AQA A-LEVEL · 7402

BIOLOGY



EXAM QUESTION PACK

3.2.4 CELL RECOGNITION AND THE IMMUNE SYSTEM

SCORE	PERCENTAGE
/532	%

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Q1.

Read the following passage.

Sizes of populations of normal intestinal bacteria are usually controlled by T cells that are produced slowly and in small numbers by the immune system. These T cells do not normally survive for very long. As a result, they do not release large amounts of cytokines. Cytokines are chemicals that can cause swelling of the lining of the intestines.

Crohn's disease is a long-lasting disease that causes swelling of the lining of the intestines. It is believed that Crohn's disease can be caused by a loss of tolerance to normal intestinal bacteria, as shown by an unusually large response by T cells. This response can be triggered by pathogenic bacteria in the intestines of people with a genetic tendency to Crohn's disease.

Some people's Crohn's disease can be controlled by a drug called 5-aminosalicylic acid (5-ASA) that reduces swelling. Another drug called 6-mercaptopurine (6-MP) may also be used. 6-MP inhibits an enzyme required to make adenine and guanine. This is effective because most cells can recycle nucleotides, but T cells are not able to do so.

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

(a) The Crohn's disease symptom of swelling of the lining of the intestines could be triggered by pathogenic bacteria in the intestines (lines 6–10).

Suggest how.

(3)

(b) Suggest the meaning of ‘a genetic tendency to Crohn’s disease’ (line 10).

(2)

(c) Suggest why 5-ASA is only effective in controlling the swelling of the lining of the intestines in **some** people with Crohn’s disease (lines 11–12).

(2)

(d) Suggest why 6-MP can be used to control the symptoms of Crohn's disease (lines 13–15).

Do **not** include details of enzyme inhibition or protein synthesis in your answer.

(3)

(Total 10 marks)

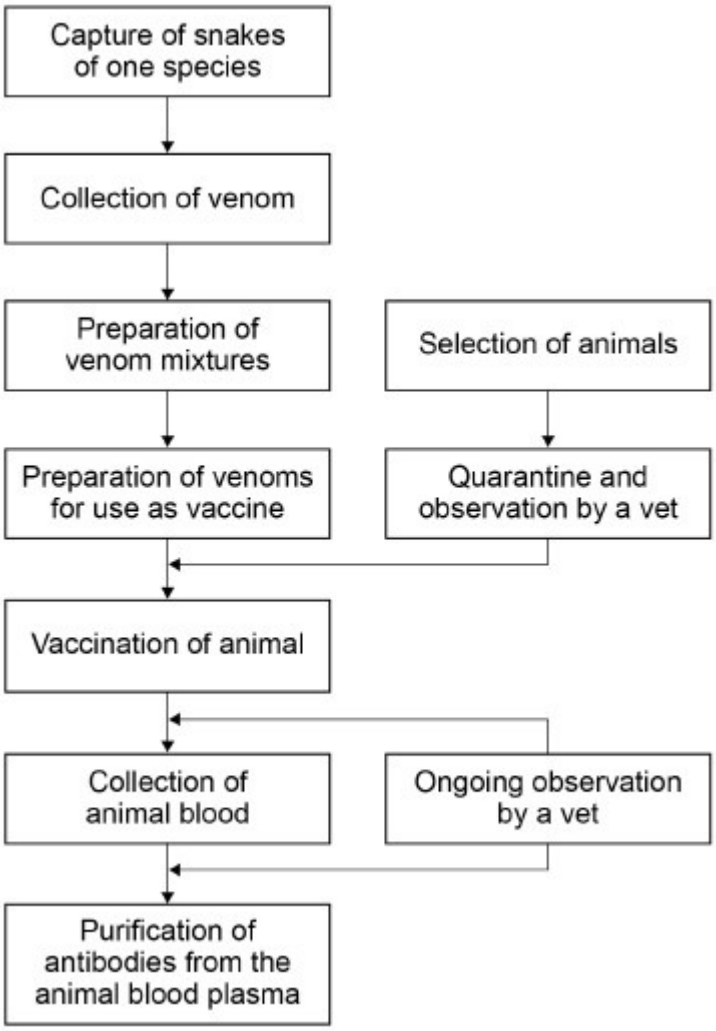
Q2.

(a) When a person is bitten by a venomous snake, the snake injects a toxin into the person. Antivenom is injected as treatment. Antivenom contains antibodies against the snake toxin. This treatment is an example of passive immunity.

Explain how the treatment with antivenom works and why it is essential to use passive immunity, rather than active immunity.

(2)

The chart shows a procedure used to produce antivenom.



(b) A mixture of venoms from several snakes of the same species is used.

Suggest why.

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(2)

(c) Horses or rabbits can be used to produce antivenoms.
When taking blood to extract antibody, 13 cm^3 of blood is collected per kg of the animal's body mass.
The mean mass of the horses used is 350 kg and the mean mass of the rabbits used is 2 kg

Using only this information, suggest which animal would be better for the production of antivenoms.
Use a calculation to support your answer.

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(2)

(d) During the procedure shown in the chart the animals are under ongoing observation by a vet.

Suggest **one** reason why.

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(1)

(e) During vaccination, each animal is initially injected with a small volume of venom. Two weeks later, it is injected with a larger volume of venom.

Use your knowledge of the humoral immune response to explain this vaccination programme.

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(3)

(Total 10 marks)

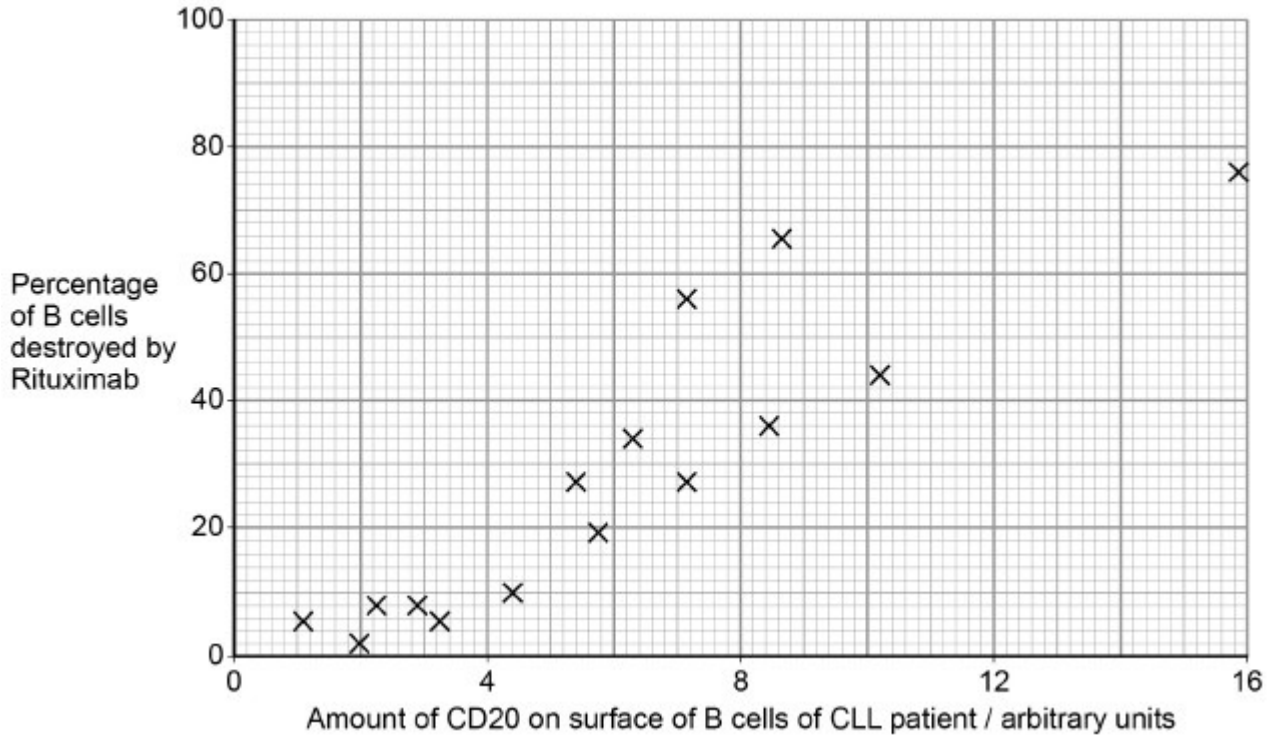
Q3.

Chronic lymphocytic leukaemia (CLL) is a cancer that affects some B cells of a person's immune system.

Rituximab is a drug used to treat CLL. It binds to a protein called CD20 on the surface of B cells. If enough Rituximab binds to a B cell, it can kill the cell. Rituximab kills **both** healthy **and** cancerous B cells. The body then produces new B cells.

The amount of CD20 on the surface of B cells varies from one person to another. Doctors investigated the relationship between the amount of CD20 on the B cells of a patient and the percentage of B cells destroyed by Rituximab.

The graph shows the doctors' results. Each cross is the result for one patient.



(a) What statistical test could the scientists have used to determine whether there was a significant relationship between the amount of CD20 on the surface of B cells and the percentage of B cells destroyed by Rituximab?
Give a reason for your answer.

Name of test _____

Reason _____

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(1)

(b) From these data, what can you conclude about the effectiveness of Rituximab in treating patients with CLL?

Do **not** include considerations of statistical analyses in your answer.

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(3)

Approximately 11 percent of people with CLL also have mutations of a gene called *NOTCH1*. This leads to production of a non-functional transcription factor associated with CD20 production.

The doctors determined the median percentage of B cells destroyed by Rituximab in people with CLL who had the *NOTCH1* mutation and those who did not.

The doctors' results are shown in the table.

	Median percentage of B cell destroyed by Rituximab
In people with CLL who had the *NOTCH1* mutation	**4**
In people with CLL who did **not** have *NOTCH1* mutation	**22**

(c) Human blood contains (approximately) 1.0×10^9 B cells per dm^3.

Use the median values in the table to calculate the difference between the number of B cells per dm^3 in the blood of people treated with Rituximab with the *NOTCH1* mutation and people without the *NOTCH1* mutation.

Express your answer in standard form. Show your working.

_____ cells per dm^3

(2)

(d) Use all of the information to suggest how the mutation of *NOTCH1* led to the difference in the percentage of B cells destroyed by Rituximab.

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(3)

(Total 9 marks)

Q4.

Read the following passage.

Azidothymidine (AZT) is a drug used to treat people infected with human immunodeficiency virus (HIV). It inhibits the enzyme that synthesises DNA from HIV RNA. This does not destroy HIV in the body but stops or slows the development of AIDS.

In the past, some people who took AZT on its own eventually developed AIDS. Some of the HIV in their bodies had become resistant to AZT. To prevent this from happening, people infected with HIV are now treated with highly active antiretroviral therapy (HAART). This involves taking AZT with other anti-HIV drugs at the same time.

AZT is taken in low doses. This is because people who took high doses over long periods of time suffered muscle wastage. It was found that high doses of AZT inhibit replication of mitochondria.

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

(a) Suggest and explain why AZT does not destroy HIV in the body but stops or slows the development of AIDS (lines 3–4).

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(4)

(b) Suggest and explain **two** advantages of using HAART (lines 7–9).

Advantage 1 _____

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Advantage 2 _____

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(4)

(c) Suggest why high doses of AZT lead to muscle wastage (lines 10–11).

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(2)

(Total 10 marks)

Q5.

(a) NMO is a disease that leads to damage to nerve cells in the spinal cord.

A person with NMO produces anti-AQP4 antibody that attacks only these nerve cells.

Explain why the anti-AQP4 antibody only damages these cells.

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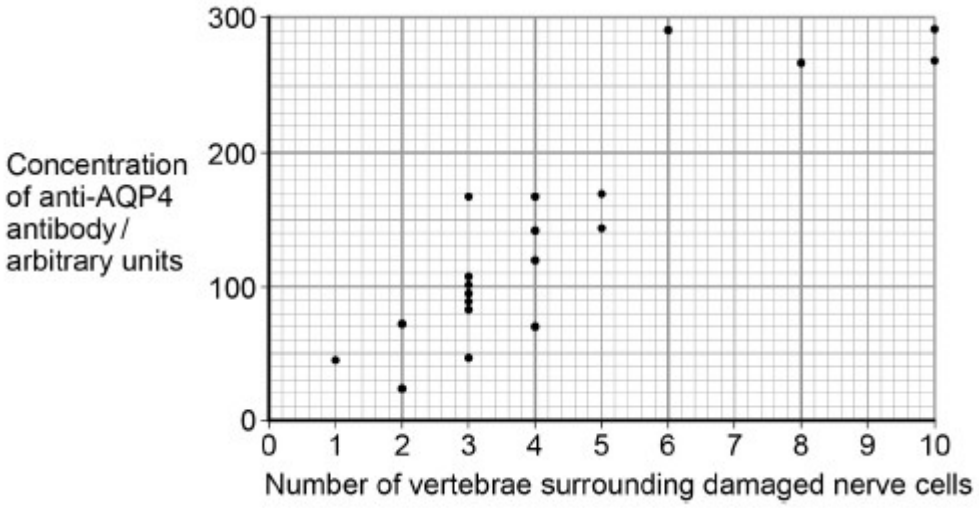
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(4)

(b) Scientists measured the concentration of anti-AQP4 antibody in the blood of people with NMO.

