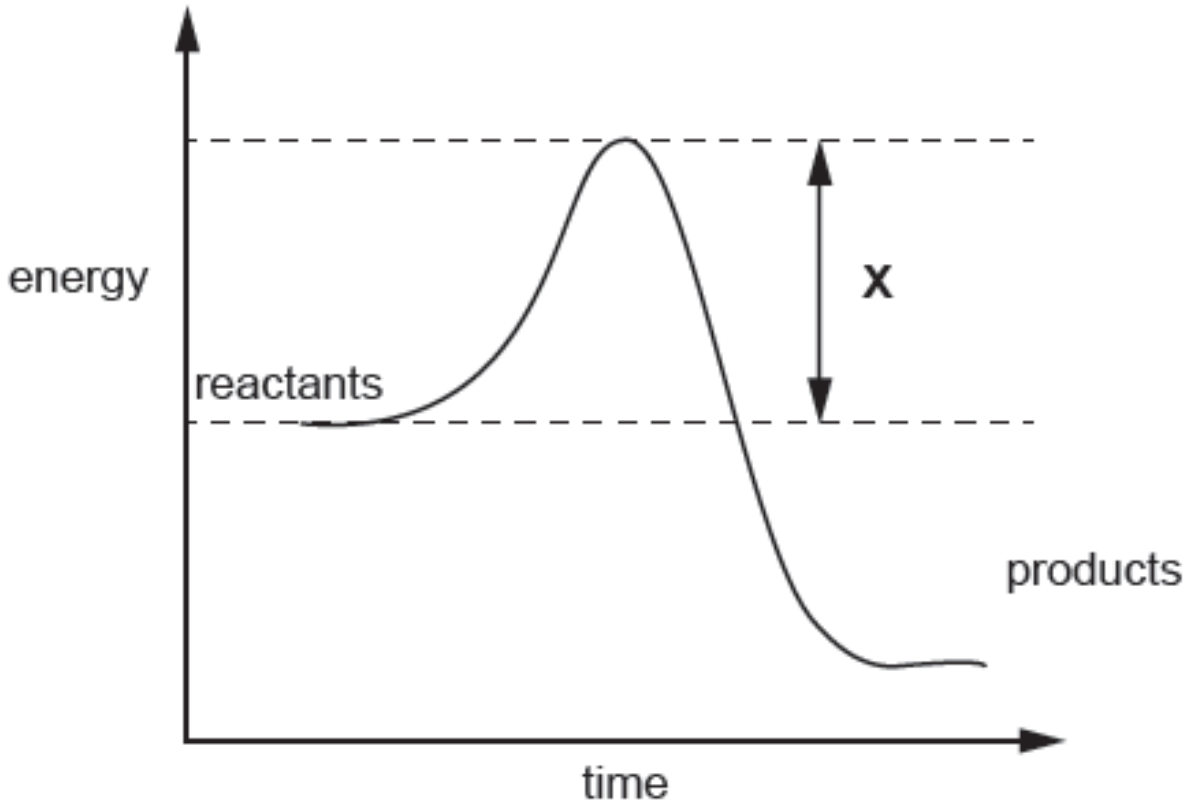
My Question Paper

1. The graph below shows the energy changes that take place during a chemical reaction.



(a) (i) What is represented by **X** on the graph above?

[1]

.....

(ii) Enzymes are biological catalysts.

Draw a line on the graph above to show the energy changes that would take place if an enzyme was present during the reaction.

[1]

(b) Succinate dehydrogenase is an enzyme found in mitochondria and is involved in respiration. The enzyme catalyses the conversion of succinate into fumarate. Using your knowledge of enzyme structure, explain why this is the **only** reaction succinate dehydrogenase can catalyse.

