EXAM PAPERS PRACTICE

Cell recognition and the immune system 1

Level: OCR A Level H420
Subject: Biology
Exam Board: Suitable for all boards
Topic: Cell recognition and the immune system 1
Type: Questionnaire

To be used by all students preparing for OCR A Level Biology H420 foundation or higher tier but also suitable for students of other boards.

1 Read the following passage.

Pathogens affect humans. They also affect farm animals. Once pathogens have entered the body of an animal they can cause disease. Vets sometimes have difficulty identifying the disease from which a particular animal is suffering. Until recently, they have had to take blood samples and send them to a laboratory. The laboratory carries out tests on the sample.

New tests have been developed. Some of these new tests use monoclonal antibodies. Tests using monoclonal antibodies are fast, specific and allow vets to identify a disease while they are still on the farm.

Brucellosis is a disease of cattle. It is caused by bacteria. These bacteria can infect people who drink milk or eat dairy products from infected cattle. A test using monoclonal antibodies allows vets to identify cattle that are carriers. The carriers are cattle that carry the brucellosis bacteria but do not show any symptoms of the disease.

Use the information from the passage and your own knowledge to answer the following questions.

(a) Other than bacteria, name **one** type of pathogen (line 1).

_____

(1)

(b) Give **two** ways in which a pathogen may cause disease when it has entered the body (lines 1–2).

1. _____

_____

2. _____

_____

(2)

(c) Some new tests use monoclonal antibodies (lines 6–7).

(i) Explain why these antibodies are referred to as monoclonal.

_____

_____

_____

(1)

(ii) Tests using monoclonal antibodies are specific (line 7). Use your knowledge of protein structure to explain why.

(3)

(d) The tests using monoclonal antibodies allow vets to identify brucellosis while they are still on a farm. Explain the advantages of this.

(3)

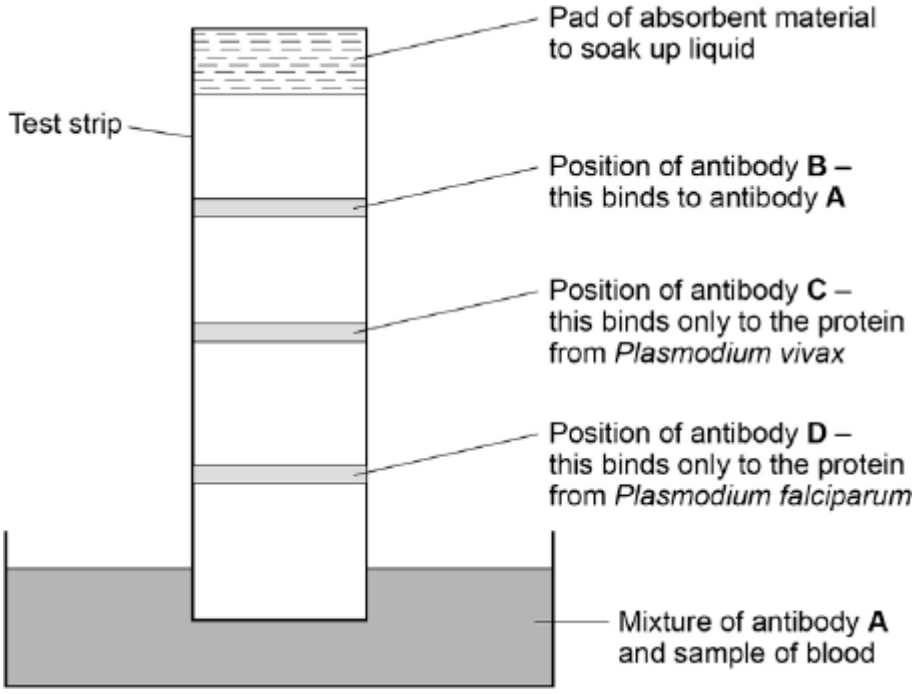
(Total 10 marks)

2 Malaria is a disease caused by parasites belonging to the genus *Plasmodium*. Two species that cause malaria are *Plasmodium falciparum* and *Plasmodium vivax*.

A test strip that uses monoclonal antibodies can be used to determine whether a person is infected by *Plasmodium*. It can also be used to find which species of *Plasmodium* they are infected by.

- A sample of a person's blood is mixed with a solution containing an antibody, **A**, that binds to a protein found in both species of *Plasmodium*. This antibody has a coloured dye attached.
- A test strip is then put into the mixture. The mixture moves up the test strip by capillary action to an absorbent pad.
- Three other antibodies, **B**, **C** and **D** are attached to the test strip. The position of these antibodies and what they bind to is shown in **Figure 1**.

Figure 1



(a) Explain why antibody **A** attaches only to the protein found in species of *Plasmodium*.

_____

_____

_____

_____

(2)

(b) Antibody **B** is important if this test shows a person is not infected with *Plasmodium*.

Explain why antibody **B** is important.

_____

_____

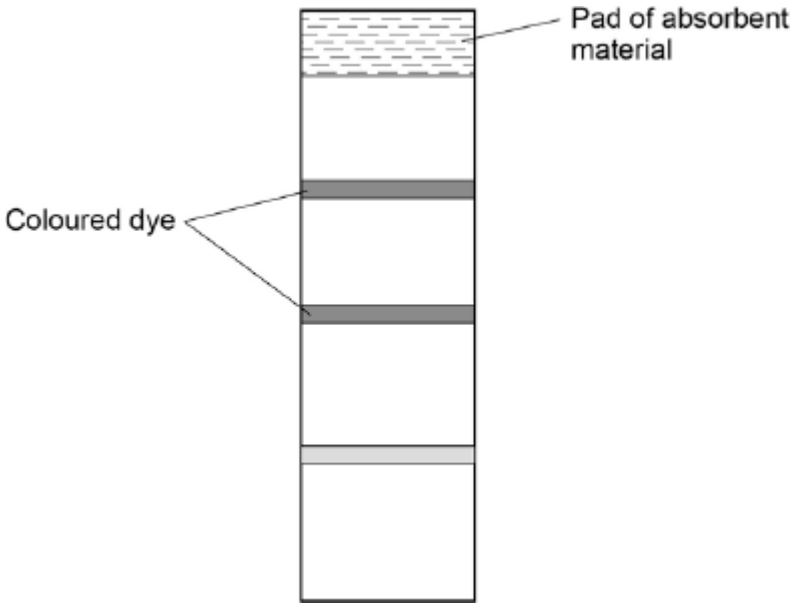
_____

_____

(2)

(c) One of these test strips was used to test a sample from a person thought to be infected with *Plasmodium*. **Figure 2** shows the result.

Figure 2



What can you conclude from this result?

Explain how you reached your conclusion.

(Extra space)

(4)

(Total 8 marks)

3 Read the following passage.

Herpes simplex virus (HSV) infects nerve cells in the face, including some near the lips. Like many other viruses, HSV can remain inactive inside the body for years. When HSV becomes active, it causes cold sores around the mouth.

Human cells infected with a virus may undergo programmed cell death. While HSV is inactive inside the body, only one of its genes is transcribed. This gene is the latency-associated transcript (*LAT*) gene that prevents programmed cell death of an infected nerve cell.

Scientists have found that transcription of the *LAT* gene produces a microRNA. This microRNA binds to some of the nerve cell's own mRNA molecules. These mRNA molecules are involved in programmed cell death of nerve cells. The scientists concluded that production of this microRNA allows HSV to remain in the body for years.

Use information from the passage and your own knowledge to answer the following questions.

(a) HSV infects nerve cells in the face (line 1). Explain why it infects **only** nerve cells.

(Extra space) _____

(3)

(b) HSV can remain inactive inside the body for years (lines 2–3). Explain why this virus can be described as **inactive**.

(2)

(c) Suggest **one** advantage of programmed cell death (line 4).

