1 As part of the immune response, a B cell has to be activated. It then divides to form a clone of cells. These cells then differentiate into plasma cells, which produce antibodies.

(a) Describe how a B cell is activated.

(3)

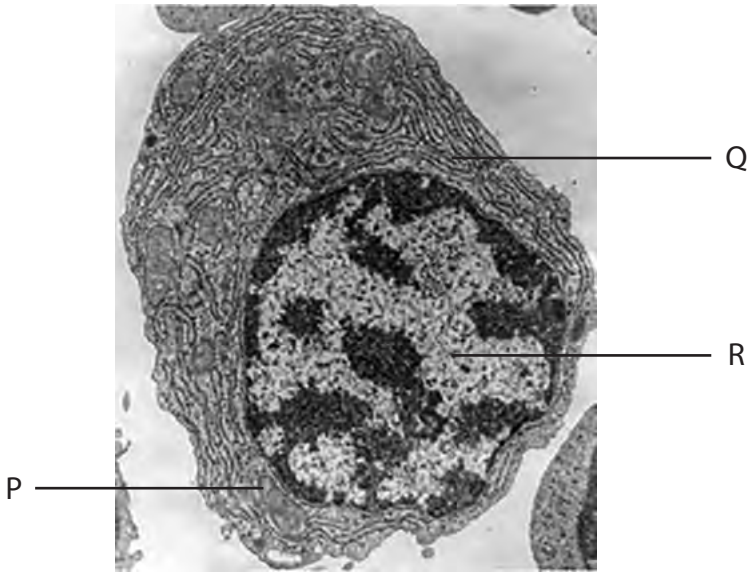
(b) (i) Name the type of division that occurs when B cells are cloned.

(1)

(ii) Suggest how a microscope slide could be prepared to observe cell division in B cells.

(3)

(c) The electronmicrograph below shows a plasma cell. Some structures inside this cell have been labelled.



Magnification ×10 000

Place a cross ☒ in the box to identify each of the following structures.

(i) Structure P

(1)

☒ **A** chloroplast

☒ **B** Golgi apparatus

☒ **C** mitochondrion

☒ **D** nucleus

(ii) Structure R

(1)

☒ **A** cytoplasm

☒ **B** lysosome

☒ **C** nucleus

☒ **D** vacuole

(iii) Name structure Q.

(1)

.....

(iv) Describe the role of structure Q in the production of antibodies.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for Question 1 = 13 marks)

2 Phagocytosis is a non-specific response of the body to infection.

(a) Explain the meaning of each of the following terms.

(i) Phagocytosis

(2)

(ii) Non-specific response

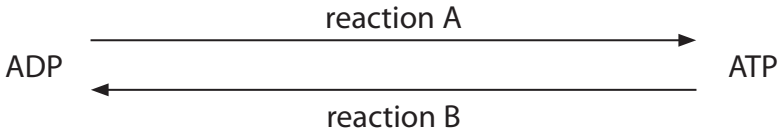
(2)

(iii) Infection

(2)

(b) Phagocytosis requires a source of energy in the form of ATP.

The diagram below shows the relationship between ATP and ADP.



Place a cross ☒ in the box next to the name of reaction A and reaction B.

(2)

Reaction	Name of reaction				
	autolysis	**decarboxylation**	**hydrolysis**	**phosphorylation**	**polymerisation**
A	☒	☒	☒	☒	☒
B	☒	☒	☒	☒	☒

(c) ATP is synthesised in mitochondria.

(i) In the space below, draw and label a diagram to show the structure of a mitochondrion.

(4)

(ii) Name **one** other organelle that synthesises ATP.

(1)

(Total for Question 2 = 13 marks)

3 The human body responds to infection by bacteria in a number of ways.

The non-specific response includes phagocytosis and lysozyme action, which can be followed by the specific immune response. The specific immune response requires antigen presentation by macrophages.

(a) Explain how phagocytosis and lysozyme action lead to antigen presentation by macrophages.

(4)

(b) Explain how macrophages present antigens to T helper cells.