[2]

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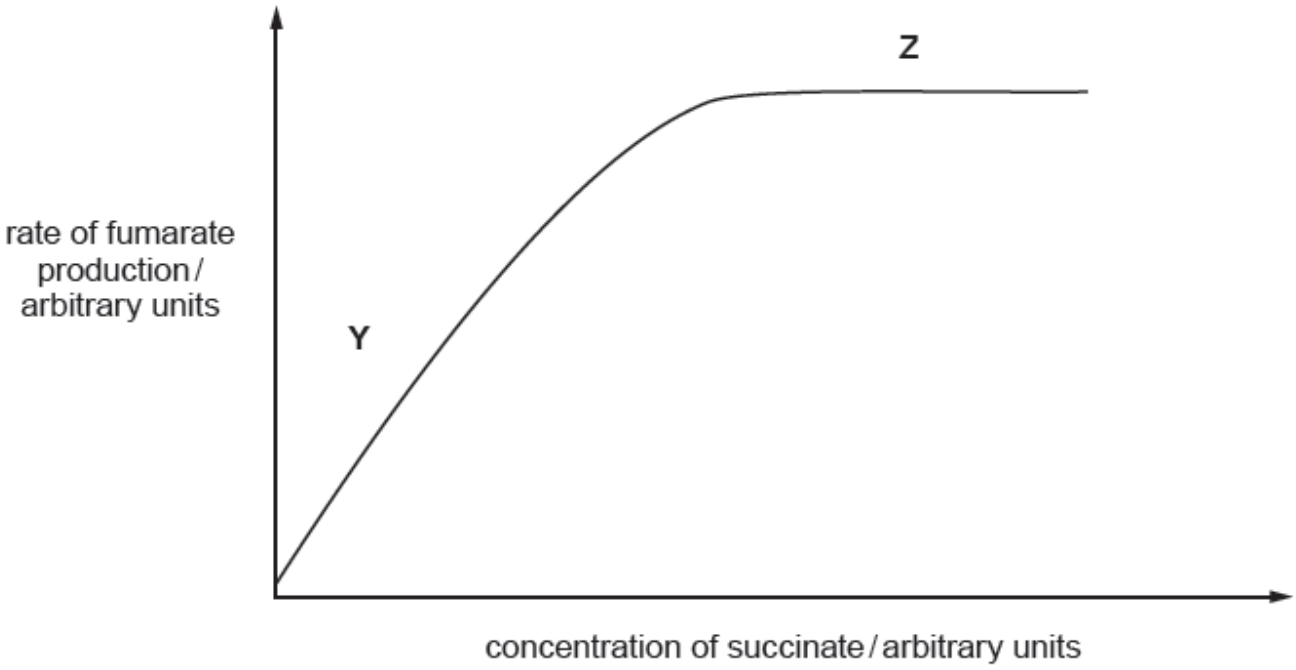
(c) The graph below shows the rate of fumarate production at varying concentrations of succinate, at optimum temperature and pH with no inhibitors present.



(i) I. State what factor is limiting the rate of reaction in the region marked **Y** on the graph.

[1]

.....

II. Use evidence from the graph to support your answer.

[1]

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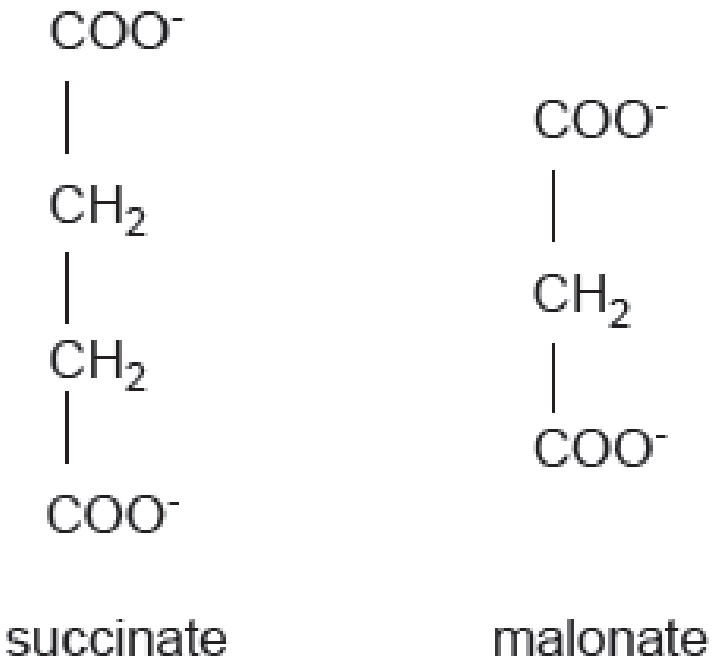
.....

