11. Immunity

11.2 Antibodies and Vaccination

Paper 2

Marking Scheme

Q1.

(a)(i)	*any **two** from:* **1** (antigen-binding site / variable region) has a shape that is complementary to antigen **;** **A** tertiary / quaternary, structure **2** (antigen-binding site / variable region has) specific, sequence(s) of amino acids / primary structure(s) **;** **3** *idea that* different amino acids have different, R-groups / side chains, so give different, tertiary structures / shapes (for binding to antigens) **;** **4** AVP **;** e.g. correct *ref. to* epitope(s)	**2**
(a)(ii)	*idea that* allows flexibility for binding (to antigens) **;** **A** at different angles for flexibility / allows variable region(s) to move	**1**
(a)(iii)	*any **one** from:* *idea that* easier for macrophage to engulf, antibodies that have bound antigens / antibody-antigen complexes **;** facilitates / AW, destruction of pathogens 'marked' by antibodies **;** **A** *ref. to* opsonisation **I** stimulates phagocytosis of the pathogen, unqualified	**1**

Q2.

(c)	*any **four** from:* **1** cells are replicating / AW (because live vaccine) **;** **2** high / increased / AW, levels of (non-self / foreign) antigen (because live vaccine) **;** **3** (so) strong / effective / good / AW, (primary) immune response **;** **A** described e.g. (T-/B-) memory cells are formed *idea that* memory cells present when *Mycobacterium* infects / AW secondary response occurs when *Mycobacterium* infects / AW **4** provides (artificial) active immunity **;** **R** natural active immunity **5** (so) boosters not needed (to build sufficient immunity) **;** **6** vaccine does not cause, disease / TB (because, weakened / attenuated) **;** **I** doesn't show symptoms **7** easy to, transport / store / deliver (because freeze-dried) **;** **8** AVP **;;** e.g. effective against *M. tuberculosis* and *M. bovis* no / few / mild, side effects, so people not discouraged (from having vaccine) memory cells / immunity, (relatively) long-lived / long-lasting only need one dose (good immunity for most individuals) provides herd immunity *(a consequential effect)*	**4**

Q3.

(b)(ii)	antigen binding site(s) ; **A** variable region	**1**
(b)(iii)	*any **two** from:* **A** antigen *for TB protein* **A** TB pathogen for pathogen causing TB (immobilised) monoclonal antibody has a binding site which is a complementary shape to the protein secreted by the TB pathogen ; monoclonal antibody on the test line will only bind with protein secreted by the by the TB pathogen ; *idea that* monoclonal antibodies with tiny gold particle are only held in place if protein secreted by the TB pathogen is present ; AVP ; e.g. *suggestion that* TB protein is specific to the TB pathogen	**2**

(b)(iv)	*any **two** from:* different shaped, variable region / antigen binding site ; *ref. to* different primary structure ; *ref. to* a different tertiary structure ; *ref. to* different (named) bonds holding the tertiary structure ;	**2**

Q4.

(b)(i)	*allow antibody or mAb or Mab for monoclonal antibody* **I** *ref. to* receptor **I** active site **I** combines / bonds *any* ***two*** *from:* specific / different, *(Vibrio* / pathogen) antigen-binding sites **/** binding sites for antigen **; R** if antibody described as enzyme **A** (each) mAb binds to a, specific / particular, *(Vibrio* / pathogen) antigen (each mAb has) specific / different, tertiary structure / variable region(s) / primary structure / sequence of amino acids **;** binding site and antigen have complementary shapes **;**	**2**

