Helicate

HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.2.4 Cell recognition and the immune system

Topic question bank

Version 1 · 1 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
9	81	No time limit	/ 81

Contents

Subtopic	Questions	Marks
Cell recognition, antigens and phagocytosis Specification 3.2.4	01–02	18
The cellular and humoral responses Specification 3.2.4	03–04	13
Vaccines, and active and passive immunity Specification 3.2.4	05–06	17
HIV and AIDS Specification 3.2.4	07	14
Monoclonal antibodies and the ELISA test Specification 3.2.4	08–09	19
Total		**81**

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

Original questions by Helicate for AQA AS and A-level Biology (7401/7402), specification section 3.2.4. Not affiliated with or endorsed by AQA.

Do not write outside the box

Cell recognition, antigens and phagocytosis 3.2.4

0 1 . 1 The immune system identifies cells using specific molecules, such as proteins, on their surfaces. It can also identify toxins.
Which of the following would a person's immune system **not** normally respond to?
Tick (✓) one box.

[1 mark]

- A cancer cell in the person's own lung ☐
- A red blood cell from the person's own blood ☐
- A kidney cell in an organ transplanted from an unrelated donor ☐
- A toxin released by bacteria that have infected the person ☐

The bacterium that causes tuberculosis (TB) is engulfed by phagocytes, but it can survive inside them. After it has been engulfed, it releases a substance that stops lysosomes fusing with the phagosome that contains it.

0 1 . 2 Explain how this substance allows the bacterium to survive inside a phagocyte.

[3 marks]

Question 1 continues on the next page

Do not write outside the box

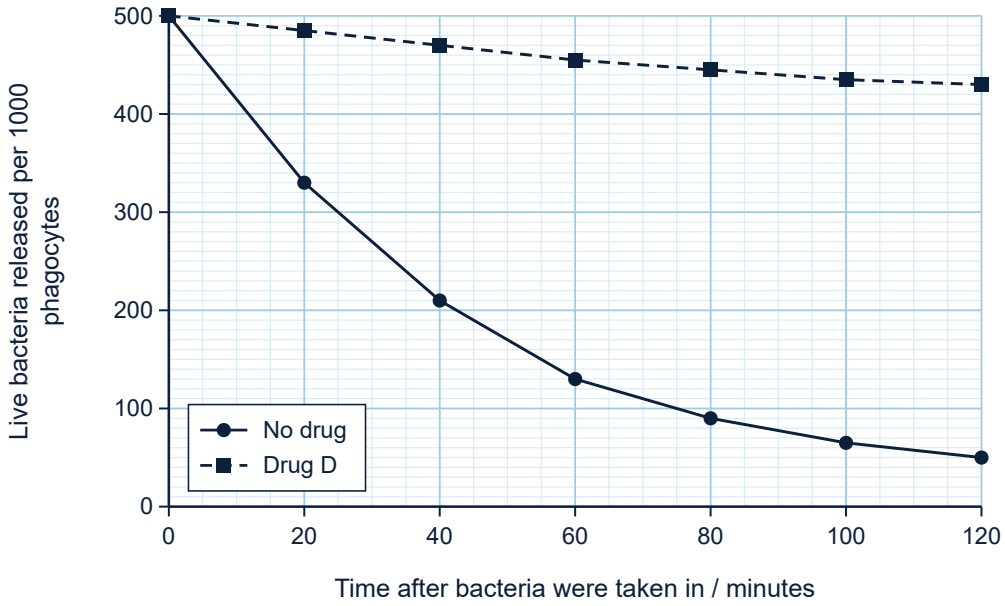
Inside a lysosome, the pH is normally about 4.5. This is the optimum pH of the enzymes in the lysosome. Drug D enters lysosomes and raises the pH inside them to about 6.5.

Scientists investigated the effect of drug D on the killing of bacteria by phagocytes. They:

- mixed phagocytes with live bacteria for 20 minutes, so that the phagocytes took in bacteria
- added an antibiotic that kills bacteria outside the phagocytes but cannot enter phagocytes, then washed the phagocytes
- divided the phagocytes into two groups, and added drug D to one group only
- at intervals, burst open a sample of phagocytes from each group and spread the released bacteria on agar plates
- counted the colonies after incubation. Each colony grew from one live bacterium.

