Antibodies and Vaccination (11.2): Cambridge (CIE) A Level Biology 9700 Exam Questions by Topic

22 questions · 47 marks · about 56 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · Paper 2 · May/June 2024 (21) · Q6(a)(i) · 2 marks

6 Antibodies are produced by plasma cells.

Fig. 6.1 shows antigens bound to antigen-binding sites of an antibody molecule.

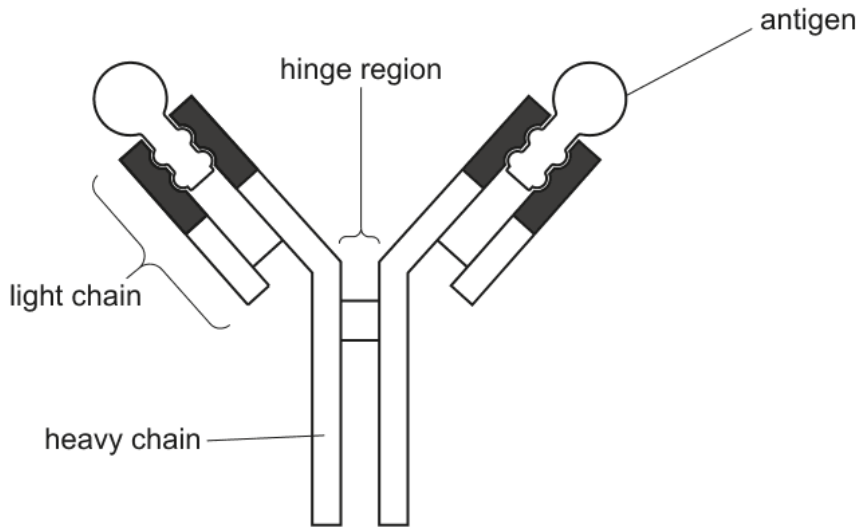


Fig. 6.1

(a) (i) Explain how the structure of an antigen-binding site makes it specific to a particular antigen, as shown in Fig. 6.1.

.....

.....

.....

.....

Question 2 · Paper 2 · May/June 2024 (21) · Q6(a)(ii) · 1 mark

(ii) State the function of the hinge region of the antibody shown in Fig. 6.1.

Question 3 · information from earlier in the question

4 Tuberculosis (TB), influenza and polio are examples of infectious diseases.

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 3 · Paper 2 · February/March 2023 (22) · Q4(c) · 3 marks

(c) The influenza virus can mutate frequently to produce different strains of the virus. A new vaccine is often necessary to stimulate the production of new antibodies to these new strains.

Explain why different antibodies need to be produced to give immunity to these new strains.

.....

.....

.....

.....

.....

.....

Question 4 · Paper 2 · October/November 2025 (22) · Q2(c)(ii) · 3 marks

(ii) The production of monoclonal antibodies for treatment involves the formation of hybridoma cells from two different cell types.

Name the **two** types of cell that fuse to form a hybridoma cell **and** explain why this fusion is necessary.

.....

.....

.....

.....

.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 5 · information from earlier in the question

6 Fig. 6.1 is a simplified diagram representing a section through the human immunodeficiency virus (HIV) particle that causes HIV/AIDS. The diagram shows the virus particle about to attach to the cell surface membrane of a T-helper cell at a receptor protein called CD4. A second protein (coreceptor) called CCR5 is also necessary for the virus particle to enter and then infect the T-helper cell.

