

Q1.

3 (a) Correct letter order on Question Paper:

A - nucleus;  
C - mitochondria; B - RER;  
D - Golgi apparatus;  
E - cell surface membrane;

max 4

*R. process statements instead of letters*

(b) secrete/release/produce/make antibodies;

1

A. immunoglobulins

R. memory cells unless linked to antibody production

(c) nucleus/nuclear envelope/nuclear membranes/nucleolus;  
no cell wall;

have organelles/named visible organelles; (golgi/mitochondrion/  
RER) R. more organelles

larger (cell);

fixed ribosomes/ribosomes attached to E.R./no free  
ribosomes;

max 2

[Total 7]

Q2.

- 6 (a) mitosis / mitotic division; **R** cell division / cytokinesis 1
- (b) clone; 1
- (c) T cell receptor is correct / exact / perfect match / fit /  
complementary to antigen; **R** corresponds / identical / same  
ref to different / wrong shapes of receptors on J and / or L;  
ref to specificity; 2 max
- (d) *N.B. Mark first role given  
either*
- helper cells*  
secrete / release / produce, cytokines / lymphokines / hormones;  
to stimulate B cells to, divide / develop into plasma cells;  
(which) produce antibodies;  
(and) stimulate macrophages to carry out phagocytosis / (idea of);
- or*
- cytotoxic / killer T cells*  
seek out / find / bind to (foreign) antigens on host cells / pathogens;  
destroy, host cells / intracellular parasites / virally infected cells /  
viruses;  
attach to surface of cells / 'punch holes' into cells;  
release toxic substances / interferons / hydrogen peroxide (into  
cells); **R** enzymes 2 max
- (e) (i) carcinogen / mutagen; **R** all other responses 1
- (ii) T cells do not recognise antigens;  
no immune response / weak immune response / no secondary  
immune response;  
no / few antibodies produced;  
no / few T killer cells produced;  
susceptible / vulnerable to / increased likelihood of, infection /  
disease / opportunistic infections;  
**R** refs to cancer / autoimmune disease 2 max
- [Total: 9]

Q3.

- 5 (a) A passive artificial ;  
B active artificial ;

*if artificial omitted score one mark if passive and active are correct*

[2]

(b) mark (i) and (ii) together

(i) antibody, destroyed/broken down ;  
antibody excreted ;

(ii) no antigen entered body ;  
no immune response ;  
no, (active) B cells/plasma cells/memory cells ;  
no antibody made ;

AVP ; e.g. further detail of lack of immune response /  
no stimulation of B cells by T helper cells/no cloning

[max. 3]

(c) *line drawn on graph to show*

increase occurs faster than in primary response ;

higher peak of concentration than in primary response ;

[2]

(d) antibody is specific (for tetanus) ;  
further detail ; e.g. variable region  
always some (circulating) antibody molecules, linked with qual ;

[max. 2]

**[Total: 9]**

Q4.

2 (a) allow immunoglobulin for antibody

structure	name of structure	function of structure within plasma cell
<b>A</b>	nucleus ; A (eu)chromatin R heterochromatin R chromosome	ref. gene(s) / genetic information / genetic material / DNA, (coding) for, antibody / protein / polypeptide ; transcription (occurring) / mRNA synthesis ; AW (ref. antibodies) <i>allow ecf for nucleolus</i>
<b>B</b>	mitochondrion ; A mitochondria	provides / synthesises / produces / makes, ATP (for antibody synthesis / exocytosis) ; <i>treat as neutral other uses of ATP</i> <i>allow ecf for lysosomes</i>
<b>C</b>	rough endoplasmic reticulum ; ignore RER	synthesis / modification / processing / transport, of, antibody / protein / polypeptide ; A translation <i>allow ecf for Golgi or SER or ER</i>

[max 6]

(b) (i) 1 part of the immune response ; A primary / secondary, response

*many plasma cells*

2 to produce high, concentration / level / AW, of, antibody / immunoglobulin ;  
3 (high concentration antibody so) more effective against pathogens / AW ;

*identical plasma cells*

4 specific / particular / AW, to an, antigen / epitope ;  
*in context of antibodies or plasma cells*  
5 antibody (molecules) produced are all the same ; A ora, qualified  
6 only the gene coding for particular antibody, switched on / transcribed / expressed ;

[max 3]

(ii) *accept from annotated diagrams*

*cell cycle stages are not required for mark points 1, 3, 4 and 7  
reject if incorrect mitotic stage given for these mark points*

