

Cell recognition and the immune system

5 questions · 44 marks

Answer all questions. The marks available are shown against each part. Every question is taken unaltered from a past paper; the source is noted beneath it.

1. In Europe, viruses have infected a large number of frogs of different species. The viruses are closely related and all belong to the Ranavirus group. 8 marks

Previously, the viruses infected only one species of frog.

- 1 Suggest and explain how the viruses became able to infect other species of frog. [2 marks]

- 2 Name **two** techniques the scientists may have used when analysing viral DNA to determine that the viruses were closely related. [1 mark]

- 1
2

- 3 Determining the genome of the viruses could allow scientists to develop a vaccine. Explain how. [2 marks]

- 4 Describe how the B lymphocytes of a frog would respond to vaccination against Ranavirus. You can assume that the B lymphocytes of a frog respond in the same way as B lymphocytes of a human. Do **not** include details of the cellular response in your answer. [3 marks]

— AQA 7402/3 Biology · June 2020 · Paper 3, Question 3

2.

1

Describe the structure of the human immunodeficiency virus (HIV).

[4 marks]

8 marks

Some people infected with HIV do not develop AIDS. These people are called HIV controllers.

Scientists measured the number of HIV particles (the viral load) and the number of one type of T helper cell (CD4 cells) in the blood of a group of HIV controllers and also in a group of HIV positive patients who had symptoms of AIDS.

The median values and the range of their results are shown in **Table 3**.

Table 3

HIV status of people	Median viral load / virus particles per cm ³ of blood (range)	Median number of CD4 cells per mm ³ of blood (range)
HIV controllers	212 (<50 to 609)	693 (529 to 887)
HIV positive people with AIDS symptoms	66 274 (30 206 to 306 163)	248 (107 to 365)

2

A test sample of 500 mm³ of blood is taken from an HIV controller to determine the viral load.

Tick (✓) **one** box that shows the number of virus particles that would be present in a test sample of blood taken from an HIV controller with the median viral load.

[1 mark]

106 000

☐

10 600

☐

1060

☐

106

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3

Use the data in **Table 3** and your knowledge of the immune response to suggest why HIV controllers do not develop symptoms of AIDS.

[3 marks]

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[Extra space]

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— AQA 7402/1 Biology · June 2019 · Paper 1, Question 5

3. 1 Describe how the human immunodeficiency virus (HIV) is replicated **once inside** helper T cells (T_H cells). 9 marks
- [4 marks]**

HIV-1 is the most common type of HIV. HIV-1 binds to a receptor on T_H cells called CCR5.

Current treatment for HIV-1 involves the use of daily antiretroviral therapy (ART) to stop the virus being replicated. Only 59% of HIV-positive individuals have access to ART.

Scientists have found that two HIV-1-positive patients (**P** and **Q**) have gone into remission (have no detectable HIV-1). This happened after a blood stem cell transplant (BSCT).

- Patient **P** was given **two** BSCTs, and patient **Q** was given **one** BSCT.
- All BSCTs came from a donor with T_H cells **without** the CCR5 receptor.
- In addition, patient **P** had radiotherapy, and patient **Q** had chemotherapy. Both of these treatments are toxic.
- **Both** patients (**P** and **Q**) stopped receiving ART 16 months after BSCT.

18 months after stopping ART, **both** patients had **no** HIV-1 RNA in their plasma, **no** HIV-1 DNA in their T_H cells and **no** CCR5 on their T_H cells.

2

Use the information given to evaluate the use of BSCT to treat HIV infections.

[5 marks]

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— AQA 7402/3 Biology · 2021 · Paper 3, Question 2

4.

1

Some hospital patients suffer from diarrhoea caused by infection with the bacterium *Clostridium difficile*. The *C. difficile* bacteria release toxins. These toxins cause the diarrhoea.

9 marks

The toxins damage the cells lining the ileum, causing them to lose their microvilli. The damage to the cells reduces the absorption of the products of digestion and reduces the absorption of water, resulting in diarrhoea.

Explain why the damage to the cells lining the ileum reduces absorption of the products of digestion **and** why this reduces absorption of water.

