Mark Scheme (Results)

January 2020

Pearson Edexcel International Advanced Level In Biology (WBI14) Paper 01
Energy, Environment, Microbiology and Immunity

Question number	Answer	Additional guidance	Mark
1(a)	Box **A** gross primary productivity (1) Box **B** (plant) respiration (1)	**NB** Both correct for one mark **ACCEPT** GPP **ACCEPT** R energy lost by respiration **DO NOT ACCEPT** energy lost for respiration	**(1)**

Question number	Answer	Additional guidance	Mark
1(b)(i)	organisms interacting with each other **AND** with (physical / chemical) environment	**ACCEPT** species / plants **and** animals / biotic factors **IGNORE** habitat **ACCEPT** abiotic factors / non-living environment **e.g.** all organisms interacting with each other and the abiotic factors	**(1)**

Question number	Answer	Mark
1(b)(ii)	**D** kJ m^{-2} yr^{-1} The only correct answer is **D** ***A*** *is incorrect because it is kJ not kg and should be* m^{-2} ***B*** *is incorrect because it is kJ not kg and should be* yr^{-1} ***C*** *is incorrect because it should be* m^{-2}	**(1)**

Question number	Answer	Additional guidance	Mark
1(b)(iii)	A calculation that shows the following steps: • percentage of NPP contained in the roots (1) • units of NPP calculated (1) **OR** • units of NPP in leaves and wood calculated (1) • units of NPP in leaves and wood subtracted from 11 700 (1)	Example of calculation 27 3159 3978 and 4563 / 8541 3159 Correct answer with no working gains 2 marks **IGNORE** any units given	**(2)**

Question number	Answer	Additional guidance	Mark
2(a)(i)	An explanation that includes two of the following points: • microorganisms are (already) involved in the {carbon cycle / decomposition} (1) • because they {produce enzymes (for decomposition) / will be able to produce enzymes for break down of plastics} (1) • mutation occurs (that results in the breakdown plastics) (1)	**ACCEPT** microorganisms can (already) break down {polymers / organic molecules} **DO NOT ACCEPT** break down plastics	**(2)**

Question number	Answer	Additional guidance	Mark
2(a)(ii)	An explanation that includes the following points: • mutation occurs resulting in an enzyme that breaks down plastics (1) • (presence of) {plastics / lack of food} acts as a selection pressure (1) • these {genes / alleles } are passed onto next generation (by asexual reproduction / conjugation / plasmids) (1)	**NB** this mp can only be awarded if the allele / gene has been linked to breaking down plastics **IGNORE** mitosis	**(3)**

Question number	Answer	Mark
2(b)	**D** hydrolysis | hydrolysis The only correct answer is **D** ***A*** *is incorrect because molecules break down by hydrolysis and both reactions are breaking molecules down* ***B*** *is incorrect because molecules break down by hydrolysis and both reactions are breaking molecules down* ***C*** *is incorrect because molecules break down by hydrolysis and both reactions are breaking molecules down*	**(1)**

Question number	Answer	Mark
3(a)	**A** carbon dioxide and methane The only correct answer is **A** ***B*** *is incorrect because oxygen is not a greenhouse gas* ***C*** *is incorrect because oxygen is not a greenhouse gas* ***D*** *is incorrect because oxygen is not a greenhouse gas*	**(1)**

Question number	Answer	Mark
3(b)	**B** 1.1 The only correct answer is **B** ***A*** *is incorrect because the data should not be extrapolated from the peaks* ***C*** *is incorrect because the data should not be extrapolated from the troughs* ***D*** *is incorrect because the general trend is increasing not decreasing*	**(1)**

Question number	Answer	Mark
3(c)	**B** passes through / does not pass through The only correct answer is **B** ***A*** *is incorrect because infra-red is absorbed by greenhouse gases* ***C*** *is incorrect because ultraviolet light passes through and infra-red is absorbed by greenhouse gases* ***D*** *is incorrect because ultraviolet passes through greenhouse gases*	**(1)**

Question number	Answer	Mark
3(d)(i)	**A** dendrochronology The only correct answer is **A** ***B*** *is incorrect because entomology is the study of insects* ***C*** *is incorrect because epigenetics is the modification of DNA* ***D*** *is incorrect because proteomics is the study of proteins*	**(1)**

Question number	Answer	Additional guidance	Mark
3(d)(ii)	An explanation that includes three of the following points: • the tree rings (in1970) would be narrower because (mean) temperatures were cooler (1) • {enzymes / RUBISCO} would be working more slowly (1) • photosynthesis would be slower / less GALP produced (1) • therefore less {biomass / organic matter / xylem } would be produced (1)	**Accept the converse for 2010** **ACCEPT** smaller rings less carbon dioxide more water wider rings **ACCEPT** more xylem if more water stated in 1970 **IGNORE** growth	**(3)**

Question number	Answer	Additional guidance	Mark
4(a)(i)	A calculation showing the following steps: • 1% of 47 278 calculated (1) • 85.6% calculated and added to 47 278 (1) • answer expressed in standard form with between 2 and 5 sig figs (1)	Example of calculation 1% = 47 278 ÷ 14.4 = 3283.194 3283.194 × 85.6 + 47 278 = 328319.4 3.28×10^5 **NB** wrong value correctly expressed in standard form = 1 mark	**(3)**

Question number	Answer	Additional guidance	Mark
4(a)(ii)	An explanation that includes the following points: • biodiversity could decrease as species {become extinct / number decrease} due to {loss of habitat / decrease in food} **OR** biodiversity could decrease due to as decrease in genetic diversity within a species due to {loss of habitat / decrease in food} (1) • population could decrease as organisms (of one species) die because there is not enough {food / habitat / camouflage} (1)	**ACCEPT** territory decrease in species richness **IGNORE** migration **ACCEPT** territory starve if not enough food **IGNORE** migration Award 1 mark if biodiversity and population given the wrong way round or rolled in together	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)(i)	An explanation that includes the following points: • behavioural because the moths are drinking where the bees drink (1) • {anatomical / physical / structural / morphological} because the moths have the {transparent wings / fur} like the bees (1)	**ACCEPT** blue bands to blend in with the water **NB** two explained adaptations given but not linked to type = 1 mark one example given for each stated type of adaptation but no link to bees = 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)(ii)	An answer that includes two of the following points: • deter predators (as they resemble bees / bees sting) (1) • the bees may not attack the moths (1) • moths are hidden in amongst the bees whilst drinking (1)	**ACCEPT** less likely to be eaten as more (insects) present	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)(iii)	An answer that includes three of the following points: • amplify the DNA of both species using PCR (1) • use of (gel) electrophoresis (1) • credit details of gel electrophoresis (1) • compare the DNA **bands** of the two moths (1)	 e.g. agarose gel, apply a current, use of dye, use of restriction enzymes	 **(3)**

Question number	Answer	Additional guidance	Mark
5(a)(i)	An answer that includes the following points: • {(genetic) code / genetic material / genetic information / genes} for {(viral) proteins / amino acid sequence} (1) • credit a named example from the diagram (1)	 **IGNORE** references to transcription, DNA and RNA synthesis e.g. RNA polymerase, VP 40 **ACCEPT** glycoproteins / protein coat / capsid 'carry the genetic code for the proteins shown in the diagram' = 2 marks	 **(2)**

Question number	Answer	Additional guidance	Mark
5(a)(ii)	An answer that includes two of the following points: • attach to the host cell (1) • by binding to (specific) receptors (1) • avoid host's immune sytem (1)	**ACCEPT** {liver / endothelial / immune} cells **ACCEPT** molecules / antigens / glycoproteins / TIM-1 ' bind to receptors on host cell' = 2 marks	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)	An explanation that includes the following points: • to make (viral) RNA / transcription (of viral RNA) (1) • because the host cell does not have this enzyme (1)	**ACCEPT** mRNA **DO NOT ACCEPT** to make DNA / protein	**(2)**

Question number	Answer	Additional guidance	Mark
5(c)	An answer that includes the following points: • (assembling) {**RNA** / (viral) **genome**} and **proteins** (1) • to make a (new) virus particle (1) • credit example given from diagram (1)	**IGNORE** envelope e.g. VP 40 incorporated into the capsid, RNA enclosed in the capsid	**(2)**

Question number	Answer	Additional guidance	Mark
5(d)	An explanation that includes the following points: • interferon is involved in the non-specific response (against viruses) (1) • therefore (if no interferons are produced) the host cells will not be protected from infection with Ebola (1)	**NB ACCEPT** converse where appropriate **ACCEPT** inhibits viral replication named examples e.g. stimulates production of protein kinase, reduced protein synthesis, stimulates destruction of RNA, stimulates host cell (self) destruction, increases MHC I antigens on host cells, increases recognition of host cells by T killer cells **DO NOT ACCEPT** {specific / immune response} **ACCEPT** virus can {spread / infect other cells} **DO NOT ACCEPT** virus being killed or dying throughout **IGNORE** interferons prevent binding of virus to host cells throughout	**(2)**

Question number	Answer	Additional guidance	Mark
6(a)	An explanation that includes three of the following points: • niche is the role that an organism plays (in its habitat) (1) • the two types of barnacles are found on different parts of the rock • credit a stated reason (1) • which reduces competition (between the two species) (1)	**ACCEPT** a description pieced together e.g. food sources / temperature tolerances / dessication rates / rock types	**(3)**

Question number	Answer	Additional guidance	Mark
6(b)(i)	An answer that includes four of the following points: • reliable because the mean is calculated (1) • more larvae settled on rock with barnacles, then bare rock, then stones (1) • error bars (between rock with barnacles and either of the other two surfaces) do not overlap so this is reliable (1) • data for bare rock and stones is less reliable as the error bars are touching (1) • the most reliable data is for rock with barnacle as the error bars are relatively smaller than the other sets of data (1)	**ACCEPT** standard deviation / range bars for error bars throughout significant / reproducible and repeatable for reliable throughout **ACCEPT** most larvae on the rock with barnacles **and** the least on the stones **PIECE TOGETHER** **ACCEPT** error bars (just) overlap	**(4)**

Question number	Answer	Additional guidance	Mark
6(b)(ii)	An answer that includes four of the following points: • all three surfaces set up in (same) {container / water} (1) • all surfaces should have the same (surface) area (1) • stated number (min 100) of larvae added to the tank (1) • leave for a period of time (for larvae to settle) (1) • calculate number of larvae per unit area / experiment repeated (minimum 3 times) and the mean and standard deviation calculated (1)	**ACCEPT** min 50 larvae added to each tank if first mp not awarded **ACCEPT** when all larvae have settled in vivo expts described could be awarded mp 2 and 5	**(4)**

Question number	Answer	Mark
7(a)(i)	<table><tr><td>green</td><td>brown</td><td>red</td></tr></table> The only correct answer is **A** ***B*** *is incorrect because C. officinalis has a lot of carotenoids* ***C*** *is incorrect because U.fasciata has a lot of chlorophylls a and b* ***D*** *is incorrect because U.fasciata has a lot of chlorophylls a and b and C. officinalis has a lot of carotenoids*	**(1)**

Question number	Answer	Additional guidance	Mark
7(a)(ii)	An explanation that includes the following points: • to **absorb** light so that the electrons will be {excited / released from photosystems} (1) • so that reduced NADP and ATP can be synthesised (1)	**ACCEPT** NADPH / photophosphorylation	**(2)**

Question number	Answer	Additional guidance	Mark
7(b)(i)	An answer that includes three of the following points: • GALP converted into {hexose / glucose / sugar} (1) • amino acids made from {hexose / glucose / sugar} and nitrates (1) • amino acids joined by {peptide bonds / condensation reactions} (1) • glucose respired to produce ATP for protein synthesis (1)	**IGNORE** other nitrogenous compounds	**(3)**

Question number	Answer	Additional guidance	Mark
*7(b)(ii)	Indicative content: **Healthy** • source of protein – for growth and repair • source of carbohydrate – source of energy • low lipid - reducing risk of heart disease • antioxidants present - reducing risk of heart disease • presence of lipid - risk factor for heart disease **Environmentally-friendly** • sustainable • grows naturally - no need to destroy other habitats / seashore habitats destroyed • photosynthesise - remove carbon dioxide from the atmosphere • do not produce methane like cattle do – less greenhouse gas • vehicles needed to harvest seaweed - produce carbon dioxide **Economic** • seaweed can be grown in situ – no costs planting • do not need fertilisers – no costs buying fertilisers • no buildings needed • no heat needed Level 1 : 1 or 2 relevant points made from at least one aspect Level 2 : 3 or 4 relevant points made from at least two aspects Level 3 : 5 or 6 relevant points from all three aspects which include 1 or 2 justifications		**(6)**

Question number	Answer	Mark
8(a)	**C** The only correct answer is **C** ***A*** *is incorrect because macrophages present antigen to T helper cells* ***B*** *is incorrect because macrophages present antigen to T helper cells and host-infected cells present antigen to T killer cells* ***D*** *is incorrect because host-infected cells present antigen to T killer cells*	**(1)**

Question number	Answer	Mark
8(b)(i)	The only correct answer is **B** Human immunodeficiency virus ***A*** *is incorrect because Ebola infects endothelial cells and liver cells* ***C*** *is incorrect because λ phage infects bacteria* ***D*** *is incorrect because TMV infects plants*	**(1)**

Question number	Answer	Additional guidance	Mark
8(b)(ii)	An explanation that includes the following points: • T cells need to {express CAR gene / produce CAR receptor} (1) • in order to bind to the {tumour (cells) / tumour antigen / specific (tumour) antigen} (1)	**ACCEPT** cancer	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(iii)	An explanation that includes the following points: • to produce genetically-identical cells (1) • that will all have the {the CAR gene / CAR receptor} (1) • to increase the number of cells so that there are enough {for the treatment / to destroy the cancer cells} (1)	 **ACCEPT** clones **ACCEPT** fast treatment	 **(3)**

Question number	Answer	Additional guidance	Mark
8(b)(iv)	An explanation that includes the following points: • so that the patient will not have an immune response against the T cells (1) • because there will not be any foreign **antigens** on the T cells (1) • therefore the T cells will not be destroyed (1) • to reduce the risk of transmitting pathogens / no need to take immunosuppressants / no need to find a donor (1)	 **ACCEPT** lower chance of rejection **ACCEPT** will have same / self **antigens** **ACCEPT** description e.g engulfed, digested	 **(3)**

Question number	Answer	Additional guidance	Mark
8(b)(v)	An answer that includes two of the following points: • {CAR-T cell / CAR receptor} does not bind to {solid / other types of} tumour (1) • {solid / other types of} tumours {do not have the specific **antigen** / have different **antigens**} (1) • T cells are not able to reach the cancer cells / too many cancerous cells for the treatment to work (1)	**ACCEPT** {CAR-T cell / CAR receptor} **only** bind to blood cell cancers **ACCEPT only** blood cell tumours have the specific **antigen** **ACCEPT** reason why T cells cannot reach the cancer cells e.g T cells cannot leave the blood stream, solid tumours produce T cell inhibitors, no chemicals released to attract the T cells to the solid tumour	**(2)**

Question number	Answer	Additional guidance	Mark
9(a)	• the larger the {microorganisms / cells} the greater the optical density (1)	**ACCEPT** converse **ACCEPT** positive correlation	**(1)**

Question number	Answer	Additional guidance	Mark
9(b)	A calculation that shows the following steps: values read from the graph (1) bacteria number divided by yeast number (1)	 0.5×10^{6} and 12.5×10^{6} 25	**(2)**

Question number	Answer	Additional guidance	Mark
9(c)(i)	• as the concentration (of bacteria) increases, the optical density increases and then levels off (between 15 and 16 $\times 10^6$ cells per cm^3) (1)		**(1)**

Question number	Answer	Additional guidance	Mark
9(c)(ii)	An answer that includes two of the following points: • with more cells present there is **more** reflection of light from the cells (1) • some light being reflected away from the detector (1) • some light being reflected towards the detector (1)	**ACCEPT** scattered / hitting converse **ACCEPT** bacteria block the light so that it does not reach the detector **'** at higher concentration the optical density levels off **'** = 1 mark if no other marks awarded	**(2)**

Question number	Answer	Additional guidance	Mark
9(d)	A calculation that shows the following steps: • numbers substituted into equation (1) • equation rearranged (1) • time given in hours (to a maximum of 3 decimal places) (1)	Example of calculation $0.963 = (7.079 - 3.778) \div 0.301t$ $0.963 \times 0.301\ t = 3.301$ $0.289863\ t = 3.301$ CE if log of logs taken $0.963 \times 0.301t = 11994000$ 11 / 11.4 / 11.39 / 11.388 (hours) CE if log of logs taken 41378168 hours **ACCEPT** 11 hours = 660 minutes 11.4 hours = 684 minutes 11.39 hours = 683.4 minutes 11.388 hours = 683.28 minutes	**(3)**

Question number	Answer	Additional guidance	Mark
***9(e)**	Indicative content: • some organisms are larger than others • light more likely to hit a larger organism and be reflected • therefore optical density will be higher • photometers are designed differently • light may have further to travel through the organisms • so is more likely to be reflected back • decreasing optical density • concentration of organisms affects the optical density • so different calibration curves may be necessary for higher concentrations • the light absorbance is specific to the organism • and therefore will affect the absorbance value Level 1 : 1 mark = 1 comment 2 marks = 2 comments Level 2 : 3 marks = 3 comments that includes 1 description / explanation 4 marks = 4 comments that includes 1 description / explanation Level 3 : 5 marks = 5 comments that includes 2 description / explanation 6 marks = 6 comments that includes 2 description / explanation		**(6)**

Mark Scheme (Results)

October 2020

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In Biology (WBI14)
Paper 01: Energy, Environment, Microbiology and Immunity

Question number	Answer	Mark
1(a)	**C** thylakoid membranes | stroma The only correct answer is **C**. ***A*** *is incorrect because the light-dependent reactions take place in the thylakoid membranes* ***B*** *is incorrect because the light-dependent reactions take place in the thylakoid membranes and the light-independent reactions take place in the stroma* ***D*** *is incorrect because the light-independent reactions take place in the stroma*	**(1)**

Question number	Answer	Additional guidance	Mark
1(b)	An answer that includes three of the following points: • DNA (loop) drawn and labelled (1) • starch grain drawn and labelled (1) • {envelope / inner membrane / outer membrane} drawn and labelled (1) • grana / grana stack / granum / (inter granal) lamellae (1) • ribosomes drawn and labelled (1)	**IGNORE** lipid droplets, stroma, thylakoid membranes **ACCEPT** plasmid / plasmid-like DNA **ACCEPT** starch granules **ACCEPT** / double membrane **IGNORE** size references	**(3)**

Question number	Answer	Mark
1(c)	The only correct answer is **B**. ***A*** *is incorrect because green wavelengths are reflected* ***C*** *is incorrect because green wavelengths are reflected* ***D*** *is incorrect because green wavelengths are reflected*	**(1)**

Question number	Answer	Additional guidance	Mark
1(d)	• rate of photosynthesis at different wavelengths of light		**(1)**

Question number	Answer	Mark
1(e)(i)	The only correct answer is **A** ***B*** *is incorrect because dendrochronology is the study of tree growth rings* ***C*** *is incorrect because osmosis is the movement of free water molecules from a high solute potential to a lower solute potential* ***D*** *is incorrect because PCR amplifies the number of DNA molecules*	**(1)**

Question number	Answer	Mark
1(e)(ii)	The only correct answer is **B**. ***A*** *is incorrect because the Rf value of* ***J*** *is distance moved by* ***J*** *divided by distance moved by solvent front = 6 ÷ 7.5 = 0.800* ***C*** *is incorrect because the Rf value of* ***J*** *is distance moved by* ***J*** *divided by distance moved by solvent front = 6 ÷ 7.5 = 0.800* ***D*** *is incorrect because the Rf value of* ***J*** *is distance moved by* ***J*** *divided by distance moved by solvent front = 6 ÷ 7.5 = 0.800*	**(1)**

Question number	Answer	Additional guidance	Mark
2(a)	• using a {thermometer / (temperature) probe} to take the temperature of the {liver / rectum}	**ACCEPT** into the core / deep into the body / up the anus **IGNORE** other parts of body	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)(i)	• drop in body temperature in first 12 hours calculated and subtracted from 11.5°C (1) • this value divided by 0.4, added to 12 hours and answer rounded to nearest hour (1)	11.5 - (0.78 × 12) / 11.5 – 9.36 / 2.14 17 (hours) 17.35 = 1 mark Correct answer with no working gains 2 marks	**(2)**

Question number	Answer	Additional guidance	Mark
2(b)(ii)	An explanation that includes the following points: • (this) estimate would be {shorter / an under-estimate} (1) • because a body loses <u>heat</u> faster (in cooler conditions) (1)	**ACCEPT** converse	**(2)**

Question number	Answer	Additional guidance	Mark
2(c)	An explanation that includes three of the following points: • because temperature affects {rigor / body stiffness} (1) • because deciding when a body is stiff or not stiff is subjective (1) • because if the body is stiff, the time since death can only be estimated as being between 3 and 36 hours (1) • because if the body is not stiff, there is no way of telling if it has been dead for less than 3 hours or more than 36 hours (1)	**ACCEPT** exercise / body shape / body fat / ATP levels **ACCEPT** gives a wide range of (time) values **ACCEPT** if not stiff cannot tell how many hours after 36 hours time of death was	**(3)**

Question number	Answer	Additional guidance	Mark
3(a)(i)	2772	**IGNORE** any other units given	**(1)**

Question number	Answer	Additional guidance	Mark
3(a)(ii)	An explanation that includes four of the following points: • light is absorbed by {photosystems / chlorophyll} (1) • which {excites electrons / releases high-energy electrons / releases electrons to higher energy levels} (1) • these electrons are passed along a series of (electron) carriers (1) • therefore releasing <u>energy</u> to phosphorylate ADP into ATP (cyclic)(1) • phosphorylation of ADP via the proton gradient to form ATP (non-cyclic) (1)	**ACCEPT** description e.g. hydrogen ions pass through ATP synthase releasing energy for phosphorylation of ADP **NB** reference to ATP being synthesised from ADP only needed once to award both 4th and 5th marking point	**(4)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	• two from: C - H, C - O and C - C	**IGNORE** O - H **ACCEPT** bond between carbon and hydrogen bond between carbon and oxygen bond between carbon and carbon	**(1)**

Question number	Answer	Mark
3(b)(ii)	The only correct answer is **C**. ***A*** *is incorrect because there is no cytoplasm inside chloroplasts* ***B*** *is incorrect because the matrix is not found in chloroplasts* ***D*** *is incorrect because glucose is synthesized in the stroma of chloroplasts*	**(1)**

Question number	Answer	Mark
3(c)(i)	<table><tr><td>carbon and nitrogen</td><td>condensation</td></tr></table> The only correct answer is **A**. ***B*** *is incorrect because bonds form by condensation reactions not hydrolysis* ***C*** *is incorrect because the peptide bond joins the C of one amino acid to the N of the other* ***D*** *is incorrect because the peptide bond joins the C of one amino acid to the N of the other and bonds form by condensation reactions not hydrolysis*	**(1)**

Question number	Answer	Additional guidance	Mark
3(c)(ii)	An explanation that includes two of the following points: • because amino acids contain nitrogen (1) • because some {amino acids / R groups} contain sulfur (1) • nitrogen obtained from nitrates / sulfur obtained from sulfates (1)	**ACCEPT** glucose does not contain nitrogen **IGNORE** nitrates **ACCEPT** glucose does not contain sulfur **IGNORE** sulfates **ACCEPT** nitrates / sulfates needed	**(2)**

Question number	Answer	Additional guidance	Mark
4(a)(i)	• swollen / enlarged (hands)	**ACCEPT** oedema **IGNORE** other symptoms	**(1)**

Question number	Answer	Additional guidance	Mark
4(a)(ii)	Any **two** from: pain / hurts / tender / aches redness / red warmth / heat / increased temperature / hot	**IGNORE** swelling **IGNORE** immobility / itching **IGNORE** fever	**(1)**

Question number	Answer	Additional guidance	Mark
4(b)(i)	An explanation that includes two of the following points: • because when the virus replicates the {DNA / gene} will be transcribed (1) • and when the RNA is translated the {protein / TNF} will be synthesized (1) • TNF incorporated into capsid when virus is assembled (1)	**ACCEPT** RNA / mRNA will be made **ACCEPT** description **ACCEPT** when new particles are made **NB** The {gene / DNA} is transcribed and translated = 1 mark if no other mark awarded	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)(ii)	An explanation that includes two of the following points: • antibody {binds to / neutralises / agglutinates} TNF (1) • therefore will prevent the TNF from binding to the cells (1) • and therefore inflammatory responses will not be triggered (1)	**DO NOT ACCEPT** antibody binds to cells / antibody destroys TNF **IGNORE** opsonisation **DO NOT ACCEPT** antibody binds to receptors (on the cells) **ACCEPT** inflammation will {not occur / be reduced}	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)(iii)	An explanation that includes four of the following points: • because (as a result of the TNF antibodies binding to TNF) phagocytosis (by macrophages) will {not happen / be reduced} (1) • therefore {fewer bacteria will be destroyed / bacteria will increase in number} (if less phagocytosis) (1) • credit details of what will not take place if <u>macrophages</u> are impaired (1) • therefore tubercles (more likely to) form (1) • credit example of how TB can cause death (1)	e.g. antigen presentation / activation of T helper cells / humoral immune response e.g. destruction of lung tissue / organ failure / opportunistic infection / pneumonia / HIV / lung damage	**(4)**

Question number	Answer	Mark
5(a)	The only correct answer is **C** lambda phage (λ phage) ***A*** *is incorrect because Ebola virus infects humans* ***B*** *is incorrect because the HIV infects humans* ***D*** *is incorrect because TMV infects plants*	**(1)**

Question number	Answer	Additional guidance	Mark
5(b)(i)	A description that includes two of the following points: • provide a {polar / hydrophilic} channel (1) • so that lysins can pass through the {non-polar / hydrophobic} {membrane / phospholipids / fatty acid tails} (out of cell) (1) • down their concentration gradient (1)	**IGNORE** direction of movement with respect to the cell	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)(ii)	An explanation that includes three of the following points: • primary structure is the sequence of amino acids that will determine the (tertiary) structure of {holin / protein} (1) • as this will determine the {bonds / position of bonds} (1) • (amino acids with) polar R groups will face into the channel (1) • (amino acids with) non-polar R groups will face outwards to the {fatty acids / phospholipids / membrane} (1)	**PIECE TOGETHER** **DO NOT ACCEPT** bases **ACCEPT** correctly named bond	**(3)**

Question number	Answer	Additional guidance	Mark
5(b)(iii)	An explanation that includes the following points: • lysins break bonds between the {peptidoglycan / murein} molecules (1) • therefore the virus particles {leave the bacterial cells / get (out) through the cell wall} (once formed) (1)	**ACCEPT** are enzymes that breakdown {peptidoglycan / murein} **ACCEPT** causing {bacterial cells to burst / pores in the cell wall}	**(2)**

Question number	Answer	Additional guidance	Mark
6(a)	22.5 (cm^3)	**ACCEPT** 23.3 / 23.6 **IGNORE** any other units given	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(i)	An answer that includes the following points: • give squirrel access to all three types of nut (1) • a range of sizes used (1) • determine the {number / order} that the nuts are eaten (by the squirrel) (1)	. **ACCEPT** record which size they prefer / comparing measurements made before and after	**(3)**

Question number	Answer	Additional guidance	Mark
6(b)(ii)	An answer that includes the following points: • a reason based on size (1) • a reason based on shell (1) • a reason based on energy content (1)	e.g. more hazelnuts eaten (in the investigation) because they are smaller walnuts are too big to fit in the pouch e.g hazelnuts are easier to eat than walnuts because they have a hard covering and not a hard shell walnuts have a hard shell but squirrels have sharp teeth e.g. walnuts provide a lot of energy so squirrels get enough energy for hibernation more acorns have to be eaten as they store less energy **NB** if a comparison is made between the nuts using the three sets of information, award 1 mark if no other marks awarded	**(3)**

Question number	Answer	Additional guidance	Mark
6(c)	An answer that includes three of the following points: • variation is size of pouches / polygenic (1) • squirrels with larger pouches could {gather / store} more food (1) • squirrels with (largest) pouches survived and reproduced (1) • increasing (large) food pouch allele frequency (1)	**ACCEPT** mutation in {DNA / gene} resulting in pouches **ACCEPT** squirrels with pouches can store food (compared to those without pouches) **ACCEPT** passed the (large) food pouch alleles onto their offspring **DO NOT ACCEPT** gene for allele	**(3)**

Question number	Answer	Mark
7(a)(i)	The only correct answer is **B**. ***A*** *is incorrect because nuclei, Golgi apparatus and mitochondria are organelles surrounded by membrane* ***C*** *is incorrect because nuclei, Golgi apparatus and mitochondria are organelles surrounded by membrane* ***D****is incorrect because nuclei, Golgi apparatus and mitochondria are organelles surrounded by membrane*	**(1)**

Question number	Answer	Additional guidance	Mark
7(a)(ii)	An explanation that includes the following points: • it is not a plant because it has glycogen granules (1) • it is not an animal because it has a cell wall (1) • it is not a bacterium because it has {nuclei / Golgi apparatus / mitochondria / membrane-bound organelles} (1)	**ACCEPT** does not have cellulose cell wall **IGNORE** chloroplast / vacuole **IGNORE** flagellum / pili / capsule / ER **DO NOT ACCEPT** ribosomes / cytoplasm / glycogen granules / cell membrane / cell wall unless qualified as {chitin / not peptidoglycan}	**(3)**

Question number	Answer	Additional guidance	Mark
7(b)	An explanation that includes four of the following points: • there is a correlation between the number of prescriptions and the percentage of resistant *E.coli* (1) • the use of aminopenicillin acts as a selection pressure (1) • therefore the resistant bacteria reproduce and the non-resistant bacteria die (1) • percentage of resistant *E. coli* falls when prescriptions fall because non-resistant *E. coli* are not destroyed (1) • credit a comment about competition between resistant and non-resistant bacteria (1)	**ACCEPT** pattern / trend **IGNORE** directly proportional **ACCEPT** therefore the resistant bacteria {are **more** likely to reproduce / reproduce **more**} **ACCEPT** as the prescriptions go up the number of resistant bacteria go up **and** when the prescriptions go down the number of bacteria go down for 1 mark if no other marks awarded	**(4)**

