

APOLLO

Enzymes and metabolism

HL

Biology

First assessment 2025

11 questions | mark schemes

Mark-scheme answers

Biology HL | Paper 1A | May 2025 TZ1 | Q5 | 1 marks

5. B

Biology HL | Paper 1A | May 2025 TZ2 | Q5 | 1 marks

5. C

Biology HL | Paper 1A | May 2025 TZ3 | Q5 | 1 marks

5. D

Biology HL | Paper 1A | May 2025 TZ3 | Q6 | 1 marks

6. B

3.	a	i	statin/inhibitor concentration OR type of statin;		1
3.	a	ii	pH / temperature / concentration of substrate/enzyme / volume of substrate/enzyme / size of containers / time;		1 max
3.	b		<u>Similarities [max 2]</u> a. (overall) with both statins, activity of HMG-CoA reductase/enzyme decreases as concentrations (of statins) increase; b. both statins cause the most reduction/decrease in activity / inhibition (of HMG-CoA reductase/enzyme) when concentrations increase from 0 to 80 μM; c. the activity of HMG-CoA reductase/ the enzyme is the same between 0-40 μM/at 260 μM of statins <u>Differences [max 2]</u> d. between 80 and 160 μM, activity (of HMG-CoA reductase/enzyme) decreases more with S1 than with S2; e. as concentrations of statins increase from 160 to 320 μM, the activity (of HMG-CoA reductase/enzyme) increases with S1 but continues decreasing with S2; f. the greatest inhibitory effect/ reduction in enzyme activity occurs at a concentration of 160 μM with S1, but at 320 μM with S2;	Both similarities and differences needed for 3 marks c. Allow values between 0-50 μM / 250-270 μM. d. Vice versa.	3 max

Question		Answers	Notes	Total								
3.	c	a. volume/concentration of product present divided by time taken for its appearance OR volume/concentration of substrate used divided by time taken for its disappearance; b. reciprocal of time taken (1/time taken) for either product to appear or substrate to disappear;	<i>Must have an indication of time.</i> <i>Accept correct formula.</i>	1 max								
3.	d	<table><tr><th>Competitive</th><th>Non-competitive</th></tr><tr><td>a. binds to <u>active</u> site</td><td>binds to <u>allosteric</u> site</td></tr><tr><td>b. blocks the active site</td><td>changes the shape of the enzyme/active site</td></tr><tr><td>c. affected by substrate concentration</td><td>not affected by substrate concentration</td></tr></table>	Competitive	Non-competitive	a. binds to <u>active</u> site	binds to <u>allosteric</u> site	b. blocks the active site	changes the shape of the enzyme/active site	c. affected by substrate concentration	not affected by substrate concentration	<i>Answer should include both distinguishing statements to gain 1 mark.</i>	1 max
Competitive	Non-competitive											
a. binds to <u>active</u> site	binds to <u>allosteric</u> site											
b. blocks the active site	changes the shape of the enzyme/active site											
c. affected by substrate concentration	not affected by substrate concentration											

Question		Answers		Notes	Total
3.	e			Process and description must match for 2 marks	2 max
		a. name of process	b. description		
		(blood) clotting;	thrombin converts fibrinogen to fibrin (blocks/prevents entrance of pathogens);		
		phagocytosis;	(hydrolytic) enzymes (present in lysosomes) digest/ break down pathogens/ bacteria;		
		secretion of mucus;	enzymes in mucus kill/destroy pathogens;		
		B-lymphocytes/ plasma B-cells;	use enzymes to produce antibodies (once activated);		

