

Mark schemes

Q1.

- (a) 1. A = Attachment protein;
Accept gp41 /gp140 /gp120/CD4/ glycoprotein
Accept antigen
Ignore receptor protein
2. B = Capsid
- OR**
- Capsomere
- OR**
- Protein;
- (b) 1. Attachment proteins attach to receptors on helper T cell/lymphocyte; ²
2. Nucleic acid/RNA enters cell;
3. Reverse transcriptase converts RNA to DNA;
4. Viral protein/capsid/enzymes produced;
5. Virus (particles) assembled and released (from cell);

4 max

[6]**Q2.**

- (a) 1. Cell ingests/engulfs the antibody/ADC
- OR**
- Cell membrane surrounds the antibody/ADC (to take it inside the cell);
Accept endocytosis for ingest/engulf
2. Lysosomes fuse with vesicle/phagosome (containing ADC);
3. Lysozymes breakdown/digest the antibody/ADC to release the drug;
Accept hydrolytic enzyme for lysozyme
- (b) 1. ADC will bind to non-tumour/healthy cells;
Reject reference to active site
2. Cause death/damage of non-tumour/healthy cells

3

OR

- Cause damage to other organs/systems; 2
- (c) Correct answer for 2 marks, 9.2×10^{-5} ;;
 Accept for 1 mark,
 0.046 (correct mass injected into 23g mouse)
 0.000092 (correct answer but not in standard form) 2
- (d) Mice died
OR
 Not ethical to continue; 1
- (e) 1. Tested on other mammals to check for safety/side effects;
Accept named mammal, eg rat
2. Tested on (healthy) humans to check for safety/side effects;
Accept: Tested on (healthy) human tissue/cells to check for no side-effects
3. See if repeat doses stop the tumours regrowing (in Group J);
4. Investigate different concentrations of ADC to find suitable/safe dosage; 2 max
- [10]**

Q3.

- (a) 1. RNA converted into DNA using reverse transcriptase;
Reject 'messenger' or 'm' before RNA
2. DNA incorporated/inserted into (helper T cell)
 DNA/chromosome/genome/nucleus;
3. DNA transcribed into (HIV m)RNA;
Accept descriptions of transcription
4. (HIV mRNA) translated into (new) HIV/viral proteins (for assembly into viral particles);
Accept descriptions of translation
Accept named viral protein, eg capsid
Reject viral cells 4
- (b) For
1. (There appears to be) no virus/ HIV(-1)/RNA/DNA, so could be a

cure/effective;

Max 4 for reasons for or against

Ignore virus is killed

2. No CCR5/receptor, so not get HIV(-1) in the future

OR

No CCR5/receptor, so nothing for HIV(-1) to bind to;

Reject less CCR5/less HIV(-1) bind

3. Only one transplant/BSCT needed (shown by patient **Q**)

4. Would not need (daily) ART (16 months after BSCT);

Against

5. Don't know if chemotherapy/radiotherapy is needed

OR

Do not know if BSCT alone would be effective;

OR

Do not know which treatment is having the effect

OR

Could be due to chemotherapy/radiotherapy;

Accept: chemotherapy/radiotherapy is toxic/harmful/has side-effects

6. Only for HIV-1;

Accept: Might not work in other types of HIV

7. Don't know if it would work in all people

OR

Only worked/tried in 2 cases;

8. Might not be long term

OR

Only 18 months;

9. HIV-1 may mutate and be able to bind to a different receptor (on T_H cells);

10. Might be a lack of (suitable stem cell/BSCT) donors;

Accept stem cells/BSCT (might be) rejected

5 max

[9]

Q4.

