

11.1 Antibody Production & Vaccination

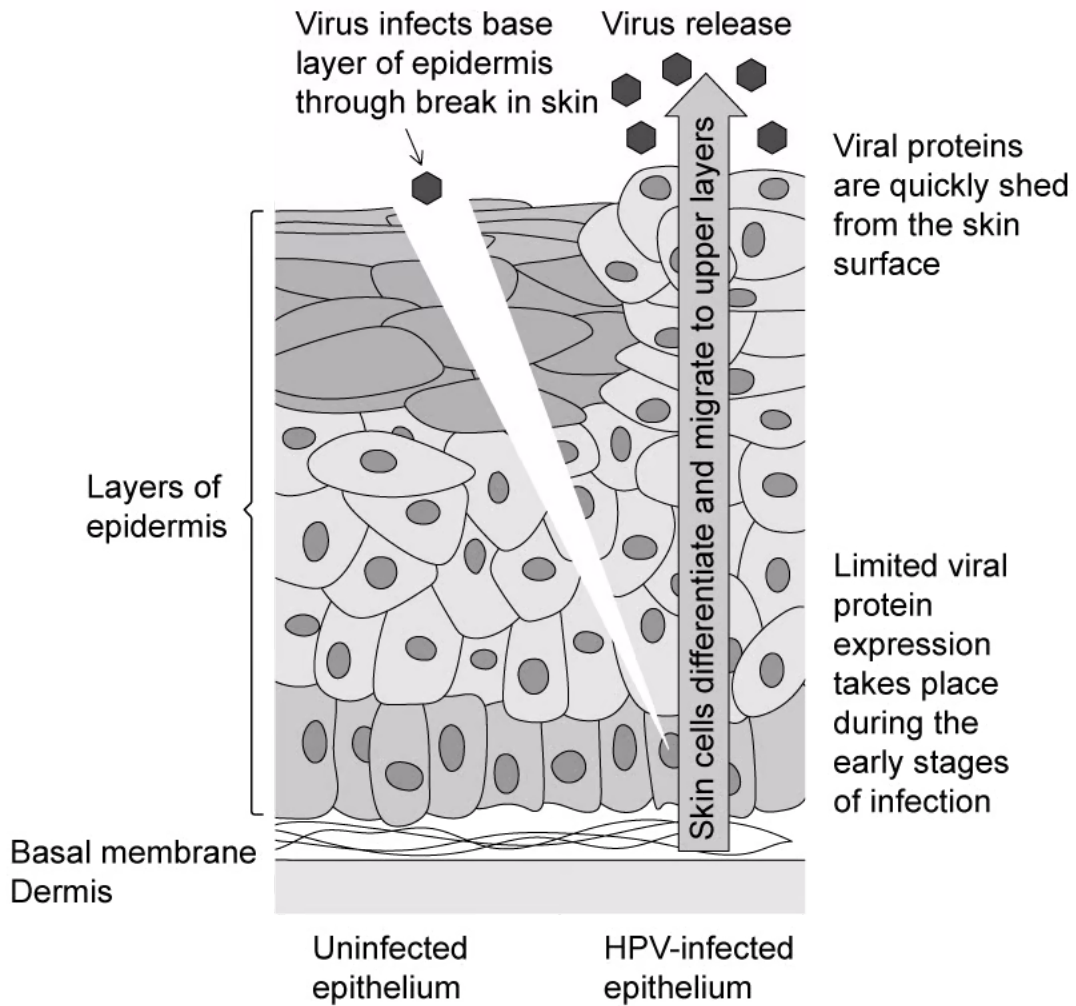
Question Paper

Course	DP IB Biology
Section	11. Animal Physiology (HL Only)
Topic	11.1 Antibody Production & Vaccination
Difficulty	Hard

Time allowed: 90
Score: /68
Percentage: /100

Question 1a

a)
The image shows the progress of infection when damaged human skin comes into contact with Human Papillomavirus, or HPV.



It can be 6–12 months before HPV antibodies can be detected in the blood of an individual with a HPV infection. Use the information in the image to suggest why this is.

