PEARSON EDEXCEL A-LEVEL BIOLOGY A · 9BN0

BIOLOGY



MARK SCHEME

TOPIC 6: IMMUNITY, INFECTION AND FORENSICS

SCORE	PERCENTAGE
/632	%

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Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
(a)(i)	1. idea that interferon involved in viral infections, lysozyme affects bacteria; 2. idea of interferon produced by infected cells, lysozyme present in {secretions / phagocytes / neutrophils / macrophages / eq }; 3. interferon {inhibits / eq} {replication / eq} of viruses, lysozyme {kills / destroys} bacteria;	**Piece together** throughout **Accept** lysosome throughout **Ignore** pathogen throughout **2. Accept** named secretion {produced / released} **3. Accept** a reference to lysozyme destroying cell walls	**(3)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	1. reference to (lysozyme) is an enzyme ; 2. idea that {proteins / active sites / enzymes} have a specific shape ; 3. idea that lysozyme acts on cell wall ; 4. of bacteria ;	**Accept** lysosome in this context	**(4)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	1. reference to histamine released as a result of damaged {tissue / cells} ; 2. (histamine released from) {basophils / mast cells / platelets} ; 3. detail of effect of histamine e.g arterioles dilate, vasodilation, increased blood flow, capillaries more permeable ; 4. named effect of inflammation e.g. {oedema / swelling /redness / heat / pain / eq} ;	**2. Accept** white blood cells, macrophages and neutrophils **4. Accept** raises temperature	**(3)**

Question Number	Answer	Additional guidance	Mark
(b)(ii)	1. idea of (only) {a local reaction produced / histamines produced around bite area} ; 2. idea that cream {has been applied to actual site of production of histamine } ; 3. idea of {effect / treatment / relief / eq} {more rapid / immediate / eq }; 4. idea of higher concentration of antihistamine at site ; 5. idea that the antihistamines will not be {digested (by enzymes) / destroyed (by acid / enzymes) / eq} ; 6. idea that tablets may lower immune response generally / lead to side-effects ;	**2-6 Accept** converse	**(3)**

Q2.

Question Number	Answer	Additional guidance	Mark
(a)(i)	1. reference to {polymerase chain reaction / PCR} ; 2. polymerase (enzyme) {added / eq }; 3. idea of need for primers and nucleotides ; 4. {90-98} (°C) → {50-65} (°C) → {70-75} (°C) ; 5. idea that cycle needs to be repeated {several times / to make several copies of DNA / eq};	**1. Accept** as a ref to PCR machine	**(4)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	(DNA) {profiling / fingerprinting / (gel) electrophoresis} ;	**Ignore** Southern blotting, PCR **Accept** DNA profile / DNA fingerprint	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)	1. idea of work appearing in a (Scientific) journal or being presented at a conference ; 2. idea that validity or reliability is considered ; 3. by other scientists / ref to peer review ;	**1. Accept** publishing a paper, scientific meeting	**(2)**

Question Number	Answer	Additional guidance	Mark
(c)(i)	1. reference to different {conditions / environments /eq} (in each region) ; 2. idea of different selection pressures ; 3. idea of {restricted gene flow / separate gene pools} ; 4. reference to reproductive isolation;	**1. Accept** appropriate named factor e.g. temperature **3. Ignore** different allele frequency	**(2)**

Question Number	Answer	Additional guidance	Mark
(c)(ii)	1. idea of different {alleles/ gene pool} ; 2. idea that this leads to {new / different} phenotypes ; 3. idea of new {allele / gene} can be {advantage / disadvantage} ; 4. reference to (advantageous) {(mutated) gene / (new) allele} passed onto offspring ;	**1. Ignore** allele frequency **2. Accept** traits / characteristics / features	**(2)**

Q3.

Question Number	Answer	Additional guidance	Mark
(i)	• using carbon (14) dating	ALLOW the deeper the layer in the peat, the older it is	graduate (1)

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to three of the following • conditions are anaerobic (1) • therefore less (aerobic) respiration by decomposers (1) • acidic conditions {inhibit /denature} enzymes (1) • therefore (enzymes) cannot {digest / break down} organic material (1)	ALLOW (waterlogging) reduces the oxygen content ALLOW microorganisms / named decomposers ALLOW decomposers respiring anaerobically ALLOW description of denaturing eg change in shape of active site ALLOW break down plants / animals /peat	Expert (3)

Q4.

Question Number	Acceptable Answer	Additional guidance	Mark
	An explanation that makes reference to the following: • it was assumed that one gene makes one protein (so there should be 100 000 genes but there are 25 000 genes) (1) • the diagram shows that one gene can make more than one mRNA (1) • one gene can code for several proteins (1) • due to removal of different exons (1) • reference to post-transcriptional change (1)		**(5)**

Q5.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(i)	An explanation that makes reference to the following: • (small pieces) provides large surface area to volume ratio (1) • (use of ethanol for a long time means) the antibacterial substance is soluble in ethanol and more will be extracted (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(a)(ii)	$\pi 2.15^2$ (1) 14.5 cm^2 (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(i)	An explanation that makes reference to the following: • the *t*-test assess the significance of the difference between the means of the two treatments (1) • Chi squared not appropriate because there are no expected values (1) • correlation coefficient not appropriate because the independent variable is discontinuous / not continuous (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(ii)	$2.37^2 \div 9 = 0.62$ and $3.60^2 \div 9 = 1.44$ (1) $\sqrt{(0.62 + 1.44)} = 1.44$ (1) $(27 - 25) \div 1.44 = t = 1.39$ (1)	Correct answer gains full marks	**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(iii)	An answer that makes reference to the following: • there is no significant difference between the clear area caused by garlic compared with that caused by chloramphenicol (1) • $p > 0.05$ (1) • difference due to chance (1) • therefore accept null hypothesis (1)	Allow marking points for the calculated value of *t* from the candidate	**(4)**

Question Number	Acceptable Answer	Additional guidance	Mark
(c)(i)	An explanation that makes reference to the following: • suggests cedar wood oil has no anti-microbial effect on *E. coli* and all other oils do (1) • quoting at least two values from: rosemary 2%, geranium 0.5%, garlic 0.125% / manipulation of data to show relative effects (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(c)(ii)	An answer that makes reference to the following: • for cedar wood oil try concentrations above 4% (1) • for all the others, try concentrations below 0.0625% (1)		**(2)**

Question Number	Acceptable Answer	Additional guidance	Mark
(c)(iii)	A description that makes reference to the following: • only one tray per species – need repeated measurements (1) • species – only used one species of bacteria / only used extracts from four plant species (1)		**(2)**

Q6.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • antibiotics reduce the number of other (species of) bacteria **(1)** • antibiotics that attack cell walls {cause lysis / are bactericidal } **(1)** • antibiotics that attack protein synthesis (machinery) {prevent growth / are bacteriostatic} **(1)** • this reduces interspecific competition from other bacteria for limited resources **(1)**	ALLOW attack ribosomes	**(3)**

Q7.

Question Number	Answer	Additional guidance	Mark
(i)	An explanation that makes reference to three of the following • ribosome shape is altered (1) • mRNA is prevented from binding (to the ribosome) / causingchange in tRNA binding (1) • therefore translation cannot occur (1) • { protein / polypeptide } is not synthesised (1)	ALLOW translation is affected /reduced / altered ALLOW faulty protein produced	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	An answer that makes reference to two of the following • bacteria have not been exposed to new antibiotics before /bacteria do not have mechanisms to make them resistant to the new antibiotics (1) • bacteria have developed resistance (to other antibiotics) by { evolving / natural selection } (1) • therefore there has been {no advantage to possessing amutation to bypass the new antibiotic / no mutation present to give resistance } (1)		**(2)**

Question Number	Answer	Mark
(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 genericmark scheme. The indicative content below is not prescriptive and candidates are not required to include all thematerial which is indicated as relevant. Additional content included in the response must be scientific and relevant. Indicative content • prepare agar plates with bacterial cultures / bacterial lawn / seeded with bacteria –use bacteria that are resistant to other antibiotics • prepare solutions of new antibiotic and penicillin • place onto paper discs / into wells in the agar / prepare mast rings • control time and temperature of incubation • same concentration and volume of both antibiotics • measure the area of inhibition • repeat for effective antibiotics • description of serial dilution of each antibiotic • range of dilutions on each plate-one antibiotic per plate • statistical test to determine which is the most effective • repeat with different strains of resistant bacteria	**(6)**

Level	Marks		Additional Guidance
0	0	No awardable content	
1	1-2	An explanation of how the investigation should be modifiedmay be attempted but with limited analysis, interpretation and/or evaluation of the scientific information. Generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Preparation of agar plates Method of adding antibiotic Use of new antibiotic and penicillin Measure zone of inhibition
2	3-4	An explanation of how the investigation should be modified willbe given with occasional evidence of analysis, interpretation and/or evaluation of the scientific information. The explanation shows some linkages and lines of scientificreasoning with some structure.	Incubated for stated time 24-72 hours Incubated at stated temperature 25-37^{0}C Method of culturing bacteria on agar plates/preparing a lawn Repeats to calculate the mean Larger zone of inhibition-more effective antibiotic
3	5-6	An explanation of how the investigation should be modified isgiven which is supported throughout by evidence from the analysis, interpretation and/or evaluation of the scientific information. The explanation shows a well-developed and sustained line ofscientific reasoning which is clear, coherent and logically structured.	Strain of bacteria known to be resistant topenicillin/other antibiotics Same volume/concentration of bothantibiotics Several strains of resistant bacteria testedwith new antibiotic Preparation of serial dilutions for bothantibiotics Range of concentrations give minimum effective dose Named statistical test eg T-test

Q8.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • a vaccinated person will have memory T cells (1) • (memory T cells) recognise (antigens specific to) the HPV-16 virus (1) • T helper cells that activate {B cells / T killer cells} (1) • (formation of) T killer cells destroy cells infected with virus (1)	ALLOW a response that begins with 'T memory cells ...' / or statement that T memory cells are already present ALLOW cytotoxic T cells for T killer cells	3

Q9.

Question Number	Answer	Additional Guidance	Mark
(a)	1. involves prophase, metaphase, anaphase and telophase ; 2. idea that produces two nuclei ; 3. idea that these are genetically identical to original ;	1. NOT if cytokinesis or interphase included as part of mitosis 2. ACCEPT produces two cells	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)	1. (SAN) is myogenic / description given ; 2. electrical activity from SAN causes atria to contract / eq ; 3. idea that activity of SAN can be changed by nerve impulses e.g. controlled by medulla ; 4. credit detail of nervous control e.g. more impulses from accelerator increases heart rate ;		(3)

Question Number	Answer	Additional Guidance	Mark
(c)	1. idea that lactase gene {activated / transcribed} ; 2. (synthesis of) lactase / eq ; 3. hydrolysis of lactose / glycosidic bonds broken ; 4. to produce glucose AND galactose ;		(3)

Question Number	Answer	Additional Guidance	Mark
(d)	1. idea that a better model than guinea pigs or mice ; 2. idea of animal rights ; 3. easy to culture / eq ; 4. (HeLa cells) susceptible to disease / HPV / eq ;	1. ACCEPT reference to only HeLa {cells / DNA} are human 3. ACCEPT cheaper (as continual supply)	(2)

Question Number	Answer	Additional Guidance	Mark
*(e)	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. idea that {motor neurone / cell body / nucleus} is destroyed ; 2. depolarisation does not occur in the neurone / (insufficient so) no action potential set up in the neurone ; 3. detail of (depolarisation / action potential) not occurring in neurone e.g. idea Na^+ does not diffuse into neurone ; 4. {neurotransmitter / named neurotransmitter} not {released / produced / eq} at junction with muscle / eq ; 5. detail of lack of neurotransmitter release e.g. vesicles (containing neurotransmitter) do not {move / fuse} with {presynaptic membrane /	QWC emphasis is clarity of expression 1. ACCEPT idea of damage to myelin sheath / Schwann cells 3. ACCEPT Na^+ / cation channels {non-functional / eq} 4. ACCEPT {neurotransmitter / named neurotransmitter} not {released / produced / eq} at {motor neurone presynaptic membrane / motor end plate}	

	eq} / eq ; 6. Ca^{2+} not released into muscle cytoplasm ; 7. Ca^{2+} not released from sarcoplasmic reticulum ; 8. no Ca^{2+} to {activate / eq} troponin ; 9. idea that muscle does not contract ;	6. ACCEPT Ca^{2+} not released into sarcoplasm	**(6)**