- (a) 1. Engulfs;
Accept endocytosis
OR
Description
Ignore 'taken in'
2. Forming vesicle/phagosome **and** fuses with lysosome;
3. Enzymes digest/hydrolyse;
Accept lysozymes for 'enzymes'
- 3

- (b) 1. (Cells from) other organisms/transplants;
2. Abnormal/cancer/tumour (cells);
3. (Cells) infected by virus;
Accept 'own cells' if autoimmune response suggested
Accept APCs
Accept non-self
- 2 max

- (c) 'X' written at either or both ends of Y shape;
- 1

- (d) Joins two (different) polypeptides;
Accept holds/attaches
Accept 'prevents polypeptide chains separating'
- 1

[7]**Q5.**

- (a) 1. Less/no antibody produced;
2. (Because HIV) destroys helper T cells;
Accept 'reduces number' for 'destroys'
3. (So) few/no B cells activated / stimulated
- OR**
- (So) few/no B cells undergo mitosis/differentiate/form plasma cells;
- 3

(b) Not effective in treating AIDS because

1. Number of T cells < 200 at 4 months;
Max 4 if not one of 9. or 10.
Accept 3.5 - 5 months

Reject day/week only once

2. (So) drug is not effective

OR

AIDS symptoms occur;

3. Does not remove (all) HIV (particles)

OR

Number of HIV (fairly) constant/stable

OR

(Slight) increase in HIV (over 16 months);

4. No stats test;
 5. Only shows (results over) 16 months;
 6. Only one person;
 7. Unknown side effects (of drug);
 8. No control group;

Effective in treating AIDS because

9. Number of T cells > 200 after 5 months

OR

Number of T cells increasing after 4 months;

Reject day/week only once

Accept any month after 5 months OR 'in the long term'

10. So drug is effective

OR

AIDS symptoms relieved/removed;

5 max

[8]

Q6.

- (a) 1. Mutation in the viral DNA/RNA/genome/genetic material;
Accept named examples mutations
2. Altered (tertiary structure of the) viral attachment protein;
Accept 'antigen' for 'attachment protein'

Accept causes antigenic variability

3. Allows it/attachment protein/virus to bind (to receptors of other species);

Accept descriptions of binding eg is complementary

2 max

- (c) 1. (The scientists) could identify proteins (that derive from the genetic code)

OR

(The scientists) could identify the proteome;

2. (They) could (then) identify potential antigens (to use in the vaccine);

Reject if answer suggests vaccine contains antibodies

2

- (d) 1. B cell (antibody) binds to (viral) specific/complementary receptor/antigen;

Accept B cell forms antigen-antibody complex

2. B cell clones

OR

B cell divides by mitosis;

3. Plasma cells release/produce (monoclonal) antibodies (against the virus);

4. (B/plasma cells produce/develop) memory cells;

Accept B cell undergoes clonal selection/expansion

3 max

Q7.

- (a) (Antibodies with the) same tertiary structure

OR

(Antibody produced from) identical/cloned plasma cells/B cells/B lymphocytes;

Accept in context of single plasma/B cell/B lymphocyte

Reject: genetically identical antibody

1

- (b) Accept any **one** suitable use, eg

Targets/binds/carries drug/medicine to specific cells/antigens/receptors

OR

Block antigens/receptors on cells;

Accept cancer/diseased cells (as a specific cell).

Ignore medical diagnosis/pregnancy/ PSA/ELISA test.

1

(c)

*Ignore mixing of direct or indirect ELISA
Accept annotated diagram(s).*

1. (First) antibody binds/attaches /complementary (in shape) to antigen;
2. (Second) antibody with enzyme attached is added;
3. (Second) antibody attaches to antigen;
*Accept (second) antibody attaches to (first) antibody
(indirect ELISA test).*
4. (Substrate/solution added) and colour changes;
Only award if enzyme mentioned.