Question number	Answer	Additional guidance	Mark
7(c)	An explanation that includes three of the following points: • because the codes of practice (regarding the prescription of antibiotics) are being ignored (1) • use of antibiotics is a selection pressure (1) • therefore the number of antibiotic resistant bacteria is increasing (1) • our (current) antibiotics may become useless and people will {remain ill / die} (1)	**ACCEPT** (medical) advice **ACCEPT** reference to evolutionary race in an appropriate context natural bacterial flora destroyed by antibiotics	**(3)**

Question number	Answer	Mark
8(a)(i)	The only correct answer is **D** blood type O ***A*** *is incorrect because A antigens are not present on red blood cells of humans with blood group B or O* ***B*** *is incorrect because B antigens are not present on red blood cells of humans with blood group A or O* ***C*** *is incorrect because A antigens are not present on red blood cells of humans with blood group B or O and B antigens are not present on red blood cells of humans with blood group A or O*	**(1)**

Question number	Answer	Additional guidance	Mark
8(a)(ii)	An explanation that includes four of the following points: • B antigens are recognised as foreign antigens (1) • and therefore initiate an (humoral) immune response (1) • credit details of humoral immune response (1) • resulting in antibodies released by plasma cells (1) • credit consequence of humoral immune response (1)	e.g. opsonisation / agglutination / destruction of RBCs (in liver / spleen / by phagocytes / formation of memory cells	**(4)**

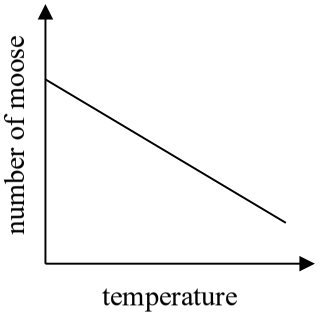
Question number	Answer	Additional guidance	Mark
8(b)(i)	An explanation that includes two of the following points: • they {reduce / destroy / prevent the growth of / prevent the infection of} pathogenic bacteria (1) • because they compete for {nutrients / named nutrient / space} (1) • produce {toxins / chemicals} (that destroy pathogenic bacteria) (1)	**ACCEPT {**foreign / other} bacteria / pathogens **IGNORE** food **ACCEPT** produce vitamin K	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(ii)	An answer that includes the following points: • (because the bacteria can) {absorb / use} sugar for respiration (1) • to produce ATP (for the bacteria) (1)	**ACCEPT** glucose for sugar throughout **ACCEPT** {it / they} to mean bacteria	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(iii)	An explanation that includes two of the following points: • there will be no (foreign) antigens on the red blood cells (1) • the immune response will not be triggered (1) • therefore this blood can be used in any transfusion (if no antigens present) (1)	**ACCEPT** antigens removed from the red blood cells red blood cells will not be recognised as {foreign / non-self} **ACCEPT** can be used in a transfusion as will not be rejected blood will act like {group O blood / universal donor}	**(2)**

Question number	Answer	Additional guidance	Mark
9(a)(i)	• extrapolation / line of best fit / calculation of mean decrease (per year)		**(1)**

Question number	Answer	Additional guidance	Mark
9(a)(ii)	• values read from the graph and subtracted • percentage drop calculated	7.6 - 3.4 / 4.2 4.2 × 100 ÷ 7.6 = 55 / 55.3 / 55.26 (%)	**(2)**

Question number	Answer	Additional guidance	Mark
9(a)(iii)	An answer that includes the following points: • temperature on the x axis (1) • number of moose on the y axis (1) • {relatively / stepped} straight line sloping down from top left to bottom right (1)	**ACCEPT** rainfall / days of drought **ACCEPT** axes labelled the other way for 1 mark **NB** Check direction of slope if axes wrongly labelled for a CE  **ALLOW** a correct graph of temperature against year for 1 mark **ALLOW** a double y axis graph correctly labelled + line for three marks	**(3)**

Question number	Answer	Additional guidance	Mark
9(b)(i)	• total number of moose added up and total number of moose with 50 000 or more ticks calculated • percentage calculated to max 2 dps	214 and 41 41 × 100 ÷ 214 = 19 / 19.16 / 19.2 CE applies if only one of the two numbers is incorrect	**(2)**

Question number	Answer	Additional guidance	Mark
*9(b)(ii)	Indicative content: **Comment on global warming (S1)** • global warming will increase the temperature of the earth's {surface / atmosphere} • winters will get warmer so less snow • winters will get shorter so snow present for fewer days **Effect of change on ticks (S2)** • warmer conditions decrease life cycle time • fewer ticks will die in the snow in early spring • more females to lay eggs • larvae less likely to be covered in snow in autumn • so more larvae become nymphs **Effect of ticks on moose (S3)** • more ticks mean larger volumes of blood removed from each moose • moose become weaker if less blood in them • moose die from lack of {nutrients / oxygen / anaemia / energy} (R) • less energy for hunting so they starve (R) • less energy for reproduction (R) • if moose lose their fur they will not be able to keep warm • moose die from the cold (R) • scratching can cause open wounds that can get infected • ticks pass on pathogens • moose die from infections (R)	**Level 1 :** 1 mark = description made from one section 2 marks = descriptions made from at least two sections but no links **Level 2 :** 3 marks = a link made between descriptions of two sections 4 marks = at least two links made between descriptions of all three sections **Level 3 :** 5 marks = links made between all sections with one reason (R) for moose number declining 6 marks = links made between all sections with two reasons (2R) for moose number declining **(6)**	

Mark Scheme (Results)

January 2021

Pearson Edexcel International Advanced Level In Biology (WBI14)
Paper 01 Energy, Environment, Microbiology and Immunity

Question number	Answer	Additional guidance	Mark
1(a)(i)	An answer that includes two of the following points: • pain / hurts / tender / aches / throbbing / dolor • redness / red / rubor • warmth / heat / hot / increased temperature / calor • loss of function	All 3 correct = 2 marks 1 or 2 correct = 1 mark **IGNORE** itching **IGNORE** rash **IGNORE** fever	**(2)**

Question number	Answer	Additional guidance	Mark
1(a)(ii)	An answer that includes two of the following points: • pain alerts the person that there is an injury (1) • warmth speeds up {chemical reactions / skin cell division / phagocytosis / increases rate of enzyme activity (of person) / defence mechanisms} (1) • swelling results in more {blood / white blood cells / platelets / phagocytes / antibodies/ tissue fluid} (to the wound) (1) • redness results in more {blood / white blood cells / platelets / phagocytes / antibodies} (to the wound) (1)	**NB CE from (i)** **ACCEPT** to avoid {contact with area / using the injured part} **ACCEPT** reduce activity of bacterial enzymes / reduce growth of bacteria * two different ideas must be given to award 2 marks	**(2)**

Question number	Answer	Additional guidance	Mark
1(b)(i)	An answer that includes the similarity and two of the three differences: Similarities: • (overall) both treatments decrease inflammation (1) Differences: • curcumin is more effective than drug A (throughout) (1) • maximum decrease for drug A is less than that for curcumin (1) • credit a comparison at specific days (1)	**DO NOT PIECE TOGETHER** but accept in adjacent sentences **ACCEPT** converse where appropriate turmeric for curcumin **IGNORE** references to rate e.g. inflammation increases {2 / 4} days after operation with drug A but increases after day 3 with curcumin extract (1)	**(3)**

Question number	Answer	Additional guidance	Mark
1(b)(ii)	The correct answer is C 33.3 (g) ***A*** *is incorrect because 0.03g contains 0.009g curcumin* ***B*** *is incorrect because 3.33g contains 0.1g of curcumin* ***D*** *is incorrect because 33.3 recurring has been rounded incorrectly*		**(1)**

Question number	Answer	Additional guidance	Mark
2(a)	An explanation that includes two of the following points: • antibiotics used to treat impetigo and whooping cough because they are caused by bacteria (1) • antibiotics not always used to treat middle ear infections or sinus infections as they {can be caused by viruses / as they are not always caused by bacteria} (1) • antibiotics not used to treat multiple sclerosis or rheumatoid arthritis as they are not caused by bacteria (1)	**NB Do not accept if clear confusion with antibodies** **ACCEPT** because some of the bacteria are resistant to antibiotics **IGNORE** any ref to cause **ACCEPT** antibiotics used for bacterial infections if no other marks awarded	**(2)**

Question number	Answer	Mark
2(b)	The only correct answer is **B**. ***A*** *is incorrect because bactericidal antibiotics decrease the number of bacteria* ***C*** *is incorrect because antibiotics do not increase the number of bacteria* ***D*** *is incorrect because antibiotics do not increase the number of bacteria*	**(1)**

Question number	Answer	Additional guidance	Mark
2(c)(i)	An explanation that includes the following points: • to compete with (pathogenic) bacteria for {nutrients / named nutrient / space} (1) • so they {reduce / destroy / prevent the growth of} (pathogenic) bacteria (1)	**IGNORE** food **ACCEPT** produce {toxins / chemicals} **ACCEPT** so that they do not increase in number and cause disease	**(2)**

Question number	Answer	Additional guidance	Mark
2(c)(ii)	An explanation that includes the following points: • (because gut flora contain) bacteria (1) • and antibiotics are not (generally) specific to one type of bacteria (1)	**ACCEPT** antibiotics {can affect different types of bacteria / can be broad spectrum}	**(2)**

Question number	Answer	Additional guidance	Mark
2(c)(iii)	• accept a value between 9×10^6 and 1.2×10^7		**(1)**

Question number	Answer	Additional guidance	Mark
2(c)(iv)	An answer that includes the following points: • antibiotic P kills all but three types (1) • antibiotic Q only kills two types (1) • antibiotic R has no effect (on gut flora / types A and B) (1)	**ACCEPT** descriptions in terms of resistance and susceptibility but not immunity throughout **ACCEPT** correct references to bactericidal and bacteriostatic **ACCEPT** kills 4 types / kills type A but has limited effect on type B **ACCEPT** results in the presence of a new type / reduces the number of type A and type B	**(3)**

Question number	Answer	Additional guidance	Mark
3(a)	A description that includes four of the following points: • vaccine contains an {inactive / attenuated} form of the {pathogen / virus / bacteria / microorganism} (1) • macrophages engulf and display antigen on cell surface (1) • macrophages will present the antigen to T helper cells (1) • T helper cells will activate {B / T killer} cells (1) • (T / B) memory cells produced (1)	**ACCEPT** antigen (found on the pathogen) / weakened pathogen **DO NOT ACCEPT** dead {virus / antigen} **ACCEPT** macrophages become antigen-presenting cells + description to T helper cells **ACCEPT** description e.g. T helper cells release cytokines that cause B cell proliferation	**(4)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	A description that includes the following points: • conclusion relating trust in scientists to income (1) • conclusion relating trust in scientists to vaccine safety (1) • conclusion relating income to vaccine safety (1)	e.g. trust goes down (slightly) with increase in income e.g. people who agree that vaccines are safe trust the scientists the most e.g. at all incomes, there are people who agree, neither agree nor disagree and disagree that vaccines are safe	**(3)**

Question number	Answer	Additional guidance	Mark
3(b)(ii)	education / (influence of) {media / family / friends / internet} / religious beliefs	previous experiences with {vaccines / medications} ethical beliefs fear of needles lack of trust in testing process allergies side effects more money for {treatment / healthcare} medical insurance	**(1)**

Question number	Answer	Additional guidance	Mark
3(c)	An answer that includes two of the following points: • vaccinated people will {not / be less likely to} develop the disease / vaccinated people will be immune (1) • fewer infected people to infect people who are not immune (1) • protect people who cannot become immune (1)	**IGNORE** less likely to be infected **ACCEPT** herd immunity e.g. allergic to vaccines, immunodeficient, immunosuppressed	**(2)**

Question number	Answer	Mark
4(a)(i)	The only correct answer is **B**. ***A*** *is incorrect because oxygen is not a greenhouse gas* ***C*** *is incorrect because oxygen is not a greenhouse gas* ***D*** *is incorrect because oxygen is not a greenhouse gas*	**(1)**

Question number	Answer	Additional guidance	Mark
4(a)(ii)	An answer that includes the following points: • (anthropogenic) caused by the effects of humans (1) • (climate change) changes to (mean) {temperature / rain fall} (1)	**IGNORE** named activities **ACCEPT** long-term (mean) change in weather patterns **IGNORE** weather unqualified / global warming / results of global warming / climate	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)	An explanation that includes the following points: • species distributed more towards the North (1) • this distribution related to a described change in climate (1) • the effect of this change explained (1)	 **ACCEPT** move away from the equator (northwards) / move towards the (North) pole **IGNORE** upwards e.g. because the temperatures have become too hot, move to a cooler area, areas have become drier, areas have become wetter, drought e.g. so the enzymes do not work effectively enough (to sustain that species), their prey have migrated (North), they would become dehydrated, plants they feed on die, lack of food	**(3)**

Question number	Answer	Additional guidance	Mark
4(c)(i)	A description that includes the following points: • temperature (that a beetle was kept at) affects males more than females (1) • the optimum temperature (for keeping both beetles) is 35°C (1)	 **ACCEPT** temperatures higher than 35°C causes a greater decrease in offspring in males than females **ACCEPT** males at 35°C and females at 38°C / optimum is between 35°C and 38°C	**(2)**

Question number	Answer	Additional guidance	Mark
4(c)(ii)	An explanation that includes three of the following points: • there are fewer (successful) fertilisations by males / (successful) fertilisations are not (as) affected in females (1) • the sperm are damaged by higher temperatures / egg cells are not (so) affected by higher temperature (1) • higher temperatures decrease sperm {viability / motility} (1) • (higher) temperatures could affect {the acrosome reaction / sperm enzymes / male enzymes} / (higher) temperatures do not (really) affect {egg cell / female} enzymes (1)	**ACCEPT** offspring for fertilisation **ACCEPT** higher temperatures make the egg cell easier to penetrate **ACCEPT** enzymes of females have a higher optimum temperature than the enzymes of {sperm / males} **NB** If no other marks awarded, credit a correct description of the effect of temperature on enzyme activity	**(3)**

Question number	Answer	Additional guidance	Mark
5(a)(i)	An explanation that includes three of the following points: • because ATP is the source of energy for {plants / all living organisms} (1) • because light energy cannot be used (directly) (1) • ATP is needed in the {light-independent reactions/ Calvin cycle} to convert GP into GALP (1)	**ACCEPT** ATP is the {usable source of energy / energy currency}	**(2)**

Question number	Answer	Additional guidance	Mark
5(a)(ii)	An answer that includes the following points: • (ADP / adenosine diphosphate) and (inorganic) {Pi / phosphate / PO_4^{3-} (ion)} (1) • hydrolysis (1)	**ACCEPT** adp **DO NOT ACCEPT** P / phosphorus **ACCEPT** dephosphorylation	**(2)**

Question number	Answer	Additional guidance	Mark
5(a)(iii)	An explanation that includes three of the following points: • to {release / excite} electrons (from chlorophyll) (1) • so that electrons can be used in {chemiosmosis / (photo)phosphorylation} (1) • photolysis to {replace electrons lost by chlorophyll / provide protons for formation of reduced NADP (1) • to produce ATP and reduced NADP for the {light-independent reactions / Calvin Cycle} (1)		**(3)**

Question number	Answer	Mark
5(b)(i)	The only correct answer is **D**. ***A*** *is incorrect because ATP is not available to light-dependent reactions in cyclic photophosphorylation* ***B*** *is incorrect because ATP is not available to light-dependent reactions in cyclic photophosphorylation* ***C*** *is incorrect because oxidised NADP is not produced*	**(1)**

Question number	Answer	Additional guidance	Mark
5(b)(ii)	An answer that includes the following points: • C and O from carbon dioxide (1) • H from water (1)	**ACCEPT** CO_2 **ACCEPT** H_2O **DO NOT ACCEPT** O from water	**(2)**

Question number	Answer	Mark
5(b)(iii)		**(3)**

New biological molecule	Nitrates	Phosphates	Both nitrates and phosphates	Neither phosphates nor nitrates
protein	**X**			
RNA			**X**	
triglyceride				**X**

Question number	Answer	Additional guidance	Mark
6(a)(i)	An explanation that includes the following points: • mutation (in the DNA) causing allele for resistance to the new chemical (1) • (new) chemical acts as a selection pressure (1) • resistant flies survive and pass this {(new) gene / allele} onto their offspring (1)	**ACCEPT** forming a (new) gene for resistance **DO NOT ACCEPT** immune for resistant selection pressure causes mutation **DO NOT ACCEPT** immune for resistant	**(3)**

Question number	Answer	Additional guidance	Mark
6(a)(ii)	flies have a short life cycle / high mutation rate in flies / flies produce many offspring / chemical is a strong selection pressure	**DO NOT ACCEPT** selection pressure causes mutation	**(1)**

Question number	Answer	Additional guidance	Mark
*6(b)	Indicative content: **Graph:** • black stripes reduce number of biting flies on body and legs (D) • 128 down to 111 / by 17 / by 13% (D) • this may not be significant as error bars overlap (D) • black and white stripes reduce number of biting flies on body and legs (D) • 128 down to {57/58} / by {70/71} / by 55% (D) • probably significant as error bars do not overlap (D) • black and white stripes reduce the number of biting flies on body and legs more than just black stripes (C) • 111 down to {57/58} / by {53/54} / by {48/49}% (C) • probably significant as error bars do not overlap between the two groups of painted cattle (C) • error bar for black stripes is 17% and 17% for black and white stripes (C) **Table 1:** • black stripes reduce number of biting flies on legs but not on body (D) • 1309 down to 1030 / by 279 / by 21% (D) • black and white stripes reduce number of biting flies on body and legs (D) (body) 662 down to 231 / by 431 / by 65% (D) (legs) 1309 down to 710 / by 599 / by 46% (D) • black and white stripes reduce the number of biting flies on body and legs more than just black stripes (C) • (body) 677 down to 231 / by 446 / by 66% (C) • (legs) 1030 down to 710 / by 320 / by 31% (C) **Table 2:** • black stripes have no effect on {flicking tail / stamping feet / twitching} (D) • black and white stripes have very little effect on {flicking tail / stamping feet} (D) • black and white stripes have small increase on skin twitching (D) • 5 up to 8 / by 3 / by 60% (D)		

	Level 1 1 mark : description of data from one source 2 marks : description of data from two sources **Level 2** 3 marks : comparison made between black stripes only and black and white stripes, from one source of data 4 marks : two comparisons made between black stripes only and black and white stripes, from two sources of data **Level 3** 5 marks : two comparisons made between black stripes only and black and white stripes, from two sources of data **+** level 2 maths calculation OR a comparison of the error bars between black stripes only and black and white stripes 6 marks : two comparisons made between black stripes only and black and white stripes, from two sources of data **+** level 2 maths calculation AND a comparison of the error bars between black stripes only and black and white stripes		**(6)**

Question number	Answer	Mark
7(a)(i)	The only correct answer is **C**. ***A*** *is incorrect because DNA polymerase is used to synthesis DNA* ***B*** *is incorrect because integrase inserts DNA into other DNA* ***D*** *is incorrect because reverse transcriptase synthesises DNA using a RNA template*	**(1)**

Question number	Answer	Additional guidance	Mark
7(a)(ii)	An explanation that includes three the following points: • because restriction enzymes recognise specific (base) sequences (1) • because these recognition sites are not equally spaced along the DNA (1) • the enzyme hydrolyses the phosphodiester bonds (1) • therefore different sized fragments move different distances through the gel (1)	**IGNORE** incorrectly named enzyme from part (i) **ACCEPT** different enzymes cut at different sites **ACCEPT** different cutting sites will result in different length fragments **ACCEPT** breaks **ACCEPT** different speeds	**(3)**

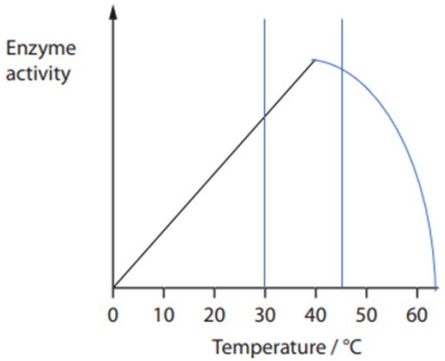
Question number	Answer	Additional guidance	Mark
7(b)(i)	• 0.2 (1) • 794 / 871 / 873 / 1000 (1)		**(2)**

Question number	Answer	Additional guidance	Mark
7(b)(ii)	indication of spot positioned between the origin and the 10 000 spot	**DO NOT ACCEPT** if clearly overlapping **CE** from 7(b)(i) i.e. if answer in 7(b)(i) is greater than 0.25, the spot would be below the 10 000 spot	**(1)**

Question number	Answer	Additional guidance	Mark
7(c)	{more molecules / more bonds / smaller spaces / fewer spaces} so higher {resistance / friction}	**ACCEPT** harder to move for higher resistance	**(1)**

Question number	Answer	Additional guidance	Mark
7(d)(i)	An answer that includes two of the following points: • bacterial {genome / chromosome} / (bacterial) nucleoid (1) • plasmid (1) • in mitochondria / mitochondrial DNA / mtDNA (1) • in chloroplasts / chloroplast DNA / cpDNA (1)	**IGNORE** loops of DNA in bacteria **IGNORE** mitochondria / chloroplasts unqualified **ACCEPT** cccDNA (formed by some viruses inside cell nuclei) viral DNA inserted into cell {ecc / extrachromosomal circular} DNA **DO NOT ACCEPT** ribosomes / in cytoplasm / in viruses	**(2)**

Question number	Answer	Additional guidance	Mark
7(d)(ii)	An answer that includes two of the following points: • linear DNA has (3' and 5') ends but circular DNA does not (1) • linear DNA is associated with (more) {proteins / histones} than circular DNA (1) • linear DNA will have (unbound) {phosphate / deoxyribose} but circular DNA will not (1) • linear DNA will have (one) fewer phosphodiester bond than circular DNA (with the same number of mononucleotides) (1)	**ACCEPT** converse **ACCEPT** circular DNA is supercoiled but linear DNA is not **ACCEPT** converse	**(2)**

Question number	Answer	Additional guidance	Mark
8(a)(i)	An answer that includes the following points: • linear line that increases with temperature and then decreases (1) • optimum temperature shown at (about) 40 °C (1)	**ACCEPT** carefully hand-drawn line sloping up to optimum **NB** line does not have to start at the origin **NB** optimum must be above 30°C and below 45°C  	**(2)**

Question number	Answer	Additional guidance	Mark
8(a)(ii)	• values at 30 °C and 40 °C chosen (1)	50 and 32.5 and 50 and 22.5	
	• rate calculated per minute for each (1)	(50-32.5) ÷ 5 / 17.5 ÷ 5 / 3.5 and (50-22.5) ÷ 5 / 27.5 ÷ 5 / 5.5 CE from reasonable values read from graph	
	• numbers substituted into equation (1)	5.5 ÷ 3.5 / 1.5714 CE if added 10 to a correct rate from mp 2	
	• correct answer to 2 / 3 sig figs with no units (1)	1.6 / 1.57 **ACCEPT** correctly rounded value for mp 3	
	OR	**OR**	
	• values at 40 °C and 50 °C chosen	50 and 22.5 and 50 and 47.5	
	• rate calculated per minute for each (1)	(50-22.5) ÷ 5 / 27.5 ÷ 5 / 5.5 and (50-47.5) ÷ 2.5 / 2.5 ÷ 5 / 0.5 CE from reasonable values read from graph	
	• numbers substituted into equation (1)	0.5 ÷5.5 / 0.090909 CE if added 10 to a correct rate from mp 2	
	• correct answer to 2 / 3 sig figs with no units (1)	0.091 / 0.0909 **ACCEPT** correctly rounded value for mp 3	**(4)**

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>8(b)(i)</td><td>• mass of monosaccharides calculated to be 1361.3 / correct ratios expressed with more than one dp (1)

• ratios shown correctly as either (all) whole numbers or both disaccharide and tetrasaccharide values correctly rounded to one dp (1)</td><td>NB check working out in space and first table for values
eg 164.012, 6.868, 1, 1.145

disaccharide 6.9 and tetrasaccharide 1.1

<table><tr><th>Type of carbohydrate</th><th>Ratio</th></tr><tr><td>monosaccharide</td><td>164</td></tr><tr><td>disaccharide</td><td>7</td></tr><tr><td>trisaccharide</td><td>1</td></tr><tr><td>tetrasaccharide</td><td>1</td></tr></table></td><td>(2)</td></tr>
</table>

Question number	Answer	Mark
8(b)(ii)	The only correct answer is **D**. ***A*** *is incorrect because inositol and raffinose have the modal concentration* ***B*** *is incorrect because inositol and raffinose have the modal concentration* ***C*** *is incorrect because inositol and raffinose have the modal concentration*	**(1)**

Question number	Answer	Additional guidance	Mark
*8(b)(iii)	**General description** • bacteria and fungi are decomposers • decomposers release enzymes for decomposition • digested molecules are absorbed into the decomposer • release carbon dioxide **Details of decomposition of carbohydrates** • carbohydrases are needed to breakdown carbohydrates • hydrolysis of glycosidic bonds • to form monosaccharides • monosaccharides taken up by diffusion • glucose used in respiration • carbon dioxide produced by respiration of glucose **Specific detail relating to carbohydrates in the table** • one glycosidic bond broken in disaccharides, two in trisaccharides, three in tetrasaccharides	**IGNORE** references to starch and amylase	

	• using one / two / three water molecules • e.g. sucrose broken down into glucose and fructose • monosaccharides do not need breaking down **Level 1 : general description of decomposition** 1 mark : one point made 2 marks : three points made **Level 2 : details about decomposition of carbohydrates** 3 marks : two points made 4 marks : three points made **Level 3 : specific details relating to carbohydrates in the table + mention of respiration releasing carbon dioxide** 5 marks : specific detail given for either di / tri / tetra saccharides 6 marks : specific detail given for two of the three types of saccharides		**(6)**

Mark Scheme (Provisional)

Summer 2021

Pearson Edexcel International Advanced Level In Biology (WBI14) Paper 01 Energy, Environment, Microbiology and Immunity

Question number	Answer	Mark
1(a)(i)	The only correct answer is **D**. **A** *is incorrect because cutting grass is biotic and competition is biotic* ***B*** *is incorrect because cutting grass is a biotic factor* ***C*** *is incorrect because cutting grass is biotic*	**(1)**

Question number	Answer	Mark
1(a)(ii)	The only correct answer is **C**. ***A*** *is incorrect because 0.7 × 100 ÷ 0.3 = 233.3* ***B*** *is incorrect because 0.7 × 100 ÷ 0.3 = 233.3* ***D*** *is incorrect because 0.7 × 100 ÷ 0.3 = 233.3*	**(1)**

Question number	Answer	Additional guidance	Mark
1(a)(iii)	An answer that includes two of the following points: • in the cut field the grass is faster growing reducing the light available to other plants (1) • in the cut field the grass is faster growing and absorbing {water / mineral ions / named mineral ion} (1) • bushes are slower growing so have not got time to grow before they are cut back (1) • bushes damaged during the cutting process (1)	**ACCEPT** bushes become established and shade the grass **ACCEPT** bushes become established and take up the {mineral ions / water}	**(2)**

Question number	Answer	Mark
1(b)(i)	The only correct answer is **D**. ***A*** *is incorrect because* ***P*** *is not the middle value and this is not a bar chart* ***B*** *is incorrect because* ***P*** *is not the middle value* ***C*** *is incorrect because this is not a bar chart*	**(1)**

Question number	Answer	Additional guidance	Mark
1(b)(ii)	• 2		(1)

Question number	Answer	Additional guidance	Mark
1(b)(iii)	1 : 2.049	**ACCEPT** 1 : 2.05 / 1 : 2 **DO NOT ACCEPT** 1 : 2.1	(1)

Question number	Answer	Additional guidance	Mark
1(b)(iv)	• class 2 mosses have (about) twice the genome size of class 1 mosses		(1)

Question number	Answer	Additional guidance	Mark
2(a)	An answer that includes three of the following points, with at least **one** similarity and **one** difference : **Similarities** • both have (circular) DNA (1) • both have ribosomes (1) • both have double membranes **Differences** • chloroplasts have stroma and mitochondria have a matrix (1) • chloroplasts have {thylakoids / thylakoid membranes / grana / intergranal lamellae} and mitochondria have {a folded inner membrane / cristae} (1) • chloroplasts have starch grains and mitochondria do not (1)	**DO NOT PIECE TOGETHER** **ACCEPT** both have an envelope	**(3)**

Question number	Answer	Additional guidance	Mark
2(b)(i)	An answer that includes the following points: • (**D**) chlorophyll / light-absorbing pigments / photosystems / PSI / PSII (1) • (**E**) electron carriers / electron transport proteins / cytochromes (1) • (**F**) {ADP / adenosine diphosphate} and (**G**) {phosphate (ions) / Pi / PO_4^{2-}} and (**H**) ATP / adenosine triphosphate (1)	**ACCEPT** named pigments **ACCEPT F** & **G** the other way around **DO NOT ACCEPT** P or incorrect formula for phosphate ions	**(3)**

Question number	Answer	Additional guidance	Mark
2(b)(ii)	• reduced NADP / NADPH	**ACCEPT** {r / red} for reduced reduced NADPH **DO NOT ACCEPT** NADP /reduced NAD/ NADH / reduced NADH	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)(iii)	A description that includes two of the following points: • to split water (1) • electrons replace those lost by {photosystems / PSI / PSII / chlorophyll} (1) • {hydrogen ions / H^+ / protons} involved in formation of NADPH (1)		**(2)**

Question number	Answer	Additional guidance	Mark
3(a)(i)	An answer that includes the following points: • a place where organisms live (1) • (African) Plains is the place and the organisms are the {lions / giraffes / (acacia) trees} (1)	**NB** the African Plains is where {lions / giraffe / (acacia) trees} live = 2 marks	**(2)**

