

(4)

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

(2)

(Total 10 marks)

Q2. (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.

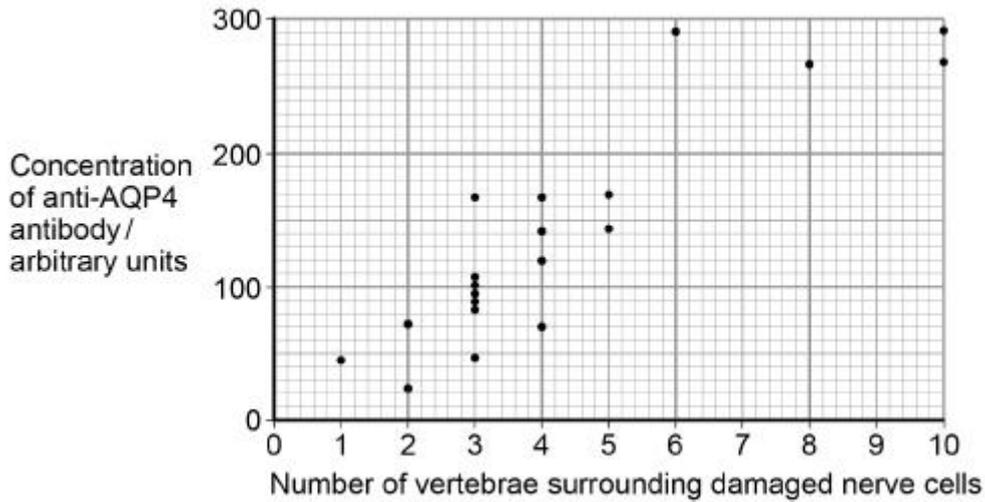
Explain why the anti-AQP4 antibody only damages these cells.

(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.

(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.

(2)

(Total 9 marks)

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).

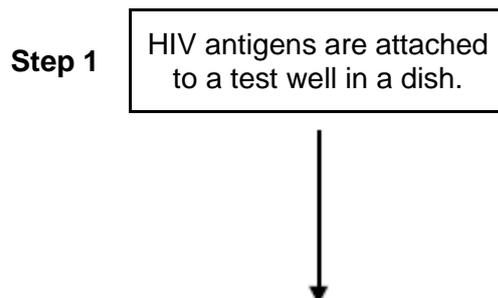
_____ (2)

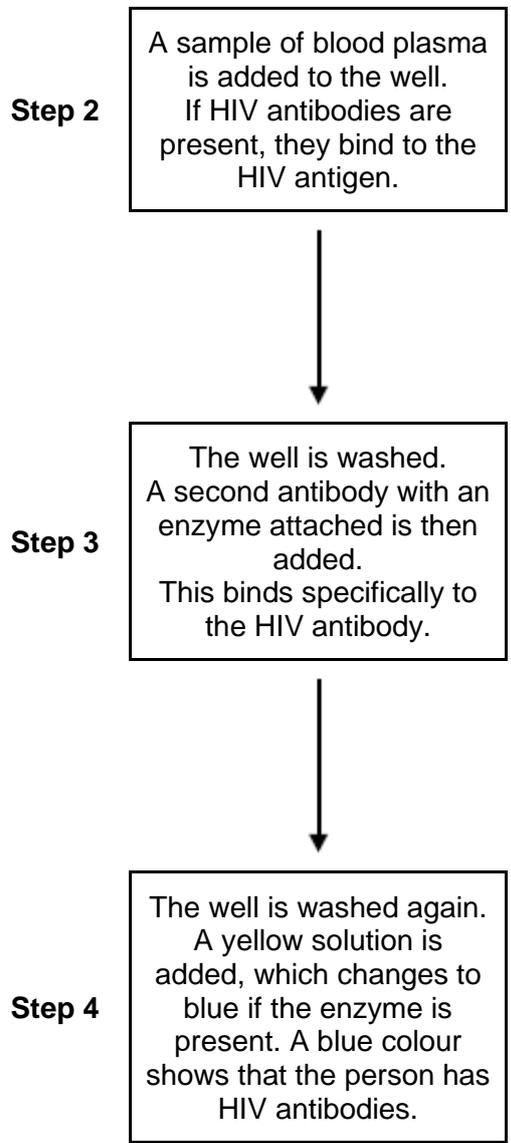
(d) Describe how the control group should have been treated.

