Mark Scheme (Results)

January 2024

Pearson Edexcel International Advanced Level In Biology (WBI14)

Paper 01: Energy, Environment, Microbiology, and Immunity

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question number	Answer	Mark
1(a)	The only correct answer is D A *is incorrect because antigens do not protect the body from infection* *B is incorrect because antigens do not protect the body from infection* *C is incorrect because interferon does not prevent infection*	(1)

Question number	Answer	Additional guidance	Mark
1(b)(i)	An answer that includes the following points: • water alone does not {remove / kill} all microorganisms / soap more effective (at removing microorganisms) (1) • more microorganisms are {removed / killed} as the time of washing increases (with both methods) (1)	ACCEPT skin flora / bacteria cleaner area IGNORE viruses / pathogens ACCEPT skin flora / bacteria cleaner area IGNORE viruses / pathogens	(2)

Question number	Answer	Additional guidance	Mark
1(b)(ii)	An explanation that includes two of the following points: • water alone will {physically remove / wash off} some of the skin flora (1) • soap {contains antimicrobials / contains chemicals / has a high pH} that kill skin flora (1) • the longer the hands are washed in soap the longer the {antimicrobials / chemicals / high pH} have to {affect / kill} skin flora (1) • (some microorganisms left) soap cannot {destroy / kill} all skin flora (1)	ACCEPT microorganisms / bacteria for skin flora ACCEPT rubbing hands together will {push / damage} microorganisms ACCEPT disinfectant / surfactant ACCEPT higher chance ACCEPT soap cannot destroy viruses	(2)

Question number	Answer	Mark
2(a)(i)	The only correct answer is D A *is incorrect because NADP is not oxidised* *B is incorrect because reduced NADP is not produced in cyclic photophosphorylation* *C is incorrect because the NADP is not oxidised*	(1)

Question number	Answer	Additional guidance	Mark
2(a)(ii)	C is from {carbon dioxide / CO_2} H is from {water / H_2O} O is from {carbon dioxide / CO_2}	One or two correct = 1 mark All three correct = 2 marks DO NOT ACCEPT any other molecule or incorrect formula DO NOT ACCEPT any other molecule or incorrect formula DO NOT ACCEPT any other molecule or incorrect formula	(2)

Question number	Answer	Additional guidance	Mark
2(b)(i)	An answer that includes three of the following points: • (overall / after 20 °C) rate of increase in C3 plants is lower (1) • the optimum temperature is lower for C3 plants (than C4 plants) (1) • at the optimum temperature, the rate of photosynthesis is slower in C3 plants (1) • credit appropriate comment about rate below 20 °C (1)	NB all mark points are comparative ACCEPT converse throughout for C4 ACCEPT above 20°C C3 plants have a lower rate of photosynthesis NB if values are given they must be correct C3 {26 / 27 / 28} and C4 {34 / 35 / 36} ACCEPT the {fastest / peak} rate for C3 is lower (than the fastest rate for C4) IGNORE any values given e.g. C3 have a higher rate of photosynthesis rate increase in C3 is non-linear but in C4 plants it is linear rate increase in C3 is less steep C3 plants (probably) photosynthesise at lower temperatures	(3)

Question number	Answer	Additional guidance	Mark
2(b)(ii)	• values for R_{20} and R_{10} read from the graph (1) • Q_{10} given as 4 (1)	6 and {21.5 / 22} DO NOT ACCEPT with units IGNORE a.u. Bald answer of 4 = 2 marks Bald answer between 3.583 and 3.667 = 1 mark	(2)

Question number	Answer	Additional guidance	Mark
3(a)	An answer that includes the following points: • (speciation) formation of one {new / different} species (from a pre-existing one) (1) • (sympatric) while both continue to inhabit the same location (1)	NB IGNORE explanations unless contradictory DO NOT ACCEPT formation of {two species / subspecies} ACCEPT without a physical barrier	(2)

Question number	Answer	Mark
3(b)	The only correct answer is D A *is incorrect because separation of original species does not take place* *B is incorrect because some of the original species do not move away from each other* *C is incorrect because some of the original species do not move away from each other*	(1)

Question number	Answer	Additional guidance	Mark
3(c)(i)	An answer that includes two of the following points: • ability to detect a different {colour / smell / shape} (of fruit) (1) • are able to {feed on / lay eggs in / penetrate} apples (1) • flies {lay their eggs / mate } at different {times of year / temperatures} (1) • {eggs/ maggots / flies} need to survive in different temperatures (1)	ACCEPT have enzymes to feed on apples ACCEPT higher / lower temps ACCEPT higher / lower temps resistance to pesticides	(2)