Question number	Answer	Additional guidance	Mark
3(a)(ii)	An answer that includes the following points: • organisms of **one** species found in a particular area (1) • {(one from) lions / giraffe / (acacia) trees} found on the (African) Plains (1)	**ACCEPT** type for species	**(2)**

Question number	Answer	Additional guidance	Mark
3(a)(iii)	An answer that includes the following points: • a group of organisms of **different** species interacting in a particular area (1) • lions, giraffes and (acacia) trees on the (African) plains (1)	**ACCEPT** {dependent / rely} on each other for interacting **ACCEPT** two of the named organisms	**(2)**

Question number	Answer	Additional guidance	Mark
3(a)(iv)	An answer that includes two of the following points: • the role of an organism in its habitat (1) **One of the following** • (acacia) trees provide food for giraffes (1) • (acacia) trees provide shade for the lions (1) • giraffes provide food for lions (1) • giraffes keeping the {size / number} of (acacia) tree under control (1) • lions keep the number of giraffes under control (1) • {lions / giraffes} are a source of mineral ions for the (acacia) trees (1)		**(2)**

Question number	Answer	Additional guidance	Mark
3(b)	8.42 / 8.4 / 8 (%)		**(1)**

Question number	Answer	Additional guidance	Mark
4(a)	An explanation that includes the following points: • allopatric speciation (1) • (allopatric) because lemurs have the same common ancestor isolated from those in Africa (1) • sympatric speciation (1) • (sympatric) because Sifakas and Indri live together but have a different diet (1)	**ACCEPT** geographic speciation **ACCEPT** description of how diet is different	**(4)**

Question number	Answer	Additional guidance	Mark
4(b)(i)	An explanation that includes two of the following points: • because only small quantities of DNA can be collected (1) • therefore need to {amplify / increase the number of copies of} DNA (1) • so that there is enough to {run on gel electrophoresis / analyse} (1)	**ACCEPT** collecting a sample is difficult	**(2)**

Question number	Answer	Additional guidance	Mark
4(b)(ii)	An explanation that includes two of the following points: • gel electrophoresis run on DNA from both groups of lemurs (1) • pattern of bands were similar showing the lemurs were genetically similar (1) • base sequencing would show similar sequences (1)	**ACCEPT** use of bioinformatics to show that the base sequences were similar	**(2)**

Question number	Answer	Mark
5(a)	The only correct answer is **C**. ***A*** *is incorrect because dendrochronology is dating trees using tree rings* ***B*** *is incorrect because epigenetics studies changes in gene expression* ***D*** *is incorrect because species diversity is a measure of the number of different species in an area*	**(1)**

Question number	Answer	Additional guidance	Mark
5(b)(i)	• 0.12 (1) • mm hr^{-1} (1)	**NB** If different units have been used, award a correct numerical value e.g. 0.012 cm hr^{-1} = 2 marks	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)(ii)	An answer that includes three of the following points: • suitable as a mean is calculated (1) • but there is no indication of sample size so may not be that suitable (1) • data looks more suitable in the first 45 hours as the error bars are small (1) • may not be suitable as the incubation temperature may be different to body temperature (1) • will not be suitable if person died more than 120 hours ago (1)	**ACCEPT** {reliable / accurate} as an alternative for suitable throughout **ACCEPT** overall the error bars are (quite) small **parts** of the graph where the error bars do not overlap are suitable / converse **ACCEPT** body temperature does not remain constant	**(3)**

Question number	Answer	Additional guidance	Mark
5(b)(iii)	A description that includes three of the following points: • (start the investigation with) several blowfly eggs (1) • measure the length of larvae (at intervals) over a period of 120 hours (1) • credit a named control variable appropriate to this data collection (1) • calculate mean **and** {standard deviation / range bars / error bars} (1)	**e.g.** same food supply, species of blowfly **IGNORE** inappropriate named control variables eg pH	**(3)**

Question number	Answer	Additional guidance	Mark
5(c)	An answer that includes four of the following points: **THREE FROM:** • body temperature is readily available information (1) • {calibration curves / formulae} available to work backwards to estimate time of death (1) • but the change in body temperature is due to several factors (1) • credit example of one of these factors (1) **AND** • therefore of limited use unless used in conjunction with other methods (1)	**ACCEPT** calculations can be made to estimate time of death **e.g.** ambient temperature **ACCEPT** on its own	**(4)**

Question number	Answer	Mark
6(a)		(4)

Structure	Carbohydrate found in			
	both plants and animals	plants but **not** animals	animals but **not** plants	neither plants nor animals
Amylose	☐	**X**	☐	☐
Glucose	**X**	☐	☐	☐
Glycogen	☐	☐	**X**	☐
Starch	☐	**X**	☐	☐

Question number	Answer	Additional guidance	Mark
6(b)(i)	• diffusion of carbon dioxide / carbon dioxide dissolving	**ACCEPT** CO_2 **DO NOT ACCEPT** CO / Co / C	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(ii)	• 6.1×10^{13} / 61 000 000 000 000 (kg)	**ACCEPT** 61 trillion / 61 million million	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(iii)	A description that includes three of the following points: • as carbon dioxide from respiration (1) **AND ANY TWO FROM:** • by plants (1) • by microorganisms that decompose (dead) plants (1) • by {animals that eat the plants / herbivores} (1)	**DO NOT ACCEPT** CO / Co / C	**(3)**

Question number	Answer	Additional guidance	Mark
6(c)(i)	An answer that includes the following points: • (anthropogenic) caused by the effect of humans (1) • (climate change) changes to (mean) {temperature / rainfall} (1)	**IGNORE** named activities **ACCEPT** long-term (mean) change in weather patterns **IGNORE** weather unqualified / global warming / results of global warming / climate	**(2)**

Question number	Answer	Additional guidance	Mark
6(c)(ii)	An explanation that includes the following points: • named example of method to reduce the burning of fossil fuels (1) • because this will reduce the carbon dioxide released into the atmosphere (1) **OR** • reforestation (1) • because more plants will absorb more carbon dioxide for photosynthesis (1) **OR** • reduce the number of cattle being farmed (1) • as this will reduce the methane being released into the atmosphere (1)	**e.g.** lift sharing, public transport, use of solar power **ACCEPT** reduce the extent of rice farming	**(2)**

Question number	Answer	Mark
7(a)(i)	The only correct answer is **D**. ***A*** *is incorrect because pH is a log scale so the difference of 2 is 100 fold* ***B*** *is incorrect because pH is a log scale so the difference of 2 is 100 fold* ***C*** *is incorrect because there are fewer hydrogen ions at pH 8.5 than pH 6.5*	**(1)**

Question number	Answer	Additional guidance	Mark
7(a)(ii)	650 (%)		**(1)**

Question number	Answer	Additional guidance	Mark
*7(a)(iii)	Indicative content: • soil depth increases with distance from the sea (D) • because these are older sand dunes (E) • so more time for humus to build up (E) • organic material increases with distance from the sea (D) • because these are older sand dunes • so more decomposition adds organic material to the sand (E) • due to activity of microorganisms (E) • pH falls with distance from the sea (D) • because more humus is added to the sand (E) • more rain (over the years) washes out minerals (E) • percentage of bare rock decreases with distance from sea (D) • because pioneer species break it down (E) • because as more soil is produced, it covers the bare rock (E) • number of different species of plant increase with distance from sea (D) • because the soil {is becoming more fertile / salinity is decreasing} (E) • organic material holds more moisture than sand alone (E) • types of plant change with distance from sea (D) • as soil becomes more favourable for more plant species (E) • more plants improve soil conditions further (E)	Level 1 : 1 mark = 1 description of {data / succession} 2 marks = 3 descriptions {of data / succession} OR 1 description of data + an explanation Level 2 : 3 marks = 2 descriptions of the data and an explanation of both 4 marks = 3 descriptions of the data and all three explained Level 3 : 5 marks = 4 descriptions of the data and all 4 explained 6 marks = 5 descriptions of the data and all five explained	**(6)**

Question number	Answer	Additional guidance	Mark
7(b)(i)	A description that includes the following points: • NPP above ground is always greater than the NPP below the ground (1) • the NPP above and below the ground depends on the type of sand dune (1) • fixed sand dunes have the highest (total) NPP / shifting sand dunes have the lowest (total) NPP (1) • shifting sand dune has the largest {percentage difference / ratio} between NPP above the ground and NPP below the ground (1)		**(3)**

Question number	Answer	Additional guidance	Mark
7(b)(ii)	An explanation that includes four of the following points: • because {light-independent reactions / Calvin cycle} produce {GALP / glucose / hexose} (1) • {GALP / glucose / hexose}} used to produce sucrose (1) • {GALP / glucose / hexose}} used to produce amino acids (1) • (sucrose / amino acids) transported in the phloem to the {roots / rhizomes} (1) • {glucose / sucrose / amino acids} used to synthesise {organic material / biomass / named organic molecule / NPP} (1)	**DO NOT ACCEPT** glucose transported	**(4)**

Question number	Answer	Additional guidance	Mark
8(a)(i)	An explanation that includes the following points: • (combination of antibiotics given) because different bacteria are resistant to different antibiotics (1) • (given for several months) to expose bacteria to high enough doses for long enough (1)	**ACCEPT** to ensure all bacteria destroyed	**(2)**

Question number	Answer	Additional guidance	Mark
8(a)(ii)	An answer that includes three of the following points: • because *Mycobacterium* infects the lungs (1) • (*Mycobacterium* infection) destroying lung tissue (1) • therefore reduced <u>gas exchange</u> (1) • so insufficient oxygen to meet (oxygen) demands of patient (1)	**ACCEPT** a description e.g. necrosis **IGNORE** breathing problems	**(3)**

Question number	Answer	Additional guidance	Mark
8(a)(iii)	An explanation that includes four of the following points: • because if DNA synthesis cannot take place neither can mitosis (1) • and therefore clonal expansion of {T cells / B cells} cannot take place (1) • without T killer cells, host-infected cells cannot be destroyed (1) • without {B cells / plasma cells} there will be no antibody for opsonisation (of bacteria) (1) • therefore macrophages cannot destroy the *Mycobacteria* (1)	**ACCEPT** {T cells / B cells} cannot divide **DO NOT ACCEPT** B cells release antibody	**(4)**

Question number	Answer	Additional guidance	Mark
*8(b)	**Indicative content:** • number of bacteria still increasing at start of phage therapy (D) • because it takes time for lytic cycle (E) • bacteria number decrease (D) • because cells get destroyed when viruses burst out (E) • due to lytic cycle (E) • virus numbers increase (D) • because viruses replicate inside bacteria (E) • and burst out (E) • virus numbers increase after bacterial numbers increase (D) • because it takes time for synthesis of new components (E) • virus particles decrease (D) • because they get {engulfed / destroyed} by macrophages (E) • cyclical increase and decrease in the number of bacteria (D) • because not all bacteria get infected (E) • therefore surviving bacteria reproduce and increase in number (E) • cyclical increase and decrease in number of viruses (D) • because macrophages cannot destroy all viruses (E) • because viruses infect more bacteria (E) • eventually no viruses or bacteria (D)	**Level 1 :** 1 mark = 1 comment made about the graph or viral infections 2 marks = 3 comments made about {graph / viral infections} **OR** 1 description and a linked explanation **Level 2 :** 3 marks = 2 descriptions and linked explanations 4 marks = 3 descriptions and linked explanations **Level 3 :** 5 marks = 4 descriptions and linked explanations that includes both virus and bacterial number changes 6 marks = 5 descriptions and linked explanations that includes both virus and bacterial number changes + the cyclical nature of the data	**(6)**

	• because viruses destroy bacteria faster than they can reproduce (E) • viruses have no more host cells / destroyed by macrophages (E)		

Mark Scheme (Results)

October 2021

Pearson Edexcel International Advanced Level
In Biology (WBI14) Paper 01
Energy, Environment, Microbiology and Immunity

Question number	Answer	Mark
1(a)(i)	The only correct answer is **D**. **A** *is incorrect because P is a ribosome (the smallest structure), Q is a starch grain (the largest structure)* ***B*** *is incorrect because P is a ribosome (the smallest structure), Q is a starch grain (the largest structure)* ***C*** *is incorrect because P is a ribosome (the smallest structure), Q is a starch grain (the largest structure)*	**(1)**

Question number	Answer	Mark
1(a)(ii)	The only correct answer is **B**. **A** *is incorrect because GALP is found in the stroma which is structure R* ***C*** *is incorrect because GALP is found in the stroma which is structure R* ***D*** *is incorrect because GALP is found in the stroma which is structure R*	**(1)**

Question number	Answer	Additional guidance	Mark
1(a)(iii)	• 14 267 / 14 270 / 14 300 / 14 400 / 14 000 (1)	**ACCEPT** in standard form e.g. 1.4267×10^4 **DO NOT ACCEPT** with units	**(1)**

Question number	Answer	Additional guidance	Mark
1(a)(iv)	An answer that includes at least one similarity and one difference: **Similarities:** • both have a phospholipid bilayer (1) **Differences:** • T has {chlorophyll / photosynthetic pigments / photosystems / PSI / PSII} in it but U does not (1) • T contains {ATP synthase / ATP ase} but U does not (1) • T contains electron carrier proteins but U does not (1)	**DO NOT PIECE TOGETHER** **ACCEPT** made of phospholipids **ACCEPT** electron carriers / ETC **NB** penalise once if refer to membranes or chloroplast as a cell	**(3)**

Question number	Answer	Additional guidance	Mark
1(b)	An answer that includes the following points: • light is needed for the replication (of chloroplast DNA) (1) • replication (of chloroplast DNA) is independent of {mitosis / cell cycle} (1)	**ACCEPT** replication of chloroplast DNA does not occur in the dark **IGNORE** DNA increases day / night	**(2)**

	Answer	Mark
2(a)(i)	The only correct answer is **A**. **B** *is incorrect because TMV does not have an envelope* ***C*** *is incorrect because λ phage does not have an envelope* ***D*** *is incorrect because TMV does not have an envelope*	**(1)**

Question number	Answer	Mark
2(a)(ii)	The only correct answer is **C**. ***A*** *is incorrect because Ebola has a helical structure* ***B*** *is incorrect because HIV has a polyhedral structure* ***D*** *is incorrect because TMV has a helical structure*	**(1)**

Question number	Answer	Mark
2(a)(iii)	The only correct answer is **C**. ***A*** *is incorrect because Ebola, HIV and TMV all have RNA and λ phage has DNA* ***B*** *is incorrect because Ebola, HIV and TMV all have RNA and λ phage has DNA* ***D*** *is incorrect because Ebola, HIV and TMV all have RNA and λ phage has DNA*	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)(i)	**U G G U U C C G C** (1)		**(1)**

Question number	Answer	Additional guidance	Mark
2(b)(ii)	An explanation that includes two of the following points: • (because the positive strand) has the {codons / codes} for the {proteins / amino acids} (1) • because the positive strand has the <u>complementary</u> base sequence needed to make the negative strand (1)	**ACCEPT** used in translation / (viral) genes negative strand does not have the correct codons **DO NOT ACCEPT** transcription **IGNORE** refs to sense and antisense (strands)	**(2)**

Question number	Answer	Additional guidance	Mark
2(c)	An explanation that includes four of the following points: • because (during 18 days) new viruses are produced (1) • (new) viruses {burst out of / damage} (host) cells (1) • infecting more cells / causing the spread of the virus (1) • takes time for the immune system to be stimulated (1) • so {person may become ill / virus out of control} before immune system stimulated (1)	**IGNORE** refs to latency / description of retroviruses / replication of DNA **IGNORE** names of host cells **ACCEPT** description of event that take place **ACCEPT** description e.g. not enough antibodies present for opsonisation **ACCEPT** before {receiving antiviral drugs / drugs can take effect} **DO NOT ACCEPT** kill virus	**(4)**

<table>
<tr><th>Question number</th><th>Answer</th><th>Mark</th></tr>
<tr><td>3(a)</td><td>
<table>
<tr><th rowspan="2">Statement</th><th colspan="4">Type of artificial immunity</th></tr>
<tr><th>both active and passive</th><th>active only</th><th>passive only</th><th>neither active nor passive</th></tr>
<tr><td>Antibodies are injected into the person</td><td></td><td></td><td>X</td><td></td></tr>
<tr><td>B cells differentiate into plasma cells</td><td></td><td>X</td><td></td><td></td></tr>
<tr><td>Memory cells are formed</td><td></td><td>X</td><td></td><td></td></tr>
</table>
</td><td>(3)</td></tr>
</table>

Question number	Answer	Additional guidance	Mark
3(b)(i)	A description that includes the following points: • engulf the virus / phagocytosis of the virus (1) • digestion of the virus (1) • antigen presentation to {T helper / CD4} {cells / lymphocytes} (1)	**ACCEPT** pathogen, if in context of virus reference to a macrophage being a phagocyte, if in context of viruses **DO NOT ACCEPT** kills the virus **ACCEPT** macrophage is an {antigen presenting cell / APC} to T helper cells **DO NOT ACCEPT** to T killer cells	(3)

Question number	Answer	Additional guidance	Mark
3(b)(ii)	An explanation that includes four of the following points: • T helper cells {activate / stimulate} B cells (to divide) (1) • because antibody will be needed for opsonisation (1) • T helper cells {activate / stimulate} T killer cells (to divide) (1) • because T killer cells destroy (virus-infected) cells (1) • so that virus can be {engulfed / destroyed} by macrophages (1)	**ACCEPT** stimulate humoral response **ACCEPT** antibodies prevent viruses binding to host cells **ACCEPT** stimulate cell-mediated response **ACCEPT** a description **DO NOT ACCEPT** killed pathogen in context of bacteria	**(4)**

Question number	Answer	Additional guidance	Mark
4(a)(i)	• 1.27 / 1.33 (1)	**DO NOT ACCEPT** 1.33 recuring	**(1)**

Question number	Answer	Additional guidance	Mark
4(a)(ii)	• 21 / 21.3 / 21.26 / 24.8 / 24.81 / 25 (%) (1)	Allow ecf from (i)	**(1)**

Question number	Answer	Mark
4(b)(i)	The only correct answer is **B**. *A is incorrect because S is the oldest ring* *C is incorrect because P is the newest ring and S is the oldest ring* *D is incorrect because P is the newest ring and S is the oldest ring*	**(1)**

Question number	Answer	Additional guidance	Mark
4(b)(ii)	An explanation that includes three of the following points: • because each year a ring will be formed (1) • and the thickness of the rings will {be different for each year / depend on the conditions} (1) • the rings in each sample can be {matched / lined up} (1) • and only counting a ring once if it overlaps (1)	**ACCEPT** the number of rings is the age this tree is {68 to 76} years old quoted figures e.g. 69 rings = 69 years **ACCEPT** named condition e.g. temperature	**(3)**

Question number	Answer	Additional guidance	Mark
4(b)(iii)	A description that includes the following points: • measure the height (of the whole tree) (1) • height divided by the {(total) number of rings / age} (1)	 **ACCEPT** length for height measure {radius / diameter / total width of rings} at bottom (of tree) **ACCEPT** {radius / diameter} at bottom of tree divided by {number of rings / age} CE from mp 1	 **(2)**

Question number	Answer	Additional guidance	Mark
5(a)(i)	methods used to prevent contamination (of person / culture) (with other microorganisms) (1)	**ACCEPT** techniques / procedures / routines **ACCEPT** prevent {entry / exit / infection} **IGNORE** growth	**(1)**

Question number	Answer	Additional guidance	Mark
5(a)(ii)	A description that includes two of the following points: • carry out work beside {a bunsen burner / in a hood} (1) • use sterilised {equipment / media} / sterilise equipment after use (1) • credit named personal procedure (1) • minimise the time that cultures are exposed to the air / do not open cultures at the end (1)	**ACCEPT** description of how equipment could be sterilised e.g. media autoclaved, wash area with disinfectant **e.g.** wearing gloves, washing hands **e.g.** transfer bacteria quickly	**(2)**

Question number	Answer	Additional guidance	Mark
5(a)(iii)	An explanation that includes two of the following points: • to prevent entry of bacteria that may compete with the *E. coli* (1) • to prevent entry of bacteria that may grow in different {types / concentrations} of microbial substances (than *E. coli*) (1) • to prevent infection (of person) with bacteria in the culture that {is / maybe} pathogenic (1)	**ACCEPT** will not know if *E.coli* or the other bacteria is growing	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)	An explanation that includes the following points: • explanation for temperature given (1) • explanation for time given (1)	e.g. appropriate temperature needed for the enzymes to function temperature not too high so the enzymes do not denature **ACCEPT** proteins for enzymes temp won't be rate limiting for growth e.g. antimicrobial effect can be seen when bacteria are growing enough time has to be allowed for the bacterial growth to become visible enough time for antimicrobials to have an effect	**(2)**

Question number	Answer	Additional guidance	Mark
5(c)(i)	An explanation that includes the following points: • to show if the cultures were contaminated (1) • because the antimicrobial agent would not {kill / inhibit the growth of} other types of bacteria (1) **OR** • to check that the *E. coli* has not changed its {susceptibility / resistance} (1) • so that the results will apply to known *E. coli* (1)	**ACCEPT** a description e.g. to see if other bacteria are growing	**(2)**

Question number	Answer	Additional guidance	Mark
5(c)(ii)	An explanation that includes the following points: • to show that the *E.coli* were viable (1) • because if there was not any growth of bacteria you would not know if the bacteria were dead or the antimicrobial agents were (very) effective (1)	**ACCEPT** alive / can replicate / can grow **ACCEPT** to show that the antimicrobials were inhibiting growth **IGNORE** antimicrobials affecting growth	**(2)**

Question number	Answer	Additional guidance	Mark
5(c)(iii)	A description that includes the following points: • description of adding equal volumes of {antimicrobial substance / antimicrobials / substance / solution} and {water / media / broth / buffer} together (1) • description of this being repeated (a few times) using previous solution (1)	**ACCEPT** the idea of doing this process in the wells directly or separately **ACCEPT** stated volumes / 50% volumes / volumes in ratio 1 : 1 **IGNORE** amount **ACCEPT** a reference to serial dilutions	**(2)**

Question number	Answer	Additional guidance	Mark
5(c)(iv)	• MIC of E and G calculated (1) • {32 / 2^5} (1)	MIC of E = 1 in 8 and MIC of G = 1 in 256 Or MIC of E = 1 in 16 and MIC of G = 1 in 512 **ACCEPT** E is {32 / 2^5} times less effective **NB** correct answer gains 2 marks **ACCEPT** 2.25 for 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
6(a)	An answer that includes the following points: • number of (different) species (1) • genetic diversity within a species (1)	**ACCEPT** species richness amount **ACCEPT** variation in {genotypes / alleles}	**(2)**

Question number	Answer	Additional guidance	Mark
6(b)	An explanation that includes two of the following points: • <u>absorb</u> light energy so that electrons are {excited / released} (1) • to synthesise ATP and reduced NADP (1)	**ACCEPT** NADPH **IGNORE** $^{+}$ signs **ALLOW** to absorb light energy so that it can be converted into ATP energy = 1 mark	**(2)**

Question number	Answer	
*6(c)(i)	Indicative content: Comparisons: • propanone extracts more chlorophyll a from species P • propanone extracts more chlorophyll a from species R • DMSO extracts more chlorophyll a from species Q than propanone • propanone and DMSO extract similar concentrations of chlorophyll b from species S • propanone extracts more chlorophyll b from species P • propanone extracts more chlorophyll b from species Q • propanone extracts more total chlorophyll from species P Generalisations: • propanone is the most effective solvent at extracting chlorophyll • species P appears to contain the most chlorophyll when using propanone • DMSO is generally less effective than propanone except when extracting chlorophyll a from species Q **Implications in identifying species:** • some chlorophyll lost when extracted together as total is less than the sum of the components • other pigments extracted in some cases as total is more than individual components added together • the choice of solvent depends on the chlorophyll / species being extracted • because of difference in solubility (of pigments / membranes) / permeability of membranes • more than one solvent needs to be used if this method is to be used for identifying species • as different solvents extract different concentrations of different chlorophylls from different species • possibility of looking at extraction of other pigments • some sort of comparison table / calibration curve needed to match profile to extraction profiles • propanone better if only using one solvent as results the most varied • avoids need for DNA analysis • comparisons can be made in the field / with simple equipment • no indication of validity of data	**Level 1 :** 1 mark = 2 comparisons listed 2 marks = 4 comparisons listed **Level 2 :** 3 marks = 6 comparisons OR 1 generalisation + 3 comparisons OR 2 generalisations 4 marks = one implication discussed **Level 3 :** 5 marks = two implications discussed 6 marks = three implications discussed

Question number	Answer	Additional guidance	Mark
6(c)(ii)	An answer that includes two of the following points: • chlorophylls have different solubility in different solvents (1) • because the chlorophylls have different structures (1) • different solvents can {permeate / dissolve / disrupt} (cell / chloroplast) membranes differently (1)	**ACCEPT** more / less will dissolve **IGNORE** Rf values reacted with solvent	**(2)**

Question number	Answer	Additional guidance	Mark
7(a)(i)	7 (g) (1)		**(1)**

Question number	Answer	Additional guidance	Mark
7(a)(ii)	• value given in the range 0.005 to 0.0083 (1) • this value given to 1 or 2 sig figs {per day / day^{-1}} (1)	**ACCEPT** answers in correct standard form to 1 or 2 sig figs **ACCEPT** {0.02 / 0.017} {per day / day^{-1}} for 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
7(a)(iii)	An explanation that includes four of the following points: • decomposition (of tea) is {faster / greater} at 25°C (1) • because enzymes {work faster / move faster / have more kinetic energy} (at warmer temperatures) (1) • as there are more (frequent / energetic) enzyme-substrate collisions (1) • loss of mass is due to release of carbon dioxide (1) • by the respiration of the {decomposers / bacteria / fungi} (1)	**ACCEPT** converse throughout **ACCEPT** description e.g. breakdown of organic matter **ACCEPT** may be due to more bacteria	**(4)**

Question number	Answer	Additional guidance	Mark
7(a)(iv)	An answer that includes the following points: • because the teas maybe composed of different molecules (1) • that {cannot be broken down as easily / are less accessible to the enzymes} (in rooibos) (1) **OR** • because the pH (in the teabag) is different (1) • therefore enzymes (of the bacteria) are less active (in rooibos) (1) **OR** • because there are {inhibitors / antimicrobials / toxins} in rooibos (1) • that {inhibit the enzymes / kill the decomposers} (1)	**ACCEPT** converse throughout **ACCEPT** named difference e.g. surface area **IGNORE** different masses of organic matter **ACCEPT** which enzymes cannot breakdown **ACCEPT** higher concentrations	**(2)**

Question number	Answer	Additional guidance	Mark
7(b)(i)	• both the decomposition rate and {S / stabilisation factor / carbon stored} are mean values (1)	**ACCEPT** average for mean	**(1)**

Question number	Answer	Additional guidance	Mark
7(b)(ii)	An explanation that includes three of the following points: • {number 6 / loamy desert} (and 3 / birch / 5 / sandy desert) (1) • because it has the highest S value and the lowest decomposition rate (1) • therefore more carbon retained (in the soil) and less {carbon / carbon dioxide} released (1) • less carbon dioxide (in the atmosphere), the less global warming (1) **OR** • {number 6 / loamy desert} (and 3 / birch / 5 / sandy desert) (1) • because it has the highest S value therefore more carbon retained (in the soil) (1) • because it has the lowest decomposition rate and therefore less {carbon / carbon dioxide} released (1) • less carbon dioxide (in the atmosphere), the less global warming (1)	**DO NOT ACCEPT** carbon dioxide retained **ACCEPT** less greenhouse effect, description **DO NOT ACCEPT** carbon dioxide retained **ACCEPT** less greenhouse effect, description	**(3)**

Question number	Answer	Additional guidance	Mark
8(a)	• how much organic matter present in organisms (1)	**ACCEPT** amount / mass / content of / measure of dry mass / tissue containing carbon plant / animal / an organism / trophic level	**(1)**

Question number	Answer	Additional guidance	Mark
8(b)(i)	• total biomass of eukarya or all organisms calculated (1) • 85.84 / 85.8 / 86 (%) (1)	468 / 545.2	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(ii)	An answer that includes two of the following points: • cannot count all organisms as individuals (1) • organisms (within a group) are different {sizes / masses} (1)	**ACCEPT** take too long to count / too small to count **IGNORE** measure **ACCEPT** biomasses	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(iii)	An answer that includes three of the following points: Advantage: • very {visual / clear / easy} (way of presenting data / to understand) (1) • credit an example (1) Disadvantage: • cannot compare polygons with different shapes (but similar size) (1) • credit an example (1)	**e.g** easy to see the organisms with the highest biomass such as arthropods **ACCEPT** areas of polygons cannot be compared e.g. such as cnidarians and livestock	**(3)**

Question number	Answer	Additional guidance	Mark
*8(c)	**Indicative content:** **Voronoi diagram:** • most biomass found on land and least found in marine (D) • because land provides the most suitable conditions to sustain living organisms* • such as light (for plants and algae) / water **Plants:** • all plants found on land (D) • because need enough light for photosynthesis • not in marine (D) • as salt water not suitable • not found deep underground (D) • as no light for photosynthesis **Fungi:** • predominantly found on land (D) • because they need a solid place to feed • because they need (gaseous) oxygen for respiration • not found deep underground (D) • because barely any other organisms live there to provide organic matter to decompose **Protists:** • found on both land and in marine environment (D) • because enough light for those that photosynthesise • they are the producers for the marine food chains* • can feed on {phytoplankton / algae} in the sea • not found deep underground (D) • because no light for those that photosynthesise • because no food **Animals:** • found on land and in a marine environment (D) • because have adapted for {feeding / movement} in both of these environment • can feed on {plants / seaweeds / other animals} • not found deep underground (D) • because no {food / water / pressure too high / ground too hard}	**Level 1 :** 1 mark = 2 descriptions 2 marks = 4 descriptions **OR** 1 {organism / Voronoi diagram} explained **Level 2 :** 3 marks = 2 {organisms / Voronoi diagram} explained 4 marks = 3 {organisms / Voronoi diagram} explained **Level 3 :** 5 marks = 4 {organisms / Voronoi diagram} explained 6 marks = 4 organisms explained **AND** explanation of Voronoi diagram* **OR** realises that there must be a non-plant producer in the sea*	**(6)**