Question Number	Answer	Additional Guidance	Mark
(f)	1. contains bases / eq ; 2. contain phosphate (groups) ; 3. have a pentose sugar ; 4. reference to phosphodiester bonds ; 5. idea of discrete strands ;	1. ACCEPT both have (4) bases / nucleotides 3. ACCEPT 5C sugar 5. ACCEPT linear	**(3)**

Question Number	Answer	Additional Guidance	Mark
(g)	1. smooth shown as dominant / wrinkled shown as recessive e.g. use of upper and lower case ; **Parental generation:** 2. both types shown as homozygous ; **F1:** 3. all shown as heterozygous ; **F2:** 4. genetic diagram to show that 75% are smooth / 25% are wrinkled ;	4. Diagram should show genotypes	**(4)**

Question Number	Answer	Additional Guidance	Mark
(h)	1. all the {DNA / eq} found in {a human / the human species / eq} ; 2. idea of genes {on different chromosomes / different positions on same chromosome} ;	1. ACCEPT population for species	(2)

Question Number	Answer	Additional Guidance	Mark
(i)	1. product (of p53 gene) {stops / eq} development of tumour cells / eq OR product (of p53 gene) {stops / regulates} progression {of cell cycle / towards mitosis} ; 2. acts as an inhibitor of {transcription / protein synthesis / eq} / eq ; 3. idea that {DNA / eq} repair ; 4. idea that leads to apoptosis ;	1. ACCEPT product stops tumour cells growing / dividing 1. ACCEPT product keeps it in {interphase / named mitotic stage} / product interferes with mitosis progress	(2)

Question Number	Answer	Additional Guidance	Mark
(j)	1. protein / glycoprotein ; 2. reference to this being CD4 ; 3. found on cell (surface) membrane / eq ; 4. that acts as a {receptor / named receptor} for HIV / eq ;	4. ACCEPT receptor for gp120	(2)

Question Number	Answer	Mark
(k)	200 (nucleotides) ;	(1)

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	1. (skin flora) {prevent growth of / kill} {pathogens / microorganisms / bacteria / eq} ; 2. competition for {space / nutrients / water / minerals / eq} ; 3. release of {chemicals / toxins / antimicrobials / lipids / enzymes /eq } ;	**1 ACCEPT** prevent colonisation **IGNORE** antigens / viruses / infections / diseases **2 IGNORE** food / resources **3 NOT** sebum / lysozymes	**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	**B** they have antimicrobial properties that inhibit the growth of bacteria		**(1)**

Q11.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to two of the following • because the pH inside the stomach is too low for the enzymes of most bacteria to function (1) • bacteria that live in the stomach have adaptations that enable them to survive (1)	ALLOW reference to bacterial enzymes being denatured ALLOW (some) bacteria have evolved specifically to withstand the conditions	**(2)**

Q12.

Question number	Answer	Additional guidance	Mark
	• surface area of virus (1) • surface area of one spike protein (1) • correct whole number (1)	Example of calculation $4 \times \pi \times 120^2 = 180955.7$ (nm^2) ALLOW 180864 / 181028.6 $(22.4 \times 20) \div 2 = 224$ (nm^2) $180955.74 \div 224 = 808$ ALLOW 807 ECF for one incorrect area values For a maximum of 2 marks Correct answer with no working gains full marks.	Expert (3)

Q13.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)	B		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(c)	B		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(d)	An answer that makes reference to one of the following points: • virus has a non-cellular structure whereas bacteria has a cellular structure (1) • a virus has a protein capsid whereas a bacterium has a polysaccharide cell wall (1) • viruses have one type of nucleic acid whereas a bacterium has two (1)		**(1)**

Q14.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to two of the following: • (70S) ribosome **(1)** • larger and smaller subunits **(1)** • containing protein and rRNA **(1)**		**(2)**

Q15.

Question Number	Answer	Additional Guidance	Mark
	respiration / decomposition / eq ;	**ACCEPT** description **NOT** photosynthesis	**(1)**

Q16.

Question Number	Answer	Additional Guidance	Mark
(i)	Correct answer gains both marks {332 + 23 + 444 / 799 } and {338 + 450 / 788 } ; (799 – 788) = 11 (au) ;	**CE** applies	**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	1. idea that rate of production of carbon dioxide is greater than rate of removal of carbon dioxide ; 2. idea of using of {fossil fuels / named fossil fuel / forests / eq} {releasing / producing} carbon dioxide ; 3. idea that this carbon (in fossil fuels / forests) was {locked up / removed from the air } years ago ; 4. idea of deforestation resulting in less {photosynthesis / carbon fixation / light independent reaction / eq} ;	**1 ACCEPT** carbon dioxide **{**production / release} is greater than used in photosynthesis **3 ACCEPT** ref to carbon sink **4 ACCEPT** less carbon dioxide used for photosynthesis	**(3)**

Q17.

Question Number	Answer	Additional Guidance	Mark
	1. idea that we can only {make predictions about the future / extrapolate data / work on correlations / eq } ; 2. idea that {scientists / industry / eq} are presenting {different views / insufficient evidence / eq} about global warming ; 3. idea that some people surveyed did not {understand / know about} global warming ; 4. idea that some people do not believe in {global warming / harmful effects of global warming} because they do not want it to affect their { lifestyle / named lifestyle / eq } ; 5. idea that some people think that a solution to global warming will be found ; 6. idea that some people do not want to think about the future ;	**NB just a reference to do not believe is too vague** 1 **ACCEPT** it is due to natural cycle / normal fluctuations	**(3)**

Q18.

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of thefollowing: • the same bacteria causes human plague and sylvatic plague (1) • antigens in the (human plague) vaccine are processed and presented to lymphocytes (in the black-footed ferret) (1) • therefore stimulating active immunity (to sylvaticplague) (1) • and producing memory cells (to these antigens) (1)	ALLOW the bacteria causing human plague and sylvatic plague have thesame antigens ALLOW enabling a secondaryimmune response	(3)

Q19.

Question Number	Answer	Additional guidance	Mark
	• A substance which can {inhibit the growth / prevent multiplication} of bacteria		**(1)**

Q20.

Question number	
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive, and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** Information • there are 20 000 different proteins • these proteins carryout different functions • there are a {large number of / 20} different {R groups / amino acids} • most R groups are non-polar, some are polar a few have a charge Linkage to **s**tructure • R groups determine {3D shape / structure} of proteins • {large number of / 20 R groups} • many combinations of amino acids required to give wide variety of protein structures • R groups can form bonds to stabilise 3D structure (e.g. cysteine) • role of R-groups in structure of haemoglobin • role of R-groups in structure of collagen • location of cysteine allows formation of disulfide bonds Linkage to **f**unction • R groups variety of protein shapes are required to allow proteins to carry out wide range of functions • examples of functions that require specific structure e.g. antibodies specific to an antigen / enzymes specific for a substrate / receptors e.g. neurotransmitters and (acetylcholine) and ion-gated channels • polar / ionic R groups increase solubility • non-polar R groups will be on outside of insoluble proteins / structural proteins / collagen / proteins inserted into membranes • role of R-groups in function of haemoglobin • role of R-groups in function of collagen Linkage to **l**ocation • polar R groups will be in aqueous environment /non-polar regions in a non-aqueous environment

	• polar /ionic R groups soluble in {plasma/ tissue fluid / cytoplasm} / line the inside of ion channels / found on the outside of soluble proteins such as hormones / transport proteins / immunoglobulins / cytokines • role of R-groups in location of haemoglobin • role of R-groups in location of collagen

Level	Marks		
0	0	No awardable content	
1	1-3	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.	Selection of some information from the table – little or no linkage Linkage to one aspect – 2 marks Two linkages for same aspect – 3 marks
2	4-6	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.	Linkage between R groups and two aspects from structure, function and location One comment on each - 4 marks An additional comment - 5 marks An additional 2 comments – 6 marks
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures.	Linkage between R groups and all three aspects (structure, function and location) One comment on each - 7 marks
		The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	An additional comment - 8 marks An additional 2 comments – 9 marks

Q21.

Question Number	Answer	Additional guidance	Mark
(i)	• calculation of the number of TB patients with HIV (1) • calculation of percentage of HIV positive TB patients that died(1)	Example of calculation 15% of 9.4 million = 1.41 million 521 700 ÷ 1 410 000 = 0.37 = 37% Correct answer with no working gains full marks	graduate(2)

Question Number	Answer	Additional guidance	Mark
(ii)	An answer that makes reference to the following • a greater percentage of patients with HIV die from TB compared with TB patients without HIV (1) • the total number of cases and deaths from TB is greater in those without HIV (1)		Expert (2)

Question Number	Answer	Mark
(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 which is indicated as relevant. Additional content included in the response must be scientific and relevant. indicative content • TB is more likely to develop in patients with HIV • Anti-viral drugs reduce the incidence of TB in patients with HIV • HIV binds to CD4 receptors on T-helper cells • HIV replicates inside T-helper cells then destroys the cells as it bursts out • This reduces the number of T helper cells • When a bacterium such as *M. tuberculosis* enters the body, the reduction in Thelper cells means there is no immune response • The patient develops TB • Drugs that prevent viral replication means T-helper cells are not destroyed • The immune system can prevent TB developing • Therefore deaths from TB will decrease in patients with HIV • However, more deaths from TB are in patients without HIV, and therefore antiviral drugs will not reduce this number	Expert (6)

			Additional guidance
Level 0	Marks	No awardable content	
Level 1	1-2	An explanation may be attempted but with limited interpretation or analysis of the scientific information 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.	Data described from information provided e.g. • TB incidence decreases as T helper cells increase • TB bacteria multiply in body • Use of antiviral drugs increases T helper cell numbers • Basic explanation
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 data e.g. Overlapping error bars indicate no difference for T helper cell counts above 300 mm^{-3} HIV infects T helper cells HIV enters T helper cells and reduces the number of T-helper cells This reduces immune response Antiviral drugs prevent replication of HIV Immune response details

Level 3	5-6	An explanation is made which 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 as to how antiviral drugs prevent TB developing by preventing HIV replication inside cells. Relevant immune response detail – T helper cells activate B cells / release cytokine / result in antibody production Explanation that antiviral drugs will only reduce TB deaths in those also infected with HIV. No effect on others as antiviral drugs do not kill bacteria.

Q22.

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of thefollowing: • pig genes are transcribed and translated to produceproteins (1) • the structure of (some of) these proteins will be different from those in humans (1) • these proteins will be recognised as foreign (1) • activating lymphocytes (1)	ALLOW pig genes code for antigens ALLOW recognised as antigens ALLOW trigger a specific immune response	Choose an item. (3)

Q23.

Question number	Answer	Additional guidance	Mark
	An answer that makes reference to the following: • {isolate / extract} RNA from (saliva) samples (1) • amplify the {RNA/DNA/nucleic acid} by PCR (1) • cut the {RNA/DNA/nucleic acid} into fragments (using restriction enzymes) (1) • (separate fragments using) gel electrophoresis (1) • more similar the {banding / profile} (of the fragments) the more closely related the strain (1)	ALLOW (reverse) transcribe RNA to DNA and amplify DNA ALLOW sequence the virus genome ALLOW the fewer the number of base changes the more closely related the strains	Expert (4)

Q24.

Question Number	Answer	Additional guidance	Mark
	An answer that makes reference to three of the following Similarities • both contain RNA (1) • both have {a (protein) capsid / glycoproteins} (1) Differences • Ebola contains one strand of RNA but HIV contains two strands of RNA (1) • HIV is spherical, Ebola virus is elongated (1)	IGNORE retrovirus ALLOW protein coat ALLOW HIV is icosahedral / Ebola is filamentous ALLOW HIV is round ALLOW HIV has a lipid layer/envelope and Ebola does not (acceptable on basis of diagram provided)	(3)

Q25.

Question Number	Answer	Mark
	The only correct answer is B *non-specific response, bacteria are destroyed by phagocytes* A is not correct because killer T-cells are not involved in the initial response C is not correct because the initial response is not the specific response D is not correct because the initial response is not the specific response	Computer (1)

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following • the bacteria are inside {macrophages /phagocytes} (1) • this bacterium has a (thick) waxy cell wall (1) • lysosomes cannot fuse with phagocytic vacuole / bacteria not destroyed by enzymes (1) • bacteria within tubercles (cannot be destroyed) (1)	ALLOW waxy coat	Expert (3)

Q2.

