**QUESTIONSHEET 1**

(a) *either*
- disease organism injected into an animal stimulates production of antibodies;
  antibodies made by the animal extracted/purified from blood plasma;
*or*
- disease organisms injected into mouse stimulates B-lymphocyte production;
  B - lymphocytes fused with cancer cells and produce monoclonal antibodies;

(b) (i) disease organisms have antigens on surface;
  antigen shape recognised by antibody and reacts with it (forming a complex);
(ii) binding reaction between antibody and antigen not visible;
  enzyme gives a visible reaction/means of visualising the reaction/antibody/antigen;

(c) bind the antigen/disease organism to the well;
  add the blood plasma of the infected person;
  add the enzyme combined with an anti-antibody/antibody to the specific disease antibody;

**TOTAL 9**

**QUESTIONSHEET 2**

(a) (i) antigens on the dead pathogen detected by (T/B) lymphocytes;
  specific B lymphocytes clone/divide rapidly by mitosis;
  plasma cells released to blood;
  plasma cells secrete antibody into blood;
  levels fall once all antigens are destroyed;

(ii) memory cells formed by first challenge/equivalent allow even greater/faster cloning (and so greater/more antibody release);

(b) influenza virus/pathogen has high rate of mutation;
  polio/tetanus pathogens have low rate of mutation;
  mutation changes antigens/proteins on surface of pathogen;
  antibodies unable to recognise changed antigens/new antibody needed to react with changed antigen;

(c) (i) antibodies against tetanus bacteria;

(ii) immediate rise due to injection;
  steady fall because liver destroys the antibodies;
  lymphocytes are not stimulated/passive immunity so no new antibodies made;

**TOTAL 10**
### QUESTIONSHEET 3

<table>
<thead>
<tr>
<th>Feature</th>
<th>Cell or cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phagocytose bacteria in tissues</td>
<td>neutrophils and monocytes/macrophages;</td>
</tr>
<tr>
<td>Secrete antiviral antibodies</td>
<td>plasma cells;</td>
</tr>
<tr>
<td>Release histamine and serotonin in allergies</td>
<td>basophils and mast cells;</td>
</tr>
<tr>
<td>Manufactured in red bone marrow</td>
<td>neutrophils, eosinophils, basophils and monocytes; (any three for a mark)</td>
</tr>
<tr>
<td>Initially stored in the thymus gland</td>
<td>T-lymphocytes;</td>
</tr>
<tr>
<td>Main cell of humoral immunity</td>
<td>B-lymphocytes/plasma cells;</td>
</tr>
<tr>
<td>Combats effects of histamine in allergic responses</td>
<td>eosinophils;</td>
</tr>
<tr>
<td>Acts as a phagocyte after transformation into a tissue macrophage</td>
<td>monocyte;</td>
</tr>
<tr>
<td>Phagocytoses the debris of antibody-antigen reactions</td>
<td>eosinophils;</td>
</tr>
<tr>
<td>Differentiates into plasma cells</td>
<td>B-lymphocytes;</td>
</tr>
<tr>
<td>Differentiates into cytotoxic killer cells</td>
<td>T-lymphocytes;</td>
</tr>
<tr>
<td>Enables rapid immune response to a second infection</td>
<td>memory cells;</td>
</tr>
<tr>
<td>Manufactured in lymphatic tissue</td>
<td>B-lymphocytes, T-lymphocytes, plasma cells, memory cells, monocytes; (any three for a mark)</td>
</tr>
</tbody>
</table>
QUESTIONSHEET 4

(a) (i) an antigen; 
    on the surface of a red blood cell;  
    2

(ii) an antibody; 
    dissolved in blood plasma;  
    2

(iii) when agglutinin a comes into contact with agglutinogen A/when agglutinin b comes into contact with agglutinogen B; 
    due to incompatible blood transfusion; 
    red cells are clumped together by agglutinins reacting with agglutinogens; 
    ref one molecule of agglutinin combines with five molecules of agglutinogen/agglutinin has a valency of five, 
    which makes clumping very effective; 
    clumped cells can block small blood vessels causing glomerular/kidney/heart/brain damage/other correct example/ 
    may result in death;  
    max 4

(b) (i) group B into group A; 
    group A into group B; 
    group AB into group A; 
    group AB into group B;  
    4

(ii) agglutinins a and b will not clump the red cells in A, B or AB blood; 
    because they are greatly diluted by the greater blood volume of the recipient; 
    would only become a problem if large volumes were transfused;  
    max 2