[3 marks]

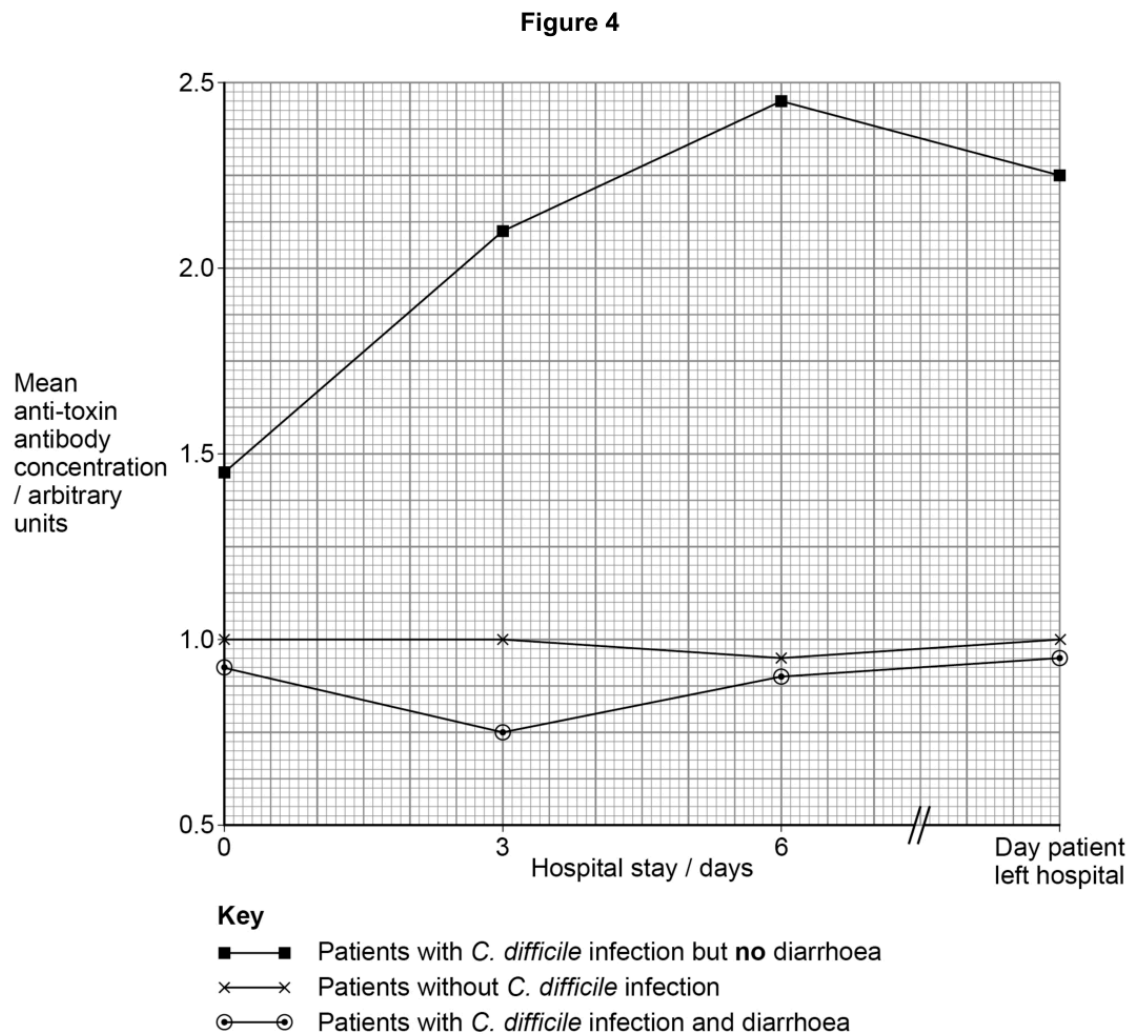
Not all patients in hospital with *C. difficile* develop diarrhoea.

Scientists measured the anti-toxin antibody concentration in hospital patients with and without *C. difficile* infection.

They measured the anti-toxin antibody concentration **four** times:

- on admission to hospital (day 0)
- on day 3
- on day 6
- on the day the patient left the hospital.

Figure 4 shows the scientists' results.



2

The scientists suggest that the anti-toxin antibody could be given to some patients as a form of passive immunity.

Use **Figure 4** to suggest how this passive immunity would work **and** which patients should be offered this anti-toxin antibody.

[3 marks]

3

To be used as passive immunity treatment, the anti-toxin antibody would be injected. If it was given by mouth, it would be digested.

Describe how the anti-toxin antibody would be digested.

[3 marks]

— AQA 7402/1 Biology · June 2023 · Paper 1, Question 4

5.

Scientists investigated the cell cycle in heart cells taken from mice 6 days before their birth and then at 4, 14 and 21 days after their birth.

10 marks

Their results are shown in **Table 4**. Age 0 days = day of birth.

Table 4

Age / days	Percentage of heart cells undergoing mitosis	Percentage of heart cells undergoing DNA replication
–6	13.9	8.5
4	8.5	2.6
14	1.6	0.2
21	0.6	0.0

1Describe and explain the data in **Table 4**.**[2 marks]****[Extra space]**

The scientists determined the percentage of heart cells undergoing DNA replication by using a chemical called BrdU. Cells use BrdU instead of nucleotides containing thymine during DNA replication.

2

Describe how BrdU would be incorporated into new DNA during semi-conservative replication.

[5 marks]

[3 marks]

[Extra space]