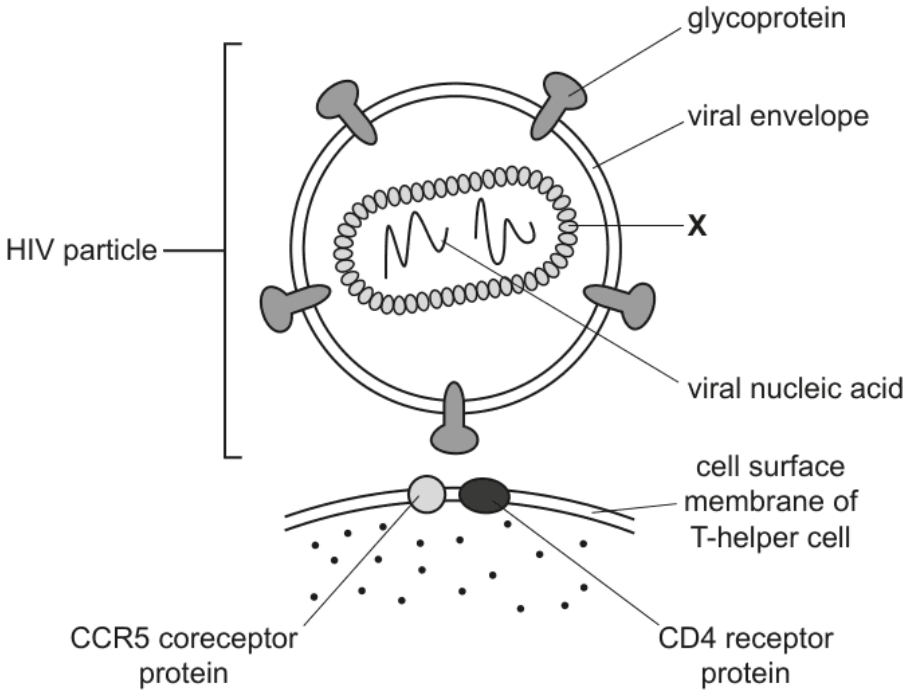


Fig. 6.1

Question 5 · Paper 2 · February/March 2024 (22) · Q6(d) · 3 marks

(d) The use of monoclonal antibodies against the CCR5 coreceptor protein (anti-CCR5) has been shown to be effective in the treatment of HIV infection.

Outline how anti-CCR5 monoclonal antibodies can be synthesised in the laboratory using the hybridoma method.

.....

.....

.....

.....

.....

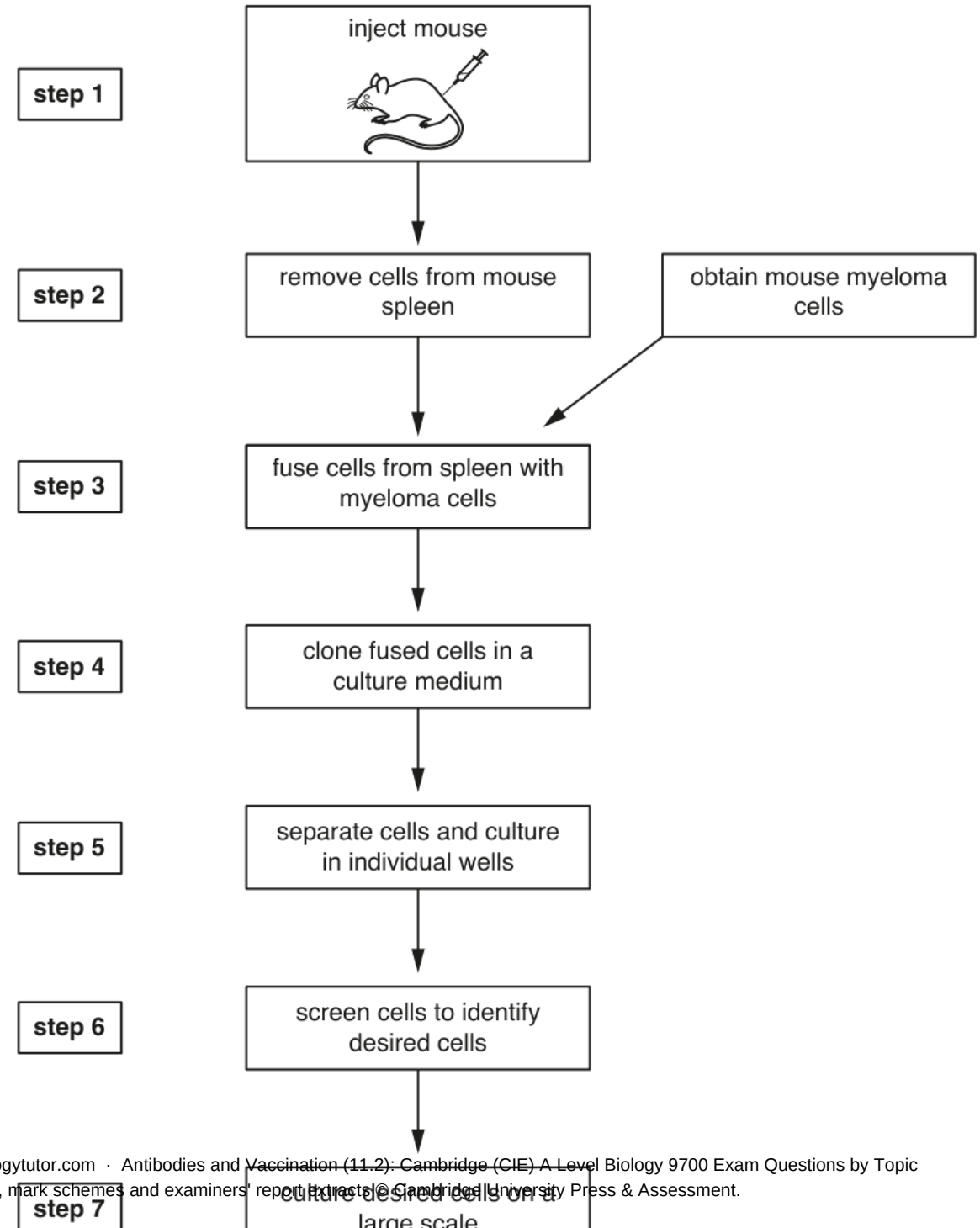
.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 4 continues on page 12