The spinal cord is surrounded by small bones called vertebrae. For each person, the scientists also determined the number of vertebrae surrounding damaged nerve cells.

Their results are shown in the graph.



A scientist suggested that the concentration of anti-AQP4 antibody in a person's blood could be used to predict the number of vertebrae surrounding damaged nerve cells they are likely to have.

Use the graph above to suggest reasons why this suggestion might **not** be valid.

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(3)

(c) A new treatment for NMO involves using a monoclonal antibody. The structure of the variable region of this monoclonal antibody is identical to the variable region of an anti-AQP4 antibody, but the rest of its structure is different.

Use this information and your knowledge of antigen-antibody complexes to suggest how this monoclonal antibody prevents anti-AQP4 damaging nerve cells.

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(2)

(Total 9 marks)

Q6.

(a) Describe how phagocytosis of a virus leads to presentation of its antigens.

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(3)

(b) Describe how presentation of a virus antigen leads to the secretion of an antibody against this virus antigen.

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(3)

(c) Collagen is a protein produced by cells in joints, such as the knee.

Rheumatoid arthritis (RA) is an auto-immune disease. In an auto-immune disease, a person's immune system attacks their own cells. RA causes pain, swelling and stiffness in the joints.

Scientists have found a virus that produces a protein very similar to human collagen.

Suggest how the immune response to this viral protein can result in the development of RA.

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(2)

(Total 8 marks)

Q7.

(a) What is an antigen?

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(2)

(b) What is an antibody?

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(2)

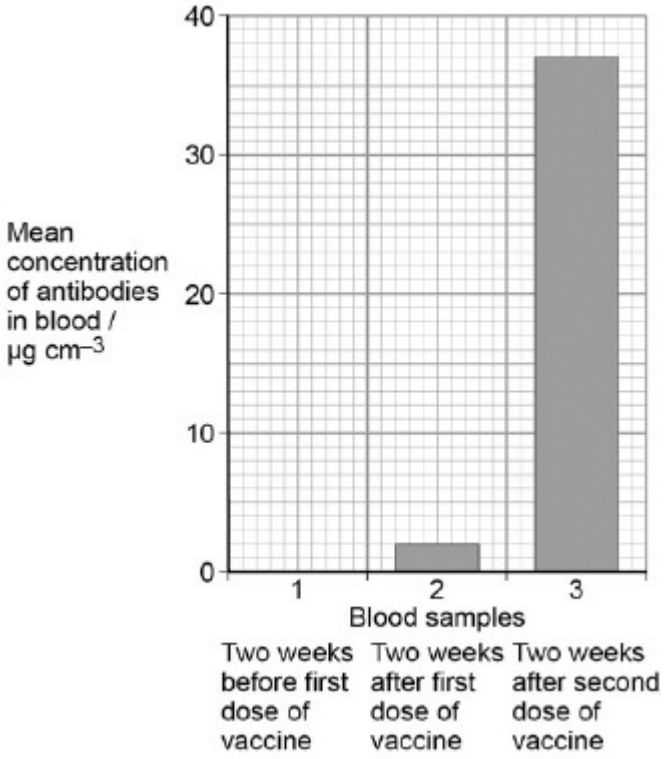
Poliomyelitis is an infection caused by a virus.

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.

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(4)

(Total 9 marks)

Q8.

Bacterial meningitis is a potentially fatal disease affecting the membranes around the brain. *Neisseria meningitidis* (Nm) is a leading cause of bacterial meningitis.

(a) In the UK, children are vaccinated against this disease. Describe how vaccination can lead to protection against bacterial meningitis.

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(6)

(b) Penicillin has been the antibiotic of choice for the treatment of bacterial meningitis. Since the year 2000, strains of *Neisseria meningitidis* that are resistant to penicillin, sulfonamides and rifampin have been discovered in the UK.

Describe how a population of *Neisseria meningitidis* (Nm) can become resistant to these antibiotics.

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(4)

(c) Contrast the structure of a bacterial cell and the structure of a human cell.

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(5)

(Total 15 marks)

Q9.

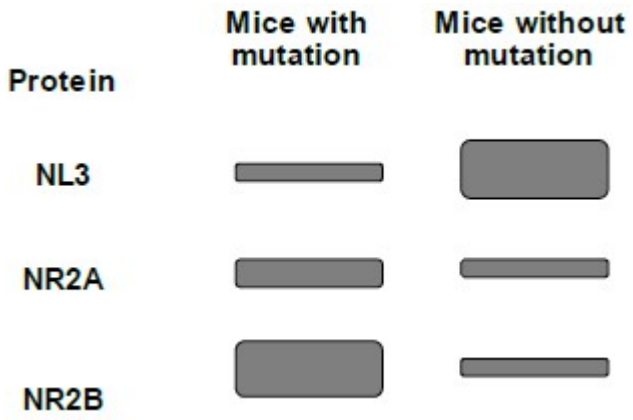
Some autism spectrum disorders (ASDs) are associated with a mutation affecting the neuroligin-3 gene. This gene codes for a protein called NL3, that is found in synapses.

Scientists investigated the effects of a mutation affecting NL3 in mice. They obtained brains from mice with the mutation and from mice without the mutation. For each type of mouse they:

- obtained a solution containing all of the proteins from synapses in one part of the brain
- separated these proteins using gel electrophoresis
- identified and measured the amount of three proteins from the solution using three different labelled antibodies.

The three proteins are parts of a postsynaptic membrane receptor.

The diagram below shows the scientists' results. Each band shows the presence of a protein. The size of a band shows the amount of the protein present.



(a) The mutation affecting NL3 in these mice was a substitution in the neuroligin-3 gene.

What is a substitution mutation?

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(1)

(b) Suggest how gel electrophoresis separated the proteins obtained from the synapses.

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(2)

(c) Each type of labelled antibody binds specifically to one of the proteins.

Explain why.

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(3)

(d) What do these data show about the effects of the mutation on the proteins?

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(2)

(e) These proteins are part of a receptor found in synapses in the part of the brain called the hippocampus. A high ratio of NR2B to NR2A protein in this receptor has been associated with good memory.

Using all of the information, suggest how the mutation affecting the NL3 protein may affect a mouse.

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(2)

(Total 10 marks)

Q10.

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.

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(3)

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

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(2)

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

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_____

(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.

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(4)

(Total 10 marks)

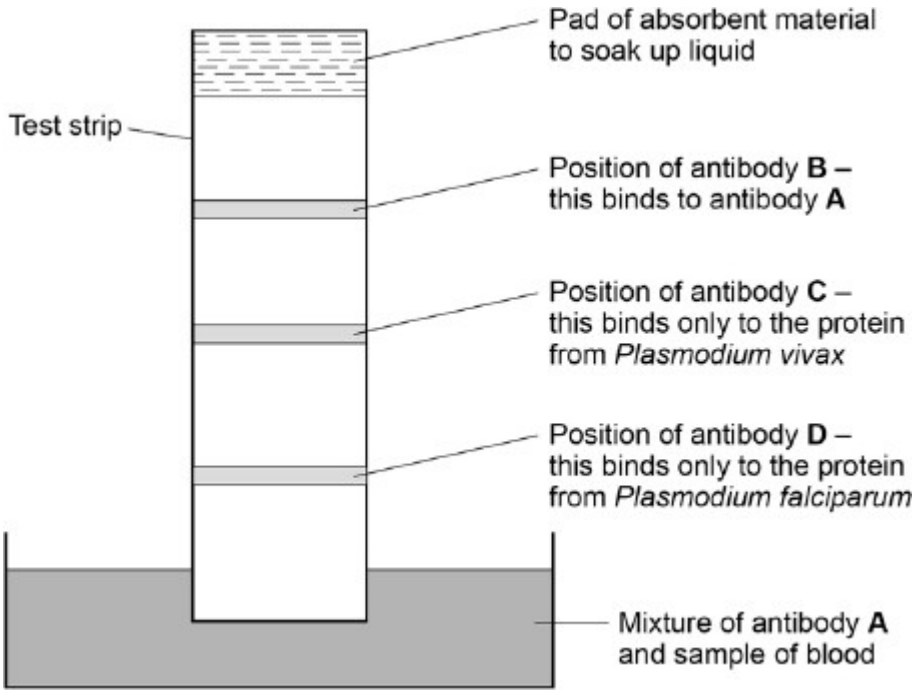
Q11.

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*.

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(2)

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

Explain why antibody **B** is important.

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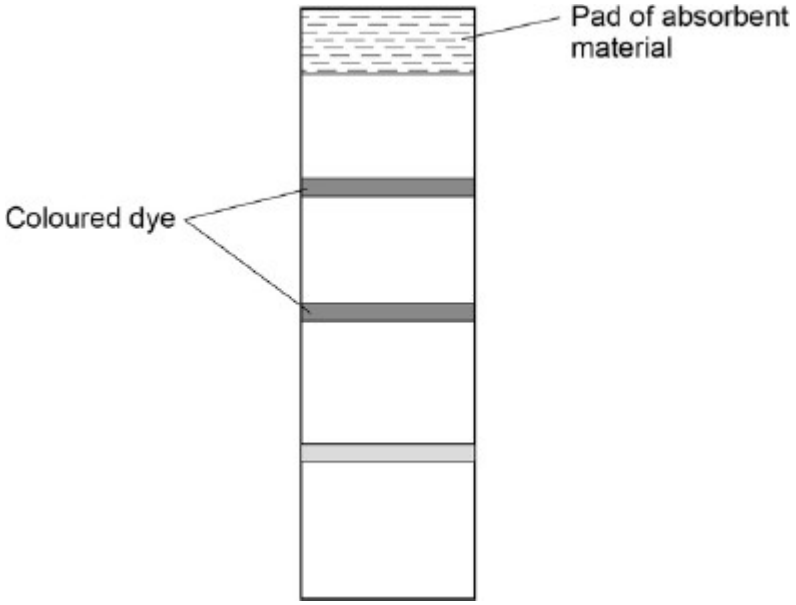
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(2)

(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.

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(4)

(Total 8 marks)

Q12.

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

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(5)

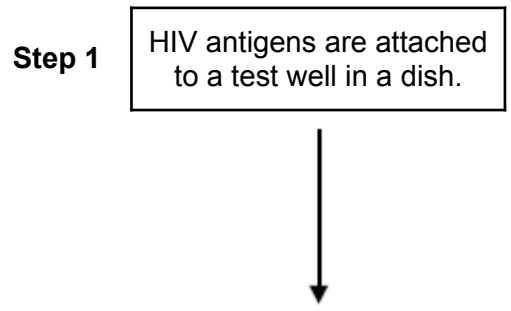
(b) Describe the difference between active and passive immunity.

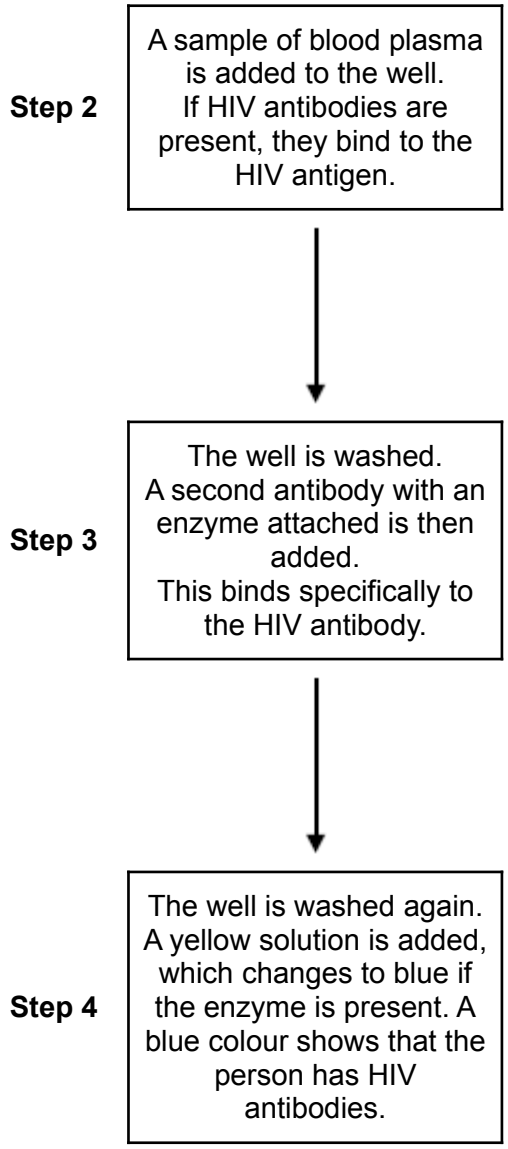
(5)

(Total 10 marks)

Q13.