Figure 1 shows their results.

Figure 1



0 1 . 3 Suggest why the scientists added an antibiotic that kills bacteria outside the phagocytes.

[1 mark]

.....

.....

.....

Question 1 continues on the next page

Do not write outside the box

0 1 . 4 Calculate the percentage of the bacteria taken in that were killed in 120 minutes by the phagocytes with no drug.

[2 marks]

Answer ..... **%**

0 1 . 5 Use Figure 1 and your knowledge of enzymes to explain the effect of drug D.

[3 marks]

The scientists also incubated the same bacteria with drug D but with no phagocytes. The number of live bacteria was the same as in bacteria incubated with no drug and no phagocytes.

0 1 . 6 Explain why this result is important when drawing a conclusion from Figure 1.

[2 marks]

12

Turn over for the next question

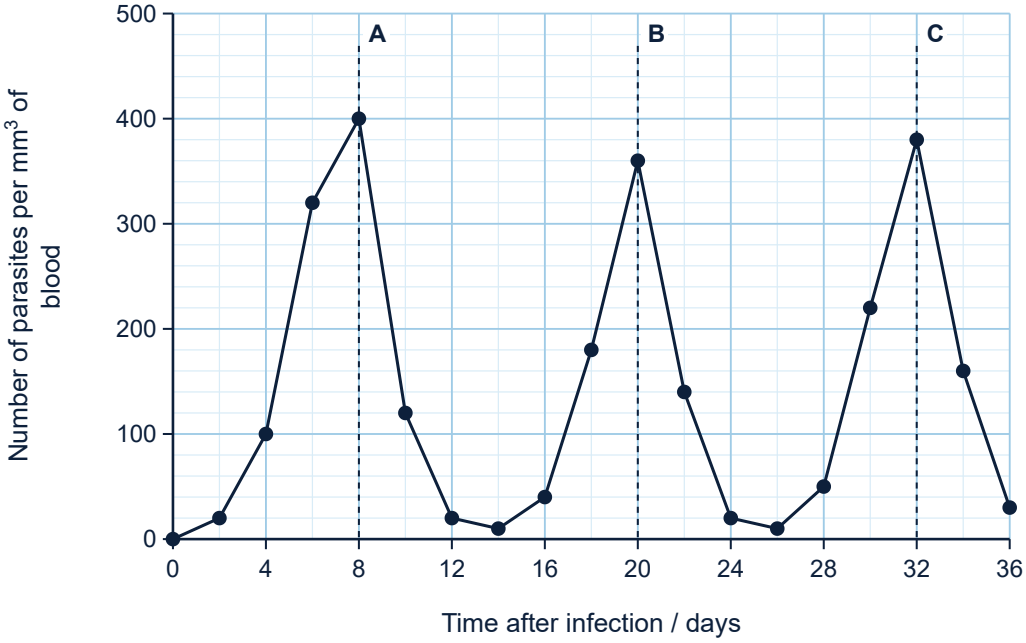
Do not write outside the box

Sleeping sickness is caused by a single-celled parasite that lives in human blood. The cell-surface membrane of each parasite is covered by many copies of one surface protein.

The parasite has genes for more than 1000 different versions of this surface protein, but each parasite uses only one version at a time. Now and then, a parasite switches to a different version, and its offspring then have the new version.

Figure 2 shows the number of parasites in the blood of one infected person. The letters **A**, **B** and **C** show which version of the surface protein most of the parasites had at each peak.

Figure 2



0 2 . 1 Give the meaning of the term *antigen*.

[1 mark]

Question 2 continues on the next page

Do not write outside the box

0 2 . 2 The person produced antibodies throughout the time shown in Figure 2.
Explain why the number of parasites increased again after day 14.

[3 marks]

0 2 . 3 Scientists suggested making a vaccine that contains version **A** of the surface protein.
Evaluate the use of this vaccine to protect people against sleeping sickness.

[2 marks]

6

Turn over for the next question

Do not write outside the box

The cellular and humoral responses 3.2.4

Scientists injected mice with protein X, which the mice had never met before. At intervals, they counted the B cells in a lymph node that had antibodies on their surface complementary to protein X.

