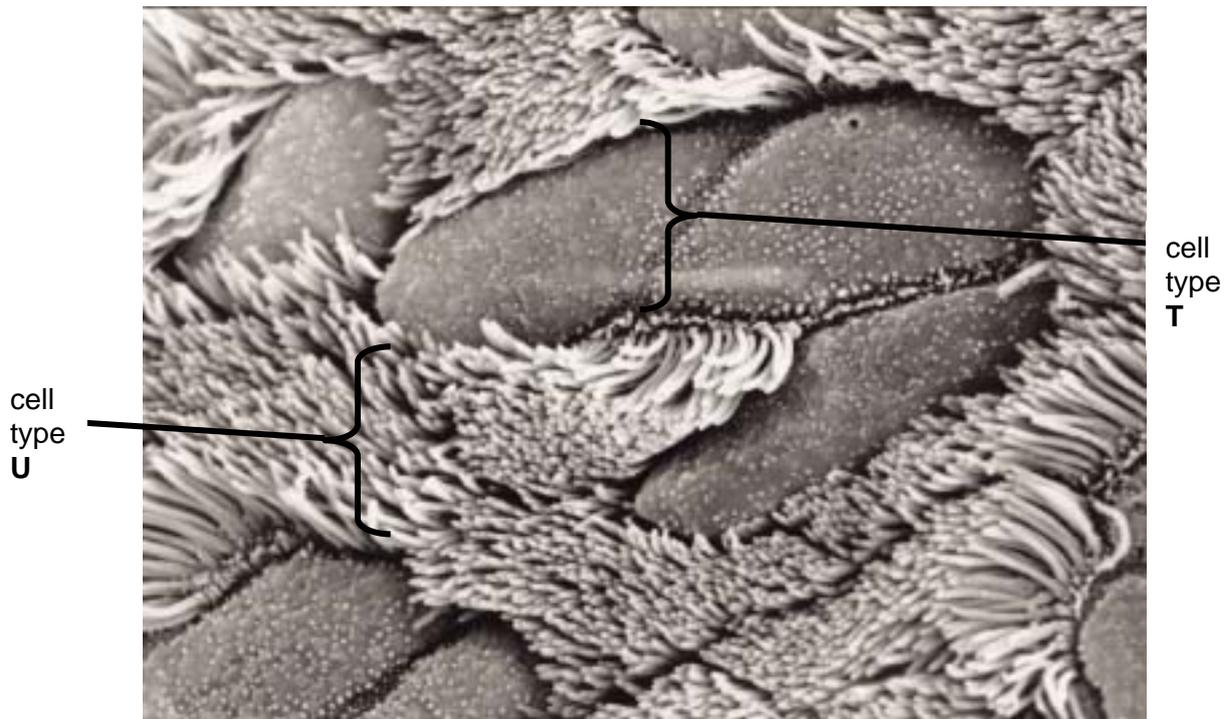
(b) Outline the mechanism of blood clotting.

[5]

[Total: 9]

<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>When the blood vessels are damaged it can expose collagen fibres. This can cause platelets to collide with the fibres and then calcium ions are released. These act as cofactors for some enzymes and it starts a cascade reaction. Prothrombin is activated into thrombin when calcium ions are present. This then causes thrombin to convert fibrinogen into fibrin. This then forms a web of fibres which trap platelets and cause a clot to form</i></p>	<p>This is an accurate and detailed answer gaining high marks. The candidate has correctly identified the key aspects of the clotting cascade and not gone into too much detail. This is a good interpretation of the command word 'outline' as opposed to 'explain' which would require more detail to be given.</p>

4 The bronchioles of the human lung transport air to and from the alveoli. The wall of the bronchioles are lined with two types of specialised cells. Fig. 4.1 shows an electron micrograph of the surface of a bronchiole with the two types of cells labelled.



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Fig 4.1

(a) (i) Name the two types of cell labelled.

In your answer, you should use appropriate technical terms, spelled correctly.

[2]

Candidate style answer	Examiner's commentary
cell type T..... <i>goblet cell</i> cell type U..... <i>ciliated epithelium</i>	Both cells are correctly identified and the correct spelling of 'ciliated' enables the QWC mark to be awarded.

(ii) Describe how these cells work together to ensure that any particles present in the inspired air are trapped and transported out of the lungs.