	Bacteria: • one of two groups to be found in all three environments (D) • because can obtain energy from decomposition on the {land / marine} • can use alternative sources of energy deep underground **Archaea:** • one of two groups to be found in all three environments (D) • because can obtain energy from decomposition on the {land / marine} • can use alternative sources of energy deep underground		

Mark Scheme (Results)

January 2022

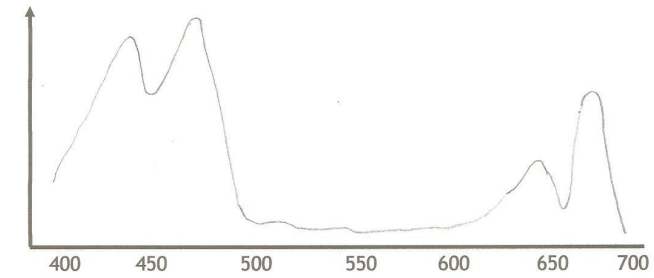
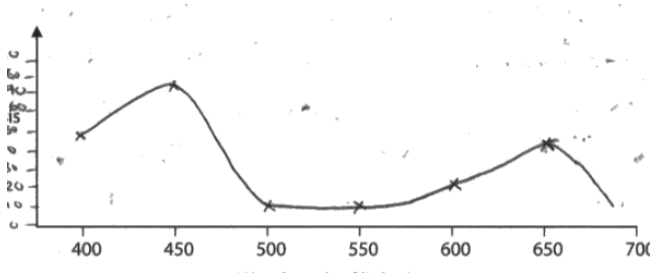
Pearson Edexcel International Advanced Level
In Biology (WBI14) Paper 01
Energy, Environment, Microbiology
and Immunity

	Answer	Mark
1(a)	The only correct answer is **D**. **A** *is incorrect because thick coat is anatomical, sitting on ice is behavioural and producing metabolic water is physiological* ***B*** *is incorrect because thick coat is anatomical, sitting on ice is behavioural and producing metabolic water is physiological* ***C*** *is incorrect because thick coat is anatomical, sitting on ice is behavioural and producing metabolic water is physiological*	**(1)**

	Answer	Mark
1(b)	The only correct answer is **C**. **A** *is incorrect because its niche is its role not something it can produce* ***B*** *is incorrect because its niche is its role not its habitat* ***D*** *is incorrect because its niche is its role not its structure*	**(1)**

Question number	Answer	Additional guidance	Mark
1(c)	An explanation that includes the following points: • because there is a lack of (fresh) water (1) • because the sea water is salty (1)	**ACCEPT** (fresh) water is frozen cannot consume the snow / ice	**(2)**

Question number	Answer	Additional guidance	Mark
1(d)	An explanation that includes the following points: • (genetic diversity) decreases • because the gene flow reduced (1) • as a result of inbreeding (1)	**IGNORE** refs to mutations increasing diversity **ACCEPT** description e.g. fewer allele combinations passed on	**(3)**

Question number	Answer	Additional guidance	Mark
2(a)(i)	An answer that includes the following points: • a line that roughly follows the contours of the absorption spectrum lines and does not drop to zero (1) • {left hand peak (if one) / peak at about 460 (if two)} is higher than a right hand {peak / peaks} (1)	  **IGNORE** extrapolation back to y axis but if it hits zero then this would negate mp 1	**(2)**

Question number	Answer	Additional guidance	Mark
2(a)(ii)	• 1.2 / 1.23 / 1.24 / 1.25		**(1)**

Question number	Answer	Additional guidance	Mark
2(a)(iii)	An explanation that includes the following points: • so that light can be <u>absorbed</u> at {each / different} wavelength of light (1) • so that the rate of photosynthesis will be maximised (1)	**IGNORE** colours of light **ACCEPT** faster / more	**(2)**

	Answer	Mark
2(b)(i)	The only correct answer is **A** **B** *is incorrect because the peptide bond forms between the amino group and the carboxyl group* ***C*** *is incorrect because its a peptide bond that forms* ***D*** *is incorrect because it's a peptide bond that forms between the amino group and the carboxyl group*	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)(ii)	A description that includes the following points: • use {GALP / glucose} (to incorporate into amino acids) (1) • use nitrates (taken up from the soil) (1)	**DO NOT ACCEPT** wrong sugars **ACCEPT** nitrogen from nitrates **IGNORE** nitrogen / sulphates **DO NOT ACCEPT** wrong ions e.g. magnesium ions	**(2)**

Question number	Answer	Additional guidance	Mark
3(a)	An explanation that includes the following points: • because it {destroys / weakens} the immune system (1) • by {destroying / decreasing the number of} T helper cells (1) • so {B cells / T killer cells} cannot be activated (1) • credit a consequence of this (1)	**ACCEPT** immunity **ACCEPT** CD4 cells **ACCEPT** {humoral / cell-mediated} immunity cannot be initiated e.g fewer antibodies produced (by plasma cells), less opsonisation, fewer infected host cells destroyed **IGNORE** phagocytosis unless description of opsonisation **DO NOT ACCEPT** viruses killed **NB** max 3 marks if no context	**(4)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	An explanation that includes the following points: • because if reverse transcriptase is inhibited, a DNA copy of the (viral) RNA cannot be made (1) • because if integrase is inhibited, this DNA cannot be incorporated into the host cell DNA (1)	**ACCEPT (**viral) DNA cannot be made (viral) RNA cannot be transcribed <u>into DNA</u> **DO NOT ACCEPT** RNA cannot be made into DNA **ACCEPT** provirus cannot be formed **NB both reasons given but not linked to each enzyme = 1 mark**	**(2)**

Question number	Answer	Additional guidance	Mark
3(b)(ii)	An answer that includes the following points: • to increase the likelihood of the drugs {being effective / destroying the virus} (1) • credit an example of why they may not be effective on their own (1) • maybe used to treat other (viral) infections (1)	**ACCEPT** a description of how this could happen e.g.targetting another site (on the virus) **DO NOT ACCEPT** kill the virus **e.g.** one type of inhibitor may not penetrate all the cells virus may have mutated and become resistant other drugs might prevent the attachment of HIV to {host cells / T helper cells / CD4}	**(2)**

Question number	Answer	Additional guidance	Mark
3(b)(iii)	An answer that includes the following points: • because the drug treatment does not completely remove the virus (1) • therefore {viral replication can occur / activation of provirus} (1) • new viral particles burst out of {host / T helper} cells (1)	**ACCEPT** enter the lytic cycle **DO NOT ACCEPT** if linked to incorporation of DNA into host DNA	**(2)**

Question number	Answer	Mark
4(a)	The only correct answer is **D**. **B** *is incorrect because all three statements are true* ***C*** *is incorrect because all three statements are true* ***D*** *is incorrect because all three statements are true*	**(1)**

Question number	Answer	Additional guidance	Mark
4(b)	An explanation that includes the following points: • attaches to the {maltoporin / *E. coli* / bacteria} (1) • so that the {DNA / genetic material / core} can penetrate into the (bacterial) cell (1)	 **IGNORE** host cell **DO NOT ACCEPT** RNA **IGNORE** ref to virus entering cell	 **(2)**

Question number	Answer	Additional guidance	Mark
4(c)(i)	• to respire / to make ATP / as an energy source (1)	**ACCEPT** regulation of gene expression formation of peptidoglycan **DO NOT ACCEPT** to make energy **NB** there may be other correct answers that will need checking	**(1)**

Question number	Answer	Additional guidance	Mark
4(c)(ii)	**Points relating to the bacterial cell:** • mutation in the {lamß gene / gene coding for maltoprotein} • changing the structure of the maltoprotein • so that the J protein can no longer {bind / bind as well} • mutation resulting in the production of a (new) enzyme • that can cleave the J protein off the maltoprotein • preventing E. coli from being {infected / destroyed} • bacteria that survive will divide (asexually) • forming a clone of resistant bacteria • presence of virus acting as a selection pressure • but the maltoprotein would need to remain functional • otherwise no sugars for respiration **Points relating to the λ phage:** • without being able to attach to the bacteria, the virus will not persist • as it needs a host cell to replicate • being able to bind is the selection pressure • mutation in the viral DNA coding for the J protein • that would result in a J protein capable of binding to the altered maltoprotein • that would result in a J protein that could bind more strongly to the maltoprotein • that would result in binding to another attachment site • viruses that can bind will result in production of viruses that can also	**Level 1:** **1 mark =** 1 relevant comment made **2 marks =** 3 points made **Level 2:** **3 marks =** 4 points made that include both virus and bacteria **4 marks =** 5 points made that include both virus and bacteria **Level 3:** **5 marks =** 6 points made that include both virus and bacteria **6 marks =** 6 points which include **Either** the need for the maltoprotein to remain functional **Or** how mutations are passed on to next generation of viruses and bacteria **NB** limited to max 3 marks if no reference made to either J protein or maltoproteins	**(6)**

	bind • as their genetic material will be cloned inside the host cell		

Question number	Answer	Additional guidance	Mark
5(a)	An answer that includes two of the following points: • nuclear DNA is linear and mtDNA is circular (1) • nuclear DNA has unbound {phosphate group / sugar} whereas mtDNA does not (1) • mtDNA has (far)fewer {phosphodiester bonds / base pairs} (1)	**DO NOT PIECE TOGETHER** **IGNORE** straight / strands double helix **IGNORE** shorter / smaller **ACCEPT** other <u>structural</u> difference e.g. nuclear DNA organised around histones whereas mtDNA {is not / organised into nucleoids} nuclear DNA has 3' and 5' ends but mtDNA does not	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)(i)	Any two from • (DNA) primers (1) • (DNA) (mono)nucleotides (1) • {taq / DNA} polymerase (1) • buffer (1)	**NB** Three correct = 2 marks, one or two correct = 1 mark **ACCEPT** all 4 listed **IGNORE** bases **DO NOT ACCEPT** RNA nucleotides **ACCEPT** taq enzyme **DO NOT ACCEPT** RNA polymerase	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)(ii)	• length of time calculated for the 35 cycles (1) • 1.38 (hours) (1)	4950 (seconds) / 82.5 (minutes) / 1.375 (hours) ecf if a given value in {seconds / minutes} is correctly converted into hours with 2 dps Bald answer of 1.38 = 2 marks Bald answer of 4950 (seconds) / 82.5 (minutes) / 1.375 (hours) = 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)(iii)	An explanation that includes the following points: • {(high) temperature / 94°C} to {break the H bonds (between the strands) / separate the strands} (1) • {temperature lowered / 54°C} so that primers can attach (1) • {temperature raised (slightly) / 72°C} new (mono)nucleotides can {align / join} to bases (to form two molecules) (1) • {35 / many} cycles so that {several molecules / enough DNA} is made (1)	**ACCEPT** temperature lowered if no mention of primers **ACCEPT** appropriate temperature for (DNA) polymerase **IGNORE** bases / strands **IGNORE** strands **NB** Max 2 marks if no ref to change or quoted temperature from our diagram, provided the steps are in the correct order	**(3)**

Question number	Answer	Additional guidance	Mark
5(c)	An explanation that includes the following points: • by DNA profiling (1) • so that banding patterns (in each crow can be produce) and compared (1) • the more similar the profiles the more closely-related the crows (1) **OR** • by DNA profiling (1) • so that base sequences (in each crow can be determined) and compared (1) • the more similar the (base) sequences the more closely-related the crows (1)	ACCEPT (gel) electrophoresis / description of the process DNA fingerprint **IGNORE** common ancestor ACCEPT bioinformatics	**(3)**

	Answer	Mark
6(a)(i)	The only correct answer is **B**. **A** *is incorrect because* ***P*** *is a ribosome* ***C*** *is incorrect because* ***R*** *is a thylakoid* ***D*** *is incorrect because* ***S*** *is a starch grain*	**(1)**

	Answer	Mark
6(a)(ii)	The only correct answer is **C**. **A** *is incorrect because starch is stored in* **S** ***B*** *is incorrect because starch is stored in* **S** ***D*** *is incorrect because starch is stored in* **S**	**(1)**

	Answer	Mark
6(a)(iii)	The only correct answer is **B**. **A** *is incorrect because* ***C*** *is incorrect because* ***D*** *is incorrect because*	**(1)**

	Answer	Mark
6(a)(iv)	The only correct answer is **A**. **B** *is incorrect because* ***P*** *is 0.02µm,* ***R*** *is 0.435 µm and* ***S*** *is 1 to 35 µm* ***C*** *is incorrect because* ***P*** *is 0.02µm,* ***R*** *is 0.435 µm and* ***S*** *is 1 to 35 µm* ***D*** *is incorrect because* ***P*** *is 0.02µm,* ***R*** *is 0.435 µm and* ***S*** *is 1 to 35 µm*	**(1)**

	Answer	Mark
6(b)(i)	The only correct answer is **C**. **A** *is incorrect because* CO_2 is used ***B*** *is incorrect because* CO_2 is used ***D*** *is incorrect because area is* mm^{-2} *and time is* hr^{-1}	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(ii)	An answer that includes the following points: **Similarities:** • both have a rise and fall (in rate of photosynthesis with an increase in temperature) (1) • both have the same rate of photosynthesis at 16.5°C (1) **Differences:** • *Spartina* has {an optimum temperature of / highest rate at} 35°C whereas *Leucopoa* has {an optimum temperature of / highest rate at} 23°C (1) • *Leucopoa* has a higher rate below 16.5°C and *Spartina* has a higher rate above 16.5°C (1)	**DO NOT PIECE TOGETHER** **ACCEPT** 16.4°C **ACCEPT** values between 34 and 36, 21 and 24 a stated value difference provided it can be obtained from these values **ACCEPT** converse	**(3)**

Question number	Answer	Additional guidance	Mark
6(b)(iii)	A description that includes the following points: • read off the rate of photosynthesis at two temperatures 10°C apart (1) • divide the rate for the higher temperature by that for the lower temperature (1)	**ACCEPT** two stated temperatures e.g. 10°C and 20°C values for two rates at appropriate temperatures quoted {calculate / get} rate **ACCEPT** from an equation if t and t+10 have been described	**(2)**

Question number	Answer	Additional guidance	Mark
6(b)(iv)	An explanation that includes the following points: • Wheatland (1) • because Wheatland has the higher temperatures (throughout the whole year) (1) • therefore enzymes will be more active (at these higher temperatures) (1)	**ACCEPT** from a description appropriate named enzyme e.g. RUBISCO	**(3)**

Question number	Answer	Additional guidance	Mark
7(a)(i)	• {the number of / all} humans in the world (1)	**ACCEPT** amount people / *Homo sapiens* Earth / this planet / globally	**(1)**

Question number	Answer	Additional guidance	Mark
7(a)(ii)	• producing enough <u>food</u> / producing <u>food</u> without damaging the environment (1)	**ACCEPT** without running out minimises carbon footprint so food can be made in the future	**(1)**

Question number	Answer	Additional guidance	Mark
7(b)(i)	An explanation that includes the following points: • reason for release of carbon dioxide into the atmosphere by land clearance (1) • reason for release of carbon dioxide into the atmosphere by farming (1) • reason for less carbon dioxide being removed from the atmosphere (1) • reason for release of methane into the atmosphere (1) • credit details of how green house gases cause global warming (1)	e.g. burning of forests, burning of (fossil) fuels by vehicles, decomposition of dead remains by bacteria e.g. burning of (fossil) fuels by {tractors, transport of food products, factories} **IGNORE** by respiration e.g. trees absorbed more carbon dioxide than crops, animals do not remove carbon dioxide from the atmosphere e.g. paddy fields, cattle, decomposition of dead remains by bacteria e.g. trap heat energy	**(3)**

Question number	Answer	Additional guidance	Mark
7(b)(ii)	• 71% of 149 million calculated (1) • farmed area calculated (1) • 5.29×10^7 / 5.3×10^7 (km^2) (1)	e.g. of calculation 105 790 000 (105 790 000 ÷ 2 =) 52 895 000 ecf incorrect answer or 105 790 000 expressed in standard form to 1 or 2 dps correctly Bald answer of 5.29×10^7 / 5.3×10^7 (km^2) = 3 marks Bald answer of 52 895 000 or incorrect standard form for this value = 2 marks Bald answer of 1.06×10^8 = 2 marks Bald answer of 105 790 000 = 1 mark	**(3)**

Question number	Answer	Additional guidance	Mark
7(b)(iii)	• values in range of 1 : 0.06 to 1 : 0.1 (with a max of 2 decimal places) **or** 1 : 11 to 1 : 15 (1)	**ACCEPT** ratio expressed either way around	**(1)**

Question number	Answer	Additional guidance	Mark
*7(c)	• recycling of plant material (D) • to add nutrients to ground • so that artificial fertiliser use is reduced • which will cause less harm to the environment • genetic engineering to produce more {insect / drought} resistant crops (D) • to grow higher yield crops • so that more food is produced from the land • and fewer habitats have to be destroyed • reduce air miles to transport food (D) • use biofuels to fuel machinery used in farming (D) • use waste crop materials to make biofuels (D) • so that less carbon dioxide is released into the air • raise fewer animals and grow more crops (D) • because animals release carbon dioxide into atmosphere • which contribute to greenhouse effect • plants absorb more carbon dioxide from atmosphere • use solar / wind power for energy need in farming (D) • as these are sustainable • and do not produce carbon dioxide • encourage population to eat more plant-based foods (D) • as more mass of food can be produced from the land • because fewer trophic levels therefore less energy lost from the food chain • credit examples given from the diagram • reduce the quantity of plastic in packaging of food (D) • because it is not biodegradable • because it can harm animals	**Level 1:** 1 mark = one aspect described 2 marks = one aspect described with a simple explanation **Level 2:** 3 marks = one aspect described with an extended explanation OR two aspects described each with a simple explanation 4 marks = two aspects described each with an extended explanation OR three aspects described each with a simple explanation **Level 3:** 5 marks = three aspects described, all with extended explanation 6 marks = three aspects described, all with extended explanation that includes energy loss from a food chain	**(6)**

Question number	Answer	Additional guidance	Mark
8(a)(i)	An explanation that includes the following points: • explanation of why another method is not accurate (1) • explanation of why entomology is accurate (1)	**e.g.** drop in body temperature is dependent on ambient temperature **e.g.** knowing life cycles and timings insects {colonise dead body in specific order / show succession}	**(2)**

Question number	Answer	Additional guidance	Mark
8(a)(ii)	An explanation that includes the following points: • some {insects /species} only found in certain habitats (1) • therefore if non-native species found on the body, it has been moved (1)		**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(i)	An answer that includes the following points: • to prevent animals from {eating / moving} it (1)	**ACCEPT** scavengers / carnivores appropriate named animal e.g. vulture, wolf **IGNORE** predators	**(1)**

Question number	Answer	Additional guidance	Mark
8(b)(ii)	• values read from the graph at 5 and 15 days / a value divided by 240 (1) • 0.08 (1)	e.g. of calculation 21 to 22 and 3 / in the range of 0.075 to 0.079166 Bald answer of 0.08 = 2 marks Bald answer between 0.075 and 0.079167 rounded up to more than 2 dps = 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(iii)	An explanation that includes four of the following points: • {very little / no} change at start because {body not colonised by insects / only insect eggs present} (1) • {small decrease at /end of bloated stage / 3.5 days} due to wild animals eating flesh (1) • {large decrease in mass / at beginning of active stage / 5 days} as holes in flesh allow gases to escape (1) • {decrease in mass / during active and advanced stages} as insects eat the flesh (1) • some mass remains because bones cannot be {eaten / digested} (1)	**ACCEPT** very few microorganisms present decomposition has not started **ACCEPT** decomposition by microorganisms small volume of gas released some insects have started to eat loss of water **ACCEPT** mass remains constant because bones remain remains cannot be digested **NB** If no marks are awarded allow 1 mark for a description of decomposition	**(4)**

Question number	Answer	Additional guidance	Mark
8(b)(iv)	• to identify the <u>species</u> (that laid the eggs) / to determine time until hatching to find out when they were laid (1)		**(1)**

Question number	Answer	Additional guidance	Mark
8(b)(v)	An explanation that includes the following points: • succession means that the species of insects (found on the decomposing mammal) will {change with time / change with stage (of decomposition) / appear in a specific sequence} (1) • *Lucilia* appears on the body first (1) • then {*Cochliomyia / Chrysomya}* appear on the body and *Lucilia* {numbers decrease / is out competed} (1) • then *Ophyra* arrives and {*Cochliomyia / Chrysomya}* {decrease in number / are out competed} (1)	**ACCEPT** pioneer species	**(3)**

Mark Scheme (Results)

June 2022

Pearson Edexcel International Advanced Level In Biology (WBI14)
Paper 01
Energy, Environment,
Microbiology and Immunity

Question number	Answer	Additional guidance	Mark
1(a)	• a {chemical / substance / medicine / drug / compound / molecule} that {kills / destroys} bacteria	**ACCEPT** pathogen / microorgansims **DO NOT ACCEPT** viruses antibodies / antigens **DO NOT ACCEPT** inhibit the growth **IGNORE** descriptions of mechanisms	**(1)**

Question number	Answer	Additional guidance	Mark
1(b)	• bacteria are prokaryotic (and humans are eukaryotic)	**ACCEPT** named target site e.g. cell wall, biochemistry, metabolism only prokaryotic cells **IGNORE** specific antigens receptors	**(1)**

Question number	Answer	Additional guidance	Mark
1(c)	A description that includes two of the following points: • finish the course of antibiotics (1) • take the antibiotics as directed (by the doctor) • warnings / precautions that may be necessary	**IGNORE** advise that would be given to doctors and not the patients **ACCEPT** specific examples e.g. correct {dose / number / timings}, do not share your antibiotics, do not take antibiotics not prescribed (by your doctor) e.g. they might make you sleepy	**(2)**

Question number	Answer	Additional guidance	Mark
1(d)	A description that includes the following points: • bacteria types J and K are {destroyed / killed / eradicates} (1) • antibiotic results in an increase in {<u>proportion / percentage / ratio</u>} of bacteria types M and N (1) • bacteria type O and L {not affected / growth inhibited} (1)	Piece together **ACCEPT** antibiotic is bactericidal to J and K **IGNORE** increase in number **ACCEPT** antibiotic is bacteriostatic to O and L	**(3)**

Question number	Answer	Mark
2(a)	The only correct answer is A. ***B** is incorrect because this is not a method of counting bacteria* ***C** is incorrect because colonies are counted not weighed* ***D** is incorrect because colonies are counted on agar. Turbidity would not work on agar.*	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)	An explanation that includes the following points: • attach lid to dish to ensure {lid does not fall off / bacteria do not enter / bacteria do not leave / no contamination} (1) • not completely sealed {so that conditions remain aerobic / prevent the growth of anaerobic bacteria} (1)	**ACCEPT** a description for both marking points e.g. sellotape used in places / sellotape not used all the way round **ACCEPT** a description of how to attach e.g. tape up the petri dish, use sellotape to seal petri dish **ACCEPT** leave gaps so there is oxygen NB leave air holes in the sealing = this mark	**(2)**

Question number	Answer	Mark
2(c)(i)	The only correct answer is **C**. **A** *is incorrect because lag comes before exponential and death comes at the end* ***B*** *is incorrect because exponential comes between lag and death* ***D*** *is incorrect because lag comes before exponential and stationery comes after*	**(1)**

Question number	Answer	Mark
2(c)(ii)	The only correct answer is **D**. **A** *is incorrect because all four are correct* ***B*** *is incorrect because all four are correct* ***C*** *is incorrect because all four are correct*	**(1)**

Question number	Answer	Additional guidance	Mark
2(c)(iii)	• $\log_{10} N_t$ and $\log_{10} N_0$ values read from graph and subtracted (1) • 2.49 (1)	6.5 – 2 / 4.5 **IGNORE** 'log' before the 6.5 and 2 if they clearly haven't used the log value ecf if log of logs have been taken and given to 2 dps = 0.28	**(2)**

Question number	Answer	Additional guidance	Mark
3(a)(i)	A description that includes the following points: • compete with pathogen for {space / nutrients / metabolites / named nutrient} (1) • (skin flora) producing toxins (to pathogens) (1) • preventing {the growth of the pathogens / colonisation (of the skin) by pathogens} (1)	**ACCEPT** other {bacteria / microorganisms} for pathogens **ACCEPT** nutrition **IGNORE** food **ACCEPT** anti-microbials chemicals if linked to mp 3 or qualified as being poisonous **DO NOT ACCEPT** sebum **ACCEPT** stimulate the immune system (toxins) kill pathogens	**(2)**

Question number	Answer	Additional guidance	Mark
3(a)(ii)	• keratin / antimicrobial secretions (by the skin) / oils / sebum	**ACCEPT** barrier **IGNORE** sweat explanations and other methods	(1)

Question number	Answer	Additional guidance	Mark
3(b)(i)	A description that includes the following points: • majority of bacteria are three types • males of all ages have the same (predominant) groups of bacteria present on their skin (1) • Proteobacteria are the highest group of bacteria in all age groups (1) • middle aged men and elderly men have similar proportions of the three types of bacteria present on their skin (1)	**IGNORE** reference to 'others' throughout **Do not piece together** **ACCEPT** Firmicutes is lowest named bacteria in all groups **ACCEPT** teenagers have {more Firmicutes and Actinobacteria / less Proteobacteria} (than middle aged and elderly men)	(3)

Question number	Answer	Additional guidance	Mark
3(b)(ii)	A description that includes two of the following points: • collect from same part of {body / skin} (1) • men should use same washing regime (1) • men from same environment (1) • men should not be taking antibiotics (1)	**ACCEPT** description e.g number of showers, same soaps **ACCEPT** same parts of the world, named environmental conditions e.g. UV light, humidity, temperature **ACCEPT** should not use antibacterial {soaps / creams} no skin conditions	**(2)**

Question number	Answer	Additional guidance	Mark
3(c)(i)	A description that includes the following points: • macrophages {engulf / phagocytose / ingest} the bacteria (1) • and destroy the bacteria with enzymes (1)	 **ACCEPT** pathogens / microorganisms **DO NOT ACCEPT** viruses **DO NOT ACCEPT** in context of opsonisation **ACCEPT** digestive enzymes / named digestive enzyme / lysozyme	 **(2)**

Question number	Answer	Additional guidance	Mark
3(c)(ii)	A description that includes two of the following points: • macrophages present antigen (on surface / on MHC) (1) • (macrophages present antigen) to {T helper / CD4} cells (1) • macrophage engulf opsonised bacteria (1)	 **DO NOT ACCEPT** to T killer cells / B cells / other cells **ACCEPT** description of opsonisation	 **(2)**

Question number	Answer	Additional guidance	Mark
4(a)(i)	• not enough (male) birds left to teach them the song	**ACCEPT** hear the songs of other birds and learn them	(1)
Question number	**Answer**	**Additional guidance**	**Mark**
4(a)(ii)	An explanation that includes the following points: • female birds will not recognise the males (song / courtship behaviour) (1) • therefore the level of breeding may drop (1) • therefore the number of birds will drop (further) / extinction (1) • hybridisation may occur (1)	**ACCEPT** reduced mating / reproduction **ACCEPT** mating with another <u>species</u> would produce infertile offspring **IGNORE** references to reproductive isolation	(3)

Question number	Answer	Additional guidance	Mark
4(a)(iii)	An answer that includes the following points: • keep them away from other species / house them with (only) their species (1) • (in captivity) keep with other birds that can sing the songs (to teach them) (1) • and then release the birds that have learnt the song back into the wild (1)	**ACCEPT** play recorded {songs / videos} / whistle the song	**(2)**
Question number	**Answer**	**Additional guidance**	**Mark**
4(b)	A description that includes the following points: • take DNA samples from {feather / dropping / skin / blood} (of both species) (1) • use of PCR (1) • (followed by) (gel) electrophoresis (1) • {number / width / position / patterns} of <u>bands</u> will show similarities (1)	**ACCEPT** DNA profiling / bioinformatics **ACCEPT** similar base sequences (using DNA profiling / bioinformatics)	**(4)**

	Answer	Mark
5(a)(i)	The only correct answer is **C**. **A** *is incorrect because m is an area so two dimensional* ***B*** *is incorrect because year is one dimensional* ***D*** *is incorrect because year is one dimensional*	**(1)**

	Answer	Mark
5(a)(ii)	The only correct answer is **B**. **A** *is incorrect because NPP = GPP - R* ***C*** *is incorrect because NPP = GPP - R* ***D*** *is incorrect because NPP = GPP - R*	**(1)**

Question number	Answer	Additional guidance	Mark
5(a)(iii)	• 98 : 10 : 1	**ACCEPT** 98 : 9.6 : 1 98.3 : 9.6 : 1 100 : 10 : 1 10 : 1 : 0.1 10.3 : 1 : 0.1 1 : 0.1: 0.01	**(1)**

Question number	Answer	Additional guidance	Mark
5(a)(iv)	An explanation that includes the following points: • because not enough energy (in trophic level 3) (1) • to sustain (organisms in) a fourth trophic level (1) **OR** • energy is lost between trophic levels (1) • so not enough energy for another trophic level (1)	**IGNORE** no energy / biomass **ACCEPT** support **IGNORE** no energy / biomass	**(2)**
Question number	**Answer**	**Additional guidance**	**Mark**
5(a)(v)	A description that includes the following points: • breakdown organic matter (1) • with (hydrolytic) enzymes (1) • releasing carbon <u>dioxide</u> from respiration (to the atmosphere) (1) • where it is used for photosynthesis (by plants) (1)	**ACCEPT** dead {tree / gerenuk / lion} / tissues / named organic molecule **ACCEPT** named enzyme **NB** release {<u>digestive / hydrolytic</u>} enzymes onto dead organisms = 2 marks	**(3)**