Question Number	Answer	Additional Guidance	Mark
(i)	A description that makes reference to three of the following: • heat to 90-98°C { to break hydrogen bonds between (DNA) strands / separate the strands of DNA} (1) • { joining of primers / annealing } at 50- 75°C (1) • { elongating / extension / addition of nucleotides } / DNA polymerase involved in formation of phosphodiester bonds (1) • to double the quantity (of the DNA) (1)	ALLOW heating to 90-98°C to break hydrogen bonds or to unzip DNA or to denature the DNA ALLOW 'binding/aligning' for joining ALLOW description of production of complementary strands of DNA ALLOW taq polymerase ALLOW replication for doubling	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	• calculation correct • correct answer provided (1)	Example of calculation 2^{20} 1 048 576 (> 1 000 000) or 1.05×10^6 Correct answer without working scores full marks	(2)

Q3.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: • correct ranking for both columns (1) • correct difference in rank (1) • correct difference squared (1)	<table><tr><td>E</td><td>48.8</td><td>4</td><td>23.6</td><td>4</td><td>0</td><td>0</td></tr><tr><td>F</td><td>50.1</td><td>7</td><td>24.2</td><td>5</td><td>2</td><td>4</td></tr><tr><td>G</td><td>49.2</td><td>6</td><td>23.1</td><td>2</td><td>4</td><td>16</td></tr></table> -2 and -4 are incorrect differences in rank	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	• numerator (top line of formula) correctly calculated (1) • denominator (bottom line of formula) correctly calculated (1) • correct answer (1)	Example of calculation 6 x 34 or 204 7 x 48 or 336 0.3929 / 0.393 / 0.39 Correct answer with no working scores full marks	(3)

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following: • no (significant) correlation (1) • as the calculated figure is less than { 0.786 / the critical value for p= 0.05 } (1)	ALLOW not statistically significant ECF - ALLOW significant correlation if the value calculated for 3aii is greater than { cv for 0.05 / 0.786 } ALLOW 5% FOR 0.05 ECF- ALLOW calculated value is greater than the cv if the value calculated for 3aii is greater than 0.786	(2)

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that makes reference to the following: • measure temperature from { several readings / random positions } (within the group of larvae) (1) • description of how mean calculated (1)	ALLOW stated number of measurements e.g. readings summated and answer divided by number of readings taken ALLOW 'average' for mean	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • increases enzyme activity for (larvae / species F) (1) • high temperature { kills / denatures enzymes of } other species (1) • (high temperature) increases food availability by { reducing competition from other species / increasing rate of decomposition of rhino } (1)	ALLOW description of increase in activity including maximizes rate of growth/digestion, shorter lifecycle IGNORE ref to metabolic activity unqualified ALLOW outcompetes other {species / larvae} for food	**(3)**

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: • increasing dose of interferon increases the survival time of the mice • because interferon inhibits viral replication (inside cells) • the greater the dose of interferon the fewer virus particles {produced / released} (to infect other cells)	ALLOW positive correlation between interferon dose and survival time ALLOW interferon prevents virus infecting other cells	**(3)**

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to two of the following: • bacteria do not possess {rER / Golgi apparatus} • polypeptide chain is not {processed / modified}properly • therefore the protein is {incorrectly folded / carbohydrate is not added}	ALLOW converse statements for each marking point ALLOW Golgi body ALLOW protein ALLOW is not glycosylated	**(2)**

Question Number	Answer	Mark
(iii)	**B** - exocytosis *The only correct answer is **B*** ***A** is not correct because endocytosis is the process used to take particles into cells* ***C** is not correct because facilitated diffusion is not used to transport proteins* ***D** is not correct because phagocytosis is a process used to engulf large particles such as bacteria*	**(1)**

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	Correct answer gains all 3 marks 1. line drawn between 25°C (core) and 15°C (ambient) ; 2. line drawn from centre of circle through the intersect of line 1 with diagonal ; 3. time of death = {23 - 24} ;	**1 ACCEPT** within the next scale line **2 CE** applies **3 CE** applies	**(3)**

Question Number	Answer	Additional Guidance	Mark
* (ii)	**(QWC – Spelling of technical terms must be correct and the answer must be**	**QWC emphasis is clarity of expression**	

Question Number	Answer	Additional Guidance	Mark
	organised in a logical sequence) **Clothing** 1. for the clothed body the {estimate was too short / eq } ; 2. because the clothing would {reduce heat loss / body would cool more slowly / temperature would drop slower / eq} ; 3. idea that clothing would {insulate / trap the heat / eq} ; **Position** 4. for the body curled up the {estimate was too short / eq } ; 5. because {heat loss is reduced / body would cool more slowly / temperature would drop slower / eq} ; 6. as the (exposed) surface area was smaller/ eq ; **Air movement** 7. for the moving air {the estimate was too long / eq } ; 8. as moving air {speeds up heat loss / body would cool faster / temperature would drop faster / eq } ;	**ACCEPT** converse arguments for Mps other than 1, 4 and 7 **1 ACCEPT** time of death was earlier / died longer ago **4 ACCEPT** time of death was earlier / died longer ago **7 ACCEPT** time of death was more recent / died later **IGNORE** submersion in water	**(6)**

Q7.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	1. levels of antibody rise sooner after infection / eq ; 2. levels of antibody rise faster after infection / eq ; 3. levels of antibody rise higher after infection / eq ; 4. credit comparative manipulation of data ;	**do not piece together** ACCEPT converse for mps 1, 2 and 3 in context of vaccination 4. e.g. increase after infection is {10 (au) more / 1.83 times more} peak after infection is 13 (au) higher rate of increase after infection is 1.27 au day^{-1} faster	**(2)**

Question Number	Answer	Additional Guidance	Mark
(a)(ii)	1. secondary (immune) response ; 2. reference to memory cells ; 3. idea that (on infection / second exposure) memory cells are {activated / cloned / stimulated / eq}; 4. idea that (in secondary response) antibodies are released from plasma cells ;	1. ACCEPT secondary immunity 3. ACCEPT B memory cells differentiate into plasma cells	**(3)**

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. idea that antibodies will only be present if antigen present ; 2. idea that antigen B is not present in vaccine ; 3. vaccination failed to stimulate immune response / eq ;		(2)

Question Number	Answer	Mark
(b)(ii)	**C** natural active	(1)

Question Number	Answer	Additional Guidance	Mark
(c)	1. idea that {a comment cannot be made / caution in interpreting results should be taken / eq} ; 2. no indication of number of rats used / eq ; 3. no data points / eq ; 4. no error bars (on graph) / no indication of variability / eq ; 5. no statistical evidence / eq ; 6. idea that no indication of {experimental details / control variables / control group / eq} ; 7. idea that mean has been used therefore there must have been some repeats / eq ;	1. IGNORE not reliable or is reliable 2. IGNORE no repeats / sample was small ACCEPT number of repeats not known / sample size not known	(3)

Q8.

Question Number	Answer	Mark
(i)	The only correct answer is A artificial active immunity *B is incorrect because the immunity is not passive* *C is incorrect because the immunity is not natural* *D is incorrect because the immunity is not natural or passive*	(1)

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to three of the following • T helper cells bind to { protein / antigen } the APC (1) • (therefore) leading to the production of {active T helper cells / T memory cells} (1) • the T helper cells activate the B cells to { divide / become } cells capable of producing antibodies (1) • The memory cells remain in the body so antibodies can be produced quickly (on re-infection) (1)	ALLOW B cells develop into B effector cells or plasma cells	(3)

Q9.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	1. {skin / epidermis} is a barrier / eq ; 2. reference to keratin ; 3. reference to lack of receptors (for the virus) ;	**Accept** prevents entry but **not** prevents infection **NB** keratin in skin forms a barrier = 2 marks **Accept** skin has different receptors	(2)

Question Number	Answer	Additional Guidance	Mark
(a)(ii)	1. idea that viruses only {infect / attach to / eq} {specific receptors / specific cells / host cells} ; 2. idea that receptors not present on {blood cells / endothelial cells / eq} ; 3. reference to {destruction / eq} of viruses by phagocytes ;	**Accept** white blood cells. neutrophils; PMN **Ignore** macrophages **Not** lymphocytes, T cells, plasma cells	(2)

Question Number	Answer	Additional Guidance	Mark
(b)	1. reverse transcriptase (required) in HIV, no reverse transcriptase in cold virus ; 2. DNA formed (using RNA) in HIV, {no DNA formed / RNA used to make protein / translation} in cold virus ; 3. reference to {provirus / latency / delay in virus formation / eq} in HIV infection, {no provirus / lytic cycle / (immediate) formation of virus particles / eq} in cold virus ;	**NB** answers can be pieced together but candidates still have to state both parts of mark point	**(2)**

Question Number	Answer	Additional Guidance	Mark
(c)(i)	1. to synthesise (common cold) RNA / eq ; 2. for amino acids to bind to tRNA / eq ; 3. to synthesise (common cold) protein (capsid) / eq ;	**Accept** translation	**(2)**

Question Number	Answer	Additional Guidance	Mark
(c)(ii)	1. idea of enzyme affecting {molecules in membrane / proteins / (phospho)lipids / cholesterol} ; 2. enzyme breaks {bonds / named bonds / eq} ; 3. reference to {(by) hydrolysis / hydrolytic enzymes} ; 4. credit detail of enzyme action ; 5. reference to enzyme U as {protease / lipase / cholesterase} ;	eg lowers activation energy, binding of active site to substrate (cannot credit reference to catalyst, as in stem of question) **Ignore** lysosyme	**(3)**

Q10.

Question Number	Answer	Additional Guidance	Mark
(a)	1. reference to enzymes {killing / destroying / eq} (microorganisms) ; 2. reference to {stomach acid / hydrochloric acid / HCl} {killing / destroying / eq} (microorganisms) ; 3. reference to lack of oxygen affecting (microorganisms) ; 4. idea of competition by gut flora with (microorganisms) ; 5. idea that insufficient numbers of (microorganisms) (to cause food poisoning) ; 6. idea that the (microorganisms) may not be {pathogenic/ harmful / cause food poisoning} ; 7. reference to (immediate) vomiting to remove (microorganisms) ;	**1. Accept** lysozymes / enzymes in saliva **Accept** enzymes destroying viruses **2. Accept** acid destroying viruses **3. Not** viruses **4. Not** viruses **6. Not** pathogens	**(3)**

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. reference to synthesis of RNA ; 2. using host cell {enzymes / named enzyme / (RNA) nucleotides} ; 3. reference to synthesis of (viral) proteins ; 4. using host cell {enzymes / named enzyme / amino acids / ribosomes / tRNA / ATP} ; 5. reference to assembly of {viruses / particles} (inside cells) ;	**1. Accept** mRNA **2. Not** reverse transcriptase **5. Accept** protein and RNA {form / make / eq} {viruses / particles}	**(4)**

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. idea of a delay (up to 24 hours) whilst viral particles are replicating / eq ; 2. idea that a virus can {result in many particles being formed / replicate very fast} ; 3. idea that more host cells infected ;	**2. Accept** reference to lytic cycle	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. reference to the {hand wash / alcohol} not affecting the virus ; 2. reference to (noro) virus {not having an envelope / surrounded by protein / eq} ; 3. alcohol does not {damage protein coat / penetrate} virus / eq ; 4. protein is hydrophilic / alcohol is an organic solvent / eq ;	**1. Not** does not kill virus **2. Accept** surrounded by a capsid	**(2)**

Mark Scheme

Q1.

Question number	Answer	Additional guidance	Mark
	An answer that makes reference to two of the following: • the integrin binds to receptors • on (the surface of capillary) endothelial cells (1) • holding the immune cell in place / stopping the immune cell moving with the blood (1) • giving the immune cells time to squeeze between the endothelial cells (into the brain) (1)	ALLOW (complementary) proteins in placxe of receptors IGNORE activates (capillary) endothelial cells ALLOW trapping the immune cell ALLOW allowing immune cells to cross {the basement membrane / capillary wall}	**(2)**

Q2.

