PEARSON EDEXCEL IAL BIOLOGY · YBI11

BIOLOGY



MARK SCHEME

UNIT 4: MICROBIOLOGY, IMMUNITY AND FORENSICS

SCORE	PERCENTAGE
/452	%

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Mark Scheme

Q1.

Question number	Answer	Mark
(a)	An explanation that includes the following points: • above 60 °C the enzymes are denatured (1) • so there will be no metabolic reactions (1) • because between 50 °C to 60 °C the enzymes are working slowly (1) • because the enzymes are denaturing (1)	(4)

Question number	Answer	Additional guidance	Mark
(b)(i)	• $\log_{10}$ of 5×10^3 and 1.3×10^5 stated (1) • denominator calculated (1) • answer (1) Example of calculation: 3.7 and 5.1 $0.301 \times 4 = 1.204$ 1 / 1.2 / 1.16	Allow ecf Award full marks for correct numerical answer without working	(3)

Question number	Answer	Mark
(b)(ii)	B exponential	(1)

Question number	Answer	Mark
(c)(i)	An explanation that includes the following points: • decomposition will be slower (1) • because the enzymes will be less active (1) • as there is less {heat / kinetic} energy (1)	(3)

Question number	Answer	Mark
(c)(ii)	An explanation that includes the following points: • cytoplasm will be frozen (1) • therefore enzymes and substrates will not be able to {move / collide} (1)	(2)

Q2.

Question number	Answer	Additional guidance	Mark
(a)(i)	• 113		(1)

Question number	Answer	Additional guidance	Mark
(a)(ii)	An explanation that includes the following points: • (albumin / R groups) {negatively charged / polar / hydrophilic} (1) • and will therefore dissolve in the {water / blood <u>plasma</u>} (1) • forms hydrogen bonds with water (1)	**ACCEPT** water / plasma is a polar solvent **ACCEPT** description of H bonds / weak bonds / Van der Waals forces **DO NOT ACCEPT** ionic bonds	(2)

Question number	Answer	Additional guidance	Mark
(b)(i)	• 1.175 ($g\ dm^{-3}$)	**ACCEPT** 3 / 3.2 / 3.24 (times higher)	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes the following points: • (thickest band) albumin is the most concentrated (in this sample) (1) • (moved the furthest) albumin could be the most soluble (1) • in the solvent used (1) • (moved the furthest) albumin could be the {lowest mass / lightest} (1)	**ACCEPT** more albumin present **ACCEPT** most (negatively) charged	(3)

Question number	Answer	Additional guidance	Mark
(c)	An explanation that includes the following points: • 15 µmol dm^{-3}. is too low to activate the channel / 500 µmol dm^{-3} will activate the channel (1) • therefore sperm will not be activated in the {seminal fluid / male} / therefore sperm activated in the {uterus / female} (1) • this will avoid waste of {resources / named resource} (1) • so more {viable / healthy} sperm (1) • so more likely fertilisation will take place (1)	**ACCEPT** refs to high or low concentrations **ACCEPT** fewer sperm activated / more sperm activated prevent early activation sperm can swim faster / acrosome enzymes will be released / sperm ready to digest the egg cell membrane e.g. energy / ATP / acrosome **ACCEPT** successful	(4)

Q3.

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

Question number	Answer	Additional guidance	Mark
(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 gas exchange (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
(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 • 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} cannotdivide **DO NOT ACCEPT** B cells releaseantibody	(4)

Question number	Answer	Additional guidance	Mark
* (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)	**Level 1 :** 1 mark = 1 comment made about the graph or viralinfections 2 marks = 3 comments made about {graph / viral infections} **OR** 1 description and a linked explanation	

	• 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) • because viruses destroy bacteria faster than they can reproduce (E) • viruses have no more host cells / destroyed by macrophages (E)	**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 thatincludes both virus and bacterial number changes 6 marks = 5 descriptions and linked explanations that includes both virus and bacterial number changes + thecyclical nature of the data	**(6)**

Q4.

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

Question number	Answer	Additional guidance	Mark
(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}	**ACCEPT** collecting a sample isdifficult	(2)

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

Q5.

Question number	Answer	Mark
(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
(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
(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 aresmall (1) • may not be suitable as the incubation temperature may be differentto body temperature (1) • will not be suitable if person died more than 120 hours ago (1)	**ACCEPT** {reliable / accurate} asan alternative for suitable throughout **ACCEPT** overall the error barsare (quite) small **parts** of the graph where the error bars do not overlap are suitable / converse **ACCEPT** body temperature doesnot remain constant	**(3)**

Question number	Answer	Additional guidance	Mark
(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
(c)	An answer that includes four of the following points: **THREE FROM:** • body temperature is readily available information • {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 othermethods (1)	**ACCEPT** calculations can be made to estimate time of death **e.g.** ambient temperature **ACCEPT** on its own	(4)

Q6.

