

# 6.3 Defence Against Infectious Disease

## Question Paper

Course	DP IB Biology
Section	6. Human Physiology
Topic	6.3 Defence Against Infectious Disease
Difficulty	Hard

**Time allowed:** 50  
**Score:** /40  
**Percentage:** /100

### Question 1a

a)

Haemophilia B is a rare genetic disorder where the body produces very little or no factor IX, a protein that is responsible for a cascade of reactions resulting in the conversion of fibrinogen into fibrin.

Explain the effect of insufficient levels of factor IX on the process of blood clotting.

[2 marks]

[2 marks]

### Question 1b

b)

A person suffering from haemophilia B will be more prone to excessive bruising.

Based on the information provided, suggest a reason for this.

[1 mark]

[1 mark]

### Question 1c

c)

Haemophilia B cannot be cured but one form of treatment involves injecting patients with factor IX, which is derived either from donated blood or artificially produced using genetic engineering.

Explain the importance of determining the correct dosage of factor IX before injecting patients.

[2 marks]

[2 marks]

### Question 1d

d)  
In certain rare cases, the body may produce antibodies against factor IX that is injected during replacement therapy,  
Suggest **one** effect these antibodies may have on the treatment.

[1 mark]

[1 mark]

### Question 2a

a)  
Lupus is an autoimmune disease in which the immune system will produce autoantibodies against the body's own tissue.  
This results in a variety of symptoms, including inflammation of the skin and organs to more serious ones such as organ failure and strokes.

Compare and contrast an autoimmune response to the immune response against a pathogen.

[2 marks]

[2 marks]

### Question 2b

b)  
The symptoms of lupus can get progressively worse over time.

Based on your knowledge of lymphocytes, suggest a reason for this.

[2 marks]

[2 marks]

**Question 2c**

c)

There are a variety of ways to treat lupus. One form of treatment involves administering immunosuppressive drugs which prevents the activation of lymphocytes.

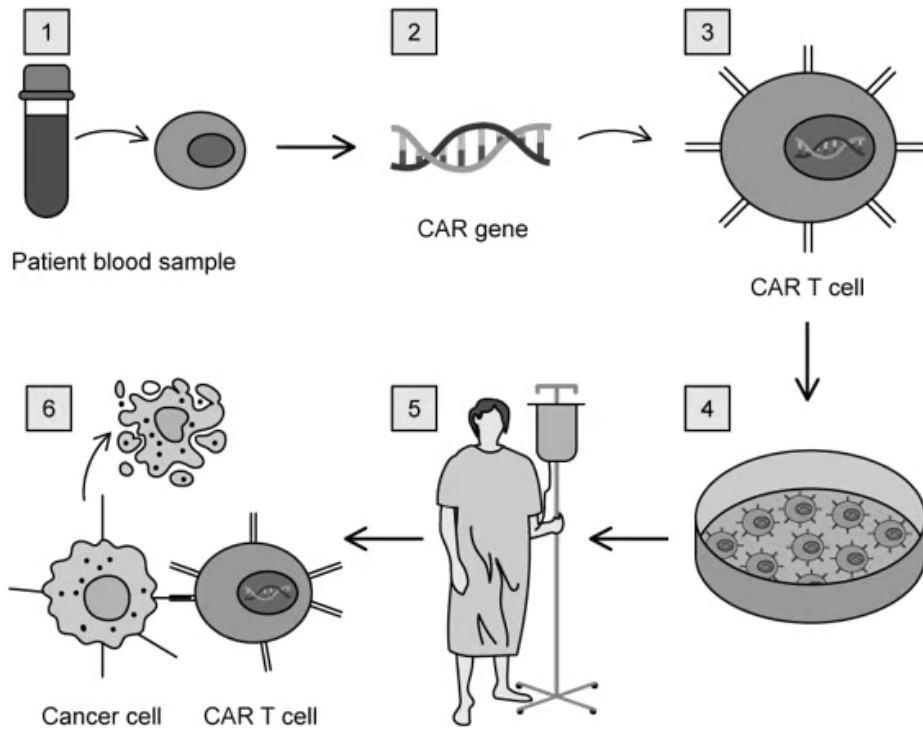
Explain the impact that this form of treatment could have on a lupus patient.

**[2 marks]****[2 marks]**

**Question 3a**

a)  
T-cells are another type of white blood cell that can help the body fight against infections. Instead of producing antibodies, T-cells will bind to the surface of infected or defective cells and destroy them directly. This ability has been harnessed in a new type of cancer treatment known as chimeric antigen receptor (CAR) T cell therapy.

During CART cell therapy, normal T cells from the patients blood are modified to enable them to bind to cancer cells with the help of cell surface receptors. The following diagram shows the treatment process of CART T cell therapy.



Contrast the differences between a normal T cell (stage 1 of the diagram) and a CART cell (stage 3 of the diagram).

[2 marks]

[2 marks]

**Question 3b**

b)  
Using the information in the diagram in part a), suggest how CART cell therapy facilitates in the treatment of certain cancers.

[2 marks]

[2 marks]

### Question 3c

c)

Traditional forms of cancer treatment include chemotherapy during which toxic chemicals are inserted into the blood stream of a patient. These chemicals will circulate through the body and kill any fast-dividing cells, which often leads to uncomfortable side effects such as hair loss, nausea and skin rashes. The chemicals used during chemotherapy are broken down by the body and therefore have a short-lived effect, requiring patients to receive multiple treatments on a regular basis in order to be effective.