[3 marks]

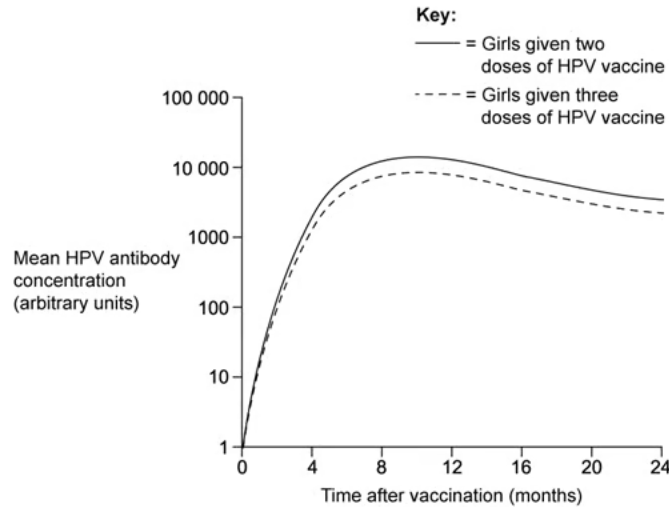
[3 marks]

Question 1b

b)

There is a vaccination for HPV which is routinely given to teenage girls, as it is thought to offer future protection against cervical cancer. The standard procedure is for each girl to receive three doses of the vaccine for full immunity, although there is some discussion about the optimum number of doses.

The graph below shows antibody production after different doses of HPV vaccine in teenage girls.



A student concluded from the data that it didn't matter whether girls were given two doses of vaccine or three. Evaluate this conclusion.

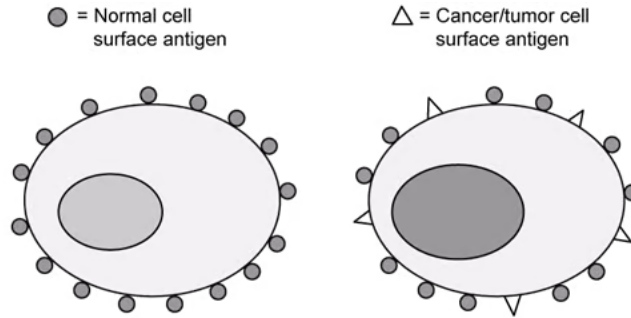
[3 marks]

[3 marks]

Question 1c

c)
HPV vaccines provide protection against cancer by preventing the virus from causing mutations in infected cells. Current medical advances in vaccine technology mean that researchers hope that it will soon be possible to vaccinate people against cancer cells themselves.

The image shows some of the changes that can take place when a cell becomes cancerous.



Use the image to suggest how a vaccine could be effective against the development of cancer.

[4 marks]

[4 marks]

Question 1d

d)

It is hoped that one day, cancer vaccinations may exist which prevent cancer rather than for treatment of cancer. Trials to test these new vaccines will be put through a rigorous development procedure as follows:

- I. Research and development stage using bioinformatics
- II. Non-clinical trials in the laboratory (testing efficacy and toxicity)
- III. Whole organism testing on animals (testing efficacy, toxicity and dosage)
- IV. Clinical trials on adult human volunteers

Compare and contrast these modern methods of vaccine development with those used by Edward Jenner in the development of the smallpox vaccine.

[Total: 4 marks]

[4 marks]

Question 1e

e)

Development of an Ethics Research Committee marks a key change in the procedures involved in the development of new drugs, including vaccines, however, there are still issues associated with the modern methods described in part **d**).

Suggest what ethical issues may be associated with these procedures.

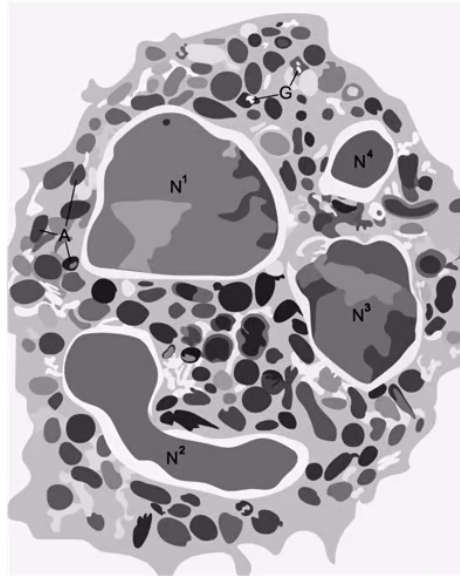
[2 marks]

[2 marks]

Question 2a

a)

This image shows a type of phagocyte called a neutrophil.



- **N1-N4:** multi-lobed nucleus
- **A:** Lysosomes
- **G:** glycogen granules

Use the image to explain how neutrophils are adapted for their role.

[3 marks]

[3 marks]

Question 2b

b)

When pathogens enter the body, phagocytes carry out a process called phagocytosis, which is a non-specific response.

Outline the process of phagocytosis and explain how it eventually leads to a specific immune response in the infected individual.