(b)(ii)	*allow antibody or mAb or Mab for monoclonal antibody* *any* ***three*** *from:* **1** person **A,** has cholera O1 / is infected with *V. cholerae* O1 and person **B**, does not have cholera **;** **A** *ref. to* person **A** testing positive for cholera O1 and person **B** testing negative to cholera **2** tests are, valid / working, because, controls / bands 4, shows bands **;** *person* ***A,*** *band / colour in area 3 because* **3** anti-O1 (mobile) antibody binds (specific antigen on) *Vibrio* O1 **;** **A** antigen-antibody (complex) 01 formed **4** antigen-antibody (complex) O1 binds to immobilised antibody *ref. to* area 3 **;** **R** if stated as, band / colour, in area 2 **5** person **B** (in test area 2 and 3) no bands form / no colour / no change, because no antibody binds with antigen / no antigen-antibody complexes formed **;**	**3**
(c)(i)	95 / 95.1 (%) **; R** 95.0%	**1**
(c)(ii)	**I** *ref. to*, cheaper / no need for (highly) trained personnel / easier to use / easier to obtain results / accurate **R** more accurate *any* ***one*** *from:* quicker to, obtain result / to do the test **; A** less time consuming can carry out test in a greater variety of places / AW **;** e.g. can be done at home less labour intensive **;** AW e.g. only needs one person / can do it yourself easier to test more people at one time / AW **;** portable **;** AVP **;** e.g. *idea of* easier to transport or distribute (to reach more people) *ref. to*, safer / less risk, from pathogen available to more people (*consequence of cheaper*) *suggestion that* dipsticks are able to identify different, forms / strains	**1**

Q5.

(b)	*any* ***three*** *from:* **1** (named) small mammal, injected / AW, with antigen **;** **2** immune response occurs (over several weeks) **;** **A** immune response described **3** plasma cells / B-lymphocytes / B-cells / splenocytes, extracted from spleen **;** **4** plasma cells / activated B-lymphocytes / activated B-cells, fused with, myeloma / tumour / cancer / AW, cells (to form hybridomas) **;** **5** AVP **;** e.g. hybridoma cells separated (into wells) to produce clones screening / selection / AW, for hybridomas producing desired, (monoclonal) antibodies / Mabs *ref. to* large scale production	**3**
(c)	*any* ***four*** *from:* **1** (artificial) passive immunity **;** **R** natural **2** no immune response **;** **I** primary / secondary **3** *idea that* antibodies are, broken down / degraded / destroyed (in the body / blood) **;** **R** 'antibodies die' **4** no long-term / only short-term / only temporary, immunity **;** **A** no formation of immunological memory **5** memory cells not produced **;** **A** memory cells only produced, in active immunity / during an immune response / after presentation of antigen **6** AVP **;** e.g. *ref. to* no, clonal selection / clonal expansion / antibodies produced	**4**

Q6.

(b)(ii)	*any **two** from:* more / easier to, pass through gaps in, capillary wall / endothelium ; (so) more enter tissue fluid (surrounding tumour cells) ; *idea of* more cancer cells destroyed quickly ; (smaller so) may not trigger an immune response ; AVP ; e.g. easier to, diffuse / move, through tumour to reach, more / all, cells binds more tightly to antigens on (cancer) cell surface(s) *suggestion that* makes macrophage response stronger smaller overall size even when drugs attached	**2**

(b)(iii)	*any **three** from:* gives (artificial) passive immunity ; fast acting / quick response / time not needed for immune response ; antibody binds to (non-self / foreign) antigen (on surface of a pathogen) ; antibodies bind to toxins, neutralising them / AW **or** antibodies act as antitoxins ; ref phagocytosis ; AVP ; e.g. opsonisation bind to flagella and immobilise pathogen antibodies cause, agglutination / clumping / AW, of pathogen	**3**

Q7.

(b)	*any **two** from:* acts as a <u>non-self / foreign, antigen</u> ; triggers / stimulates, primary immune response **or** provides (artificial) active immunity ; (leads to) formation of antigen presenting cell ; **A** endocytosis / phagocytosis, to present antigen (by, macrophage neutrophil) activates, B lymphocytes / T lymphocytes ; **A** clonal selection formation of memory cells ;	**2**

Q8.

