HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.2.4 Cell recognition and the immune system

Mark scheme

Version 1 · 1 October 2026

TOTAL MARKS	QUESTIONS
81	9

How to use this mark scheme

;	Separates marking points. Each semicolon marks the end of one creditable point, and each point is worth one mark.
;;	Two marks for this answer (used for calculations).
/	Alternative words or phrases that are credited for the same point.
OR	An alternative answer for the same mark.
( )	Words in brackets are not needed to gain the mark.
max	More marking points are listed than marks available. Award up to the number of marks shown.
Accept	An alternative answer that gains credit.
Reject	A wrong answer. It does not gain credit and cancels a correct point it contradicts.
Ignore	Neither credited nor penalised. Mark the rest of the answer.
ECF	Error carried forward: credit correct working that uses an earlier wrong answer.
AO	Assessment objective: AO1 knowledge and understanding; AO2 applying knowledge; AO3 analysing, interpreting and evaluating.

Where an answer is correct but not listed, credit it if it is biologically accurate and answers the question at the depth the marks require. Right + wrong = wrong: a contradiction cancels a correct point.

Cell recognition, antigens and phagocytosis 3.2.4

Question	Marking guidance	Mark	Comments
01.1	A red blood cell from the person's own blood;	**1** (1 × AO1)	The other options are an abnormal body cell, a cell from another individual of the same species and a toxin, which are all identified by the immune system.

Question	Marking guidance	Mark	Comments
01.2	1. Lysosomes contain lysozymes/hydrolytic enzymes; 2. (Without fusion) the enzymes are not released into/do not reach the phagosome containing the bacterium; 3. So the bacterium (eg its cell wall/proteins) is not hydrolysed/digested;	**3** (2 × AO1) (1 × AO2)	**Ignore** restatement that lysosomes do not fuse with the phagosome 1. **Reject** lysozymes for lysosomes (the organelle must be named as a lysosome) 1. **Accept** digestive enzymes/named hydrolytic enzyme, eg protease 3. **Reject** the bacterium is not engulfed **Ignore** vacuole for phagosome

Question	Marking guidance	Mark	Comments
01.3	So that only bacteria that were inside/taken in by the phagocytes are counted OR bacteria left outside the phagocytes would also form colonies;	**1** (1 × AO3)	**Ignore** 'to make it a fair test' unqualified

Question	Marking guidance	Mark	Comments
01.4	Correct answer of 90 (%) for 2 marks;; Accept for 1 mark, 450 (bacteria) killed OR 50 ÷ 500 OR 10% survived	**2** (2 × AO2)	Plotted values: 500 at 0 minutes and 50 at 120 minutes **Accept** answers in the range 89 to 91 (%) from readings to within 5 of the plotted values **Reject** 10 (%) as the final answer

Question	Marking guidance	Mark	Comments
01.5	1. Ionic/hydrogen bonds (in the tertiary structure) are changed/broken, so the active site changes shape; 2. Fewer enzyme–substrate complexes form OR substrate is no longer complementary to/does not fit the active site; 3. So (molecules in) the bacteria are not hydrolysed/digested and more bacteria survive, eg 430 compared with 50 at 120 minutes;	**3** (3 × AO2)	**Ignore** restatement of the pH values or the optimum pH given in the question Description of the results alone gains no credit; the data are credited only as part of point 3 1. **Accept** (some) enzymes denatured **Reject** enzymes killed **Accept** E-S complex / ES complex. E-S alone only if 'enzyme-substrate complex' is written elsewhere. Ignore ESC. **Reject** lysosomes are denatured

Question	Marking guidance	Mark	Comments
01.6	1. Shows drug D does not itself affect the survival/growth/division of the bacteria; 2. So the larger number of live bacteria with drug D is caused by its effect on the phagocytes/lysosomes OR by less killing/digestion inside the phagocytes;	**2** (2 × AO3)	**Accept** it is a control, if linked to either point **Ignore** 'to make it a fair test'/'reliable' unqualified

Question	Marking guidance	Mark	Comments
02.1	A (foreign) molecule/protein that stimulates an immune response OR that leads to the production of antibodies;	**1** (1 × AO1)	**Accept** a (foreign) molecule on a cell surface that is recognised by the immune system/lymphocytes **Ignore** 'a protein on the surface of a pathogen' unless linked to an immune response

Question	Marking guidance	Mark	Comments
02.2	1. Some parasites (switched and) have version B of the surface protein/a different antigen; 2. Antibodies made against version A are not complementary to/cannot bind to version B; 3. So parasites with version B are not agglutinated/destroyed by phagocytes, and they divide/increase in number; 4. A new primary response/clonal selection of different B cells is needed for version B, and this takes time/several days; 5. Memory cells (from version A) are not complementary to/do not recognise version B;	**3 max** (3 × AO2)	2. **Reject** antibodies are not the same shape as the antigen **Reject** active site for antigen-binding site **Reject** the parasites become immune/resistant to the antibodies