Question number	Answer	Additional guidance	Mark
(i)	An explanation that makes reference to two of the following: • primers have a specific base sequence (1) • bind to complementary bases (at either end) of the DNA be amplified (1) • therefore, provide a site for the DNA polymerase to bind (1)	IGNORE contain complementary bases ALLOW primers attach to the start of the STR sequence ALLOW anneal for bind ALLOW allowing DNA polymerase to create a complementary strand	**(2)**

Question number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to three of the following: • the base sequences of the alleles are different (1) • the restriction enzyme {recognises / cuts} at a specific {site / DNA base sequence} (1) • that is only present in the G20210A allele (1) • therefore, a shorter fragment is produced for the G20210A allele (1)	ALLOW they have different numbers of base pairs e.g. wild type 345bp and the G20210A has 322bp	**(3)**

Question number	Answer	Additional guidance	Mark
(iii)	An answer that makes reference to four of the following: • identify an appropriate reagent to be provided (in excess) (1) • identify appropriate conditions (to control) (1) • change the number of cycles (1) • use gel electrophoresis (to determine quantity of DNA produced) (1) • choose the smallest number of cycles that produces an observable band (1)	e.g. DNA, polymerase, primers, mononucleotides e.g. temperatures used are 95, 55 and 70°C / duration of steps in cycle ALLOW a description of gel electrophoresis ALLOW choose the number of cycles giving the {thickest / clearest} band	**(4)**

Q3.

Question Number	Answer
	Answers will be credited according to candidates' deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Comparisons between phospholipid bilayer and proteins in the cell surface membrane: • judgement about the relative importance of the phospholipid bilayer and the proteins within that bilayer Use of data: • most proteins in the cell are associated with the cell membrane • whilst quantities of phospholipid are the same the proteins have more functions Importance of proteins in the cell surface membrane: • immune response e.g. as antigens and therefore body defence, antibodies, MHC proteins • receptors e.g. receptor proteins on tip of sperm allowing acrosome reaction when encounters zona, for neurotransmitters • regulation e.g. with regards to hormones such insulin • signal / transcription e.g. transcription factors, secondary messengers • transport e.g. active transport, as channel proteins allowing facilitated diffusion, as {voltage-gated / eq} channels for the nerve impulse / resting potential or / and role of Na^+-K^+ pump Importance of phospholipid bilayer in some of: • the role of fluidity and structure of cell the membrane • inhibiting polar substances moving across due to having a hydrophobic component • having both hydrophilic and hydrophobic components which leads to the separation of the aqueous contents of the cell from its aqueous external surroundings • allowing diffusion of gases directly across it • myelin sheath / nerve impulse

Level	Marks	Descriptor	Additional guidance
0		No awardable content	
1	1-3	An explanation may be attempted but with limited interpretation or analysis of the scientific information 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.	Discussion of one type of membrane protein linked to its role May have lots of irrelevant information
2	4-6	An explanation will be given with occasional evidence of analysis, interpretation and/or evaluation of **more than one** piece of scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Discussion of more than one membrane protein linking them to their function Also discussing the role of phospholipids
3	7-9	An explanation is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of **several** pieces of scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Good discussion of role of proteins and phospholipids – reaching a judgement Linking role of proteins and phospholipids Number of specific examples of membrane proteins Very little if any irrelevant information

Q4.

Question Number	Indicative content
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. Basic information • All the treatment combinations were effective at treating TB • All treatments had some { relapses / individuals with TB } 3 years after treatment • { Group 1 / Groups 1 and 2 / Rifampicin + Pyrazinamide / Rifampicin + Isoniazid } had the lowest number of patients with TB (3 years later) Evidence for linkages made • Percentage relapse varies depending on second part of treatment • Combinations involving Rifampicin most effective • The antibiotics tested act on different targets in bacteria • Gaps in information - not all combinations tested, other combinations might be more effective • Other time scales may have been more effective Evidence for sustained scientific reasoning • Could be other reasons for infections with TB 3 years later not due to the antibiotic treatment • No information about dormant TB (only percentage of active cases) • Bacterial RNA polymerase possibly the best target for antibiotics • Antibiotics targeting synthesis of cell wall fatty acids least effective in terms of relapses • Idea of combination of antibiotics with different mode of activity most effective

Level	Mark	Descriptor	
Level 0	Marks	No awardable content	
Level 1	1-2	An answer may be attempted but with limited interpretation or analysis of the scientific information with a focus on mainly just one piece of scientific information. The answer will contain basic information with some attempt made to link knowledge and understanding to the given context.	Reference to effectiveness of different combinations of antibiotics.
Level 2	3-4	An answer will be given with occasional evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The answer shows some linkages and lines of scientific reasoning with some structure.	Reasons for differences in effectiveness considered.
Level 3	5-6	An answer is made which is supported throughout by sustained application of relevant evidence of analysis, interpretation and/or evaluation of both pieces of scientific information. The answer shows a well-developed and sustained line of scientific reasoning which is clear and logically structured.	Information about action of antibiotics related to effectiveness. Evaluation of study design considered.

Q5.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: Any two of • more (new) cases • the total number of cases is relatively constant • and the number of people dying from TB is decreasing And • so {more are being successfully treated / the programme is effective}	ALLOW only slight change in total number of cases	**(3)**

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	1. idea that bacteria are resistant to fewer {antibiotics / antibiotic combinations} (in 2006 than 2007) ; 2. in both years there are resistant strains to {streptomycin / INH + rifampicin + ethambutol / INH } ; 3. idea that there are resistant strains to INH + rifampicin in 2006 but not in 2007 ; 4. idea that there are resistant strains to {ethambutol / rifampicin} in 2007 but not in 2006 ;	**ACCEPT** clear abbreviations to the names of the antibiotics throughout **1 ACCEPT** a description e.g. new resistances, resistant to 4 in 2006 and 5 in 2007 **3 ACCEPT** idea that {resistance decreased to zero / no longer resistant} **4 ACCEPT** idea of resistance developing **NB** development of new resistances to {ethambutol / rifampicin} = Mp 1 and 4	**(3)**

Question Number	Answer	Additional Guidance	Mark
(ii)	1. bacteria have a mutation in {DNA / gene / eq } ; 2. idea that the {presence / usage of} {antibiotic (INH) / INH} acts as a selection pressure ; 3. idea that the allele (for resistance) is passed on ; 4. idea that bacteria {divide by asexual reproduction / divide by binary fission / produce clones / eq} ; 5. idea of increasing the allele frequency ;	**3 NOT** gene **4 ACCEPT** divide by mitosis / conjugation / transduction / transformation / eq	

Question Number	Answer	Additional Guidance	Mark
	6. idea that the more resistant bacteria there are, the more likely new strains will acquire the (resistance) gene ;		**(3)**

Question Number	Answer	Additional Guidance	Mark
(iii)	1. reference to codes of {practice / conduct / eq } ; 2. idea that appropriate {antibiotics / named example} should be given to patients ; 3. idea of {educating patients about taking antibiotics / taking the full course of antibiotics ; 4. credit another appropriate procedure e.g. hand washing, screening ;	**1 ACCEPT** named policy /code **NB** Mp5 is for named practice **2 ACCEPT** not giving antibiotics if not necessary / not using antibiotics for prophylactic treatment / using narrow spectrum antibiotics / rotate antibiotic use	**(2)**

Q7.

Question Number	Answer	Additional guidance	Mark
(a)(i)	1. reference to {death / killing / destroying / eq } (of bacteria cells) ; 2. idea that {bacteria / cells} burst ;	**1. Ignore** reference to stopping growth **2. Accept** lysis, loss of osmotic control	**(2)**

Question Number	Answer	Additional guidance	Mark
(a)(ii)	1. reference to cells cannot {reproduce / increase in number / produce new cells / multiply / replicate / eq} ; 2. idea of no (cell) division ;	**2. Accept** no binary fission	**(2)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	1. (A and C resistant as) no {clear zone / zone of inhibition / eq} around A and C ; 2. idea that {clear zone / eq} indicates where antibiotic {inhibits growth / kills bacteria / eq} ; 3. {clear zone / eq} around B {smaller/ eq} than clear zone around D ; 4. idea of {size / diameter / width /eq} of clear zone indicates {effectiveness / eq} ; [check diagram for appropriate labels]	**1. Accept** a clear description of this area around the disc **2. Accept** converse **3. Accept** converse	**(3)**

Question Number	Answer	Mark
(b)(ii)	C reliability ;	**(1)**

Question Number	Answer	Mark
(b)(iii)	D validity;	**(1)**

Question Number	Answer	Additional guidance	Mark
(c)	1. reference to hospitals {having / changing / eq } a {code of practice / protocol / policy / standards / eq} (for dealing with hospital acquired infections) ; 2. idea of clothing rules for hospital workers ; 3. reference to <u>improved</u> laundry of bed linen e.g. {<u>increased</u> frequency / higher washing temperature / eq} ; 4. reference to use of special {pillow cases / treatment of pillow cases} e.g. microfilters, treated with antibacterials, sterilisation, disposable pillow cases ; 5. reference to use of special procedures when carrying {pillow cases / bed linen} to laundry e.g. sealed plastic bags ; 6. screening of patients / isolation of infected patients / eq ; 7. idea of hand washing regimes / eq ;	**1. Allow** references to pillows for pillow cases throughout **3. Allow** pillow cases should be washed daily **7. Allow** hands should always be washed	**(3)**

Q8.

Question Number	Answer	Mark
(a)	**A** active artificial	(1)

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. antibodies appear (in blood) {immediately / on day 0 / eq} in group B but {on day 4 / after 3 days} in group A ; 2. antibodies reach higher levels in group B / eq ; 3. credit comparative manipulated data ;		(2)

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. antibodies present from the first vaccination / eq ; 2. idea of a secondary immune response ; 3. memory cells already present / eq ; 4. due to first vaccination / eq ; 5. memory cells mean that {antibodies produced immediately} / eq ; 6. on exposure to (same) antigen / eq ;		(3)

Question Number	Answer	Additional Guidance	Mark
(c)	1. idea that the virus will be destroyed quicker ; 2. {more / wider range of} memory cells present ; 3. so {higher levels / faster production} of antibodies ;		(2)

Question Number	Answer	Additional Guidance	Mark
(d)	**Comparisons of groups A and B** 1. not very reliable as sample size is small / eq ; 2. data for first 15 days after vaccination are reliable as error bars do not overlap ; 3. data for 30 and 60 days not reliable as error bars overlap ; **Comparisons within either of the groups** 4. there may be no change in the first fifteen days ;		**(3)**

Q9.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	A		**(1)**

Question Number	Indicative content		
***(b)**	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • Vaccination stimulates primary immune response • Reference to antigen presenting cells • Activation of T helper cells / reference to cytokines • Reference to B effector cells / activation of T killer cells • (Differentiation into) plasma cells that secrete antibody • Reference to memory cells • (Secondary immune response) antibody production is {sooner / faster / greater} for pathogen A • Insufficient antibody initially produced in primary response for pathogen B		
Level	Mark	Descriptor	
	0	No awardable content	

Level 1	1-2	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.
Level 2	3-4	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts to provide the explanation being presented. Lines of argument occasionally supported through the application of
		relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows some linkages and lines of reasoning with some structure.
Level 3	5-6	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts to provide the explanation being presented. Line(s) of argument supported throughout by sustained application of relevant evidence (scientific ideas, processes, techniques and procedures). The explanation shows a well-developed and sustained line of reasoning which is clear, coherent and logically structured.

Q10.

Question number	Answer	Additional guidance	Mark
	A description that makes reference to the following: • { phagocytes / macrophages } engulf antigens (1) • antigen is presented on the surface of antigen presenting cells (1) • lymphocytes with receptors that are (specific / complementary) to (particular) antigens bind to APC (1)	ALLOW reference to production of APCs / antigen presenting cells ALLOW CD4 receptors ALLOW T cells for lymphocytes	**(3)**

Q11.

Question Number	Answer	Additional guidance	Mark
	<table><tr><th></th><th>Keratin in the skin</th><th>Lysozyme in mucus</th><th>Hydrochloric acid in the stomach</th></tr><tr><td>Physical barrier</td><td>✓</td><td>x</td><td>x</td></tr><tr><td>Chemical barrier</td><td>x</td><td>✓</td><td>✓</td></tr></table>	3 correct answers 1 mark All correct 2 marks	**(2)**

Q12.