TOTAL 14

QUESTIONSHEET 5

(a) (i) Antigen binding sites; 
    variable portions; 
    hinges;  
    3

(ii) antigenic groups may vary slightly in their distances apart (on the bacterium/virus/red cell/other example); 
    hinges allow antibody structure to adjust for this/antibody can still attach to antigenic sites;  
    2

(iii) better ‘clumping’/agglutination ability/can clump together up to five antigenic structures/virions/bacteria/red cells/ 
    other correct example;  
    1

(b) (i) plasma cells;  
    1

(ii) 2000 x 60 x 60 x 24 ; = 172,800,000 (antibody molecules day⁻¹);  
    (units are in the question so not essential to answer)  
    2

TOTAL 9
**QUESTIONSHEET 6**

(a) (i) macrophages congregate in regions of infection in the tissues/ref chemotactic attraction; engulf bacteria and digest them/ref lysozyme activity; carry antigens into lymph nodes/spleen/nearest lymphatic tissue; present antigens to T-cells/bind to T-cells with HLA receptors and present antigen to T-cell; thus enable T-cells in lymphatic tissue to become activated by antigens (from elsewhere in the body);  

(ii) means that thousands/millions of cells are available to destroy/disable the antigen; since they are genetically identical they will all recognise/react against the (specific) antigen;  

(b) (i) leave lymph nodes/spleen/lymphatic tissue/lymph flow/blood stream and move to site of infection; ref amoeboid action/chemotaxis; congregate/collection around bacteria and secrete cytotoxic chemicals over them; ref to specific cytotoxins/lymphotoxin/perforin; also secrete chemicals/lymphokines that stimulate development of more killer T-cells/attract macrophages to the infection;  

(ii) retain the memory of the antigen allowing a rapid response if a second infection occurs/ gives long term immunity against the antigen;  

(iii) produce an interleukin/lymphokine that induces production of more killer T-cells/aid B-cells/ plasma cells to develop/produce more antibodies;  

**TOTAL 11**

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**QUESTIONSHEET 7**

<table>
<thead>
<tr>
<th>Feature</th>
<th>T-cells</th>
<th>B-cells</th>
</tr>
</thead>
<tbody>
<tr>
<td>May produce antibodies</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Are classed as small lymphocytes</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Develop in the thymus</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>May secrete interferon</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Give passive immunity to the organism which possesses them</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Give active immunity to the organisms which possesses them</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**TOTAL 6**
QUESTIONSHEET 8

(a) diphtheria bacilli are stable and do not mutate/rarely mutate into new (antigenic) forms; influenza viruses constantly mutate to produce new (antigenic) forms; new strains of virus appear every few months; thus memory cells for diphtheria antigens are effective throughout life but memory cells against influenza may not recognise the new strains; max 3

(b) smallpox virus showed little variation (antigenically) across the world/basically all the same strain/vaccines were available against all strains; smallpox victims could be easily isolated thus preventing cross infections (of people not yet immunised when cases did occur); difficult to prevent cross infection with cholera/tuberculosis which is in contaminated water/food supplies/malaria with a mosquito vector; these organisms have a higher mutation rate which changes their (antigenic) structure more frequently than smallpox; max 3

(c) colostrum/breast milk contains many antibodies produced in the mother; these can be absorbed by the baby via the stomach (from the milk); they can persist in the baby’s body for several weeks; giving short term immunity/passive immunity against many diseases/prevalent diseases; max 3

(d) antibodies/killer T-cells are produced against the Streptococci; some cell surfaces of the infected person may antigenically resemble the Streptococci; for example, β-cells of the islets of Langerhans/thyroid cells/glomeruli; thus body’s own antibodies/killer T-cells may destroy these body tissues; max 3

TOTAL 12

QUESTIONSHEET 9

(a) (i) antigen in lymph/blood/plasma; attaches to antibody on B-cell in lymph node/spleen; B-cell processes/modifies antigen and presents it on the cell membrane; presented antigen and self HLA antigen can then be recognised by receptors on helper T-cell; this produces substances which stimulate mitosis and differentiation of B-cells/activates B-cells; max 4

(ii) many cells produced so that immune response is bigger/sufficient to counter large quantities of antigen; all cells genetically identical so that they respond to the same antigen/immune response is focussed on same antigen; 2