Question number	Answer	Mark
(a)		

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**	☐	☐

(4)

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

Question number	Answer	Additional guidance	Mark
(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
(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
(c)(ii)	An explanation that includes the following points: • named example of method to reduce the burning of fossil fuels • because this will reduce the carbon dioxide released into theatmosphere (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 ofrice farming	(2)

Q7.

Question number	Answer	Mark
(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
(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
(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
(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
(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)**

Q8.

Question number	Answer					Mark
(a)	Statement	Type of artificial immunity				(3)
		both active and passive	active only	passive only	neither active nor passive	
	Antibodies are injected into the person			X		
	B cells differentiate into plasmacells		X			
	Memory cells are formed		X			

Question number	Answer	Additional guidance	Mark
(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 ofvirus 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
(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 • 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 virusesbinding to host cells **ACCEPT** stimulate cell-mediated response **ACCEPT** a description **DO NOT ACCEPT** killed pathogen in context of bacteria	(4)

Q9.

Question number	Answer	Additional guidance	Mark
(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
(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 notopen cultures at the end (1)	**ACCEPT** description of how equipment could be sterilised e.g.media autoclaved, wash area withdisinfectant **e.g.** wearing gloves, washing hands **e.g.** transfer bacteria quickly	(2)

Question number	Answer	Additional guidance	Mark
(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 theother bacteria is growing	(2)

Question number	Answer	Additional guidance	Mark
(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
(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 thegrowth 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 ifother bacteria are growing	(2)

Question number	Answer	Additional guidance	Mark
(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 / cangrow **ACCEPT** to show that the antimicrobials were inhibiting growth **IGNORE** antimicrobials affecting growth	(2)

Question number	Answer	Additional guidance	Mark
(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 previoussolution (1)	**ACCEPT** the idea of doing this process in the wells directly orseparately **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
(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)

Q10.

Question number	Answer	Mark
(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
(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
(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
(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)

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Question number	Answer	Additional guidance	Mark
(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)

Q11.

	Answer	Mark
(a)	The only correct answer is **A** $\log_{10}$ number of living bacterial cells **B** *is incorrect because the total cell number plotted would not sow the death phase* **C** *is incorrect because the exponential phase would not be a straight line* **D** *is incorrect because the exponential phase would not be a straight line*	(1)

Question number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes the following points: • because we do not want {other bacteria in the culture / contamination} (1) • as they could {compete for nutrients / produce toxins (to the bacteria being cultured)} **OR** • because we do not want to transfer the bacteria onto {ourselves / surroundings} • as they may be {pathogenic / harmful} (1)	**ACCEPT** microorganisms / pathogens **ACCEPT** microorganisms competition for space **ACCEPT** prevent infection	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An explanation that includes the following points: • one named technique explained (1) • a second named technique explained (1)	e.g. working by a Bunsen burner + to create an updraft / to move the microorganisms in the air away / to prevent {bacteria / microorganisms / spores} 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 / microorganisms / spores} present washing hands flaming necks od bottles + to prevent transferring {bacteria / microorganisms / spores} into cultures reducing exposure of cultures to air + to reduce chance of contamination close {doors / windows} + to avoid draughts	(2)

Q12.

Question number	Answer	Additional guidance	Mark
(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
(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
(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
(d)	A description that includes the following points: • bacteria types J and K are {destroyed / killed / eradicates} (1) • antibiotic results in an increase in {proportion / percentage / ratio} 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)

Q13.

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

Question number	Answer	Additional guidance	Mark
(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 standardform 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
(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 kineticenergy} (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
(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 theenzymes} (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 organicmatter **ACCEPT** which enzymes cannot breakdown **ACCEPT** higher concentrations	(2)

Question number	Answer	Additional guidance	Mark
(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
(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 decompositionrate (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)

Q14.

Question number	Answer	Additional guidance	Mark
(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
(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
(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
(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)**

Q15.