4

[6]**Q8.**

- (a) 1. Bind to antigen

OR

Are markers;

*Accept opsonin for 'marker'**Accept form (antibody-antigen) complexes/are
complementary to antigen*

2. (Antibodies) cause clumping/agglutination

OR

Attract phagocytes;

Reject clotting

2

- (b) Correct answer for 2 marks 110/111/111.1;;

Accept for 1 mark, correct readings from graph (5.1 **and** 2.1)

2

- (c) 1.
- Mean
- (antibody concentration) increases;

2. 1
- st
- injection protects some mice/1 mouse/2 mice

OR1st injection causes primary (immune) response/memory cell
production;*2. and 3. Accept correct reference to number of
unprotected mice*

3. 2
- nd
- /3
- rd
- injection protects most/all mice

OR2nd/3rd injection causes secondary (immune) response**OR**2nd/3rd injection uses memory cells;

4. Because antibody at/above protective level/2.1;

Accept converse

5. Antibody decreased (rapidly after 3rd injection);
6. No mice protected after 180 days
OR
Injections/vaccine not effective in long term
OR
Booster required (when antibody below protective level/after 120/180 days);
7. One mouse (after first injection) has big response/already had meningitis/antigen;

4 max

(d)

*Mark as pairs, 1 and 2, 3 and 4**Accept for inject, introduce, give, use*

1. Inject vaccine (again)/meningitis antigen/ inactive antigen/dead/living bacteria/ pathogen/use a booster;
Must refer to antigen or cell, 'disease' or 'meningitis' is not enough
2. (Memory cells present if) faster/more rapid production/higher concentration antibody (than 1st injection)
OR
Immune response is quicker (than 1st injection)
OR
Symptoms do not develop;
Accept converse
Must be a comparison
3. Add enzyme attached to (second) antibody against memory cell;
4. Colour change shows memory cell present;
Ignore to detect (meningitis) antibodies

2

[10]

Q9.

- (a) 1. (Antivenom/Passive immunity) antibodies bind to the toxin/venom/antigen and (causes) its destruction;
For 'bind' accept 'attach', ignore 'attack'.
For 'destruction of toxin' accept agglutination or phagocytosis.
Ignore reference to antibodies 'neutralising toxin/stopping damage'
Reject reference to 'killing' toxin/venom.
2. Active immunity would be too slow/slower;
Accept 'passive immunity is faster', not simply 'passive immunity is fast'.

2

- (b) 1. May be different form of antigen/toxin (within one species)
OR
 Snakes (within one species) may have different mutations/alleles;
2. Different antibodies (needed in the antivenom)
OR
 (Several) antibodies complementary (to several antigens);
No mark points are available for answers related to collecting venom from different species of snake.
- 2 max**

- (c) 1. Horses **because** more antivenom/antibodies could be collected (as more blood collected);
2. 4550 (cm³) v 26 (cm³) (blood collected);
Accept 175 rabbits needed to (collect the volume of blood from) one horse.
- 2**

- (d) 1. (So) the animal does not suffer from the venom/vaccine/toxin;
2. (So) the animal does not suffer anaemia/does not suffer as a result of blood collection;
3. (So) the animal does not have pathogen that could be transferred to humans;
Accept 'To fulfil licence/legal requirements'.
Accept '(So) the animal does not have pathogen that could result in it producing other antibodies (not wanted in the antivenom)'.
For 'pathogen' accept correct form of pathogen.
- 1 max**

- (e) 1. B cells specific to the venom reproduce by mitosis;
Accept in context of primary or secondary immune response.
Credit idea of specificity if given once in relation to T or B cell.
Accept a description for specificity.
Accept 'clone' for 'reproduce by mitosis'.
'Clonal selection of B cells' = MP1.
2. (B cells produce) plasma cells and memory cells;
3. The second dose produces antibodies (in secondary immune response) in higher concentration **and** quickly
OR
 The first dose must be small so the animal is not killed;
Accept 'a lot of antibody' for 'higher concentration of antibody'.

3

[10]

Q10.