(1)

(d) The scientists concluded that production of this microRNA allows HSV to remain in the body for years (lines 10–12).

Explain how this microRNA allows HSV to remain in the body for years.

(Extra space)

(4)

(Total 10 marks)

4 (a) When a vaccine is given to a person, it leads to the production of antibodies against a disease-causing organism. Describe how.

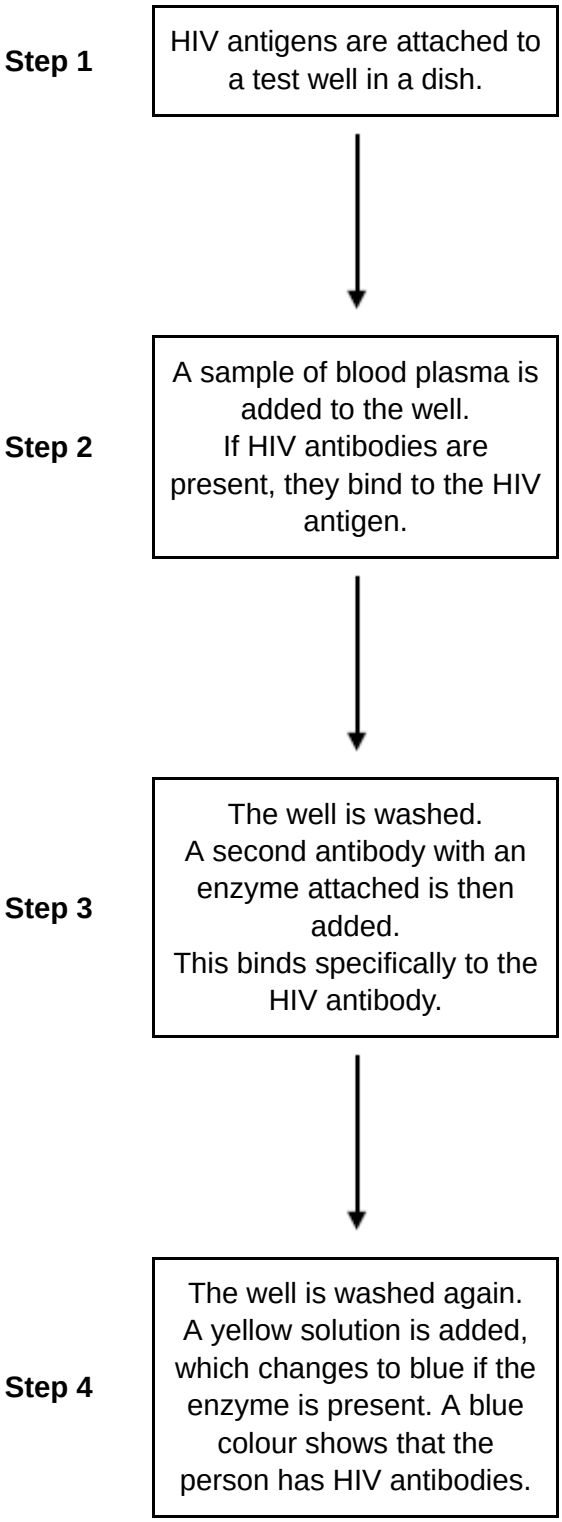
(5)

(b) Describe the difference between active and passive immunity.

(5)

(Total 10 marks)

5 The figure below shows a test that has been developed to find out if a person has antibodies to the human immunodeficiency virus (HIV) antigen.



(a) This test only detects the presence of HIV antibodies. Give **two** reasons why it cannot be used to find out if a person has AIDS.

1. _____

_____

2. _____

_____

(2)

(b) The solution will remain yellow if a person is **not** infected with HIV. Explain why.

_____

_____

_____

_____

(2)

(c) A mother who was infected with HIV gave birth to a baby. The baby tested positive using this test. This does not prove the baby is infected with HIV.
Explain why.

_____

_____

_____

_____

(2)

(d) A control well is set up every time this test is used. This is treated in exactly the same way as the test wells, except that blood plasma is replaced by a salt solution.

Use information from the figure above to suggest **two** purposes of the control well.

1. _____

_____

2. _____

_____

(2)

(Total 8 marks)

6 Metastatic melanoma (MM) is a type of skin cancer. It is caused by a faulty receptor protein in cell-surface membranes. There have been no very effective treatments for this cancer.

Dacarbazine is a drug that has been used to treat MM because it appears to increase survival time for some people with MM.

Doctors investigated the use of a new drug, called ipilimumab, to treat MM. They compared the median survival time (ST) for two groups of patients treated for MM:

- a control group of patients who had been treated with dacarbazine
- a group of patients who had been treated with dacarbazine and ipilimumab.

The ST is how long a patient lives after diagnosis.

The doctors also recorded the percentage of patients showing a significant reduction in tumours with each treatment.

The total number of patients in the investigation was 502.

The table below shows the doctors' results.

Treatment	Median survival time (ST) / months	Percentage of patients showing significant reduction in tumours
Dacarbazine	9.1	10.3
Dacarbazine and ipilimumab	11.2	15.2

(a) The doctors compared median survival times for patients in each group.

How would you find the median survival time for a group of patients?

_____

_____

_____

_____

(2)

(b) In many trials of new drugs, a control group of patients is given a placebo that does not contain any drug.

The control group in this investigation had been treated with dacarbazine.
Suggest why they had not been given a placebo.

_____

_____

(1)

(c) A journalist who read this investigation concluded that ipilimumab improved the treatment of MM.

Do the data in the table support this conclusion? Give reasons for your answer.

(Extra space)

(4)

(d) MM is caused by a faulty receptor protein in cell-surface membranes.
Cells in MM tumours can be destroyed by the immune system.

Suggest why they can be destroyed by the immune system.

(Extra space)

(3)

(Total 10 marks)

7 (a) Human papilloma virus (HPV) is the main cause of cervical cancer. A vaccine has been developed to protect girls and women from HPV.

Describe how giving this vaccine leads to production of antibody against HPV.

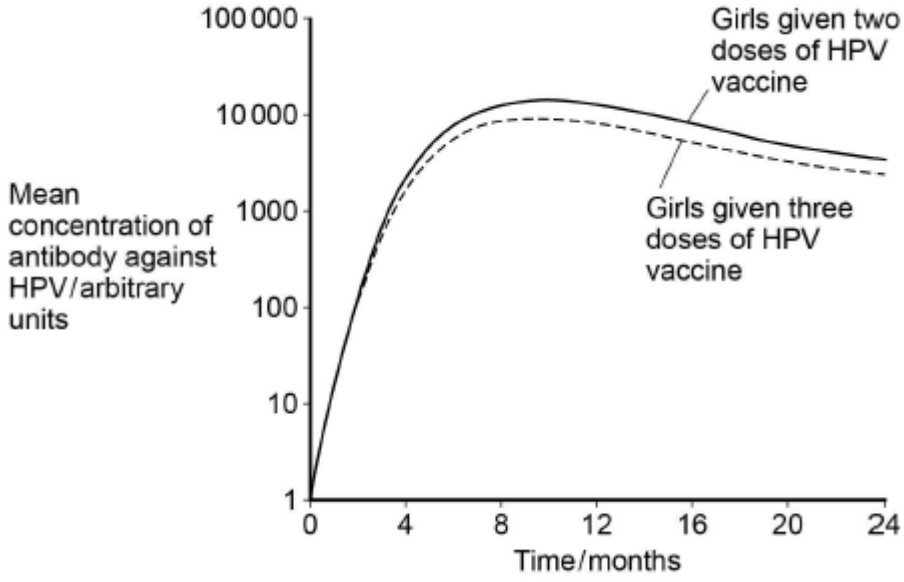
(4)

(b) Doctors investigated whether it was better to give two or three doses of the HPV vaccine. They determined the mean concentration of antibody against HPV in blood samples from girls who were given either two or three doses of the vaccine.