_____ (2)

(Total 7 marks)

Q5. 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)

Q6. 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. 10

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.

_____ (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)

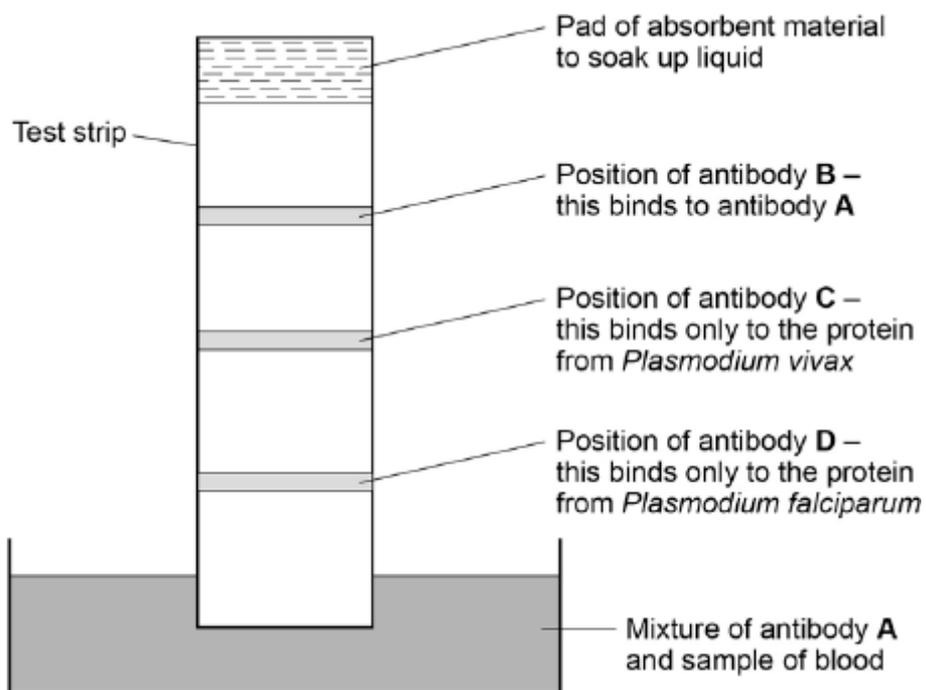
- (d) A high mutation rate makes it difficult to develop a vaccine (line 11). Explain why.

Q7. 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*.

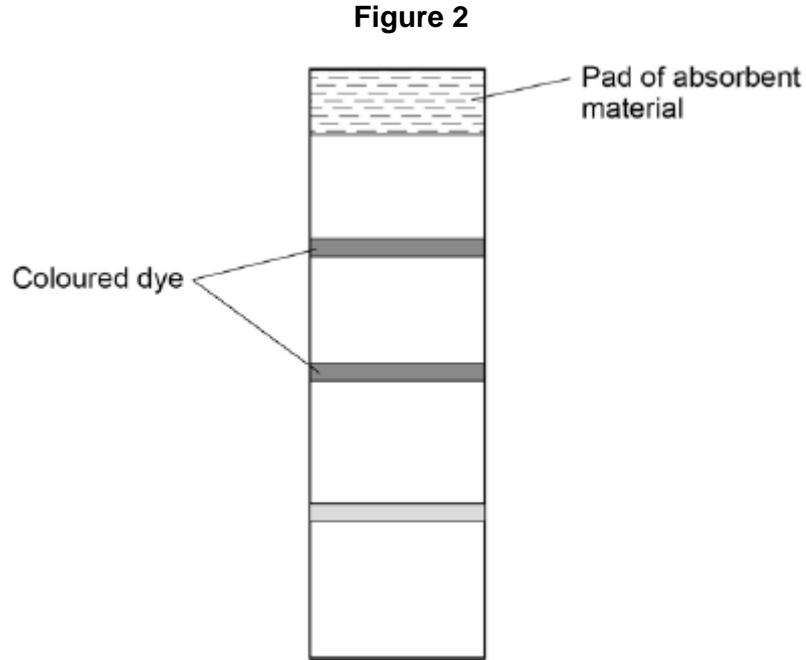
(2)

(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.