- (a) 1. Person (infected with HIV) has HIV DNA (in their DNA);
 2. New HIV (particles) still made;
 3. (AZT) inhibits reverse transcriptase;
 4. (AZT) stops these (new HIV particles) from forming new HIV DNA;

OR

- Slows / stops replication of HIV;
 5. Stops destruction of more / newly infected T cells;
 6. So immune system continues to work (and AIDS does not develop);

4. *Context is important*4. *Allow slows / stops (re)production of HIV*4. *Reject (AZT) prevents DNA replication*

4 max

- (b) 1. Slows / stops the development of AIDS;
 2. Because HIV **resistant to AZT** is damaged / destroyed / prevented from replicating (by other drugs);

OR

3. AZT continues to work as a drug;
 4. Because HAART prevents the spread of AZT-resistant HIV to rest of the human population;

OR

5. No new HIV particles made;
 6. Because HAART might interfere with viral protein synthesis;

*Mark in pairs.**Do not mix and match.*2. *Neutral HIV killed*2. *Accept other drugs prevent HIV resistant to AZT from infecting new / more cells*6. *Accept blocks transcription / translation / synthesis of lipid envelope / aspect of viral structure*

4 max

Q11.

- (a) 1. Phagosome / vesicle fuses with lysosome;
 2. (Virus) destroyed by lysozymes / hydrolytic enzymes;
 3. Peptides / antigen (from virus) are displayed on the cell membrane;

1. *Accept vacuole fuses with lysosome*1. *Reject virus fuses with lysosome*

3

- (b) 1. Helper T cell / TH cell binds to the antigen (on the antigen-presenting cell / phagocyte);
 2. This helper T / TH cell stimulates a specific B cell;
 3. B cell clones

OR

B cell divides by mitosis;

4. (Forms)
- plasma cells
- that release antibodies;

1. and 2. 'Helper' is required **once** only.

2. Accept 'This (helper) T cell stimulates a competent B cell'

'T cell stimulates B cell to undergo clonal selection'.

This statement achieves mp2 and mp3.

3 max

- (c) 1. The antibody against virus (antigen) will bind to collagen;
 2. This results in the destruction of the (human) cells / collagen;
 2. Ignore 'attacks'

2

[8]**Q12.**

- (a) 1. Foreign protein;
 Accept *glycoprotein / glycolipid / polysaccharide*
 2. (that) stimulates an immune response / production of antibody;

2

- (b) 1. A protein / immunoglobulin specific to an antigen;
 2. Produced by B cells

OR

Secreted by plasma cells;

2

- (c) 1750(%)

1

- (d) 1. Sample 1 / before vaccination no antibody released because patients not yet encountered vaccine / antigen / virus;
 Accept 'produced' for 'released'

2. (Sample 2 / primary response / after first dose) activation / clonal selection / expansion of B cells into plasma cells;3. Plasma cells release antibodies;4. (Sample 3 / secondary response / after second dose) memory cells produce more antibodies / produce antibodies more quickly;

4

[9]

Q13.

- (a)
1. Antigen / epitope on surface of *N. meningitidis* / bacterium binds to surface protein / surface receptor on a (specific / single) B cell.
If answered in context of T cell, allow Antigen binds to (specific / single) T cell
 2. (Activated) B cell divides by mitosis / produces clone;
If answered in context of T cell, allow (Activated) T cell releases cytokine.
 3. (Division) stimulated by cytokines / by T cells;
If answered in context of T cell, allow (Cytokine) stimulates production of plasma cells;
 4. B cells / plasma cells release antibodies;
 5. (Some) B cells become memory cells;
 6. Memory cells produce plasma / antibodies faster

6

Q14.

- (a)
1. Vaccine contains antigen from pathogen;
 2. Macrophage presents antigen on its surface;
 3. T cell with complementary receptor protein binds to antigen;
 4. T cell stimulates B cell;
 5. (With) complementary antibody on its surface;
 6. B cell secretes large amounts of antibody;
 7. B cell divides to form clone all secreting / producing same antibody.
- (b)
1. Active involves memory cells, passive does not;
 2. Active involves production of antibody by plasma cells / memory cells;
 3. Passive involves antibody introduced into body from outside / named source;
 4. Active long term, because antibody produced in response to antigen;
 5. Passive short term, because antibody (given) is broken down;
 6. Active (can) take time to develop / work, passive fast acting.

5 max

5 max

[10]