1: Biological molecules – Topic questions

The questions in this document have been compiled from past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
2	2017	May/June	21
4	2017	May/June	23
6	2017	May/June	23

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

2 Phosphatases are enzymes that catalyse the removal of phosphate groups from organic compounds.

Some students investigated the effect of substrate concentration on the rate of the reaction catalysed by an acid phosphatase (enzyme **A**). The results are shown in Fig. 2.1.

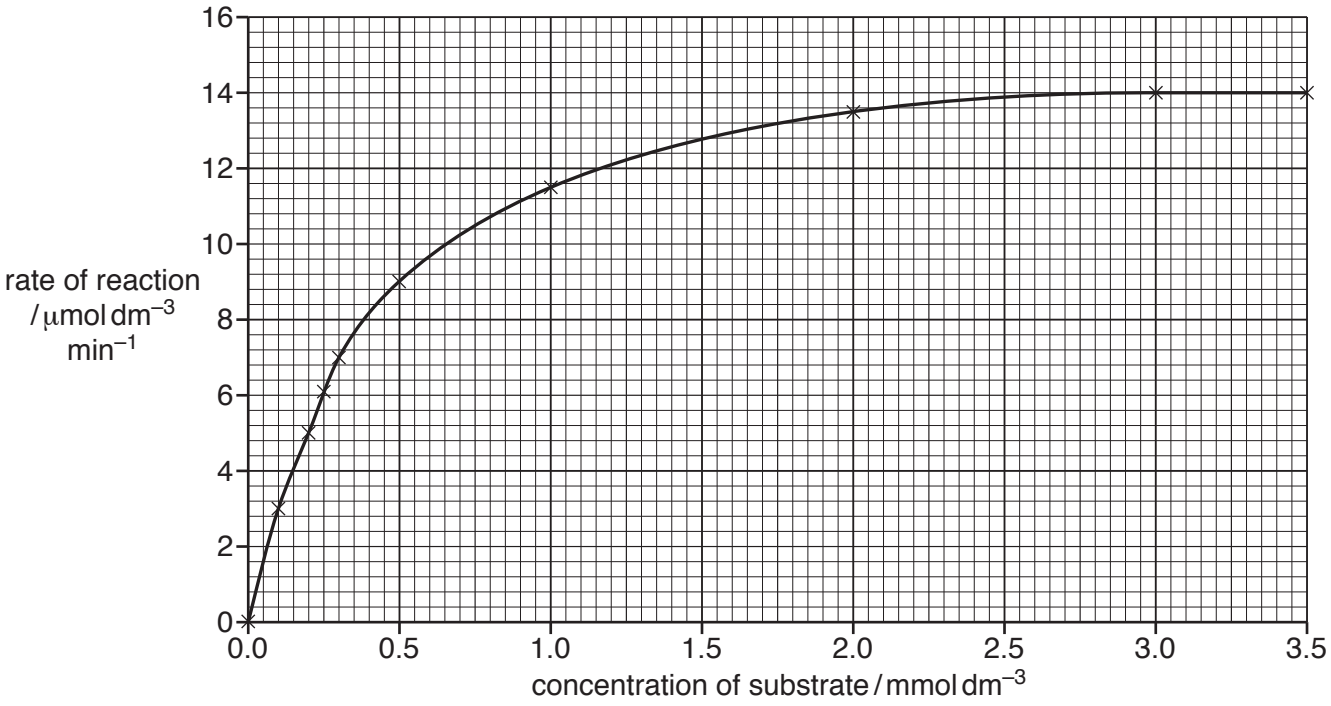

Fig. 2.1

(a) The students used Fig. 2.1 to derive the Michaelis-Menten constant (K_m) for enzyme **A** as 0.3 mmol dm^{-3}.

Explain how they derived K_m.

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.....[2]

(b) The students investigated a different phosphatase enzyme (enzyme **B**) and found the value of K_m to be higher than 0.3 mmol dm^{-3}.

Explain the difference between the values of K_m for these two phosphatase enzymes.

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.....[2]

(c) The students repeated their investigation on enzyme **A** with a competitive inhibitor.

They used the same concentrations of substrate as before, but added a competitive inhibitor to each reaction mixture.

They used the same concentration of the inhibitor in each reaction mixture.

The students found that V_{max} was the same as before, but K_m was higher than 0.3 mmol dm^{-3}.

Explain how the addition of the competitive inhibitor results in the same value for V_{max} but a higher value for K_m.

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.....[4]

[Total: 8]

4 **(a)** Complete Table 4.1 by using a tick (✓) to indicate which statements apply to each of the molecules. Use a cross (✗) for statements that do **not** apply.

Some of the boxes have been completed for you.

Table 4.1

statement	ATP	cellulose	haemoglobin	phospholipid
contains phosphorus	✓		✗	
found in plants				
contains iron				✗
has a structural role				

[4]

(b) Fig. 4.1 shows two amino acids.

Complete Fig. 4.1 to show how a peptide bond forms between these two amino acids.

Fig. 4.1

[3]

[Turn over

(c) Some glycoproteins in cell surface membranes function as transport proteins.

State two **other** functions of glycoproteins in cell surface membranes.

1 .....

.....

2 .....

.....[2]

[Total: 9]

6 **(a)** In the space below, draw a diagram to show a hydrogen bond between two water molecules.

[3]

(b) **(i)** Movement of water in xylem depends on the force of attraction between water molecules as a result of hydrogen bonding.

State the name given to this force of attraction.

.....[1]

(ii) State the property of water that results in a cooling effect as water evaporates from the surface of organisms.