What can you conclude from this result?
Explain how you reached your conclusion.

(Extra space) _____

(4)
(Total 8 marks)

Q8. 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. 5

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. 10

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)

Q9. 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)

Q10. 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)

Q11. (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)

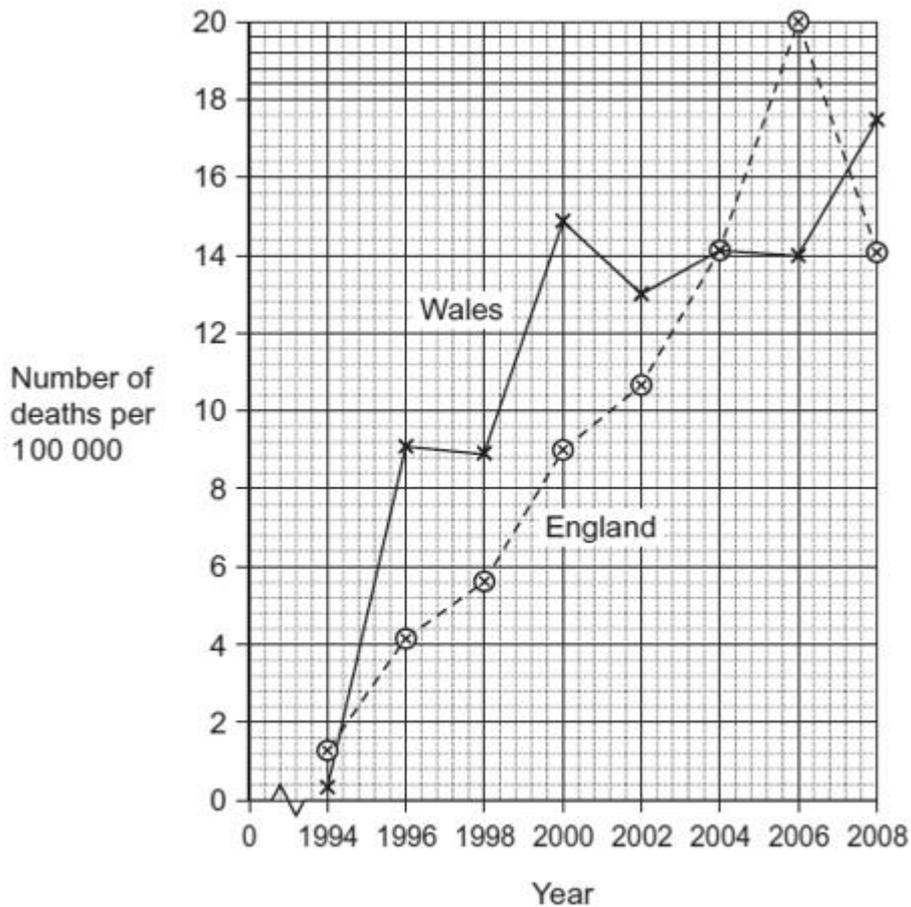
(ii) Suggest why older people are more likely to be affected by *C. difficile*.

(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.

(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)

Q12. Different cells in the body have different functions.

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

(Extra space) _____

(4)

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

(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.