.....

(ii) Explain what is limiting the rate of reaction in the region marked **Z** on the graph.

[2]

(d) Malonate is a competitive inhibitor of succinate dehydrogenase. The diagrams below show the structural formulae of succinate and malonate.



succinate malonate

(i) Using the information in the diagram above and your own knowledge, explain how malonate inhibits succinate dehydrogenase.

[3]

(ii) On the graph in part (c) opposite draw a curve to show the rate of reaction when malonate is present.

[1]

2. Answer one of the following questions.
Any diagrams included in your answer must be fully annotated.
Either, (a) Some cells produce and secrete digestive enzymes. Describe the part played by each of the organelles involved in the production and secretion of the enzymes.

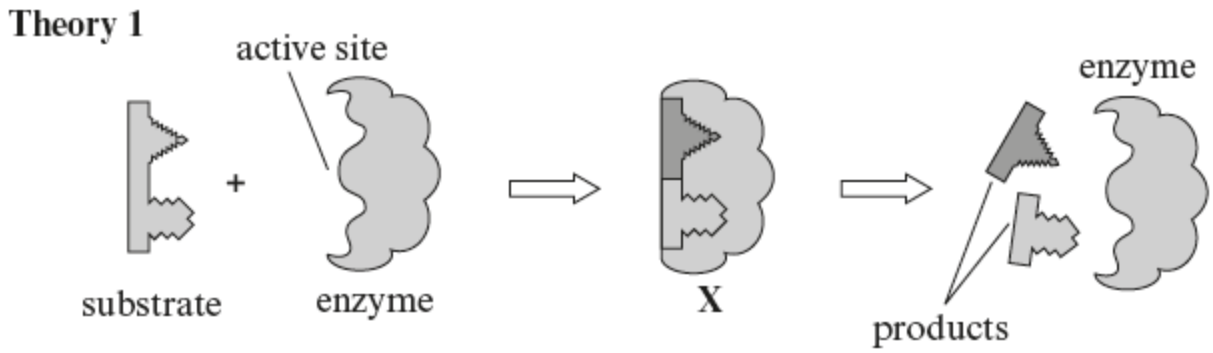
[10]

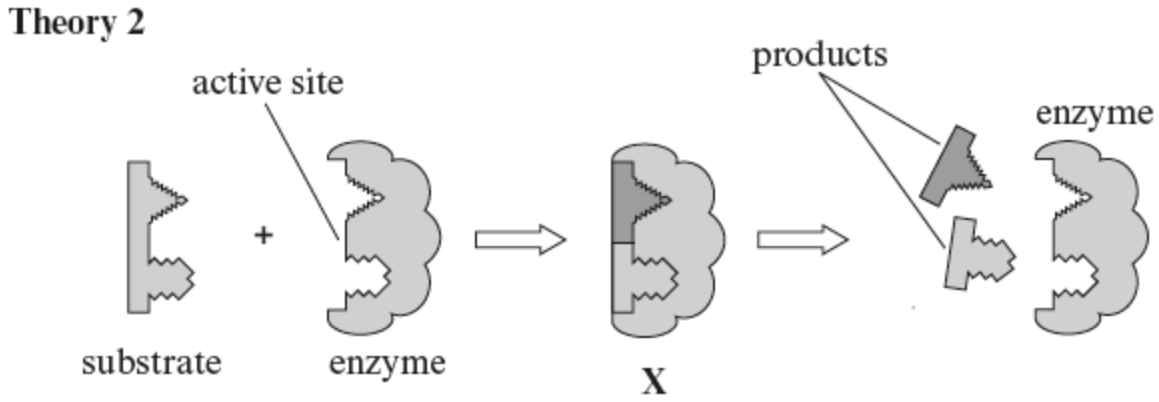
Or (b) Describe and explain how different factors affect the rate of enzyme catalysed

reactions. (Effects of enzyme inhibitors are not required.)

[10]

3. The diagram below shows two theories used to explain enzyme activity.





(a) (i) **Theory 1** shows the induced fit hypothesis. What name is given to **Theory 2**?