They also counted the B cells with antibodies complementary to protein Y. Protein Y was not injected.

Table 1 shows their results.

Table 1

Time after injection / days	Mean number of B cells in a lymph node with antibody complementary to	
	Protein X	Protein Y
0	150	210
2	160	205
4	1 280	215
6	10 240	208
8	81 920	212

0 3 . 1 Between day 2 and day 8, the B cells complementary to protein X divided at a constant rate and none of them died.
Calculate the mean time, in hours, for one division of these B cells.

[2 marks]

.....

.....

.....

.....

Answer ..... **hours**

Question 3 continues on the next page

Do not write outside the box

0 3 . 2 Explain why the number of B cells complementary to protein X increased.

[3 marks]

0 3 . 3 Some of the cells in the clone become plasma cells and some become memory cells.
Describe the role of each type of cell.

[2 marks]

0 3 . 4 Suggest why the scientists also counted B cells complementary to protein Y.

[1 mark]

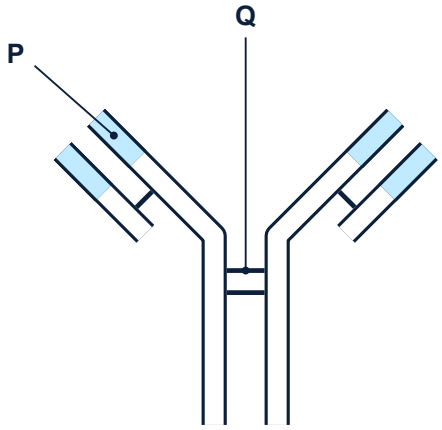
8

Turn over for the next question

Do not write outside the box

Figure 3 shows the structure of an antibody.

Figure 3



0 4 . 1 Name the parts labelled **P** and **Q** in Figure 3.

[2 marks]

P .....

Q .....

A protease enzyme hydrolyses each heavy chain of an antibody at the hinge region, just above the part labelled Q. This splits each antibody into three fragments: two identical fragments that each have one antigen-binding site, and one fragment that has no antigen-binding site.

Scientists added either whole antibodies or the antigen-binding fragments to separate suspensions of bacteria. The antibodies were complementary to an antigen on the bacteria. Both the whole antibodies and the fragments bound to the bacteria, but only the whole antibodies caused agglutination.

0 4 . 2 Explain why the fragments bound to the bacteria but did not cause agglutination.

[2 marks]

.....

.....

.....

.....

.....

Question 4 continues on the next page

Do not write outside the box

0 4 . 3 Which of the following is a role of helper T cells in the immune response?
Tick (✓) one box.

[1 mark]