(b)	*max 2 if wrong context* *e.g. vaccine contains, foreign antigens / antigens of pathogen / pathogen / antibody to bind to lymphocytes* *any three from* 1 vaccine contains antigens ; *in context of antigens of defective, T-lymphocytes and B-lymphocytes* *(accept antibody of defective B-lymphocyte as AW antigen)* 2 stimulates an immune response ; 3 detail ; e.g. macrophages and antigen presentation / AW *ref. to* specific lymphocytes involved clonal selection of lymphocytes recognition by / activation of, lymphocytes clonal expansion of lymphocytes production of plasma cells *in context of B-lymphocytes* production of memory cells T-helper cells produce cytokine 4 antibody produced against (defective), T-lymphocytes / B-lymphocytes / antibody (that binds ACh receptors) ; *in context of primary or secondary response* **R** *if context is related to the vaccine containing antibody* 5 memory cells, remain / give long-lasting effect / AW ; 6 memory cells allow secondary immune response to (defective) lymphocytes (newly produced) ;	**3**

Q9.

(b)	B-lymphocytes / B-cells ; fuse / combine / join / merge / AW ; **R** hybridise / bind / bond hybridoma ;	**3**

(c)	*any three from* **1** results are accurate (rely on monoclonal antibodies) ; **2** results are obtained quickly / diagnosis is quick ; **3** low cost / cheap ; **4** does not need highly trained medical professional / easy to read / easy to use / AW ; **5** does not need specialised equipment ; **6** easily, transported / distributed (in bulk) ; **7** can ensure appropriate treatment is given immediately malaria is confirmed ; **8** reduces unnecessary use of antimalarial drugs (just in case) ; **9** (a small area for S so) only a small sample of blood needed ; **10** AVP ; e.g. can identity different species of *Plasmodium* **I** *ref. to* line C and working correctly	**3**

Q10.

(c)(ii)	*any **two** from:* cells are dead so cannot, cause disease / reproduce / AW ; only part of a choleragen molecule, so no toxic effect ; recognised by / trigger clonal selection of, more than one type of B-lymphocyte ; stimulates production of different antibodies ; stimulates the production of more than one type of memory cell / AW ; *ref. to* immune system cells can respond to bacterial cells and the toxin produced ; AVP ; e.g. different antigens on the surface of the cells	**2**

Q11.

(d)	*any two from* *max 1 if no ref. to antigens* leprosy bacterium has similar (shaped) antigens ; memory cells, recognise / bind, antigens on leprosy bacterium ; anti-TB antibodies also bind to leprosy antigens ; AVP ; e.g. similar / same, genes so synthesise similar proteins	**2**

(e)	*any three from* **artificial active** / **natural passive** deliberate / AW **A** from medical staff / **or** not deliberate / from mother / in breast milk / across placenta ; vaccine / (foreign) antigens in injection / **or** antibodies passed on ; immune response / **or** no immune response ; antibodies / memory cells produced / **or** no, antibodies / memory cells produced ; longer lasting / **or** short-lived ; protection not immediate / **or** immediate protection ;	**3**

Q12.

(b)(ii)	*advantage any **one** relevant e.g.* tumour cells may have more than one TSA ; stimulate a specific immune response to each TSA ; *idea that* TSA on patient's tumour cells has the appropriate antigen *idea that* personalised treatment so more effective *disadvantage any **one** relevant e.g.* high cost of personalised treatment ; immune system may not recognise TSA on own body cell as, foreign / non-self , the cells in the tumour may not have the TSA in the vaccine ; patient's tumour may not be large enough to obtain enough cells for treatment ; patient needs surgery to obtain (large quantity of) cells ; AVP ; e.g. *suggestion that* tumour cell may settle in a part of the body and not be destroyed	**2**

Q13.

(a)(i)	*Mycobacterium tuberculosis* or *Mycobacterium bovis* ;	**1**
(a)(ii)	artificial active immunity ✓ ; artificial passive immunity natural active immunity natural passive immunity	**1**

Q14.