(c) In a person who has been infected with HIV-1, the most common strain of HIV, a sample of blood can be tested for the presence of the virus.
One test that can only be used in the early stages of infection involves a monoclonal antibody specific for p24, a structural protein present in the virus.

Fig. 4.2 is a flow chart outlining the steps in the production of anti-HIV p24 monoclonal antibody.



Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 7 · information from earlier in the question

4 Viruses share common structural features. Some viruses, such as human immunodeficiency virus (HIV), also have an outer envelope as part of their structure.

Question 7 · Paper 2 · October/November 2018 (22) · Q4(c)(ii) · 1 mark

(ii) Explain why several weeks, rather than several days, separates **step 1** and **step 2**.

.....

.....

Question 8 · Paper 2 · October/November 2018 (22) · Q4(c)(iii) · 1 mark

(iii) State **one** feature of the myeloma mouse cells, used in **step 3**, that is essential for this production process.

.....

.....

Question 9 · Paper 2 · October/November 2018 (22) · Q4(c)(iv) · 1 mark

(iv) Name the fused cells formed in **step 4**.

Question 10 · Paper 2 · October/November 2018 (22) · Q4(c)(v) · 1 mark

(v) Suggest why **step 6** is necessary.

.....

.....

Question 11 · information from earlier in the question

2 Cholera is a life-threatening and infectious disease caused by the bacterium *Vibrio cholerae*. One of the symptoms of the disease is severe diarrhoea.

V. cholerae O1 and *V. cholerae* O139 are the two forms of the pathogen that are associated with cholera epidemics (large outbreaks). These two forms have different antigens that can be detected.

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(b) Rapid diagnostic testing (RDT) can be used to diagnose cholera by detecting the presence of *V. cholerae*. One type of RDT involves using a dipstick that contains mobile and immobilised monoclonal antibodies.

Monoclonal antibodies (mAbs) are specific in their action.

Fig. 2.1 shows a simplified diagram of an RDT dipstick that can be used to distinguish between *V. cholerae* O1 and *V. cholerae* O139. A faecal sample from a person with suspected cholera is collected and added to a reagent solution to form the test mixture.