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. _____

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2. _____

_____

(2)

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

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(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.

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(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. _____

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2. _____

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(2)

(Total 8 marks)

Q14.

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?

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(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.

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(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.

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(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.

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(3)

(Total 10 marks)

Q15.

(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.

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(3)

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

1. _____

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2. _____

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3. _____

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(3)

(Total 8 marks)

Q16.

(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.

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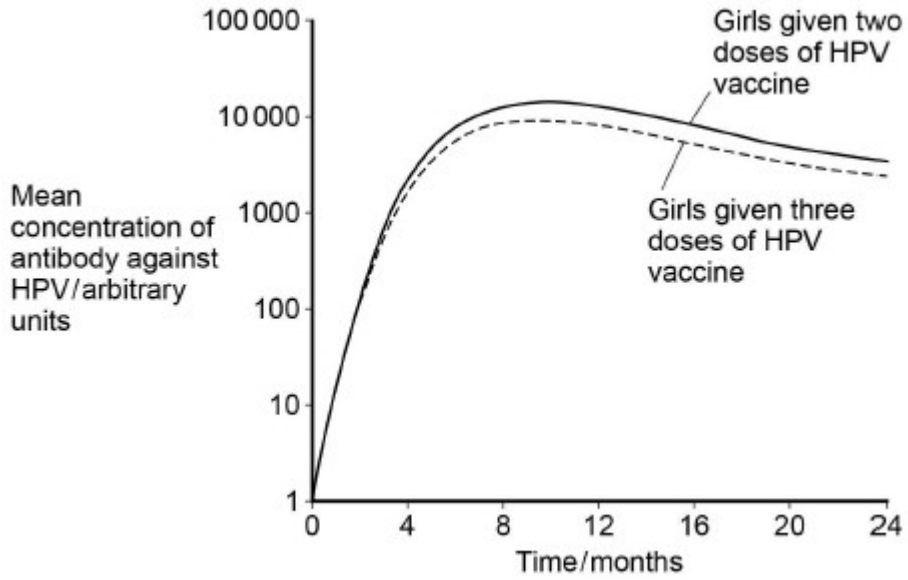
(4)

(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.

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(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. _____

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(2)

(Total 9 marks)

Q17.

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.

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.

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.

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(2)

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

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(2)

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

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(3)

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

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(3)

(Total 10 marks)

Q18.

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.

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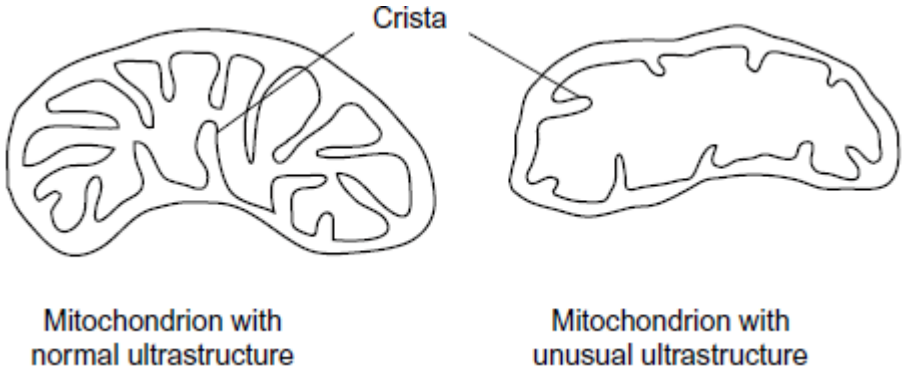
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(3)

(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.

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(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.

_____

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(3)

(Total 10 marks)

Q19.

(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.

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(3)

(Total 5 marks)

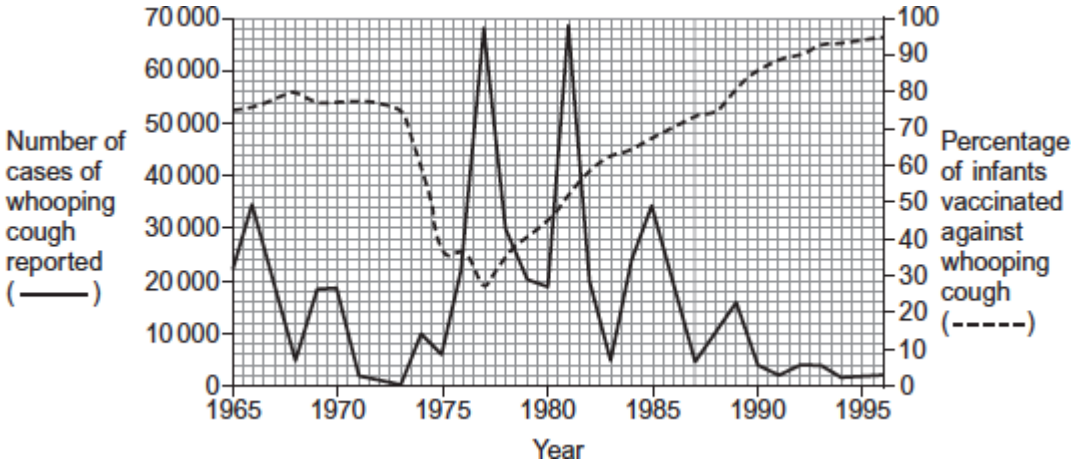
Q20.

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.

_____

_____

_____

_____

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(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.

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(2)

(Total 6 marks)

Q21.

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).

_____

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(2)

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

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q22.

(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.

_____

_____

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(3)

(Total 6 marks)

Q23.

(a) Describe how bacteria are destroyed by phagocytes.

_____

_____

_____

_____

_____

_____

(3)

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

1. _____

_____

2. _____

_____

(2)

(Total 5 marks)

Q24.

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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(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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(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.

_____

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(2)

(Total 10 marks)

Q25.

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.

_____

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_____

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(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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(3)

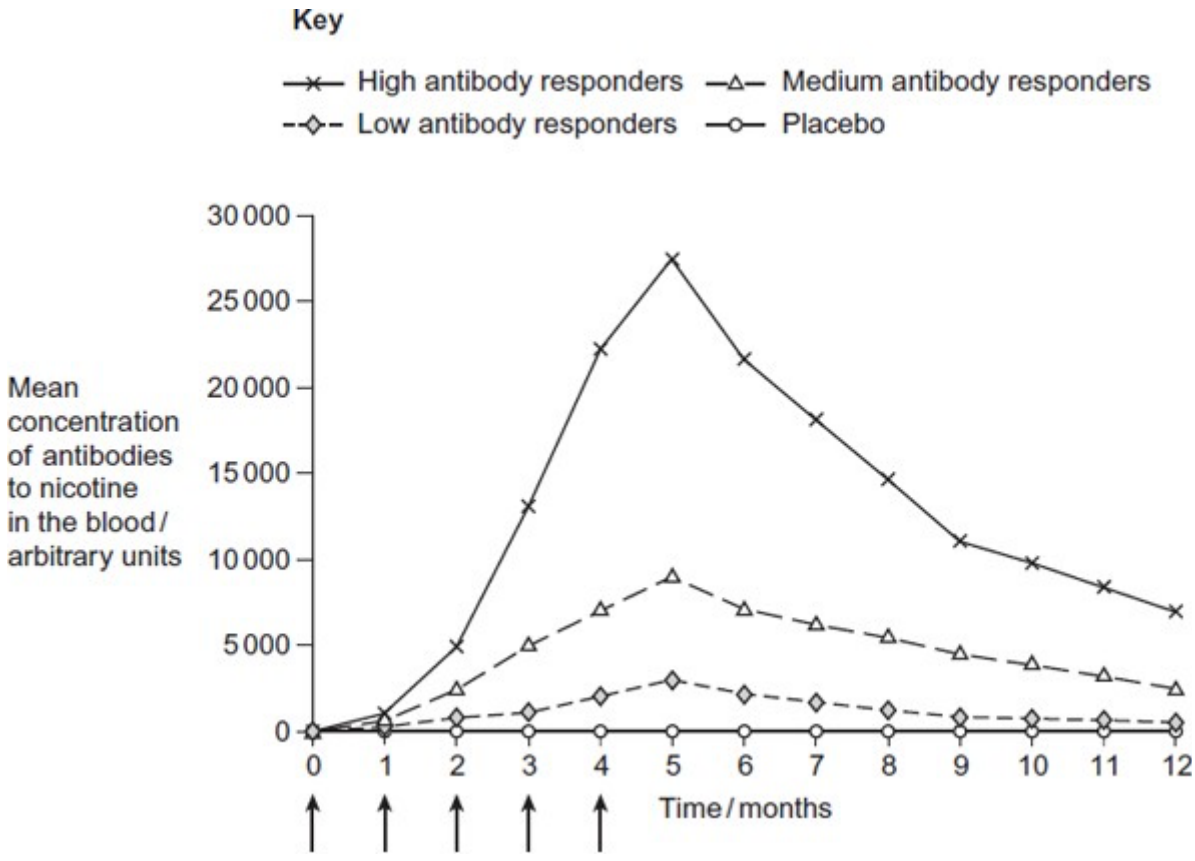
The scientists measured the concentration of antibodies to nicotine in the blood of the volunteers for 12 months after the first vaccination. As a result of these measurements, they divided the volunteers who received the nicotine vaccine into three groups:

- 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.



Month when vaccine or placebo was given

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.

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(5)

(Total 15 marks)

Q26.

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. 5

Scientists believe that it may be possible to develop vaccines that make use of microfold cells. These vaccines could be swallowed in tablet form. 10

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.

_____

_____

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(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.

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(5)

(Total 8 marks)

Q27.

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.

_____

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(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).

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_____

_____

_____

_____

(2)

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

_____

_____

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_____

_____

(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.

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(3)

(Total 10 marks)

Q28.

(a) What is a pathogen?

_____

(1)

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

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(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.

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(2)

(Total 7 marks)

Q29.

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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_____

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_____

(3)

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

_____

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_____

(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. _____

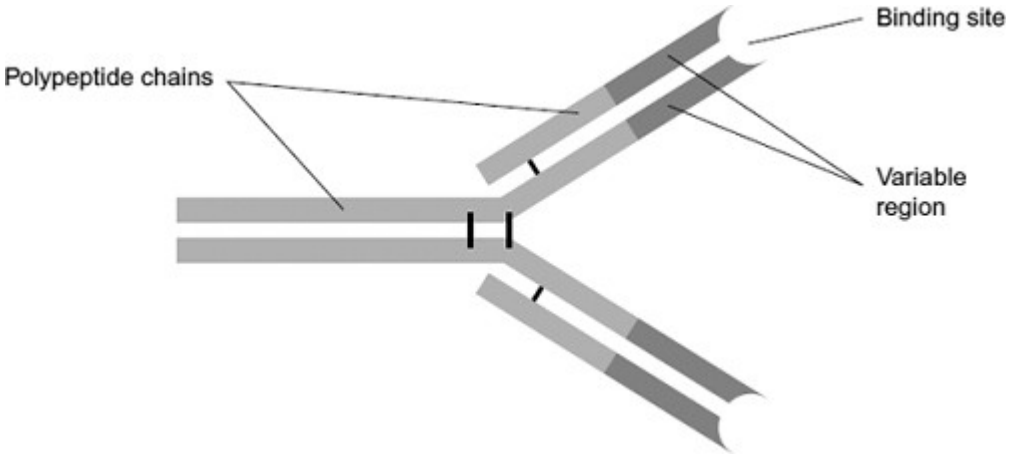
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(2)

(Total 7 marks)

Q30.

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.

_____

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(3)

(Total 4 marks)

Q31.

Vaccines protect people against disease. Explain how.