Question	Answers	Notes	Total
----------	---------	-------	-------

Mark-scheme answers

Biology HL | Paper 1A | Nov 2025 TZ1 | Q5 | 1 marks

5. A

Biology HL | Paper 1A | Nov 2025 TZ3 | Q6 | 1 marks

6. D

9.	a	a. signalling chemicals/ligands bind to receptors; b. reference to specificity / the shape (and chemical properties) of the ligand-binding site match those of the ligand; c. receptors can be in (either) the plasma membrane / intracellular / in the cytoplasm / or nucleus OR ligand can bind to transmembrane receptors/receptors in the plasma membrane or intracellular receptors; d. only cells with a receptor to a signalling chemical will respond; e. reference to signal transduction (initiated by signalling chemical-receptor binding); f. example of signalling chemical;	<i>Do not accept the role of glycoproteins in cell-cell recognition or ABO glycoproteins.</i> <i>For b: do not accept "complementary" as this is part of the stem question.</i> <i>For e. OWTTE</i> <i>For e. the reference may include the pathway followed by a given example of a signalling chemical.</i> <i>Appropriate example for (f):</i> • Neurotransmitters/named neurotransmitter • any named hormone • Cytokine • Calcium ions	4 max
----	---	---	--	----------

Question		Answers	Notes	Total
9.	b	a. enzymes are globular proteins with an active site (for catalysis); b. substrates must bind to the active site to be catalysed; c. description of induced fit mechanism / substrate can cause active site to change shape; d. conformational changes/changes in tertiary structure do not allow substrate to bind to active site / enzyme is denatured; e. denaturation decreases enzyme activity / enzymes no longer work; f. high temperatures/temperatures above the optimum break bonds in the enzymes / cause conformational changes to active site / denature enzymes; g. below the optimum temperature enzymes may be inhibited OR increased temperature increases kinetic energy, increasing enzyme activity (because of more collisions) up to optimum temperature; h. (changes in) pH cause changes in charges /alteration of (ionic/ H) bonds (between amino acids) / affect shape of active site / the enzyme becomes denatured (at higher or lower pH values than the optimum) i. <u>non-competitive inhibitors</u> bind to an allosteric site; j. (non-competitive inhibitors) cause disruption of hydrogen/ionic/disulfide/hydrophobic interactions; Marking point for 9b continued on next page...	<i>Ignore references to substrate concentration</i> <i>Ignore references to competitive inhibitors</i> <i>For h. do not accept that the enzyme is inhibited because of pH different from optimum.</i>	7 max

9b continued...

9.	b	k. (non-competitive inhibitors) cause conformational change of the enzyme / changes in the active site of the enzyme; l. (non-competitive inhibitors) decrease rate of enzyme-substrate complex formation / substrate can no longer bind to the active site / decrease enzyme activity;		
----	---	---	--	--

Question	Answers	Notes	Total
9. c	a. haemoglobin transports oxygen by binding to it in the lungs and releasing it in tissues that require oxygen OR association/loading of oxygen to haemoglobin happens in the lungs OR dissociation/unloading of oxygen from haemoglobin occurs at cells that require oxygen/respoding tissues; b. each haemoglobin molecule can carry four oxygen molecules OR reference to cooperative binding / the binding of one oxygen molecule to a haemoglobin (subunit) increases the affinity of the other subunits for oxygen/makes it easier for the other oxygen molecules to bind; c. at low partial pressures of oxygen/when oxygen concentration is low, hemoglobin has a low affinity for oxygen OR at high partial pressures of oxygen/when oxygen concentration is high, oxygen has a high affinity for haemoglobin / (readily) binds to haemoglobin; d. (at low partial pressures of oxygen/ when oxygen concentration is low) this enables oxygen to dissociate/diffuse more readily at/into respoding tissues; e. provides more oxygen for aerobic respiration in the tissues; Marking point for 9c continued on next page...	<i>For a. accept OWTTE.</i> <i>For c. and g. Can be answered using a dissociation curve graph with labelled axes and annotations referring to the marking points c. and g.</i> <i>Ignore references to foetal haemoglobin (question requires adult only)</i>	4 max

9c continued...