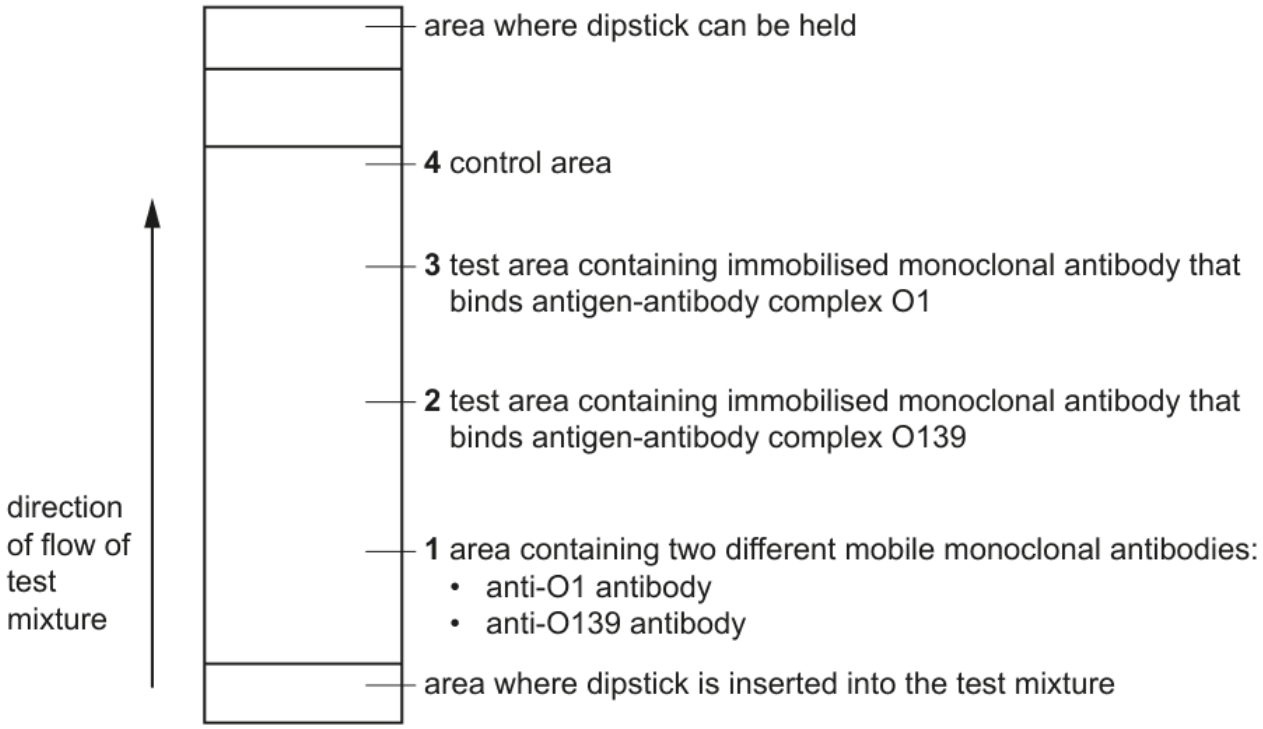


Fig. 2.1

The test mixture moves up the dipstick through area **1**. The mobile monoclonal antibodies are attached to tiny gold particles. If these antibodies collect in test area **2** or **3**, a coloured band becomes visible.

A coloured band that becomes visible in area **4** confirms that the test strip is working and that the results are valid.

(i) Explain how the structure of the monoclonal antibodies in the dipstick allows them to be specific in their action.

.....

.....

.....

.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(ii) Fig. 2.2 shows the results for samples taken from two different people, **A** and **B**, who are suspected of having cholera.

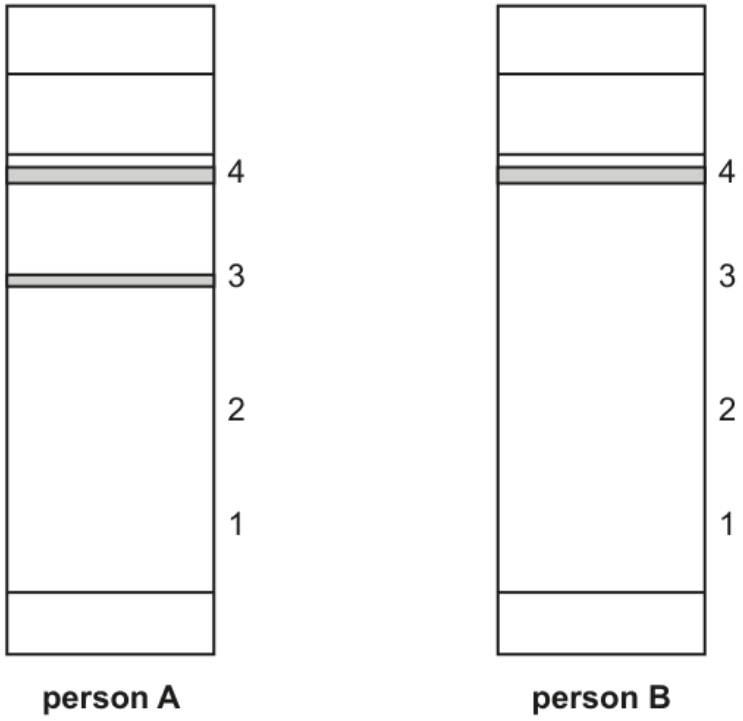


Fig. 2.2

With reference to Fig. 2.2, state **and** explain the conclusions that can be drawn from the results of the RDT dipsticks for each person.

.....

.....

.....

.....

.....

.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 13 · information from earlier in the question

6 Horseradish peroxidase (HRP) is an enzyme that can be extracted from the roots of the horseradish plant, *Armoracia rusticana*. HRP is used extensively in industry and technology.

In the reaction catalysed by HRP, hydrogen peroxide (H_2O_2) is used to oxidise an organic substrate. This is summarised in Fig. 6.1.

$$\text{organic substrate + hydrogen peroxide} \xrightarrow{\text{HRP}} \text{oxidised substrate + water}$$

Fig. 6.1

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(c) HRP is used in an immunological test known as a sandwich ELISA. One use of the test is to diagnose disease.

Fig. 6.3 outlines the main steps in a sandwich ELISA in which a toxin released by a pathogen is detected in a sample of body fluid taken from a person who is ill.

The test involves two types of monoclonal antibody that can bind to the toxin, a capture antibody and a detection antibody.