[1]

.....

(ii) Which theory represents the activity of lysozyme?

[1]

.....

(b) Name **X** as shown in both theories.

[1]

.....

(c) Enzymes are biological catalysts. How do they bring about their effect of speeding up a reaction?

[1]

(d) What characteristic of an enzyme at the **end of a reaction** is visible in both diagrams?

[1]

(e) State **three** factors which affect enzyme activity, excluding the presence of inhibitors.

[3]

(f) Distinguish between intracellular and extracellular enzymes.

[1]

Total

[9]

4.

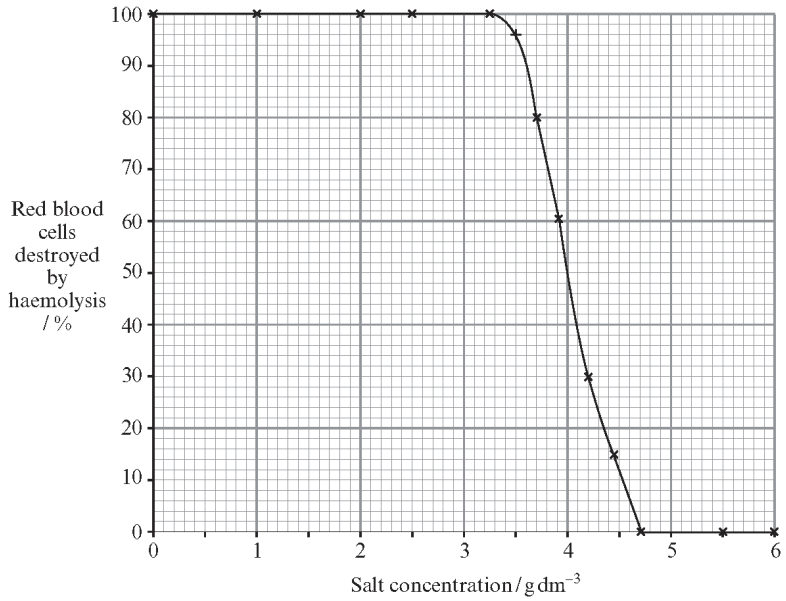
Answer **one** of the following questions.
Any diagrams included must be fully annotated.

Either, *(a)* Describe and explain the effect of inhibitors on enzyme action. [10]

Or *(b)* Describe and explain the effects of placing animal and plant cells in solutions of differing solute concentration. [10]

5.

(a) An investigation was carried out in which red blood cells were placed in salt (sodium chloride) solutions of different concentrations. The percentage of cells destroyed by bursting (haemolysis) was recorded and the results shown in the graph below.



(i) Explain, in terms of water potential, why red blood cells burst when placed in a solution that has a lower concentration than plasma. [3]

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(ii) State the salt concentration at which the number of cells haemolysed is equal to that not haemolysed. [1]

.....

(iii) The graph shows that haemolysis occurs between 3.3 – 4.7 g dm^{-3} salt concentration. Suggest why there is a range. [2]

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.....

(b) An investigation was carried out on the uptake of potassium ions by root tissue.
The root was cut into four discs of uniform size and each disc was added to an equal volume of a solution containing a fixed potassium ion concentration.
The experiment was carried out in different oxygen concentrations and the results are shown in the table below.

Oxygen concentration / arbitrary units	0	4	11	20
Rate of potassium ion uptake / arbitrary units	7	27	92	100

(i) State, with a reason, **one** *other* variable that should be kept constant. [2]

.....

.....

(ii) Using the information in the table, state with an explanation, the **main** method by which potassium ions are taken into the root. [3]

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.....

.....

(c) State the rate of uptake you would expect if a drop of cyanide solution had been added to **each** of the four solutions.
Explain your answer. [3]

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.....

.....

(Total 14 marks)

Marking Scheme

1.

