



Mark Scheme (Results)

Summer 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	Additional guidance	Mark
1(a)	The only correct answer is A B is incorrect because dendrochronology counts tree growth rings C is incorrect because gel electrophoresis separates according to size D is incorrect because polymerase chain reaction amplifies DNA		(1)

Question number	Answer	Additional guidance	Mark
1(b)(i)	An answer that includes three, at least one of which is a difference and one a similarity, of the following points: Similarities: - all have β-carotene (1) - all have chlorophyll a (1) - all have one of the xanthophyll types (1) Differences: - brown seaweed has pigment P and Q that spinach (and red seaweed) does not have (1) - spinach has {three (types of) xanthophylls but both seaweeds have only one / two other (types of) xanthophylls / more types of xanthophyll} (1) - spinach had chlorophyll b which the seaweeds do not have / only spinach has chlorophyll b (1) - spinach has {more types / wider range} of pigments	DO NOT PIECE TOGETHER IGNORE bands plants explanations of function of pigments ACCEPT seaweed for seaweeds throughout unless contradicted ACCEPT all have xanthophyll ACCEPT only brown seaweed has pigments P and Q NB both have one of the xanthophyll types but spinach has two others = 2 marks spinach has chlorophyll a and b whereas the seaweed has only a = 2 marks	(3)

Question number	Answer	Additional guidance	Mark
1(b)(ii)	A description that includes the following points: • use the distance of pigment P and the {solvent (front) / leading edge} from the origin (1) • (calculate / use) Rf value (1) • look up name of pigment using Rf values for same solvent (1)	ACCEPT distance moved by pigment P and the {solvent (front) / leading edge} from a correct equation ACCEPT retention factor / retardation factor / relative (to) front ACCEPT run chromatogram with known pigments {using same solvent / in the same tank}	(3)

Question number	Answer	Additional guidance	Mark
1(c)(ii)	An explanation that includes the following points: - to maximise {light / (light) energy} absorption (1) - located separately to avoid competition for {(green / blue) light / space} (1)	ACCEPT brown seaweed has outcompeted red seaweed for {(green / blue) light / space} red/brown below green to avoid competition for {(blue) light / space} two types of red separate to avoid competition for green light	(2)

Question number	Answer	Mark
1(c)(i)	The only correct answer is C <i>A is incorrect because green seaweed reflects green light</i> <i>B is incorrect because green seaweed reflects green light</i> <i>D is incorrect because green seaweed can absorb red light</i>	(1)

Question number	Answer	Additional guidance	Mark
2(a)(i)	An explanation that includes the following points: - because we do not want {other bacteria in the culture / contamination of culture} (1) - as they could {give an over-estimate of the number of bacteria / compete for nutrients / produce toxins (to the bacteria being cultured) / as they could be pathogens} (1) OR - because we do not want to transfer the bacteria onto {ourselves / surroundings} (1) - as they may be {pathogenic / harmful} (1)	ACCEPT microorganisms / pathogens ACCEPT to ensure only the test bacteria are used competition for space ACCEPT prevent infection / contamination of person NB Prevent infection with pathogenic bacteria = 2 marks	(2)

Question number	Answer	Additional guidance	Mark
2(a)(ii)	An explanation that includes the following points: • technique described (1) • technique explained (1)	ACCEPT pathogens / microorganisms / spores e.g. working by a bunsen burner / safety hood + to create an updraft / to move the microorganisms in the air away / to prevent bacteria falling into culture IGNORE kill bacteria in the air autoclaving {agar / culture fluid / equipment} using sterile equipment disinfecting work area washing hands + to kill any bacteria present reducing exposure of cultures to air / keep lid on plates / close {doors / windows} + to reduce bacteria falling into cultures	(2)