Question number	Answer	Additional guidance	Mark
*5(b)	**Level 1 points:** • due to natural selection (Descriptions of differences in features) • gerenuk's food is higher up / springbok's food is lower down • gerenuks have longer {necks / limbs} • gerenuk's white areas are {underneath / more concealed} • better adapted organisms survive and reproduce • passing their alleles onto their offspring **Level 2 points:** • occupy a different niche because they eat different food (Descriptions of how mutation caused a difference) • change in length of {neck / limbs} due to a mutation • change in type of horns due to a mutation (Explanations of how a features are an adaptation / result in difference in behaviour) • organisms with longer neck could reach the higher leaves • organisms with smaller horns did not get caught up in branches • smaller organisms had to go to waterhole for water • organisms with larger horns could defend off predators • male gerenuks kept horns for fighting for females • reference to {reduced gene flow / change in allele frequency / reproductive isolation} with no links made **Level 3 points:** • length of {neck / limbs} is a polygenic characteristic • type of horns is a polygenic characteristic • therefore organisms will show (continuous) variation for this phenotype • height of food acted as a selection pressure on size • {branches / predators} acted as a selection pressure on horns • organisms that {occupy a different niche / feed on different food} are not in competition with each other • two groups of organisms moved apart depending on where their food was • sympatric speciation / organisms not separated by a physical barrier • therefore reduced gene flow (between the two groups) • resulting in changes in the allele frequency • eventually resulting in reproductively isolated • and the formation of two species	**Level 1:** 1 mark = 1 point made from any level 2 marks = 3 points made from any level **Level 2:** **NB Must be a reference to the data / context of the question** 3 marks = 4 points made which include at least one level 2 point 4 marks = 5 points made which include at least one level 2 point **Level 3:** **NB Horns and {leg / neck} length must be included** 5 marks = 6 points made which includes at least one level 3 point 6 marks = 7 points made which includes at least one level 3 point	**(6)**

Question number	Answer	Mark
6(a)(i)	The only correct answer is **D**. **A** *is incorrect because R is a glycoprotein* ***B*** *is incorrect because Q is an enzyme* ***C*** *is incorrect because S is the capsid*	**(1)**

Question number	Answer	Mark
6(a)(ii)	The only correct answer is **D**. **A** *is incorrect because Q is an enzyme, R is a glycoprotein and S is the protein capsid* ***B*** *is incorrect because Q is an enzyme, R is a glycoprotein and S is the protein capsid* ***C*** *is incorrect because Q is an enzyme, R is a glycoprotein and S is the protein capsid*	**(1)**

Question number	Answer	Mark
6(a)(iii)	The only correct answer is **A**. **B** *is incorrect because TMV does not have an envelope* ***C*** *is incorrect because TMV does not have an envelope* ***D*** *is incorrect because Ebola virus has both an envelope and RNA*	**(1)**

Question number	Answer	Mark
6(a)(iv)	The only correct answer is **D**. ***A*** *is incorrect because 60mm is 60 000 000 nm, divide this by 120nm = 500 000* ***B*** *is incorrect because 60mm is 60 000 000 nm, divide this by 120nm = 500 000* ***C*** *is incorrect because 60mm is 60 000 000 nm, divide this by 120nm = 500 000*	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(i)	An explanation that includes two of the following points: • because the y axis would have to be extended to {37 / 38 / 39 / 40} (1) • otherwise this would make the rest of the data too squashed (1) **OR** • so that <u>all</u> the data can be plotted on one graph (1) • so that it can <u>all</u> be compared (1)	**ACCEPT** would require a bigger scale larger graph **ACCEPT** changes in deaths and new infections would not be so accurately presented **ACCEPT** with data for new infections and deaths **IGNORE** easier / harder other data **ACCEPT** with data for new infections and deaths **IGNORE** easier / harder other data	**(2)**

Question number	Answer	Additional guidance	Mark
6(b)(ii)	An answer that includes two of the following points: • two values read from graph, subtracted and divided by 5 (1) • 2×10^5 / 2.0×10^5 / 2.00×10^5 (1)	(3.2 – 3.1) ÷ 5 = 0.02	**(2)**

Question number	Answer	Additional guidance	Mark
6(b)(iii)	An explanation that includes two of the following points: • more infected people are surviving (1) • (more) people are surviving due to {better / new} {treatments / health care} (1)	 **ACCEPT** fewer infected people are dying **IGNORE** death rates **IGNORE** vaccines, antibiotics, technology	 **(2)**

Question number	Answer	Additional guidance	Mark
6(b)(iv)	• extrapolation (of data / graph / line) / extending the line (to 2025) (1)	**ACCEPT** extend a line of best fit **IGNORE** draw a line of best fit unqualified	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(v)	An explanation that includes two of the following points: • because vaccines result in {(artificial active) immunity / an immune response} (1) • due to the {formation / presence} of memory cells (1) • therefore (as a result of the vaccine) there would be fewer people with HIV (1) • and therefore non-immune people less likely to become infected by someone with HIV (1)	 **ACCEPT** number of infections decrease **ACCEPT** herd immunity	 **(3)**

Question number	Answer	Additional guidance	Mark
7(a)	• 83 / 83.0 / 83.3 / 83.33 (%) (1)	**DO NOT ACCEPT** any other values including recurring numbers e.g. $83.\dot{3}$ **IGNORE** {decrease / - / ↓}	**(1)**

Question number	Answer	Additional guidance	Mark
*7(b)(i)	**Table:** • Tasmanian devils spend less time feeding in cancer areas (D) • because there are fewer Tasmanian devils in these areas (E) • because they have died from the cancer (E) • because they are sick and get chased away by the other scavengers (E) • because they are sick and have lost their appetite (E) • {ravens / quolls / cats} all spend longer feeding in cancer areas (D) • because there are fewer Tasmanian devils (E) • therefore more food to go round / less competition (E) • because there are fewer Tasmanian devils to frighten them away (E) • because sick Tasmanian devils are too ill to chase scavengers away (E) • ravens, quolls and feral cats in similar proportions in both areas (D) • because they eat different parts of the carcass (E) • so are not in competition with each other (E) **Graph:** • carcasses in cancer areas are lasting longer than those in the healthy area (D) • because there are fewer Tasmanian devils to feed on the carcass (E) • because they are sick and have lost their appetite (E) • because scavengers do not eat as fast as Tasmanian devils (E) • because scavengers do not eat all the carcasses (E) • but they eventually breakdown by {decomposers / other scavengers} (E)	**ACCEPT** converse throughout where appropriate **Level 1:** 1 mark = one description only 2 marks = two descriptions **OR** one simple explanation **Level 2:** 3 marks = more than one explanation from either table or graph 4 marks = explanations for both table and graph **Level 3:** 5 marks = explanations for both table and graph, one of which is extended 6 marks = to include extended explanations for both table and graph **NB** Extended explanation either offers two alternative explanations or has two steps to it	**(6)**

Question number	Answer	Additional guidance	Mark
7(b)(ii)	An explanation that includes four of the following points: • (type or number) {microorganisms / insect species} that decompose the carcasses (1) • other species of scavengers as they would also feed on the carcasses (1) • people as this could frighten away the {scavengers / Tasmanian devils} (1) • other predators because they could affect the number of {scavengers / Tasmanian devils} feeding (1) • pathogens as they could affect the number of {scavengers / Tasmanian devils} feeding (1)	**ACCEPT** competing for carcass **ACCEPT** named activity of people and the effect **NB** If no marks awarded, allow 1 mark for a named biotic factor from the mark scheme	**(4)**

Question number	Answer	Additional guidance	Mark
8(a)(i)	A description that includes three of the following points: • need to withstand {harsh / extreme} environments (1) • need to be able to withstand {dessication / lack of shade} (1) • have a low requirement for {minerals / mineral ions / named mineral ion / soil} (1) • have {fast life-cycles / grow fast / reproduce asexually / produce lots of seeds / wide dispersal mechanisms} (1)	**ACCEPT** can live in dry conditions **ACCEPT** can grow in {poor quality soil / bare rock} **IGNORE** nutrients	**(3)**

Question number	Answer	Additional guidance	Mark
8(a)(ii)	An explanation that includes two of the following points: • changes to the habitat have to take place before a different organism can survive there (1) • credit named improvement (1) • credit organism that would appear in next stage following this improvement (1)	**ACCEPT** (one species) {improves conditions / provides suitable conditions} (for the next species) e.g. make soil, improve soil, provide food (for animals) e.g. (deeper soil) bushes / trees, (food / shelter) animals	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(i)	An answer that includes the following points: • eruption results in a drop in temperature (within 1.25 years) (1) • by 0.2°C (1)	**IGNORE** references to subsequent increase **ACCEPT** value in range of 0.02 to 0.2, but must be correct if time period stated **OR** • (overall) increase in temperature (1) • by {0.1 / 0.15}°C (1)	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(ii)	An explanation that includes the following points: • less (UV / shorter wave length) light will (indirectly) result in cooler temperatures (1) • because there will be less {IR (radiation) / long wave length} (reflected from the Earth's surface to warm up the atmosphere) (1) • with time, the particles will {disperse / decrease} (1) • and more (UV / shorter wave length) light will be able to {reach the Earth / pass through} increasing the temperature (1)	**ACCEPT** {particles / ash / sulfur dioxide} throughout **IGNORE** heat **ACCEPT** less heat trapped	**(4)**

Question number	Answer	Additional guidance	Mark
8(b)(iii)	• 700 / 7×10^2 (times / eruptions) (1)		**(1)**

Question number	Answer	Additional guidance	Mark
8(b)(iv)	An answer that includes four of the following points: • graph shows that there is no significant change in levels of carbon dioxide following the eruptions (1) • but there is evidence that volcanoes release some carbon dioxide (1) • so they might contribute to the greenhouse effect and cause {climate change / global warming / increase in temperatures} (1) • but this might be offset by the {sulfur dioxide / ash} produced (1)	**ACCEPT** volcanoes {do release / increase} carbon dioxide **ACCEPT** volcanoes do contribute to the greenhouse effect and cause {climate change / global warming / increase in temperatures} **ACCEPT** carbon dioxide is a greenhouse gas and causes climate change	**(3)**

Mark Scheme (Results)

October 2021

Pearson Edexcel International Advanced Level In Biology (WBI14) Paper 01 Energy, Environment, Microbiology and Immunity

Question number	Answer	Mark
1(a)(i)	The only correct answer is **D**. **A** *is incorrect because P is a ribosome (the smallest structure), Q is a starch grain (the largest structure)* ***B*** *is incorrect because P is a ribosome (the smallest structure), Q is a starch grain (the largest structure)* ***C*** *is incorrect because P is a ribosome (the smallest structure), Q is a starch grain (the largest structure)*	**(1)**

Question number	Answer	Mark
1(a)(ii)	The only correct answer is **B**. **A** *is incorrect because GALP is found in the stroma which is structure R* ***C*** *is incorrect because GALP is found in the stroma which is structure R* ***D*** *is incorrect because GALP is found in the stroma which is structure R*	**(1)**

Question number	Answer	Additional guidance	Mark
1(a)(iii)	• 14 267 / 14 270 / 14 300 / 14 400 / 14 000 (1)	**ACCEPT** in standard form e.g. 1.4267×10^4 **DO NOT ACCEPT** with units	**(1)**

Question number	Answer	Additional guidance	Mark
1(a)(iv)	An answer that includes at least one similarity and one difference: **Similarities:** • both have a phospholipid bilayer (1) **Differences:** • T has {chlorophyll / photosynthetic pigments / photosystems / PSI / PSII} in it but U does not (1) • T contains {ATP synthase / ATP ase} but U does not (1) • T contains electron carrier proteins but U does not (1)	**DO NOT PIECE TOGETHER** **ACCEPT** made of phospholipids **ACCEPT** electron carriers / ETC **NB** penalise once if refer to membranes or chloroplast as a cell	**(3)**

Question number	Answer	Additional guidance	Mark
1(b)	An answer that includes the following points: • light is needed for the replication (of chloroplast DNA) (1) • replication (of chloroplast DNA) is independent of {mitosis / cell cycle} (1)	**ACCEPT** replication of chloroplast DNA does not occur in the dark **IGNORE** DNA increases day / night	**(2)**

	Answer	Mark
2(a)(i)	The only correct answer is **A**. **B** *is incorrect because TMV does not have an envelope* ***C*** *is incorrect because λ phage does not have an envelope* ***D*** *is incorrect because TMV does not have an envelope*	**(1)**

Question number	Answer	Mark
2(a)(ii)	The only correct answer is **C**. ***A*** *is incorrect because Ebola has a helical structure* ***B*** *is incorrect because HIV has a polyhedral structure* ***D*** *is incorrect because TMV has a helical structure*	**(1)**

Question number	Answer	Mark
2(a)(iii)	The only correct answer is **C**. ***A*** *is incorrect because Ebola, HIV and TMV all have RNA and λ phage has DNA* ***B*** *is incorrect because Ebola, HIV and TMV all have RNA and λ phage has DNA* ***D*** *is incorrect because Ebola, HIV and TMV all have RNA and λ phage has DNA*	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)(i)	**U G G U U C C G C** (1)		**(1)**

Question number	Answer	Additional guidance	Mark
2(b)(ii)	An explanation that includes two of the following points: • (because the positive strand) has the {codons / codes} for the {proteins / amino acids} (1) • because the positive strand has the complementary base sequence needed to make the negative strand (1)	**ACCEPT** used in translation / (viral) genes negative strand does not have the correct codons **DO NOT ACCEPT** transcription **IGNORE** refs to sense and antisense (strands)	**(2)**

Question number	Answer	Additional guidance	Mark
2(c)	An explanation that includes four of the following points: • because (during 18 days) new viruses are produced (1) • (new) viruses {burst out of / damage} (host) cells (1) • infecting more cells / causing the spread of the virus (1) • takes time for the immune system to be stimulated (1) • so {person may become ill / virus out of control} before immune system stimulated (1)	**IGNORE** refs to latency / description of retroviruses / replication of DNA **IGNORE** names of host cells **ACCEPT** description of event that take place **ACCEPT** description e.g. not enough antibodies present for opsonisation **ACCEPT** before {receiving antiviral drugs / drugs can take effect} **DO NOT ACCEPT** kill virus	**(4)**

Question number	Answer	Mark
3(a)	<table><tr><th rowspan="2">Statement</th><th colspan="4">Type of artificial immunity</th></tr><tr><th>both active and passive</th><th>active only</th><th>passive only</th><th>neither active nor passive</th></tr><tr><td>Antibodies are injected into the person</td><td></td><td></td><td>X</td><td></td></tr><tr><td>B cells differentiate into plasma cells</td><td></td><td>X</td><td></td><td></td></tr><tr><td>Memory cells are formed</td><td></td><td>X</td><td></td><td></td></tr></table>	**(3)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	A description that includes the following points: • engulf the virus / phagocytosis of the virus (1) • digestion of the virus (1) • antigen presentation to {T helper / CD4} {cells / lymphocytes} (1)	**ACCEPT** pathogen, if in context of virus reference to a macrophage being a phagocyte, if in context of viruses **DO NOT ACCEPT** kills the virus **ACCEPT** macrophage is an {antigen presenting cell / APC} to T helper cells **DO NOT ACCEPT** to T killer cells	**(3)**

Question number	Answer	Additional guidance	Mark
3(b)(ii)	An explanation that includes four of the following points: • T helper cells {activate / stimulate} B cells (to divide) (1) • because antibody will be needed for opsonisation (1) • T helper cells {activate / stimulate} T killer cells (to divide) (1) • because T killer cells destroy (virus-infected) cells (1) • so that virus can be {engulfed / destroyed} by macrophages (1)	**ACCEPT** stimulate humoral response **ACCEPT** antibodies prevent viruses binding to host cells **ACCEPT** stimulate cell-mediated response **ACCEPT** a description **DO NOT ACCEPT** killed pathogen in context of bacteria	**(4)**

Question number	Answer	Additional guidance	Mark
4(a)(i)	• 1.27 / 1.33 (1)	**DO NOT ACCEPT** 1.33 recuring	**(1)**

Question number	Answer	Additional guidance	Mark
4(a)(ii)	• 21 / 21.3 / 21.26 / 24.8 / 24.81 / 25 (%) (1)	Allow ecf from (i)	**(1)**

Question number	Answer	Mark
4(b)(i)	The only correct answer is **B**. *A is incorrect because S is the oldest ring* *C is incorrect because P is the newest ring and S is the oldest ring* *D is incorrect because P is the newest ring and S is the oldest ring*	**(1)**

Question number	Answer	Additional guidance	Mark
4(b)(ii)	An explanation that includes three of the following points: • because each year a ring will be formed (1) • and the thickness of the rings will {be different for each year / depend on the conditions} (1) • the rings in each sample can be {matched / lined up} (1) • and only counting a ring once if it overlaps (1)	**ACCEPT** the number of rings is the age this tree is {68 to 76} years old quoted figures e.g. 69 rings = 69 years **ACCEPT** named condition e.g. temperature	**(3)**

Question number	Answer	Additional guidance	Mark
4(b)(iii)	A description that includes the following points: • measure the height (of the whole tree) (1) • height divided by the {(total) number of rings / age} (1)	 **ACCEPT** length for height measure {radius / diameter / total width of rings} at bottom (of tree) **ACCEPT** {radius / diameter} at bottom of tree divided by {number of rings / age} CE from mp 1	 **(2)**

Question number	Answer	Additional guidance	Mark
5(a)(i)	methods used to prevent contamination (of person / culture) (with other microorganisms) (1)	**ACCEPT** techniques / procedures / routines **ACCEPT** prevent {entry / exit / infection} **IGNORE** growth	**(1)**

Question number	Answer	Additional guidance	Mark
5(a)(ii)	A description that includes two of the following points: • carry out work beside {a bunsen burner / in a hood} (1) • use sterilised {equipment / media} / sterilise equipment after use (1) • credit named personal procedure (1) • minimise the time that cultures are exposed to the air / do not open cultures at the end (1)	**ACCEPT** description of how equipment could be sterilised e.g. media autoclaved, wash area with disinfectant **e.g.** wearing gloves, washing hands **e.g.** transfer bacteria quickly	**(2)**

Question number	Answer	Additional guidance	Mark
5(a)(iii)	An explanation that includes two of the following points: • to prevent entry of bacteria that may compete with the *E. coli* (1) • to prevent entry of bacteria that may grow in different {types / concentrations} of microbial substances (than *E. coli*) (1) • to prevent infection (of person) with bacteria in the culture that {is / maybe} pathogenic (1)	**ACCEPT** will not know if *E.coli* or the other bacteria is growing	**(2)**

Question number	Answer	Additional guidance	Mark
5(b)	An explanation that includes the following points: • explanation for temperature given (1) • explanation for time given (1)	e.g. appropriate temperature needed for the enzymes to function temperature not too high so the enzymes do not denature **ACCEPT** proteins for enzymes temp won't be rate limiting for growth e.g. antimicrobial effect can be seen when bacteria are growing enough time has to be allowed for the bacterial growth to become visible enough time for antimicrobials to have an effect	**(2)**

Question number	Answer	Additional guidance	Mark
5(c)(i)	An explanation that includes the following points: • to show if the cultures were contaminated (1) • because the antimicrobial agent would not {kill / inhibit the growth of} other types of bacteria (1) **OR** • to check that the *E. coli* has not changed its {susceptibility / resistance} (1) • so that the results will apply to known *E. coli* (1)	**ACCEPT** a description e.g. to see if other bacteria are growing	**(2)**

Question number	Answer	Additional guidance	Mark
5(c)(ii)	An explanation that includes the following points: • to show that the *E.coli* were viable (1) • because if there was not any growth of bacteria you would not know if the bacteria were dead or the antimicrobial agents were (very) effective (1)	**ACCEPT** alive / can replicate / can grow **ACCEPT** to show that the antimicrobials were inhibiting growth **IGNORE** antimicrobials affecting growth	**(2)**

Question number	Answer	Additional guidance	Mark
5(c)(iii)	A description that includes the following points: • description of adding equal volumes of {antimicrobial substance / antimicrobials / substance / solution} and {water / media / broth / buffer} together (1) • description of this being repeated (a few times) using previous solution (1)	**ACCEPT** the idea of doing this process in the wells directly or separately **ACCEPT** stated volumes / 50% volumes / volumes in ratio 1 : 1 **IGNORE** amount **ACCEPT** a reference to serial dilutions	**(2)**

Question number	Answer	Additional guidance	Mark
5(c)(iv)	• MIC of E and G calculated (1) • {32 / 2^5} (1)	MIC of E = 1 in 8 and MIC of G = 1 in 256 Or MIC of E = 1 in 16 and MIC of G = 1 in 512 **ACCEPT** E is {32 / 2^5} times less effective **NB** correct answer gains 2 marks **ACCEPT** 2.25 for 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
6(a)	An answer that includes the following points: • number of (different) species (1) • genetic diversity within a species (1)	**ACCEPT** species richness amount **ACCEPT** variation in {genotypes / alleles}	**(2)**

Question number	Answer	Additional guidance	Mark
6(b)	An explanation that includes two of the following points: • <u>absorb</u> light energy so that electrons are {excited / released} (1) • to synthesise ATP and reduced NADP (1)	**ACCEPT** NADPH **IGNORE** $^{+}$ signs **ALLOW** to absorb light energy so that it can be converted into ATP energy = 1 mark	**(2)**

Question number	Answer	
*6(c)(i)	Indicative content: Comparisons: • propanone extracts more chlorophyll a from species P • propanone extracts more chlorophyll a from species R • DMSO extracts more chlorophyll a from species Q than propanone • propanone and DMSO extract similar concentrations of chlorophyll b from species S • propanone extracts more chlorophyll b from species P • propanone extracts more chlorophyll b from species Q • propanone extracts more total chlorophyll from species P Generalisations: • propanone is the most effective solvent at extracting chlorophyll • species P appears to contain the most chlorophyll when using propanone • DMSO is generally less effective than propanone except when extracting chlorophyll a from species Q **Implications in identifying species:** • some chlorophyll lost when extracted together as total is less than the sum of the components • other pigments extracted in some cases as total is more than individual components added together • the choice of solvent depends on the chlorophyll / species being extracted • because of difference in solubility (of pigments / membranes) / permeability of membranes • more than one solvent needs to be used if this method is to be used for identifying species • as different solvents extract different concentrations of different chlorophylls from different species • possibility of looking at extraction of other pigments • some sort of comparison table / calibration curve needed to match profile to extraction profiles • propanone better if only using one solvent as results the most varied • avoids need for DNA analysis • comparisons can be made in the field / with simple equipment • no indication of validity of data	**Level 1 :** 1 mark = 2 comparisons listed 2 marks = 4 comparisons listed **Level 2 :** 3 marks = 6 comparisons OR 1 generalisation + 3 comparisons OR 2 generalisations 4 marks = one implication discussed **Level 3 :** 5 marks = two implications discussed 6 marks = three implications discussed

Question number	Answer	Additional guidance	Mark
6(c)(ii)	An answer that includes two of the following points: • chlorophylls have different solubility in different solvents (1) • because the chlorophylls have different structures (1) • different solvents can {permeate / dissolve / disrupt} (cell / chloroplast) membranes differently (1)	**ACCEPT** more / less will dissolve **IGNORE** Rf values reacted with solvent	**(2)**

Question number	Answer	Additional guidance	Mark
7(a)(i)	7 (g) (1)		**(1)**

Question number	Answer	Additional guidance	Mark
7(a)(ii)	• value given in the range 0.005 to 0.0083 (1) • this value given to 1 or 2 sig figs {per day / day^{-1}} (1)	**ACCEPT** answers in correct standard form to 1 or 2 sig figs **ACCEPT** {0.02 / 0.017} {per day / day^{-1}} for 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
7(a)(iii)	An explanation that includes four of the following points: • decomposition (of tea) is {faster / greater} at 25°C (1) • because enzymes {work faster / move faster / have more kinetic energy} (at warmer temperatures) (1) • as there are more (frequent / energetic) enzyme-substrate collisions (1) • loss of mass is due to release of carbon dioxide (1) • by the respiration of the {decomposers / bacteria / fungi} (1)	**ACCEPT** converse throughout **ACCEPT** description e.g. breakdown of organic matter **ACCEPT** may be due to more bacteria	**(4)**

Question number	Answer	Additional guidance	Mark
7(a)(iv)	An answer that includes the following points: • because the teas maybe composed of different molecules (1) • that {cannot be broken down as easily / are less accessible to the enzymes} (in rooibos) (1) **OR** • because the pH (in the teabag) is different (1) • therefore enzymes (of the bacteria) are less active (in rooibos) (1) **OR** • because there are {inhibitors / antimicrobials / toxins} in rooibos (1) • that {inhibit the enzymes / kill the decomposers} (1)	**ACCEPT** converse throughout **ACCEPT** named difference e.g. surface area **IGNORE** different masses of organic matter **ACCEPT** which enzymes cannot breakdown **ACCEPT** higher concentrations	**(2)**

Question number	Answer	Additional guidance	Mark
7(b)(i)	• both the decomposition rate and {S / stabilisation factor / carbon stored} are mean values (1)	**ACCEPT** average for mean	**(1)**

Question number	Answer	Additional guidance	Mark
7(b)(ii)	An explanation that includes three of the following points: • {number 6 / loamy desert} (and 3 / birch / 5 / sandy desert) (1) • because it has the highest S value and the lowest decomposition rate (1) • therefore more carbon retained (in the soil) and less {carbon / carbon dioxide} released (1) • less carbon dioxide (in the atmosphere), the less global warming (1) **OR** • {number 6 / loamy desert} (and 3 / birch / 5 / sandy desert) (1) • because it has the highest S value therefore more carbon retained (in the soil) (1) • because it has the lowest decomposition rate and therefore less {carbon / carbon dioxide} released (1) • less carbon dioxide (in the atmosphere), the less global warming (1)	**DO NOT ACCEPT** carbon dioxide retained **ACCEPT** less greenhouse effect, description **DO NOT ACCEPT** carbon dioxide retained **ACCEPT** less greenhouse effect, description	**(3)**

Question number	Answer	Additional guidance	Mark
8(a)	• how much organic matter present in organisms (1)	**ACCEPT** amount / mass / content of / measure of dry mass / tissue containing carbon plant / animal / an organism / trophic level	**(1)**

Question number	Answer	Additional guidance	Mark
8(b)(i)	• total biomass of eukarya or all organisms calculated (1) • 85.84 / 85.8 / 86 (%) (1)	468 / 545.2	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(ii)	An answer that includes two of the following points: • cannot count all organisms as individuals (1) • organisms (within a group) are different {sizes / masses} (1)	**ACCEPT** take too long to count / too small to count **IGNORE** measure **ACCEPT** biomasses	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)(iii)	An answer that includes three of the following points: Advantage: • very {visual / clear / easy} (way of presenting data / to understand) (1) • credit an example (1) Disadvantage: • cannot compare polygons with different shapes (but similar size) (1) • credit an example (1)	**e.g** easy to see the organisms with the highest biomass such as arthropods **ACCEPT** areas of polygons cannot be compared e.g. such as cnidarians and livestock	**(3)**

Question number	Answer	Additional guidance	Mark
*8(c)	**Indicative content:** **Voronoi diagram:** • most biomass found on land and least found in marine (D) • because land provides the most suitable conditions to sustain living organisms* • such as light (for plants and algae) / water **Plants:** • all plants found on land (D) • because need enough light for photosynthesis • not in marine (D) • as salt water not suitable • not found deep underground (D) • as no light for photosynthesis **Fungi:** • predominantly found on land (D) • because they need a solid place to feed • because they need (gaseous) oxygen for respiration • not found deep underground (D) • because barely any other organisms live there to provide organic matter to decompose **Protists:** • found on both land and in marine environment (D) • because enough light for those that photosynthesise • they are the producers for the marine food chains* • can feed on {phytoplankton / algae} in the sea • not found deep underground (D) • because no light for those that photosynthesise • because no food **Animals:** • found on land and in a marine environment (D) • because have adapted for {feeding / movement} in both of these environment • can feed on {plants / seaweeds / other animals} • not found deep underground (D) • because no {food / water / pressure too high / ground too hard}	**Level 1 :** 1 mark = 2 descriptions 2 marks = 4 descriptions **OR** 1 {organism / Voronoi diagram} explained **Level 2 :** 3 marks = 2 {organisms / Voronoi diagram} explained 4 marks = 3 {organisms / Voronoi diagram} explained **Level 3 :** 5 marks = 4 {organisms / Voronoi diagram} explained 6 marks = 4 organisms explained **AND** explanation of Voronoi diagram* **OR** realises that there must be a non-plant producer in the sea*	**(6)**

	Bacteria: • one of two groups to be found in all three environments (D) • because can obtain energy from decomposition on the {land / marine} • can use alternative sources of energy deep underground **Archaea:** • one of two groups to be found in all three environments (D) • because can obtain energy from decomposition on the {land / marine} • can use alternative sources of energy deep underground		

Mark Scheme (Results)

January 2023

Pearson Edexcel International Advanced Subsidiary Level In Biology (WBI14/01)
Paper 01: Energy, Environment, Microbiology, and Immunity

Question number	Answer	Additional guidance	Mark
1(a)	An answer that includes two of the following points: • sterilise equipment (1) • work beside a bunsen burner (1) • cover / minimise the length of time that cultures are open (1)	 **ACCEPT** named methods of sterilisation and named equipment washing hands / gloves / wiping down surfaces with disinfectant **ACCEPT** selective media **NB** aseptic technique if no other marks awarded	**(2)**

Question number	Answer	Mark
1(b)	The only correct answer is **C** **A** *is incorrect because 10 µg is 0.01 mg, and 0.5 mg ÷ 0.01 = 50* ***B*** *is incorrect because 10 µg is 0.01 mg, and 0.5 mg ÷ 0.01 = 50* ***D*** *is incorrect because 10 µg is 0.01 mg, and 0.5 mg ÷ 0.01 = 50*	**(1)**

Question number	Answer	Additional guidance	Mark
1(c)	An explanation that includes three of the following points: • not A and D because {they have no effect / the bacteria are resistant to them / there is no zone of inhibition} (1) • B as it {is most effective / has the largest zone of inhibition} (1) • use {high mass / 200 µg} antibiotic C as lower masses are not effective (1) • use antibiotic B at 10 µg as higher masses are no more effective (1)	**ACCEPT** use antibiotics B, C and E as {they are effective / the bacteria are not resistant to them / they have a zone of inhibition} **PIECE TOGETHER** **ACCEPT** do not use {low mass / 20µg} of C as it is not effective	**(3)**