9.	c	f. carbon dioxide from respiring tissues binds to haemoglobin; g. low pH / high concentration of carbon dioxide/carbonic acid causes Bohr shift / shift of curve to the right OR low pH / high concentration of carbon dioxide/carbonic acid promotes the release of oxygen from haemoglobin (to tissues); h. Bohr shift reduces the affinity of haemoglobin for oxygen OR Bohr shift results in oxygen unloading/diffusing easier to respiring tissues;		
----	---	--	--	--

Question	Answers	Notes	Total
----------	---------	-------	-------

Mark-scheme answers

Biology HL | Paper 1A | Specimen 2025 | Q7 | 1 marks

7. D

Biology HL | Paper 1A | Specimen 2025 | Q8 | 1 marks

8. A

9.	a	a. some toxins/DDT are persistent/degrade slowly (once released into the environment); b. (some toxins/DDT) enter the food chain through producers/lower trophic levels; c. (some toxins/DDT) are passed on to higher trophic levels in the food chain; d. (they are) difficult to excrete / are not excreted; e. (they) accumulate in fatty tissues of animals; f. higher trophic levels/top consumers have higher/the highest concentration of pesticides in their bodies; g. they bioaccumulate/biomagnify;		4																						
9.	b	<table><tr><td>Competitive inhibition</td><td>Non-competitive inhibition</td></tr><tr><td colspan="2">Similarities:</td></tr><tr><td colspan="2">slow down enzyme activity;</td></tr><tr><td colspan="2">interact with R chains of amino acids at the surface of enzyme molecule;</td></tr><tr><td colspan="2">Differences:</td></tr><tr><td>inhibitor binds to active site</td><td>does not bind to active site</td></tr><tr><td>inhibitor does not bind to allosteric site;</td><td>inhibitor binds to allosteric site;</td></tr><tr><td>substrate cannot bind due to blockage of active site</td><td>substrate cannot bind due to disruption/change in shape of active site;</td></tr><tr><td>inhibition is reversible</td><td>inhibition is (usually) permanent;</td></tr><tr><td>inhibitor has similar shape to substrate</td><td>inhibitor does not have similar shape to substrate;</td></tr><tr><td>can be reversed by increasing substrate concentration</td><td>adding substrate does not reduce inhibition;</td></tr></table> a valid example of each;	Competitive inhibition	Non-competitive inhibition	Similarities:		slow down enzyme activity;		interact with R chains of amino acids at the surface of enzyme molecule;		Differences:		inhibitor binds to active site	does not bind to active site	inhibitor does not bind to allosteric site;	inhibitor binds to allosteric site;	substrate cannot bind due to blockage of active site	substrate cannot bind due to disruption/change in shape of active site;	inhibition is reversible	inhibition is (usually) permanent;	inhibitor has similar shape to substrate	inhibitor does not have similar shape to substrate;	can be reversed by increasing substrate concentration	adding substrate does not reduce inhibition;	Answers must have at least one similarity for 7 max.	7 max
Competitive inhibition	Non-competitive inhibition																									
Similarities:																										
slow down enzyme activity;																										
interact with R chains of amino acids at the surface of enzyme molecule;																										
Differences:																										
inhibitor binds to active site	does not bind to active site																									
inhibitor does not bind to allosteric site;	inhibitor binds to allosteric site;																									
substrate cannot bind due to blockage of active site	substrate cannot bind due to disruption/change in shape of active site;																									
inhibition is reversible	inhibition is (usually) permanent;																									
inhibitor has similar shape to substrate	inhibitor does not have similar shape to substrate;																									
can be reversed by increasing substrate concentration	adding substrate does not reduce inhibition;																									

(continued...)

(Question 9 continued)

Question	Answers	Notes	Total
9. c	a. lower rate of <u>aerobic</u> respiration / inhibits <u>aerobic</u> respiration; b. reduced NAD (not oxidised) accumulates; c. fewer/no electrons (from reduced NAD and FADH) to be transported by carriers; d. less/no energy to transfer protons (from matrix to intermembrane space); e. proton gradient cannot be maintained; f. less/no diffusion of protons through ATP synthase; g. ADP is not phosphorylated / less ATP produced / no energy to produce ATP; h. oxygen not binding to protons / accepting electrons / no water formed;		4

Question	Answers	Notes	Total
----------	---------	-------	-------