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(Total 5 marks)

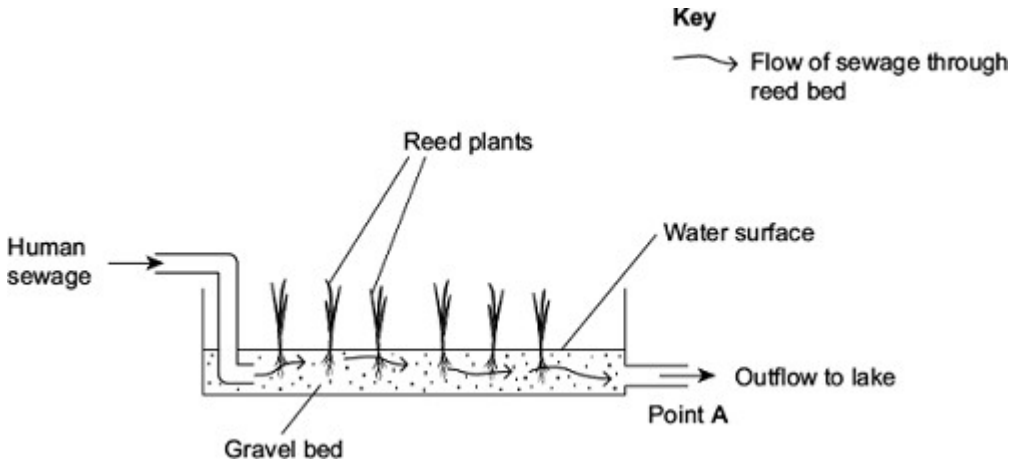
Q32.

(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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_____

(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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_____

(3)

(Total 8 marks)

Q33.

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.

_____

_____

_____

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_____

(3)

(Total 7 marks)

Q34.

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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(4)

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

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(6)

(Total 10 marks)

Q35.

(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*.

_____

_____

_____

_____

_____

(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.

_____

_____

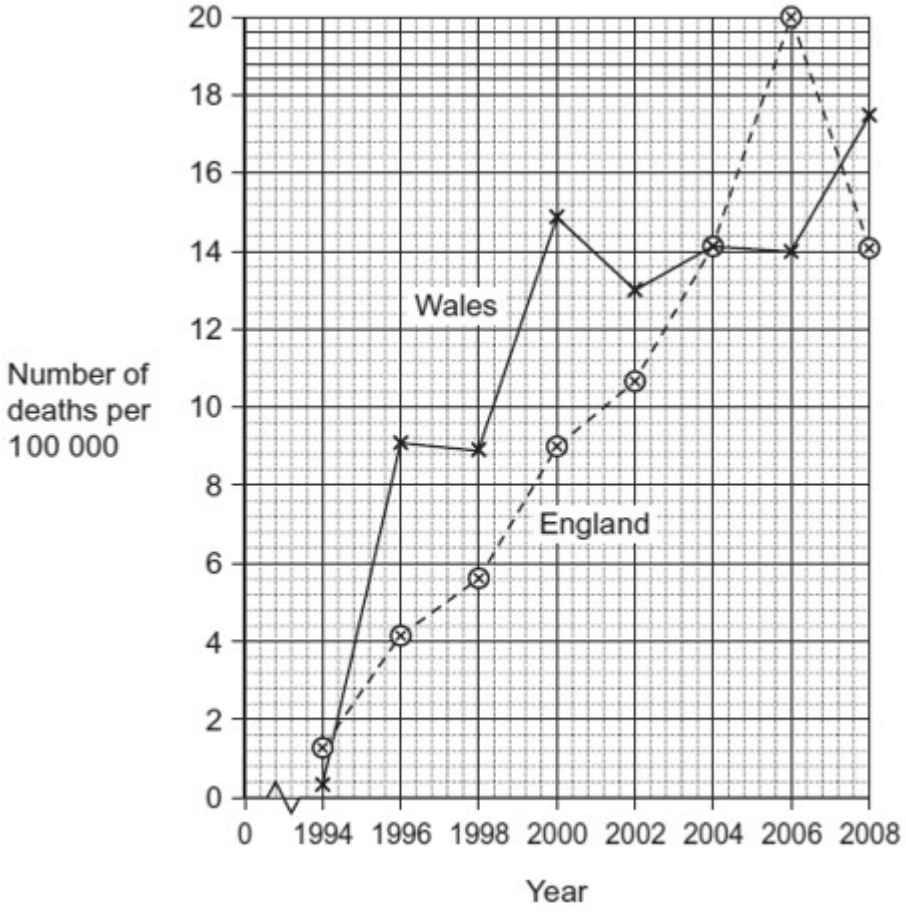
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(2)

(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)

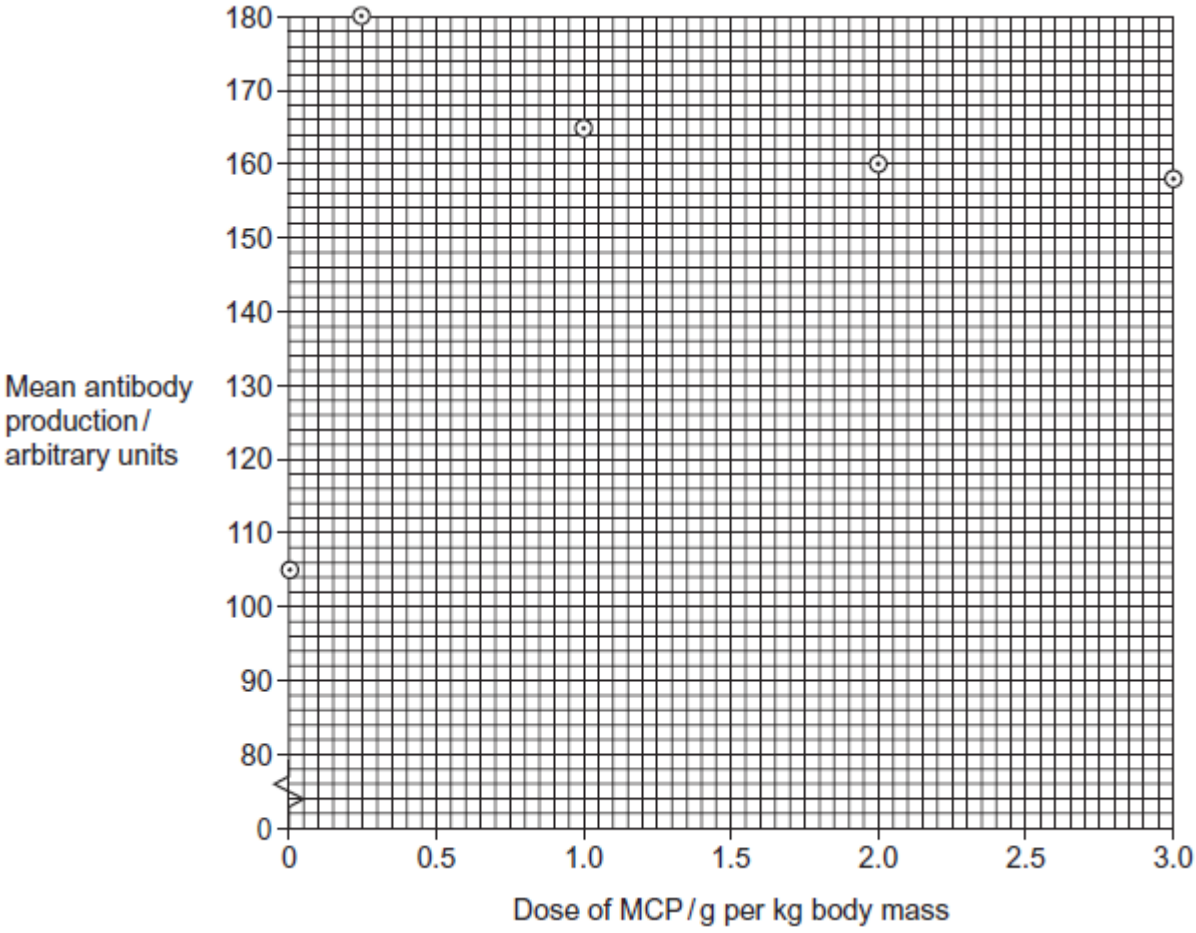
(Total 9 marks)

Q36.

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.

_____

_____

_____

_____

_____

_____

(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)

Q37.

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)

Q38.

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)

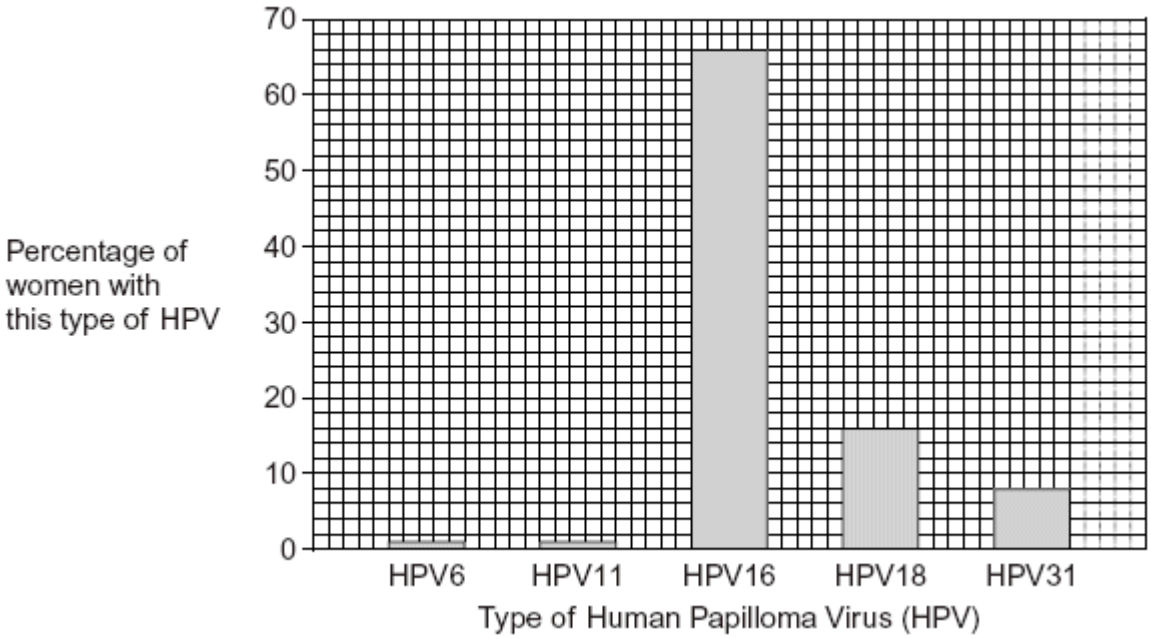
(Total 10 marks)

Q39.

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)

Q40.

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)

Q41.

(a) Give **two** ways in which pathogens can cause disease when they enter the body of their host.

1. _____

_____

2. _____

_____

(2)

(b) Vaccines provide protection against disease. What is a vaccine?

_____

_____

_____

_____

(2)

(c) The only vaccine used against pulmonary tuberculosis is the BCG vaccine. Scientists have carried out trials on a 'booster' vaccine, MVA85A. This 'booster' vaccine is designed to increase the immune response to the BCG vaccine. One trial involved measuring the increase in the number of memory T cells in three groups of adult volunteers following different vaccination programmes.

- Group **A** – injected with BCG
- Group **B** – injected with MVA85A
- Group **C** – injected with BCG and, two weeks later, injected with MVA85A

(i) Suggest **two** factors the scientists should have considered when selecting adult volunteers for this trial.

1. _____

2. _____

(2)

(ii) The adults in group C produced the greatest increase in the number of memory T cells. Suggest what this shows about the BCG and MVA85A vaccines.

_____

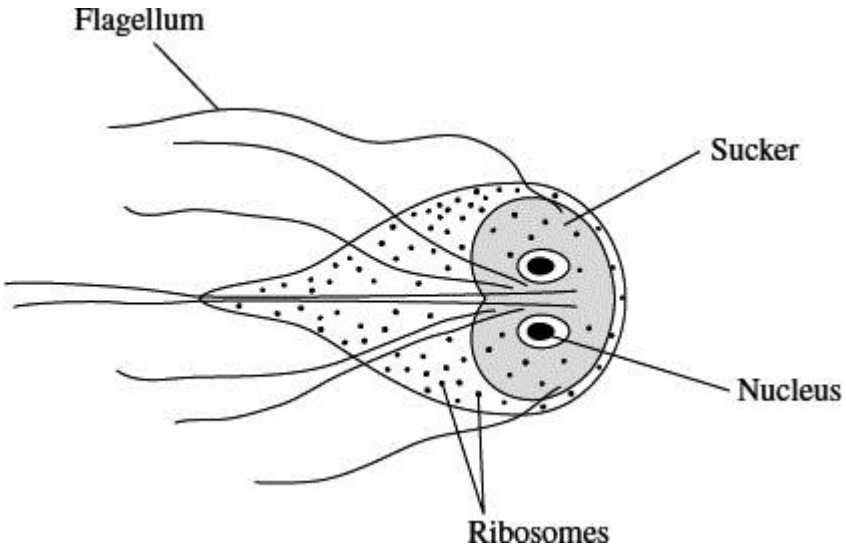
_____

(1)

(Total 7 marks)

Q42.