[3]

Candidate style answer	Examiner's commentary
<i>Particles in inspired air get trapped in the mucus made by the goblet cells. The cilia are little .tiny hairs which can move and beat together. They then waft the mucus up to the top of the throat. Any particles which are caught in the sticky mucus get carried with it and then when the person swallows it removes them and then this keeps the lungs clean</i>	The candidate scores marks for a clear description of the role of cilia and the removal of particles.

(b) A spirometer was used to investigate lung volumes. Measurements of tidal volume were taken from the student. The measurements were used to calculate

- the alveolar ventilation rate, which is the volume of air reaching the gaseous exchange surface per minute.
- The air in the lungs which is not in contact with the gaseous exchange surface is called dead space. The dead space in this student is 150 cm³.

The results of this investigation are shown in Table 4.1.

Table 4.1

breathing rate / breaths min ⁻¹	tidal volume / cm ³	alveolar ventilation rate / cm ³ min ⁻¹
30	200	
10	600	4500

The alveolar ventilation rate is calculated using the following formula:

$$\text{alveolar ventilation rate} = (\text{tidal volume} - \text{dead space}) \times \text{breathing rate}$$

(i) Using this formula, calculate the alveolar ventilation rate at a breathing rate of 30 breaths min⁻¹. Show your working.

$$200 - 50 = 150$$

$$150 \times 30 = 4500$$

[2]

Candidate style answer	Examiner's commentary
<i>cm³ min⁻¹</i>	This candidate gains marks as they have calculated the correct answer. However, even higher attaining candidates can fail to place the answer in the correct place. In this case, this is not penalised as the final answer is clear to the examiner.

(ii) Using a breathing tube such as a snorkel has the effect of increasing the dead space

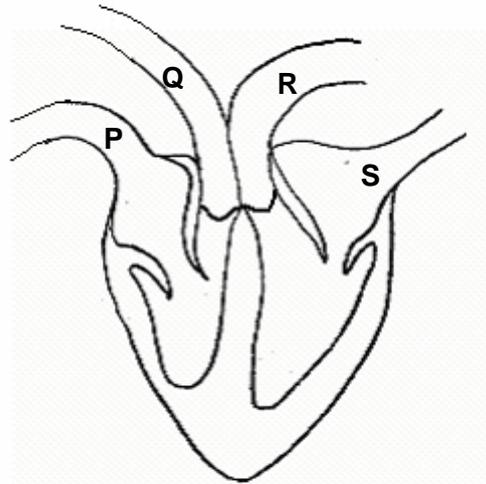
Predict what would happen to the breathing rate and tidal volume if the dead space is increased and explain the reason for the changes you have described.

[3]

[Total 10]

Candidate style answer	Examiner's commentary
<i>The breathing rate and tidal volume will increase. This is important to make sure the body gets enough oxygen</i>	The candidate has made the correct prediction. The second mark cannot be awarded as there is no clear indication as to why the oxygen is required i.e. aerobic respiration. Candidates should be encouraged to always preface the term <i>respiration</i> with aerobic, anaerobic or, aerobic and anaerobic as appropriate.

5 Fig. 5.1 shows a diagrammatic view of the internal structure of a human heart
 Fig 5.1



(a) Which of the blood vessels labelled P to S carries blood under highest pressure? [1]

Candidate style answer	Examiner's commentary
R	Correct response.

(b) The ventricles shown in Fig. 5.1 are filling with blood. Use evidence from Fig. 5.1 to explain why the ventricles are filling with blood. [2]

Candidate style answer	Examiner's commentary
The atrio-ventricular valves are open to enable the blood to enter the ventricles. The valves in S and P are open in the diagram to enable the blood to move from the atria. into the ventricles.	Although the candidate attempts to use evidence from the diagram, they have failed to make two separate points.

(c) Describe the functions of the following in co-ordinating the cardiac cycle:
 (i) the SA node [2]

Candidate style answer	Examiner's commentary
The SAN sends the message to the atria walls to make them contract	Partially correct. The candidate should be reminded to make at least the same number of statements/bullet points as there are marks to be awarded.

(ii) the AV node [2]

Candidate style answer	Examiner's commentary
The AVN delays the impulse by 0.1ms making the ventricles contract after the atria	This answer lacks detail.

(iii) the purkyne tissue		[2]
<i>Candidate style answer</i>	<i>Examiner's commentary</i>	
<i>The impulse is passed down the Purkinje fibres to the bottom of the heart which makes the ventricles contract upwards</i>	The candidate would gain some marks here.	