- 1 ref. to, duplication / replication, of centrioles (in late interphase / before prophase);  
    **A** dividing  
    **R** splitting
- 2 (centriole pairs) move to opposite poles in prophase ;  
    *accept asters or centrosomes for centrioles*
- 3 (movement allows) spindle formation / organisation of spindle fibres /  
microtubule assembly / microtubule organisation / AW, (in prophase) ;
- 4 (late prophase / early metaphase / metaphase), chromosomes / centromeres,  
attach to, spindle fibres / microtubules ;
- 5 chromosomes, line up / aligned / AW, at, equator / metaphase plate ;
- 6 ref. separation of, sister / identical, chromatids, at anaphase (to poles) ;  
    **A** sister chromatids move to opposite poles at anaphase  
    **A** daughter chromosomes *for sister chromatids*
- 7 ref., pulling / shortening, by, microtubules / spindle fibres ; AW [max 4]

[Total: 13]

Q5.

- 2 (a) (infected) person, sneezes/coughs/talks/breathes out, (airborne)  
droplets/aerosol/moist air ;  
**ignore** contact  
inhaled/inspire/breathed in, by uninfected, person ; [2]  
**ignore** transplacental transmission

- (b) (i) *variable region*  
binds/attaches/combines, to antigen ;  
**R** receptor site **R** 'fit'  
ref. to specificity ;  
**ignore** complementary shape (to antigen)  
**R** same/similar shape [max 2]

- (ii) *disulphide bond*  
**ignore** ref. to hinge  
  
holds, polypeptides/heavy chains/long chains, together ;  
**ignore** constant as description of chains  
maintains, tertiary/quaternary/3D, structure/shape ;  
**R** shape unqualified [max 1]

- (iii) *constant region*  
binds to, receptors/cell (surface) membrane, on, phagocytes/macrophages ;  
antigen, marking/tagging, for, phagocytosis/macrophage action ; AW  
**A** ref. to opsonisation  
**R** agglutination [max 1]

[Total: 6]

Q6.

- 3 (a) (i) 2 marks for the correct answer – leeway on measurement to be decided.
- $\frac{10 \text{ mm}}{100\,000}$  ;
- 100 nm. [2]
- (ii) Good/high, resolution. A short wavelength [1]
- (b) (T lymphocyte) makes viral, protein/enzyme;  
Cell needs more enzymes for replicating, DNA/protein synthesis/AW;  
AVP. max [1]

Q7.

- (c) (i) Mitosis. [1]
- (ii) Bone (marrow). [1]
- (iii) Antigen. [1]
- (iv) X plasma cell;  
Y antibody ; A immunoglobulin [2]
- (v) Memory cell. [1]
- Remains in, lymph node/blood/lymph/lymphatic system/body;  
Recognises next infection by same, antigen/(measles) virus;  
Secondary response;  
(More) rapid (than primary);  
Immunological memory;  
AVP. max [2]

Q8.

- (b) *phagocytes*  
ingest/engulf/digest, bacteria; R destroy/kill/phagocytosis unqualified act as APC  
(Antigen Presenting Cell) to stimulate B/T cell response; [max 1]
- T helper cells*  
secrete/release, cytokines/lymphokines;  
to activate/stimulate B lymphocytes to produce plasma cells/antibodies/memory  
cells, or stimulate/activate phagocytosis; [max 1]
- [2]
- (c) resistance; R bacteria become immune  
ref to selection of resistant bacteria;  
antibiotic, can then not be used/are ineffective/no longer kill bacteria;  
ref to multiple resistance;
- R answers that suggest people become resistant [max 2]

Q9.

- 1 (a) check column A and B for correct ref. to feature if not clear in first column e.g. gives description

feature	phagocyte (A)	plasma cell (B)
rough endoplasmic reticulum / RER <i>allow ER if rough / RER stated in next column(s) R SER</i>	small quantity / AW A few, less	large quantity / AW ; A many, more
ribosomes	few or ref. to free	many ; or not free / fixed
lysosomes	some / present / ✓	none / absent / x ;
vacuoles / vesicles / phagosomes	some / present / ✓	none / absent / x ;
nucleus	lobed / AW A irregular, not round R curved, elongated, no definite shape	round / not lobed / not irregular / AW ; A spherical, circular
Golgi (body)	absent / x	present / ✓ ;
plasma / cell (surface), membrane	with, endocytotic / pinocytotic / phagocytic / exocytotic, vesicles / vacuoles A invaginations, infoldings R indentations	without, endocytotic / pinocytotic / phagocytic / exocytotic, vesicles / vacuoles A no invaginations, no infoldings R no indentations
mitochondria	less / few / 3	more / many / 7 ;