Question number	Answer	Additional guidance	Mark
2(b)	3.2 (1) 3 / 2.7 / 2.66 / 2.658 (1)	ACCEPT $\log 5.2 - \log 2 = 3.2$ ECF 0.3 / 0.34 / 0.345 = 1 mark Bald answer of {3 / 2.7 / 2.66 / 2.658} = 2 marks Bald answer of 2.6578073089700996677 {incorrectly rounded up to three decimal places max / correctly rounded to more than three decimal places} = 1 mark Bald answer of 3.2 = 1 mark Bald answer of {0.3 / 0.34 / 0.345} = 1 mark	(2)

Question number	Answer	Additional guidance	Mark
2(c)(i)	63 / 63.1 (: 1) OR 0.02 / 0.016 (:1)		(1)

Question number	Answer	Additional guidance	Mark
2(c)(ii)	An answer that includes the following points: (student P) {cell counts (not using an exclusion dye) / optical methods / turbidity / absorption of light / colorimeter / counting chamber} as total cell counts (1) (student Q) {dilution plating / colony counting / counting chamber using an exclusion dye} as only living cells counted (1)	NB both mark points but the wrong way round for 1 mark ACCEPT haemocytometer / Neubauer chamber living and dead IGNORE calorimeter ACCEPT {haemocytometer / Neubauer chamber} using an exclusion dye named exclusion dye e.g. eosin / trypan blue	(2)

Question number	Answer	Additional guidance	Mark
3(a)	4.2×10^7 (1)		(1)

Question number	Answer	Mark
3(b)	The only correct answer is B <i>A is incorrect because antigenic means can stimulate an immune response</i> <i>C is incorrect because epigenetic means a change in gene expression</i> <i>D is incorrect because polygenic means many genes determining a characteristic</i>	(1)

Question number	Answer	Additional guidance	Mark
3(c)(i)	production of recycled {textiles / clothing} / using waste + that {decreases destruction of habitats / maintains biodiversity / does not harm the environment / reduces production of greenhouse gases / does not increase global warming} (1)		(1)

Question number	Answer
*3(c)(ii)	Positives: • reduces area of land used for cotton farming so {habitats won't be destroyed / biodiversity won't decrease} • fewer vehicles used in cotton production / harvesting / manufacturing decreasing greenhouse gases / reducing global warming • reduces the volume of water used in irrigation so there will be more water available for {humans / wildlife / natural plants} • reduces the mass of textiles being burnt so reduces {greenhouse effect / climate change / greenhouse gases released / toxins} • reduces the use of landfill sites so reduces {habitats destroyed / release of toxins / land for housing issues} • producing recycled clothes provides people with clothing in a more sustainable way • producing recycled clothes provides employment so increases {quality of life / country's economy} • fewer cattle reared for leather for clothing so less methane released • fewer cattle reared for leather for clothing so more land available for growing crops • could reduce the number of items made from crude oil {so decreasing the damage to habitats in mining it / carbon dioxide produced transporting it / conserving its use for other things} Negatives: • new industries need establishing so clothing could be {expensive / unavailable} • fossil fuels still burnt in {machinery used in production / vehicles used in transport} which will still release greenhouse gases • land will still be used in the recycling industries so this will {reduce habitats / decrease biodiversity / cause deforestation} • {waste products will still be produced / dyes will still need removing} which could be toxic

Simple discussion points in context of current methods or recycling: 1 mark = 1 point raised 2 marks = 2 points raised
Extended discussion points in the context of recycling: 3 marks = 2 points raised, plus one which is extended 4 marks = 2 points raised, both of which are extended 3 points raised, one of which is extended
Extended discussion points which illustrate that the sustainable textiles won't completely reduce the conflict: 5 marks = 3 points raised, two of which are extended 4 points raised, one of which is extended 6 marks = 3 points raised which includes discussion of the positive and negative sides of the argument

Question number	Answer	Mark
4(a)(i)	The only correct answer is C <i>A is incorrect because cellulose is made of beta glucose</i> <i>B is incorrect because cellulose is made of beta glucose and has 1 - 4 glycosidic bonds only</i> <i>D is incorrect because cellulose has 1 - 4 glycosidic bonds only</i>	(1)