Question	Marking guidance	Mark	Comments
02.3	1. For: memory cells (and antibodies) for version A are made, so parasites with version A would be destroyed quickly/could prevent the first peak; 2. Against: parasites with other versions (eg B/C, over 1000 possible) would not be recognised/bound by antibodies/memory cells, so the infection could continue OR high antigen variability makes the vaccine ineffective;	**2** (2 × AO3)	One mark for each side **Reject** vaccine contains antibodies

The cellular and humoral responses 3.2.4

Question	Marking guidance	Mark	Comments
03.1	Correct answer of 16 (hours) for 2 marks;; Accept for 1 mark, 9 divisions/generations OR 81 920 ÷ 160 = 512 OR 2^9 = 512	**2** (2 × AO2)	**Accept** 144 ÷ 9 for 2 marks **Accept** a correct answer from any two times between day 2 and day 8, eg day 4 to day 6: 8 = 2^3, 48 ÷ 3 = 16

Question	Marking guidance	Mark	Comments
03.2	1. Each B cell has a specific antibody/receptor on its surface, so only a few B cells are complementary to protein X; 2. B cells complementary to protein X bind protein X/the antigen (and are selected); 3. (These B cells are) stimulated/activated by helper T cells; 4. (Selected B cells) divide by mitosis to form a clone OR clonal selection/clonal expansion;	**3 max** (2 × AO1) (1 × AO2)	**Reject** meiosis **Reject** active site 3. **Accept** activated by T cells that have bound antigen presented by an antigen-presenting cell

Question	Marking guidance	Mark	Comments
03.3	1. Plasma cells secrete/release (monoclonal) antibodies complementary to protein X; 2. Memory cells remain in the blood/body (for a long time); 3. Memory cells divide rapidly (into plasma cells) if protein X enters the body again OR give a faster/larger secondary response;	**2 max** (2 × AO1)	**Max 1** if only one type of cell is described **Ignore** memory cells 'remember' the antigen **Ignore** memory cells produce antibodies

Question	Marking guidance	Mark	Comments
03.4	(Control) to show that the increase is only in B cells complementary to protein X/the injected antigen OR to show that the injection did not increase the number of all B cells;	**1** (1 × AO3)	**Ignore** 'for comparison' unqualified

Question	Marking guidance	Mark	Comments
04.1	1. P: variable region OR antigen-binding site; 2. Q: disulfide bridge;	**2** (2 × AO1)	**Reject** active site for P **Ignore** light chain/heavy chain for P **Accept** disulfide bond/sulfur bridge for Q **Reject** hydrogen bond/peptide bond for Q

Question	Marking guidance	Mark	Comments
04.2	1. Each fragment has an antigen-binding site/variable region that is complementary to the antigen, so it forms antigen–antibody complexes; 2. Agglutination needs one antibody to bind to antigens on two (different) bacteria at the same time, linking/clumping them together; 3. A fragment has only one binding site, so it cannot link two bacteria together;	**2 max** (2 × AO2)	2 and 3. **Accept** a whole antibody has two binding sites, so it can join two bacteria **Reject** active site **Reject** clotting/clots for agglutination

Question	Marking guidance	Mark	Comments
04.3	They stimulate B cells to divide by mitosis;	**1** (1 × AO1)	

Vaccines, and active and passive immunity 3.2.4

Question	Marking guidance	Mark	Comments
05.1	1. Dose 1 causes a primary response: few B cells are complementary to the antigen, so clonal selection/division takes time; 2. Memory cells are made after dose 1; 3. After dose 2, memory cells recognise the antigen and divide rapidly into plasma cells; 4. More plasma cells, so more antibody is released (faster) OR a faster/larger rise after dose 2, eg 380 compared with 40 (arbitrary units);	**3 max** (1 × AO1) (2 × AO2)	Description of the data alone gains no credit; the data are credited only as part of point 4 **Accept** secondary response for point 3 only if memory cells are also mentioned **Ignore** memory cells produce antibodies

Question	Marking guidance	Mark	Comments
05.2	9.5;	**1** (1 × AO2)	Plotted values: 380 (week 9) and 40 (week 4) **Accept** answers in the range 9.2 to 9.8 **Accept** 9.5 : 1

Question	Marking guidance	Mark	Comments
05.3	A baby taking in antibodies in its mother's milk;	**1** (1 × AO1)	