[3 max]

- (b) (to nearest whole number) (x) 6000 :: A 5900 – 6100  
allow 1 mark for correct working if answer incorrect / not to whole number  
e.g. length of scale bar in mm × 1000, divide by actual size  
60mm × 1000 / 10     A 59 – 61mm

[2]

- (c) *phagocyte*  
 move to sites of infection ;  
 ingest / engulf / pseudopodia enveloping / phagocytosis of / endocytosis of, bacteria /  
 microbes / pathogens / AW ;  
 R antigens, virus  
 (form) phagocytic / endocytotic, vacuoles ;  
 A vesicles, phagosomes  
 ref to lysosomes ;  
 enzymes / named (hydrolytic) enzymes ;  
 digest / hydrolyse, (bacteria / AW) ;  
 antigen presentation / description ; [3 max]
- plasma cell*  
 produce / secrete / release / synthesise, antibodies ; A make  
 into, plasma / tissue fluid / lymph ; A blood  
 antibodies are proteins ;  
 ref to, RER / ribosomes ;  
 specificity qualified e.g. of, antibodies / lymphocyte / plasma cell  
 or description e.g. each type of plasma cell produces one type of antibody ;  
 Golgi (body) packages antibodies / ref to formation of (Golgi) vesicles ; [3 max]
- (d) (bacteria likely to be) resistant to (at least) one antibiotic (so useless) ;  
 less likely to be resistant to all / chance that bacteria will develop resistance to all  
 antibiotics used is very small ;  
 ref to mutation / change to DNA ;
- (bacteria are) inside cells where protected from antibiotics ;  
 (mycobacteria) divide / grow, slowly ;  
 ensures all bacteria killed / reduces below critical level ;  
 otherwise, bacteria remain / reservoir of infection ;  
 (so) prevents development of antibiotic resistance ; [4 max]
- [Total: 15]

Q10.

- (iii) both made of, protein / polypeptide(s) / amino acids ;  
 both have  
 disulphide bond ;  
 antigen binding site ;  
 variable region ;  
 constant region ; A non-variable [2 max]
- (b) *helper cells*  
 secrete / release / produce, cytokines / lymphokines / hormones ;  
 to stimulate B cells to, divide / develop into plasma cells ;  
 (which) produce antibodies ;  
 stimulate macrophages to carry out phagocytosis ;
- cytotoxic / killer T cells*  
 seek out / find / bind to, (foreign) antigens, on host cells / pathogens ;  
 destroy, virally infected host cells / intracellular parasites / viruses ;  
 attach to surface of cells / 'punch holes' into cells / disrupt cell surface (plasma) membrane;  
 (release) toxic substances / hydrogen peroxide (into cells) / interferons ;  
 R enzymes [4 max]

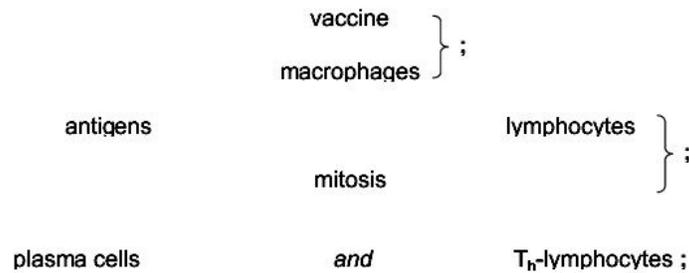
Q11.