- Girls given two doses received an initial vaccination, followed by a second at 6 months.
- Girls given three doses received an initial vaccination, followed by a second at 1 month and a third at 6 months.

The doctors measured the concentration of antibody each month.

The results are shown below.



What do these results suggest about whether it is better to give two or three doses of the vaccine? Give reasons for your answer.

(2)

(c) The doctors carried out a statistical test to determine whether the antibody concentrations were significantly different in girls given two doses of the vaccine, compared with those given three doses. They determined the mean concentrations of antibody 9 months after the first dose of vaccine.

What statistical test should the doctors have used? Give the reason for your choice.

Test _____

Reason _____

_____

(1)

(d) There is genetic diversity within HPV.

Give **two** ways doctors could use base sequences to compare different types of HPV.

1. _____

_____

2. _____

_____

(2)

(Total 9 marks)

8 (a) The table below shows features of a bacterium and the human immunodeficiency virus (HIV) particle.

Complete the table by putting a tick (✓) where a feature is present.

Feature	**Bacterium**	**Human immunodeficiency virus (HIV) particle**
RNA		
Cell wall		
Enzyme molecules		
Capsid		

(2)

(b) When HIV infects a human cell, the following events occur.

- A single-stranded length of HIV DNA is made.
- The human cell then makes a complementary strand to the HIV DNA.

The complementary strand is made in the same way as a new complementary strand is made during semi-conservative replication of human DNA.

Describe how the complementary strand of HIV DNA is made.

(3)

(c) Contrast the structures of DNA and mRNA molecules to give **three** differences.

1. _____

2. _____

3. _____

(3)

(Total 8 marks)

9

Ebola is a disease caused by a virus. The Ebola virus has a glycoprotein on its surface which binds to a specific receptor protein in the cell-surface membranes of human cells. When it binds to this receptor protein, the virus can enter the cell. Some people do not produce this receptor protein. These people may become infected with the Ebola virus but do not develop the disease. 5

A blood test can be used to determine whether a person has Ebola. People with Ebola have large numbers of specific plasma cells and a specific antibody in their blood. Some scientists have suggested treating people suffering from Ebola by using transfusions of blood plasma from people who have recently recovered from the disease. 10

The Ebola virus has a high mutation rate. This makes it difficult to develop a vaccine.

(a) People who do not have the specific receptor protein in their cell-surface membranes may be infected with the Ebola virus but do not develop the disease (lines 1–5).

Explain why they do **not** develop the disease.

_____

_____

_____

_____

_____

(2)

(b) Explain the increase in specific plasma cells and antibody in people infected with the Ebola virus.

_____

_____

_____

_____

_____

(2)

(c) Explain how a blood transfusion from a patient recently recovered from Ebola may be an effective treatment (lines 8–10).

(3)

(d) A high mutation rate makes it difficult to develop a vaccine (line 11).
Explain why.

(3)

(Total 10 marks)

10 Multiple sclerosis (MS) is a condition caused when the body's own immune system attacks the myelin sheath around axons. The cell bodies of the neurones themselves can also be damaged or destroyed. People with MS usually have periods of time when their MS gets no worse, followed by relapses when it gets worse.

Scientists investigated the effects on neurones of damage to myelin. The scientists obtained a modified antigen from the myelin sheath of humans and injected it into mice. After a number of days, this injection of antigen resulted in the myelin sheaths in the mice being damaged. Some cell bodies of neurones were also damaged.

(a) Suggest how the injection of the antigen resulted in the myelin sheaths being damaged.

_____

_____

_____

_____

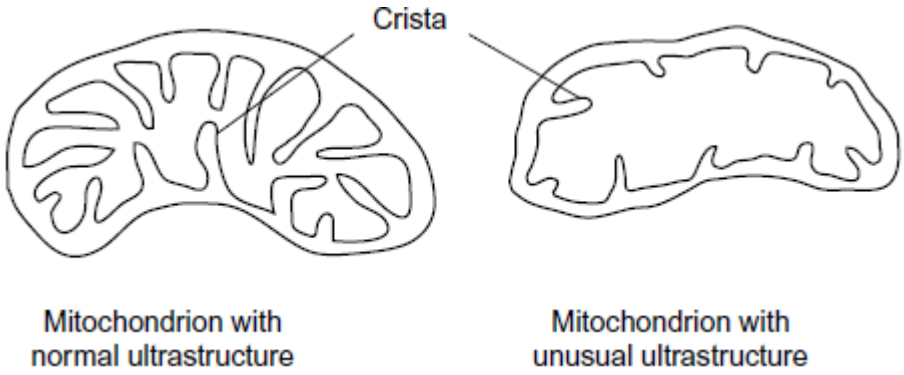
_____

_____

(3)

(b) The scientists compared the ultrastructure of normal and damaged neurones. They found that damaged neurones contained many mitochondria with an unusual ultrastructure.

The diagram shows a mitochondrion with normal ultrastructure and one with the unusual ultrastructure.



Suggest why having a large number of mitochondria with this unusual ultrastructure could lead to neurones dying.

(3)

(c) The scientists took a large number of photographs of thin sections through neurones. Using these photographs, they found that 40% of mitochondria had the unusual ultrastructure in damaged neurones.

(i) What sort of microscope would the scientists use to take the photographs? Give **one** reason for your answer.

Type of microscope _____

Reason _____

_____

_____

(1)

(ii) Suggest how the scientists found the percentage of mitochondria with the unusual ultrastructure.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

11 (a) Give **two** ways in which pathogens can cause disease.

1. _____

_____

2. _____

_____

(2)

(b) Putting bee honey on a cut kills bacteria. Honey contains a high concentration of sugar.

Use your knowledge of water potential to suggest how putting honey on a cut kills bacteria.

[Extra space]

(3)

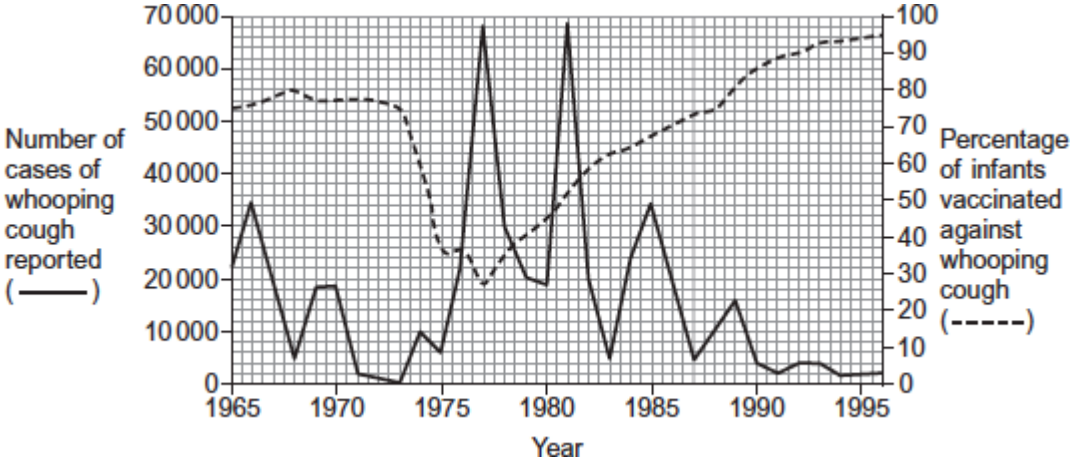
(Total 5 marks)

12 Whooping cough is a disease that affects some infants. Doctors collected data relating to whooping cough between 1965 and 1996.

They collected data for:

- the number of cases of whooping cough reported
- the percentage of infants vaccinated against whooping cough.

The graph shows the data collected by the doctors.



(a) Suggest **two** reasons why the percentage of infants vaccinated decreased between 1973 and 1975.