[5 marks]

[5 marks]

Question 2c

c)

Antigens associated with allergens such as pollen or food substances can trigger both specific and non-specific immune processes.

One such process is the release of histamines in response to activation of B-lymphocytes.

Justify, with a reason, which part of this process constitutes a specific immune response.

[2 marks]

[2 marks]

Question 2d

d)

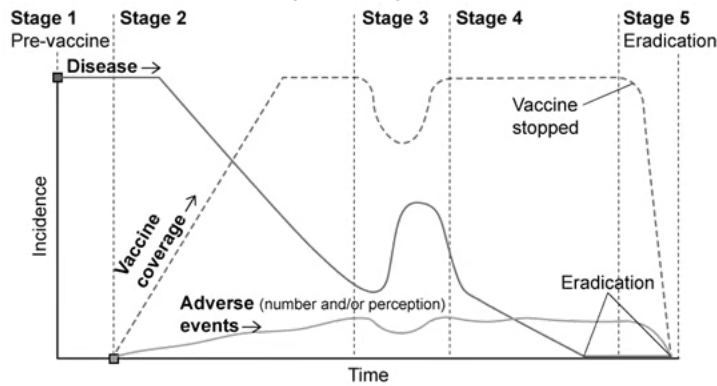
Explain how the histamines released during an allergic reaction may assist phagocytes in their role.

[2 marks]

[2 marks]

Question 3a

a)
The graph below shows the events that take place during the progression of a vaccination program



Suggest an explanation for the events seen in stage 3 of the vaccination program.

[4 marks]

[4 marks]

Question 3b

b)
Towards the end of **stage 4** in the graph from part **a**), the disease incidence drops to zero.

Explain what needs to happen within the vaccination programme to reach a disease incidence of zero.

[3 marks]

[3 marks]

Question 3c

c)

The table shows the herd immunity thresholds for several different diseases.

Disease	Herd Immunity Threshold (%)
Smallpox	80–85
Measles	92–94
Polio	75–92
SARS	50–75
SARS-CoV-2 (COVID-19)	82–85

Of the diseases listed, only smallpox has been fully eradicated.

Use the information in the table and your own knowledge to explain why.

[3 marks]

[3 marks]

Question 3d

d)

In the 1850's a law was passed in the UK to make vaccination against smallpox compulsory in infants.

At this time, there was an estimated population of 27 368 800 and the birth rate was 35 live births per 1000 people.

Calculate how many babies needed to be vaccinated to reach the herd immunity threshold suggested in part c).

[2 marks]

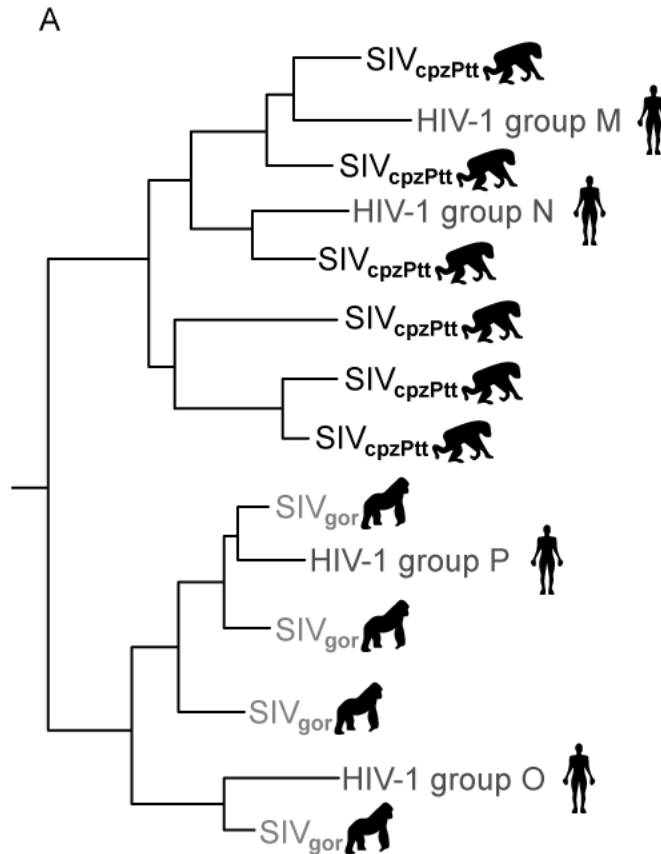
[2 marks]

Question 4a

a)

The image shows the evolutionary links between simian immunodeficiency virus (SIV) and human immunodeficiency virus (HIV).

Note that the image shows the evolution of two strains of SIV, one in chimpanzees (*cpzPtt*) and one in gorillas (*gor*).