Giardiasis is an intestinal disease. It is caused by the microorganism *Giardia lamblia*. The drawing shows some of the structures present in *G. lamblia*.



(a) Name **one** structure shown in the drawing which confirms that *G. lamblia* is a eukaryotic organism.

_____

(1)

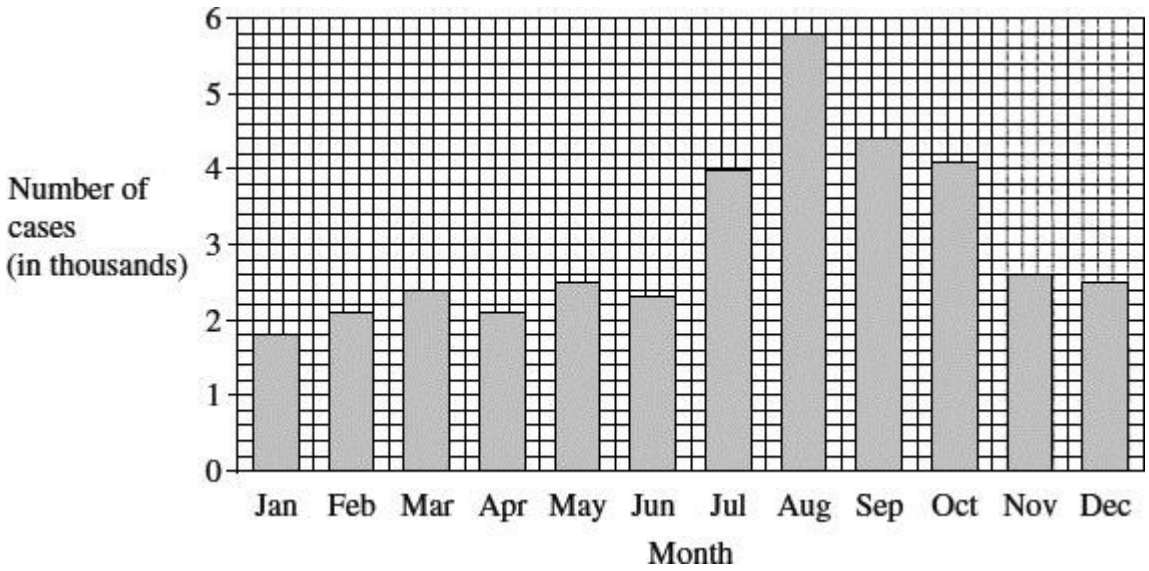
(b) *G. lamblia* can attach itself with its sucker. Explain how this is an adaptation to living in the intestines.

_____

_____

(1)

(c) Giardiasis is one of the main causes of diarrhoea in the USA. It is usually transmitted by drinking contaminated water. The bar chart shows the number of cases of giardiasis in one state of the USA during one year.



(i) Calculate the percentage increase in the number of cases of giardiasis from January to August. Show your working.

Answer _____

(2)

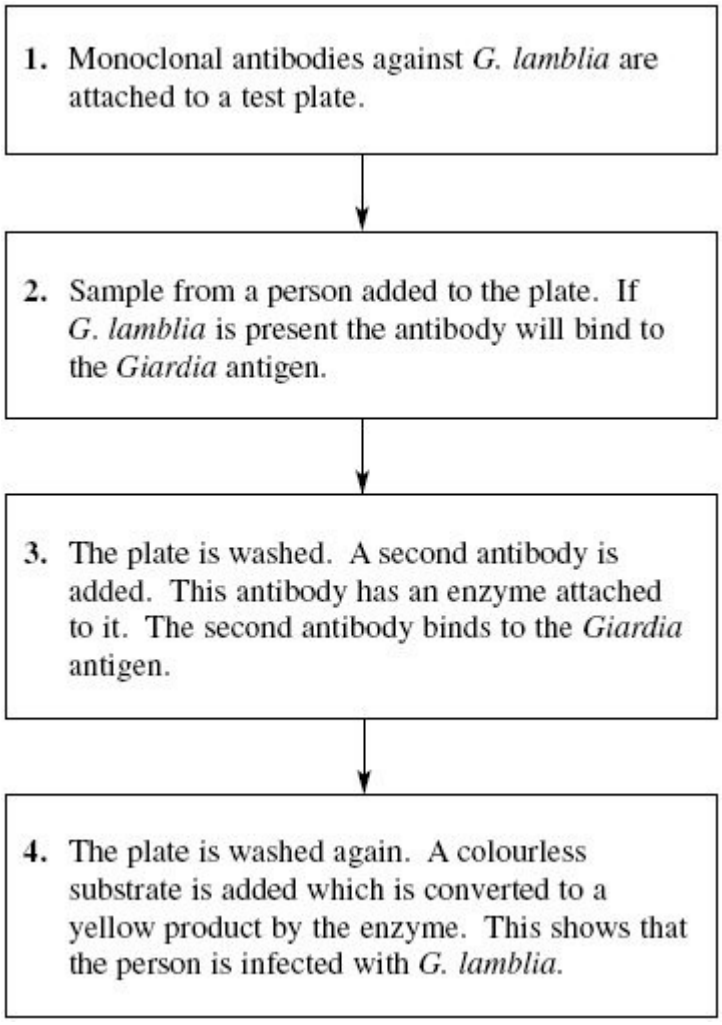
(ii) Suggest **one** reason for the number of cases being highest in the late summer months.

_____

_____

(1)

(d) A test has been developed to find out whether a person is infected with *G. lamblia.* The test is shown in the flow chart.



(i) Explain why the antibodies used in this test must be monoclonal antibodies.

_____

_____

(1)

(ii) Explain why the *Giardia* antigen binds to the antibody in step **2**.

_____

_____

(1)

(iii) The plate must be washed at the start of step **4**, otherwise a positive result could be obtained when the *Giardia* antigen is not present. Explain why a positive result could be obtained if the plate is not washed at the start of step **4**.

_____

_____

_____

_____

(2)

(Total 9 marks)

Q43.

Read the following passage.

Several diseases are caused by inhaling asbestos fibres. Most of these diseases result from the build up of these tiny asbestos fibres in the lungs.

One of these diseases is asbestosis. The asbestos fibres are very small and enter the bronchioles and alveoli. They cause the destruction of phagocytes and the surrounding lung tissue becomes scarred and fibrous. The fibrous tissue reduces the elasticity of the lungs and causes the alveolar walls to thicken. One of the main symptoms of asbestosis is shortness of breath caused by reduced gas exchange.

People with asbestosis are at a greater risk of developing lung cancer. The time between exposure to asbestos and the occurrence of lung cancer is 20–30 years.

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

(a) Destruction of phagocytes (lines 4–5) causes the lungs to be more susceptible to infections. Explain why.

_____

_____

_____

_____

(2)

(b) (i) The reduced elasticity of the lungs (lines 6–7) causes breathing difficulty. Explain how.

_____

_____

_____

_____

(2)

(ii) Apart from reduced elasticity, explain how changes to the lung tissue reduce the efficiency of gas exchange.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) (i) Doctors did not make the link between exposure to asbestos and an increased risk of developing lung cancer for many years. Use information in the passage to explain why.

_____

_____

(1)

(ii) Give **one** factor, other than asbestos, which increases the risk of developing lung cancer.

_____

(1)

(Total 10 marks)

Q44.

(a) Phagocytes and lysosomes are involved in destroying microorganisms. Describe how.

_____

_____

_____

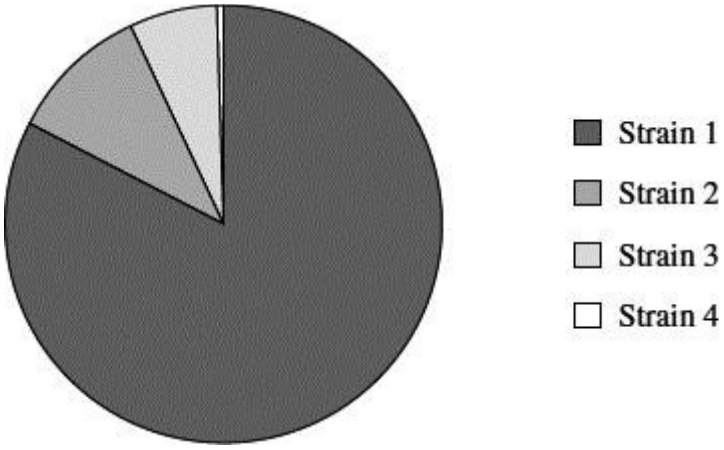
_____

_____

_____

(3)

(b) The pie chart shows the proportions of people infected with four different strains of influenza virus early in 2004.



(i) A person may develop influenza twice within a short time. Use information from the pie chart to explain why.

_____

_____

_____

_____

(2)

(ii) The information in the pie chart is valuable to companies who make influenza vaccines. Use your knowledge of antigens to explain why.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q45.

Read the following passage.

Campylobacter jejuni is a bacterium. It is one of the commonest causes of diarrhoea in humans. The illness that it causes does not usually last very long and many sufferers do not even go to the doctor. The only treatment required is the use of oral rehydration solutions to replace the water lost by diarrhoea. In 1998, laboratory tests confirmed 60 000 cases of diarrhoea caused by this bacterium in the UK. The bacterium was more frequently found in males than in females with a ratio of 1.5 : 1.

In rare cases, the nervous system may be affected. Scientists are now beginning to understand the cause of this. Sugars in the antigens on the surface of the bacteria are identical to some of the sugars on the surface of nerve cells. Antibodies produced against the bacteria may therefore attack the body's nerve cells. There can be serious problems if this leads to paralysis of the diaphragm. Breathing difficulties result and the patient may die.

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

(a) (i) The number of cases of diarrhoea confirmed as being caused by *Campylobacter jejuni* in the UK in 1998 was 60 000 (lines 4–5). Explain why the true number of cases is thought to be more than this.

_____

_____

_____

(1)

(ii) Calculate the number of cases of diarrhoea confirmed as being caused by *Campylobacter jejuni* in men in 1998.

Answer _____

(1)

(b) Explain why antibodies produced against *Campylobacter jejuni* also attack nerve cells (lines 9 –10).

_____

_____

_____

_____

_____

_____

(3)

(c) Explain how paralysis of the diaphragm leads to breathing difficulties (line 11).

_____

_____

_____

_____

_____

(2)

(Total 7 marks)

Q46.

(a) Describe how B-lymphocytes respond when they are stimulated by antigens.

_____

_____

_____

_____

_____

_____

_____

(4)

(b) The table gives information about some components of a red blood cell.

Component	Glycoprotein	Phospholipid	Haemoglobin
Location in cell	on outer surface of plasma membrane	within plasma membrane	in cytoplasm

Suggest which component of an intact red blood cell is most likely to act as an antigen during a blood transfusion. Explain your answer.

Component _____

Explanation _____

_____

_____

(2)

(Total 6 marks)

Q47.

(a) What is an antigen?

_____

_____

_____

(2)

(b) Describe how B-lymphocytes respond when they are stimulated by antigens.