(c)	*three from* **I** *statements about locating or diagnosis of disease* specific / targeted, therapy / treatment ; AW **A** only affects, one cell type in the body / B lymphocytes bind to / recognition of, receptors / antigens / CD20, on cell surface (of diseased cells) ; **A** in context of B lymphocytes or diseased cells monoclonal antibodies, are not recognised as foreign / do not trigger an immune response ; **A** *ref. to* humanisation of antibodies example of presence of monoclonal antibody stimulating the immune system / AW ; *in context of examples given* **A** stimulates phagocytosis / activates B-cells attach, radioactive substance / drug (to treat / kill, B lymphocytes / diseased cells) ; *must be in context*	**3**

Q15.

(e)	*any four from:* **1** (*Plasmodium*) is a, eukaryote / protoctist, so has many antigens ; **R** bacterium / virus, is a eukaryote **or** (*Plasmodium*) has many genes coding for (different) antigens ; **I** antigenic variation **2** *idea that* different *Plasmodium* species have different antigens ; **I** antigenic variation **I** strains *for species* **3** (*Plasmodium*) has different stages of life cycle (within human) with different antigens / shows antigenic variation ; **4** antigenic concealment / *Plasmodium* spends part of life cycle within host cells / AW ; **A** short time in blood plasma **A** spends time inside, red blood cells / liver cells **5** need to find the antigens that give the strongest immune response ; **6** need to, develop / use, more than one type of vaccine ; **A** cannot use only one type of vaccine **7** AVP ; e.g. mutations will give changed antigens need to find antigens present in, all / most, stages of life cycle *difficulties in producing a generic vaccine max 2* **8** costly to produce / need to keep costs low / developing countries need to be able to afford vaccine ; **9** needs to have a long shelf life / be stable / be easily stored (e.g. without cold storage) / AW ; **10** (immunity) needs to be long-lasting / aim to avoid boosters / need to develop a single dose vaccine ; AW	**4**

Q16.

(b)(ii)	cell / membrane, fusion / AW ; **I** 'mix' (named) fusogen / hybridogen used ; e.g. polyethylene glycol / electrofusion / electric current **A** PEG for polyethylene glycol (between) plasma cell / (activated) B-lymphocyte / (activated) B-cell / splenocyte, **and**, tumour / cancer / myeloma, cell ; **R** β cells	**3**

(b)(iii)	*any three from:* **1** some mAbs act **directly** on target cells / some mAbs work **indirectly** to kill cells / mAbs do not damage other (non-target) cells ; **2** by binding to, specific / complementary, antigens/cell surface receptors ; **3** (named), drugs / radioactive isotopes, can be attached to mAbs ; **A** 'tagged' **I** labelled **4** enzymes can be attached to mAbs ; **5** so drug can be activated at site of action (linked to mp4) ; **6** bispecific mAbs attach two cells together ; **7** *ref. to* interrupting cell signalling ; **8** use of mAbs for passive immunity ; **A** described *in context of therapeutic antibody for treatment of disease* **9** stimulating / AW, immune system / phagocytes / macrophages / T-lymphocyes, to kill, cancer cells ; **10** name of a cancer or autoimmune disease that is treated with mAbs ;	**3**

Q17.

(b)	*two from:* *treatment of disease* **I** *statements about locating or diagnosis of disease* specific / targeted, therapy / treatment ; **A** specific to diseased, cells / tissue **A** examples bind to / recognition of, receptors / antigens, on cell surface (of diseased cells) ; kill the cell by stimulating the immune system / AW ; **A** correct immune responses e.g. stimulates phagocytosis / activates B-cells attach, radioactive substance / drug (to treat / kill diseased cells) / AW ; treat infectious diseases / bind to (antigens on) pathogens / recognition of antigens on pathogens ; **A** viruses **I** bacteria *unless stated that they cause disease* *allow examples such as treatment of ebola or rabies or tetanus (by immunising with antibody)*	**2**

Q18.