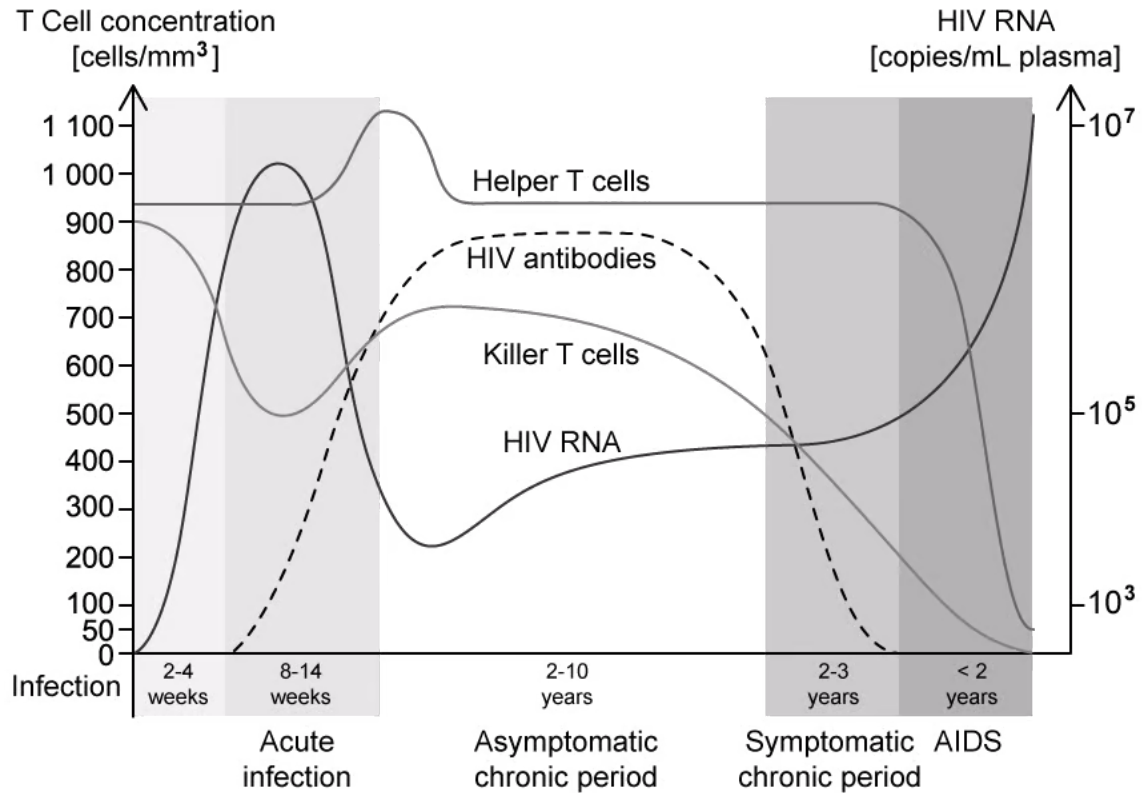
Suggest what the image indicates about the emergence of HIV in human populations.

[3 marks]

Question 4b

b)

The image shows some of the changes that take place in the blood after infection by HIV.



After 2 years since infection, HIV leads to the development of Acquired Immunodeficiency Syndrome (AIDS).

Use the information in the graph and your knowledge of the immune system to explain this.

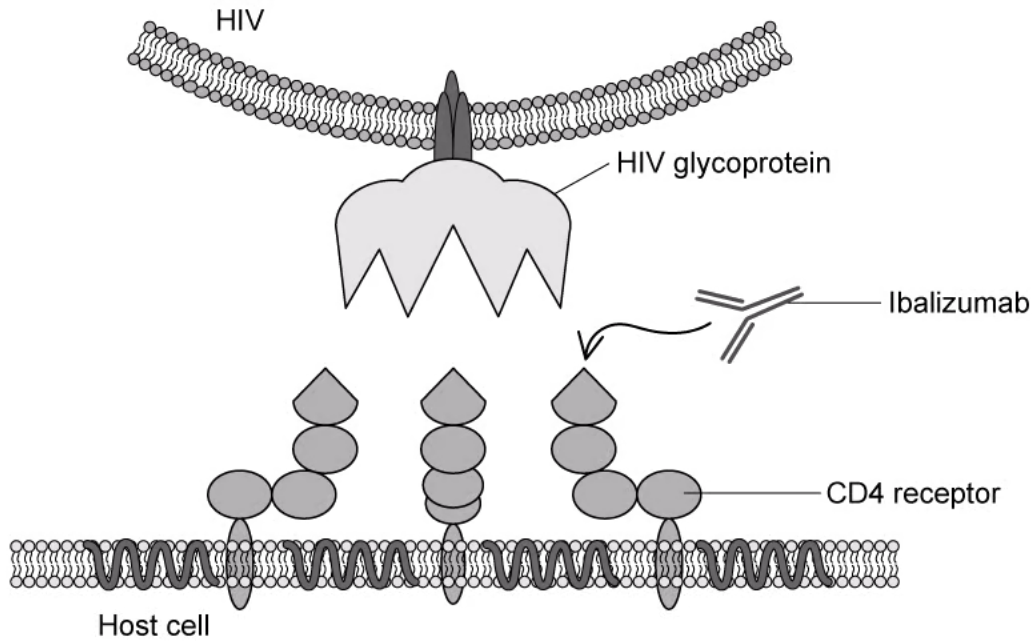
[4 marks]