Question number	Answer	Additional guidance	Mark
(a)	A description that includes three of the following points: • whether it caused side effects (in humans) (1) • whether or not it reduced the size of the plaques (1) • {(an effective) concentration / the half life} of the drug (1) • the (best) method to administer the drug (1) • how long to administer drug (for amyloid to be destroyed) (1)	**ACCEPT** named side effect e.g. allergic reaction **ACCEPT** {plaque / amyloid} disappeared better than existing drugs effective **ACCEPT** dose	(3)

Question number	Answer	Additional guidance	Mark
(b)(i)	An explanation that includes the following points: • antibodies can <u>only</u> bind to their antigen / this antibody can <u>only</u> bind to ß amyloid (1) • because of the (complementary) shape of {antigen / antibody} (1)	**ACCEPT** FAB region / FAB receptor / receptor	(2)

Question number	Answer	Additional guidance	Mark
(b)(ii)	An answer that includes the following points: • {ATD / antibodies} will bind to the <u>amyloid</u> (1) • macrophages engulf the amyloid (1) • macrophages {destroy / digest} the amyloid with {enzymes / lysozymes} (1)	**ACCEPT** opsonisation **ACCEPT** phagocytes / neutrophils **ACCEPT** phagocytes / neutrophils protease **DO NOT ACCEPT** lysosome	(3)

Question number	Answer	Additional guidance	Mark
(c)(i)	An answer that includes the following points: • because their immune system had already been activated (against amyloid) (1) • and therefore {the amyloid was broken down / plaques could not form} (by phagocytes) (1)	**ACCEPT** a description e.g. a primary immune response had already taken place, the person had memory cells (to amyloid) antibodies present **DO NOT ACCEPT** by antibodies / B cells	(2)

Question number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that includes the following points: • because people with Alzheimer's disease will not have these memory cells (1) • and therefore there will not be any memory cells that can differentiate into the plasma cells that produce the antibody (1)	**ACCEPT** B memory cells not effective **ACCEPT** no memory cells that will result in the production of antibody **DO NOT ACCEPT** no memory cells to produce the antibody	(2)

Q16.

Question number	Answer	Mark
(a)(i)	B human immunodeficiency virus (HIV) and tobacco mosaic virus (TMV)	(1)

Question number	Answer	Mark
(a)(ii)	D tobacco mosaic virus (TMV) only	(1)

Question number	Answer	Mark
(a)(iii)	D protein	(1)

Question number	Answer	Additional guidance	Mark
(a)(iv)	• calculation of volume of TMV (1) • calculation of size difference (1) Example of calculation: 3.14 × 40 × 40 × 300 = 1 507 200 19 / 19.4 / 19.42	 Allow ecf Correct answer with no working shown gains full marks	(2)

Question number	Answer	Mark
(b)(i)	• reverse transcriptase and integrase	(1)

Question number	Answer	Mark
(b)(ii)	An explanation that includes the following points: • because these enzymes are not present in the host cell (1) • because reverse transcriptase is needed to make a DNA copy of the viral RNA (1) • because integrase is needed to incorporate the DNA copy into the host cell genome (1)	(3)

Q17.

Question number	Answer	Additional guidance	Mark
(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
(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
(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
(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)**

Q18.

	Answer	Mark
(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
(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
(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
(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
(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
*(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 /	**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	

Question number	Answer	Additional guidance	Mark
	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	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)**

Q19.

Question number	Answer	Additional guidance	Mark
(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
(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
(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
(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
(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
(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
(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)**

Q20.

Question number	Answer	Mark
(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
(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
(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
(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
(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 all the data can be plotted on one graph (1) • so that it can all 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
(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
(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
(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
(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)

Mark Scheme

Q1.

Question number	Answer	Mark
(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
(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
(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
(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
(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
(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)

Q2.

Question number	Answer	Additional guidance	Mark
(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
(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
(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
(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)

Q3.

Question number	Answer	Mark
(a)	An explanation that includes the following points: • each antibody can bind to two bacteria resulting in agglutination (1) • antibody {can bind to both the phagocyte and the bacteria / causes opsonisation} (1) • therefore phagocytosis is enhanced (1) • toxins are neutralised (1)	(4)

Question number	Answer	Mark
(b)(i)	A description that includes the following points: • IgG produced by mother increases in months before birth and then decreases after birth (1) • IgG produced by child increases rapidly after birth (1) • IgA increases slowly after birth (1)	(3)

Question number	Answer	Mark
(b)(ii)	D natural passive	(1)

Question number	Answer	Mark
(b)(iii)	An answer that includes the following points: • child has not been exposed to all types of antigen (1) • no {IgM / other classes of antibody} produced yet (1)	(2)

Q4.

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

Question number	Answer	Additional guidance	Mark
(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
(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
(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
(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)**

Q5.