Question Number	Answer	Additional Guidance	Mark
(a)	1. bacteria have DNA, viruses have DNA or RNA ; 2. idea that bacteria have {circular / eq} genetic material, viruses have {linear / straight} ; 3. bacterial DNA is double-stranded, viral {DNA / RNA} is single (or double) stranded / eq; 4. bacteria (may) have plasmids, viruses do not have plasmids / eq;	**NB** piece answers together throughout **Do not accept** in context of plasmid	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. reference to {phagocytosis /endocytosis / engulfing} ; 2. credit details of phagocytosis ; 3. reference to bacterium inside a {vacuole / vesicle / phagolysosome} ;	eg formation of {pseudopodia / membrane extensions around bacteria} / cytoplasmic streaming / binding to bacteria **Not** phagolysozyme	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. idea that bacteria need to be accessible to antibiotics ; 2. idea of bacteria inside macrophages ; 3. reference to waxy layer of (these) bacteria ; 4. idea that (bacteriostatic) antibiotics affect dividing bacteria; 5. reference to antibiotic resistance (of these bacteria) ;	**Not** bacteriocidal antibiotics	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. idea of {dead / attenuated / eq} {organisms / pathogen / bacterium / eq} put into person; 2. reference to (stimulation of) {specific / primary} (immune) response ; 3. credit details of T helper cell activation ; 4. credit details of B cell activation ; 5. credit details of T killer cell activation ; 6. reference to production of memory cells ;	**NB** not simply crediting ref to vaccination as in stem of question **Accept** antigen eg macrophages as APCs eg involvement of cytokines, B cells as APCs eg involvement of cytokines, infected cells as APCs	**(3)**

Question Number	Answer	Additional Guidance	Mark
(c)	1. reference to {<u>further</u> lung damage / severe breathing problems / eq} ; 2. idea that the *Mycobacterium* get into the {blood / lymph}; 3. idea that organ failure (leads to death) ; 4. idea of {reduced / weakened} immune response (due to a loss of T cells) ; 5. credit detail of role of T (helper) cells ; 6. credit detail of effect of no T killer cells ; 7. credit detail of effect of no B cells ; 8. ref to {secondary / opportunistic / other} infections (causing death) ;	eg cannot obtain enough oxygen eg production of cytokines eg infected cells will not be destroyed eg no antibody produced	**(4)**

Q13.

Question Number	Answer	Additional guidance	Mark
(i)	A description that makes reference to three of the following • (small groups of) healthy volunteers are given the vaccine to testfor side effects (1) • (healthy volunteers) tested for presence of antibodies to the virus (following vaccination) (1) • a group of people at risk of contracting the disease is given the vaccine (1) • the number of people who develop the viral disease (following vaccination) are monitored (1)		(3)

Question Number	Answer	Additional guidance	Mark
(ii)	An answer that makes reference to four of the following • large numbers of people died from the disease (1) • health workers are in close contact with people suffering from the disease (1) • the side effects of the vaccine will not be worse than contracting Ebola(1) • vaccinating immediate family will help to reduce the spread of disease(1) • if health workers were vaccinated they could care for more people (1)	ALLOW disease is (usually) fatal ALLOW health workers and family most likely to be exposed to the virus ALLOW risk from the disease is much greater than the risk from the vaccine	(4)

Q14.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to three of the following: <u>Similarities</u> • both contain { genetic material / RNA } (1) • both have a phospholipid bilayer (1) <u>Differences</u> • (only) bacteria have { cytoplasm / ribosomes / pili / slime capsule / flagellum /cell wall / cell membrane / plasmid } (1) • (only) HIV has { capsid / protein coat / GP 120 } (1)	IGNORE both have DNA ALLOW lipid bilayer ALLOW converse i.e. HIV does not have... ALLOW converse i.e. bacterium does not have...	**(3)**

Q15.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to four of the following: <u>Similarities</u> • to avoid adverse environmental conditions **(1)** • formation of resistant {outer coating / capsule} **(1)** • reduce metabolic activity **(1)** <u>Differences</u> • sporulation and no sporulation **(1)** • different reasons for entering dormancy **(1)** • (only) genetic material is in a protective capsule in Bacillus **(1)**	e.g. mycobacterium enters dormancy to avoid immune response and Bacillus to survive lack of resources	**(4)**

Q16.

Question Number	Answer	Mark
	B - smaller than ribosomes in eukaryotes *The only correct answer is **B*** ***A** is not correct because bacterial ribosomes are smaller than eukaryotic ribosomes* ***C** is not correct because bacterial ribosomes are smaller than animal ribosomes* ***D** is not correct because bacterial ribosomes are smaller than plant ribosomes*	**(1)**

Q17.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to two of the following: • only one cell as opposed to potentially many **(1)** • no nucleus present **(1)** • no membrane-bound organelles present / absence of named membrane-bound organelle other than nucleus **(1)**	 ALLOW DNA not associated with histones ALLOW example e.g. no mitochondrion	**(2)**

Q18.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • at the start of composting the percentage of organic carbon is less and the percentage of nitrogen is more when cow dung is added (1) • adding cow dung does not change the decrease in organic carbon (1) • adding cow dung causes {a slight / no change} to the increase in nitrogen (1) • adding cow dung has no significant effect on composting (of coffee husks) (1)	e.g. 12.8% and 12.7% e.g. 0.43% compared with 0.47%	3

Q19.

Question Number	Indicative content		
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • the CVID group is more susceptible to bacterial infections • the CVID group produces fewer antibodies to bacterial antigens • have a reduced percentage of B cells • have a similar ratio of T helper to T killer cells • have a normal percentage of T lymphocytes • can defend themselves against viruses but not bacteria • (therefore) antiviral medication not required • could prescribe (prophylactic) antibiotics • could provide passive immunity by giving them antibodies / immunoglobulins		
Level	Mark	Descriptor	
0	0	No awardable content	
1	1-2	Limited scientific judgement made with a focus	

Level	Mark	Descriptor
		on mainly just one method, with a few strengths/weaknesses identified. A conclusion may be attempted, demonstrating isolated elements of biological knowledge and understanding but with limited evidence to support the judgement being made.
2	3-4	A scientific judgement is made through the application of relevant evidence, with strengths and weaknesses of each method identified. A conclusion is made, demonstrating linkages to elements of biological knowledge and understanding, with occasional evidence to support the judgement being made.
3	5-6	A scientific judgement is made which is supported throughout by sustained application of relevant evidence from the analysis and interpretation of the scientific information. A conclusion is made, demonstrating sustained linkages to biological knowledge and understanding with evidence to support the judgement being made.

Q20.

Question Number	Acceptable Answer	Additional Guidance	Mark
(i)	• positive correlation		**(1)**

Question Number	Acceptable Answer		Additional Guidance	Mark
(ii)	• correct diameter or radius measured	(1)	14 mm Example of Calculation $3.14 \times 7^2 = 154\ mm^2$	**(2)**
	• correct answer	(1)	Allow full marks for correct answer with no working	

Q21.

Question Number	Answer	Mark
(a)	**C** hydrolysis	**(1)**

Question Number	Answer	Mark
(b)(i)	**B** to give a range of values for the independent variable	**(1)**

Question Number	Answer	Mark
(b)(ii)	**B** one	**(1)**

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. idea that {bacteria / fungi / decomposers / eq} release enzymes (for decomposition) ; 2. idea of the formation of {monomers / glucose / amino acids / small molecules} / eq ; 3. that {are soluble / dissolve} ; 4. idea that some (soluble) molecules {soak into the ground / taken up (by organisms) ; 5. idea of {respiration / fermentation} of {glucose / eq} (by decomposers); 6. carbon dioxide (released) / eq ; 7. idea of water loss ; 8. idea of {worm / appropriate named organism} activity;	1. ACCEPT external digestion / extracellular digestion 7. e.g. evaporation of water / leaves drying out 8. e.g. animals eat the leaves, leaves pulled into soil	**(4)**

Question Number	Answer	Additional Guidance	Mark
(b)(iv)	1. idea that an increase in temperature would increase the rate of decomposition (up to an optimum temperature) ; 2. reference to enzymes (in decomposition) ; 3. idea that increased {heat / kinetic} energy results increase in {number of collisions / energy of collisions (between enzymes and substrate) / enzyme-substrate complexes} ; 4. idea that increased temperature increases rate at which bacteria increase ; 5. idea that above a certain temperature rate of decomposition would {decrease / stop} ; 6. idea that at higher temperatures enzymes become denatured OR bacteria killed ;	6. NOT enzymes start to denature NB need the term 'denaturing' or its derivative	**(4)**

Q22.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	larvae show no significant preference for light over dark side (1)	Allow vice versa Must have NO in hypothesis.	**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(i)	calculation of expected frequency 10 and 10 (1) $(O-E)^2/E$ for both light and dark sides $49 \div 10 = 4.9$ (1) sum = 9.8 (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(ii)	An answer that makes reference to the following: • higher than 3.84 therefore Chi square value as high as 9.8 arise by chance alone less than 1 in 20 / 0.05 therefore there is a significant difference (1)	allow ECF for incorrect value of Chi allow converse if calculated of Chi is lower than 3.84	**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(c)	An explanation that makes reference to five of the following: • use of dead tissue containing toxin and dead tissue not containing tissue so valid comparison can be made (1) • {young larvae of same length / fly eggs} allowed access to both types of dead tissue so they have same potential for growth (1) • reference to time scale before growth of larvae measured to allow time for growth to occur (1) • length measured for several larvae to ensure reliability (1) • control of {temperature / type of tissue / age of tissue / species of larvae} because these factors affect growth (1) • recognition that comparison of results may show under or over estimate of time of death (1)		**(5)**

Q23.

Question Number	Answer	Mark
(a)	**A** bacteria and fungi	(1)

Question Number	Answer	Mark
(b)(i)	**A** none	(1)

Question Number	Answer	Mark
(b)(ii)	**D** validity	(1)

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. 2. ref to hydrolysis ; 3. by {enzymes / cellulase} / eq ; 4. produced by microorganisms / eq ; 5. into(β) glucose ; 6. uptake of glucose into microorganisms / eq ; 7. idea that glucose is used in {respiration / fermentation} ; 8. releasing carbon dioxide into the atmosphere / eq ; 9. idea that some of glucose (solution) soaks into ground ;		(4)

Question Number	Answer	Additional Guidance	Mark
(b)(iv)	1. to make investigation valid ; 2. idea that {temperature / heat energy} affects {rate of enzyme reactions / enzyme activity / rate of decomposition} ; 3. increase in {heat / kinetic} energy results in more {collisions / energetic collision / enzyme-substrate complexes / eq} ; 4. idea that high temperature results in enzyme {denaturing / becoming denatured} ; 5. (so) decomposition would stop / eq ;	4. ACCEPT bacteria killed / eq	**(4)**

Q24.

Question number	Answer	Additional guidance	Mark
	An answer that makes reference to two of the following: • PERVs (are retroviruses) present in the pig'sgenome (1) • PERV virus particles {are produced by / bud of from} the pig cells (1) • PERVs bind to membrane receptors (on humancells) (1) • PERVs insert their nucleic acid into the cells (1)	ALLOW pigs inherit the PERVs /retroviruses in their genomic DNA ALLOW membrane coated particlesfuse with human cells ALLOW enter cells by endocytosis	Choose an item. (2)

Q25.

Question Number	Answer	Additional guidance	Mark
(i)	A description that makes reference to three of the following: • standardisation of pigs studied (1) • named {environmental condition / abiotic factor} controlled (1) • record the presence of different species (of insects) (1) • at regular intervals of time (1)	e.g. same {size / breed / mass / type / age /sex} ALLOW example of an abiotic factor being monitored such as temperature e.g. every 24 hours, every day, hourly, weekly	**(3)**

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to three of the following: • record which {insects / species} are present (on the human) (1) • compare with results from investigation (on pigs) to determine time of death (1) • take into account which stages of the lifecycle are present (1) • (when using stage of succession to determine time of death) environmental variables need to be taken into account (1)		**(3)**

Mark Scheme

Q1.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to the following • an increase in temperature will increase the rate of { decomposition / decay } (1) • (an increase in temperature) increases enzyme activity (1) • an increase in temperature increases growth rate of {bacteria / fungi / decomposers} (1)	ALLOW converse for all points for the effects of a decrease in temperature ALLOW high temperatures may denature enzymes and decrease rate of decomposition ALLOW increases rate of multiplication	**(3)**

Q2.