They present antigens on their surface to phagocytes ☐

They release antibodies that are complementary to antigens ☐

They stimulate B cells to divide by mitosis ☐

They destroy body cells that have been infected by a virus ☐

5

Turn over for the next question

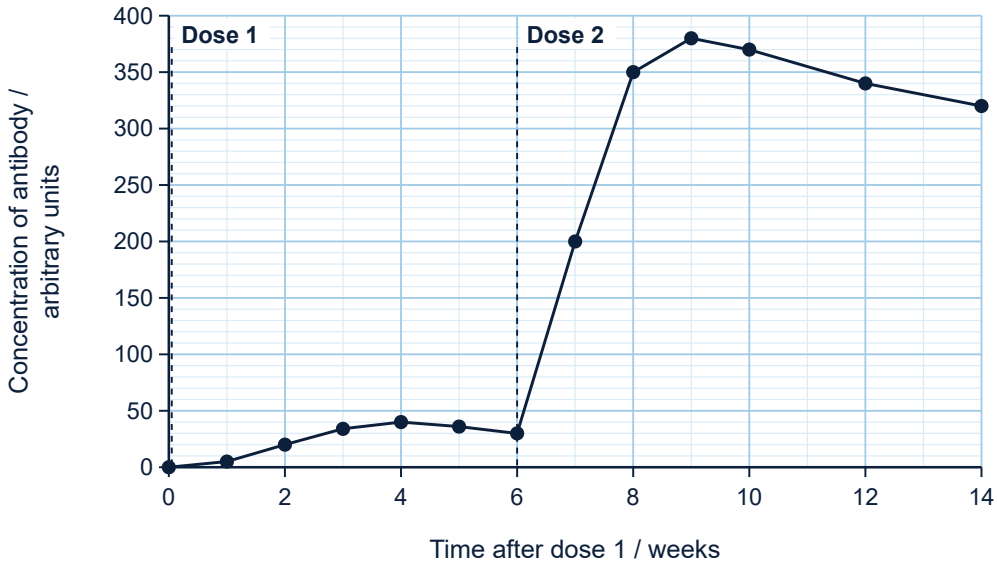
Do not write outside the box

Vaccines, and active and passive immunity 3.2.4

A new vaccine against virus R was tested on a group of volunteers. Each volunteer was given two doses of the vaccine: dose 1 at week 0 and dose 2 at week 6.

Figure 4 shows the mean concentration of antibody against virus R in the blood of the volunteers.

Figure 4



0 5 . 1 Use Figure 4 to explain the differences between the responses to dose 1 and dose 2.

[3 marks]

Question 5 continues on the next page

Do not write outside the box

0 5 . 2 Calculate how many times greater the highest concentration of antibody after dose 2 was than the highest concentration after dose 1.

[1 mark]

Answer .....

0 5 . 3 The vaccine gives active immunity.
Which of the following gives passive immunity?
Tick (✓) one box.

[1 mark]

An injection containing a harmless form of a virus ☐

A baby taking in antibodies in its mother's milk ☐

Recovering from an infection by a pathogen ☐

An injection containing an inactivated toxin ☐

People who have been exposed to virus R, but who have not been vaccinated, can be given an injection of antibodies against virus R.

0 5 . 4 Explain why the injected antibodies protect the person immediately, but protect them for only a few weeks.

[3 marks]

8

Turn over for the next question

Do not write outside the box

A vaccine against virus R was tested in a trial. The volunteers were aged 18 to 60 years. They were split at random into two equal groups:

- one group was given the vaccine
- the other group was given a placebo, an injection with no antigen.

Neither the volunteers nor the doctors knew who had been given which injection. The volunteers were followed for 6 months. Table 2 shows the results.

Table 2

	Vaccine group (15 000 people)	**Placebo group (15 000 people)**
Number of people who developed the disease	45	405
Number of people admitted to hospital with the disease	2	36
Number of people who had a fever within 2 days of the injection	1 950	270
Number of people who had a serious medical problem during the trial	4	3

0 6 . 1 Calculate the percentage reduction in the number of people who developed the disease in the vaccine group compared with the placebo group.

[2 marks]

Answer ..... **%**

Question 6 continues on the next page

Do not write outside the box

The vaccine is planned to be offered to everyone aged over 70. People in this age group are the most likely to die from the disease caused by virus R.

0 6 . 2 Evaluate whether the results of this trial support offering the vaccine to everyone aged over 70.

[5 marks]

Question 6 continues on the next page

Do not write outside the box

After the vaccine was introduced, scientists recorded the number of cases of the disease in people who had not been vaccinated, in five regions. Table 3 shows their results.

Table 3

Region	Percentage of people vaccinated	Number of cases per 100 000 unvaccinated people per year
1	15	820
2	40	640
3	60	390
4	80	140
5	92	20

0 6 . 3 Use Table 3 to explain how vaccination protects people who have not been vaccinated.

[2 marks]