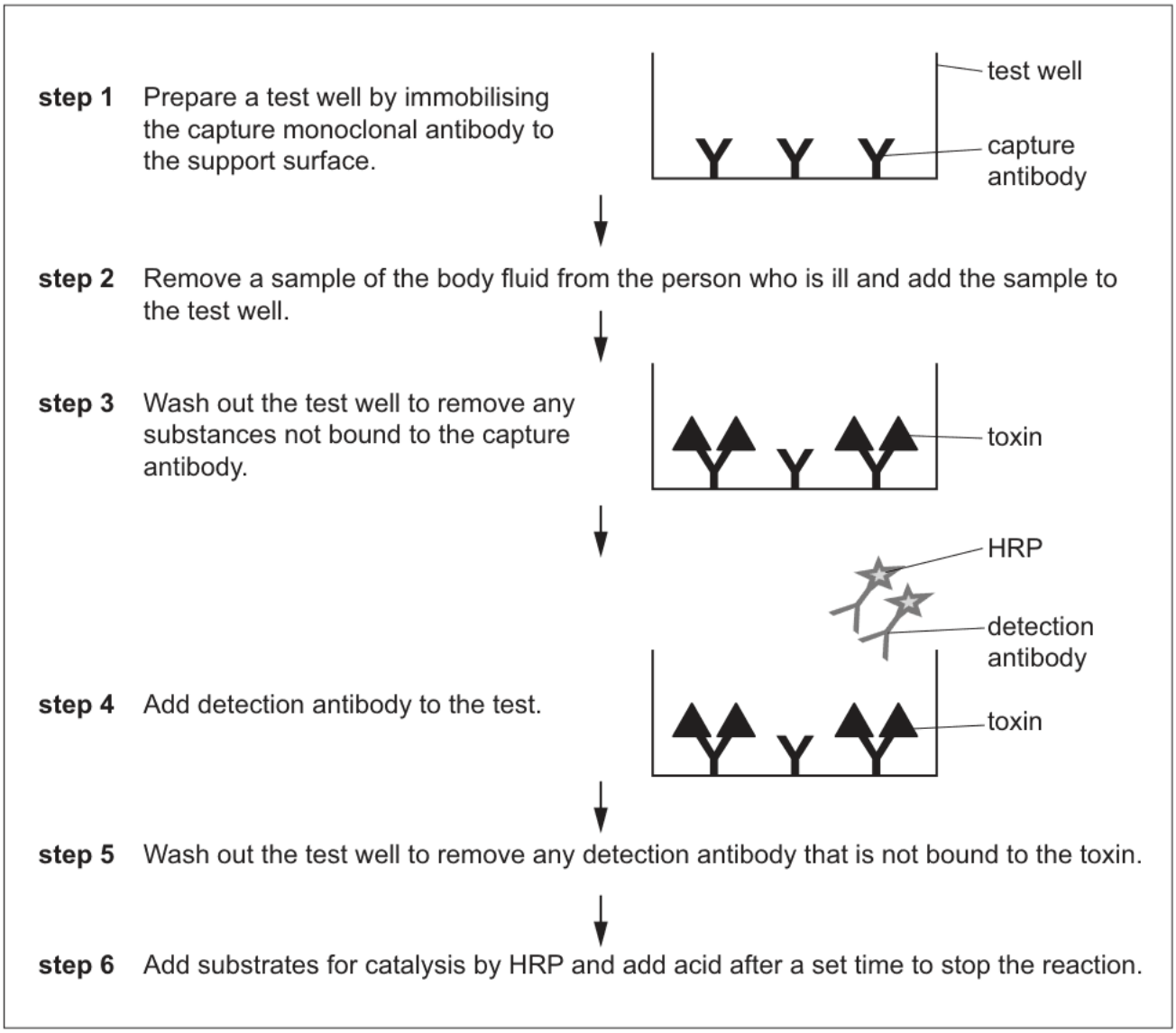


Fig. 6.3

(i) Complete Fig. 6.4 to show the situation in the test well after **step 5**.



Fig. 6.4

[1]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 14 · Paper 2 · May/June 2025 (22) · Q6(c)(ii) · 1 mark

(ii) With reference to Fig. 6.3, describe **one** difference between the capture antibody and the detection antibody.

.....

.....

.....

Question 15 · information from earlier in the question

6 Enzyme inhibitors and monoclonal antibodies can be used in the treatment of disease.

Question 15 · Paper 2 · May/June 2018 (22) · Q6(b) · 2 marks

(b) Outline the use of monoclonal antibodies in the treatment of disease.

.....

.....

.....

.....

Question 16 · information from earlier in the question

2 Cholera is an infectious intestinal disease caused by a bacterial pathogen.

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(c) Mass vaccination using an oral cholera vaccine (OCV) can be carried out in situations where there is a high risk of people developing the disease.