(d) The pressure of blood in an artery varies during the cardiac cycle. Explain what happens to the wall of the artery at different points during the cardiac cycle <u>and</u> the effect this has on blood flow			[3]													
<i>Candidate style answer</i>	<i>Examiner's commentary</i>															
<i>The walls of the arteries have elastin and smooth muscle in them. When the heart contracts the blood is pumped out at high pressure and they relax and contract to smooth out the blood flow. The muscle helps the blood pass in pulses and elastin stops them from bursting.</i>	<p>This candidate can recall the tissue types found in the blood vessel wall but fails to distinguish correctly the role of each type and does not relate it to the role within the cardiac cycle. This can be reinforced by the use of a summary table such as the one below:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Blood vessel</th> <th>Tissue type</th> <th>Role of tissue</th> </tr> </thead> <tbody> <tr> <td rowspan="3">Artery</td> <td><i>Elastin</i></td> <td><i>Allows wall to stretch when pressure is high to prevent damage. It recoils when pressure is low to encourage blood flow through the lumen.</i></td> </tr> <tr> <td><i>Smooth muscle</i></td> <td><i>Contracts to smooth out pulsatile blood flow.</i></td> </tr> <tr> <td><i>Collagen</i></td> <td><i>Provides strength to withstand high pressures</i></td> </tr> <tr> <td>Capillary</td> <td><i>Single layer of epithelium</i></td> <td><i>Enables exchange of materials through cells and between fenestrations</i></td> </tr> </tbody> </table>			Blood vessel	Tissue type	Role of tissue	Artery	<i>Elastin</i>	<i>Allows wall to stretch when pressure is high to prevent damage. It recoils when pressure is low to encourage blood flow through the lumen.</i>	<i>Smooth muscle</i>	<i>Contracts to smooth out pulsatile blood flow.</i>	<i>Collagen</i>	<i>Provides strength to withstand high pressures</i>	Capillary	<i>Single layer of epithelium</i>	<i>Enables exchange of materials through cells and between fenestrations</i>
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Capillary	<i>Single layer of epithelium</i>	<i>Enables exchange of materials through cells and between fenestrations</i>														

(e) How reliable blood pressure measurements may be taken.		[4]
<i>Candidate style answer</i>	<i>Examiner's commentary</i>	
<i>.Digital meters can be used to measure blood pressure and heart rate by medically trained staff. A special device called a sphygmometer can also be used.</i>	A concise answer gaining high marks but some areas are confused, such as the 'second sound'. It is the disappearance of the sound which indicates the diastolic pressure. Candidates can be encouraged to have a	

This is when a black cuff is wrapped around the top of the arm and then blown up. The nurse then places a stethoscope under the cuff and listens for different sounds. When she releases the cuff pressure she listens for the first sound which is the systolic pressure, the next sound she hears is the diastolic pressure. Most blood pressures are about 120 over 70

separate notebook to make notes for such procedures. Candidates should be encouraged to make bullet point methods of ~15 steps which can be followed by another student. If this is collated during the course of the GCE it will not only become a useful revision resource but an invaluable reference book for general use.

6 Enzymes are globular protein molecules that are able to catalyse chemical reactions. Maintaining the body temperature at 37 °C optimises the activity of enzymes within the human body.

(a) Fig. 6.1 shows how the activity of an enzyme varies with temperature.

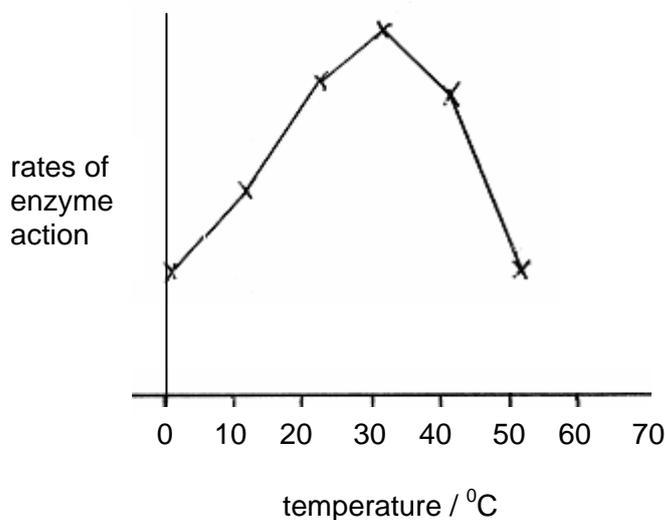


Fig. 6.1

(i) Explain the reasons for the change in enzyme activity between 0 °C and 30 °C

[2]