Question number	Answer	Mark
4(a)(ii)	The only correct answer is A <i>B is incorrect because bacteria do not have nuclei</i> <i>C is incorrect because bacteria do not have nuclei</i> <i>D is incorrect because enzymes are released by exocytosis</i>	(1)

Question number	Answer	Additional guidance	Mark
4(b)(i)	because different leaves have different water content (1)	ACCEPT water content fluctuates no {energy / organic matter / nutritional content} in water biomass is the organic matter biomass does not include water	(1)

Question number	Answer	Additional guidance	Mark
4(b)(ii)	{62 / 63 / 64} and 8 (1) 0.60 / 0.61 / 0.62 (1)	Bald answer of 0.60 / 0.61 / 0.62 = 2 marks Bald answer of 0.6 / 0.611111 / 0.622222 = 1 mark	(2)

Question number	Answer	Additional guidance	Mark
4(b)(iii)	A description that includes two of the following points: - both decompose at the same (approximate) rate in the first {30 / 60} days (1) - decomposition levels off after 30 days in the white oak but continues to decrease in the sugar maple (1) - sugar maple leaves decompose faster (overall) (1)	ACCEPT converse for white oak leaves refs to {changes in dry mass / breakdown} for decomposition ACCEPT sugar maple leaves decompose more	(2)

Question number	Answer	Additional guidance	Mark
4(c)(i)	4 / 4.1 / 4.13 / 4.125 (times) (1)		(1)

Question number	Answer	Additional guidance	Mark
4(c)(ii)	An answer that includes the following points: • more bacteria present (on the maple leaves) to start with (1) • so numbers will increase faster (because binary fission) (1) OR • more {sugar / nutrients} (in sugar maple leaves) (1) • (more sugar) for faster {respiration / replication} (of bacteria) (1)	ACCEPT converse throughout for oak ACCEPT idea that sugars are more accessible IGNORE food ACCEPT growth	(2)

Question number	Answer	Additional guidance	Mark
4(c)(iii)	An answer that includes the following points: • {sugar / nutrient} was exhausted / leaves produce toxins (1) • the bacteria were dying (faster than reproducing) (1) OR • competition for {nutrients / space} between microorganisms (1) • bacteria were dying (faster than reproducing) (1) OR • bacteria are eaten (1) • by organisms living on the white oak leaves / predators (1) OR • the value at 90 days is an anomaly (1) • and therefore indicates a decrease that did not happen (1)	ACCEPT insufficient nutrients IGNORE food ACCEPT bacteria were in the {death / decline} phase IGNORE cannot reproduce ACCEPT microorganisms producing toxins ACCEPT bacteria were in the {death / decline} phase	(2)

Question number	Answer	Additional guidance	Mark
5(a)	An explanation that includes two of the following points: - by {mutations / change in (DNA) base sequence} (1) - because errors (in DNA) can occur during {DNA replication / mitosis} (1) - that {affect the functioning of the cell / result in uncontrolled cell division} (1)	ACCEPT carcinogens / named carcinogen / epigenetics / switching {on / off} genes / binding of (different) transcription factors to a gene / (mutation in) {tumour suppressor gene / proto-oncogene} ACCEPT rapid cell division / apoptosis inhibited	(2)

Question number	Answer	Mark
5(b)(i)	The only correct answer is C <i>A is incorrect because Ebola has RNA</i> <i>B is incorrect because Ebola has RNA</i> <i>D is incorrect because Ebola has RNA</i>	(1)

Question number	Answer	Additional guidance	Mark
5(b)(ii)	attachment to {host cells / (host) cell receptors / (host) cell antigens} (1)	ACCEPT attach to cells to infect them involved in evading the immune response	(1)