Question number	Answer	Additional guidance	Mark
(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
(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 (ofperson) / defence mechanisms} (1) • swelling results in more {blood / white blood cells / platelets / phagocytes / antibodies/ tissue fluid} (to thewound) (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
(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 butincreases after day 3 with curcumin extract (1)	(3)

Question number	Answer	Additional guidance	Mark
(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)

Q6.

Question number	Answer	Mark
(a)	An answer that includes the following points: • can differentiate into all cell types (1) • have no Hayflick limit / can divide indefinitely (1)	(2)

Question number	Answer	Mark
(b)(i)	B negatively-charged fragments move towards the positive end of the gel	(1)

Question number	Answer	Mark
(b)(ii)	A 1	(1)

Question number	Answer	Mark
(b)(iii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** • Bands 1, 2, 5, 9 and 11 in the embryo are also found in the mother • therefore, they must have been present in the nucleus of the egg cell from the mother • Bands 4, 6, 7, 8 and 10 in the embryo are also found in the father • therefore they must have been present in the nucleus of the sperm from the father • Bands 3 and 12 in the embryo are not found in either the mother or the father • therefore they must have been the mitochondrial DNA from the donor • both mother and father have bands not found in the embryo • the bands in the mother could be her mitochondrial DNA	(6)

Level	Marks	Descriptor
	0	No awardable content.
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.
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.
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.

Q7.

Question number	Answer	Additional guidance	Mark
(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
(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
(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
(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
(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)

Q8.

Question number	Answer	Additional guidance	Mark
(a)	An explanation that includes two of the following points: • antibiotics used to treat impetigo and whooping coughbecause 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 confusionwith 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
(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
(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 innumber and cause disease	**(2)**

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

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

Question number	Answer	Additional guidance	Mark
(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 notimmunity throughout **ACCEPT** correct references tobactericidal and bacteriostatic **ACCEPT** kills 4 types / kills type A buthas limited effect on type B **ACCEPT** results in the presence of a new type / reduces the number of typeA and type B	(3)

Q9.

Question number	Answer	Additional guidance	Mark
(a)	An explanation that includes the following points: • because MRSA has developed {antibiotic / methicillin} resistance (1) • so we have had to find new drugs that this bacteria is not resistant to (1)	**NB ACCEPT** pathogens / bacteria throughout **DO NOT ACCEPT** immune for resistance throughout **ACCEPT** spreading / increasing **ACCEPT** that will destroy it	(2)

Question number	Answer	Additional guidance	Mark
(b)	An explanation that includes the following points: • because skin flora {prevent the growth of / destroy / kill} {other bacteria / pathogens} (1) • by competing for {space / nutrients} / producing toxins (1)	**ACCEPT** provide a barrier in protecting the body from infection **ACCEPT** produce lactic acid **DO NOT ACCEPT** sebum	(2)

Question number	Answer	Additional guidance	Mark
(c)	An answer that includes two of the following points: • (if the bacteria are weaker) they will {not reproduce as fast / infect fewer cells} (1) • therefore there will be fewer toxins produced (1) • therefore an immune response will be more effective (1)	**ACCEPT** descriptions e.g. macrophages will be able to engulf more, more antibodies produced, more T killer cells activated	(2)

Question number	Answer	Additional guidance	Mark
(d)(i)	An explanation that includes the following points: • so that the size of the infection with the solvent could be measured (1) • so that the effect of the drug itself can be determined (1)	**ACCEPT** to show {the effect of Castaneroxy / that Castaneroxy is effective}	(2)

Question number	Answer	Additional guidance	Mark
(d)(ii)	An answer that includes any **two** of the following points: • comment about effect of Castaneroxy on size during time period 0 and 6 days (1) • comment made about Castaneroxy (compared to solvent) on size during time period {0 / 6} and 14 days (1) • comment comparing the two concentrations of Castaneroxy (1) **AND** • credit calculation to quantify reduction in size (1)	e.g. Castaneroxy does not prevent increase in size, the size does not increase as much as the solvent e.g. Castaneroxy reduces mean size e.g. Castaneroxy at high concentration decreases the size more than at lower concentrations, high concentrations clear up the infection completely but low concentrations do not	(3)

Question number	Answer	Additional guidance	Mark
(d)(iii)	• mass of Castaneroxy A needed in 1 dm^3 calculated (1) • mass of leaves needed for 50 000 µg (1) • converted into kg and rounded up to 3 (kg) (1) **OR** • 50 µg converted into kg (1) • mass needed in 1 litre (1) • converted into kg and rounded up to 3 (kg)	50 000 2 631 578 947 0.00000005 0.00005	(3)

Q10.