Question Number	Answer	Additional Guidance	Mark
	1. idea that the temperature of the {body / core} changes (with time after death) ; 2. idea that (core) temperature depends upon the {ambient / eq} temperature ; 3. idea that {other post-death changes / muscle contraction / insect life cycles / decomposition / eq} depend on (ambient / body) temperature ;	**1 ACCEPT** cooling	**(3)**

Q3.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)	• correct reading of temperatures (1) • after 24 hours, lowest body temperature 22 minus 5.6^{0}C (1)	22 ±5.6 Accept calculation of maximum ambient temperature <u>Example of calculation</u> 22 – 5.6 = (lower than / equal to) 16.4^{o}C	**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)	An answer that makes reference to the following: • range smaller at higher temps (1) • only the highest temperature shows no overlap (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(c)	An answer that makes reference to two of the following: • body size (1) • fat level (1) • position of body i.e. in fetal position or not (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(d)	An explanation that makes reference to the following: • rectal temperature is core temperature / it would be 37°C at time of death (1) • skin surface temperature would be more variable (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(e)	An answer that makes reference to two of the following: • rigor mortis (1) • degree of decomposition (1) • forensic entomology (1)		**(2)**

Q4.

Question Number	Answer	Mark
(i)	The only correct answer is C – polynucleotides and phospholipids *A is incorrect because phosphate is not in cellulose* *B is incorrect because polysaccharides do not contain phosphate* *D is incorrect because phosphate is not in polysaccharides*	**(1)**

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to three of the following • the stems contain starch or cellulose (1) • enzymes are {secreted / released} by the microorganisms (1) • which break down the glycosidic bonds (1) • which releases glucose that is used by the microorganisms in respiration (1)	ALLOW lignin ALLOW enzymes from microorganisms digest (starch / cellulose)	**(3)**

Q5.

Question Number	Acceptable Answer	Additional guidance	Mark
(a)	A description that makes reference to the following: • reference to PCR to include reference to {primers / DNA polymerase / nucleotides} (1) • procedure repeated {multiple times / 20 to 40 times} (1) • temperature requirements to denature and anneal (1)		**(3)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(i)	C		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(b)(ii)	An explanation that makes reference to: • pattern of bands different between 1 and 3 and 2 and 4 (1) • so *Allolobophora chlorotica* not all one species (1)		**(2)**

Q6.

Question number	Answer	Additional guidance	Mark
(i)	An explanation that makes reference to two of the following: • (pre-)mRNA splicing / post-transcriptional modification (1) • different exons removed (1) • (therefore) producing different {sequences of amino acids / mRNA sequences} (1)	ALLOW the exons can be joined in different sequences ALLOW (the acetylcholinesterase) gene ismade up from several exons and introns IGNORE producing different primary structure	Choose an item. (2)

Question number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to three of the following: • {hormones / signal molecules / chemical signals} bind toreceptors found only in some {tissues / cells} (1) • regulating a {transcription factor / repressor molecules}(1) • {transcription factor / repressor molecule} binds to thepromotor region of the (acetylcholinesterase) gene (1) • therefore switching {on / off} transcription (1)	ALLOW epigenetic changes occur in some tissues ALLOW only act on some {tissues / cells} ALLOW {allowing / preventing} binding of RNA polymerase	Choose an item. (3)

Q7.

Question Number	Answer	Additional Guidance	Mark
(a)	1. proteins consist of amino acids joined together by peptide bonds; 2. credit reference to named bonds (between R groups) involved in holding {3D structure / eq} ; 3. carbohydrates consist of {monsaccharides / glucose / eq} ; 4. reference to glycosidic {bonds / eq} between (adjacent) {glucose / eq} molecules ;		**(3)**

Question Number	Answer	Additional Guidance	Mark
(b)	1. idea that the drugs could {bind to / alter shape of} {glycoproteins / gp120} ; 2. idea that drugs bind to {receptors / antigens} on membrane / eq ; 3. called CD4 (antigen / molecules) ; 4. preventing virus attaching to T (helper / $CD4^+$) cells / eq ;		**(3)**

Question Number	Answer	Additional Guidance	Mark
***(c)**	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. reference to reverse transcriptase ; 2. idea of formation of (viral) DNA ; 3. from (viral) RNA ; 4. reference to integrase ; 5. idea of integration of (viral) DNA into (host) DNA ; 6. idea that {T helper cells / eq} would be {destroyed / killed / burst / eq} (by virus particles leaving cell) ; 7. idea that more T (helper) cells would become infected ;	**QWC focussing on clarity of expression** 2. reject idea that RNA is {turned into / converted into} DNA 5. ACCEPT idea of {latency / formation of provirus / eq}	**(5)**

Q8.

Question Number	Answer	Mark
(a)(i)	C T helper cells ;	**(1)**

Question Number	Answer	Mark
(a)(ii)	D reverse transcriptase ;	**(1)**

Question Number	Answer	Additional guidance	Mark
(b)(i)	1. reference to glycoprotein ; 2. credit detail of structure e.g. specific (3D) shape, L and H regions, Y-shape, 4 (peptide) chains, disulphide bridges between peptides, hinge region ; 3. reference to {antigen-binding site / variable region / Fab (region) / eq }; 4. idea of antibodies have a {similar / constant / Fc / eq } region; 5. produced by plasma cells / present on B cells ; 6. role of antibody described e.g. opsonisation, immobilisation, agglutination, lysis ;	**1. Accept** protein, chains of amino acids **2. Ignore** active site **Accept** a Y-shaped drawing **3. Accept** references to {binding to specific antigen / antigen-specific / antigen receptors} **5. Accept** present on B effector cells	**(2)**

Question Number	Answer	Additional guidance	Mark
***(b)(ii)**	(QWC – answer must be organised in a clear, logical sequence) 1. reference to artificial (active) immunity ; 2. reference to {vaccine / vaccination } ; 3. containing {synthetic molecule / (synthetic) antigen / (synthetic) glycoprotein } ; 4. ref to stimulation of the {specific / humoral} immune response (to the synthetic antigen) ; 5. credit detail of process of producing effector B cells e.g. clonal expansion of B cells, involvement of cytokines, T helper cells activate B cells ; 6. reference to (production of B) memory cells ; 7. idea that (2G12) antibodies are produced {faster / in greater concentration} on {reinfection / eq} ;	Mps are awarded if the statements are clearly expressed **5. Ignore** references to production of activated T killer cells **6. Ignore** references to production of T memory cells **7. Accept** ref to secondary immune response	**(5)**

Question Number	Answer	Additional guidance	Mark
(c)	1. idea that HIV infection does not always produce symptoms ; 2. reference to {provirus / latency } ; 3. reference to test needed to detect (symptomless) HIV ; 4. idea that only people who suspect they may have contracted HIV would have a test ; 5. idea that {some people would not want to be tested / impossible to test everyone} ; 6. idea that symptoms are common to other diseases ; 7. {new cases arising/ patients dying} all the time / eq ; 8. idea of new strains of virus arising ;	**2. Accept** virus is dormant	**(2)**

Q9.

Question Number	Answer	Mark
	The only correct answer is D - RNA and reverse transcriptase ***A*** *is incorrect because it is does not contain DNA* ***B*** *is incorrect because it is does not contain DNA* ***C*** *is incorrect because it does not contain DNA polymerase*	**(1)**

Q10.

Question Number	Answer	Additional Guidance	Mark
(a)	1. (structure G is {glycoprotein / gp120} ; 2. used for {attachment / eq} to CD4 (molecules / receptors /antigens) ; 3. on T helper {cells / lymphocytes} ;	1. IGNORE gp 41 and gp 160 and other wrong numbers 3. ACCEPT macrophages / dendritic cells / CD4 cells	**(3)**

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. they are globular proteins ; 2. it has an active site ; 3. idea of {charged R groups on outside of molecules / composed of many small R groups} ;	2. idea of active site R groups enable binding of substrate 3. idea of hydrophilic on the outside	**(3)**

Question Number	Answer	Additional Guidance	Mark
*(b)(ii)	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. idea that drugs would prevent viral replication ; 2. idea that T (helper) {cells / lymphocytes} will not be { killed / burst / destroyed}(by virus particles leaving cell) ; 3. idea of {inhibition / eq} of reverse transcriptase ; 4. idea that (viral) DNA could not be made; 5. from the (viral) RNA ; 6. idea of {inhibition / eq} of integrase ; 7. idea that (viral) DNA cannot integrate into (host) {DNA / genome} / eq ;	QWC emphasis on **clarity** of expression 1. ACCEPT description of virus formation 3. ACCEPT drugs prevent action of reverse transcriptase 4. reject idea that RNA is {turned into / converted into} DNA 6. ACCEPT drugs prevent action of integrase 7. ACCEPT idea that drugs would prevent {latency / formation of provirus / eq} ;	**(5)**

Q11.

Question number	Answer	Additional guidance	Mark
	A description that makes reference to four of the following: • stem cell is undifferentiated whereas a 'key player' is differentiated (to undertake a specific function) (1) • example of a 'key player' (1) • example of specific function of a named 'key player' cell (1) • number of divisions of a stem cell is unlimited whereas for a 'key player' the number of cell divisions is limited (1) • 'key player' has undergone differential gene expression (1)	ALLOW unspecialised and specialised e.g. B cells / plasma cells / phagocytes / lymphocytes e.g. (B cells) produce antibodies ALLOW Hayflick limit for 'key players' but not for stem cells	Expert (4)

Q12.

Question Number	Answer	Additional guidance	Mark
(i)	A description that makes reference to three of the following: • {glycoproteins / GP120} on the (surface of the) virus(1) • bind to (CD4) receptors on the (surface of the) T (helper) cells(1) • viral envelope fuses with cell membrane of T helper cell (1) • viral RNA enters the cell (1)	ALLOW GP130 IGNORE capsid	**(3)**

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following • (lack of T helper cells) reduces cytokine production (1) • therefore reducing { cloning / activation } of B cells (1) • reducing antibody production (1) • there is an increased risk of opportunistic infections (1)	ALLOW reduced production of {B effector cells/plasma cells} ALLOW example eg TB	**(4)**

Q13.

Question Number	Answer	Mark
	The only correct answer is C - preventing the multiplication of bacteria ***A*** *is not correct because bacteriostatic antibiotics do not destroy bacteria* ***B*** *is not correct because antibiotics are not effective against viruses* ***D*** *is not correct because antibiotics do not prevent the development of antibiotic resistance*	**(1)**

Q14.

Question Number	Answer	Mark
(i)	**B** – plasma cell *The only correct answer is **B*** ***A** is not correct because macrophage does not produce antibodies* ***C** is not correct because red blood cells do not produce antibodies* ***D** is not correct because T cells do not produce antibodies.*	**(1)**

Question Number	Answer	Mark
(ii)	**D** – natural passive immunity - the immunity is provided by components of the mother's milk produced as part of a natural immune response. The baby has not produced these components so the immunity is passive. *The only correct answer is **D*** ***A** is not correct because the baby has not produced the immunity gained from the mother's milk so it is not active immunity* ***B** is not correct because the immunity from the mother was not generated by artificial exposure to antigens (e.g. immunisation) so it is not artificial immunity* ***C** is not correct because the baby has not produced the immunity gained from the mother's milk so it is not active immunity*	**(1)**

Q15.