Question number	Answer	Additional guidance	Mark
5(b)(iii)	An explanation that includes two of the following points: - so that the {envelope proteins / virus} {binds to the cancer cells (only) / cannot bind to the normal cells} (1) - so that the virus {would be able to infect the (cancer) cells / cannot cause the sores (in nose and mouth)} (1)	NB accept converse for what would not happen ACCEPT targets for binds need complementary {receptors / proteins / antigens} to cancer cell {receptors / antigens} ACCEPT virus won't be pathogenic IGNORE cannot infect the person cannot cause symptoms	(2)

Question number	Answer	Additional guidance	Mark
5(b)(iv)	An explanation that includes the following points: - because {it / virus} will {burst / lyse / ruptures} the cancer cells (1) - when the newly-formed virus particles are formed / during the lytic cycle / when virus replicates (1) OR (virus infected cancer cell) will stimulate the immune system (1) - so that T killer cells can destroy the cancer cell (1)	DO NOT ACCEPT lysogenic cycle / latency / replication occurring whilst viral DNA is incorporated into cancer cell DNA ACCEPT CD8 cells / cytotoxic cells	(2)

Question number	Answer	Additional guidance	Mark
5(c)	An explanation that includes four of the following points: • {(virally-) infected / cancer} cells act as antigen-presenting cells (to T killer cells) (1) • T killer cells release {perforins / chemicals / enzymes} (1) • that will cause the {cancer / virus infected} cells to {burst / lyse} (1) • T helper cells produce cytokines to activate B cells (1) • because antibodies (to the cancer cells / virus) will be produced (by plasma cells) (1) • that will increase phagocytosis (of tumour cells by macrophages) (1)	ACCEPT T killer cells will be activated by {cancer antigens / viral antigens (on cancer cells)} stimulated / clonal selection / proliferation / produced {CD8 / cytotoxic} cells for T killer cells ACCEPT {CD8 / cytotoxic} cells IGNORE destroy ACCEPT CD4 cells for T helper cells ACCEPT resulting in opsonisation / agglutination IGNORE easier	(4)

Question number	Answer	Mark
6(a)	The only correct answer is A <i>B is incorrect because $(120 - 74) \div 120 = 0.383333333333$</i> <i>C is incorrect because $(120 - 74) \div 120 = 0.383333333333$</i> <i>D is incorrect because $(120 - 74) \div 120 = 0.383333333333$</i>	(1)

Question number	Answer	Mark
6(b)(i)	The only correct answer is C <i>A is incorrect because $3200 \div 6.25 = 512$</i> <i>B is incorrect because $3200 \div 6.25 = 512$</i> <i>D is incorrect because $3200 \div 6.25 = 512$</i>	(1)

Question number	Answer	Additional guidance	Mark
6(b)(ii)	A description that includes three of the following points: - all the heavy metals kill (some of) the bacteria at {high concentrations / concentrations of above $200 \mu\text{g cm}^{-3}$} (1) - none of the heavy metals kill bacteria at concentrations up to $100 \mu\text{g cm}^{-3}$ (1) - different minimum concentrations are needed to kill the bacteria (1) - Cr is least {toxic / effective} / Cu is most {toxic / effective} (1) - all <i>Vibrio</i> are killed at high concentration of Cu and Ni / chromium does not kill all the <i>Vibrio</i> at {high concentrations (tested) / at concentrations of $3200 \mu\text{g cm}^{-3}$} (1)	ACCEPT mark points in context of survival ACCEPT a minimum concentration of $100 \mu\text{g cm}^{-3}$ is needed below $100 \mu\text{g cm}^{-3}$ ACCEPT <i>Vibrio</i> is most {tolerant / resistant} to Cr / <i>Vibrio</i> is least {tolerant / resistant} to Cu IGNORE efficient ACCEPT no conclusion can be made about chromium above concentrations of $3200 \mu\text{g cm}^{-3}$	(3)

