PEARSON EDEXCEL A-LEVEL BIOLOGY B · 9BI0

BIOLOGY



MARK SCHEME

TOPIC 6: MICROBIOLOGY AND PATHOGENS

RESPONSE TO INFECTION

SCORE	PERCENTAGE
/102	%

STEMUP

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Mark Scheme

Q1.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	An answer that makes reference to the following: • correct reading from graph for IL-10 (1) • correct calculation of increase (1)	<u>Example of calculation</u> IL-10 is 3.4 – 2.0 = 1.4 Allow 3.3 to 3.5 (1.4×100)÷2.0 = 70% Allow 65% to 75%	**(2)**

Q2.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: • one group treated with { placebo / inert substance / saline } (1) • one group with no intervention (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: • the vaccine is very effective against PV2 and PV3, supporting widespread use (1) • there is no alternative vaccine or treatment, so the 60-70% protection against PV1 is still useful (1) • allergic reaction is (very) rare given the size of the study (1) • the effects of polio are serious and there is no cure, therefore benefits of vaccination are greater than { risks / costs } (1)		**(4)**

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • humanised antibodies will not trigger an immune response / mouse antibodies could trigger an immune response **(1)** • antibodies would {bind to cancer cells so that macrophages could destroy the cancer cells / opsonise the cancer cells} **(1)** • the antibodies are target specific **(1)** • reducing the need for other {treatments / named treatment} **(1)**	**Accept** humanised antibodies will not be recognised as {foreign / as an antigen} / mouse antibodies could be recognised as {foreign / as an antigen} **Accept** antibodies will bind only to cancer cells **Accept** have less {side effects / named side effects}	**(3)**

Question Number	Indicative content
* (ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **Description:** • mouse antibody is made of all mouse components • humanised antibody consists mostly of human components • mouse antibody recognised by the patient's immune system (rejection) • mouse protein acts as an antigen **Consequence:** • mouse antibody could be destroyed • mouse antibodies would not persist in the body • macrophages may not bind to mouse antibody • so phagocytosis of the cancer cells would not be enhanced • humoral / B cell immune response could be initiated • macrophages may phagocytose the mouse antibody **Immunology:** • details of how macrophage destroys antibody • macrophage becomes an antigen-presenting cell • T helper cells become activated • antibodies against the mouse antibodies could be produced (by plasma cells) **Accept converse for humanised antibody throughout**

Level 0	0	No awardable content
Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context. **Description of mouse antibody resulting in rejection (Accept converse for humanised antibody throughout)**
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented. Lines of argument occasionally supported through the application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows some linkages and lines of reasoning with some structure. **Details given on why the mouse antibodies may not be effective in treating the cancer (Accept converse for humanised antibody throughout)**
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented. Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured. **Explanation of how the mouse antibody could be destroyed by the immune system (Accept converse for humanised antibody throughout)**

Q4.

Question Number	Acceptable Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • inactivated poliovirus has antigens on surface that bind to complementary B cell receptor (1) • therefore B cells become { antigen-presenting cells / APCs } (1) • complementary T helper cells bind to { B cells / APCs } and produce cytokines (1) • therefore B cells differentiate into plasma cells that secrete antibodies (1)		**(4)**

Q5.

Question Number	Answer	Mark
	The only correct answer is D ***A*** *is not correct because macrophages do not produce antibody* ***B*** *is not correct because memory cells do not produce antibody* ***C*** *is not correct because neutrophils do not produce antibody*	**(1)**

Q6.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)	• calculation of percentage decrease (1)	Example of Calculation: $\left(\frac{(400{,}000-291)}{400{,}000} \times 100 = \right)$ 99.9%	**(1)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)	• calculation of 85% of 196 million but only 95% of this population is actually immune (1) • • correct answer to the nearest million (1)	(196 000 000 x 0.85) / 0.95 OR (196 000 000 / 0.95) x 0.85 = 175 million Allow full marks for correct answer with no working	**(2)**

Q7.

Question Number		Additional Guidance	Mark
	An answer that makes reference to five of the following: • use mice not exposed to the {virus / antigen} (1) • mice given vaccine and mice {not given vaccine / saline / placebo} / GM plant and normal plant} (1) • assess {antibodies / white blood cells / named white blood cell} (1) • {large number of mice / 10+ mice} for each treatment (1) • control {sex / age / species} of mice (1)	**ACCEPT** range of vaccine concentration if one is zero **ACCEPT** (infection with virus and) {observe symptoms / ill / diseased / survive} **DO NOT ACCEPT** group	**(5)**

Q8.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	$(10^6 - 10^2) \div 10^2$ x 100 (1) 999900 % (1)	Correct answer gains full marks with no working	**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)	An explanation that makes reference to the following: • overall the T helper cell count falls from {week 0 / initial HIV infection} and the amount of viral RNA increases (1) • between week 6 and week 12 the amount of viral RNA falls, therefore the T helper cell count increases (1) plus any three of the following: • virus attaches to (CD4) surface receptors (1) • virus genetic material / RNA enters T helper cell (1) • virus genetic material produces virus proteins / new virus particles (1) • T helper cells lyse (1) • T killer cells attack infected T helper cells / phagocytosis by macrophages (1)		**(5)**

Q9.