Question Number	Answer	Additional Guidance	Mark
(a)	1. bacteria are cells, viruses are {not / particles} ; 2. idea of bacteria surrounded by {cell wall / slime / capsule } , viruses surrounded by {protein / capsids / envelope} **;** 3. bacteria have { plasmids / ribosomes / other named structure} , viruses do not have {plasmids / ribosomes / other named structure } ; 4. bacteria (genome) are DNA, viruses can be DNA or RNA ; 5. bacterial DNA is double-stranded, viral genetic material is single (or double) stranded / eq ; 6. idea that bacteria have {circular / eq} genetic material, viruses have {linear / straight} genetic material ;	**NB** piece answers together throughout **Accept** only matched structures **2. Accept** for envelope: membrane / phospholipid layer / eq **3. Accept** bacteria have membranes, flagella cytoplasm, glycogen, lipid droplets **6. Not** in context of plasmid	**(3)**

Question Number	Answer	Additional Guidance	Mark
(b)(i)	1. reference to humoral (immune) response ; 2. reference to {phagocytosis / eq} by {phagocytes /named phagocyte} ; 3. reference to macrophages as { antigen-presenting cells / APCs} (to T helper cells) ; 4. reference to B cells as { antigen-presenting cells / APCs} (to itself) ; 5. idea that T helper cells release cytokines for B cell {activation / stimulation} ; 6. idea of B cells {forming clones / dividing /eq} (to form B effector cells) ; 7. reference to {differentiation of B cells into plasma cells / formation of plasma cells from B cells} (subsequent to cloning) ;	**2. Accept** dendritic cells / Langerhans cells / B cells **3 Accept** dendritic cells / Langerhans cells 4. **Accept** antigen binds to B cells **6. Not** to form plasma cells	**(4)**

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. reference to {opsonisation / antibodies bind to bacteria / eq} ; 2. (as a result) enhancing phagocytosis / eq ; 3. reference to {immobilisation / agglutination / eq } (of bacteria) ; 4. idea of antibodies neutralising toxins / eq ;	**1. Not** reference to killing bacteria **2. Accept** easier, better	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. idea that the immune response will be weaker ; 2. person may not recover from this infection / eq ; 3. idea of {other (opportunistic) infection / cancer} ; 4. reference to cytokines released from {T helper / CD4 } cells ; 5. idea that cytokines are involved in {activation / division } of {B cells / T killer cells} ; 6. credit consequence of impaired B cell function ; 7. credit consequence of impaired T killer cell function ;	**1. Accept** in context of either humoral or cell-mediated immune response **6. Accept** e.g. no antibody produced by plasma cells **7. Accept** e.g. infected cells not destroyed	**(4)**

Q16.

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to four of the following: • (cytokines / histamine) increases permeability of the capillaries (1) • (cytokines / histamine) cause vasodilation (1) • increasing blood flow to site of inflammation (1) • allowing white blood cells to { migrate / move } from the blood into the tissue space (1) • cytokines attract white blood cells (1)	ALLOW cause arterioles to dilate MP4 and 5 ALLOW immune cells / phagocytes / macrophages / monocytes ALLOW chemicals in place of cytokines	**(4)**

Q17.

Question number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following: • {chemical mediators / histamine} released (1) • increasing blood flow / increasing capillary permeability / causing oedema (1) • {increasing number of / activating / recruiting} white blood cells (in the area of inflammation) (1) • (stimulating) the release of (catabolic) enzymes / increasing phagocytosis (of damaged tissue) (1)	ALLOW activating T killer cells / activating phagocytes / activating macrophages ALLOW tissues destroyed by {macrophages / phagocytes / T killer cells}	Expert (3)

Q18.

Question Number	Answer
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. • standardisation of composition of compost heaps • identification of species • abundance of each species of organism in the sample • determination of C:N / set up compost heaps with different C:N ratios • time e.g. days / intervals / repetition of sampling • other factors to monitor or control e.g. water / gases / humidity / temperature / aeration / mass • sampling technique e.g. location of sample within compost heap / repetition of sampling

Level	Mark	Descriptor	
0	Marks	No awardable content	
Level 1	1-2	An explanation of how the investigation should be modified may be attempted but with limited analysis, interpretation and/or evaluation of the scientific information. Generalised comments made. The explanation will contain basic information with some attempt made to link knowledge and understanding to the given context.	Measure / set up compost heaps with different C:N ratios Observe species present over time
Level 2	3-4	An explanation of how the investigation should be modified will be given with occasional evidence of analysis, interpretation and/or evaluation of the scientific information. The explanation shows some linkages and lines of scientific reasoning with some structure.	Recording species present / numbers of each species / measuring C:N ratio Monitoring changes over time Control of relevant factors
Level 3	5-6	An explanation of how the investigation should be modified is given which is supported throughout by evidence from the analysis, interpretation and/or evaluation of the scientific information. The explanation shows a well-developed and sustained line of scientific reasoning which is clear, coherent and logically structured.	Description of a suitable sampling technique Linking species present or species density to C:N measurements Use of a statistical test to compare changes of time / C:N ratio Use information on numbers of species and population sizes to demonstrate succession

Q19.

Question Number	Answer	Additional guidance	Mark
(i)	An calculation that shows the following • selection of correct data from table and difference calculated (1) • calculation of percentage to three significant figures (1)	Example of calculation 1855-135 = 1720 92.7 (%) Correct answer with no working gains full marks.	graduate (2)

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following • as the vaccination rate increases the number of cases of measles decreases (in some years) (1) • example from data to show why the conclusion is valid (1) • (the effects of changes in percentage vaccination are seen in the following year) because it takes time for {antibodies / memory cells} to be produced (1) • time taken for herd immunity to develop (1)	ALLOW reference to data from specific years such as 2013 to 2014, 2014 to 2015	Expert (4)

Q20.

Question Number	Answer	Mark
(i)	The only correct answer is B *produced when B cells are activated to become plasma cells* A is not correct because B cells do not become killer cells C is not correct because macrophages do not become B cells D is not correct because plasma cells do not become memory cells	Computer (1)

Question Number	Answer	Mark
(ii)	The only correct answer is A *active artificial immunity* B is not correct because immunity due to vaccination is not natural immunity C is not correct because passive immunity does not lead to the production of antibodies D is not correct because immunity due to vaccination is not natural immunity and passive immunity does not lead to the production of antibodies	Computer (1)

Question Number	Answer	Additional guidance	Mark
(iii)	An explanation that makes reference to three of the following • due to a loss of memory cells there is no secondary immune response (1) • therefore antibodies cannot be produced quickly (1) • therefore there is less immunity (to diseases previously vaccinated against) (1) • need to repeat vaccinations to produce more memory cells (1)	ALLOW converse for repeat vaccination ALLOW converse for repeat vaccination ALLOW diseases can be contracted that children were previously immune to	Expert (3)

Q21.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to the following • flora in the gut and skin are better adapted to the conditions (1) • therefore they can outcompete pathogenic organisms (1) • bacteria in the gut secrete {chemicals /lactic acid} which help to destroy pathogens (1)	ALLOW details of competition for space or nutrients ALLOW enzymes	(3)

Q22.

Question Number	Answer	Additional guidance	Mark
(i)	A description that makes reference to the following • pre mRNA contains exons and introns (1) • introns are removed and exons are spliced together (to produce a strand of mRNA) (1)	ALLOW reference to introns and exons in the correct context i.e. exons are coding and introns are non-coding regions ALLOW 'joined together' for 'spliced'	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to the following • the {exons can be spliced together in a different order / different exons can be removed } (1) • therefore producing different sequences of amino acids (1)		(2)

Q23.

Question number	Answer	Additional guidance	Mark
	A description that makes reference to four of the following: • extract mRNA for one form of the (tau protein) (1) • copy mRNA into DNA (1) • use restriction enzymes {to create sticky ends) / cut theDNA and a vector} (1) • {ligate / insert / integrate} the TAU DNA into the vector(DNA) (1) • introduce vector into {fertilised egg / embryonic stem /zygote / cells / neural cell stem cells} (1)	IGNORE cut / remove TAU gene from a humanALLOW synthesis DNA sequence for one form e.g. use code specific for one of the tau proteins ALLOW insert gene into fertilised egg cell /embryonic stem cell ALLOW egg cell fertilised after inserting gene	Choose an item. (4)

Q24.

Question Number	Answer	Additional guidance	Mark
(i)	An answer that makes reference to two of the following: • the protein is a receptor in the cell surface membrane of Thelper cells (1) • { glycoprotein / GP120 } is unable to bind with the (CD4)receptor (on the host cell) (1) • viral RNA cannot enter the cell (1)	ALLOW the receptor that HIV binds to ALLOW HIV cannot enter the cell	**(2)**

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation that makes reference to four of the following: • stem cells (from the bone marrow) can differentiateinto specialised cells (1) • the stem cells will differentiate into T helper cells that { are resistant to HIV / have the mutated protein } (1) • T helper cells are destroyed by HIV so the patientcannot produce an immune response (1) • mutated (CD4) receptor prevents HIV entering the(replacement) T helper cells (1) • T helper cells are not destroyed therefore { HIV is notpresent in the blood / AIDS does not develop } (1)		**(4)**

Q25.

Question Number	Answer	Additional Guidance	Mark
(a)	1. idea that {bacteria / pathogen / virus / eq} have to be taken into macrophage / eq ; 2. idea of fusion of {phagosome / eq} with lysosome ; 3. idea that {bacteria/ pathogen / virus / eq} are {digested / broken down / eq} (by enzyme) ; 4. credit named enzyme other than lysozyme ; 5. idea that part of the {bacteria/ pathogen / virus / eq} has to be on {membrane / (outer) surface} (of the macrophage) ;	1. IGNORE phagocytosis unqualified 2. ACCEPT phagocytic vesicle 3. IGNORE destroy / killed 4. e.g. protease 5. ACCEPT antigen / protein	(4)

Question Number	Answer	Additional Guidance	Mark
(b)	1. idea of macrophage {binding/ eq} to T (helper) {cell / lymphocyte} ; 2. reference to {MHC / major histocompatibility complex } (on macrophage) ; 3. reference to CD4 (receptor on T cell) ;		(2)

Question Number	Answer	Additional Guidance	Mark
(c)	1. idea that a mutation has occurred (in the DNA) ; 2. idea that there is a change in {antigen /outer surface / cell wall / slime layer} (of bacteria) ; 3. idea that memory (T) cells will not recognise the (new) antigen ; 4. idea that another (primary) immune response needed e.g. (new) antigen needs to be presented (to the T helper cell) ; 5. to activate (another) population of T (helper) cells / eq ; 6. idea that {phagocytes / macrophages} unable to {recognise / engulf / phagocytose / digest / destroy / eq} the {*Mycobacterium tuberculosis* / bacteria} ; 7. idea that antigen presentation is not possible ;	1. NOT a mutation of the antigen	**(3)**

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to three of the following: • (large) circular DNA (1) • DNA not associated with histone proteins (1) • (small / several) plasmids (1) • located in the cytoplasm / not inside a nucleus (1)	ALLOW nucleoid NOT two marks for plasmids are circular DNA	3

Q2.

Question Number	Answer	Additional guidance	Mark
	A description that makes reference to four of the following: • DNA obtained from the two types of grass snake (1) • { PCR / restriction enzymes } used to produce fragments of DNA (1) • gel electrophoresis used to analyse the DNA samples (1) • (gel electrophoresis) used to separate the fragments of DNA (1) • more differences in the pattern of bands produced would indicate that the snakes are different species (1)	ALLOW produce different length sections of DNA or target regions of DNA ALLOW description of gel electrophoresis e.g. use of agarose gel and electric current ALLOW similar patterns in the bands would indicate they are the same species	**(4)**

Q3.

Question Number	Acceptable Answer	Additional Guidance	Mark
	A description that makes reference to the following: • response that is effective against (wide) range of infectious agents (1) • does not involve recognition of infectious agent (1) • does not react to specific antigens (1)		**(3)**

Q4.

Question Number	Answer	Additional guidance	Mark
	A description that makes reference to three of the following: • (body) temperature falls (1) • rigor mortis / stiffening of the muscles (1) • autolysis / break down of cells by enzymes in the body (1) • putrefaction / discolouration / bloating (1)	ALLOW algor mortis ALLOW breakdown of tissues by enzymes ALLOW accumulation of gases	**(3)**

Q5.

Question Number	Answer	Additional guidance	Mark
	A description that makes reference to three of the following: • hand wash (stations) (1) • (doctors / nurses) not to wear { ties / watches / long sleeves } (1) • testing patients for the presence of antibiotic resistant bacteria before admission / {isolation / quarantine} of infected patients (1) • increased washing of bedding / disinfection of { beds / surfaces } (1)	ALLOW antibacterial / antiseptic /alcohol gel / hand sanitisers ALLOW use of disposable bedding	**(3)**

Q6.

Question Number	Answer	Additional Guidance	Mark
	1. decomposition / idea of breakdown of {organic matter / plant material / biomass / eq} ; 2. idea of (bacteria) producing {enzymes (for digestion) / correctly named hydrolytic enzyme} ; 3. respiration {produces / eq} {carbon dioxide / eq} ;	**1** **ACCEPT** animal material decay / rot	**(3)**

Q7.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to two of the following: • decomposers break down organic material (from the dead body) • (decomposers) respire • releasing carbon dioxide (into the atmosphere)	 ALLOW organic molecules / named organic molecule / organic compounds ALLOW respiration takes place ALLOW methane in context of anaerobic respiration	**(2)**

Q8.