Based on the information provided and your knowledge of the immune system, suggest **two** advantages of CART cell therapy over chemotherapy.

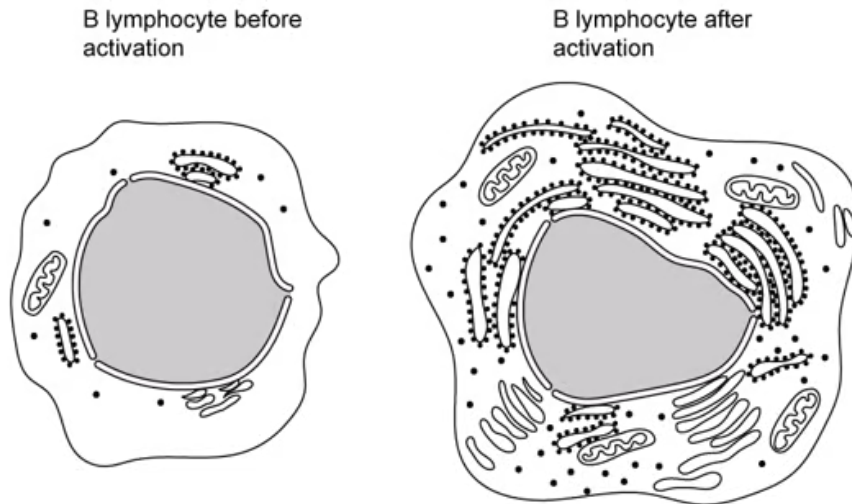
[2 marks]

[2 marks]

### Question 4a

a)  
B lymphocytes are a type of white blood cell. These lymphocytes produce antibodies in response to activation by the presence of an antigen on a pathogen.

The diagram below shows the appearance of a B lymphocyte before and after it has been activated.



Explain the changes that can be observed within the B lymphocyte when it is activated.

[3 marks]

[3 marks]

### Question 4b

b)  
Rituximab is a type of antibody that is used to treat certain B lymphocyte cancers (leukaemia). It binds to the cell surface protein CD20 found on B-lymphocytes. Once the antibody binds to the protein it triggers cell death in the cancerous B-lymphocyte. Patients are given rituximab through a drip into a vein on a regular basis for the duration of their cancer treatment.

Based on your knowledge of the immune system, explain why patients would need regular infusions with rituximab.

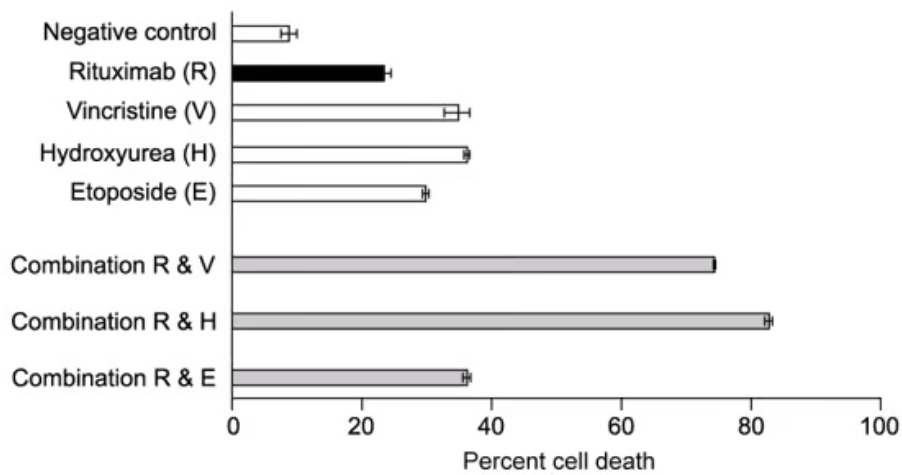
[2 marks]

[2 marks]

**Question 4c**

c)  
When treating more aggressive forms of B lymphocyte cancer, rituximab is often combined with more traditional chemotherapies.

The graph below shows the results of a trial looking at the effects of several different treatments, alone and in combination, on B lymphocytes grown in the laboratory.



Rituximab on its own killed 23% of the B lymphocytes while when combined with hydroxyurea it killed 82% of B-lymphocytes in the laboratory.

Calculate the percentage effectiveness of using rituximab in combination with hydroxyurea compared to rituximab on its own. Show your working and give your answer to three significant figures.

[2 marks]

[2 marks]



### Question 4d

d)

A medical doctor concluded that drug combinations are a more effective cancer treatment for human patients than any of the drugs used alone.

Use the information from part c) to evaluate this conclusion.

**[3 marks]**

**[3 marks]**

### Question 5a

*One mark is available for clarity of communication throughout this question.*

a)

Phagocytes and lymphocytes play an important role in the immune system of the body.

Compare and contrast the role of phagocytes and lymphocytes in the immune system.

**[5 marks]**

**[5 marks]**

**Question 5b**

b)

Certain species of bacteria may develop resistance to antibiotics over time.

Outline the development of antibiotic resistance in a bacterial population.

**[7 marks]****[7 marks]**