- 1 (a) (i) circle around one or two variable regions ; [1]
- (ii) line(s) between **one** light polypeptide and **one** heavy polypeptide,  
line(s) between the two heavy polypeptides ;  
*maximum of six lines in each site* [1]
- (iii) 1 (disulfide) bonds are between, cysteine(s) / cysteine residues ;  
A between R groups S-H S-H  
2 covalent bond ;  
3 strong bond / not easily broken ;  
4 hold, polypeptides / chains / protein , together ; R proteins / strands  
5 (in protein with) tertiary / quaternary (structure) ;  
6 maintain shape / stop loss of shape / prevent deforming ;  
A 3D structure R structure unqualified [3 max]
- (b) 1 secreted / synthesised / produced / released, by, plasma cells / B lymphocytes / B cells ;  
2 combines / AW, with, antigens / pathogens / toxins / viruses / bacteria / microbes ;  
A 'bonds with' / 'sticks to' / 'attaches to' R 'disease'  
3 ref to, specificity / described ; *in context of antibody / B cells / antigen*  
4 variable region is antigen binding region ; R 'receptors on antibodies'  
5 neutralises toxins / antitoxin(s) ;  
6 lysis of pathogens / described / lysis(s) ; R breaks down  
7 prevents viruses entering cells ;  
8 clumps / agglutinates / aggregates / AW, bacteria ; R 'coagulation'  
9 opsonisation / opsonins ; A enable recognition  
10 coats / AW, bacteria to facilitate phagocytosis ; *only in context 8 or 9*  
11 receptors on phagocytes for constant regions (of antibodies) ; [4 max]
- (c) 1 (carrier / channel protein for) facilitated diffusion / described ;  
A action of (co-) transport protein described  
2 (carrier protein for) active transport / described ;  
3 cell recognition / distinguishing self from non-self / act as antigens / AW ;  
4 receptor ; A binding site qualified in terms of, hormones / neurotransmitters / cytokines /  
cell signalling molecules ;  
5 T-cell receptor / described ;  
6 cell (to cell) adhesion / described ;  
7 enzyme ;  
8 form (hydrogen) bonds with, water / fluid surroundings, to stabilise membrane ; [3]

[Total: 12]

Q12.

4 (a)



[3]

no ecf from (a) to (b)

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(b) 1 active (artificial) immunity ;

2 memory cells / immunological memory ;

3 *idea that* many specific, B-cells / T-cells / lymphocytes, in the body ;  
A large(r) clones of specific, B- / T-cells or lymphocytes

*actual invasion by the pathogen*

4 fast secondary (immune) response ;

5 fast increase in antibodies / immediate production of antibodies ;  
ignore incorrect type of cell secreting antibodies

6 high(er) concentration of antibodies are produced ; A more antibodies produced

7 pathogen destroyed before person becomes ill / AW ; R antigen

A pathogen do not, increase in number / infect cells / AW

[max 3]

(c) *two points to look for*

(if) most / sufficient / many / AW, people / children, immunised / vaccinated ;  
A herd immunity

reduces the pool of infected, people / children, in the, community / population ;

A fewer people can catch disease and be source of infection

A protects those unvaccinated as, disease / illness, does not spread

A less chance of transmission

A pathogen cannot develop in immunised people

A reduced exposure to pathogen

[max 2]

[Total: 8]

Q13.

4 (a) R if mark points are in context of secondary response

sensitised / activated / AW, by (foreign) antigen / epitope ; *accept once only*  
correct ref. specificity ; *accept once only*  
production of memory cells ; *accept once only*

*T lymphocytes*

(T-helper / Th) secrete, cytokines / lymphokines ;  
(T-helper / Th) stimulate, B cells to divide ; A stimulate humoral response  
(T-killer / Tk / T-cytotoxic / Tc) secrete, perforin / hydrogen peroxide / AW ;  
A toxins  
R hormones  
(T-killer / Tk / T-cytotoxic / Tc) kill / destroy / AW, non-self cells / pathogens / infected  
cells ;  
(T-suppressor / Ts) ref., suppresses / reduces, response (on recovery) ;

*B lymphocytes*

formation of plasma cells ;  
antibody production ;

[max 4]

(b) no more antigen / AW ;

(remaining) antibodies, removed from the blood / broken down (in the liver) ;

R excreted

plasma cells, are short-lived / begin to die / are not replaced ;

no more antibody produced ;

AVP ; e.g. detail of removal / macrophage engulfs, digested, peptide bonds broken [max 3]

(b) no more antigen / AW ;

(remaining) antibodies, removed from the blood / broken down (in the liver) ;

R excreted

plasma cells, are short-lived / begin to die / are not replaced ;

no more antibody produced ;

AVP ; e.g. detail of removal / macrophage engulfs, digested, peptide bonds broken [max 3]

(c) line drawn continuous with that provided ;

and rising more steeply before day 55 ; *should start to rise from day 40 / should rise  
more steeply initially / should not remain as a plateau from day 40*

reaches higher than primary response between day 45-55 and, peaks / plateaus ;  
*must not go below the day 40 antibody concentration*

[3]

[Total: 10]

Q14.