Passive immunisation involves transferring antibodies into a person for the prevention or treatment of an infectious disease. Some of the infectious diseases for which passive immunisation is available use monoclonal antibody. Passive immunisation for cholera using monoclonal antibody could be available in the future.

(i) Complete Table 2.1 to compare an OCV and passive immunisation for cholera:

- fill in the empty box in **row 1**
- circle the correct answers from the choices given in **rows 3**, **4** and **5**.

Table 2.1

row	feature	oral cholera vaccine	passive immunisation for cholera
1	component causing the desired response		antibody
2	type of immunity gained	artificial active	artificial passive
3	stimulates production of memory lymphocytes	yes / no	yes / no
4	length of time needed to have an effect	shorter same longer	longer same shorter
5	duration of immunity	shorter same longer	longer same shorter

[4]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 17 · Paper 2 · February/March 2025 (22) · Q4(b)(i) · 1 mark

(b) A second person was given a different injection to give protection against another infectious disease, infectious disease **F**. The person had **not** previously been infected with disease **F**.

The concentration in the blood of the antibody specific to disease **F** was measured over a period of 60 days from the time of the injection.

Fig. 4.2 shows the concentration of the antibody in the blood over the period of 60 days.

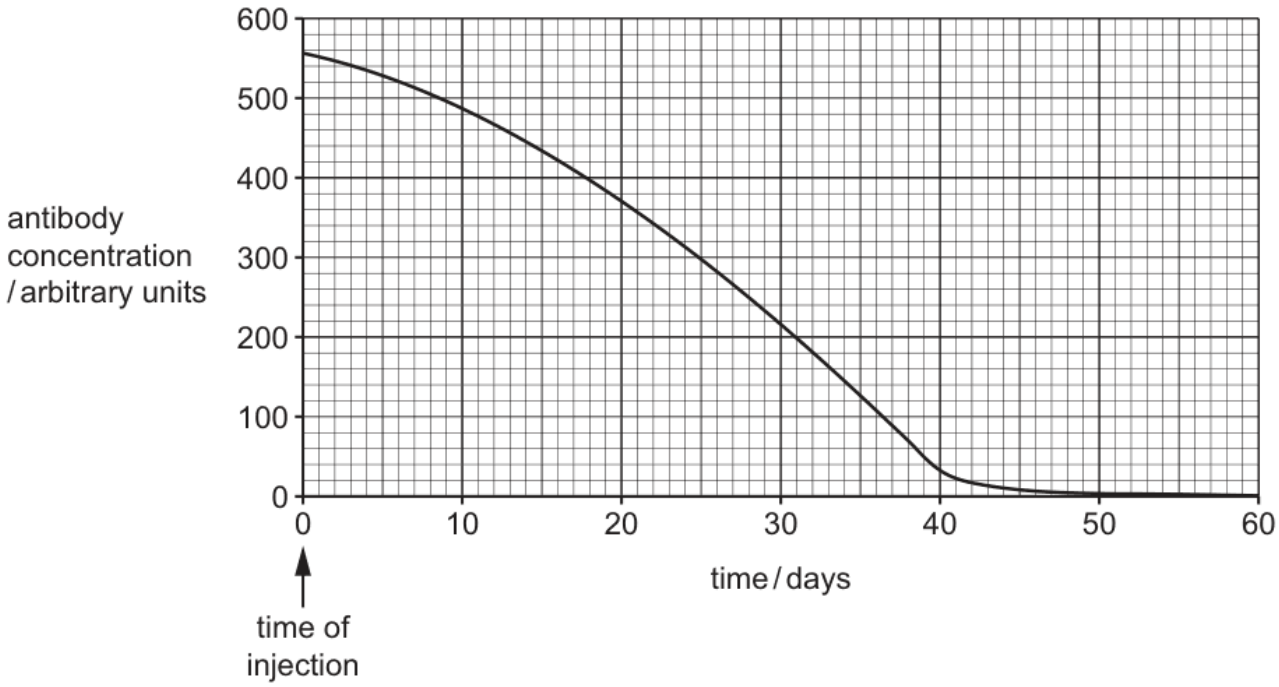


Fig. 4.2

(i) State the type of immunity that results from the injection given as protection against disease **F**.

Question 18 · Paper 2 · February/March 2025 (22) · Q4(b)(ii) · 2 marks

(ii) Describe features of the type of immunity resulting from the injection given as protection against disease **F**.

.....

.....

.....

