Infection and the Immune System - Mark Scheme

Q1.

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.

Q2.

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)**

Q3.

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)**

Q4.

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)**

Q5.

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)**

Q6.

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 ;	**1. Accept** protein, chains of amino acids	
	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 ;	**2. Ignore** active site **Accept** a Y-shaped drawing	
	3. reference to {antigen-binding site / variable region / Fab (region) / eq };	**3. Accept** references to {binding to specific antigen / antigen-specific / antigen receptors}	
	4. idea of antibodies have a {similar / constant / Fc / eq } region;		
	5. produced by plasma cells / present on B cells ;	**5. Accept** present on B effector cells	
	6. role of antibody described e.g. opsonisation, immobilisation, agglutination, lysis ;		**(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)**

Q7.

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)**

Q8.

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)

Q9.

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

Q10.

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)**

Q11.

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)**

Q12.

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)**