Question Number	Indicative content
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. For vaccination: • vaccination does protect against influenza and vulnerable groups will need protection • there are many strains of influenza • the World Health Organisation may not have had time to create vaccines against the latest virus type • the vaccine will protect against other varieties of influenza which may also be circulating • vaccinating as many people as possible will help to develop herd immunity • alarmist headlines will put people off being vaccinated for other diseases Against vaccination: • anti-viral drugs could also be used • influenza viruses are always mutating • most of the deaths will be in older people • vaccination programmes are not cost effective • vaccination programmes ineffective unless everyone immunised

Level	Marks	
Level 0	0	No awardable content
Level 1	1-2	Limited scientific judgement made with a focus on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.
Level 2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.
Level 3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.

Q10.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: • because stops DNA replication in endothelial cells (1) • dividing cells {take up / use} the (radioactive) thymidine (1) • so that any radioactive thymidine uptake will be by the T cells (only) (1)	N.B. 'They' or 'cells' refers to the endothelial cells ACCEPT DNA synthesis uses thymidine ACCEPT only T cell division can be measured	

Q11.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to two of the following: • MHC needed if endothelial cells were to {present antigen / be antigen presenting cells} (1) • antigen binds to MHC molecules (1) • MHC-antigen complex involved in activation of T helper cells (1)	ACCEPT antigens presented on MHC ACCEPT MHC-antigen complex binds to (CD4) receptor on T helper cells	

Q12.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to the following: • to remove any thymidine (not taken up) (1) • which would result in an over estimate of the {number of T cells / thymidine present} (1)	ACCEPT {inaccurate / not valid} result for the T cells	

Q13.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • to determine any passive uptake of radioactive thymidine / to see if T cells take up thymidine without antigen present (1)	ACCEPT to compare the thymidine with and without antigen	
	• to show that antigen is stimulating the T cells (to divide) (1)	ACCEPT to see the effect of antigen (on T cells)	

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • endothelial cells are best at presenting Con A (and MBP) / Con A (and MBP) are presented (1) • endothelial cells are least effective at presenting OVA (and PPD) / OVA (and PPD) are not presented (1) • because there is very little difference between antigen and {no antigen / control} (1) • because {error bars for Con A and MBP are not overlapping / error bars for OVA and PPD are overlapping} with the control (1)		
		N.B. Con A (and MBP) have the highest level of thymidine and OVA (and PPD) the least = 1 mark if no other marks awarded	

Q14.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • to prevent DNA {replication / unwinding / unzipping} (1) • so that macrophages could not {divide / carry out mitosis} (1) • so that any division could be attributed to the T cells only / radioactive thymidine incorporate into T cells only (1)	**ACCEPT** separating **ACCEPT** number of macrophages remains constant **ACCEPT** no thymidine incorporated into the macrophage	**(3)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: • {complementary to / binds to / forms H bonds with} adenine (on the DNA) (1) • forming phosphodiester bonds (with adjacent nucleotides) (1)	**ACCEPT** formation of a sugar-phosphate backbone	**(2)**

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to four of the following: • most (radioactive) thymidine incorporated into T cells that were the same strain as the macrophages (1) • because these cells are dividing more (1) • because {the (MHC and CD4) receptors bind together better / antigen presentation improved} (1) • due to genetic compatibility (1) • strain 2 {macrophages are better antigen presenters / T cell proliferate faster than strain 13} (1)	**ACCEPT** converse throughout **ACCEPT** more T cells if antigen is presented by macrophages from same {strain / number} guinea pig description **ACCEPT** faster mitosis **ACCEPT** better recognition **ACCEPT** self-antigens **ACCEPT** antigen presentation is more effective	**(4)**

Q15.