Question number	Answer	Additional guidance	Mark
3(c)(ii)	An explanation that includes three of the following points: • mutation (in the DNA / existing gene) (1) • mutation was present in the gametes of {either one / both} flies (1) • (this) {gene / allele} passed onto the offspring (1) • {presence of apples / lack of berries} acted as a selection pressure (1)	DO NOT ACCEPT caused by selection pressure	(3)

Question number	Answer	Additional guidance	Mark
3(c)(iii)	An explanation that includes two of the following points: • so that there was no (interspecific) competition for {food (maggots / adults) / space (to lay eggs)} (1) • maggots (of both species) are more likely to {grow / develop / survive} (if less competition) (1) • increasing the numbers of (both types of) flies (if less competition) (1)	ACCEPT hatched eggs ACCEPT hatched eggs	(2)

Question number	Answer	Additional guidance	Mark
3(c)(iv)	An answer that includes two of the following points: • eggs {laid / hatched} at different times of the year (1) • so the {adults / flies} were present at different times of the year (1) • different breeding behaviours / incompatible {gametes / genitalia} (1)	ACCEPT mating occurred at different times of the year ACCEPT anatomically incompatible do not recognise each other	(2)

Question number	Answer	Additional guidance	Mark
4(a)(i)	• {0.29 / 0.3} metres per year metres yr^{-1} m yr^{-1} m per y metres / year (1)	ACCEPT with or without - sign DO NOT ACCEPT m per yr^{-1} m / yr^{-1} m^{-1}	(1)

Question number	Answer	Additional guidance	Mark
4(a)(ii)	An explanation that includes the following points: • because of global warming (being greater) (1) • so {temperatures were higher / increase in temperature was greater} (1) • therefore melting (more) {ice / glacier} (1)	NB converse if talking about 1980 to 1985 ACCEPT example of something that causes increase in global warming e.g. more fossil fuels burnt, more greenhouse gases IGNORE climate change	(3)

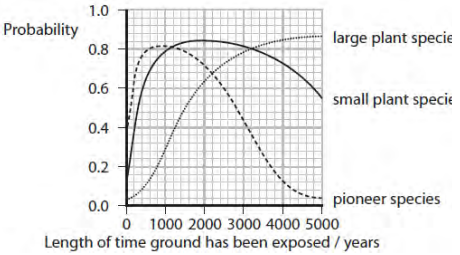
Question number	Answer	Mark
4(b)	The only correct answer is B A *is incorrect because pioneer species will not grow on the ice* *C is incorrect because pioneer species grow on newly exposed ground* *D is incorrect because pioneer species grow on newly exposed ground*	(1)

Question number	Answer	Mark
4(c)(i)	The only correct answer is D A *is incorrect because anthropogenic is the effect of humans* *C is incorrect because evolution is the change in inheritable characteristics over time* *D is incorrect because speciation is the formation of a new species*	(1)

Question number	Answer
*4(c)(ii)	Indicative content:

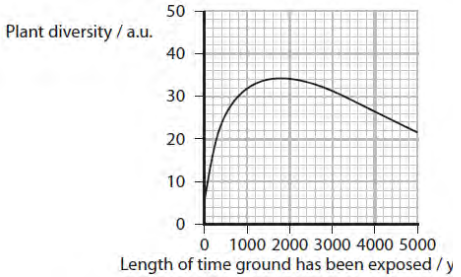
Graph 1 possible explanations :

- conditions and organisms vary with distance from glacier due to succession
- pioneer species arrive first because {conditions hostile / no soil / dry conditions}
- pioneer species die and improve the mineral / humus content in the soil
- these new conditions support small plants
- as small plants arrive, they compete with pioneer species for resources
- as small plants die they improve the soil mineral content / depth
- which will support larger plants
- which then compete with small plants for resources
- until a climax community is reached
- but this is not shown on the graph as the numbers are still changing



Graph 2 possible explanations :

- biodiversity is low when only pioneer species present
- increases as small plants arrive
- increases further as larger plants begin to arrive
- decreases as more larger plants grow
- as fewer plant species can be supported
- may decrease due to habitat loss



Carbon:nitrogen table possible explanations :

- ratio increases as more carbon added to soil / nitrogen is removed from the soil
- early increase corresponds with increase in pioneer species
- as dead plants decompose adding carbon / humus to the soil
- further increase as small plants arrive and die
- animals will be attracted to area with increase in plants species
- as plants provide food and shelter
- animal excrement and decomposing dead animals will add nitrogen to the soil
- decrease in ratio corresponds with increase in number of large plant species
- as more nitrogen because of leaf litter / nitrogen-fixing bacteria / nitrifying bacteria
- as less carbon due to more decomposition / respiration by decomposers