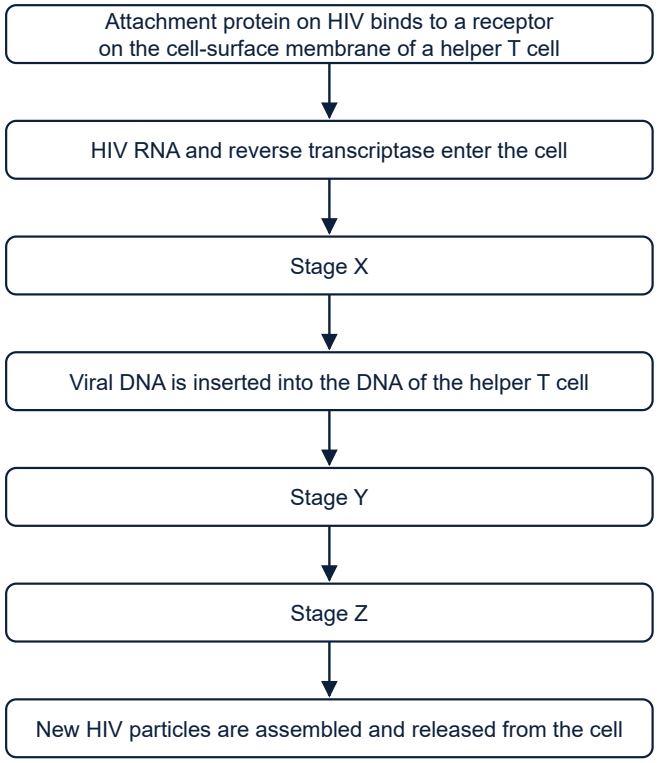
9

Turn over for the next question

HIV and AIDS 3.2.4

Figure 5 shows the stages in the replication of the human immunodeficiency virus (HIV) in a helper T cell. Three stages, **X**, **Y** and **Z**, have been left out.

Figure 5



0 7 . 1 Describe what happens at stages **X**, **Y** and **Z**.

[3 marks]

X .....

.....

Y .....

.....

Z .....

.....

Question 7 continues on the next page

Do not write outside the box

Scientists added HIV to separate cultures of three types of human cell. After 2 days, they found the percentage of cells in each culture that contained viral DNA. Table 4 shows their results.

Table 4

Type of cell	Percentage of cells containing viral DNA after 2 days
Helper T cells	34
B cells	0
Red blood cells	0

0 7 . 2 Explain why only the helper T cells contained viral DNA.

[2 marks]

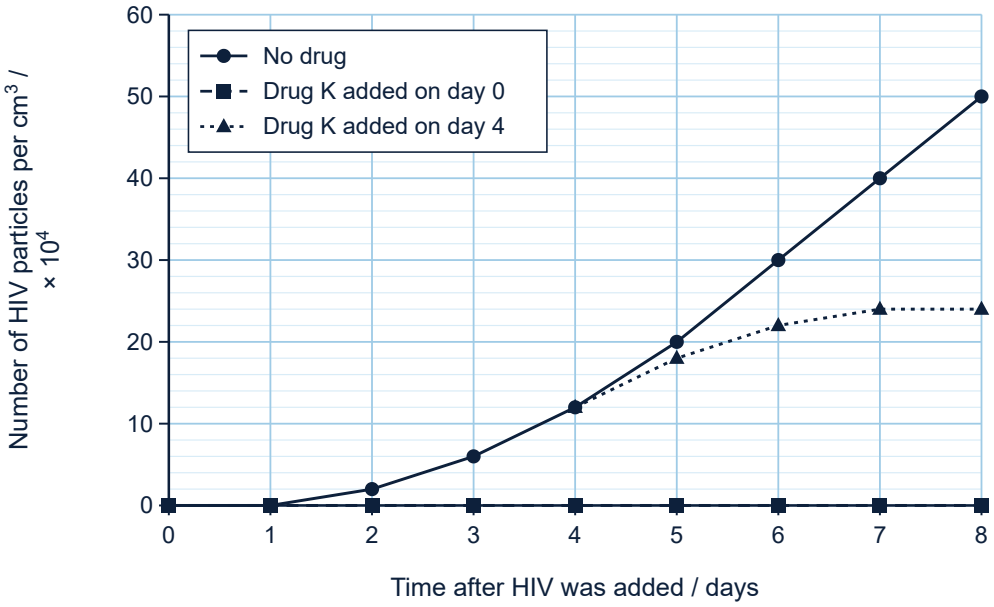
Question 7 continues on the next page

Do not write outside the box

The scientists then grew helper T cells in three cultures and added HIV to each culture on day 0. Drug K inhibits reverse transcriptase. They added drug K to one culture on day 0 and to another culture on day 4. The third culture had no drug.

They measured the number of HIV particles in the liquid around the cells. Figure 6 shows their results.

Figure 6



0 7 . 3 Calculate the mean rate of increase in the number of HIV particles per cm^3 between day 2 and day 8 in the culture with no drug. Give your answer in standard form.