1. _____

_____

_____

2. _____

_____

_____

(2)

(b) Between 1980 and 1990, there were three peaks in the number of reported cases of whooping cough. After 1981, the number of cases of whooping cough in each peak decreased.

Use the information from the graph to suggest why.

[Extra space]

(2)

(c) The percentage of the population vaccinated does **not** need to be 100% to be effective in preventing the spread of whooping cough.

Suggest why.

[Extra space]

(2)

(Total 6 marks)

13 Read the following passage.

Low-density lipoprotein (LDL) is a substance found in blood. A high concentration of LDL in a person's blood can increase the risk of atheroma formation. Liver cells have a receptor on their cell-surface membranes that LDL binds to. This leads to LDL entering the cell. A regulator protein, also found in blood, can bind to the same receptor as LDL. This prevents LDL entering the liver cell. People who have a high concentration of this regulator protein in their blood will have a high concentration of LDL in their blood. Scientists have made a monoclonal antibody that prevents this regulator protein working. They have suggested that these antibodies could be used to reduce the risk of coronary heart disease.

A trial was carried out on a small number of healthy volunteers, divided into two groups. The scientists injected one group with the monoclonal antibody in salt solution. The other group was a control group. They measured the concentration of LDL in the blood of each volunteer at the start and after 3 months. They found that the mean LDL concentration in the volunteers injected with the antibody was 64% lower than in the control group.

Use the information in the passage and your own knowledge to answer the following questions.

(a) The scientists gave an injection to a mouse to make it produce the monoclonal antibody used in this investigation (line 7).

What should this injection have contained?

_____

(1)

(b) LDL enters the liver cells (lines 3−4).

Using your knowledge of the structure of the cell-surface membrane, suggest how LDL enters the cell.

_____

_____

_____

_____

_____

(2)

(c) Explain how the monoclonal antibody would prevent the regulator protein from working (lines 7−8).

(2)

(d) Describe how the control group should have been treated.

(2)

(Total 7 marks)

14 (a) Describe how bacteria are destroyed by phagocytes.

(Extra space)

(3)

(b) Give **two** structures a bacterial cell may have that a white blood cell does not have.

1. _____

_____

2. _____

_____

(2)

(Total 5 marks)

15 (a) (i) A mutation of a tumour suppressor gene can result in the formation of a tumour.

Explain how.

_____

_____

_____

_____

(2)

(ii) Not all mutations result in a change to the amino acid sequence of the encoded polypeptide.

Explain why.

_____

_____

_____

(1)

(b) Some cancer cells have a receptor protein in their cell-surface membrane that binds to a hormone called **growth factor**. This stimulates the cancer cells to divide.

Scientists have produced a monoclonal antibody that stops this stimulation.

Use your knowledge of monoclonal antibodies to suggest how this antibody stops the growth of a tumour.

[Extra space]

(3)

(Total 6 marks)

16 Read the following passage.

Whooping cough is caused by the bacterium *Bordetella pertussis*. The first vaccines for whooping cough contained whole bacterial cells that had been heated for several minutes. Today, most vaccines only contain between one and three parts of the bacterial cells. People given whole-cell vaccines were more likely to develop harmful side effects than the people given the vaccines containing parts of the bacterial cells. Those given whole-cell vaccines produced a greater range of antibodies against the bacterium.

There have been suggestions that whooping cough vaccines may not work very well. These suggestions are due to recent reports of large rises in the number of cases of whooping cough. Doctors who examined a group of patients with coughs diagnosed about 17% of them as having whooping cough. Scientists tested the blood of the same group of patients for antibodies against a toxin produced by *Bordetella pertussis*. They concluded that 4% of this group actually had whooping cough.

Use the information in the passage and your own knowledge to answer the following questions.

(a) (i) People given whole-cell vaccines were more likely to develop harmful side effects than the people given the vaccines containing parts of the bacterial cells (lines 4–6).

Suggest reasons why.

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*(Extra space)*_____

_____

_____

(3)

(ii) People given whole-cell vaccines produced a greater range of antibodies against the bacterium than the people given the vaccines containing parts of the bacterial cells (lines 7–8).

Explain why.

_____

_____

_____

_____

(2)

(b) The scientists concluded from their test that 4% of patients with long-term coughs actually had whooping cough (line 15).

Explain how they used the results of their test to reach this conclusion.

_____

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*(Extra space)*_____

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_____

(3)

(c) What does the scientists' work suggest about reports of large rises in the number of cases of whooping cough (lines 10–11)?

Explain your answer.

_____

_____

_____

_____

(2)

(Total 10 marks)

17 Nicotine is the addictive substance in tobacco. When nicotine reaches the brain, it binds to a specific protein. This causes the release of chemicals that give a feeling of reward to the smoker. This reward is part of the reason why people find it difficult to stop smoking.

Scientists have developed a vaccine against nicotine to help people stop smoking.
They set up an investigation, which involved a large number of volunteers. Once a month for 5 months, one group of volunteers was given the vaccine and the other group was given a placebo.

At regular intervals, the scientists measured the concentration of antibodies to nicotine in the blood of each group of volunteers. They also calculated the percentage of volunteers who had stopped smoking from months 2 to 6 of the investigation.

(a) (i) In this investigation, neither the volunteers nor the scientists knew if a particular volunteer was receiving the vaccine or a placebo.

Suggest **two** reasons why this made the scientists' results more reliable.

1. _____

_____

2. _____

_____

(2)

(ii) The scientists measured the concentration of nicotine in the blood of two volunteers who smoked the same number of cigarettes per day.

Suggest **two** reasons why the concentration of nicotine in the blood of these smokers might be different.

1. _____

_____

2. _____

_____

(2)

(b) (i) Suggest how this vaccine could help people to stop smoking.

_____

_____

_____

_____

_____

_____

(Extra space) _____

_____

_____

(3)

(ii) Some people have suggested that this vaccine should **not** be given free to smokers on the National Health Service (NHS). Evaluate this suggestion.

_____

_____

_____

_____

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(Extra space) _____

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(3)

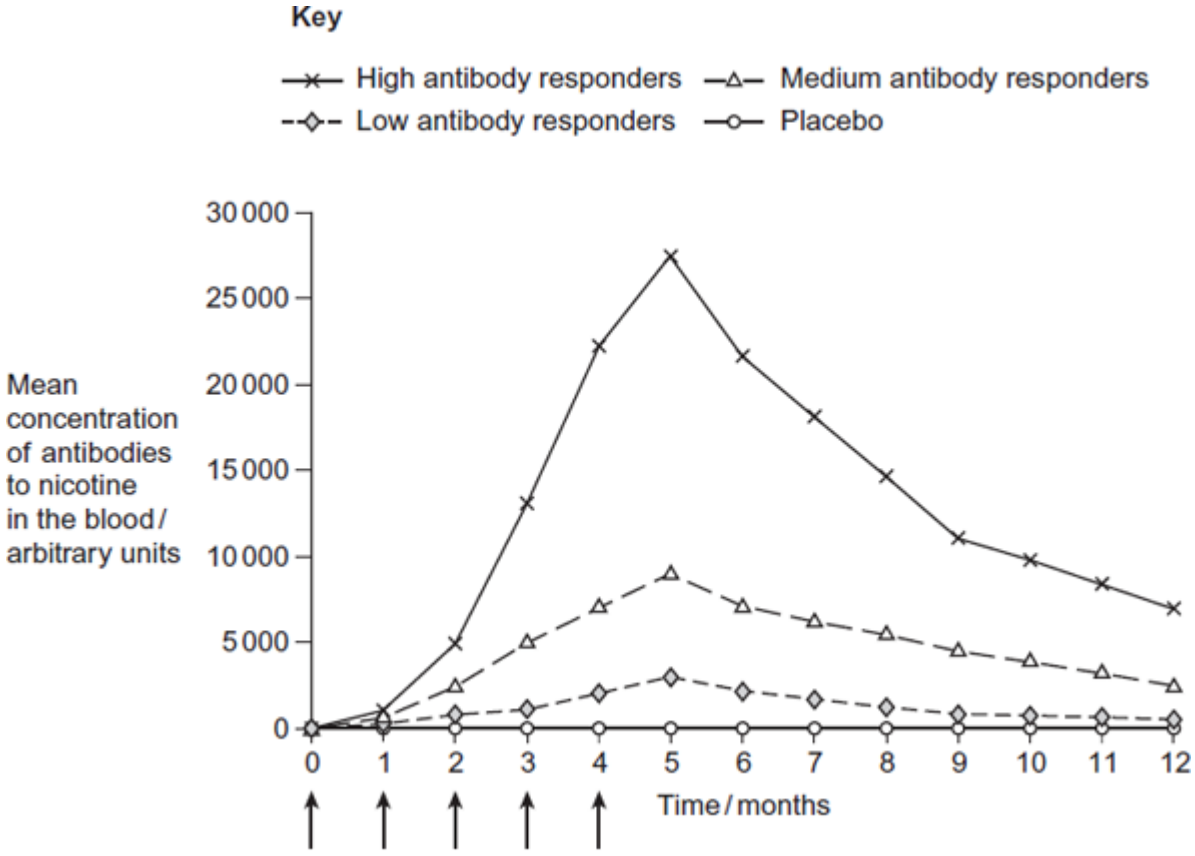
The scientists measured the concentration of antibodies to nicotine in the blood of the volunteers for 12 months after the first vaccination. As a result of these measurements, they divided the volunteers who received the nicotine vaccine into three groups:

- high antibody responders
- medium antibody responders
- low antibody responders.

The figure below shows their results.

The scientists also recorded the number of volunteers who had stopped smoking from months 2 to 6 of the investigation.

The table below shows these results.



Group	Percentage of volunteers who had stopped smoking from months 2 to 6 of the investigation
High antibody responders	56.6
Low antibody responders	38.1
Medium antibody responders	32.1
Placebo	31.3

(c) A journalist reported that this vaccine is a major breakthrough in helping people to stop smoking. Do these data support this statement? Explain your answer.

(Extra space) _____

(5)

(Total 15 marks)

18 Read the following passage.

Microfold cells are found in the epithelium of the small intestine. Unlike other epithelial cells in the small intestine, microfold cells do not have adaptations for the absorption of food.

Microfold cells help to protect against pathogens that enter the intestine. They have receptor proteins on their cell-surface membranes that bind to antigens on the surface of pathogens. The microfold cells take up the antigens and transport them to cells of the immune system. Antibodies are then produced which give protection against the pathogen.

Scientists believe that it may be possible to develop vaccines that make use of microfold cells. These vaccines could be swallowed in tablet form.

Use information from the passage and your own knowledge to answer the following questions.

(a) (i) Microfold cells have receptor proteins on their cell-surface membranes that bind to antigens (line 5). What is an antigen?

_____

_____

_____

(1)

(ii) Microfold cells take up the antigens and transport them to cells of the immune system (lines 6-7). Antigens are not able to pass through the cell-surface membranes of other epithelial cells. Suggest **two** reasons why.

_____

_____

_____

_____

_____

(2)

(b) Scientists believe that it may be possible to develop vaccines that make use of microfold cells (lines 9-10). Explain how this sort of vaccine would lead to a person developing immunity to a pathogen.

(5)

(Total 8 marks)

19

The human immunodeficiency virus (HIV) leads to the development of acquired immunodeficiency syndrome (AIDS). Eventually, people with AIDS die because they are unable to produce an immune response to pathogens.

Scientists are trying to develop an effective vaccine to protect people against HIV. There are three main problems. HIV rapidly enters host cells. HIV causes the death of T cells that activate B cells. HIV shows a lot of antigenic variability.

Scientists have experimented with different types of vaccine for HIV. One type contains HIV in an inactivated form. A second type contains attenuated HIV which replicates in the body but does not kill host cells. A third type uses a different, non-pathogenic virus to carry genetic information from HIV into the person's cells. This makes the person's cells produce HIV proteins. So far, these types of vaccine have not been considered safe to use in a mass vaccination programme.

Use the information in the passage and your own knowledge to answer the following questions.

(a) People with AIDS die because they are unable to produce an immune response to pathogens (lines 2-4).

Explain why this leads to death.

_____

_____

_____

_____

_____

_____

*(Extra space)*_____

_____

_____

(3)

(b) Explain why each of the following means that a vaccine might **not** be effective against HIV.

(i) HIV rapidly enters host cells (lines 6-7).

(2)

(ii) HIV shows a lot of antigenic variability (lines 7-8).

(2)

(c) So far, these types of vaccine have not been considered safe to use in a mass vaccination programme (lines 14-15).

Suggest why they have **not** been considered safe.

(Extra space)

(3)

(Total 10 marks)

20 (a) What is a pathogen?

_____

(1)

(b) When a pathogen enters the body it may be destroyed by phagocytosis.
Describe how.

_____

_____

_____

_____

_____

_____

_____

_____

*(Extra space)*_____

_____

_____

_____

(4)

(c) When a pathogen causes an infection, plasma cells secrete antibodies which destroy this pathogen.

Explain why these antibodies are only effective against a specific pathogen.

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

21 Read the following passage.

Gluten is a protein found in wheat. When gluten is digested in the small intestine, the products include peptides. Peptides are short chains of amino acids. These peptides cannot be absorbed by facilitated diffusion and leave the gut in faeces

Some people have coeliac disease. The epithelial cells of people with coeliac disease do not absorb the products of digestion very well. In these people, some of the peptides from gluten can pass between the epithelial cells lining the small intestine and enter the intestine wall. Here, the peptides cause an immune response that leads to the destruction of microvilli on the epithelial cells.

Scientists have identified a drug which might help people with coeliac disease. It reduces the movement of peptides between epithelial cells. They have carried out trials of the drug with patients with coeliac disease.

Use the information in the passage and your own knowledge to answer the following questions.

(a) Name the type of chemical reaction which produces amino acids from proteins.

_____

(1)

(b) The peptides released when gluten is digested cannot be absorbed by facilitated diffusion (lines 2 – 3). Suggest why.

_____

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*(Extra space)*_____

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_____

(3)

*(Extra space)*_____

_____

_____

(3)

(c) Explain why the peptides cause an immune response (lines 7 – 8).

_____

_____

_____

(1)

(d) Scientists have carried out trials of a drug to treat coeliac disease (lines 10 – 11). Suggest **two** factors that should be considered before the drug can be used on patients with the disease.

1. _____

_____

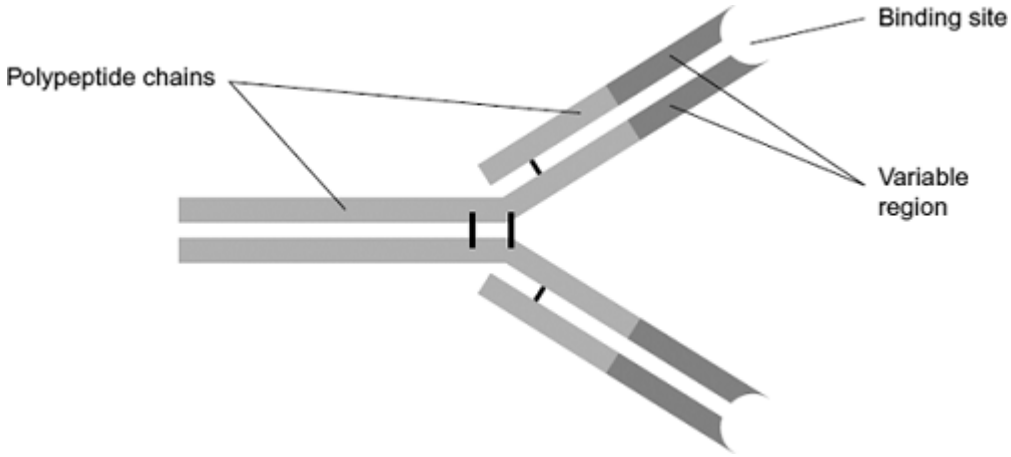
2. _____

_____

(2)

(Total 7 marks)

22 The diagram shows an antibody molecule.



(a) What is the evidence from the diagram that this antibody has a quaternary structure?