	Answer	Mark
2(a)(i)	The only correct answer is **C** **A** *is incorrect because P is a ribosome* ***B*** *is incorrect because Q is the cell wall* ***D*** *is incorrect because T is the membrane*	**(1)**

	Answer	Mark
2(a)(ii)	The only correct answer is **C** **A** *is incorrect because light-dependent reaction takes place on membranes and Q is the cell wall* ***B*** *is incorrect because light-dependent reaction takes place on membranes and S is the cytoplasm* ***D*** *is incorrect because light-dependent reaction takes place on membranes and U is the flagellum*	**(1)**

	Answer	Mark
2(a)(iii)	The only correct answer is **B** **A** *is incorrect because light-independent reaction takes place in the cytoplasm and Q is the cell wall* ***C*** *is incorrect because light-independent reaction takes place in the cytoplasm and T is the cell membrane* ***D*** *is incorrect because light-independent reaction takes place in the cytoplasm and U is a flagellum*	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)	A description that includes two of the following points: • bacterial (pigments) can absorb (light) at a greater range of wavelengths (1) • bacterial (pigments) absorb more (light) at most wavelengths (1) • bacterial (pigments) absorb most (light) at 380 nm and 880 nm and plant pigments at 440 nm (1)	**ACCEPT** bacterial (pigments) absorb at the end of the spectrum as well but plants do not **ACCEPT (**overall) more absorption there are more peaks for bacterial (pigments) **ACCEPT** +/- 10	**(2)**

Question number	Answer	Additional guidance	Mark
2(c)	A description that includes the following points: • distance solvent moved (from the origin) measured (1) • distance {pigment / solute} moved from the origin (1) • equation {described / given} (1)	**DO NOT ACCEPT** at end of paper **ACCEPT** measure from {centre / leading edge} of pigment (1) Rf = distance moved by pigment ÷ distance moved by solvent	**(3)**

Question number	Answer	Mark
3(a)	The only correct answer is **D** **A** *is incorrect because TMV is an RNA virus* ***B*** *is incorrect because TMV is an RNA virus* ***C*** *is incorrect because TMV does not have an envelope*	**(1)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	• 8.7% of the 8.3×10^{12} calculated (1) • 7.6×10^{12} (1) **OR** • percentage recycled calculated (1) • 7.6×10^{12} (1)	0.7221×10^{12} / 7.221×10^{11} 91.3 Bald answer of 7.6×10^{12} = 2 marks Bald answer of 7.5779×10^{12} / 76×10^{11} / 0.7221×10^{12} / 7.221×10^{11} / 91.3 = 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
3(b)(ii)	An explanation that includes the following points: • because they {produce / release} enzymes (1) • that can {break / hydrolyse} bonds within the plastic (1)		**(2)**

Question number	Answer	Additional guidance	Mark
3(b)(iii)	An explanation that includes the following points: • because breakdown products {taken up / absorbed} (by the bacteria) (1) • respiration produces carbon dioxide (1) • (bacterial) {biomass / stored material} is {(other) organic molecules / converted breakdown products / glycogen / polysaccharide / protein / lipid} (1)	**ACCEPT** converting what is taken up into {another molecule / glucose / named (simple) molecule} **DO NOT ACCEPT** molecules not found in bacteria e.g. starch, chlorophyll	**(3)**

Question number	Answer	Additional guidance	Mark
4(a)	• 5 {million / × 10^6} 5 000 000 4.8 / 4.9 {million / × 10^6} 4 800 000 / 4 900 000 4.78 / 4.85 / 4.86 / 4.92 {million / × 10^6} 4 780 000 / 4 850 000 / 4 860 000 / 4 920 000		**(1)**

Question number	Answer	Additional guidance	Mark
4(b)	A description that includes four of the following points: • GALP converted to glucose (1) • glucose converted to {fructose / sucrose} (1) • sucrose transported in phloem (1) • phosphates used / phosphorus needed (in component molecule / rubber) (1) • credit details of {phosphates / phosphorus} (1) • glucose respired for energy / enzymes used in the production of {component molecule / rubber} (1)	**ACCEPT** converted to component (rubber) molecules **ACCEPT** component (rubber) molecules transported in phloem **DO NOT ACCEPT** glucose e.g. phosphates taken up from the soil by {active transport / facilitated diffusion} / phosphates transported in xylem / breakdown product of ATP / ATP provides the phosphorus	**(4)**

Question number	Answer	Additional guidance	Mark
4(c)	An explanation that includes the following points: • {trunk / base of tree} sample removed (1) • rings counted (1) • because {one ring is made each year / number of rings equals age of tree} (1)	**DO NOT ACCEPT** chopping tree down / using branches	**(3)**

Question number	Answer	Additional guidance	Mark
5(a)(i)	An explanation that includes the following points: • because it is making predictions (1) • based on {knowledge / data} (1) • it is a visual representation (of what might happen) (1)	**ACCEPT** guess / an idea / estimation / what might happen **ACCEPT** statistics / what has happened **NB** award {extrapolation / correlation / trend} once in either context of mp 1 or mp 2	**(2)**

Question number	Answer	Additional guidance	Mark
5(a)(ii)	• 33 / 33.3 / 33.33 (%)		(1)

Question number	Answer	Mark
*5(b)	**1 Aspect : Positive impact on local (human) population:** • crops will provide food • forests will provide materials for {building / making fires} • {crops / forest} will provide {employment / income} • {crops / forests} encourage new animals that might provide food • credit effect of reduced global warming on people e.g. no extremes of temperature, no droughts **2 Aspect : Negative impact on local (human) population:** • {crops / forests} may replace the crops they were growing already • {crops / forests} may {reduce / replace} the land they were using for animals • {crops / forests} may {reduce / replace} the land they were {living on / using for houses / factories} • crops use {pesticides / fertilisers} which is expensive for farmers **3 Aspect : Positive impact on global warming:** • carbon dioxide will be removed from the atmosphere • decreasing the greenhouse effect • extremes of temperature should be reduced • extremes of precipitation should be reduced **4 Aspect : Negative impact on global warming:** • planting crops may reduce carbon dioxide levels less than {forests / pre-existing crops} • machinery used in {planting {forests / crops} / harvesting crops} produces carbon dioxide • burning {plants / trees} produces carbon dioxide **5 Aspect : Positive impacts on biodiversity:** • planting {crops / forests} may increase (new) habitat • plants may provide food • increase in herbivores may increase carnivores **6 Aspect : Negative impacts on biodiversity:** • planting {crops / forest} could reduce (original) habitat • crops are monocultures and therefore reduce biodiversity • trees planted may not be suitable species • crops use pesticides that could harm food chains	**(6)**

			Additional guidance
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. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.	Simple links made between plants and their impact
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts / concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.	Extended links made between plants and their advantages or disadvantages
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant biological facts / concepts. Consequences are discussed which supported throughout by sustained linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Clear discussions on the types of plants and their advantages and disadvantages

Question number	Answer	Mark
6 (a)	The only correct answer is **C** **A** *is incorrect because enzymes are organic molecules that decrease activation energy* ***B*** *is incorrect because enzymes are organic molecules* ***D*** *is incorrect because enzymes increase activation energy*	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(i)	• log / logarithmic / $\log_{10}$ / log to the base 10 (scale)	**DO NOT ACCEPT** ln / $\log_e$ / natural log	**(1)**

Question number	Answer	Mark
6(b)(ii)	The only correct answer is **C** **A** *is incorrect because both level of salt and wave action are abiotic* ***B*** *is incorrect because wave action is abiotic* ***D*** *is incorrect because level of salt is abiotic*	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(iii)	An explanation that includes three of the following points: • enzymes needed for the metabolism (of the fish) (1) • because enzyme activity is not sufficient at both higher and lower temperatures (than zone of tolerance) (1) • because at lower temperatures there will not be enough kinetic energy for {collisions / enzyme-substrate complexes to be formed} (1) • because at higher temperatures {the enzymes denature / active site changes shape} (1)	**PIECE TOGETHER** **ACCEPT** converse **ACCEPT** enzymes do not work fast enough / no enzyme activity / in zone of tolerance enzyme <u>activity</u> is at an optimum **DO NOT ACCEPT** start to denature	**(3)**

Question number	Answer	Additional guidance	Mark
6(c)(i)	• values for 20 °C and 30 °C read from the graph (1) • numbers substituted into the equation and evaluated (1) • 1.5 / 1.6 / 1.56 / 1.62 with no units (1)	{2.6 / 2.7 / 2.8} and 4.2 4.2 ÷ 2.6 = 1.615384615 4.2 ÷ 2.7 = 1.555555555556 4.2 ÷ 2.8 = 1.5 answer to 1 or 2 decimal places Bald answer of 1.5 / 1.6 / 1.56 / 1.62 with no units = 3 marks Bald answer of 1.556 / 1.615 or more correctly rounded dps = 2 marks Bald answer of {2.6 / 2.7 / 2.8} and 4.2 = 1 mark	**(3)**

Question number	Answer	Additional guidance	Mark
6(c)(ii)	An explanation that includes three of the following points: • as storage time increases the {activity / optimum temperature (of the enzyme)} decreases (1) • the active site changes shape (due to storage time) (1) • because the bonds break (due to more energy) (1) • as more energy causes more vibration between the R groups (1) • the longer the active site is distorted the less likely it is to return to normal shape (1)	**ACCEPT** tolerance to temperature decreases **ACCEPT** enzyme {changes shape / changes structure / is denatured} **DO NOT ACCEPT** any named bond not found in an enzyme	**(3)**

Question number	Answer	Mark
7(a)(i)	The only correct answer is **B** **A** *is incorrect because* ***Q*** *is a hydrogen bond* ***C*** *is incorrect because* ***R*** *is a covalent bond* ***D*** *is incorrect because* ***Q*** *is a hydrogen bond*	**(1)**

Question number	Answer	Mark
7(a)(ii)	The only correct answer is **C** *A is incorrect because a deoxyribose does not have a negative charge* *B is incorrect because a covalent bond does not have a charge* *D is incorrect because the bases do not have a negative charge*	**(1)**

Question number	Answer	Additional guidance	Mark
7(b)(i)	• {Maleo / this bird / it} is only found in {Indonesia / this country / forest}	**DO NOT ACCEPT** answer given in context of habitat	**(1)**

Question number	Answer	Additional guidance	Mark
7(b)(ii)	• the newly hatched birds cannot fly to the forest / the birds cannot get to beach	**ACCEPT** not enough beach left to lay eggs / not enough forest left for {roosting / feeding} / humans damage {eggs / nests} / decrease gene flow / inbreeding	**(1)**
Question number	Answer	Additional guidance	**Mark**
7(b)(iii)	An explanation that includes the following points: • because laying eggs in the sand will {keep them warm / hide them from predators / protect from wave action} (1) • because if the adults leave the site {there will be no indication that there are eggs laid there / they can go and find food (for themselves) / can avoid predators / it is too hot on the beach} (1) • because if the young can fly (straightaway) they can {avoid predators / get food} (1)		**(3)**

Question number	Answer	Additional guidance	Mark
7(b)(iv)	An explanation that includes the following points: • primers needed so that (DNA / taq) polymerase can bind (to one strand) (1) • because one primer is needed for each strand (1) • because the DNA strands {are antiparallel / are complementary / have different base sequences at each end} (1)	**ACCEPT** one primer can bind to each end of the DNA molecule **ACCEPT** two primers each with a complementary sequence of bases are needed **DO NOT ACCEPT** one for 3‘ and one for 5’ end	**(2)**

Question number	Answer	Additional guidance	Mark
7(b)(v)	An explanation that includes the following points: • this sample of eggs had more males than females so the {birds may not be monogamous / claim may not be true} (1) • the sample size is too small (1) • the number of chicks may not represent the number of adults (1)	**ACCEPT** fewer females than males any correct <u>manipulated</u> data that illustrates this, including not a 1:1 **ACCEPT** a suitable description of why e.g. more males die	**(3)**

Question number	Answer	Additional guidance	Mark
8(a)(i)	A description that includes the following points: • (viral) RNA interacts with (host cell) ribosomes (1) • credit detail of role of (host) tRNA (1) • peptide bonds form between the (adjacent host) amino acids (1)	**ACCEPT** two tRNAs bind to RNA (at any one time) each tRNA carries a specific amino acid tRNA anticodons bind to RNA codons tRNA binds to RNA with hydrogen bonds **DO NOT ACCEPT** polypeptide bond / dipeptide bond	**(3)**

Question number	Answer	Additional guidance	Mark
8(a)(ii)	An answer that includes three of the following points: • inhibitor binds to protease so that it cannot bind to {the (poly)protein / its substrate} (1) • therefore the (polyprotein peptide) bonds will not be broken (1) • therefore {no / fewer} {individual / smaller / component / named component} proteins will be made (1) • therefore the {components / named components} cannot be assembled (into individual viruses) (1)	**ACCEPT** inhibitor binds to (poly)protein / inhibitor stops protease binding to (poly)protein **ACCEPT** (individual) proteins will not be separated **ACCEPT** virus cannot be put together from (poly)protein	**(3)**

Question number	Answer	Additional guidance	Mark
8(b)	An explanation that includes four of the following points: • if number of platelets were higher blood would clot faster (1) • and this would help to reduce the bleeding (1) • more {white blood cells / appropriately named white blood cell} {to destroy the virus / increase immune response} (1) • credit a role of a named type of white blood cell in the immune response (1) • credit reason why {phagocytes / named phagocyte} can attach (more) viruses (1)	**ACCEPT** higher rate e.g. macrophages for antigen presentation to T helper cells T helper cells in activating {T killer cells / B cells} T killer cells to destroy host cells infected with virus B cells to differentiate into plasma cells plasma cells to produce antibody to the virus **DO NOT ACCEPT** B cells produce antibody antibodies destroy virus e.g. opsonisation agglutination antibodies bind macrophage to the virus viruses released from host cells so accessible to phagocytes	**(4)**

Question number	Answer	Additional guidance	Mark
8(c)	A description that includes two of the following points: • credit advantage of this method being effective (1) • credit advantage of bacteria being passed to future generations (1) • the mosquitoes are not removed from the food chain (1) • more ethical as mosquitoes not harmed (1)	e.g. decreases chance of epidemic fewer people will die less need for {drugs / vaccines} no side effects of drugs e.g. the prevention will spread as the number of mosquitoes infected with the bacteria increase not every {mosquito / mosquito egg} has to be treated saving {time / money} treatment has to be done only once **ACCEPT** description of a consequence e.g. food webs not disrupted	**(2)**

Question number	Answer	Additional guidance	Mark
9(a)	• 1 (children) : 2.7 (women) : 4.7 (men) **OR** 1 (children) : 3 (women) : 5 (men)	**ACCEPT** 0.4 : 1 : 1.8 0.2 : 0.6 : 1 **ACCEPT** values in different order if clearly shown which is which	**(1)**

Question number	Answer	Additional guidance	Mark
9(b)	An explanation that includes three of the following points: • because formation of {plaques / tubercles / granuloma} in (lungs / other organs) (1) • therefore insufficient oxygen for (aerobic) respiration (1) • causes (other) organ failure (1) • weakens immune system so (death from) {other infections / tumours} (1)	**ACCEPT** reduces {gas exchange / gas exchange surface} **ACCEPT** description e.g. less oxygen enters blood **ACCEPT** named organ (in a correct context) / heart attack **ACCEPT** opportunistic infections (other than {TB / HIV} with / without ref to weakened immune system)	**(3)**

Question number	Answer	Additional guidance	Mark
9(c)(i)	An explanation that includes the following points: • because the untreated macrophages did not release IL-1ß (1) • and therefore any inhibition by infection could not be shown / to compare the effect of infection on IL-1ß (1)	**ACCEPT** did not release much IL-1ß **ACCEPT** so that the inhibition could be seen to show the effect of TB (on macrophages / IL-1B)	**(2)**

Question number	Answer	Additional guidance	Mark
9(c)(ii)	An answer that includes four of the following points: • the antibody attached to the plastic otherwise everything will be washed away (1) • antibodies used (stage 1 or 5) are specific to the IL-1B (1) • so that they are bound to the {antigen / IL-1B} (stage 1 or 5) (1) • a dye has to be attached to antibodies to make {reaction / antigen / complex} visible (1) • unattached {antibodies / antigen / molecules / dye} have to be washed away (so that only the antigen-antibody complexes remain) (1)	**ACCEPT** stain the {antigen / complex}	**(4)**

Question number	Answer	Additional guidance	Mark
9(c)(iii)	A description that includes four of the following points: • both types of bacteria cultured in the same culture conditions (1) • use {aseptic technique / description of a technique} (1) • credit {named / description of} equipment used (1) • {calibration / standard} curve used to determine concentration of bacteria (1) • credit {description of how growth rate would be determined / appropriate stats test named to compare growth rate} (1)	**ACCEPT** same concentration of bacteria named condition e.g. temperature, time e.g. light meter / light sensor / spectrophotometer / colorimeter / cross underneath the flask / shine a light through and measure {transmission / absorbance} **ACCEPT** description of how the light {absorbed / transmitted} is determined by the number of bacteria ecf if haemocytometer used ecf if haemocytometer used	**(4)**

Question number	Answer	Additional guidance	Mark
9(c)(iv)	• use in a vaccine (1)	**ACCEPT** used to develop an {inhibitor of / antibody to / enzyme to break down / chemical to breakdown} this protein used to develop a way of switching off the gene coding for the protein (in the bacteria)	**(1)**

Mark Scheme (Results)

Summer 2023

Pearson Edexcel International Advanced Subsidiary Level In Biology (WBI14)
Paper 01
Unit 4: Energy, Environment, Microbiology and Immunity

Question number	Answer	Additional guidance	Mark
1(a)	An explanation that includes the following points: • (magnesium ions are) components of chlorophyll (1) • which absorbs {light / photons} (1)	Examiners will need to check other roles if seen	(2)

- component of (leaf) ribosomes
- necessary for translation

- cofactor / allosteric modulator
- enabling {carboxylases / phosphatases / protein kinases / RNA polymerase / ATP synthases} to function

One of these would give 1 mark only:

involved in {phloem loading / sucrose transport in phloem / improved root : shoot ratio / vigorous root growth}
supports {transpiration rate / stomatal conductance / carbon dioxide fixation / non-cyclic photophosphorylation}
stabilises DNA
involved in ATP synthesis

Question number	Answer	Additional guidance	Mark
1(b)	An explanation that includes four of the following points: • uptake of magnesium ions levels off without oxygen but continues to increase with oxygen (1) • uptake of magnesium ions increases as the ions can be taken up against the concentration gradient (1) • {ATP / energy} is needed for {this / active transport} (1) • and oxygen is used in aerobic respiration to produce this ATP (1) • if {active transport was not involved / uptake was passive} the rate would have been the same in both groups (1)	**ACCEPT** more magnesium ions are taken up in presence of oxygen rate of uptake is faster in presence of oxygen **NB** piece together **PIECE TOGETHER**	**(4)**

Question number	Answer	Additional guidance	Mark
2(a)(i)	• mass of large and small bears calculated (1) • 88 / 88.1 / 88.13 (kg)	133.5294117647 and 45.4 88.1294117647058 Bald correct answer = 2 marks Bald masses = 1 mark Bald unrounded = 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
2(a)(ii)	An explanation that includes the following points: • because the food that Hank was {stealing / eating} was higher in {kilojoules / energy} (than ants and berries) (1) • Hank was storing energy as {biomass / fat} / hibernating bears were {losing biomass / losing weight / living off their reserves} (1)	**ACCEPT** calories / fats / carbohydrates eating food throughout the whole year was eating food in the winter when the hibernating bears were not diets of other bears had fewer calories **DO NOT ACCEPT** NPP	**(2)**

Question number	Answer	Mark
2(b)(i)	The only correct answer is **D** ***A** is incorrect because DNA could not be analysed using an electron microscope* ***B** is incorrect because DNA could not be analysed using an electron microscope* ***C** is incorrect because entomology studies insects*	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)(ii)	A description that includes the following points: • {comparison / differences} of the (pattern /size / number / position) bands} (1) • bands specific to females found on two of the tests but not on Hank's (1) • all (three) bears will have different {banding patterns / (DNA) fingerprints} (1)	**ACCEPT** use {base sequencing / DNA profiling / genetic fingerprint / gel electrophoresis} **DO NOT ACCEPT** females will have the same bands **ACCEPT** there will be (some) differences in the bands for all (three) bears **DO NOT ACCEPT** all the bands will be different **IGNORE** they don't have similar bands	**(3)**

Question number	Answer	Additional guidance	Mark
3(a)	An answer that includes the following points: **Similarity:** • both target bacteria (1) **Differences:** • {bacteriostatic antibiotics / tetracycline) prevent {cell division / growth} and {bactericidal / vancomycin} {kill / destroy} (bacteria) (1)	**ACCEPT** both affect bacteria both used to treat bacterial infections both bacteria even if qualification is wrong - this would negate mp 2 not mp 1 **IGNORE** description of mechanisms named antibiotics	**(2)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	A description that includes three of the following points: • antibiotics dissolved in a solvent (1) • (then) antibiotics loaded onto the {filter paper / origin} (1) • filter paper (then) dipped into solvent (below the origin) (1) • and (then) left to run until the leading edge is near end of filter paper) (1)	**ACCEPT** named solvent e.g.water, ethanol **ACCEPT** added to the filter paper / chromatogram / TLC plate / other appropriate medium **IGNORE** onto glass **ACCEPT** named solvent	**(3)**

Question number	Answer	Mark
3(b)(ii)	The only correct answer is **B** *A is incorrect because the tetracycline spot is about three-quarters of the way up so Rf value is approx. 0.75* *C is incorrect because the tetracycline spot is about three-quarters of the way up so Rf value is approx. 0.75* *D is incorrect because the tetracycline spot is about three-quarters of the way up so Rf value is approx. 0.75*	**(1)**

Question number	Answer	Additional guidance	Mark
3(b)(iii)	An explanation that includes two of the following points: • because different solvents were used (1) • difference in solubilities (1) • tetracycline is more soluble (in both solvents) / vancomycin is less soluble (in both solvents) / both antibiotics are more soluble in the solvent used in method 2 (1) • different solid phase used (1)	**ACCEPT** two named solvents **ACCEPT** the more soluble the further it will travel antibiotics bind to medium differently different charge / molecular mass **IGNORE** dissolve differently **IGNORE** size / mass / structure / properties **ACCEPT** converse for method 1	**(2)**

Question number	Answer	Mark
4(a)	The only correct answer is **C** ***A** is incorrect because cellulose is made of β glucose* ***B** is incorrect because cellulose is made of β glucose* ***D** is incorrect because cellulose is a straight chain polymer*	**(1)**

Question number	Answer	Mark
4(b)		**(3)**

Structure	Microorganism			
	Bacteria only	Fungi only	both bacteria and fungi	neither bacteria nor fungi
mitochondria	[x]	[x]	[x]	[x]
nuclei	[x]	[x]	[x]	[x]
70S (small) ribosomes	[x]	[x]	[x]	[x]

Question number	Answer	Mark
4(c)(i)	The only correct answer is **D** *A is incorrect because relative abundance of Streptococcus is highest in cubs, Escherichia and Shigella highest in sub-adults and Clostridium highest in adults* *B is incorrect because relative abundance of Streptococcus is highest in cubs, Escherichia and Shigella highest in sub-adults and Clostridium highest in adults* *C is incorrect because relative abundance of Streptococcus is highest in cubs, Escherichia and Shigella highest in sub-adults and Clostridium highest in adults*	**(1)**

Question number	Answer	Additional guidance	Mark
4(c)(ii)	A description that includes four of the following points: • source of sample identified (1) • name of method of determining numbers (1) • credit appropriate detail of method (1) • method for {identifying / eliminating} bacteria (1) • description of how the relative abundance will be determined (1)	 e.g. faeces, intestinal flush **IGNORE** other samples e.g. colony counts, dilution plating, colorimeter, spectrophotometer, turbidity, counting chamber, haemocytometer **ACCEPT** description of the method e.g. light passed through to measure transmission e.g. serial dilutions, shaking sample before counting, safety precautions, culture conditions, aseptic technique e.g. colour of colonies, use of antibiotics, use of antibodies, use of {selective / indicator} media e.g. number of each streptococcus in each sample from each age group of panda comparing light transmission for each age group percentage of streptococcus of total number of bacteria	**(4)**

Question number	Answer	Additional guidance	Mark
5(a)(i)	• tangent correctly drawn (1) • rate calculated (1) • rate value between 0.060 and 0.090 expressed to 3 dps max (1)	line touches the outside of the curve at 1 200 seconds e.g. 65 ÷ 880 = 0.073863636363 50 ÷ 720 = 0.069444444 ECFs: 147 ÷ 1120 = 0.1386792 147.5 ÷ 1120 = 0.131696428571 148 ÷ 1120 = 0.13962 147 ÷ 1130 = 0.13725490 147.5 ÷ 1130 = 0.13053097 148 ÷ 1130 = 0.1383177 Ecf values from mp 2 correctly rounded to a max of 3 dps Ecf value of 0.1225 / 0.122916 / 0.12333 correctly rounded to max 3 dps but do not accept recurring numbers	**(3)**

Question number	Answer	Additional guidance	Mark
5(a)(ii)	An explanation that includes three of the following points: • oxygen is produced by photolysis (1) • presence of PBF (on *C. pyrenoidosa*) produces {oxygen faster / more oxygen} (than *C. pyrenoidosa*)} OR PBF (alone) produces {no / very little} oxygen (1) • ({no / very little} oxygen produced by PBF) as it is {only a molecule / cannot photosynthesise} (1) • (more oxygen produced) because {more light absorbed / wider range of wavelengths absorbed / green light absorbed as well} by PBF (1)	**ACCEPT** presence of PBF means that light (intensity) is not rate limiting **ACCEPT** converse for algae alone producing less oxygen	**(3)**

Question number	Answer	Additional guidance	Mark
5(b)	An explanation that includes the following points: • because {faster light-dependent reaction / more ATP produced / more reduced NADP produced} (1) • more {GALP / glucose} produced {light-independent / Calvin cycle / carbon fixation} (by *C. pyrenoidosa*) with PBF) (1) • therefore (more) {large organic molecules / NPP / biomass} produced (1)	**ACCEPT** NADPH **DO NOT ACCEPT** NAD **ACCEPT** faster {light-independent / Calvin cycle / carbon fixation} to produce {GALP / glucose} (by *C. pyrenoidosa*) with PBF) **ACCEPT** named polymer e.g. starch, protein, cellulose	**(3)**

Question number	Answer	Additional guidance	Mark
6(a)	• {presence / entry / invasion} of a pathogen inside {cells / tissues}	**ACCEPT** named pathogen e.g. bacteria / virus / viral genetic material / *Plasmodium* / sporozoites / merozoites named {cell / tissue} if correct **IGNORE** body	**(1)**

Question number	Answer	Mark
6(b)(i)	The only correct answer is **B** *A is incorrect because the rate = 229 × 10^6 ÷ 4.09 × 10^5 = 559.9 = 600* *C is incorrect because the rate = 229 × 10^6 ÷ 4.09 × 10^5 = 559.9 = 600* *D is incorrect because the rate = 229 × 10^6 ÷ 4.09 × 10^5 = 559.9 = 600*	**(1)**

Question number	Answer	Mark
6(b)(ii)	The only correct answer is **D** *A is incorrect because 274 000 : (409 000 – 274 000) = 274 000 : 135 000 = 2 : 1* *B is incorrect because 274 000 : (409 000 – 274 000) = 274 000 : 135 000 = 2 : 1* *C is incorrect because 274 000 : (409 000 – 274 000) = 274 000 : 135 000 = 2 : 1*	**(1)**

Question number	Answer	Additional guidance	Mark
6(c)(i)	An explanation that includes three of the following points: • sporozoites more accessible to immune system (than other stages) (1) • because memory cells need to be generated (against the sporozoites) (1) • so that they will be destroyed by (secondary) immune response (1) • to prevent them {entering liver cells / damaging liver cells } (1)	**ACCEPT** converse idea for merozoites **ACCEPT** description of destruction by secondary immune response e.g. phagocytosis by macrophages **BUT NOT IN THE CONTEXT OF THE PRIMARY RESPONSE** **DO NOT ACCEPT** antibodies destroy **ACCEPT** before they can develop into merozoites	**(3)**

Question number	Answer	Additional guidance	Mark
6(c)(ii)	An explanation that includes three of the following points: • because {the immune response takes time to develop / phagocytes may not be able to engulf all the sporozoites} (1) • therefore a chemical needed to kill the sporozoites {in the vaccine / that get into the liver / so that they cannot produce merozoites} (1) • second chemical needed to kill the merozoites in case the first chemical does not kill all the sporozoites (1) • to avoid the risk of the person developing malaria (from the live sporozoites in the vaccine) (1)	**ACCEPT** the vaccine may be ineffective / the person may have a weakened immune system / the immune system may not destroy all the sporozoites **ACCEPT** weaken / reduce the number of **IGNORE** in case one chemical does not work	**(3)**

Question number	Answer	Additional guidance	Mark
6(c)(iii)	An explanation that includes three of the following points: • because the two strains of sporozoites had (some) same antigens (1) • and the vaccine stimulated {an immune response / memory cells / production of antibodies} (to these common antigens) (1) • because a secondary immune response took place (1) • and both types of sporozoites {were destroyed (by the immune system) / engulfed by macrophages} (1)	**ACCEPT** (surface) {molecules / proteins} **ACCEPT** (surface) {molecules / proteins}	**(3)**

Question number	Answer	Additional guidance	Mark
7(a)(i)	• 16.82 / 16.83 / 16.87 / 16.8 / 16.9 / 17 (1)		**(1)**

Question number	Answer	Additional guidance	Mark
7(a)(ii)	A description that includes two of the following points: • used to make {amino acids / proteins} needed for growth (1) • used to make enzymes for chemical reactions • used to make DNA {which contains the genetic code / when (plant) cells divide} (1) • used to make ATP needed {as a source of energy / named process} (1) • used to make {chlorophyll / named light absorbing pigment} to <u>absorb</u> light for {light-dependent stage / photolysis} (1)	**ACCEPT** used to make amino acids to make {proteins / enzymes} used to make membrane transport proteins **ACCEPT** named enzyme in named chemical reaction **ACCEPT** used to make {bases / named base} to make {DNA / RNA / nucleic acids} **ACCEPT** used to make adenine to make {ADP / ATP}	**(2)**