Length of time that the ground has been exposed / years	Carbon : nitrogen ratio in the soil
< 200	9.8
2000	11.6
3500	10.7
7200	10.3

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and with a focus on mainly just one piece of scientific information. The explanation will contain basic information, with some attempt made to link knowledge and understanding to the given context.	Simple description /explanation of data with no real attempt of an explanation 1 mark = some description of the data 2 marks = simple explanation of one of: succession or biodiversity or table
Level 2	3-4	An explanation will be given, with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning, with some structure.	Some explanation given using the information given / own knowledge 3 marks = simple explanation of two of: succession or biodiversity or table 4 marks = more detailed explanation one of: succession or biodiversity or table
Level 3	5-6	An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.	Detailed explanation given using the information given / own knowledge 5 marks = detailed explanation of two of: succession or biodiversity or table with some ref to data 6 marks = detailed explanation of succession and biodiversity that also demonstrates an understanding of C : N ratio

Question number	Answer	Additional guidance	Mark
5(a)	An explanation that includes four of the following points: • HIV's host cell is T helper cells / HIV {targets / infects } T helper cells (1) • number of T (helper) cells reduced / T (helper) cells {destroyed / killed} (by HIV) (1) • when HIV enters lytic {cycle / phase} (T helper cells are destroyed) (1) • without T helper cells the (humoral) immune response is {not initiated / weaker} (1) • therefore *Mtb* are not opsonised (1) • and therefore without antibody phagocytosis (of *Mtb*) is not so effective (1)	ACCEPT CD4 cells attacks DO NOT ACCEPT other named cells ACCEPT {replication / reproduction} stage comes out of latency ACCEPT B cells not activated person is immunocompromised IGNORE T killer cells not activated ACCEPT no antibodies to bind to *Mtb* agglutination (TB) bacteria ACCEPT description involving macrophages providing ref to lack of antibodies	(4)

Question number	Answer	Additional guidance	Mark
5(b)(i)	An answer that includes two of the following points: • credit one reason for not testing everyone (1) • credit one reason for not testing everyone (1) • people with HIV may not want to admit they are HIV positive (1) • false negative results / people {only just infected / small viral load} will not test positive (1)	e.g reasons: impossible to test everyone not everyone willing {people don't have symptoms / HIV is dormant } {lack / cost} of {equipment / healthcare} NB if neither mp 1 or mp 2 awarded, 'not everyone is tested' = 1 mark ACCEPT lie ACCEPT false positives	(2)

Question number	Answer	Additional guidance	Mark
5(b)(ii)	• 1×10^7 / 1.002×10^7 (1)	ACCEPT $1 \cdot 10^7$ / $1.002 \cdot 10^7$	(1)

Question number	Answer	Additional guidance	Mark
5(c)(i)	An answer that includes two of the following points: • (overall) positive correlation / as percentage of people with HIV increases so does number of people with TB (1) • {which is less clear cut / greater spread / weaker correlation} between 0 and {5 / 5.5 / 6 / 6.5} % of HIV (1) • people who have TB do not necessarily have HIV (1)	ACCEPT directly proportional DO NOT ACCEPT causal relationship ACCEPT converse comment for above {5 / 5.5 / 6 / 6.5} % IGNORE some countries have no HIV but do have TB	(2)

Question number	Answer	Additional guidance	Mark
5(c)(ii)	A description that includes three of the following points: • correlation (coefficient) test / named (correlation) test (1) • {coefficient / rho / r / r_s / ρ} value calculated (1) • closer (r) value is to {1 / -1} the stronger the correlation (1)	e.g. Pearson, Spearman DO NOT ACCEPT incorrect named test e.g. T test, Z test, MWU, chi squared ACCEPT compare r value to critical values at (less than) {0.05 / 5%} sig levels	(3)

Question number	Answer	Additional guidance	Mark
6(a)(i)	An answer that includes the following points: • a place where organisms live (1) • (southeast Asian) (rain) forest (1)	ACCEPT trees	(2)

Question number	Answer	Additional guidance	Mark
6(a)(ii)	An answer that includes the following points: • (the number of the) organisms of one species in {a particular area / habitat / the rainforest} (1) • (one from) {loris / tigers} in the (southeast Asian) (rain)forest (1)	ACCEPT type for species ACCEPT trees (for forest)	(2)