_____

_____

_____

_____

_____

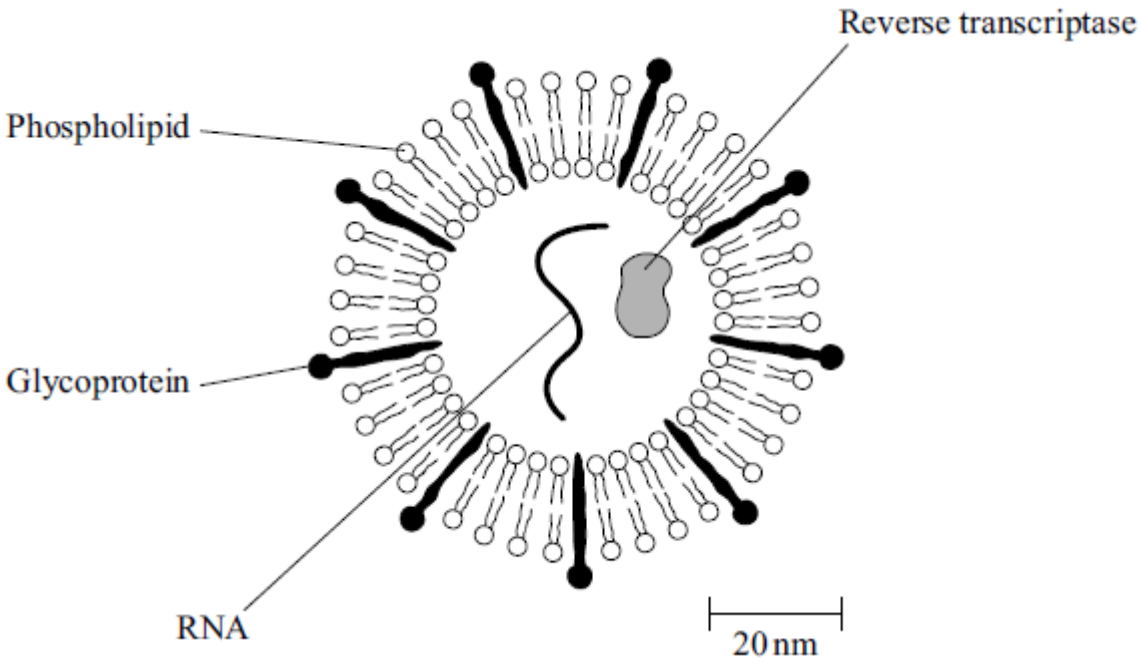
_____

_____

_____

(4)

(c) The diagram shows some components of a human immunodeficiency virus (HIV).



(i) Suggest which labelled component of the virus is most likely to act as an antigen. Give a reason for your answer.

Component _____

Reason _____

_____

(1)

(ii) A cell that HIV infects is 15 μm in diameter. Calculate how many times larger in diameter this cell is than an HIV particle. Show your working.

Answer _____ times larger

(2)

(Total 9 marks)

Q48.

(a) What is vaccination?

_____

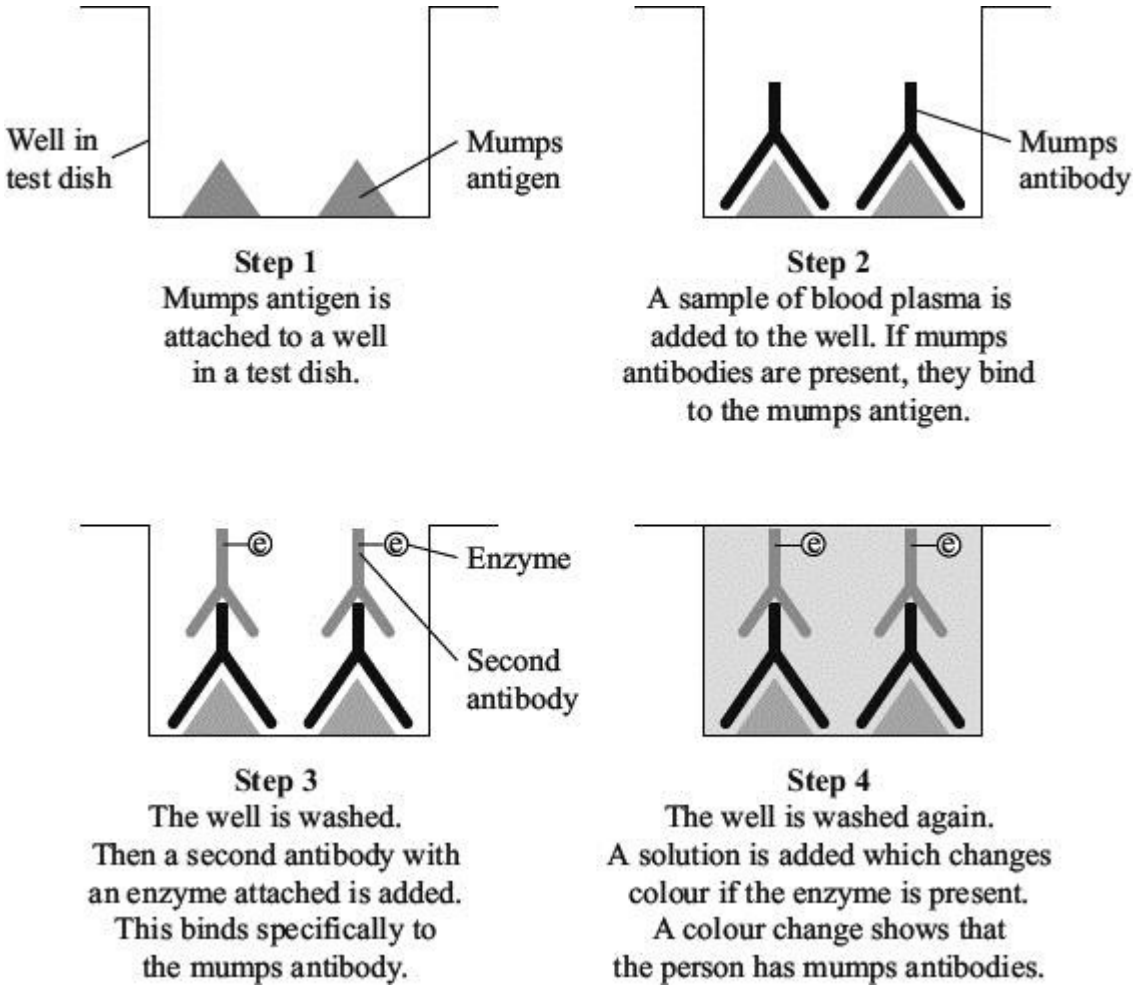
_____

_____

_____

(2)

(b) A test has been developed to find out whether a person has antibodies against the mumps virus. The test is shown in the diagram.



(i) Explain why this test will detect mumps antibodies, but not other antibodies in

the blood.

_____

_____

(1)

(ii) Explain why it is important to wash the well at the start of **Step 4**.

_____

_____

_____

_____

(2)

(iii) Explain why there will be no colour change if mumps antibodies are not present in the blood.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q49.

The box jellyfish produces a poison (venom) which enters the blood when a person is stung. A person who has been stung can be treated with an injection of antivenom. This antivenom is produced by injecting small amounts of venom from box jellyfish into sheep, then extracting antibodies from the sheeps' blood. These antibodies are then injected into the person who has been stung.

(a) If a sheep is injected with the box jellyfish venom on more than one occasion a higher yield of antivenom is obtained. Explain why.

_____

_____

_____

_____

(2)

(b) Injecting antivenom does not give a person lasting protection against the venom of box jellyfish. Explain why.

_____

_____

_____

_____

(2)

(c) Suggest **one** possible problem in injecting people with antivenom made in this way.

_____

_____

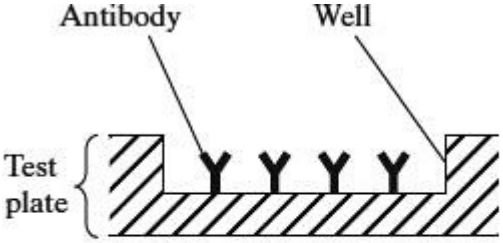
(1)

(Total 5 marks)

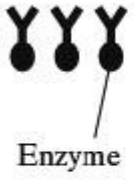
Q50.

A test has been developed to determine if a person is infected with variant CJD (vCJD), the human form of BSE (mad cow disease). The test detects the protein which causes vCJD in a urine sample.

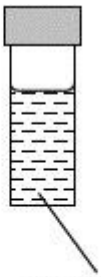
The test kit contains the following components.



A test plate with wells containing antibodies to the protein which causes vCJD

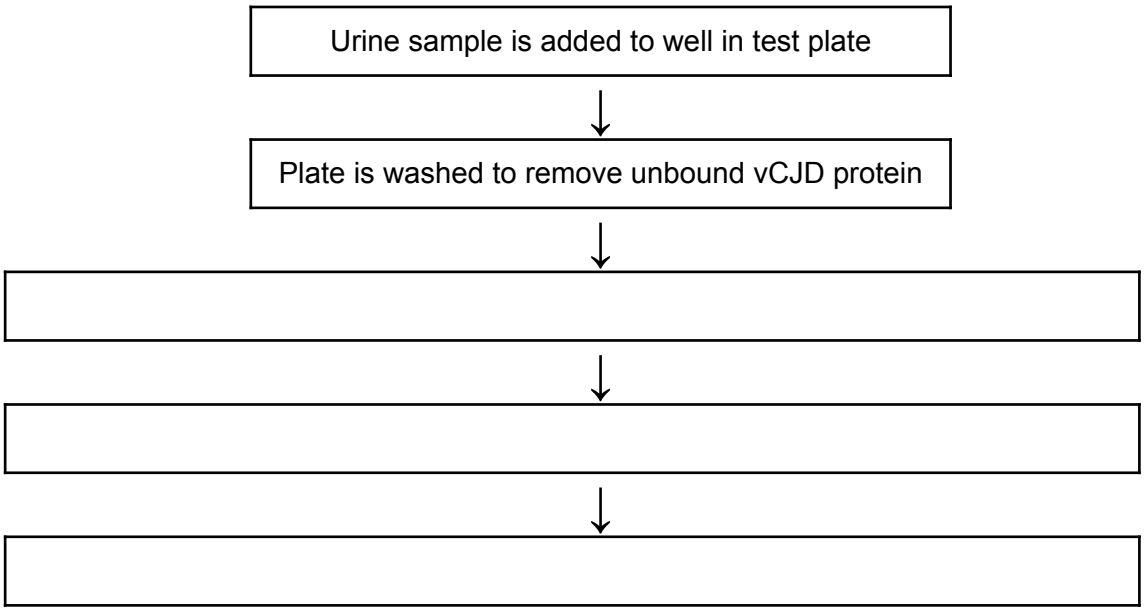


Antibodies to the protein which causes vCJD. These antibodies have an enzyme attached to them



Colourless solution which turns blue if the enzyme is present

(a) Complete the flow chart to describe how this test would be used.



(3)

(b) Explain why this test would detect vCJD, but not other antigens in the urine.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q51.

Read the following passage.

Herpes viruses cause cold sores and, in some cases, genital warts. Scientists are well on the way to producing an antibody which will counteract herpes infection. This antibody works by sticking to the virus and blocking its entry into cells. It has proved very effective in animal tests.

5 One drawback with this approach, however, is that antibodies are at present produced using hamster ovary cells. This method is expensive and only produces limited amounts. A new technique is being developed to produce antibodies from plants. It involves introducing the DNA which codes for the required antibody into crop plants such as maize.

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

(a) (i) What is an antibody?

_____

_____

_____

_____

(2)

(ii) Describe how antibodies are produced in the body following a viral infection.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(b) Describe how the antibody gene could be isolated from an animal cell and introduced into a crop plant such as maize (lines 7-8).

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Taking a course of these antibodies from plants to treat a herpes infection would not produce long-term protection against disease. Explain why.

_____

_____

_____

_____

(2)

(d) Explain **one** advantage of using antibodies from plants to treat a disease, rather than antibodies produced in an experimental animal (lines 5-6).

_____

_____

(1)

(Total 15 marks)

Q52.

Some strains of the bacterium that causes gonorrhoea are resistant to antibiotics. This makes the disease difficult to treat. One way of testing the effectiveness of antibiotics is to use discs of paper soaked in antibiotic. These are placed in the centre of an agar plate covered by bacteria. A clear zone forms around the disc if the antibiotic is effective.

The table shows some results of an investigation into the effect of four different antibiotics on gonorrhoea bacteria.

Antibiotic	Diameter of clear zone / mm	Minimum diameter of clear zone if antibiotic is effective / mm
A	47	52
B	30	28
C	22	40
D	33	34

(a) Give **two** reasons why it would be important to use sterile techniques during this investigation.

1. _____

_____

2. _____

_____

(2)

(b) (i) The antibiotic reached the bacteria by diffusion. Suggest why an effective antibiotic may produce only a small clear zone.

_____

_____

(1)

(ii) Which antibiotic used in the investigation would be most useful for treating gonorrhoea? Explain your answer.