Question			Marking details	Marks Available
4	*(a)*	(i)	Activation energy;	1
		(ii)	Line starting and finishing at the same point but with a lower activation energy;	1
	(b)		The active site (of succinate dehydrogenase) has a specific shape; Succinate has a complementary shape; (and therefore) {fits/ binds/ bonds to} into the active site; NOT attaches	Max 2
	(c)	(i)	I The concentration of succinate/ substrate; II As the concentration of the {succinate/substrate} increases {the rate of reaction/production of fumarate increases};	1 1
		(ii)	The concentration of succinate dehydrogenase/ enzyme; all of its active sites are occupied (at any given moment);	2
	(d)	(i)	Malonate has a similar {shape/structure} to {succinate/ substrate} / malonate has a complementary {shape/structure} the active site; NOT same shape Malonate {binds/ competes} to the active site; Prevents succinate binding / fewer enzyme-substrate complexes are formed; (MP3 must be in context of competitive inhibition)	3
		(ii)	Curve rising at a lower rate and plateaus at the max rate at a higher concentration; Accept max rate may not be reached	1
			Question 4 Total	**[12]**

2. (a)
A Nucleus; 1
B Contains DNA code for amino acid sequence; NOT genetic information alone; 1
C Carries out transcription / makes RNA copy; 1
D Nucleolus; 1
E Makes ribosomes / organises transcription / makes rRNA; 1
F {Rough ER / Ribosomes} { translate mRNA / put amino acids together / protein synthesis}; 1
G Endoplasmic reticulum; 1
H Transports protein; 1
I (To) Golgi; 1
J Packages protein into vesicle; 1
K Modifies protein or description; 1
L Secretory vesicle; 1
M Vesicle migrates towards plasma membrane; (can award M and N if use vesicle instead of secretory vesicle) 1
N Vesicle fuses / merges with plasma membrane; 1
O Contents of vesicle emptied by exocytosis; 1

Question total 10

(b)
A Temperature; 1
B description of (exponential) increase to optimum / maximum / certain temperature then (sudden) decline / sketch graph showing; 1
C Increasing temperature increases rate because of increased energy / moving molecules faster / kinetic energy / ORA; 1
D {Increasing frequency of / more / more likely} successful collisions / Enzyme Substrate Complexes forming / ORA; 1
E pH; 1
F description of optimum pH and declining activity further from optimum in both directions / sketch graph / optimum pH and narrow range; 1
(Award G, H, I, J in context for Temp and/or pH)
G (3D) shape of active site changes; 1
H Changing away from optimum affects bonds holding tertiary structure / structure of enzyme molecules; 1
I Correct reference to hydrogen / covalent / ionic bonds; NOT disulphide / peptide 1
J Substrates do not fit into active site / is not complementary (so rate reduced); 1
K Substrate concentration; NOT amount; 1
L Enzyme concentration; NOT amount;
(Award M,N, O in context for Enzyme conc and/or Substrate conc) 1
M Activity increases up to maximum when it levels off / sketch graph showing / ORA; 1
NmmIncreasing substrate / enzyme conc. increases number of active sites occupied / Enzyme Substrate complexes / successful collisions / ORA; 1
O Maximum rate when all active sites occupied / saturated correct reference to limiting factors; 1

Question total 10

3.

Question			Marking details	Marks Available
2.	(a)	(i)	Lock and key;	1
		(ii)	Theory 1/ induced fit;	1
	(b)		Enzyme substrate complex; NOT ESC/ ES complex	1
	(c)		Lower the activation energy/eq;	1
	(d)		Enzyme/ active site is unchanged/can be re-used; NOT active sites are a specific shape unqualified	1
	(e)		Temperature (not heat); pH; NOT acidity Enzyme concentration; Substrate concentration; NOT amount	3
	(f)		Intracellular: inside the cell + Extracellular:outside the cell; NOT inside body	1
			Question 2 total	**[9]**

4.