Question number	Answer	Additional guidance	Mark
7 (b)(i)	• 74 (%) (1)	**DO NOT ACCEPT** any other valuw	**(1)**

Question number	Answer	Additional guidance	Mark
7 (b)(ii)	• 1.5×10^{12} / 1.54×10^{12} (kg) (1)		**(1)**

Question number	Answer	Mark
*7(b)(iii)	**Indicative content:** **Aspect 1 : Phytoplankton** • more phytoplankton results in more photosynthesis • absorbing more carbon dioxide from the air • therefore less greenhouse gases • so less infra red radiation trapped • reducing global warming • release of nutrients into oceans will increase number of phytoplankton • because they use the nitrate for growth and division **Aspect 2 : Animals other than whales** • so there will be more carbon dioxide released into the air • due to respiration • which would increase global warming • increase in phytoplankton will increase numbers of whales / other animals **Aspect 3 : Whales** • more whales more carbon dioxide from respiration • more whales more nitrates released • there would be a lot of carbon stored in the whale's body • as {carbohydrate / protein / fat} • whale acts as a carbon sink • dead {whales / organisms} decompose very slowly • as conditions unfavourable for {decomposers / decomposition} • therefore this carbon will not be released back into the atmosphere as carbon dioxide • helping to reduce global warming **Aspect 4 : Decomposition of phytoplankton and other animals** • increase in phytoplankton and other animals means more dead organisms • so more decomposition • releasing {methane / carbon dioxide} into the atmosphere • due to respiration by microorganisms • increasing global warming	**(6)**

		Additional guidance
Level 0	No awardable content	
Level 1	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context.	1 mark = one simple comment 2 marks = simple comments
Level 2	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts / concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure.	3 marks = simple discussion of one aspect 4 marks = detailed discussion of one aspect AND simple discussion of one other aspect OR simple discussion of three aspects
Level 3	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant biological facts / concepts. Consequences are discussed which supported throughout by sustained linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	5 marks = detailed discussion of one aspect AND simple discussion of two other aspects OR detailed discussion of two aspects 6 marks = detailed discussion of two aspects AND simple discussion of two other aspects OR detailed discussion of three aspects

Question number	Answer	Additional guidance	Mark
8(a)	An explanation that includes two of the following points: • because if existing trees are destroyed {carbon dioxide / carbon} will be released (back into the atmosphere) (1) • because they are {established / native} and therefore more resistant to {fires / storms / drought / disease / protect from soil erosion} (1) • because they are {homes / source of food} to other species (animals) (1)	**ACCEPT** existing forests are carbon sinks established trees are already removing (high levels of) carbon dioxide (from the atmosphere) new trees would remove less carbon dioxide (from the atmosphere) **ACCEPT** human dependent on them for {food / medicines}	**(2)**

Question number	Answer	Additional guidance	Mark
8(b)	An answer that includes two of the following points: • because the local people rely on the land (that is planned for reforestation) (1) • local people need to {understand the issues / be onside / feel that there livelihoods are safe / protect the trees} (1) • local people will understand {the area / climate / their land use / animals} better (1)	**ACCEPT** named land use organisations need to be aware of the needs of the local people **IGNORE** avoid conflicts	**(2)**

Question number	Answer	Additional guidance	Mark
8(c)	An explanation that includes the following points: • to avoid {destroying / disturbing / competition with} other ecosystems when planting trees (1) • as this would result in the {loss / decrease} of {other species / biodiversity} • to avoid destroying the {homes / farmland} of the local people by planting trees (1) • as this would cause {resentment / hunger / loss of income} (1) • to join together fragments of remaining forests / reduce isolation (of a particular) species by planting trees (1) • increase genetic diversity / prevent loss of genetic diversity (1) • {conditions / named condition} at the site of original forest must be appropriate (for those trees) (1) • therefore reforestation will be {faster / more effective / more likely to be successful} (1)	**NB** max 3 for reasons without explanations (reasons = mp 1, 3, 5 and 7) e.g. soil type, rainfall, temperature, nutrient levels **DO NOT ACCEPT** when clearly written in the direct context of succession	**(4)**

Question number	Answer	Additional guidance	Mark
8(d)	An explanation that includes four of the following points: • (overall) to increase biodiversity (1) • native species because they are adapted for the conditions (1) • native species as they will support the indigenous wild life of the area **OR** native species to avoid the risk of non-native species outcompeting the native species (1) • endangered species to avoid {extinction / inbreeding / drop in genetic diversity} (1) • genetically-diverse species to expand the gene pool (1)	**ACCEPT** increase gene flow increase biodiversity within that species **ACCEPT** increase biodiversity within that species	**(4)**

Question number	Answer	Additional guidance	Mark
9(a)(i)	A description that includes the following points: • use the (liver / rectal / core) temperature (immediately) (1) • use the graph and this temperature to get the {number of hours after death / time (after death)} (1) • subtract this value from the time of finding the corpse (1)	**NB** be careful not to award time of death **ACCEPT** work backwards using the graph	**(3)**

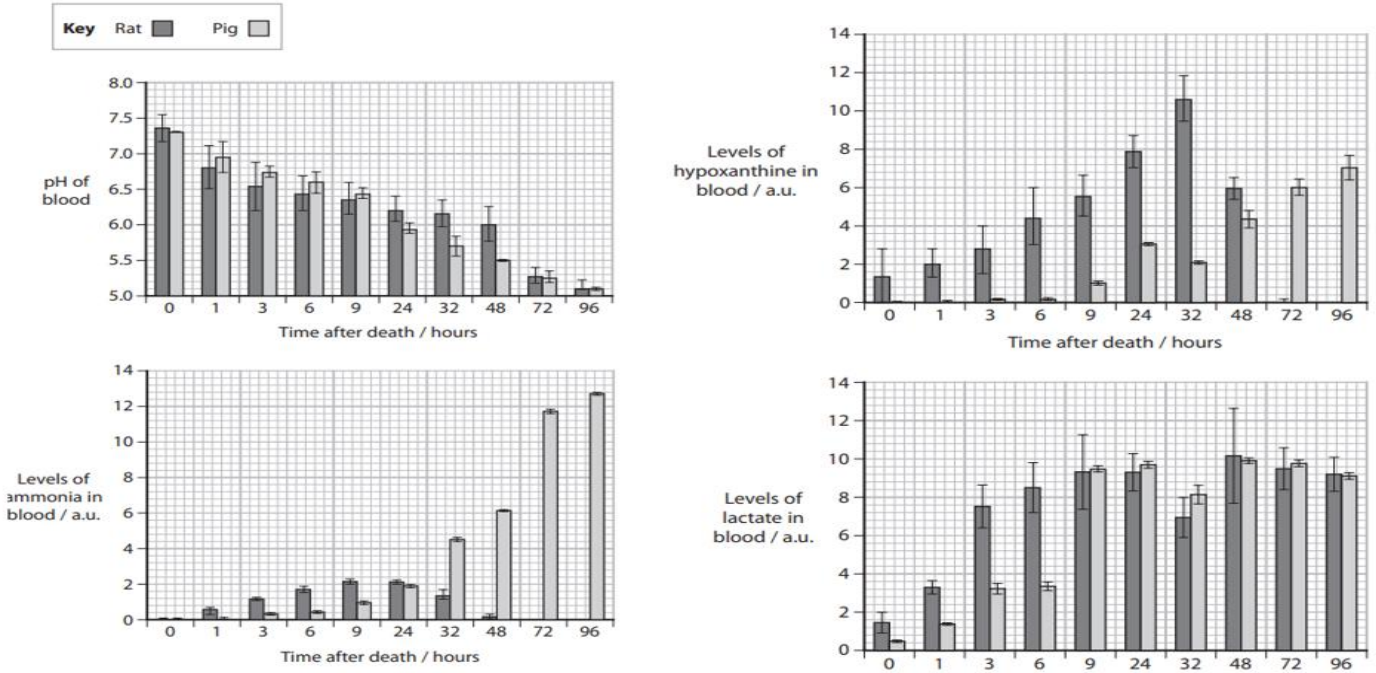
Question number	Answer	Additional guidance	Mark
9(a)(ii)	An explanation that includes the following points: • {other factors / named factor} affects {heat loss / rate of heat loss / body temperature (after death)} (1) • credit an explanation for how a named factor affects {heat loss / temperature} (1)	e.g. several hours since death body may have been moved to a cooler area e.g. {clothing / fat} {acts as an insulator / limits heat loss} cooler ambient temperature cools body faster	**(2)**

Question number	Answer	Additional guidance	Mark
9(b)(i)	• not ethical / dead person cannot give their permission / relatives may not agree / humans are genetically diverse	**IGNORE** more available similar tissues	(1)

Question number	Answer	Mark
*9(b)(ii)		(6)

Chemical tests	Discussion of usefulness
pH	
Pigs	Useful because decrease with time Useful as there is an increase with time with {small error bars / very little overlap in error bars} so timings are quite accurate
Rats	Useful because decrease with time Useful as there is an increase with time but error bars overlap so would not give accurate timings
Ammonia	
Pigs	Useful as there is an increase with time Useful as there is an increase with time with no overlap in error bars so timings will be accurate
Rats	Not very useful as {no clear patterns / no trend / data goes up and down} Not very useful because data goes up and down so one value will give two times Not useful as no ammonia after 48 hours Useful for determining that there was more than 48 hours since time of death as no ammonia present
Hypoxanthine	
Pigs	Useful as there is an increase with time Useful as there is an increase with time with no overlap in error bars so timings will be accurate Very low levels between 0 and 6 hours with overlapping error bars so may not be useful {then / until after 6 hours} There is an anomaly (at 24 hours) so this would need further investigation to see if this affects accuracy
Rats	Not very useful as {no clear patterns / no trend / data goes up and down} Only useful up to {9 hours /32 hours} Only useful up 6 hours otherwise one level could give two different timings
Lactate	
Pigs	Not very useful as {no clear patterns / no trend / data goes up and down} Could be useful up to 9 / 24 hours as there is an increase in levels / not useful after 9 /24 hours as levels fluctuate
Rats	Not very useful as {no clear patterns / no trend / data goes up and down} Could be useful up to 9 hours as there is an increase in levels / not useful after 9 hours as levels fluctuate
General	small sample size so questionable significance use more than one marker and combine results results indicate that the test are species specific overall pigs are more useful than rats

Level 1: Limited comments
1 mark = description of data for one chemical
2 marks = description of data for two chemicals
Level 2: Limited comments on usefulness
3 marks = usefulness of one chemical commented on **OR** one general comment
4 marks = usefulness of two chemicals commented on **OR** one chemical and one general comment
Level 3: Extended comments on usefulness
5 marks = usefulness of three chemicals commented on **OR** two chemicals and one general comment, that includes at least one extended comment
6 marks = usefulness four chemicals commented on **OR** three chemicals and one general comment, that includes at least one extended comment



Question number	Answer	Additional guidance	Mark
9(b)(iii)	An answer that includes three of the following points: • {pH / some chemicals} seem to have similar patterns so could be useful (in humans) (1) • some patterns seem to be species-specific so may not be useful (1) • therefore testing will need to be done (on humans) / but will the testing be {allowed / possible} (1) • credit suitable comment about {sample size / error bars} (1) • chemical tests will need to be used in conjunction with other methods (1)	**ACCEPT** pH decreases in both species so could be useful (in humans) **ACCEPT** are different in pigs and rats humans may be similar to {pigs / rats}	**(3)**

Mark Scheme (Results)

October 2023

Pearson Edexcel International Advanced Level
In Biology (WBI14)
Paper 01 Unit 4: Energy, Environment, Microbiology and Immunity

Question number	Answer	Mark
1(a)	The only correct answer is **C** *A is incorrect as photolysis takes place on the thylakoid membranes and P is a ribosome* *B is incorrect as photolysis takes place on the thylakoid membranes and R is the stroma* *D is incorrect as photolysis takes place on the thylakoid membranes and V is DNA*	(1)

Question number	Answer	Mark
1(b)	The only correct answer is **D** *A is incorrect as DNA contains genes and P is a ribosome* *B is incorrect as DNA contains genes and Q is a starch grain* *C is incorrect as DNA contains genes and S is DNA thylakoid*	(1)

Question number	Answer	Mark
1(c)	The only correct answer is **C** *A is incorrect as hydrogen ions accumulate in the thylakoids and Q is a starch grain* *B is incorrect as hydrogen ions accumulate in the thylakoids and R is the stroma* *D is incorrect as hydrogen ions accumulate in the thylakoids and V is DNA*	**(1)**

Question number	Answer	Mark
1(d)(i)	The only correct answer is **C** *A is incorrect as T, U and W are all made of phospholipids* *B is incorrect as T, U and W are all made of phospholipids* *D is incorrect as T, U and W are all made of phospholipids*	**(1)**

Question number	Answer	Mark
1(d)(ii)	The only correct answer is **A** ***B** is incorrect as phospholipids are* made of a glycerol attached to two fatty acids and one phosphate group ***C** is incorrect as phospholipids are* made of a glycerol attached to two fatty acids and one phosphate group ***D** is incorrect as phospholipids are* made of a glycerol attached to two fatty acids and one phosphate group	**(1)**

Question number	Answer	Additional guidance	Mark
1(e)	• (0.0085 cm =) 85 (µm) (1) • 7.3 (µm) (1) OR • length in cm calculated (1) • 7.3 (µm) (1)	Bald answer of 7.3 = 2 marks Bald answer of 85 (µm) = 1 mark Bald answer with the values (7.2649572 / 0.00072649572) correctly rounded but not to 2 sig figs = 1 mark Bald answer to 2 sig figs but wrong order of magnitude = 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
2(a)(i)	• pain and swelling / pain and loss of function / swelling and loss of function (1)	**ACCEPT** hurts / tender / aches / throbbing / dolor oedema / blistering	**(1)**

Question number	Answer	Additional guidance	Mark
2(a)(ii)	An explanation that includes two of the following points: • because (an increase in / high) {temperature / heat} speeds up {enzyme / lysozyme} activity (1) • pathogens destroyed faster by {phagocytes / lysozymes / neutrophils / macrophages} (1) • (high) {temperature / heat} denatures enzymes (of pathogens) so pathogens {destroyed / inhibited / cannot reproduce} (1)	**ACCEPT** destroyed by phagocytosis faster increases the immune response **ACCEPT** infected cells damaged **DO NOT ACCEPT** viruses killed	**(2)**

Question number	Answer	Additional guidance	Mark
2(b)	A description that includes two of the following points: • interferons are secreted by infected cells (1) • they are anti-viral proteins (1) • preventing {viral replication / synthesis of viral proteins / spread of virus} (1) • involved in activation of {macrophages / T killer cells} (1)	**ACCEPT** prevent viruses {entering / binding to} cells **ACCEPT** activation of cell-mediated response	**(2)**

Question number	Answer	Additional guidance	Mark
2(c)	An answer that includes *three* of the following **with the similarity:** **Similarities:** • concentration of antibody rises (and falls) in both (1) **Differences:** • antibody concentration rise {sooner / immediately} following the second infection (1) • antibody concentration rise higher following the second infection (1) • antibody concentration rise faster following the second infection (1)		**(3)**

Question number	Answer	Additional guidance	Mark
3(a)	• 8.5×10^5 (1)		(1)

Question number	Answer	Additional guidance	Mark
3(b)	An explanation that includes the following points: • (no increase in number of bacteria) because the cells had to {adjust to new environment / warm up / synthesise new enzymes} (1) • (increase in number of bacteria) as {conditions are suitable / nutrients available / pH appropriate / oxygen levels appropriate / appropriate temperature} (1)		(2)

Question number	Answer	Additional guidance	Mark
3(c)(i)	A description that includes the following points: • use serial dilutions (1) • sample {added to agar and spread / spread over agar / used to create a lawn of bacteria (on agar)} (1)	**ACCEPT** description of serial dilutions e.g. dilute several times, / add bacteria to water and repeat	(2)

Question number	Answer	Additional guidance	Mark
3(c)(ii)	An explanation that includes three of the following points: • {optical methods / turbidity} measure {total cell counts / dead and alive cells} (1) • dilution plating measure (numbers of) living bacteria (1) • therefore in the optical method number of cells stayed the same as no new cells being produced (1) • therefore in the dilution plating number of cells stayed the same as number of new cells equals cells dying **OR** therefore in the dilution plating number of cells fell as were dying (1)		**(3)**

Question number	Answer	Additional guidance	Mark
4(a)	• whole number in range of 55 to 70 (%) (1)		**(1)**

Question number	Answer	Additional guidance	Mark
4(b)(i)	A description that includes two of the following points: • {same types of / all (types) / the five types} bacteria (found in gut) in {babies fed with both milks / all babies} (1) • babies fed with breast milk had a {higher proportion of Bifidobacterium and Bacteroides / lower proportion of Enterococcus, Streptococcus and Veillonella} (1) • Bifidobacterium is the highest in babies fed with both types of milk (1)		**(2)**

Question number	Answer	Additional guidance	Mark
4(b)(ii)	An explanation that includes the following points: • to prevent the growth of pathogenic bacteria / so pathogenic bacteria cannot survive (1) • gut flora compete with other bacteria for {space / nutrients} **OR** gut flora produce {toxins / lactic acid} (1)		**(2)**

Question number	Answer	Additional guidance	Mark
4(c)	An explanation that includes three of the following points: • oligosaccharides {provide an alternative to antibiotics that the bacteria are resistant to / can be used on resistant bacteria} (1) • using oligosaccharides removes the selection pressure (1) • oligosaccharides {will have fewer side effects / will not destroy the gut bacteria} (1) • oligosaccharides will increase the gut bacteria which {can then outcompete / will reduce the number of} the {GBS / resistant bacteria} (1)	**ACCEPT** bacteria are not resistant to oligosaccharides **ACCEPT** description e.g. reduces the use of antibiotics so number of resistant bacteria does not increase	**(3)**

Question number	Answer	Additional guidance	Mark
5(a)	• 3.2×10^7 / 3.18×10^7 (1)		**(1)**

Question number	Answer	Mark
5(b)(i)	The only correct answer is **A** **B** *is incorrect because glycosidic bonds are in carbohydrate molecules* ***C*** *is incorrect because hydrogen bonds are between water molecules* ***D*** *is incorrect because there are no ionic bonds in water*	**(1)**

Question number	Answer	Mark
5(b)(ii)	The only correct answer is **B** **A** *is incorrect because ATP does not store hydrogen* ***C*** *is incorrect because plants and seaweeds do not store glycogen* ***D*** *is incorrect because RUBISCO is not a fuel*	**(1)**

Question number	Answer	Mark
5(b)(iii)	The only correct answer is **C** **A** *is incorrect because carbon dioxide and hydrogen combine during the light-independent reactions and oxygen is released during the light-dependent reactions* ***B*** *is incorrect because carbon dioxide and hydrogen combine during the light-independent reactions and oxygen is released during the light-dependent reactions* ***D*** *is incorrect because carbon dioxide and hydrogen combine during the light-independent reactions and oxygen is released during the light-dependent reactions*	**(1)**

Question number	Answer	Additional guidance	Mark
*5(c)	**Indicative content:** **Diagram 1:** • seaweed taking up space of other organisms • {fish / sea mammals} could get caught up in wires • could prevent {fishing / water sports / water activities / shipping} **Diagram 2:** • seaweed could reduce {food / habitat} of water animals • seaweed could compete with other (wild) aquatic plants for light • could provide labour for local population • increasing the economy of the area • increase in carbon dioxide removed from {atmosphere / water} / reduces greenhouse effect • machinery used to {grow / harvest} seaweed might disturb other organisms • causing them to {move away / be stressed} • interrupting food chain • presence of seaweed might provide {food source / habitat} for different species • which would compete with current species • interrupting food chain • increase biodiversity • machinery used to {transport /process} seaweed will burn fossil fuels **Other ideas:** • maybe other organisms brought into area on the seaweed • which would compete with other species for {food / habitat} • could bring in diseases • that could weaken or kill other species • will Europe have high enough {temperature / light levels} to sustain growth	**Level 1: Simple comments about aspects** 1 mark = one relevant comment 2 marks = simple comments relating to at least three aspects **Level 2: discussion about aspects linked to at least one diagram / idea** 3 marks = at least one aspect discussed in more detail 4 marks = at least two aspects discussed in more detail **Level 3: detailed discussion about aspects from both diagrams** 5 marks = at least three aspects discussed in more detail 6 marks = at least four aspects discussed in more detail which includes an idea not included in the diagram	**(6)**

Question number	Answer	Mark
6(a)(i)	The only correct answer is C **A** *is incorrect because the base is not attached to the phosphate group* ***B*** *is incorrect because the phosphate group is not attached to the base* ***D*** *is incorrect because the phosphate group and base are not attached to adjacent carbons*	**(1)**

Question number	Answer	Additional guidance	Mark
6(a)(ii)	• phosphodiester (bond / link) (1)		**(1)**

Question number	Answer	Additional guidance	Mark
6(b)(i)	An explanation that includes the following points: • as temperature increases the {rate of enzyme reactions / length of lizards} increases (1) • due to more {frequent collisions / energetic collisions} between enzymes and substrates (1) • credit a named enzyme-controlled reaction that would contribute to faster growth (1)	**ACCEPT** as rate of enzyme reactions increase the length of lizards increases increases enzyme activity **ACCEPT** due to more enzyme substrate complexes forming due to increase in kinetic energy increase in {metabolic reactions / metabolism} e.g. DNA synthesis, mitosis, protein synthesis, respiration, cell division	**(3)**

Question number	Answer	Additional guidance	Mark
6(b)(ii)	A description that includes two of the following points: • at 46 mm there is no change in the abundance of lizards (1) • as the length of the lizard increases above 46 mm there is decrease in the abundance of lizards (1) • lizards {between 44.5 and 46 mm / less than 46 mm} in length increased in abundance (1) • the length of the lizard affects its {chance of survival / abundance} (1)	**ACCEPT** shorter lizards (are more likely to) have a greater chance of survival / converse lizards of 44.5 mm (are more likely to) have greatest chance of survival	**(2)**

Question number	Answer	Additional guidance	Mark
6(b)(iii)	An explanation that includes three of the following points: • because the cells in the longer lizards would have divided more (1) • and every time a cell divides DNA synthesis takes place (1) • {shorter telomeres / damaged chromosomes} cause cell death (1) • so the longer lizards are in lower abundance / lizards die before they can grow any longer (1)	**ACCEPT** number of cell divisions increases with growth	**(3)**

Question number	Answer	Additional guidance	Mark
7(a)	An answer that includes the following points: • active immunotherapy {stimulates the immune system / causes an immune response / uses (cancer) antigens} (1) • so memory cells generated (1)	**ACCEPT** description of what is stimulated e.g. B cells, antibody production	**(2)**

Question number	Answer	Additional guidance	Mark
7(b)(i)	An explanation that includes the following points: • because a mutation causes a change in the {DNA / base} sequence (1) • and this can result in a {change in the / new} {amino acid sequence / primary structure} (1)	**ACCEPT** change in genetic code change in one base **ACCEPT** (poly) peptide change in one amino acid	**(2)**

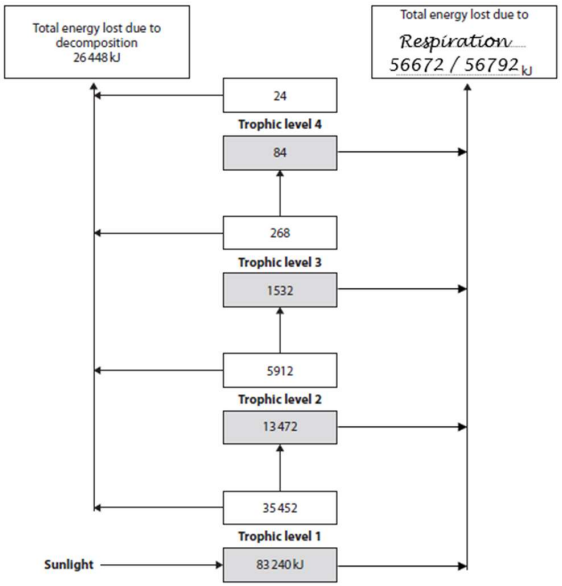
Question number	Answer	Additional guidance	Mark
7(b)(ii)	An explanation that includes four of the following points: • the mRNA results in the production of the neoantigens (1) • the body will recognise these neoantigens as foreign (1) • therefore macrophages will {engulf the neoantigens / express neoantigens on surface} (1) • and macrophages present the neoantigens to {T helper / CD4} cells (1) • which will then release cytokines to stimulate {an immune response / humoral response / cell-mediated immunity / B cells / T killer cells} (1)	**ACCEPT** mRNA translated (into neoantigens) **ACCEPT** present on surface / express on MHC **ACCEPT** macrophages become APC {to T_h cells / and T helper cells bind to {macrophage / neoantigen / MHC} **ACCEPT** chemicals for cytokines	**(4)**

Question number	Answer	Additional guidance	Mark
7(c)	An explanation that includes the following points: • because the antibodies will {bind to the neoantigens / form an antigen antibody complex} (1) • and therefore the cancer cells will be destroyed faster by the {macrophages / phagocytes} (1) **OR** • antibodies binding cancer cells together_ (1) • and therefore the cancer cells will be {destroyed faster by the macrophages / prevented from spreading} (1)	**ACCEPT** opsonisation (of cancer cells) **ACCEPT** engulfed by macrophages faster **ACCEPT** agglutination (of cancer cells) **ACCEPT** engulfed by {macrophages / phagocytes} faster	**(2)**

Question number	Answer	Additional guidance	Mark
7(d)	An explanation that includes the following points: • because large number (T helper cells) are needed to activate {B cells / T killer cells} (1) • because genetically identical cells will not be rejected (1)	**IGNORE** pathogens throughout **ACCEPT** large number (T killer cells) are needed to destroy cancer cells effects of {HI / CMI} e.g. more antibody produced **ACCEPT** need to be specific to the (cancer cell) antigens	**(2)**

Question number	Answer	Additional guidance	Mark
7(e)	An answer that includes two of the following points: • must not be {pathogenic / cause disease / cause cancer} (1) • must {be specific to / target} the {cancer cells / neoantigens} (1) • must be able to destroy the cancer cells (1)	**ACCEPT** can bind to cancer cells / can enter cancer cells / only affect cancer cells / do not affect healthy cells	**(2)**

Question number	Answer	Additional guidance	Mark
8(a)(i)	An answer that includes the following points: • 35 452 and 83 240 (1) • 43 / 42.6 / 42.59 (%) (1)	Bald answer of {43 / 42.6 / 42.59} = 2 marks Bald answer containing {too many dps / incorrect rounding with acceptable number of dps} = 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
8(a)(ii)	An answer that includes the following points: • (total energy lost to) respiration / heat (energy) (1) • (total energy lost to) 56 672 / 56 792 (1) • four arrows each coming out of a different grey box pointing to the vertical RH arrow (1)		(3)

Question number	Answer	Additional guidance	Mark
8(a)(iii)	An explanation that includes three of the following points: • because enzymes are needed to breakdown dead organisms (1) • so that the (products of) digested molecules are soluble (1) • so that the (digested) molecules can be {taken up / used} by microorganisms (1) • so that the dissolved molecules can soak into the ground (1) • important in {recycling / carbon cycle} (1)	**ACCEPT** named molecule e.g. cellulose **ACCEPT** named molecule e.g. glucose	**(3)**

Question number	Answer	Additional guidance	Mark
8(b)	An explanation that includes the following points: • (overall) {TLN / trophic level number} has increased (with time) (1) • because the (proportion of) meat in the diet has increased (1) • greatest increase in meat in diet was after 1983 (1) • people are eating less than 50 % meat (throughout the time period) (1) • because the TLN is low (1)	**ACCEPT** proportion of plants has decreased **ACCEPT** people are eating more than 50 % plants (in their diet) people eating more plants than animals / less meat than plants} **ACCEPT** below {3 / 2.5}	**(3)**

Question number	Answer	Additional guidance	Mark
9(a)(i)	• 380 and 210 / 170 / 380 and 215 / 165 (1) • 11.3 (if 210 used) / 11.0 (if 215 used) (1)	**DO NOT ACCEPT** 11.00 / 11.30 Bald answer of {11.0 / 11.3} = 2 marks Bald answer with incorrect number of sig figs = 1 mark Bald answer of {170 / 165} = 1 mark	**(2)**

Question number	Answer	Additional guidance	Mark
9(a)(ii)	• answer in the range of 468 to 470.7 to max one dp (1)		**(1)**

Question number	Answer	Additional guidance	Mark
9(a)(iii)	An answer that includes the following points: • (graph / line / plastic production shows a) non-linear increase (1)	**ACCEPT** exponential rate (of increase) is not the same fluctuates increasing gradient	(1)

Question number	Answer	Additional guidance	Mark
9(b)(i)	A description that includes two of the following points: • (the probability of death increases as the number of pieces of plastic increases in a) {S / sigmoidal} (shape) (1) • there is a critical number of pieces of plastic above which the probability of death increases sharply (1) • probability of death is zero when number of pieces of plastic is very low (1)	**ACCEPT** description e.g. shallow increase then a sharp increase and then a shallow increase but non-linear positive correlation **ACCEPT** above a certain number of pieces . . . . . . **ACCEPT** rapid increase **ACCEPT** below a certain number of pieces of plastic the probability is zero	(2)

Question number	Answer	Additional guidance	Mark
9(b)(ii)	A description that includes two of the following points: • cause of death of the turtles not known (1) • therefore {no direct evidence that the plastic did cause the death of the turtles / correlation not causation} (1) • the size of the plastic was not taken into account (1) • {species / size} of turtle not known (1) • no indication of timescale of plastic inside turtle (1) • no values given on the graph (1)	**ACCEPT** other factors may have caused death **ACCEPT** mass / type **ACCEPT** age of turtle	**(2)**