Antibiotic _____

Explanation _____

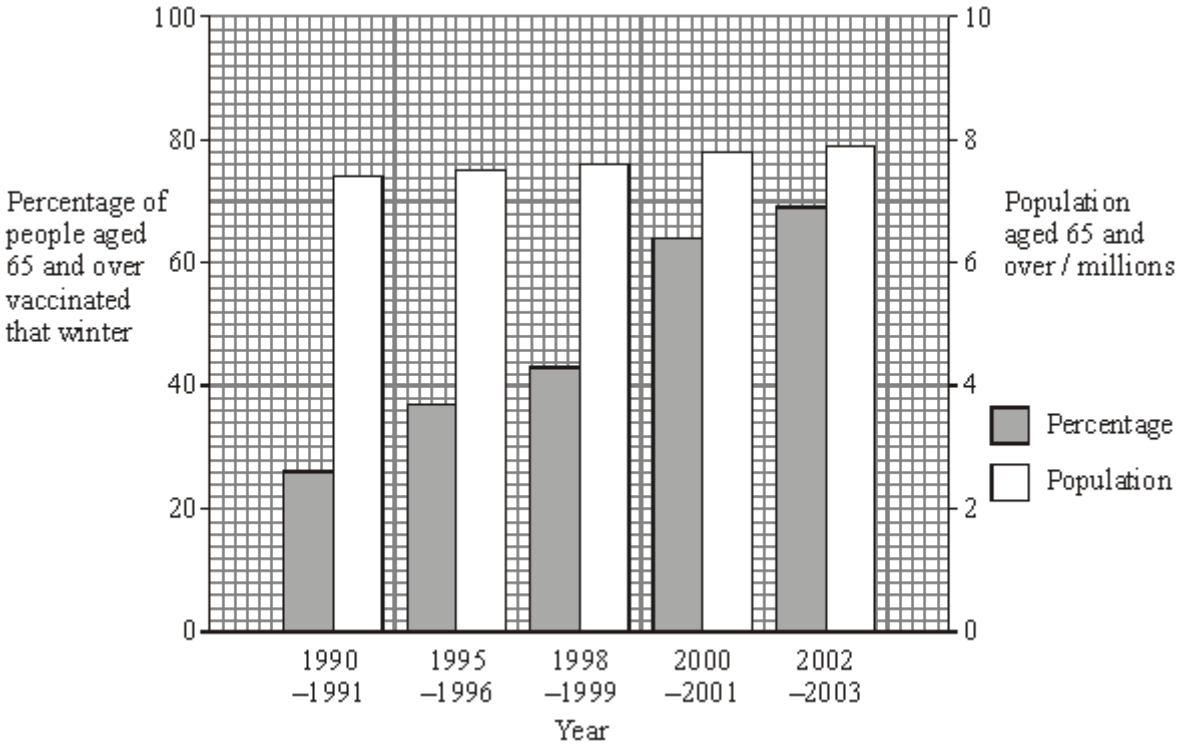
_____

(2)

(Total 5 marks)

Q53.

People considered ‘at risk’ are offered a vaccination against influenza each year. The bar chart shows the number of people in the UK population aged 65 and over and the percentage of those who were vaccinated against influenza each winter.



(a) Suggest **one** reason to explain the change in the percentage of people aged 65 and over being vaccinated.

_____

_____

(1)

(b) (i) Calculate the change in the total number of people aged 65 and over being vaccinated between 1990/91 and 2000/01. Show your working.

Answer _____

(2)

(ii) A student suggested that some people aged 65 and over were being vaccinated every year. Explain how the information in the bar chart supports this suggestion.

_____

_____

_____

_____

_____

(2)

(iii) Suggest why it is advisable for people to be vaccinated against influenza every year.

_____

_____

_____

_____

(2)

(c) An influenza virus consists of a protein coat surrounding nucleic acid. The influenza vaccine consists only of the protein coat of the virus. Explain how the influenza vaccine produces immunity in the body.

_____

_____

_____

_____

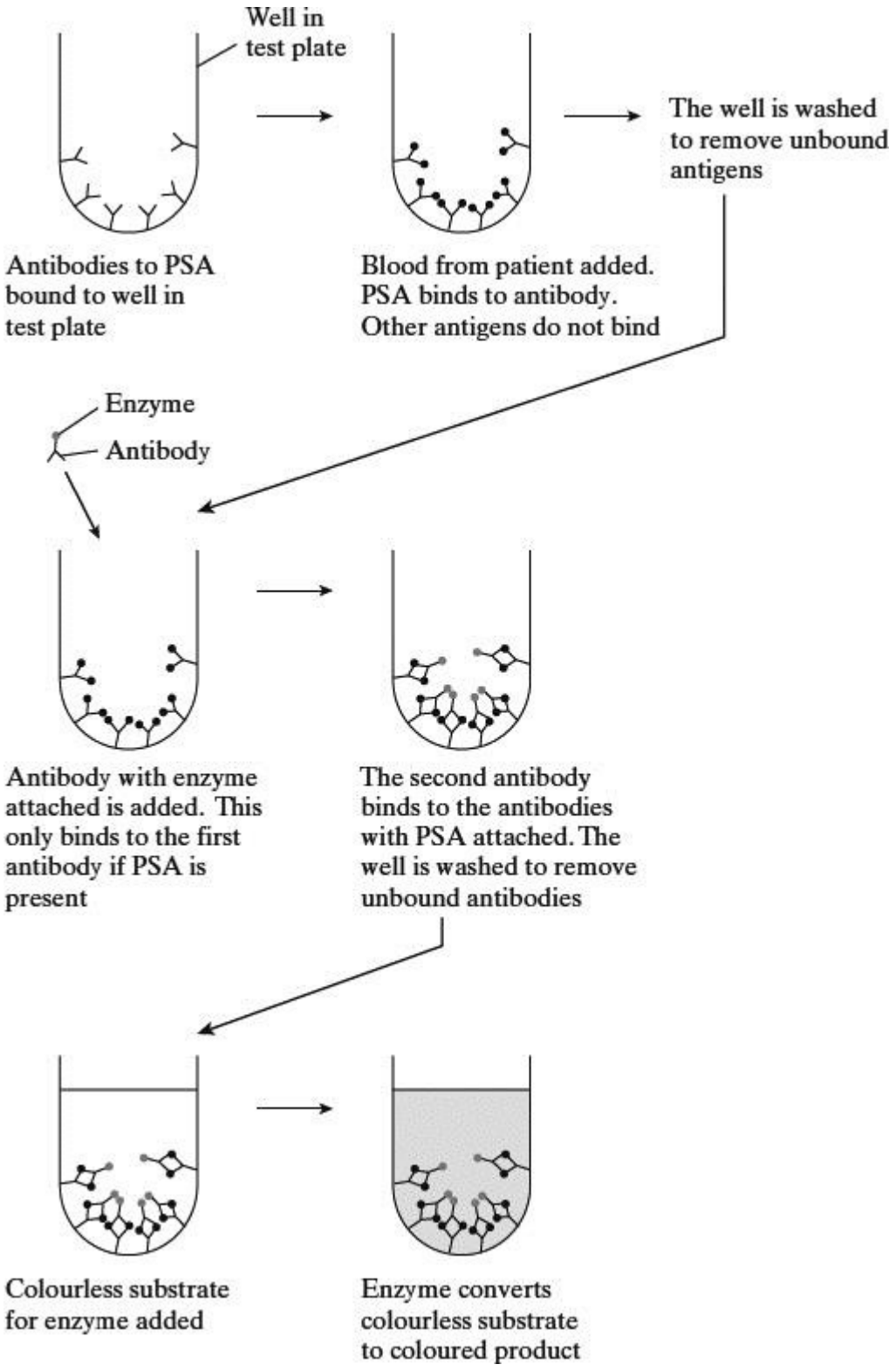
(2)

(Total 9 marks)

Q54.

An antigen called PSA is present in the blood of men in the early stages of prostate cancer.

There is a blood test for PSA. The test uses monoclonal antibodies to PSA. The stages in the test are shown in the diagram.



(a) (i) What is an antigen?

_____

_____

_____

_____

(2)

(ii) What is a *monoclonal* antibody?

_____

_____

_____

_____

(2)

(b) (i) Explain why this test detects prostate cancer, but not any other disease.

_____

_____

_____

_____

(2)

(ii) Explain why there will not be a colour change if the blood sample does not contain PSA.

_____

_____

_____

_____

(2)

(Total 8 marks)

Q55.

Read the following passage.

The life cycle of the malarial parasite consists of a number of stages. Some of these stages occur in humans and some occur in mosquitoes. At each stage, the parasite has different antigens on the surface of its cells. Attempts have been made to extract some of these antigens and use them to make vaccines to combat the disease. A trial has recently been carried out with one of these vaccines. An injection of the vaccine was given to a group of people chosen at random at the start of the trial. Another injection was given 30 days later.

Blood samples were taken at regular intervals throughout the trial. After the first injection, the concentration of antibody in the blood rose slowly then fell quickly. After the second injection, the concentration rose quickly. It reached a maximum concentration of approximately twice the concentration it reached after the first injection.

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

(a) What is meant by *antigens* (line 3)?

_____

_____

_____

_____

(2)

(b) (i) Use information from the passage to sketch a graph to show the effects of the two injections on the concentration of antibody in the blood.

(3)

(ii) Suggest **one** reason why it was necessary to give two injections of the vaccine (line 6).

_____

_____

(1)

(iii) Although this vaccine is made from antigens from malarial parasites, it does not cause malaria. Explain why this vaccine does not cause malaria.

_____

_____

_____

_____

(2)

(c) The blood from those taking part in the trial was also examined under the microscope at the beginning of the trial. Explain how this would enable those who had malaria to be identified.

_____

_____

(1)

(Total 9 marks)

Q56.

Read the following passage.

Malaria is a disease so deadly that it has devastated armies and destroyed great civilisations. It has been estimated that in the course of history malaria has been responsible for the death of one out of every two people who have ever lived. Even today, with all the advantages of modern technology, it is still responsible for some three million deaths a year.

The first half of the twentieth century was a time of hope for malarial control. The drugs chloroquine and proguanil had just been discovered and there seemed a real possibility of a malaria-free world. Unfortunately, this honeymoon ended almost as soon as it had started, with the emergence of drug-resistant parasite populations. Scientists now accept that whatever new drug they come up with, it is likely to have a very limited effective life. As a result, they are increasingly looking at combinations of drugs.

The approach to malaria control which holds the best hope is the production of a vaccine. One of these is being developed by a researcher in South America. His vaccine is based on a small synthetic polypeptide called SPf66 which is dissolved in a saline solution and given as an injection. A series of early trials on human volunteers produced confusing results. In one trial the effectiveness of the vaccine was claimed to be 80% while, in others, the results were statistically insignificant. Not only were the results inconclusive but the methods used were challenged by other scientists. In particular, the controls were considered inappropriate.

Another, possibly more promising, approach has been the development of a DNA-based vaccine. In theory, all that is required is to identify the DNA from the parasite which encodes key antigens. Unfortunately, scientists have hit snags. Although they have succeeded in sequencing the human genome, the genome of the malarial parasite has created major difficulties. This is partly because of the very high proportion of the bases adenine and thymine. In some places these two bases average 80%, and on chromosomes 2 and 3 nearly 100% of the bases present are adenine and thymine. Because of this, it has proved impossible to cut the relevant DNA with the commonly available restriction enzymes into pieces of a suitable size for analysis.

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

(a) Explain how a resistant parasite population is likely to arise and limit the life of any new anti-malarial drug (lines 8 - 9).

_____

_____

_____

_____

_____

_____

(3)

(b) A person has a 1 in 500 probability of being infected by a chloroquine-resistant strain of malarial parasite and a 1 in 500 probability of being infected by a proguanil-resistant strain. Use a calculation from these figures to explain why scientists are “increasingly looking at combinations of drugs” (lines 9 - 10).

_____

_____

_____

_____

(2)

(c) (i) Explain why trials of the SPf66 vaccine needed a control.

_____

_____

(1)

(ii) The controls for the SPf66 vaccine trials were considered inappropriate (line 17).

Suggest how the control groups in these trials should have been treated.

_____

_____

_____

_____

(2)

(d) In some of the DNA of a malarial parasite, the proportion of adenine and thymine bases averages 80% (lines 22 - 23). In this DNA what percentage of the nucleotides would you expect to contain

(i) phosphate; _____

(ii) guanine? _____

(2)

(e) (i) Use your knowledge of enzymes to explain why restriction enzymes only cut DNA at specific restriction sites.

_____

_____

_____

_____

_____

_____

(3)

(ii) Restriction enzymes that can cut the DNA of chromosomes 2 and 3 produce pieces that are too small for analysis. Explain why these restriction enzymes produce small DNA fragments.

_____

_____

_____

_____

(2)

(Total 15 marks)

Q57.

(a) Give **two** factors, other than cost, that should be considered when selecting an antibiotic to treat a bacterial disease.