(a)	*five from:* **A** 'cells' for 'lymphocytes' throughout 1 ref. to antigen presentation ; **A** macrophage presents antigen 2 recognition / binding (in context of B-, or T-lymphocytes) ; e.g. cell surface receptor specific to toxoid / clonal selection **A** immunoglobulin / antibody on surface of B-lymphocytes 3 T-lymphocytes or B-lymphocytes, divide by mitosis / clonal expansion ; 4 (some) plasma cells, formed / AW ; **R** if in context of T-lymphocytes 5 antibody molecules / antibodies, secreted / produced / released ; **R** if in context of T-lymphocytes 6 T helper cells secrete, cytokines / interleukins ; 7 ref. to action of cytokines / interleukins ; e.g. to stimulate, humoral response / B-lymphocytes / to stimulate macrophages / angry macrophages 8 formation of memory cells ; *only in context of B- / T-lymphocyte activation*	**5**

(b)(i)	*three from:* 1 failure to distinguish between self and non-self / AW ; 2 specific B-,lymphocytes / cells, are not destroyed (during development) ; 3 antibodies are produced against, cell surface / ACh, receptors on, muscle cell / neurones / nerve cells ; 4 antibodies, bind to / block, receptors ; **A** antibody–antigen, binding / complex *if receptors already given* 5 AVP ; any detail related to the disease e.g. (chemical) transmitter molecules / acetylcholine, cannot bind (to receptor) impulses are not transmitted across synapse / neurones cannot send impulses ref. to causing, muscle weakness / muscle fatigue ref. to neuromuscular junction does not function	**3**
(b)(ii)	*two from:* so immune response, occurs all the time / recurs ; (defective) B-lymphocytes still being produced / AW ; **I** T (helper) cells **A** not destroyed / remain plasma cells / B-lymphocytes, continue to release antibodies against receptors ; memory cells / immunological memory, present ; receptors are always present (on neurones / nerve cells) ; AVP ; e.g. no cure	**2**

Q19.

(c)(i)	(HIV) antigen / p24 ; **A** capsid protein / capsomere(s) / protein coat **R** HIV	**1**
(c)(ii)	(time needed) so, immune response / clonal expansion / production of B-lymphocytes / production of plasma cells, can occur ; **A** B-cells / splenocytes **R** plasma cells need to multiply **I** *ref. to* antibody production	**1**

(c)(iii)	*any one from* immortal / long-lived ; able to replicate / capable of cell division ; uncontrolled cell division, can grow / survive, in cell culture ; cannot grow on, HAT / hypoxanthine-aminopterin-thymidine / step **4**, (culture) medium ; **A** do not have gene coding for ability to grow on HAT	**1**
(c)(iv)	hybridoma ;	**1**
(c)(v)	*any one from* (check cells for) production / AW, (by hybridoma cells) of, anti-HIVp24 antibody / antibody against p24 ; **A** the antibody / monoclonal antibody **A** check cells, contain / have / AW, desired antibody / AW *idea that* only want cells that produce desired antibody / do not want cells that produce different antibodies / need to remove cells that don't produce the antibody ; waste of, money / resources, to culture other cells / if no antibody produced ;	**1**

Q20.

(c)	*any four from* VEGF protein / antigen, injected into, mouse / small mammal ; time for immune response to occur ; **A** description of event in immune response plasma cells / B-lymphocytes / splenocytes, extracted from mouse ; plasma cells / AW, fused with, myeloma / cancer, cells ; (to produce) hybridoma cells ; clone hydridoma cells ; separate cells and culture in individual wells ; screen for cells secreting desired antibody ; hybridoma cells grown in large scale culture / AW ; AVP ; e.g. *ref.* to fusogen	**4**
(d)	*any one from* monoclonal antibodies identified, as foreign / non-self / act as an antigen ; (monoclonal antibodies) stimulate an, immune / allergic, response ; AVP ; e.g. (antibodies destroyed so) not enough antibody (to be effective)	**1**