(b) **Describe the effects of placing animal and plant cells in solutions of differing solute concentration.**

A Osmosis is the (net) movement of water molecules down a water potential gradient/from a higher water potential to a lower water potential;

B through a partially/selectively permeable membrane;

C Hypotonic solutions have a higher water potential than the (cytoplasm of the) cells;

D Water moves into the cells (by osmosis);

E Animal cells swell /burst/ref osmotic lysis; reject turgid

F Plant cells the cytoplasm swells up/cell contents/plasma membrane pushes against the cell wall;

G (plant cells) becomes turgid/ψ_p>0/cell wall prevents osmotic lysis;

H Hypertonic solutions have a lower water potential than the (cytoplasm of the) cells;

I Water moves out of the cells (by osmosis);

J Animal cells shrink/crenated; reject flaccid

K In plant cells the cytoplasm shrinks / the (plasma) membrane is pulled away from the cell wall;

L Plant cell becomes plasmolysed/ ψ_p=0;

M Isotonic solutions have the same water potential as the cytoplasm of the cell;

N (In isotonic solutions) there is no net movement of water molecules;

O At incipient plasmolysis 50% of the cells in a plant tissue will be turgid and 50% will be plasmolysed;

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5.

(ii) active transport; **[1]**

is energy/ATP dependent;

aerobic respiration/oxygen required, to liberate energy/for ATP prod;

greater oxygen concentration produces greater uptake; **[2]**

(c) * all would be 7au; **[1]**

cyanide inhibits aerobic respiration/ inhibits cytochrome oxidase/

stops/ reduces prevents ATP production;

when no oxygen is present there is still some uptake;

by diffusion;

which is a passive process; **[2]**

must have *. Plus 2 others

(Total 14 Marks)

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Examiner's Comments

1. Knowledge of enzymes is so fundamental to the understanding of metabolism that it was very disappointing to see the responses given by the candidates, especially given the fact they many of them will have studied respiration and photosynthesis in BY4. The answers in part (a) were appalling, it seemed they had never seen an activation energy graph before. Candidates provided vague answers to part (b) and failed to make reference to enzyme structure. The quality of responses to part (c) varied with only a minority of students gaining full marks; candidates interpreted the graph correctly and in part*(ii)* explained that all of the active sites were full, but failed to state that the enzyme concentration was the limiting factor. Unfortunately many candidates interpreted the graph as 'mass of product' against 'time' and therefore gained no marks. The majority of candidates gave a good account of competitive inhibition, but then drew a curve showing non-competitive inhibition on the graph.

*This comment originally referred to question **4** on paper **1071/01 (08/01/2014)***

2. Option 7(a) was the less popular choice, with only very few candidates attempting it. A range of marks were awarded, but those candidates who gained fewer than the full 10 marks had clearly not prepared properly and gave very weak answers. Option 7(b) was attempted by the vast majority of candidates and most of those who did attempt it gained the maximum 10 marks. (Many could have been awarded all of the available 15). The quality of written communication was an issue for a small number of candidates and some had clearly not prepared themselves properly because they did not present any details.

*This comment originally referred to question **7** on paper **1071/01 (14/05/2012)***

3. Some confusion over the lock and key hypothesis, although generally most sections were attempted and answered correctly. There were some weak answers to (f) which did not gain credit, since comments that extracellular enzymes work outside the 'body' were not acceptable.

*This comment originally referred to question **2** on paper **1071/01 (21/05/2013)***

4. (a) This question was answered by the majority of candidates. Many gave coherent accounts of the effects of inhibitors on enzymes gaining most if not all the marks available. Many candidates included diagrams in their responses and graphs showing the effects on the rate of reaction, unfortunately a large proportion labelled the X-axis as time and not substrate concentration.

(b) The more able students gave excellent responses to this essay and gained full marks were not uncommon, however they were in the minority. Many candidates were clearly confused by the terminology surrounding this topic, but managed to pick up some marks. There were many common errors such as referring to animal cells as either 'turgid' or 'plasmolysed'; many students mustn't realise that plant cells actually have a plasma membrane as they stated that in turgid cells 'the cytoplasm pushes against the cell wall' and in plasmolysed cells 'the cytoplasm pulls away from the cell wall'.

*This comment originally referred to question **7** on paper **1071/01 (09/01/2013)***

5. The question (a)(i) asked for answers to be in terms of water potential. Answers referring to water concentration were therefore, not acceptable, and the term should not be used. Many candidates made reference to the water potential of plasma rather than of the solution and a sizeable number had water leaving the red blood cells rather than entering. The answers to part (a)(ii) were poor with little understanding that the water potentials of the red blood cells would vary within the range.

*This comment originally referred to question **3** on paper **1071/01 (11/01/2011)***