1. _____

_____

2. _____

_____

(2)

(b) The table describes the effects of two antibiotics on bacteria.

Antibiotic	Effect
Tetracycline	prevents tRNA binding
Chloramphenicol	prevents peptide bonds forming

(i) Explain how each of these antibiotics slows down the rate of growth of bacteria.

Tetracycline _____

_____

_____

_____

Chloramphenicol _____

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(4)

(ii) Suggest why tetracycline has no effect on human cells.

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(1)

(Total 7 marks)

Q58.

(a) An antigen in a vaccine leads to the production of antibodies. Describe the part played by B lymphocytes in this process.

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(4)

(b) Hepatitis B vaccine contains a viral antigen produced by genetically modified bacteria. Describe how the isolated gene that codes for a protein in the virus's coat could be transferred to the bacterial cells.

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(3)

(Total 7 marks)

Q59.

(a) *Salmonella typhimurium* causes food poisoning in humans but not in other mammals. Explain why these bacteria attach to human cells but not to the cells of other mammals.

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(2)

(b) Salmonella bacteria release toxins that cause the body temperature to rise. Although a small increase in body temperature can be beneficial, a large increase can cause serious harm.

Explain how a large increase in a person's body temperature can cause harm.

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_____

_____

_____

(2)

(c) Some species of bacteria, which live in soil and decompose organic material, release exotoxins. Suggest how the release of exotoxins benefits the bacteria.

_____

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(1)

(d) Washing hands with anti-bacterial soap reduces the risk of transmission of the bacteria that cause food poisoning. Tea tree oil is a plant extract used in soaps. It is claimed to have anti-bacterial properties. Outline a method for investigating this claim.

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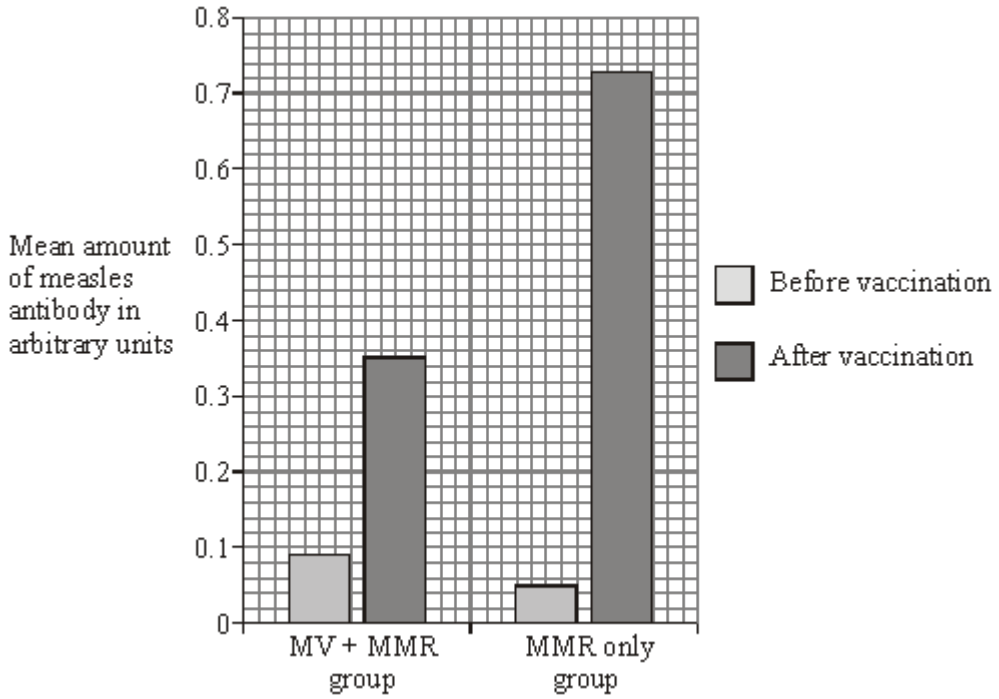
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(4)

(Total 9 marks)

Q60.

Measles is an infectious disease that can cause serious complications in children. In countries where measles is uncommon a combined measles, mumps and rubella vaccine (MMR) is given at 15 months. In a country where measles is common a single measles vaccine (MV) may be given at 9 months, followed by MMR at 15 months. In an investigation, the efficiency of the two vaccination programmes was compared in a country where measles is common. The amount of measles antibody in the blood of children before vaccination and after completing vaccination were measured. The graph shows the results. All difference are statistically significant.



(i) What was the effect of vaccination in the MMR only group? Express your answer as the percentage increase in the amount of measles antibody in the MMR group after vaccination. Show your working.

Percentage increase _____ %

(2)

(ii) The MV + MMR group had more measles antibodies in their blood before vaccination than the MMR only group. Suggest an explanation for this.

_____

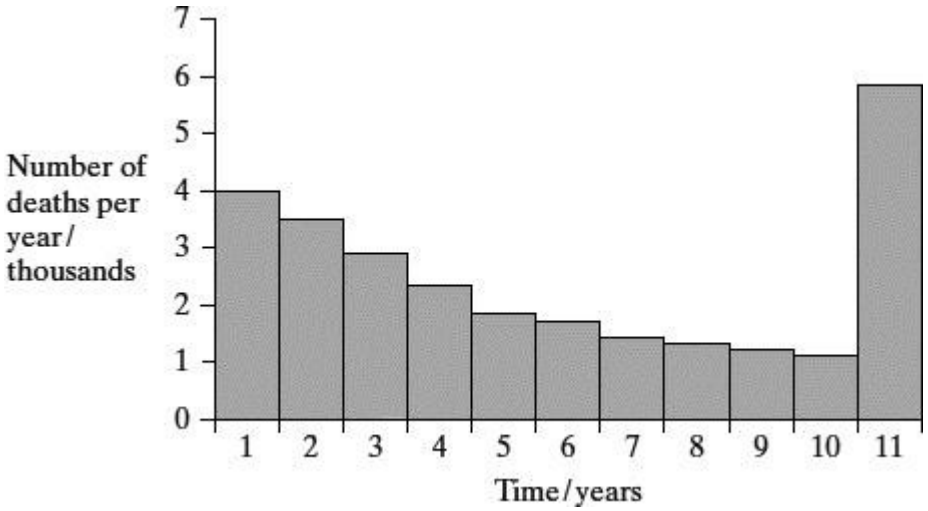
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(1)

(Total 3 marks)

Q61.

(a) The graph shows the number of deaths from influenza per year in a developed country.



(i) Suggest an explanation for the change in the number of deaths from influenza during the first 10 years.

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_____

(1)

(ii) Suggest an explanation for the large increase in the number of deaths from influenza in year 11.

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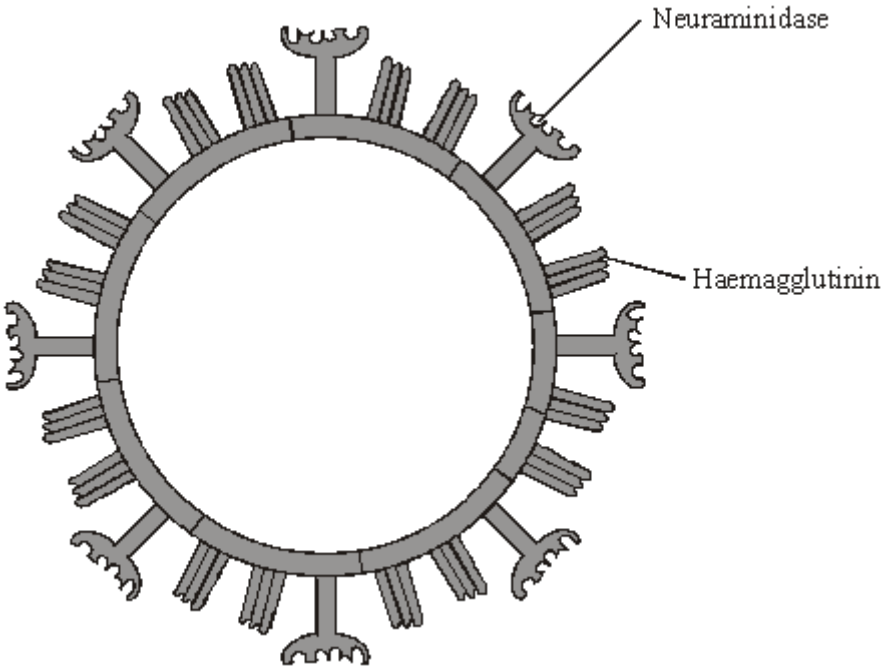
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(2)

(b) The diagram shows some of the structures on the outside of an influenza virus.



Haemagglutinin and neuraminidase are protein molecules. Haemagglutinin binds to receptor molecules on the surface of epithelial cells in the breathing system. Neuraminidase is an enzyme which breaks down molecules in the surface membrane of epithelial cells and allows the viruses to be released from the cells.

(i) Describe how T lymphocytes recognise and respond to the influenza virus.

_____

_____

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_____

(2)

(ii) Describe how B lymphocytes respond to the influenza virus.

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(2)

(c) New drugs have recently become available for treating influenza. One type is a neuraminidase inhibitor. Explain how this type of drug would act as a treatment for influenza.

_____

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(2)

(Total 9 marks)

Q62.

(a) Changes to the protein coat of the influenza virus cause antigenic variability. Explain how antigenic variability has caused some people to become infected more than once with influenza viruses.

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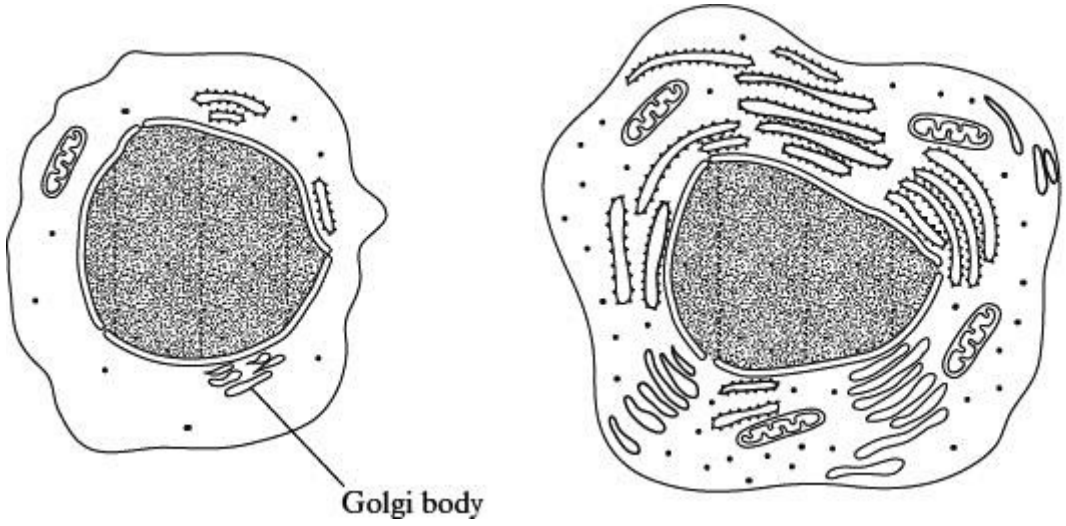
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(2)

(b) The drawings show the changes in a B lymphocyte after stimulation by specific antigens.



B lymphocyte before stimulation B lymphocyte after stimulation

(i) Describe the role of macrophages in stimulating B lymphocytes.

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_____

(1)

(ii) Explain how the changes shown in the drawings are related to the function of B lymphocytes.

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(4)

(Total 7 marks)

Q63.

A medical officer investigated the effectiveness of five different types of influenza vaccine. A total of 1350 people agreed to be vaccinated. The medical officer divided these into five groups. The number who suffered from influenza in the following year was recorded. The results are shown in the table.

	Number of people vaccinated			
Type of influenza vaccine	**Suffered from influenza**	**Did not suffer from influenza**	**Total**	**Proportion suffering from influenza**
I	43	237	280	0.15
II	52	198	250	0.21
III	25	245	270	0.09
IV			260	0.18
V	57	233	290	0.20

(a) Complete the spaces in the table for the people vaccinated with type IV vaccine.

(1)

(b) The medical officer used a statistical test to assess the effectiveness of the five different vaccines.

(i) What would be the null hypothesis?

_____

_____

(1)

(ii) The statistical test gave a probability of less than 0.05. What conclusion can be drawn from this?

_____

_____

(1)

(c) It was suggested that the raw data showed that the type III vaccine was the most effective. Give **two** reasons why this conclusion may not be reliable.

1. _____

_____

2. _____

_____

(2)

(Total 5 marks)