Question Number	Answer	Additional Guidance	Mark
(i)	**The only correct answer is D** **A** is incorrect because antibodies have two antigen binding sites **B** is incorrect because the two binding sites attach to the antigen and not the macrophage **C** is incorrect because there is only one macrophage binding site		(1) COMP

Question Number	Answer	Additional Guidance	Mark
(ii)	**The only correct answer is B** **A** is incorrect because hydrolysis reactions breakdown molecules **C** is incorrect because nucleotides are the monomers of polynucleotides not proteins **D** is incorrect because nucleotides are the monomers of polynucleotides not proteins		(1) COMP

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: • (because water enters part of cell) by osmosis (1) • from a high water potential to a low water potential / because the osmotic potential inside the cell is lower / from a low solute concentration to a higher solute concentration (1)	**ACCEPT** more concentrated cytoplasm solute potential for osmotic potential **IGNORE** concentration gradient unqualified water concentration	(2) EXP

Question Number	Answer	Additional Guidance	Mark
(iv)	A description that makes reference to three of the following: • bacteria engulfed and {digested / broken down} (1) • antigen attached to MHC antigen (1) • macrophage becomes an antigen-presenting cell (to the T helper cell) (1) • CD4 (antigen) of T (helper) cell binds to {antigen / macrophage} (1)	**ACCEPT** macrophage presents the antigen (to the T helper cell) **NB** CD4 (antigen) of T (helper) cell binds to {antigen-MHC complex = 2 marks	(3) EXP

Q16.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to the following: • antigen on {surface / membrane} of macrophage (1) • binding of antigen to {CD4 / receptor} on T helper cell (1)	ACCEPT antigen on MHC on macrophage	**(2)**

Q17.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to three of the following: • because more viruses delivered (1) • because {lipid / sphere} can pass through cell membrane / no need to bind to (cell) receptors / can bind to any cell (1) • because {lipid / sphere} protects viruses from {enzymes / stomach acid / phagocytes / immune system} (1) • credit a link between one reason and the information given (1)	e.g. more cells infected so symptoms develop faster more cells infected so symptoms are worse virus particles not destroyed so more cells infected	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: • because the lipids could be {targetted / broken down} (1) • by an enzyme (that breaks down lipid) (1) • resulting in {fewer virus particles arriving at cells (in one go) / exposure to immune system} (1)	**ACCEPT** using a drug that can penetrate the lipid **ACCEPT** therefore destroying the viruses **ACCEPT** {fewer / no} viruses (arriving at the cells)	(2)

Q18.

Question Number	Indicative content		Mark
*	**Indicative content:** **Graph 1** (concentration of bacteria) • as time increases the number of bacteria taken up increases • the more microorganisms present the more enhanced the uptake is • but this is not proportional to number present • effect only seen after 10 minutes **Graph 2** (number of macrophages) • the more macrophages present the more uptake of bacteria • but this difference is only marked with 100 000 macrophages present • effect only seen after 30 minutes **Graph 3** (source of macrophages) • source of macrophages affects how many bacteria are taken up • bone marrow cells take up more of both types of bacteria • type of bacteria affects how many bacteria are taken up • combination of both affects uptake	**Level 1:** 1 mark = 1 comment on one set of data 2 marks = two sets of data commented on **Level 2:** Comments must relate to phagocytosis ie not just a description of green glow 3 marks = three sets of data commented on 4 marks = four sets of data commented on **Level 3:** 5 marks = four sets of data commented on, with an extended comment on one set 6 marks = four sets of data commented on, with an extended comment on at least two sets of data	6 EXP

	Graph 4 (concentration of ATP synthase inhibitor) • presence of ATP synthase inhibitor reduces uptake of bacteria • as there is no ATP available for phagocytosis • but differences only really seen are concentrations of 100 a.u. and above	**NB** extended comment = two or more points made about a set of data	

Q19.

Question Number	Answer	Additional guidance	Mark
(i)	B (T helper cell)		**(1)**

Question Number	Answer	Additional guidance	Mark
(ii)	D (proteins that activate T killer cells)		**(1)**

Q20.

Question Number	**Answer**	**Additional Guidance**	**Mark**
(i)	An explanation that makes reference to the following: • to {kill / attenuate / inactivate / weaken / prevent reproduction} (1) • therefore less risk of {infection / disease / malaria} (1)		**(2)**

Question Number	**Answer**	**Additional Guidance**	**Mark**
(ii)	• vaccinate with {no *Plasmodium* / saline / water}	**ACCEPT** placebo	**(1)**

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to three of the following: • effective for {group B / high dose} because zero infected / not effective for {group A/ low dose} as some infected (1) • sample size of {group B / high dose} was {small / only 6 people} / sample sizes were small (1) • {group A / low dose} result similar to the {control / group C} (1) • (sample selection unknown so) no information about {gender / age / culture / health / prior infection} (1)	**ACCEPT** 100% effective for group B	**(3)**

Question Number	Answer	Additional Guidance	Mark
(iv)	A description that makes reference to five of the following: • antigen presenting cells / MHCs (1) • APC binds to {T cell / CD4 receptors} (1) • production of T memory cells (1) • (activated) T cells {stimulate B cells / release cytokines} (1) • production of B memory cells (1) • plasma cells release antibodies (1)		**(5)**