[2 marks]

Answer ..... **particles per cm^3 per day**

Question 7 continues on the next page

Do not write outside the box

0 7 . 4 Use Figure 6 and your knowledge of HIV replication to explain the difference between the results when drug K was added on day 0 and when it was added on day 4.

[4 marks]

0 7 . 5 Which statement explains why people with AIDS develop infections that rarely cause disease in other people?
Tick (✓) one box.

[1 mark]

- HIV destroys the antibodies in the blood ☐
- HIV kills helper T cells, so fewer B cells and cytotoxic T cells are stimulated ☐
- HIV infects plasma cells, so they release viral proteins instead of antibodies ☐
- HIV damages red blood cells, so less oxygen reaches the tissues ☐

Question 7 continues on the next page

Do not write outside the box

0 7 . 6 A person with HIV was given an antibiotic to treat a bacterial infection of the lungs.
Explain why the antibiotic had no effect on HIV.

[2 marks]

14

Turn over for the next question

Do not write outside the box

Monoclonal antibodies and the ELISA test 3.2.4

Protein T is found in large amounts in the cell-surface membrane of prostate cancer cells. It is found in only very small amounts on a few types of healthy cell.

Tumours can be found by injecting a monoclonal antibody that is complementary to protein T. A radioactive substance is attached to each antibody. A scanner then shows where the radioactivity is in the body.

0 8 . 1 Explain why the radioactivity becomes concentrated in tumours.

[2 marks]

Question 8 continues on the next page

Do not write outside the box

Scientists tested the labelled antibody in mice with human prostate tumours. They measured the radioactivity in different tissues 2 hours and 48 hours after the injection. Table 5 shows their results.

Table 5

Tissue	Radioactivity / percentage of injected dose per gram of tissue	
	2 hours after injection	48 hours after injection
Tumour	3.2	12.0
Blood	18.5	2.4
Kidney	4.1	3.6
Liver	2.0	1.2
Muscle	0.6	0.3

0 8 . 2 Calculate the ratio of radioactivity in the tumour to radioactivity in the blood 48 hours after the injection.

[1 mark]

Answer .....

0 8 . 3 Use Table 5 to suggest why scans should be taken 48 hours after the injection, rather than 2 hours.

[2 marks]

Question 8 continues on the next page

Do not write outside the box

0 8 . 4 The same monoclonal antibody could be attached to a drug that kills cells, to treat prostate cancer.
Use Table 5 to suggest why this treatment might damage the kidneys.

[2 marks]

To make the monoclonal antibody, scientists injected mice with protein T. After several weeks, the mice were killed and B cells were removed from their spleens.

0 8 . 5 Give **one** ethical argument for, and **one** ethical argument against, making monoclonal antibodies in this way.

[2 marks]

For

Against

9

Turn over for the next question

Do not write outside the box

Virus W causes a disease in cattle. A farmer wants to know which cows in her herd have antibodies against virus W. A vet has:

- plastic plates with small wells, coated with protein A, an antigen from virus W
- a sample of blood serum from each cow
- a second antibody that binds to any cow antibody, with an enzyme attached to it
- a colourless substrate that the enzyme converts into a blue product
- a washing solution.

0 9 . 1 Describe how the vet could use these materials in an ELISA test to find out which cows have antibodies against virus W. Include suitable controls.

[6 marks]

Question 9 continues on the next page

Do not write outside the box

Some cows had been vaccinated against virus W. The vaccine contains only protein A.

The vet repeated the test using wells coated with protein C, a capsid protein of virus W. She used a colorimeter to measure the absorbance of the solution in each well. An absorbance of 0.30 or more shows that the serum contains antibody against the protein in the well. Table 6 shows the results for four cows.

Table 6

Cow	Absorbance	
	Well coated with protein A	Well coated with protein C
1	1.42	1.18
2	1.35	0.08
3	0.06	0.05
4	0.88	0.94

0 9 . 2 Which cow had been vaccinated but had never been infected with virus W? Explain your answer.

[3 marks]

0 9 . 3 Explain why these results cannot show whether cow 4 had been vaccinated.

[1 mark]

10

END OF QUESTIONS

Copyright © 2026 Helicate. All rights reserved.