(2)

(c) There is an 'evolutionary race' between some bacteria, such as *Mycobacterium tuberculosis* (TB), and their hosts.

Suggest how this could affect antigen presentation to T helper cells. Give an explanation for your answer.

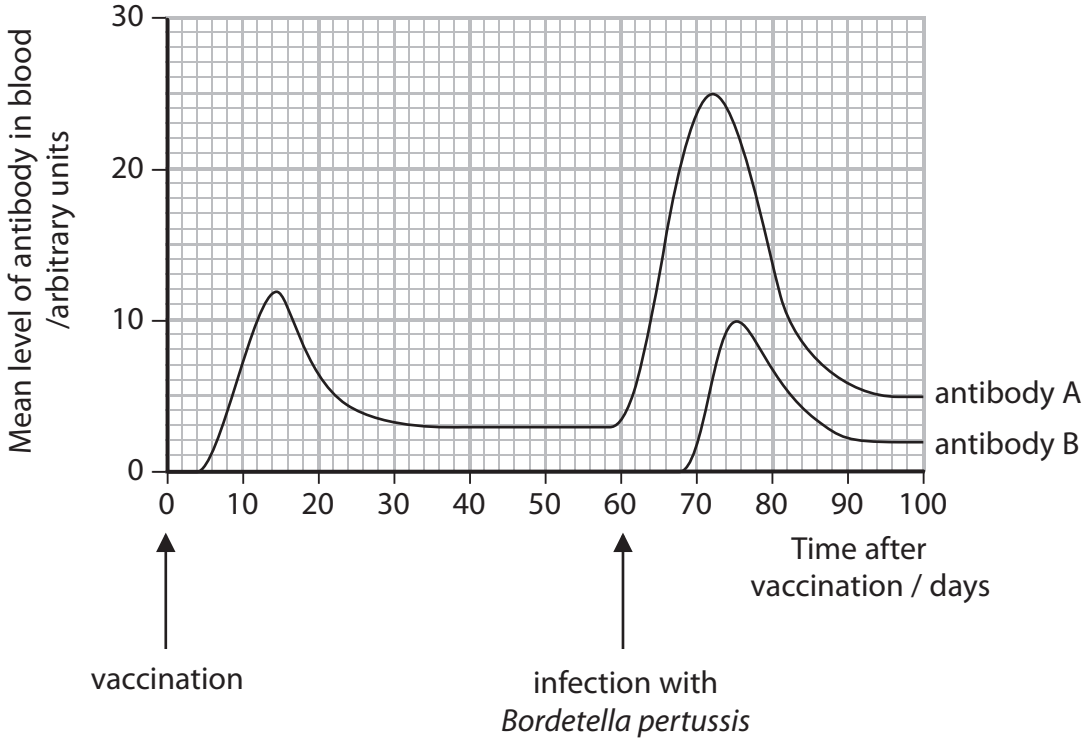
(3)

(Total for Question 3 = 9 marks)

4 Whooping cough is a disease that is particularly serious in young children. Whooping cough is caused by the bacterium *Bordetella pertussis*. Children may be vaccinated against whooping cough.

In an investigation, a group of rats was vaccinated. Sixty days later these rats were infected with *Bordetella pertussis*. In this investigation, the levels of two antibodies in the blood of the rats were measured.

The graph below shows the mean levels of antibody A and antibody B.



(a) (i) For antibody A, compare the increase in mean level after the vaccination with the increase in mean level after infection with *Bordetella pertussis*.

(2)

(ii) Explain the changes in mean level of antibody A after infection with *Bordetella pertussis*.

(3)

(b) (i) Suggest why antibody B was not present in the blood of these rats until after infection with *Bordetella pertussis*.

(2)

(ii) Place a cross ☒ in the box next to the term that describes the type of immunity that results in the production of antibody B.

(1)

☒ **A** artificial active

☒ **B** artificial passive

☒ **C** natural active

☒ **D** natural passive

(c) Comment on the reliability of the data shown in the graph.

(3)

(Total for Question 4 = 11 marks)