Question number	Answer	Additional guidance	Mark
6(a)(iii)	An answer that includes the following points: • a group of different {species / populations} interacting in a particular area (1) • trees and loris and tigers in the (southeast Asian) (rain)forest (1)	ACCEPT {dependent / rely} on each other for interacting ACCEPT two of the named organisms in the rainforest	(2)

Question number	Answer	Additional guidance	Mark
6(b)	An explanation that includes the following points: • niche is the role of an organism in its habitat / slender loris provides food for the tigers (1) • therefore tigers will be {found / distributed} where the loris are found (1) • therefore the more loris, the more tigers (1)	ACCEPT converse for mp 2 and 3 NB "more tigers are found in areas where there are more slender loris" = 2 marks	(3)

Question number	Answer	Additional guidance	Mark
6(c)	An explanation that includes the following points: • remove a (small) sample from {base of tree / trunk} (1) • {count / determine} the (number of) rings (of growth) (1) • because {one ring is equivalent to one year of growth / one ring is made each year / number of rings equals age of tree} (1)	ACCEPT description DO NOT ACCEPT chopping tree down / branches NB measure trunk circumference / count whorls / carbon dating = 1 mark only	(3)

Question number	Answer	Additional guidance	Mark
7(a)(i)	• 3500 nm / 3.5×10^3 nm / 3.5 µm (1)	ACCEPT {3 / 3.3} {× / times} DO NOT ACCEPT correct value with wrong unit 3 / 3.3 with units 3 500 or 3.5 without units	(1)

Question number	Answer	Mark
7(a)(ii)		(2)

Statement about cells	Type of microorganism			
	both *S. cerevisiae* and *S. aureus*	*S. cerevisiae* only	*S. aureus* only	neither *S. cerevisiae* nor *S. aureus*
Contain both DNA and RNA	☒	☐	☐	☐
Have membranes around the cytoplasm and around the nucleus	☐	☒	☐	☐

Question number	Answer	Additional guidance	Mark
7(b)(i)	• explanation of how the number of yeast cells are determined that includes dealing with yeast on the edges and matches their number if given (= 16 / 17 / 18) (1) • (0.00625 µl =) 0.00000625 / 6.25×10^{-6} (cm^3) (1) • (concentration =) 2 560 000 / 2 600 000 / 2.56×10^6 / 2.6×10^6 / 2 720 000 / 2 700 000 / 2.72×10^6 / 2.7×10^6 / 2 880 000 / 2 900 000 / 2.88×10^6 / 2.9×10^6 (cells per cm^3) (1)	e.g. 16 + 2 halves = 17 cells touching two sides are counted in IGNORE ref to living / dead / exclusion dyes ecf if mp2 is correct except for wrong order of magnitude Bald answer of 2 560 000 / 2 720 000 / 2 880 000 etc gets 2 max	(3)

Question number	Answer	Additional guidance	Mark
7(b)(ii)	An answer that includes the following points: • both axes labelled : log (living) {(number)cells / yeast} and time (1) • units for x axis : hours (1) • shape of curve drawn correctly (1) • all four phases labelled correctly (1)	ACCEPT ln / $\log_{10}$ ACCEPT minutes i.e. lag + {log / exp} + stationary + {death / decline} Log cells  Time / hrs	(4)

Question number	Answer	Additional guidance	Mark
7(b)(iii)	A description that includes the following points: • indication of where log values have come from (1) • during {log / exponential} phase (1) • determine t / subtract the two time values (1) • growth rate equation used to calculate the constant (1)	e.g $\log_{10}$ {concentration / number} read from a log graph calculated from actual numbers (from a graph) ACCEPT description e.g. at end of lag phase and beginning of stationary phase ACCEPT from a reasonable attempt at giving the formula ACCEPT from a reasonable attempt at giving the formula $k = \frac{\log N_t - \log N_0}{0 \cdot 301t}$	(4)

Question number	Answer	Additional guidance	Mark
8(a)			(2)

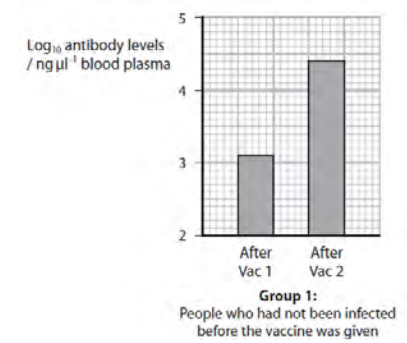
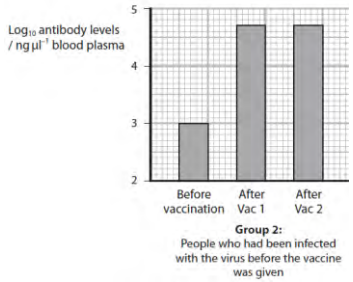
Statement	Type of artificial immunity			
	both active and passive	active only	passive only	neither active nor passive
Antigens are injected into the person	☐	☒	☐	☐
Immunity is long term	☐	☒	☐	☐