Question number	Answer	Additional guidance	Mark
6(c)(i)	An explanation that includes the following points: - because if mutation occurred that made the bacteria resistant (1) - the presence of the antibiotic would have acted as a selection pressure (1) - increase in the number of bacteria with the resistance allele (1) - and the resistant bacteria would {survive / replicate} OR the non-resistant bacteria would {decrease in number / die / not replicate} (1)	ACCEPT horizontal transmission of resistance plasmid DO NOT ACCEPT {selection pressure / antibiotic} caused the mutation ACCEPT a description of the term selection pressure ACCEPT increase in resistance allele frequency	(3)

Question number	Answer	Additional guidance	Mark
6(c)(ii)	An answer that includes the following points: the bactericidal antibiotic would {kill / destroy} the bacteria AND the bacteriostatic antibiotic would prevent {growth / division} (1)	ACCEPT pathogen / microorganism for bacteria DO NOT ACCEPT virus ACCEPT prevents {protein synthesis / DNA synthesis / metabolism} keeps bacteria in the stationary phase	(1)

Question number	Answer	Additional guidance	Mark
6(c)(iii)	An answer that includes the following points: • grow the bacteria without any antibiotics present and then add the antibiotics (1) + • colonies will be present on bacteriostatic and not bactericidal antibiotics (1) OR • add a dye to the agar plates (1) + • if the cells are stained then the antibiotic was bactericidal and if the cells are {not blue / colourless} then the antibiotic was bacteriostatic (1) OR • grow in liquid culture with the antibiotics then plate out the bacteria onto (plain) agar (1) + • colonies will be present on bacteriostatic and not bactericidal antibiotics (1) OR • grow in liquid culture and then count the number of bacteria in a counting chamber using an exclusion dye (1) + • if the cells are blue then the antibiotic was bactericidal and if the cells are {not blue / colourless} then the antibiotic was bacteriostatic (1) OR • add a known number of cells to a liquid culture containing antibiotics (leave and recount) (1) + • if cell number stays the same then the antibiotic is bacteriostatic and if the cell number decreases it is bactericidal (1)	ACCEPT colonies will show around filter paper disc if bacteriostatic but there would be a zone of inhibition if bactericidal ACCEPT fluorescent tag / indicator + appropriate description of what would be seen	(2)

Question number	Answer	Additional guidance	Mark
7(a)	A description that includes three of the following points: • by carbon fixation (1) • resulting in the formation of GP (1) • resulting in the formation of GALP / glucose / hexose (1) • which is used to make (polymer) organic molecules (1)	ACCEPT description e.g. carbon dioxide {binds to / reacts with} RuBP ACCEPT other alternative names for GP ACCEPT other alternative names for GALP and glucose ACCEPT named organic molecule e.g. cellulose	(3)

Question number	Answer	Additional guidance	Mark
7(b)(i)	An explanation that includes the following points: • increase in temperature speeds up RUBISCO / more carbon dioxide enters (leaf) <u>by diffusion</u> (1) • so {carbon fixation / light-independent reactions / Calvin cycle) faster (1)	ACCEPT converse / in context of denaturing RUBISCO and carbon fixation stopping ACCEPT description e.g. GP produced faster	(2)

Question number	Answer	Additional guidance	Mark
7(b)(ii)	An explanation that includes two of the following points: - increased rate of respiration (in plant roots) (1) - faster {active transport / uptake} of (mineral) ions (needed for photosynthesis) (1) - credit use of named ion in photosynthesis (1) OR - osmosis faster (into roots) (1) - therefore more water transported to leaves in xylem (1) - therefore more water for {photolysis / light-dependent reactions} (1) OR - increased membrane permeability (of plant roots) (1) - increased {osmosis / diffusion of (mineral) ions} (1) - therefore more water for {photolysis / light-dependent reactions / credit use of named ion in photosynthesis} (1)	ACCEPT converse for lower temperature IGNORE metabolism DO NOT ACCEPT photorespiration ACCEPT named mineral ion needed for photosynthesis e.g. magnesium ions, nitrates, sulfates, phosphates IGNORE diffusion, nutrients, easier ACCEPT more decomposition providing more mineral in soil	(2)