_____

_____

(1)

(b) Scientists use this antibody to detect an antigen on the bacterium that causes stomach ulcers. Explain why the antibody will only detect this antigen.

(*Extra space*)

(3)

(Total 4 marks)

23 Vaccines protect people against disease. Explain how.

(*Extra space*)

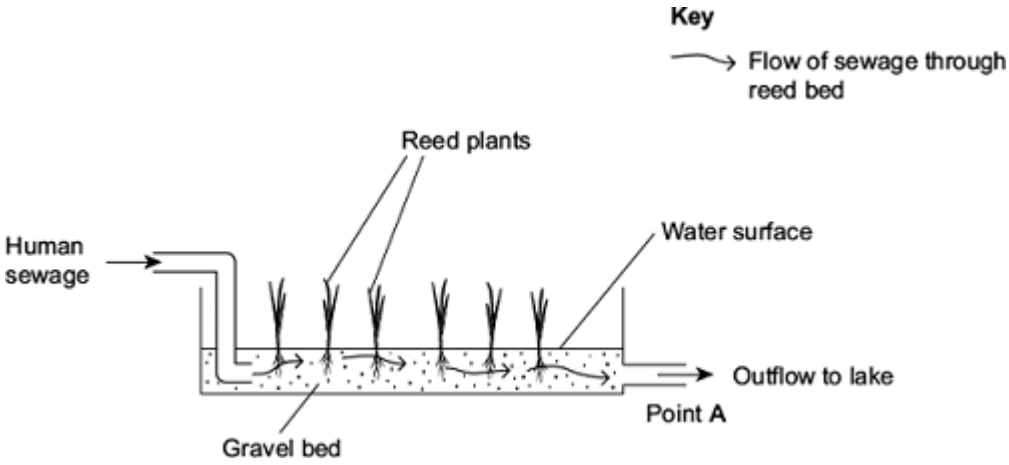
(Total 5 marks)

24 (a) Name the process by which some bacteria oxidise ammonia to nitrate.

_____

(1)

Reeds are plants that grow with their roots under water. A reed bed contains a large number of growing reeds. Reed beds may be used to absorb nitrates produced when bacteria break down human sewage. The diagram shows a reed bed.



(b) Reeds have hollow, air-filled tissue in their stems which supplies oxygen to their roots. Explain how this enables the roots to take up nitrogen-containing substances.

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_____

_____

_____

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(2)

(c) (i) There is an optimum rate at which human sewage should flow through the reed bed. If the flow of human sewage is too fast, the nitrate concentration at point **A** falls. Explain why.

_____

_____

_____

_____

_____

(2)

(ii) An increase in nitrate concentration in the water entering the lake could affect algae and fish in the lake. Explain how.

_____

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_____

_____

_____

_____

*(Extra space)*_____

_____

_____

(3)

(Total 8 marks)

25 Read the following passage.

Chlamydia is a bacterium. Scientists have shown that infection with chlamydia can cause heart disease in humans. Infection with the bacterium can stimulate the formation of atheroma. This can lead to a heart attack.

Other scientists have been working with mice. These scientists have suggested that chlamydia may cause heart disease in a different way. They have found a protein on the surface of chlamydia cells which is similar to a protein in the heart muscle of mice. After an infection with chlamydia, cells of the immune system of the mice may attack their heart muscle cells and cause heart disease.

Use the information in the passage and your own knowledge to answer the following questions.

(a) (i) Using information from the passage, explain what is meant by an antigen.

_____

_____

_____

_____

(2)

(ii) After an infection with chlamydia, cells of the immune system of the mice may attack the heart muscle cells (lines 7-8). Explain why.

(2)

(b) Some scientists have suggested that people should be vaccinated to prevent infection by chlamydia. Evaluate this suggestion.

(Extra space)

(3)

(Total 7 marks)

26 (a) *Clostridium difficile* is a bacterium that is present in the gut of up to 3% of healthy adults and 66% of healthy infants.

(i) *C. difficile* rarely causes problems, either in healthy adults or in infants. This is because its numbers are kept low by competition with harmless bacteria that normally live in the intestine.

Use this information to explain why some patients treated with antibiotics can be affected by *C. difficile*.

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_____

_____

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_____

(2)

(ii) Suggest why older people are more likely to be affected by *C. difficile*.

_____

_____

_____

(1)

(b) The antibiotic methicillin inhibits the enzyme transpeptidase. This enzyme is used by some bacteria to join monomers together during cell wall formation. Methicillin has a similar structure to these monomers. Use this information to explain how methicillin inhibits the enzyme transpeptidase.

_____

_____

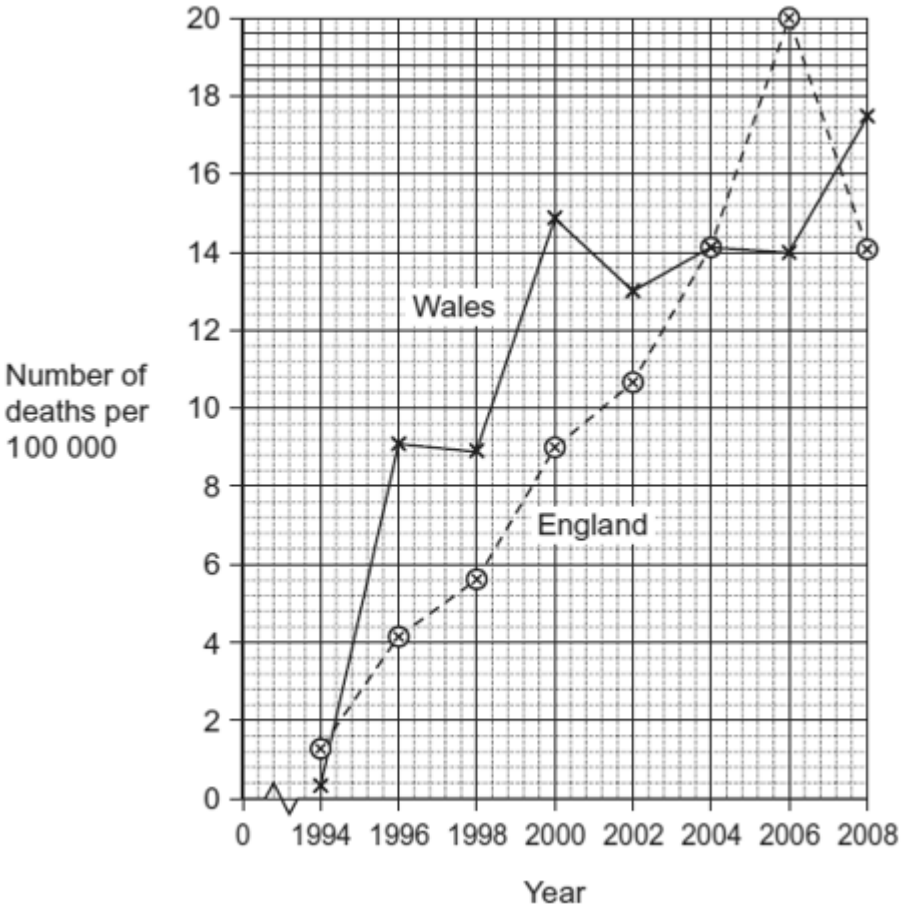
_____

_____

_____

(2)

(c) MRSA is a variety of *Staphylococcus aureus*. It is difficult to treat infections caused by this bacterium because it is resistant to methicillin and to some other antibiotics. As a result, some patients who are already very ill may die if they become infected with MRSA. The graph shows the number of deaths in England and Wales between 1994 and 2008 caused by MRSA.