Candidate style answer

As the temperature increases the molecules gain energy and move around more. This increases the chance of a successful collision between the substrate and the enzyme and more temporary enzyme-substrate complexes are formed

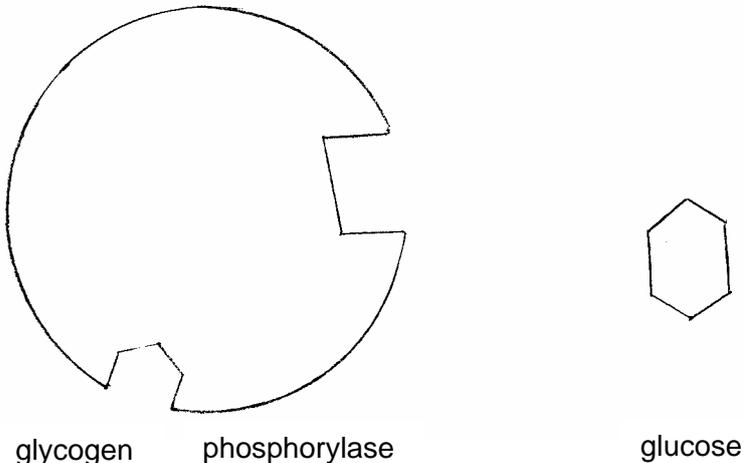
Examiner's commentary

The candidate has given a good detailed answer.

(ii) between 30 °C and 50 °C.		[2]
<i>Candidate style answer</i>	<i>Examiner's commentary</i>	
<i>If enzymes are heated above their optimum temperature it can cause the protein to change shape and this can change the shape of the active site. This is when the enzyme is then denatured and then the substrate can not fit into its specific active site</i>	Again, the candidate has given a good detailed answer.	

(b) Glycogen phosphorylase is an enzyme that breaks down glycogen in muscle cells. Glucose acts as a non-competitive inhibitor to glycogen phosphorylase.

Fig.6.2 shows representations of a glycogen phosphorylase and a glucose molecule.

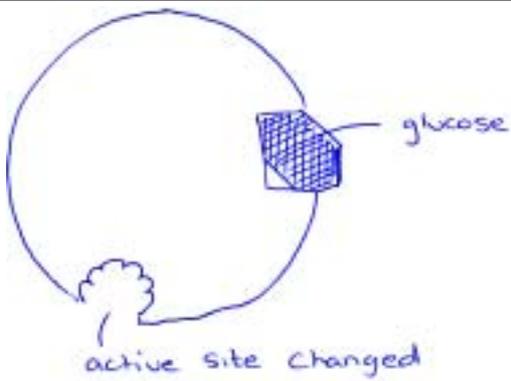


glycogen phosphorylase
glucose

Fig. 6.2

(i) Draw a diagram based on the molecules in Fig. 6.2 to show how glucose acts as a non-competitive inhibitor to glycogen phosphorylase.

[2]

<i>Candidate style answer</i>	<i>Examiner's commentary</i>
	This has been accurately and clearly answered.

<p>(ii) Suggest why the action of glucose as a non-competitive inhibitor is an advantage to muscle cells.</p> <p style="text-align: right;">[2] [Total 8] [Paper Total 60]</p>	
<i>Candidate style answer</i>	<i>Examiner's commentary</i>
<p><i>If inhibitor binds at a site other than the active site it will change the shape of the active site and this will then stop the glycogen phosphorylase enzyme working. This means that there it will not break down any more glycogen when there is enough glucose about</i></p>	<p>The candidate has made a fair attempt at the question and gains mark point 2. More marks could be gained by discussing the two different situations i.e. when the glucose concentration is high and when it is low.</p>

Overall Banding: High.

Overall Comments: This candidate has demonstrated ability typical of a higher ability candidate. There is good evidence of the use of key terms but some areas lack basic rote learning and hence the failure to score maximum marks. Typically, the enzyme question is answered well and is understood at a high level. Additional marks could be gained by providing answers with more clarity and by sticking to the command word used in the question. Practice past papers will provide the candidate with an insight into the level of detail required at AS and, as such, will also enable them to recognise the key areas that gain credit.