(iii) secrete specific antibody against antigen; antibody molecules are released from lymph node/spleen into lymph/blood; each cell can release up to 2000 antibody molecules per second for about five days/huge quantities of antibodies are released; max 2

(iv) retain memory of specific antigen so that a quicker/ more forceful response can occur to a second infection by the same antigen; 1

(b) the primary response involves the activation/multiplication of lymphocytes and elimination of the antigens; takes 7 – 10 days to develop/ levels of antigen rise slowly/ lasts about two weeks; the secondary response involves activation of (long lived) memory cells; takes 2-3 days to develop/levels of antigen rise much higher/can last for months; max 3

TOTAL 12
QUESTIONSHEET 10

(a) chicken pox infection in babies/children is not serious/usually mild/relatively short lasting/very frequent; and gives excellent life long immunity; measles/polio are killer diseases/cause serious long term damage; thus must give vaccination against these to prevent infection/reduce impact of infection; max 3

(b) infection from tetanus bacteria/spores can set up a rapid infection; which could be fatal; secondary immune response to tetanus takes time/several days to become effective; especially if booster immunisations have been missed; thus the antibody is injected to give immediate passive immunity/immediate protection; max 3

(c) non-infectious allergens such as inhaled pollen; can provoke the acute inflammatory reaction; in which basophils/mast cells release histamine to make blood vessels more leaky/more dilated leading to nasal congestion; antihistamines will neutralise the histamine thus reducing the unpleasant effects/symptoms; max 3

(d) epitomes/chemical nature of antigens are similar for cowpox and smallpox; thus antibodies against cowpox will be effective against smallpox; epitomes/chemical nature of antigens are different for chickenpox and smallpox; thus previous infection by chickenpox/chickenpox antibodies will not protect against smallpox infection; max 3

TOTAL 12

QUESTIONSHEET 11

(a) ready made antibodies are transferred to the individual; across the placenta from mother to foetus/baby in womb; in milk from mother to baby during breast feeding; ref to tetanus/rabies antibody given after possible infection/anti snake venom antibodies; gives short term immune protection only/lasts only a few weeks; but can give protection until acquired immunity develops; max 4

(b) (i) naturally acquired immunity is accidentally obtained due to exposure to a particular antigen (during the normal course of life); artificially acquired immunity is the result of an intentional exposure to an antigen through immunisation; max 2

(ii) viruses: polio; measles; rubella/German measles; max 2
bacteria: diphtheria, whooping cough, tetanus; tuberculosis; max 2
(accept other examples if correct)

(c)

<table>
<thead>
<tr>
<th>protection by vaccination</th>
<th>no protection by vaccination</th>
</tr>
</thead>
<tbody>
<tr>
<td>whooping cough</td>
<td>lung cancer</td>
</tr>
<tr>
<td>German measles</td>
<td>diabetes mellitus</td>
</tr>
<tr>
<td>measles</td>
<td>schizophrenia</td>
</tr>
<tr>
<td>diphtheria</td>
<td>asthma</td>
</tr>
<tr>
<td>tuberculosis</td>
<td>cystic fibrosis</td>
</tr>
<tr>
<td>tetanus</td>
<td>HIV</td>
</tr>
<tr>
<td>polio</td>
<td>AIDS</td>
</tr>
</tbody>
</table>

(diseases can be in any order, but delete a mark for each error or omission) max 7

TOTAL 17
QUESTION SHEET 12

(a) (i) no response visible from first injection for 10 days, response to second injection visible at 3 - 4 days;
much higher levels of antibody appeared (in the plasma/blood) after the second injection;
antibody titre/level falls fairly sharply after 20 days from the first injection, persists/does not fall much after second injection; 3

(ii) memory cells can be immediately activated after second injection allowing a rapid response;
after first injection B-cells must receive and modify the antigen and interact with helper T-cells before activation
(and this takes time);
after first injection a few activated B-cells must undergo many mitoses to produce a clone of several million (antibody producing)
plasma cells;
several million memory cells probably exist and only need a few mitoses to produce the needed number of plasma cells;
thus more plasma cells means more antibody molecules produced more quickly (after second injection);
larger number of antibody molecules means that they will persist longer/take longer to be recycled by liver; max 4

(a) body cells have many surface antigens which differ from person to person;
these can provoke an immune response when foreign tissue is transplanted into another person;
resulting in T-cell immunity/cellular immunity/production of killer T-cells;
which will destroy/damage the transplanted tissue;
tissues to be transplanted must have antigens which closely match those of the recipient; max 3

TOTAL 10