(i) It may be difficult to identify MRSA as the actual cause of death. Explain why.

_____

_____

_____

(1)

(ii) Describe the change in the number of deaths caused by MRSA in England in the period shown in the graph.

_____

_____

_____

(1)

(iii) Calculate the percentage increase in the number of deaths caused by MRSA in Wales from 1996 to 2006. Show your working.

Answer _____

(2)

(Total 9 marks)

27 Different cells in the body have different functions.

(a) Some white blood cells are phagocytic. Describe how these phagocytic white blood cells destroy bacteria.

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_____

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_____

*(Extra space)*_____

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_____

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(4)

(b) The epithelial cells that line the small intestine are adapted for the absorption of glucose. Explain how.

(Extra space)

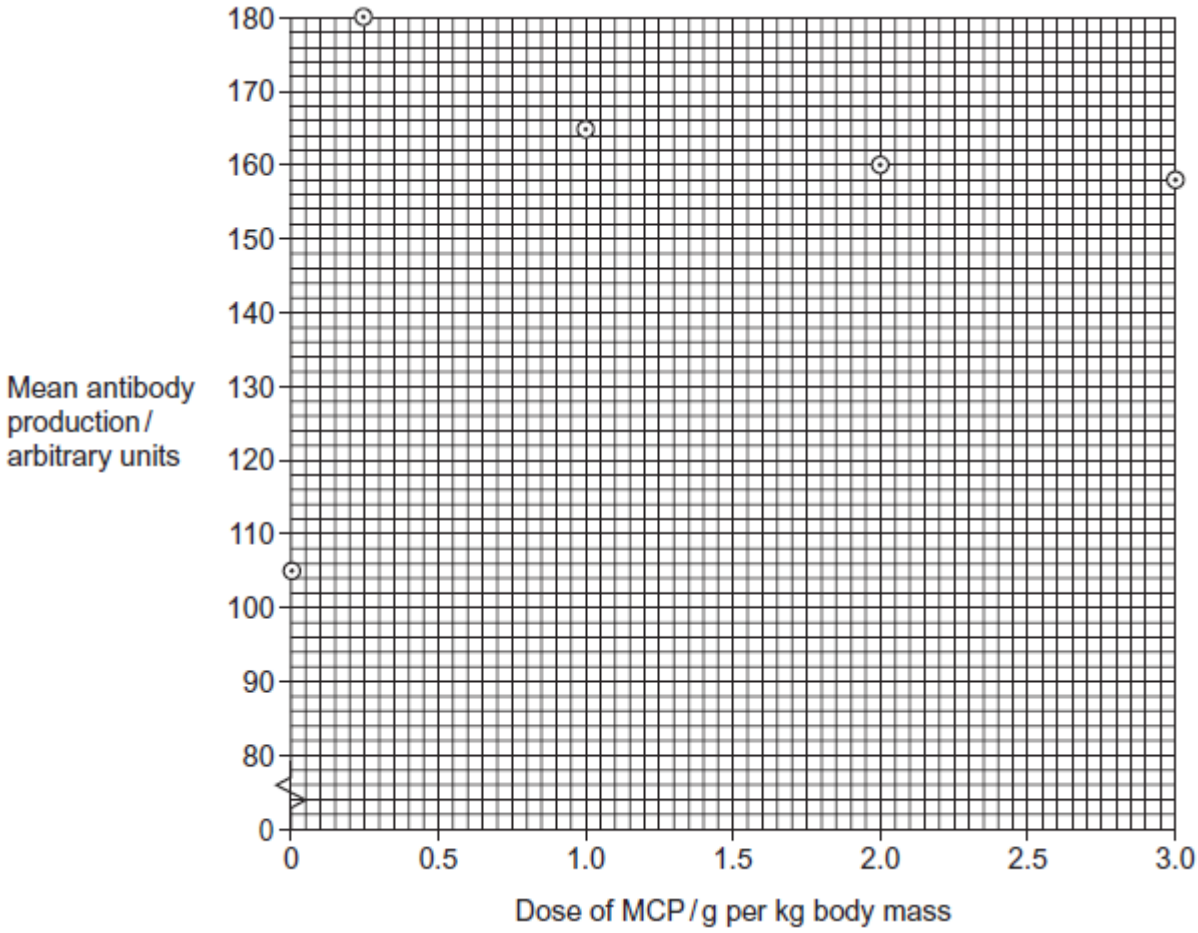
(6)

(Total 10 marks)

28 Scientists tested a claim that modified citrus pectin (MCP) increased the production of antibodies by the immune system.

- They divided a large number of mice into five groups.
- They gave the mice in each group a different amount of MCP in their food.
- The scientists then stimulated antibody production in the mice. They did this by injecting them with a solution containing sheep red blood cells.

The results are shown in the graph.



(a) The data obtained in this investigation have been plotted on a graph. How would you join the points? Give a reason for your answer.

_____

_____

_____

(1)

(b) Use the graph to describe the effect of MCP on mean antibody production.

_____

_____

_____

_____

_____

(2)

(c) Calculate the percentage increase in antibody production from when there was no MCP in the diet to when the dose is 1.0 g per kg.

Answer _____%

(2)

(d) The dose of MCP given to the mice was calculated in g per kg body mass. Explain why the dose was calculated per unit mass.

_____

_____

(1)

(e) Explain how antibodies were produced when the mice were injected with sheep red blood cells.

(Extra space)

(3)

(f) A newspaper suggested that these data show that taking MCP will give people increased resistance to disease. With reference to the data give **two** reasons why this conclusion may **not** be valid.

1.

2.

(2)

(Total 11 marks)

29 In the early 1980s, before DNA analysis had been developed, scientists investigated the genetic variation of cheetahs living in captivity. They used skin grafts to do this. They carried out skin grafts on anaesthetised animals by

- removing a small piece of skin from one animal. This animal was the recipient.
- replacing the removed skin by a piece of skin taken from another animal. This animal was the donor.
- attaching the new piece of skin with stitches.

A graft may be accepted by the recipient. It will be rejected if the recipient's immune system recognises the antigens on the skin as foreign.

Scientists carried out skin grafts between cheetahs living in captivity and domestic cats. The table shows the data that they obtained.

Recipient of skin graft	Donor of skin graft	Relationship	Time taken for the graft to be rejected / days
Domestic cat 1	Domestic cat 2	Unrelated	13
Cheetah 1	Domestic cat 3	Unrelated	12
Cheetah 1	Cheetah 2	Sisters	No rejection after 52 days
Cheetah 3	Cheetah 4	Unrelated	49
Cheetah 5	Cheetah 6	Unrelated	No rejection after 78 days
Cheetah 7	Cheetah 8	Unrelated	No rejection after 41 days
Cheetah 9	Cheetah 10	Unrelated	No rejection after 24 days
Cheetah 11	Cheetah 12	Unrelated	No rejection after 14 days
Cheetah 13	Cheetah 14	Unrelated	No rejection after 44 days

The scientists also grafted skin from one area to another on the same animal. These grafts were not rejected.

(a) (i) The scientists grafted skin from a domestic cat to a cheetah. Suggest why.

_____

_____

(1)

(ii) They also grafted skin from one area to another on the same animal. Explain why.

_____

_____

(1)

(b) (i) Give **three** conclusions that you can make from the data in the table above about the time taken for rejection.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(ii) Give **one** reason why these conclusions may **not** be reliable.

_____

_____

(1)

(iii) There are proteins on the skin of cheetahs that act as antigens. What do the data in the table suggest about these cheetah antigens?

_____

_____

(1)

(iv) Antigens are proteins. Explain why a knowledge of antigens can show that animals are genetically similar.