Question number	Answer	Additional guidance	Mark
*9(c)	**Graph 1:** • fewer mangoes are diseased (D) • so they will be more edible / less wastage • so more food to go round • increase profits of mango-producing countries **Graph 2:** • less mass is loss than no packaging / (slightly) more mass lost than plastic (D) • which is probably due to dehydration of the mango • therefore fruit will be more succulent • and add water to the diet • important in arid countries **Table:** • decomposes relatively quickly (D) • therefore biodegradable • will not be any plastics to go into the sea / land fill sites • so less damage to wild life • less interruption to food chain • contributes to carbon cycle **Other ideas:** • sustainable / carbon neutral • more banana plants grown reducing carbon dioxide levels • maybe less toxic • production of plastic results in burning of fossil fuels • plastics not always available to countries producing mangos • using plastic adds more to cost of mangos • plastics are expensive	**Level 1: simple** 1 mark = data in {one graph / table} described 2 marks = data in {both graphs / one graph and table} described **OR** one advantage described **Level 2:** advantages described 3 marks = one advantage discussed in detail **OR** two advantages described 4 marks = two advantages discussed in detail **OR** three advantages described **Level 3:** extended discussion 5 marks = three advantages discussed in detail **OR** four advantages described 6 marks = as for 5 marks but covers 3 sections	**(6)**

Pearson Edexcel

Mark Scheme (Results)

January 2024

Pearson Edexcel International Advanced Level In Biology (WBI14)

Paper 01: Energy, Environment, Microbiology, and Immunity

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)**

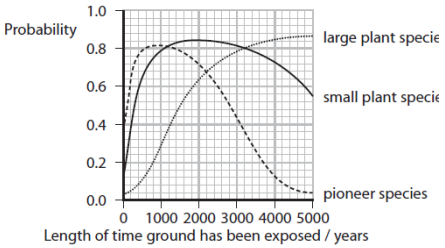
Question number	Answer	Mark
4(b)	The only correct answer is **B** **A** *is incorrect because pioneer species will not grow on the ice* ***C*** *is incorrect because pioneer species grow on newly exposed ground* ***D*** *is incorrect because pioneer species grow on newly exposed ground*	**(1)**

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:

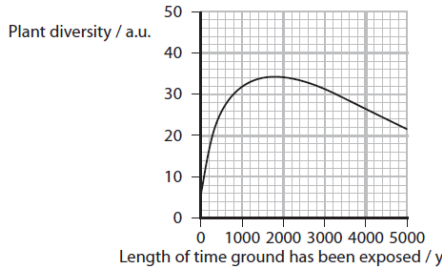
Graph 1 possible explanations :

- 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)**

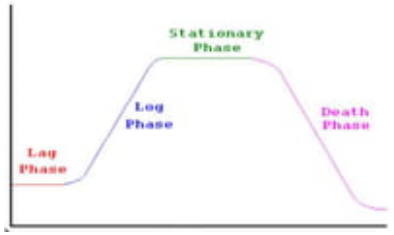
Question number	Answer	Additional guidance	Mark
6(c)	An explanation that includes the following points: • remove a (small) sample from {base of tree / trunk} (1) • {count / determine} the (number of) rings (of growth) (1) • because {one ring is equivalent to one year of growth / one ring is made each 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)**

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>8(a)</td><td>
<table>
<tr><th rowspan="2">Statement</th><th colspan="4">Type of artificial immunity</th></tr>
<tr><th>both active and passive</th><th>active only</th><th>passive only</th><th>neither active nor passive</th></tr>
<tr><td>Antigens are injected into the person</td><td>☐</td><td>☒</td><td>☐</td><td>☐</td></tr>
<tr><td>Immunity is long term</td><td>☐</td><td>☒</td><td>☐</td><td>☐</td></tr>
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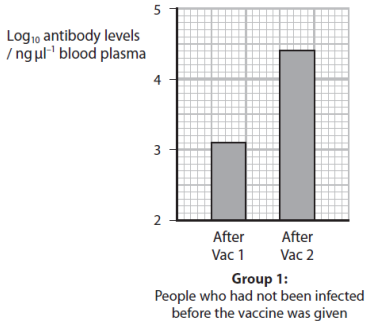
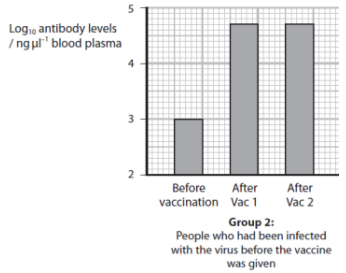
Question number	Answer	Additional guidance	Mark
8(b)	A description that includes two of the following points: • T (helper) cells release cytokines (to stimulate B cells) **OR** • T (helper) cells activate B cells (1) • B cells {differentiate into / specialise into} plasma cells (that produce antibodies) (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

Mark Scheme (Results)

Summer 2024

Pearson Edexcel International Advanced Level
In Biology (WBI14) Paper 01
Energy, Environment, Microbiology, and Immunity

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 ß-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** **A** *is incorrect because green seaweed reflects green light* ***B*** *is incorrect because green seaweed reflects green light* ***D*** *is incorrect because green seaweed can absorb red light*	**(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** **A** *is incorrect because antigenic means can stimulate an immune response* ***C*** *is incorrect because epigenetic means a change in gene expression* ***D*** *is incorrect because polygenic means many genes determining a characteristic*	**(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 wont 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 wont 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** *A is incorrect because cellulose is made of beta glucose* *B is incorrect because cellulose is made of beta glucose and has 1 – 4 glycosidic bonds only* *D is incorrect because cellulose has 1 – 4 glycosidic bonds only*	**(1)**

Question number	Answer	Mark
4(a)(ii)	The only correct answer is **A** *B is incorrect because bacteria do not have nuclei* *C is incorrect because bacteria do not have nuclei* *D is incorrect because enzymes are released by exocytosis*	**(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** **A** *is incorrect because Ebola has RNA* ***B*** *is incorrect because Ebola has RNA* ***D*** *is incorrect because Ebola has RNA*	**(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)	**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	
	• T killer cells release {perforins / chemicals / enzymes} (1)	**ACCEPT** {CD8 / cytotoxic} cells	
	• that will cause the {cancer / virus infected} cells to {burst / lyse} (1)	**IGNORE** destroy	
	• T helper cells produce cytokines to activate B cells (1)	**ACCEPT** CD4 cells for T helper cells	
	• 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** resulting in opsonisation / agglutination **IGNORE** easier	**(4)**

Question number	Answer	Mark
6(a)	The only correct answer is **A** **B** *is incorrect because (120 – 74) ÷ 120 = 0.383333333333* ***C*** *is incorrect because (120 – 74) ÷ 120 = 0.383333333333* ***D*** *is incorrect because (120 – 74) ÷ 120 = 0.383333333333*	**(1)**

Question number	Answer	Mark
6(b)(i)	The only correct answer is **C** **A** *is incorrect because 3200 ÷ 6.25 = 512* ***B*** *is incorrect because 3200 ÷ 6.25 = 512* ***D*** *is incorrect because 3200 ÷ 6.25 = 512*	**(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 μg cm^{-3}} (1) • none of the heavy metals kill bacteria at concentrations up to 100 μg 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 *Vibrio* are killed at high concentration of Cu and Ni / chromium does not kill all the *Vibrio* at {high concentrations (tested) / at concentrations of 3200 μg cm^{-3}} (1)	**ACCEPT** mark points in context of survival **ACCEPT** a minimum concentration of 100 μg cm^{-3} is needed below 100 μg cm^{-3} **ACCEPT** Vibrio is most {tolerant / resistant} to Cr / Vibrio is least {tolerant / resistant} to Cu **IGNORE** efficient **ACCEPT** no conclusion can be made about chromium above concentrations of 3200 μg 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) by diffusion (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** **A** *is incorrect because the mean is the sum of all values divided by the number of values* ***C*** *is incorrect because mode is the most common value* ***D*** *is incorrect because standard deviation is a measure of variance*	**(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

Mark Scheme (Results)

October 2024

Pearson Edexcel International Advanced Level
In Biology (WBI14)
Paper 01 Energy, Environment, Microbiology, and Immunity

Question number	Answer	Additional guidance	Mark
1(a)	An answer that includes two of the following points: • not all wavelengths of light can be absorbed (by the plant) (1) • green light is reflected (off the leaf) (1) • not all the light falls on the leaves (1) • {transmitted through/ passes through} {leaf / chloroplast / chlorophyll} (1)	**IGNORE** shading / competition **ACCEPT** colours	**(2)**

Question number	Answer	Additional guidance	Mark
1(b)(i)	• 1.1×10^5 / 1.13×10^5 / $1.1 \cdot 10^5$ / $1.13 \cdot 10^5$ (1)	**ACCEPT** 1.10×10^5 **DO NOT ACCEPT** 1.13×10^5 recurring	**(1)**

Question number	Answer	Additional guidance	Mark
1(b)(ii)	• 25 (1)	**DO NOT ACCEPT** 25.0	**(1)**

Question number	Answer	Additional guidance	Mark
1(b)(iii)	• 0.02 / 0.016 / 0.0162 / 2×10^{-2} / 1.6×10^{-2} / 1.62×10^{-2} (%) (1)		(1)

Question number	Answer	Additional guidance	Mark
2(a)(i)	An explanation that includes the following points: • {to amplify / to increase the sample / to increase the number of copies} (of DNA) (1) • so that there is {enough / more} to {analyse / use in profiling / use in gel electrophoresis} (1)	**ACCEPT** (DNA) samples are too small **DO NOT ACCEPT** to increase the length of DNA **ACCEPT** so will not be enough to analyse **IGNORE** easier / more accurate	(2)

Question number		Additional guidance	Mark
2(a)(ii)	A description that includes two of the following points: • to bind to the {DNA / primers} (1) • and line up the nucleotides along the DNA strands (1) • and form phosphodiester bonds between the nucleotides (on one strand) (1)	**ACCEPT** forms a (new) strand of DNA / adds nucleotides to the new strand / helps in formation of hydrogen bonds between base pairs / causes complementary base pairing	**(2)**

Question number	Answer	Mark
2(b)(i)	The correct answer is **B (restriction enzyme)** ***A*** *is incorrect because integrase joins viral DNA into host DNA* ***C*** *is incorrect because reverse transcriptase makes a DNA copy of RNA* ***D*** *is incorrect because RUBISCO is involved in the light-independent stages of photosynthesis*	**(1)**

Question number	Answer	Additional guidance	Mark
2(b)(ii)	An answer that includes three of the following points: • the (original) broccoli and the {genetically modified / clubroot resistant} broccoli **OR** the linseed and the {genetically modified / clubroot resistant} broccoli (1) • genetically modified plants to check that the resistance gene had been inserted (1) • the original plants to identify the broccoli bands (1) • the linseed to identify the resistance {genes / bands} (1)	**NB Piece together** **ACCEPT** bands with resistance gene **ACCEPT** idea that the linseed profile is compared to modified broccoli to find a {common / over-lapping} band to show successful modification = 3 marks	**(3)**

Question number	Answer	Additional guidance	Mark
3(a)	A description that includes two of the following points: • (complex) transported to the Golgi (apparatus / body) (in vesicles) (1) • transported in vesicles (from the Golgi through the cytoplasm) to the (surface) membrane (1) • (released onto surface) by fusion of vesicles with membrane (1)	**ACCEPT** exocytosis from the (surface) {membrane / cell}	**(2)**

Question number	Answer	Additional guidance	Mark
3(b)(i)	• 0.37 (nm) (1)	3.7×10^{-1}	(1)

Question number	Answer	Additional guidance	Mark
3(b)(ii)	• the microscope is able to distinguish two lines if they are {3.7 Ä / 0.37 nm} or more apart (1)	**ACCEPT** value given in (i) structures / objects / points different / separate e.g minimum distance of 3.7 angstroms required for two things to be seen apart if two objects are closer together than 3.7 angstroms they appear as a single object **IGNORE** particles resolve / clear / more detail / quality / focus **DO NOT ACCEPT** magnification	(1)

Question number	Answer	Additional guidance	Mark
3(c)	An explanation that includes two of the following points: • because antigen presentation is needed to activate the T killer cells (1) • so that T killer cells will divide (1) • so that there are {enough / many} T killer cells to {destroy / lyse / release perforins onto} the host-infected cells (1)	**ACCEPT** cytotoxic T cells / CD8 cells throughout **ACCEPT** initiate CMI / clonal selection **ACCEPT** clone / clonal expansion **ACCEPT** chemicals / enzymes / proteases cause apoptosis	**(2)**

Question number	Answer	Additional guidance	Mark
3(d)	An explanation that includes the following points: • T killer cells {destroy / lyse / perforate} the {infected / host} cells (1) • releasing {viruses / viral components} (1) • so that macrophages can destroy them (1)	**ACCEPT** pathogen but not bacteria **IGNORE** damaged **DO NOT ACCEPT** virus / antigen **ACCEPT** phagocytes / phagocytosis of virus / virus engulfed / virus digested virus particles will not assemble (if components not inside a cell) **DO NOT ACCEPT** kills virus / T killer cells phagocytose / antibodies destroy	**(3)**

Question number	Answer	Mark
4(a)(i)	The correct answer is **C (forensic entomology)** ***A*** *is incorrect because chromatography is a separation method* ***B*** *is incorrect because dendrochronology is the study of tree growth rings* ***D*** *is incorrect because heterozygosity is a measure of genetic diversity*	**(1)**

Question number	Answer	Mark
4(a)(ii)	The correct answer is **D (1, 2 and 3)** ***A*** *is incorrect because all three factors provide the information* ***B*** *is incorrect because all three factors provide the information* ***C*** *is incorrect because all three factors provide the information*	**(1)**

Question number	Answer	Mark
4(b)(i)	The correct answer is **B (pushing a temperature probe into the liver)** ***A*** *is incorrect because this would measure external temperature of body + air temperature effect* ***C*** *is incorrect because the mouth is not deep inside the body* ***D*** *is incorrect because the arm pit is not inside the body*	**(1)**

Question number	Answer	Mark
4(b)(ii)	The correct answer is **A (increase, increase)** ***B*** *is incorrect because more clothing will keep the body warmer and increase the time estimate + higher ambient temperature would reduce heat loss and increase the estimate* ***C*** *is incorrect because more clothing will keep the body warmer and increase the time estimate + higher ambient temperature would reduce heat loss and increase the estimate* ***D*** *is incorrect because more clothing will keep the body warmer and increase the time estimate + higher ambient temperature would reduce heat loss and increase the estimate*	**(1)**

Question number	Answer	Additional guidance	Mark
4(c)(i)	An explanation that includes the following points: • ATP decreases as {oxygen levels / aerobic respiration (by muscle cells)} decrease (1) • lactic acid increases as anaerobic respiration (in muscle cells) takes place (1) • pH decreases because of the {production of / increase in} lactic acid (1)	**ACCEPT** used during muscle relaxation drop in pH reduces ATP synthase activity	**(3)**

Question number	Answer	Additional guidance	Mark
4(c)(ii)	An explanation that includes three of the following points: • because muscle contraction increases and decreases (with time after death) (1) • gives two different estimates (1) • (degree of) muscle contraction affected by {other factors / named factor} (1) • judging (extent of) muscle contraction is subjective (1)	**ACCEPT** stiffen and relax idea that muscles will be relaxed before and after contraction **ACCEPT** two quoted times that extent of contraction is the same only useful between 2.4 and 36 hours after death cannot estimate the TOD after 36 hours as the muscles will be relaxed similar contraction at {flat region / between 15 to 23 hours}	**(3)**

Question number	Answer	Additional guidance	Mark
5(a)	• (a series of) changes in the (types of) species (within a habitat) with time (1)		**(1)**

Question number	Answer	Mark
5(b)	The correct answer is **B (a place that meets the environmental conditions as organism needs to survive)** ***A*** *is incorrect because it describes a community of organisms* ***C*** *is incorrect because it describes a population* ***D*** *is incorrect because an organism's niche is its role*	**(1)**

Question number	Answer	Mark
*5(c)	**Early changes:** • bare rock needs breaking down • by pioneer species / presence of alder and spruce • soil conditions improve when organisms die **Increase in numbers of plants:** • alder / spruce one of first plants to appear • because early soil is suitable / early stages of succession have to take place • because seeds brought in • numbers of alder / spruce rise • because the plants reproduce • alder reproduces faster than spruce • because there is little competition from other plants • hemlock last of the three plants to appear • because seeds brought in later • because early soil is not suitable for this plant • numbers of hemlock increase • because of reproduction **Numbers of hemlock become stable:** • because only this number can be supported by the environment • because still too many spruce trees present **Decrease in number of plants:** • numbers of alder / spruce fall • due to competition for {water / light / mineral ions / space} • due to disease • number of alder fall / drop to zero • because spruce out competes alder for {water / light / mineral ions / space} • because spruce is taller / grows faster • affected more by the appearance of hemlock • spruce numbers do not fall to zero • numbers of hemlock are not high enough to completely out compete the species • climax community not yet reached **Numbers of alder remain at zero:** • because they are {extinct / (completely) eaten by animals / disease has wiped them out}	(6)

			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 descriptions / limited explanation of the data 1 mark = a description of some changes 2 marks = a simple explanation for one aspect of data **OR** an account of succession with no reference to the changes shown
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 of the changes 3 marks = simple explanations for two aspects of data 4 marks = simple explanations for three aspects of data
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 of the changes 5 marks = plus one additional detailed explanation 6 marks = plus two additional detailed explanations

Question number	Answer	Mark
6(a)(i)	The correct answer is **A ($\frac{5}{11}$)** ***B*** *is incorrect because it is (3.3-1.8) ÷ 3.3 =* $\frac{5}{11}$ ***C*** *is incorrect because it is (3.3-1.8) ÷ 3.3 =* $\frac{5}{11}$ ***D*** *is incorrect because it is (3.3-1.8) ÷ 3.3 =* $\frac{5}{11}$	**(1)**

Question number	Answer	Mark
6(a)(ii)	The correct answer is **B (logarithmic)** ***A*** *is incorrect because this is already a linear scale* ***C*** *is incorrect because standard deviation is not an axis scale* ***D*** *is incorrect because standard form is not an axis scale*	**(1)**

Question number	Answer	Additional guidance	Mark
6(b)	An answer that includes the following points: • each subtype had {same / similar} antigens (1) • the vaccine contained {two types / more than one type} of antigen (1)	**ACCEPT** vaccine contained two types of {attenuated / deactivated} virus vaccine stimulates production of more than one type of antibody	**(2)**

Question number	Answer	Additional guidance	Mark
6(c)(i)	An explanation that includes five of the following points: • the vaccine contained (RSV) antigens (1) • the (mother's) immune response was initiated (1) • credit details of humoral immune response (1) • plasma cells released antibodies (to RSV) (1) • these antibodies will pass across the placenta (to fetus) (1) • and remained in the blood until after the baby was born (1)	**ACCEPT** {inactivated / attenuated} {virus / RSV} **DO NOT ACCEPT** dead virus e.g. macrophages presented antigen to T helper cells / cytokines released from T helper cell stimulated B cells / activated B cells differentiated into plasma cells **IGNORE** details of CMI **ACCEPT** antibodies passed from mother's blood into fetus **DO NOT ACCEPT** baby {cells / blood} pass into fetal blood **ACCEPT** remain in the blood temporarily	**(5)**

Question number	Answer	Additional guidance	Mark
6(c)(ii)	An answer that includes three of the following points: • pregnant women were used and were given the (RSV) vaccine (1) • one large group of {pregnant vaccinated women / babies of these pregnant vaccinated women / babies with passive immunity to RSV} (1) • babies (from vaccinated pregnant women) monitored for a period of time (1) • number of babies who developed RSV infections requiring medical attention and number not requiring medical attention recorded **OR** number of babies who developed RSV not requiring medical attention divided by the total number of infected babies (× 100) (1)	**ACCEPT** stated period of time up to 2 years **ACCEPT** converse for calculating percentage who did need medical attention	**(3)**

Question number	Answer	Additional guidance	Mark
7(a)	An explanation that includes four of the following points: • without chloroplasts the plant will not be able to {photosynthesise / absorb light} (1) • {bacteria living in the xylem / sticky gum} could prevent {water / mineral ions} {reaching the leaves / being transported (up)} (1) • no water for {photolysis / hydration / turgidity} (1) • no magnesium ions for chlorophyll (1) • no {GALP / glucose} will be synthesised (1)	**NB ACCEPT** less for no, throughout **ACCEPT** white parts / streaks will not photosynthesise no light-dependent reaction **IGNORE** mineral ions **ACCEPT** other named ion and function that would prevent photosynthesis from occurring or plant dying **ACCEPT** named molecule e.g. sucrose / chlorophyll biomass no ATP	**(4)**

Question number	Answer	Additional guidance	Mark
7(b)(i)	A description that includes the following points: • DNA in prokaryotic cells is {circular / looped} and in human cells is linear (1) • DNA in prokaryotic cells has (one) more phosphodiester bond than human cells (of the same number of nucleotides) (1)	**PIECE TOGETHER THROUGHOUT** **IGNORE** numbers of strands / double helix / plasmids / non-structural comments **ACCEPT** prokaryotes do not have 3' and 5' ends but human cells do **ACCEPT** prokaryotes have no unbound phosphate group but humans do	**(2)**

Question number	Answer	Additional guidance	Mark
7(b)(ii)	An answer that includes the following points: • because the bacteria will {die / not be able to grow / will not be able to divide} (due to the inability of DNA to supercoil) (1) • human cells do not have {DNA gyrase / the enzyme} / <u>only</u> bacteria have the enzyme affected (1) • therefore human cells will not be {affected / damaged / harmed} (1)	**NB ACCEPT** pathogen or bacteria or prokaryotic cell throughout **ACCEPT** bactericidal / bacteriostatic **IGNORE** consequences of no supercoiling **DO NOT ACCEPT** in context of no {chloroplasts / xylem}	**(3)**

Question number	Answer	Additional guidance	Mark
7(b)(iii)	An explanation that includes the following points: • because bacteria are becoming (increasingly) resistant to antibiotics (1) • so we will not be able to treat {antibiotic-resistant bacteria / diseases / infections} (1)	**ACCEPT** pathogens because bacteria will not be resistant to new antibiotics to win the evolutionary race **DO NOT ACCEPT** viruses **ACCEPT** so people will not die from bacterial infections	**(2)**

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr><td>8(a)</td><td>

- (radius calculated) 37 / 25 (1)
- (radius converted into mm) 0.037 / 0.025 (1)
- (mm^3) expressed to max of 3 sig figures (1)

</td><td>

ECF if 62 is used

ACCEPT standard form
ECF for wrong conversion

Correct bald answer = 3 marks, but with wrong order of magnitude = 2 marks or too many sig figs = 2 marks, or both order of magnitude and too many sig figs = 1 mark
Correct bald answer for d = 62 = 2 marks, but with wrong order of magnitude = 1 mark or too many sig figs = 1 mark

D	R (μm)	R(mm)	R3	π	4×π×R3	÷3	1 sig fig	2 sig figs	3 sig figs	Stand for
	mp 1	mp 2					mp 3	mp 3	mp 3	
74	37	0.037	0.000050653	3	0.000608	0.0002026	0.0002	0.00020	0.000203	10 -4
74	37	0.037	0.000050653	3.14	0.000636	0.000212067	0.0002	0.00021	0.000212	10 -4
74	37	0.037	0.000050653	3.142	0.000637	0.000212202	0.0002	0.00021	0.000212	10 -4
74	37	0.037	0.000050653	3.141593	0.000637	0.000212175	0.0002	0.00021	0.000212	10 -4
50	25	0.025	0.000015625	3	0.000188	0.0000625	0.00006	0.000063	0.0000625	10 -5
50	25	0.025	0.000015625	3.14	0.000196	6.54167E-05	0.00007	0.000065	0.0000654	10 -5
50	25	0.025	0.000015625	3.142	0.000196	6.54583E-05	0.00007	0.000065	0.0000655	10 -5
50	25	0.025	0.000015625	3.141593	0.000196	6.54498E-05	0.00007	0.000065	0.0000654	10 -5
62		0.031	0.000029791	3	0.000357	0.000119164	0.0001	0.00012	0.000119	10 -4
62		0.031	0.000029791	3.14	0.000374	0.000124725	0.0001	0.00012	0.000125	10 -4
62		0.031	0.000029791	3.142	0.000374	0.000124804	0.0001	0.00012	0.000125	10 -4
62		0.031	0.000029791	3.141593	0.000374	0.000124788	0.0001	0.00012	0.000125	10 -4

</td><td>(3)</td></tr>
</table>

Question number	**Answer**	**Additional guidance**	**Mark**
8(b)(i)	15 / 15.0	**DO NOT ACCEPT** any other values	**(1)**

Question number	**Answer**	**Additional guidance**	**Mark**
8(b)(ii)	A description that includes the following points: • credit for appropriate {sample to be used / details of method} (1) • {stain / dye} {plates / (plates and) cells} (1) • credit what is being compared that would work (1)	e.g. cells and shed plates / two groups of cells / one large group of cells / put together in a tank of sea water / use a microscope **ACCEPT** marker / fluorescent tag **IGNORE** genetic profiling / gel electrophoresis / carbon dating **NB** if using unstained plates and unstained (naked) *E. huxley* this mark would be awarded for use of microscope and something else would be credited in mp 1 e.g. coloured plates attached to cells / cells different colour to plates **ECF** DNA profiling / gel electrophoresis : different bands on plates and cells **ECF** carbon dating : differences in	**(3)**

		year plates produced	

Question number	Answer	Mark
*8(b)(iii)	**Effect of healthy *E. huxleyi*:** • carbon dioxide absorbed from the oceans to make plates • carbon dioxide absorbed for photosynthesis **Effect of marine snow :** • {decomposers / increase in animals feeding on snow} respire • {releasing carbon dioxide / increasing carbon dioxide} levels in {water / air} • so more carbon dioxide will be released from water into air • plates sunk to the bottom of the ocean will act like a carbon sink • therefore carbon dioxide levels {will not increase / fall} in {water / air} • as {no / less} carbon dioxide will dissolve in the water from the air • {plates / *E. huxleyi*} stuck together will have a lower surface area • so will absorb less carbon dioxide from {water / air} • so less carbon dioxide will dissolve in the water from the air • marine snow will block light reaching {seaweeds / plants} • so less photosynthesis so less carbon dioxide removed from {water / air} • less carbon dioxide will be absorbed by the water from the air **Effects on global warming / climate change:** • more / less carbon dioxide accumulates in atmosphere so more / less infrared radiation will be trapped in the earth's atmosphere **Implications of climate change :** • flooding / melting of ice caps / enzyme denaturation	**(6)**

			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 descriptions 1 mark = one relevant comment 2 marks = description of global warming / effects on climate change / what healthy *E. huxleyi* do
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.	Explanation of how {infected cells / marine snow} affects global warming / levels of carbon dioxide in air / water 3 marks = explanation of how {infected cells / marine snow} results in uptake or release of carbon dioxide 4 marks = plus a second reason for a change **or** the effect of a change on global warming **or** effect of a change on carbon dioxide levels {in water / in air}
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.	Clear explanation of how the infected cells / marine snow affects climate change and its effects 5 marks = explanation includes either the implications of climate change **or** an understanding of how the levels of carbon dioxide in the water affect the carbon dioxide in the air 6 marks = explanation includes either the implications of climate change **and** an understanding of how the levels of carbon dioxide in the water affect the carbon dioxide in the air

Question number	Answer	Additional guidance	Mark
9(a)	An explanation that includes three of the following points: • because {it / light} is needed for photolysis (1) • because {electrons released (from the water) are needed to replace those lost from the photosystems / hydrogen ions are used to reduce NADP} (1) • because {it / light} is needed to {excite / release} the electrons of the {photosystems / chlorophyll / PS / photosynthetic pigments} (1) • electrons (from photosystems) used to produce ATP (and reduced NADP) (1)	**ACCEPT** description of photolysis **ACCEPT** protons / H^+ to produce {reduced NADP / NADPH}	**(3)**

Question number	Answer	Additional guidance	Mark
9(b)(i)	The correct answer is **D (sunlight)** ***A*** *is incorrect because green light would have been a negative control* ***B*** *is incorrect because green light is not included in the study* ***C*** *is incorrect because ultra violet is not part of the visible spectrum*		**(1)**

Question number	Answer	Additional guidance	Mark
9(b)(ii)	An explanation that includes four of the following points: • high rate of photosynthesis in {red / blue and red} light (1) • because there is more (light) energy available (for photosynthesis) (1) • leaf biomass will be high when photosynthesis is fast (1) • as more {glucose / GALP} synthesised to produce {(insoluble) organic molecules / biomass} (1) • the control light does not have as much red and blue light so {the rate of photosynthesis will not be so high / leaf biomass will be lower} (1)	**ACCEPT** low rate of photosynthesis in amber light **ACCEPT** converse for amber **ACCEPT** converse **ACCEPT** converse	**(4)**

Question number	Answer	Additional guidance	Mark
9(b)(iii)	An answer that includes three of the following points: • all three types of pigment are found regardless of the type of light shone on the plants (1) • the type of light shone at the plants affects the concentrations of pigments found (1) • {chlorophyll a is the most abundant / anthocyanins are the least abundant} (in all four groups / in total) (1) • red light results in the highest (total) concentration of pigments / amber light results in the lowest concentration of pigments (1) • anthocyanin content least {affected / varied} <u>by the type of light</u> (1)	**ACCEPT** mass for concentration throughout **ACCEPT** type of light affects each pigment differently **ACCEPT** proportion / amount / highest / lowest **ACCEPT** all had similar concentrations	**(3)**

Question number	Answer	Additional guidance	Mark
9(b)(iv)	An explanation that includes the following points: • credit **two** appropriate genes named (1) • credit correct explanation for one named gene (1) • credit correct explanation for the other named gene (1)	**e.gs** ATP synthase : phosphorylation of ADP chlorophyll (a) (production) : absorption of light / to release electrons / table shows increased chlorophyll a concentrations carotene (production) : absorption of light / to release electrons RUBISCO: carbon fixation / description ETC (proteins) : pump protons into thylakoid (space) / pass protons to NADP to reduce it RNA polymerase: to synthesise RNA enzymes to catalyse reduction of NADP : so reduced NADPH can be produced for conversion of GP into GALP named enzyme in Calvin Cycle : reaction specified **NB Explanations for chlorophyll and carotene must be different to award full marks**	**(3)**