Question number	Answer	Additional guidance	Mark
7(c)	An explanation that includes the following points: • less water for photolysis (1) • less ATP and {reduced NADP / NADPH} (1) • limiting the rate of the {light-independent reactions / Calvin cycle} (1)	NB must be in context of what would happen with less water for 3 marks to be awarded	(3)

Question number	Answer	Additional guidance	Mark
7(d)	An explanation that includes four of the following points: • AM increase {biomass / nitrate availability} in high nitrate soil and decrease {biomass / nitrate availability} in low nitrate soil (1) • (decrease) due to {cell death / decomposition / respiration greater than photosynthesis} (1) • ECM is able to {provide more nitrate ions / make more nitrate available} (to plants) (1) • nitrates are used (by plants) in production of {amino acids / protein} (1) • {nitrates / named nitrogen-containing molecule} needed for plant {biomass production / growth} (1)	NB piece together ACCEPT description of how nitrates are made more available IGNORE ECM produces more nitrates ACCEPT DNA / enzymes / plant growth factors	(4)

Question number	Answer	Additional guidance	Mark
8(a)	An explanation that includes four of the following points: • (because a large spleen) can {store / release} {more / a lot of} {red blood cells / oxygen} (1) • oxygen {dissociates from the haemoglobin / diffuses out of the red blood cells} (1) • (delivering / providing) oxygen (to the cells) for aerobic respiration (1) • allowing the seals to stay {underwater / dive} longer (1) • credit an advantage of this (1)	DO NOT ACCEPT {store / release} of blood ACCEPT muscles can contract for longer e.g. prevent buildup of lactic acid seals can escape predators seals can find food	(4)

Question number	Answer	Mark
8(b)(i)	The only correct answer is B <i>A is incorrect because the mean is the sum of all values divided by the number of values</i> <i>C is incorrect because mode is the most common value</i> <i>D is incorrect because standard deviation is a measure of variance</i>	(1)

Question number	Answer	Additional guidance	Mark
8(b)(ii)	A description that includes two of the following points: • {median / middle} size of spleens of Saluan people is smaller (than the Bajau people) (1) • (some) Bajau people have larger spleens than any of the Saluan people (1) • there is a greater {range / spread / variation} in the sizes of spleens in the Bajau people than the Saluan people (1)	ACCEPT converse ACCEPT some Saluan have larger spleens than the Bajua	(2)

Question number	Answer
*8(c)	Aspect 1 : how spleens became enlarged • mutation may have occurred • in gene coding for {spleen size / ability to store more red blood cells} • spleen size maybe polygenic / multi-allelic • so wide range of spleen sizes • selection pressure for larger spleens • {increased chance of survival / more food / more oxygen in body} acted as a selection pressure Aspect 2 : advantages of large spleens • large spleens allowed the Bajau people to dive for longer • as more oxygen was supplied to their cells • when they were holding their breath • enabling them to spend more time hunting under water / not returning surface • and therefore catching more food • increasing their chances of survival Aspect 3 : how the allele frequency increased • natural selection • those who survived were more likely to reproduce • passing the alleles onto their offspring • offspring more likely to survive • repeated over many generations • increasing the frequency of the allele in the population Aspect 4 : interactions with divers and non-divers / lack of interactions with Saluan people • Bajau people did not reproduce with Saluan people • because the Bajau people lived in house boats / Saluan people lived on the main land • therefore the alleles not introduced into this population of people • or if it was it became diluted • diving and non-diving Bajau people reproduced together • therefore the allele for large spleens was present in both divers and non-divers

			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 comments / explanation 1 mark = simple explanation of one aspect 2 marks = simple explanation of two aspects
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 extended explanation 3 marks = extended explanation of one aspect 4 marks = at least two aspects covered which includes extended explanation of one of the aspects
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.	Extended explanation clearly linked to size of spleen 5 marks = extended explanation of two aspects 6 marks = coherent extended explanation of three aspects