6 (a) bone marrow ; [1]

(b) (i) **A** = macrophage / APC ; **A** monocyte  
**B** = B, lymphocyte / cell ;  
**C** = T, lymphocyte / cell ;

*allow one mark if lymphocyte given for both B and C but not qualified or incorrectly qualified* [3]

(ii) thymus ; [1]

(c) *max 4 if no reference to, antigen / non-self*

foreign / AW, antigens are non-self ;  
non-self / foreign antigens, induce immune response ; AW ora

*macrophage / APC (A)*  
phagocytosis / described ;  
cuts up / AW, bacterium / pathogen ;  
presents antigens / becomes antigen presenting cell / antigens on cell surface ;

*B/T, cells (B and C)*  
antigen recognition by lymphocytes ;  
(with) complementary / specific, receptors / immunoglobulins (B) / antibodies (B) ;  
divide by mitosis ; **A** clonal expansion  
ref. formation of memory cells (for secondary response);

*T<sub>h</sub> cells (C)*  
secrete cytokines to stimulate B cells ;  
cytokines stimulate macrophages ;

*T<sub>c</sub>/k cells (C)*  
ref. destroy pathogen / AW ;  
produce perforin / AW ;

*B cells (B)*  
B cells become plasma cells ;  
(plasma cells) secrete antibodies ;

AVP ; e.g.  
macrophages, non-specific / faster response  
ref. specificity of, lymphocytes / B and T cells  
antibody variable region is the antigen binding site ;

[5 max]

[Total: 10]

Q15.

- 2 (a) 'cell' is not required as it is in the stem of the question
- (i) macrophage ; **A** antigen-presenting cell **R** mycrophage [1]
  - (ii) neutrophil ; **A** PMN / polymorphonuclear leucocyte [1]
  - (iii) T-killer /  $T_K$  / T-cytotoxic /  $T_C$ , lymphocyte ; **A** cell for lymphocyte [1]
  - (iv) memory B- lymphocyte ; A cell for lymphocyte [1]

Q16.

- (b) transcription (of specific genes) ; **A** reference to gene switching  
 protein / polypeptide, synthesis ; **A** translation  
 production of haemoglobin ;  
 further detail ; e.g. assembly of quaternary structure  
 (production of) carbonic anhydrase ;  
 loss of, mitochondria / named organelles ;  
 loss of nucleus ;  
 adopts biconcave disc shape ; [max 3]
- (c) occurs in both primary and secondary (immune) responses ;  
 selected / specific / AW ;  
lymphocytes / B -cells / T-cells / divide (by mitosis) ;  
 clonal expansion / described in terms of producing, clone / many cells ;  
**A idea that** different types of immune cell can result  
 reference mitosis in memory cells (for rapid) secondary response ; [max 3]
- (d) *T helper / Th*,  
 secrete, cytokines / interleukins ;  
 activate B-lymphocytes to, divide / form plasma cells ; **A** idea that leads to enhanced  
 antibody levels  
 enhances / AW, phagocyte / macrophage, response ; **A** angry macrophages ;
- T cytotoxic / Tc / T killer / Tk*  
 attach to / kill / AW, infected cells / damaged cells / tumour cells / cells with non-self  
 antigens / AW;  
 mechanism of killing ; e.g. perforin
- T memory / Tm*  
 already exposed to antigen ;  
 reference to role in secondary response ;
- AVP ; ; e.g. T suppressor cells  
 function of suppressor cells [max 3]

Q17.

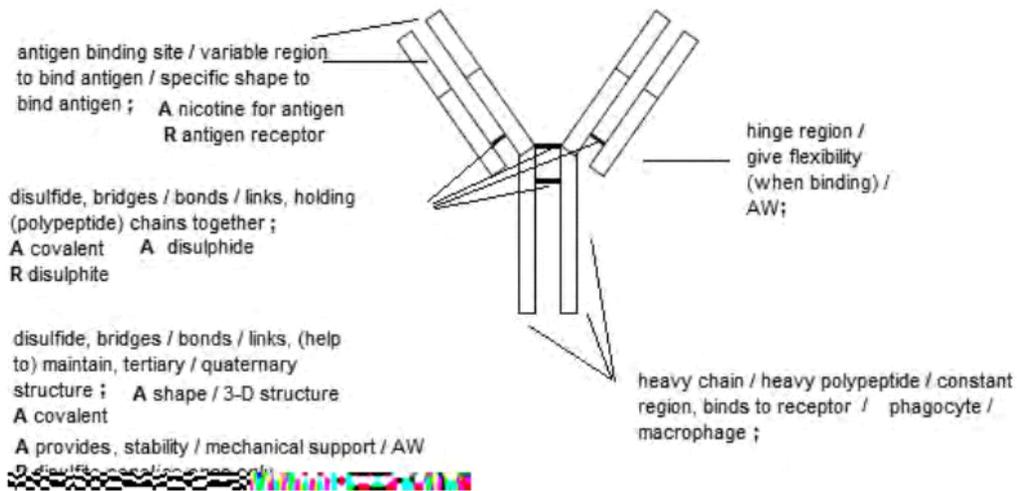
(ii) allow microorganisms or named type of microorganism or infectious agent for pathogens