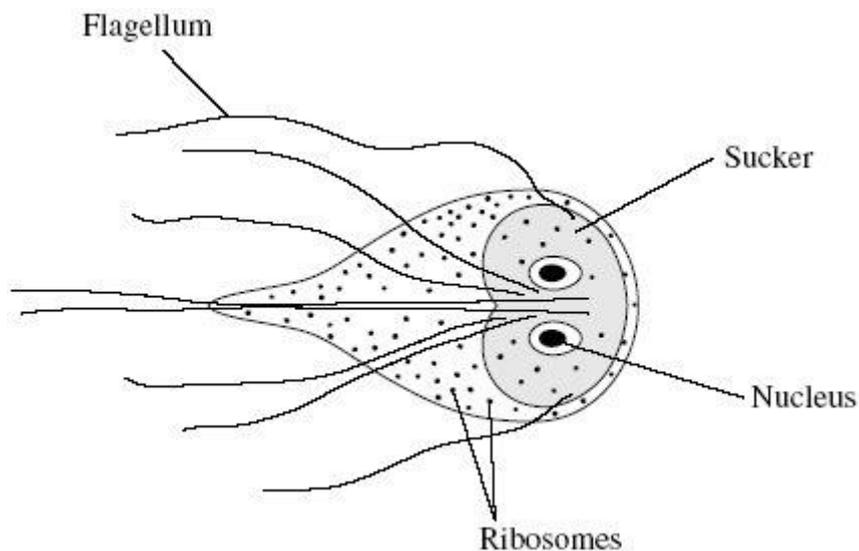
(2)

- (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)

Q15. Giardiasis is an intestinal disease. It is caused by the microorganism *Giardia lamblia*. The drawing shows some of the structures present in *G. lamblia*.

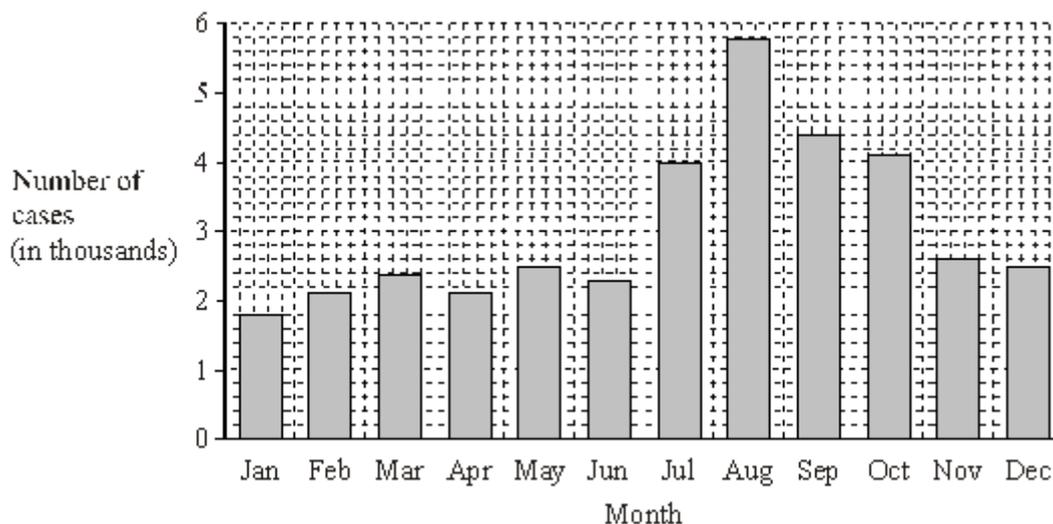


- (a) Name **one** structure shown in the drawing which confirms that *G. lamblia* is a eukaryotic organism.

(1)

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

- (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.