Question number	Answer	Additional guidance	Mark
8(b)	A description that includes two of the following points: • T (helper) cells release cytokines (to stimulate B cells) OR • T (helper) cells activate B cells (1) • B cells {differentiate into / specialise into} plasma cells (that produce antibodies) (1)	ACCEPT CD4 cells DO NOT ACCEPT cytokinins ACCEPT description e.g. causing B cells to divide IGNORE T killer cells activated DO NOT ACCEPT {make / produce / divide into / clonal expansion into} plasma cells	(2)

Question number	Answer	Additional guidance	Mark
8(c)(i)	An explanation that includes two of the following points: • both groups received same dose of vaccine so that there was the same number of antigens (1) • nobody should have a disorder of the immune system otherwise an immune response may be affected (as effectively) (1) • {levels of antibodies measured / vaccines given} at same time intervals as antibody levels change (with time) (1) • people in group 2 should all have had the infection at a similar time otherwise the antibody levels maybe different (1)	ACCEPT volume / concentration / mass affect the immune system to the same degree ACCEPT other reasons with the explanation : do not have {HIV / weakened immune system} appropriate named variable relating to people in group e.g. age, gender, obesity people are not taking {drugs / medication} people do not have an infection	(2)

Question number	Answer	Additional guidance	Mark
8(c)(ii)	• 1258.925412 and 25118.8643 (1) • 19.95 / 20 (x) (1) OR • (4.4 - 3.1 =) 1.3 (1) • 19.95 / 20 (x) (1)	Bald answer of 19.95 / 20 (x) = 2 marks Bald answer of 1.3 = 1 mark Bald answer of 23859.9389 rounded correctly = 1 mark Bald answer of 19.9526 = 1 mark	(2)

Question number	Answer	Additional guidance	Mark
8(c)(iii)	• there will not be any antibodies (in the blood plasma) if the person had not been previously infected / if they had not been infected the immune system would not have been stimulated (1)	ACCEPT no plasma cells that produce this antibody DO NOT ACCEPT antibodies to kill virus antibiotics	(1)

Question number	Answer
*8(c)(iv)	Indicative content: Group 1 Vac 1 • antibody levels increase following vac 1 because (primary) immune response initiated • credit details of primary immune response • resulting in plasma cells releasing antibodies Vac 2 • vac 2 contains antigens that were in vac 1 • stimulate secondary immune response • because memory cells present • therefore results in higher levels of antibody released • could be other antigens in vac 2 which stimulated production of other types of antibodies • so both stimulated a primary immune response Group 2 Before vaccination • antibodies present as person previous infected so primary immune response generated Vac 1 • vac 1 stimulated secondary immune response • memory cells formed from infection • so levels of antibodies produced were higher • could have been other antigens present in vac 1 • contributing to higher levels of antibody Vac 2 • vac 2 resulted in same levels of antibodies suggesting that antigens in vac 1 and vac 2 were the same • but the time lapse between vaccination and testing was long enough for antibody levels to decrease • vac 2 may have had different antigens to vac 1 but still stimulated secondary response  **Group 1:** People who had not been infected before the vaccine was given  **Group 2:** People who had been infected with the virus before the vaccine was given

			Additional guidance
Level 0	0	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information and with a focus on mainly just one piece of scientific information. The explanation will contain basic information, with some attempt made to link knowledge and understanding to the given context.	Simple explanation of data 1 mark = some description of the data in one graph 2 marks = some description of the data in both graphs
Level 2	3-4	An explanation will be given, with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows some linkages and lines of scientific reasoning, with some structure.	Some explanation given using the information given / own knowledge 3 marks = simple explanation of either primary or secondary immune response OR of either graph 1 or graph 2 4 marks = simple explanation of both primary and secondary immune response OR of both graph 1 and graph 2 OR detailed explanation of one aspect (only)
Level 3	5-6	An explanation is made that is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning, which is clear and logically structured.	Data logically explained with extended use of information provided 5 marks = detailed and accurate explanation of one graph and simple explanation of the other graph 6 marks = clear, detailed and accurate explanation of both graphs

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