- 1 recognise, non-self/ foreign, antigens, (on pathogen) ;
- 2 receptors (on macrophage) bind antigens (on pathogen) ;
- 3 (or), pathogen /AW, adheres / 'sticks', to (cell surface) membrane ;
- 4 infolding of (macrophage cell surface) membrane around /envelop/ phagocytosis of, pathogen ; **R** engulf antigen
- 5 vacuole /vesicle/ phagosome, forms ;
- 6 ref. to lysosomes ;
- 7 hydrolytic /digestive/ named, enzymes ;  
e.g. lysozyme /protease /nuclease  
**A** pathogen broken down by enzymes
- 8 hydrolysis of named compound(s) ;
- 9 ref. to destroying /killing, pathogen ;
- 10 ref. to antigen presentation ;  
*accept idea even though does not occur in alveoli*

[max 4]

Q18.

6 (a) labels to correct areas, mark to max 3



AVP ; e.g.  
light and heavy polypeptide chain, ref. forming variable region / different primary  
structure(s) giving different shapes ;  
heavy / polypeptide, chain constant region gives antibody class ; AW

[max 3]

Q19.

- 1 (a) (i) variable region / antigen binding site ; A antigen binding region  
A light, polypeptide / chain R antigen receptor [1]
- (ii) disulfide ; I bridge  
A disulphide R disulfite / covalent [1]
- (iii) two or more / more than one , polypeptide(s) / tertiary structure(s) ;  
R any specific number of polypeptide on its own  
R more than one type of polypeptide / many polypeptides  
R more than two / several, polypeptides  
I ref to prosthetic group [1]

- (b) 1 antigen recognised as / AW, non-self / foreign ;  
*accept once for macrophage, B-lymphocyte or T-lymphocyte*  
A non-self / foreign, antigen leads to immune response
- 2 *idea of phagocytosis leading to antigen presentation ;*
- 3 antigen (on pathogen or APC) binding to, receptor / membrane, of B-cell(s) /  
B-lymphocyte(s) ; A clonal selection of B-lymphocytes occurs
- 4 (helper) T-cell / T-lymphocyte, activate B-cells ; I killer T-cells  
A release cytokines to stimulate B-cells
- 5 B-cells / B-lymphocytes, divide by mitosis ; A replicates / proliferates by mitosis  
A clonal expansion of B-cells
- 6 plasma cells, formed / AW ;
- 7 plasma cells / B-cells / B-lymphocytes, produce / secrete / AW, antibody /  
immunoglobulin / Iq ; [max 4]

- (c) *parasite / Plasmodium / pathogen / protoctist / protist / protozoan must be mentioned at least once somewhere in the answer to gain any marks*  
*e.g. 'malaria / disease has many antigens' = 0*

*if malaria is caused by a virus / bacterium penalise once only*

- 1 (malarial) parasite / pathogen / *Plasmodium*, (is eukaryotic) has many genes ;  
A has greater genetic complexity of smallpox / AW
- 2 different (malarial) parasite, species / strains / AW, have different antigens ;  
R 'strands'
- 3 (malarial) parasite has different antigens in different stages of its life cycle ;
- 4 (malarial) parasite / *Plasmodium*, switches antigens / idea of antigens changing during  
infection / different genes coding for antigens switching on / AW ;  
R 'active sites' of antigens changing  
R 'antigens mutate'
- 5 parasite / antigen / stages of the life cycle, inside (host / liver / red blood) cells ; [max 2]

[Total: 9]

Q20.

**(b)** *must be in context of B-lymphocytes / B-cells / plasma cells*  
*max 3 if T-cells*

*secondary response A ora*

presence of memory cells / AW (giving larger numbers) ;

ref. increased chance of, encountering antigen / antigen presentation / clonal selection ;

ref. larger numbers cells following, clonal expansion / AW (cf primary response) ;

(so) shorter duration for onset of antibody production ;

(so) higher antibody concentration ;

secondary response antibody production (by plasma cells) lasts longer ;

AVP ; e.g. faster rate, plasma cell / antibody, production, ref. longer-life of cells

involved in secondary response

[max 4]