.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 19 · Paper 2 · May/June 2024 (22) · Q2(c) · 4 marks

(c) Research has shown that vaccination programmes are cost effective and are very helpful in the prevention and control of TB. The programmes may be aimed at particular groups of people that are at a high risk of getting the disease, or they may be aimed at an entire population because the country has a high number of cases of TB.

The Bacillus Calmette-Guérin (BCG) vaccine is freeze-dried and contains live, weakened (attenuated) *Mycobacterium bovis*.

Apart from being cost effective, suggest **and** explain the advantages of using the BCG vaccine for the prevention and control of TB.

.....

.....

.....

.....

.....

.....

.....

Question 20 · Paper 2 · October/November 2016 (22) · Q5(c) · 3 marks

(c) Explain how vaccination can control infectious diseases.

.....

.....

.....

.....

.....

.....

Question 21 · information from earlier in the question

4 Tuberculosis (TB), influenza and polio are examples of infectious diseases.

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 21 · Paper 2 · February/March 2023 (22) · Q4(d)(i) · 3 marks

(d) Polio is a serious viral disease affecting young children. In 1996, polio caused paralysis in more than 75 000 children across Africa. A long-term vaccination programme allowed the World Health Organization (WHO) to declare that Africa was largely free of polio in 2020.

(i) Explain how vaccination programmes can help to control the spread of infectious diseases, such as polio.

.....

.....

.....

.....

.....

.....

Question 22 · Paper 2 · October/November 2019 (22) · Q5(e) · 4 marks

(e) After many years of intense research and development, WHO reported in 2016 that a pilot vaccination programme would be trialled between 2017 and 2020.

The programme uses a vaccine acting against the most widespread species of *Plasmodium*.

Explain the difficulties faced by researchers in developing a malaria vaccine.

.....

.....

.....

.....

.....

.....

.....

.....

.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Mark schemes

Question 1 · Paper 2 · May/June 2024 (21) · Q6(a)(i) · 2 marks

6(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**

Question 2 · Paper 2 · May/June 2024 (21) · Q6(a)(ii) · 1 mark

6(a)(ii)	*idea that* allows flexibility for binding (to antigens) ; **A** at different angles for flexibility / allows variable region(s) to move	**1**

Question 3 · Paper 2 · February/March 2023 (22) · Q4(c) · 3 marks

4(c)	*any **three** from:* 1 (as influenza virus mutates) antigen (proteins) altered / altered capsid proteins / AW ; 2 antibodies are specific to antigens ; 3 ref. to complementary shape (between variable regions of antibody and antigen) ; 4 ref. to variable regions / Fab, at the ends ;	**3**

Question 4 · Paper 2 · October/November 2025 (22) · Q2(c)(ii) · 3 marks

2(c)(ii)	B-lymphocyte / plasma cell / splenocyte, and, myeloma / tumour, cell ; **A** B-cell *for B-lymphocyte* **A** cancer cell *for myeloma cell* *plus **two** from:* (B-lymphocyte) synthesises (specific / desired) / AW, antibody ; **I** has the antibody (B-lymphocyte) cannot survive (for long) / dies, in culture ; (myeloma cell) can divide / can carry out mitosis / long-lived ; **I** rapidly / fast **A** plasma cell cannot divide **R** (hybridoma cell) divides uncontrollably	**3**

Question 5 · Paper 2 · February/March 2024 (22) · Q6(d) · 3 marks

6(d)	*any **three** from:* 1 (named) small mammal, injected / AW, with CCR5 ; **A** 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 / B-lymphocytes / B-cells, fused with, myeloma / tumour / cancer / AW, cells (to form hybridomas) ; 5 screening / selection / AW, for hybridomas producing desired, (monoclonal) antibodies ; 6 AVP ; e.g. hybridoma cells separated (into wells) to produce clones ref. to large scale production	**3**

Question 6 · Paper 2 · October/November 2018 (22) · Q4(c)(i) · 1 mark

4(c)(i)	(HIV) antigen / p24 ; **A** capsid protein / capsomere(s) / protein coat **R** HIV	**1**

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 7 · Paper 2 · October/November 2018 (22) · Q4(c)(ii) · 1 mark

4(c)(ii)	(time needed) so, <u>immune response</u> / 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**

Question 8 · Paper 2 · October/November 2018 (22) · Q4(c)(iii) · 1 mark

4(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**

Question 9 · Paper 2 · October/November 2018 (22) · Q4(c)(iv) · 1 mark

4(c)(iv)	<u>hybridoma</u> ;	1

Question 10 · Paper 2 · October/November 2018 (22) · Q4(c)(v) · 1 mark

4(c)(v)	*any one from* (check cells for) production / AW, (by hybridoma cells) of, anti-HIVp24 <u>antibody</u> / <u>antibody</u> against p24 ; **A** the antibody / monoclonal antibody **A** check cells, contain / have / AW, desired antibody / AW *idea that* only want cells that produce desired <u>antibody</u> / 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**