Question Number	Answer	Additional Guidance	Mark
	A description that makes reference to two of the following: • (skin flora) {prevents /reduces } colonisation by other microbes (1) • make environment hostile for other microbes (1) • outcompetes other microbes (1)	ALLOW {bacteria / pathogenic bacteria / pathogens} for other microbes e.g. produce { lactic acid / lactate }	(2)

Q9.

Question Number	Answer	Additional Guidance	Mark
(i)	**C** keratin		(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	1. idea of little {tertiary / quaternary } structure / eq OR mainly secondary structure ; 2. made up of {long / linear / straight / eq} {molecules / (poly)peptides / polymers }; 3. idea of cross-linking (between one polypeptide chain and another) ; 4. idea of repeating amino acid sequences / eq ; 5. insoluble / eq ; 6. tough / strong / eq ;	**3 NOT** peptide bonds **5 IGNORE** hydrophobic on outside	(4)

Q10.

Question Number	Answer	Additional Guidance	Mark
(i)	• 66	ALLOW 67	**(1)**

Question Number	Answer	Additional Guidance	Mark
(ii)	• correct values taken from the graph • correct rate calculated from figures used from graph	<u>Example of calculation</u> (12 - 6.8) ÷ (90-60) = or 5.2 ÷ 30 = ALLOW 5.0, 5.1 or 5.2 0.17 (mm hour^{-1}) (0.1667 or 0.167 – one mark only) Correct answer without working gains full marks	**(2)**

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: • temperature affects {enzymes / metabolism / reactions} • an increase in temperature increases kinetic energy • producing more (frequent) collisions between enzyme and substrate (molecules) (1)	ALLOW protein synthesis / cell division ALLOW converse statement for temperature decrease ALLOW more (frequent) formation enzyme-substrate complexes	**(3)**

Q11.

Question Number	Answer	Mark
	The only correct answer is B polymerase chain reaction ***A*** *is not correct because it is not profiling* ***C*** *is not correct because it is not RNA* ***D*** *is not correct because it is not translation*	**(1)**

Q12.

Question Number	Answer	Additional Guidance	Mark
* (a)(i)	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence) 1. multiple copies of DNA made / eq ; 2. using {PCR / *polymerase chain reaction*} ; 3. credit any correct detail of PCR ; 4. reference to *restriction {enzymes / endonucleases}* to produce DNA {*fragments* / eq} ; 5. reference to *(gel) electrophoresis* ; 6. idea of {loading / eq} the DNA onto the {*gel* / named *gel*} ; 7. idea that an {*electric current* / charge} is applied ; 8. reference to use of {*dye / fluorescent tag / UV light / Southern blotting / gene probes / radioactive labelling* / eq};	QWC emphasis on **spelling** 1. IGNORE refs to amplification, large amounts 3. e.g. step 1: 90 to 95 °C, step 2: 50 to 65 °C, step 3: 70 to 80 °C, use of {*primers* / DNA *polymerase / nucleotides*}, many repetitions 6. e.g. *agarose, agar* 7. ACCEPT apply *potential difference*	**(6)**

Question Number	Answer	Additional Guidance	Mark
(a)(ii)	1. idea of comparing total number of {bands / eq} ; 2. idea of comparing position of {bands / eq} ; 3. idea of comparing {size / width} of {bands / eq} ;	ACCEPT idea of comparing bands for 1 mark if mps 1, 2 or 3 cannot be awarded ACCEPT bars / blocks	(3)

Question Number	Answer	Additional Guidance	Mark
(b)	1. {scientific / peer reviewed} {papers / journals / magazines / article} ; 2. (scientific) {conferences / lecture / forums} ; 3. media reports ;	3. e.g. TV, radio, newspaper, internet	(2)

Q13.

Question Number	Answer		Mark
(a)	1. {scientific / peer reviewed} {papers / journals / magazines / article} ; 2. (scientific) {conferences / lecture / forums} ; 3. media reports ;	 3. e.g. TV, radio. newspaper ' internet	 **(2)**

Question Number	Answer	Additional Guidance	Mark
***(b)(i)**	(QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence)	**QWC focussing on spelling**	
	1. idea of using *proteomics* (to study protein); **Any 5 from :** 2. idea of using DNA {*profiling / fingerprinting*} (to study DNA) ; 3. idea of obtaining {*tissue / cell*} sample from tomcod ; 4. multiple copies of DNA made / eq ; 5. using {PCR / *polymerase chain reaction*} ; 6. ref to *restriction* {*enzymes / endonucleases*} to produce DNA {fragments / eq} ; 7. reference to *(gel) electrophoresis* ; 8. idea of {loading / eq} the DNA onto the {*gel / named gel*}; 9. idea that an {*electric current / charge*} is applied ; 10. reference to use of {dye / *fluorescent staining* / UV light /*Southern blotting / gene probes / radioactive labelling* / eq};	 4. IGNORE refs to amplification, large amounts 8. e.g. *agarose, agar* 9. ACCEPT apply *potential difference*	 **(6)**

Question Number	Answer	Additional Guidance	Mark
(b)(ii)	1. same number of chromosomes ; 2. idea that the mutation affected the sequence of DNA ; **OR** 3. idea that (all / most of) the {bands / eq} are the same (size / position / width) ; 4. idea that only {a small region of DNA / the AHR2 gene} is affected ;	1. ACCEPT both contain AHR2 gene	**(2)**

Question Number	Answer	Additional Guidance	Mark
(b)(iii)	1. a protein with a different {structure / amino acids / function} / eq ; 2. idea that the mutation will affect the DNA ;	1. ACCEPT two AAs missing 2. e.g. two codons missing	**(2)**

Q14.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to the following • by comparing the {location / number of} bands produced bythe two types of DNA (1) • similarities would indicate interbreeding (in the past) (1)	ALLOW a description eg looking whether the bands are next to each other	**(2)**

Q15.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)	An explanation that makes reference to the following: • antibiotics target { organelles / structures / processes } found in bacteria (1) • viruses therefore unaffected by antibiotics (1)		**(2)**

Question Number	Acceptable Answer	Additional Guidance	Mark
(b)	An explanation that makes reference to the following: • survivors will have antibodies specific to the virus in their plasma (1) • antibodies given to individuals infected with Ebola will provide passive immunity (1) • the antibodies provided will		**(3)**

Question Number	Acceptable Answer	Additional Guidance	Mark
	therefore { agglutinate / opsonise } the virus particles (1)		

Question Number	Acceptable Answer	Additional Guidance	Mark
(c)	An explanation that makes reference to the following: • vaccine stimulates immune response to make antibodies specific to viral proteins (1) • mutations in the virus nucleic acid (1) • results in a change in the shape of the viral proteins (1) • therefore antibodies can no longer bind to the virus (1)	Accept reference to antigens Ebola is an RNA virus but allow reference to mutations in DNA	**(4)**

Q16.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to the following: • tetracycline { is bacteriostatic / stops bacteria dividing } (because the number of bacteria stays the same) (1) • penicillin {is bactericidal / kills bacteria } (because the number of bacteria decreases) (1)		**2**

Q17.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to four of the following • restriction { enzymes / endonucleases } used to cut DNA (frommodern humans and Neanderthals) into fragments (1) • DNA samples are loaded onto (agarose) gel (1) • {electric current is passed through / potential difference isapplied across} the gel (1) • markers are added to visualise the bands (1) • the position of the bands produced can be compared (1)	ALLOW use of fluorescent dyes	**(4)**

Q18.

Question number	Answer	Additional guidance	Mark
	A description that makes reference to two of the following: • (accumulation of) mutations resulting in change in target recognised by host (1) • transfer of genetic material coding for resistance genes (1) • example of a resistance mechanism (1)	ALLOW mutations result in change in shape of antigens ALLOW transfer of plasmids between bacteria e.g. enzyme / change in shape of receptor binding protein / TB mechanisms, waxy coat / virus using host cell membrane	Expert (2)

Q19.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to four of the following: • histamine is released • (histamine) causes {arterioles to dilate/ vasodilation} • which increases the blood flow (to the site causing redness) • (histamine) also causes the permeability of capillaries to increase • allowing blood plasma to {leave the capillary / enter the tissues} (causing oedema / swelling)	ALLOW reference to 'leaky' capillaries	**(4)**

Q20.

Question Number	**Answer**	**Additional Guidance**	**Mark**
	An explanation that makes reference to five of the following: • detail of loading of electrophoresis tank (1) • { current / potential difference } applied across the gel (1) • use { gene probe / DNA stain} (1) • use of { STRs / DNA } of black panther (1) • compare { bands / DNA profiles } (1) • a match would indicate that (DNA from) a black panther was present (1)	e.g. use of agarose gel, use of a buffer, sample placed in wells ALLOW voltage e.g. fluorescent dye, methylene blue, iodine or ethidium bromide ALLOW reference to Southern blot technique ALLOW compare lines	**(5)**

Q21.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to four of the following: • bacterial molecules are engulfed by { macrophages / phagocytes / B cell } (1) • antigen presented on the surface of cell / antigen presenting cell produced (1) • T (helper) cells with complementary { CD4 / receptor } bind to APCs (1) • cytokine released causes { cloning of B cells / formation of B effector cells } (1) • plasma cells { produce / release } antibodies (1)	ALLOW reference to antigens on MHCs ALLOW APC	**(4)**

Q22.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to four of the following: • (donated) { proteins / cells / tissues / organs} act as antigens (1) • (which are) presented by {macrophages / phagocytic cells / antigen presenting cells} (1) • (leading to) activation of T helper cells (1) • (leading to) activation of {T killer cells / cytotoxic T cells / B cells / plasma cells to produce antibodies} (1) • (resulting in) destruction of the transplanted tissue (1)	ALLOW { proteins / cells / tissues / organs} are recognised as being foreign ALLOW cells { destroyed / marked for destruction }	**(4)**

Q23.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to three of the following: • virus binds to receptors on (neural) cells (1) • { virus / genetic material } is taken into the cell (1) • virus replicates (1) • causing (neural) cells to {die / burst} / inhibiting replication of (neural) cells / spreads to other (neural) cells (1)	(It must be clear that the answer refers to either neural cells or brain cells to gain the first or last marking point) IGNORE viral DNA / RNA replicated IGNORE virus reproduces	**(3)**

Q24.

Question Number	Answer	Additional guidance	Mark
	An explanation that makes reference to the following • an increase in temperature will increase the rate of { decomposition / decay } (1) • (an increase in temperature) increases enzyme activity (1) • an increase in temperature increases growth rate of {bacteria / fungi / decomposers} (1)	ALLOW converse for all points for the effects of a decrease in temperature ALLOW high temperatures may denature enzymes and decrease rate of decomposition ALLOW increases rate of multiplication	**(3)**

Q25.

Question Number	Answer	Additional Guidance	Mark
(i)	1. idea of binding of {bacteria / virus / pathogen / microorganism / antigen / non-self / foreign matter / eq} to (phagocytic) cell ; 2. idea that {bacteria / virus / pathogen / microorganism / antigen / eq} is {engulfed by / taken into / endocytosis into } (phagocytic) cell ; 3. idea of bacteria being inside a {vacuole / phagosome / eq} ;	**1 ACCEPT** phagocyte **2 ACCEPT** phagocyte **3 ACCEPT** vesicle	**(2)**

Question Number	Answer	Additional Guidance	Mark
(ii)	1. idea that the body {reacts / defends itself / responds /eq } to a {bacteria / virus / pathogen / microorganism / antigen / non-self /	**1 NOT** reference to immune response **2 ACCEPT**	**(2)**

Question Number	Answer	Additional Guidance	Mark
	foreign matter / eq} ; 2. idea that the response is not dependent on the specific {bacteria / virus / pathogen / microorganism / antigen / eq} ; 3. credit named reaction e.g. lysozymes , inflammation, phagocytosis, interferon production ;	idea of no previous infection / responds to any pathogen **3 IGNORE** egs of barriers	

Question Number	Answer	Additional Guidance	Mark
(iii)	1. reference to {bacteria / virus / pathogen / microorganism / eq} ; 2. being inside {tissues / cells } / eq ;	**1 IGNORE** disease / infection / foreign matter / antigen **2 IGNORE** body **ACCEPT** idea that has evaded barriers, named cell or tissue **IGNORE** {infects / attaches / harms / attacks} cells	**(2)**