Question number	Answer	Additional guidance	Mark
(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 structural 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
(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
(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
(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
(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)

Q11.

Question number	Answer	Mark
(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
(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
(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
(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 bind • as their genetic material will be cloned inside the host cell	**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)**

Q12.

Question number	Answer	Additional guidance	Mark
(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
(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
(b)	D  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)

Q13.

Question number	Answer	Additional guidance	Mark
(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
(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
(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
(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
(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
(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)

Q14.

	Answer	Mark
(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
(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
(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
(b)(i)	U G G U U C C G C (1)		(1)

Question number	Answer	Additional guidance	Mark
(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
(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 immunesystem stimulated (1)	**IGNORE** refs to latency / description ofretroviruses / replication of DNA **IGNORE** names of host cells **ACCEPT** description of event that takeplace **ACCEPT** description e.g. not enoughantibodies present for opsonisation **ACCEPT** before {receiving antiviral drugs / drugs can take effect} **DO NOT ACCEPT** kill virus	(4)

Q15.

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

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

Question number	Answer	Additional guidance	Mark
(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
(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 $0.963 \times 0.301t = 1994000$ 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
* (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)

Q16.

Question number	Answer	Additional guidance	Mark
(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
*(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)	**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	(6)

	• 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)	**NB** Extended explanation either offers two alternative explanations or has two steps to it	

Question number	Answer	Additional guidance	Mark
(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)**

Q17.

Question number	Answer	Additional guidance	Mark
(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
(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
(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
(c)	An answer that includes the following points: • (assembling) {**RNA** / (viral) **genome**} and **proteins** • 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
(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)

Q18.

Question number	Answer	Mark
(a)	B fatty acid	(1)

Question number	Answer	Mark
(b)(i)	• bacteria make cell walls only following cell division	(1)

Question number	Answer	Mark
(b)(ii)	An explanation that includes the following points: • if there is no mycolic acid the lysozymes will be able to digest the bacteria (1) • therefore antigens will be produced (1)	(2)

Question number	Answer	Mark
(b)(iii)	An explanation that includes the following points: • if there is no mycolic acid in the cell wall, they will be more susceptible to lysozyme action (1) • the membrane structure will be affected (1) • therefore the cell will lose control of molecules entering and leaving (1)	(3)

Question number	Answer	Mark
(b)(iv)	An explanation that includes the following points: • transcription will be inhibited (1) • therefore bacteria will not be able to synthesise proteins (1) • therefore {structure / function} of cell will be affected (1)	(3)

Question number	Answer	Mark
(b)(v)	An explanation that includes any two of the following points: • greater exposure to antibiotics increases chances of resistance (1) • therefore bacteria could become resistant to a greater number of antibiotics (1) • greater chance that patients will not take antibiotics correctly (1)	(2)

Q19.

Question number	Answer	Mark
(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
(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
(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
(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)**

Q20.

Question number	Answer	Additional guidance	Mark
(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 + descriptionto T helper cells **ACCEPT** description e.g. T helper cellsrelease cytokines that cause B cell proliferation	**(4)**

Question number	Answer	Additional guidance	Mark
(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 inincome e.g. people who agree that vaccines are safetrust the scientists the most e.g. at all incomes, there are people whoagree, neither agree nor disagree and disagree that vaccines are safe	(3)

Question number	Answer	Additional guidance	Mark
(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
(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)

Q21.

Question number	Answer	Mark
(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
(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
(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
(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)**

Q22.

Question number	Answer	Mark
(a)	<table><tr><th rowspan="2">Structure</th><th colspan="4">Virus</th></tr><tr><th>Ebola only</th><th>HIV only</th><th>both Ebola and HIV</th><th>neither Ebola nor HIV</th></tr><tr><td>DNA</td><td>[x]</td><td>[x]</td><td>[x]</td><td>[x]</td></tr><tr><td>helical capsid</td><td>[x]</td><td>[x]</td><td>[x]</td><td>[x]</td></tr><tr><td>envelope</td><td>[x]</td><td>[x]</td><td>[x]</td><td>[x]</td></tr></table>	(3)

Question number	Answer	Additional guidance	Mark
(b)(i)	• (RNA) reverse transcriptase	**ACCEPT** RNA-dependent DNA polymerase DNA nucleotidyltransferase (RNAdirected) revertase **DO NOT ACCEPT** other named enzymes / molecules	(1)

Question number	Answer	Additional guidance	Mark
(b)(ii)	• (this DNA polymerase found in cancer cells) so healthy cells will not be affected by the drug	**ACCEPT** so that DNA synthesis will not occur and the cancer cells cannot divide	(1)