Question 11 · Paper 2 · May/June 2022 (22) · Q2(b)(i) · 2 marks

2(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) <u>antigen</u> (each mAb has) specific / different, tertiary structure / variable region(s) / primary structure / sequence of amino acids ; binding site and <u>antigen</u> have complementary shapes ;	**2**

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 12 · Paper 2 · May/June 2022 (22) · Q2(b)(ii) · 3 marks

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**

Question 13 · Paper 2 · May/June 2025 (22) · Q6(c)(i) · 1 mark

6(c)(i)	(each) detection antibody attached to a (different) toxin **;** *allow one antibody attached to two toxins (astride)* **A** at least one detection antibody attached **R** if one detection antibody attached directly to immobilised antibody **R** if unattached detection antibody shown	**1**

Question 14 · Paper 2 · May/June 2025 (22) · Q6(c)(ii) · 1 mark

6(c)(ii)	*any **one** from:* bind, to different, locations / sites / AW, on toxin **;** AW **A** bind different, epitopes / antigenic determinants detection antibody has, HRP / enzyme (attached) **; ora** *ignore similarity of both bind toxin to award if stated detection antibody has enzyme* capture antibody is immobilised **; ora**	1

Question 15 · Paper 2 · May/June 2018 (22) · Q6(b) · 2 marks

6(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**

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 16 · Paper 2 · October/November 2025 (22) · Q2(c)(i) · 4 marks

2(c)(i) — **4**

antigen is a standalone mark then move to rows 3,4,5

if no marks gained from rows 3,4,5, check for correct answers in these rows going down the column to award 1 mark

row	feature	oral cholera vaccine	passive immunisation for cholera
1	component causing the desired response	antigen(s) ; **I** weak / weakened / toxin **A** toxoid / inactivated toxin **R** dead antigen **A** weakened / attenuated / dead, pathogen / *V. cholerae*	antibody
2	type of immunity gained	artificial active	artificial passive
3	stimulates production of memory lymphocytes	(yes) / no	yes / (no);
4	length of time needed to have an effect	shorter same (longer)	longer same (shorter);
5	duration of immunity	shorter same (longer)	longer same (shorter);

Question 17 · Paper 2 · February/March 2025 (22) · Q4(b)(i) · 1 mark

4(b)(i)	passive **and** artificial ;	**1**

Question 18 · Paper 2 · February/March 2025 (22) · Q4(b)(ii) · 2 marks

4(b)(ii)	*any **two** from:* temporary / short term ; immediate effect ; involves injection of, antibodies immunoglobulin ; does not, stimulate the immune system / initiate a primary immune response ; AVP ; e.g. no memory cells produced no new antibodies made	**2**

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 19 · Paper 2 · May/June 2024 (22) · Q2(c) · 4 marks

2(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**

Question 20 · Paper 2 · October/November 2016 (22) · Q5(c) · 3 marks

(c) *three from*

1 vaccination, gives (active) immunity / stimulates an immune response ;
must be in context of active artificial immunity

2 detail ; e.g. primary immune response
clonal, selection / expansion (specific, B / T, lymphocytes)
formation of antibodies
formation of memory cells
artificial active (immunity)

3 secondary (immune) response, when, pathogen / antigen, present
or
presence of antigen / pathogen, gives, faster response / higher antibody production / AW ; **R** disease (for antigen / pathogen)

4 (effects of vaccination / immunity) long-lived / AW ;
A memory cells remain (in circulation) for a long time

5 herd effect ;

6 explained ; e.g. sufficient, (successfully) vaccinated / immune, so, susceptible / non-vaccinated, people protected

7 stops the transmission cycle ;
A less people with disease so reduces spread

8 AVP ; *ref. to* ring vaccination [3]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 21 · Paper 2 · February/March 2023 (22) · Q4(d)(i) · 3 marks

4(d)(i)	*for children, allow people* *for polio allow disease* *any **three** from:* 1 ref. to vaccination programme aims to vaccinate, whole populations / large numbers ; 2 vaccine allows (most), children / people, to have an immune response (against antigens of the disease organism) ; 3 develop, long-term immunity / artificial active immunity / memory cells against, polio / disease ; 4 *idea that* vaccinated individuals cannot, transmit virus / transmit polio / infect others ; 5 herd immunity / described ; 6 AVP ; e.g. ref. to vaccination programme aims to break the transmission cycle	**3**

Question 22 · Paper 2 · October/November 2019 (22) · Q5(e) · 4 marks

5(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**

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.