Question	Marking guidance	Mark	Comments
05.4	1. Antibodies bind to/are complementary to the virus (antigen) at once OR no time lag for clonal selection/plasma cells to form; 2. Antibodies are (proteins that are) broken down/hydrolysed (over time); 3. No memory cells are made OR no B cells are stimulated; 4. So the antibodies are not replaced OR there is no secondary response if the virus enters later;	**3 max** (2 × AO1) (1 × AO2)	1. **Accept** a primary response is not needed **Ignore** antibodies are 'used up' **Reject** antibodies are killed/die

Question	Marking guidance	Mark	Comments
06.1	Correct answer of 88.9 (%) for 2 marks;; Accept for 1 mark, 360 OR 45 ÷ 405 = 0.111/11.1%	**2** (2 × AO2)	**Accept** 88.89 or 89 (%) **Reject** a percentage increase

Question	Marking guidance	Mark	Comments
06.2	1. For: far fewer people in the vaccine group developed the disease (45 compared with 405/about 89% reduction); 2. For: fewer admitted to hospital (2 compared with 36), so the vaccine reduces severe disease; 3. For: large sample (30 000) OR random allocation OR placebo/control group OR double-blind trial, so results are more likely to be valid; 4. For: serious medical problems were similar in both groups (4 and 3), so the vaccine appears safe; 5. Against: no one over 60 was in the trial, so older people may respond differently/less well to the vaccine OR may have more side effects; 6. Against: fever was much more common after the vaccine (1 950 compared with 270), which could be more harmful to older people; 7. Against: volunteers were followed for only 6 months, so the length of protection is not known OR boosters may be needed; 8. Against: no data on deaths, so it is not known whether the vaccine prevents death (in the over-70s);	**5 max** (5 × AO3)	**Max 3** if only points for, or only points against, are given **Accept**, as an alternative point against, virus R may mutate/show antigen variability, so the vaccine may become less effective **Ignore** 'no statistical test' and 'no repeats' unqualified **Ignore** sample size unless the number of volunteers is used **Reject** the vaccine contains antibodies

Question	Marking guidance	Mark	Comments
06.3	1. As the percentage vaccinated increases, cases in unvaccinated people fall, eg from 820 at 15% to 20 at 92%; 2. Fewer people can be infected/carry the virus, so there is less spread/transmission OR unvaccinated people are less likely to come into contact with an infected person;	**2** (1 × AO2) (1 × AO3)	2. **Accept** herd immunity only if it is linked to reduced spread/transmission **Reject** unvaccinated people become immune

HIV and AIDS 3.2.4

Question	Marking guidance	Mark	Comments
07.1	1. X: reverse transcriptase makes DNA from/using the (viral) RNA (as a template); 2. Y: (viral) DNA is transcribed to make (HIV) mRNA; 3. Z: (HIV) mRNA is translated (by the cell's ribosomes) to make viral proteins, eg capsid/attachment proteins/reverse transcriptase;	**3** (3 × AO1)	X. Reject mRNA or messenger RNA for the viral RNA Z. Accept polypeptides for proteins **Reject** viral cells **Ignore** 'uses the cell's machinery' unqualified

Question	Marking guidance	Mark	Comments
07.2	1. Attachment protein (of HIV) binds to/is complementary to a receptor (protein) on the helper T cell (membrane); 2. B cells and red blood cells do not have this receptor, so HIV cannot attach to them/enter them;	**2** (1 × AO1) (1 × AO2)	1. **Reject** active site 2. **Accept** red blood cells have no nucleus/DNA for viral DNA to be inserted into, for red blood cells only **Reject** HIV kills B cells/red blood cells

Question	Marking guidance	Mark	Comments
07.3	Correct answer of 8.0×10^4 (particles per cm^3 per day) for 2 marks;; Accept for 1 mark, 48×10^4 OR 4.8×10^5 (increase) OR 80 000 (answer not in standard form)	**2** (2 × AO2)	Plotted values: 2×10^4 at day 2 and 50×10^4 at day 8 **Accept** answers in the range 7.7×10^4 to 8.3×10^4 from readings to within one small square **Reject** 8.0e4 or 8.0 E4 for standard form

Question	Marking guidance	Mark	Comments
07.4	1. Drug K stops reverse transcriptase making DNA from the viral RNA; 2. Day 0: so no viral DNA is inserted into the helper T cells, so no viral mRNA/proteins and no new HIV particles are made; 3. Day 4: cells infected before day 4 already have viral DNA in their DNA/genome; 4. This viral DNA is transcribed and translated without reverse transcriptase, so these cells continue to release HIV particles (so the number still rises after day 4); 5. The new particles cannot establish infection in other cells, so the number levels off (at 24×10^4)/is lower than with no drug;	**4 max** (4 × AO2)	Description of the results alone gains no credit; the data are credited only as part of point 5 5. **Accept** infected cells die/stop producing particles and no new cells are infected **Reject** drug K kills HIV/the virus **Reject** drug K is an antibiotic