[4 marks]

Question 4c

c)
HIV infects human T-cells by binding to a cell surface receptor called CD4. This binding causes a shape change in the viral surface glycoproteins, enabling the virus to enter the host cell.

A new treatment for HIV involves a monoclonal antibody called Ibalizumab, the action of which is shown in the diagram below.



Suggest how Ibalizumab works as a treatment for HIV.

[3 marks]

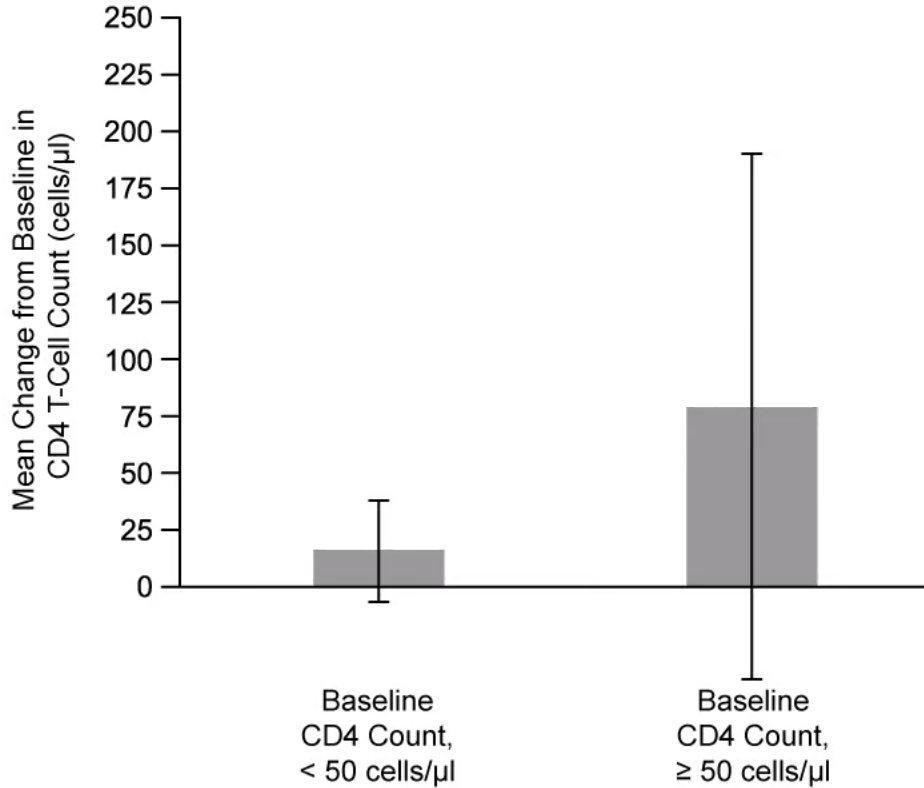
[3 marks]

Question 4d

d)

A trial looking at the efficacy of Ibalizumab investigated its impact on CD4 cell (also known as helper T cell) count after 25 weeks of treatment.

The results are shown in the graph and include the standard deviations for each group of patients.



State and explain what can be concluded about the efficacy of Ibalizumab from the results shown.

[3 marks]

[3 marks]

Question 5a

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

a)

Describe and explain the changes that take place to the cell ultrastructure of a B-cell after activation to ensure it is adapted for its function.

[4 marks]

[4 marks]

Question 5b

b)

Outline the process which occurs in a pregnancy test to give a positive test result.

[5 marks]

[5 marks]

Question 5c

c)

Discuss the benefits and risks associated with vaccination programmes.

[6 marks]**[6 marks]**