_____

_____

_____

_____

(2)

(Total 9 marks)

30 Read the passage below.

Most cases of cervical cancer are caused by infection with Human Papilloma Virus (HPV). This virus can be spread by sexual contact. There are many types of HPV, each identified by a number. Most of these types are harmless but types 16 and 18 are most likely to cause cervical cancer.

A vaccine made from HPV types 16 and 18 is offered to girls aged 12 to 13. Three injections of the vaccine are given over six months. In clinical trials, the vaccine has proved very effective in protecting against HPV types 16 and 18. However, it will be many years before it can be shown that this vaccination programme has reduced cases of cervical cancer. Until then, smear tests will continue to be offered to women, even if they have been vaccinated. A smear test allows abnormal cells in the cervix to be identified so that they can be removed before cervical cancer develops.

The Department of Health has estimated that 80% of girls aged 12 to 13 need to be vaccinated to achieve herd immunity to HPV types 16 and 18. Herd immunity is where enough people have been vaccinated to reduce significantly the spread of HPV through the population.

Use information from this passage and your own knowledge to answer the following

(a) HPV vaccine is offered to girls aged 12 to 13 (line 5). Suggest why it is offered to this age group.

_____

_____

_____

(1)

(b) The vaccine is made from HPV types 16 and 18 (line 5). Explain why this vaccine may **not** protect against other types of this virus.

_____

_____

_____

_____

_____

(2)

(c) Three injections of the vaccine are given (lines 5 to 6). Use your knowledge of immunity to suggest why.

(2)

(d) It will be many years before it can be shown that this vaccination programme has reduced cases of cervical cancer (lines 7 to 9). Suggest **two** reasons why.

1.

2.

(2)

(e) Smear tests will continue to be offered to women, even if they have been vaccinated (lines 9 to 10). Suggest why women who have been vaccinated still need to be offered smear tests.

(1)

(f) Suggest **one** reason why vaccinating a large number of people would reduce significantly the spread of HPV through the population (lines 14 to 16).

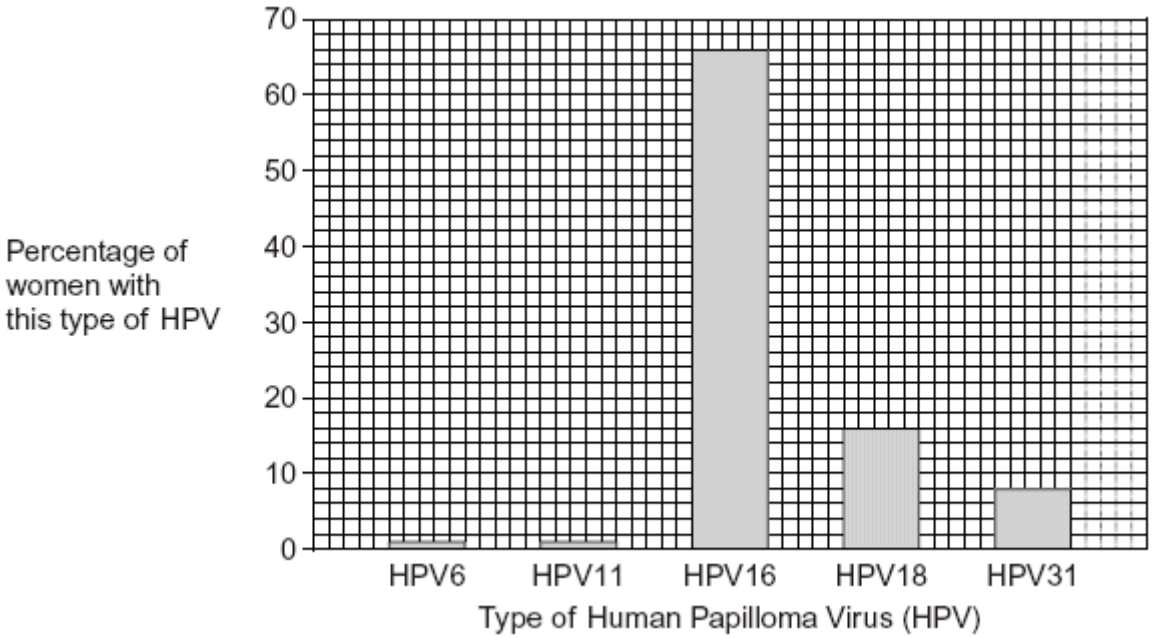
(2)

(Total 10 marks)

31 Cervical cancer occurs in the neck of the uterus.

Scientists investigated the link between cervical cancer and infection with some types of Human Papilloma Virus (HPV).

The graph shows the frequency of five different types of HPV in women who had cervical cancer.



(a) A local newspaper published an article about cervical cancer with the headline 'HPV causes cervical cancer'.

Do the data shown in the graph support this claim? Explain your answer.

(3)

(b) Scientists have developed vaccines against HPV. One of the vaccines contains HPV antigens.

(i) What is an HPV antigen?

_____

_____

_____

_____

(2)

(ii) A vaccine can be used to produce immunity to HPV. Describe how memory cells are important in this process.

_____

_____

_____

_____

_____

_____

(3)

(c) Some doctors suggested offering the vaccine to young men. Explain the advantage of vaccinating young men as well as young women.

_____

_____

_____

_____

(2)

(Total 10 marks)

32 (a) What is an antigen?

_____

_____

(2)

(b) What is an antibody?

_____

_____

(2)

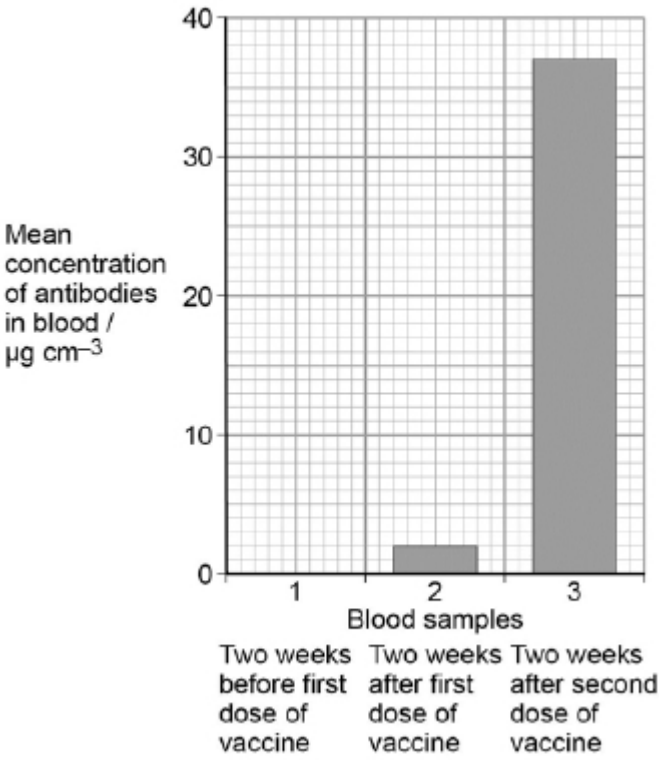
Poliomyelitis is an infection caused by a virus.

A doctor vaccinated a group of patients against poliomyelitis. He gave each patient two doses of vaccine, 3 months apart.

An immunologist tested three samples of blood from each of the patients:

- (sample 1) taken 2 weeks before the first dose of vaccine
- (sample 2) taken 2 weeks after the first dose of vaccine
- (sample 3) taken 2 weeks after the second dose of vaccine.

He measured the concentration of antibodies against the poliomyelitis virus in the patients' blood each time. The results are shown in the graph.



(c) Calculate the percentage increase in the mean concentration of antibodies in blood between samples 2 and 3.

Answer = _____ %

(1)

(d) Explain the differences between the mean concentrations of antibodies in blood samples 1, 2 and 3.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 9 marks)