Question	Marking guidance	Mark	Comments
07.5	HIV kills helper T cells, so fewer B cells and cytotoxic T cells are stimulated;	**1** (1 × AO1)	

Question	Marking guidance	Mark	Comments
07.6	1. Antibiotics act on structures/enzymes/processes found in bacteria, eg (murein) cell wall formation OR bacterial ribosomes; 2. HIV has no cell wall/murein OR has no ribosomes/metabolism of its own OR uses the host cell's enzymes/ribosomes;	**2** (2 × AO1)	**Accept** peptidoglycan for murein **Reject** HIV has a cell wall/cell membrane **Ignore** viruses are not living **Ignore** viruses hide inside cells **Reject** antibodies for antibiotics

Monoclonal antibodies and the ELISA test 3.2.4

Question	Marking guidance	Mark	Comments
08.1	1. Antigen-binding site/variable region of the antibody is complementary to protein T OR antibody binds to protein T forming antigen–antibody complexes; 2. Protein T is (mainly) on (the surface of) cancer cells, so the antibody and radioactive substance bind (mostly) to (cancer cells in) tumours; 3. Monoclonal antibodies are all identical/have the same binding site, so all bind to protein T;	**2 max** (2 × AO2)	**Reject** active site **Reject** antibody is the same shape as protein T

Question	Marking guidance	Mark	Comments
08.2	5.0 : 1;	**1** (1 × AO2)	**Accept** 5 : 1 OR 5.0 OR 5 **Reject** 1 : 5 OR 0.2

Question	Marking guidance	Mark	Comments
08.3	1. At 2 hours, radioactivity in the blood is (much) higher than in the tumour (18.5 compared with 3.2) OR most antibody is still in the blood/not yet bound; 2. At 48 hours, the tumour has much more radioactivity than the blood and every other tissue (12.0 compared with 3.6 or less), so the tumour shows up clearly;	**2** (2 × AO3)	2. **Accept** unbound antibody has been removed from the blood, so the tumour is easier to tell apart from other tissues

Question	Marking guidance	Mark	Comments
08.4	1. Kidney cells have (some) protein T on their surface OR the kidney has the highest radioactivity of the healthy tissues at 48 hours (3.6); 2. So the antibody (and drug) binds to/collects in kidney cells, and the drug kills/damages healthy kidney cells;	**2** (2 × AO2)	1. **Accept** the antibody–drug (or its breakdown products) is removed from the blood by/passes through the kidneys **Reject** the antibody kills the kidney cells unless the drug is mentioned

Question	Marking guidance	Mark	Comments
08.5	1. For: the antibody can find/diagnose/treat cancer (earlier), so saves human lives/reduces suffering; 2. Against: mice are killed OR mice may suffer/be harmed (by the injections/being kept in laboratories) OR mice cannot give consent;	**2** (1 × AO2) (1 × AO3)	**Ignore** 'uses animals' unqualified for the argument against **Ignore** cost

Question	Marking guidance	Mark	Comments
09.1	1. Add (the same volume of) serum from each cow to a separate well; 2. Antibodies against virus W are complementary to/bind to protein A (the antigen); 3. Wash the well to remove unbound antibodies/proteins; 4. Add the enzyme-linked second antibody, which binds to the cow antibody (bound to protein A); 5. Wash (again) to remove unbound enzyme-linked second antibody; 6. Add the substrate: a blue colour shows the cow has antibodies against virus W OR no colour change shows it has none; 7. Negative control: serum from a cow known not to have antibodies/never exposed to virus W OR a well with no serum; 8. Positive control: serum known to contain antibodies against virus W; 9. Keep volumes/times/temperature the same for every well OR measure the colour with a colorimeter;	**6 max** (3 × AO1) (3 × AO3)	**Max 4** unless at least one control (point 7 or 8) is given 3 and 5. 'Wash between each stage' alone gains only one of these points 6. **Accept** the enzyme converts the substrate to a coloured product **Accept** E-S complex / ES complex. E-S alone only if 'enzyme-substrate complex' is written elsewhere. Ignore ESC. **Reject** the test detects the virus/antigen in the cow's blood (it detects antibody)

Question	Marking guidance	Mark	Comments
09.2	1. Cow 2; 2. Has antibody against protein A (1.35, above 0.30), because the vaccine contains protein A; 3. Has no antibody against protein C (0.08, below 0.30), so it has never met the whole virus OR infected cows make antibodies against both proteins A and C;	**3** (1 × AO2) (2 × AO3)	Do not award points 2 and 3 if a different cow is identified

Question	Marking guidance	Mark	Comments
09.3	Infection with the (whole) virus also leads to antibody against protein A, so its antibody against protein A could come from infection or from vaccination;	**1** (1 × AO3)	**Accept** cow 4 has antibodies against both proteins, so it has been infected, and infection alone gives antibody against protein A

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