.....

.....[1]

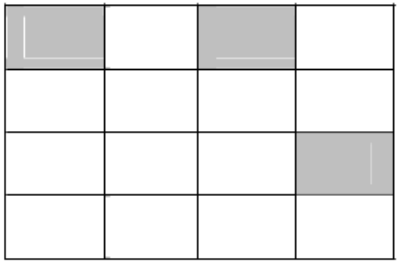
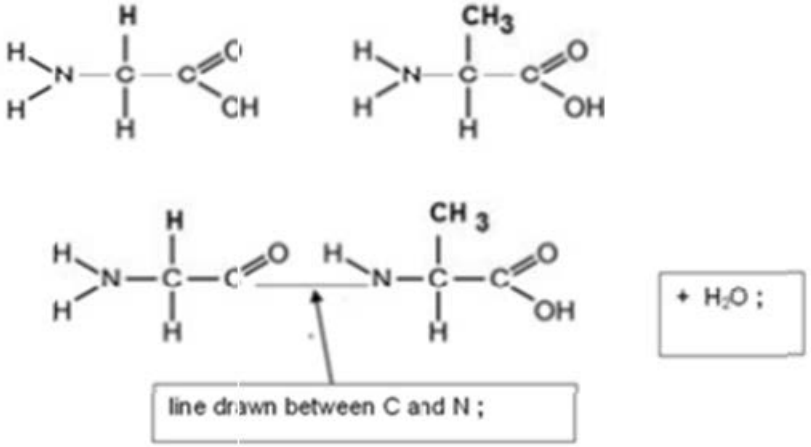
[Total: 5]

Mark scheme abbreviations

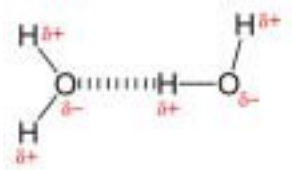
;	separates marking points
/	alternative answers for the same point
A	accept (for answers correctly cued by the question, or by extra guidance)
R	reject
AW	alternative wording (where responses vary more than usual)
underline	actual word given must be used by candidate (grammatical variants accepted)
max	indicates the maximum number of marks that can be given
ora	or reverse argument
mp	marking point (with relevant number)
ecf	error carried forward
I	ignore
AVP	alternative valid point

Question	Answer	Mark
2(a)	half V_{max} / AW, = 7 (µmol dm^{-3} min^{-1}) / take half of V_{max} of 14 (µmol dm^{-3} min^{-1}) **;** **A** description of using the graph to find ½ V_{max} without reference to figures read (substrate concentration) from *x*-axis / AW **;** *alternative* plot 1 / [S] = x	**2**

Question	Answers	Marks
2(b)	***allow*** *phosphate group(s) / organic compound for substrate* *if affinity not used, accept idea of ability to form ESC* *check for* ***ora*** **I** *ref. to* competitive inhibition **1** enzyme **B** has a lower affinity for its substrate (than enzyme **A**) **or** the higher the K_m the lower the affinity of the enzyme for its substrate **;** **R** if substrate has affinity for the enzyme **2** enzyme **B** needs a higher concentration of substrate to reach, V_{max} / ½V_{max} / K_m (than enzyme **A**) **;** **3** AVP **;** e.g. enzyme **B** forms fewer ESC in the same unit of time enzyme **B** active site is a less good fit for substrate *idea that* in normal cell enzyme **A** is saturated (with substrate) so works at a constant rate variations in substrate concentration will have less effect on the rate of formation of product by enzyme **A** **I** *ref. to* turnover number(s)	**max 2**
2(c)	*marks can be taken from a sketch graph* **1** competitive inhibitor, occupies / competes with substrate for / AW, active site (of the enzyme) **;** **2** reduces frequency of collisions (with substrate) / fewer ESCs form **;** **R** no ESCs form **3** reduces reaction rate at low substrate concentrations **;** ***4*** *idea that* curve with inhibitor is to the right of the curve without inhibitor **;** **5** at high substrate concentration / with increasing substrate concentration, the inhibitor has, no / less, effect **;** **A** *idea that* substrate outcompetes inhibitor at high substrate concentration **6** therefore V_{max} is the same as it is determined by the enzyme concentration / AW **;** **A** explanation in terms of active sites, saturated / fully occupied ***7*** *idea of* intercept to curve gives a higher value for K_m **;**	**max 4**
		Total: 8

Question	Answer	Marks
4(a)		**4**
4(b)	*allow diagrams with glycine on right*  bond forms between the C of the carboxyl group and the N of the amino group **;** **A** amine *for amino* water / H_2O, is formed **;** **A** condensation (reaction) **R** hydrolysis amino acid residues correctly drawn **;**	**3**

Question	Answer	Marks
4(c)	receptor(s) / cell signalling **;** cell recognition / antigens **;** cell adhesion **;** form H-bonds with water to stabilise membrane **;** enzyme **;** AVP **;** e.g. *ref. to* role in antigen presentation / MHC	**max 2**
		Total: 9

Question	Answer	Marks
6(a)	two water molecules drawn with correct bonding **; I** Fischer projections partial charges shown as σ+ on at least one H and σ– on at least one O **;** hydrogen bond shown **;** e.g. labelled or as dashed or dotted lines between H of one molecule and O of another **;** 	**3**
6(b)(i)	cohesion **;**	**1**
6(b)(ii)	high / large, latent heat of, vapourisation / evaporation **;** **A** takes a large amount of, heat / energy, to evaporate / turn liquid to water vapour	**1**
		Total: 5