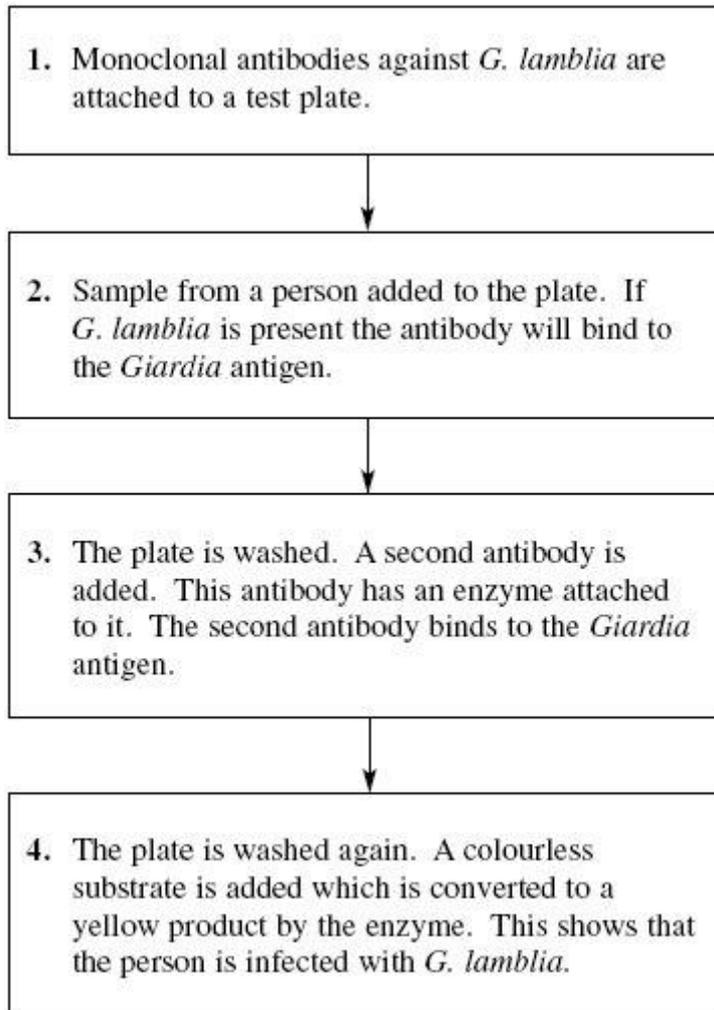
Answer _____

(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)

Q16. 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.

5

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.

10

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)

Q17. 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. 5

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. 10

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.

(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)

Q18. 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.

5 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.

10 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) Antibiotics are **not** used to treat viral infections, such as HIV. Explain why.

(2)

(d) (i) When HIV, anti-gal and the *adaptor molecule* were added to a culture of human cells, 90% of the virus did **not** infect human cells. (lines 12-15). Explain why.

(2)

(ii) Explain why a different type of adaptor molecule will have to be made to use against MRSA. (lines 16-17)

(2)

(Total 20 marks)

Q22.

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. 5

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. 10

15

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.

(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)

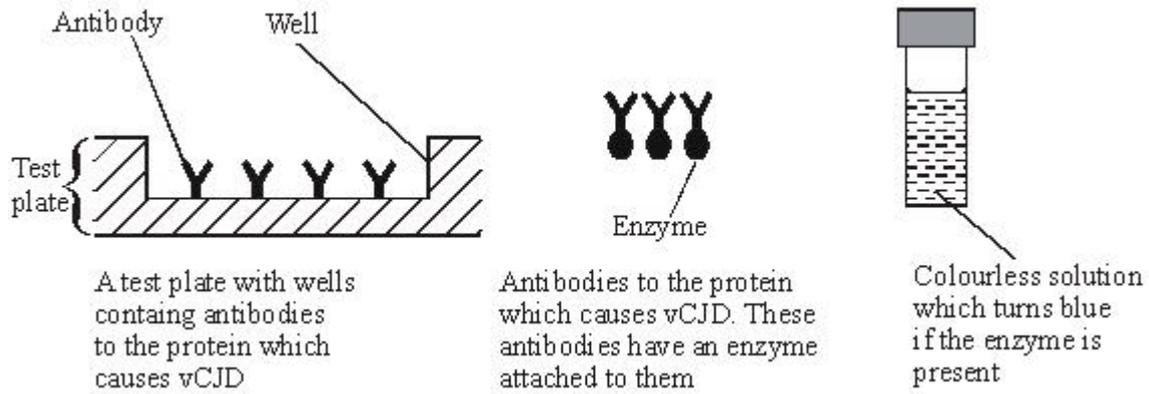
- (f) Suggest **one** reason why vaccinating a large number of people would reduce significantly the spread of HPV through the population (lines 14 to 16).

(2)

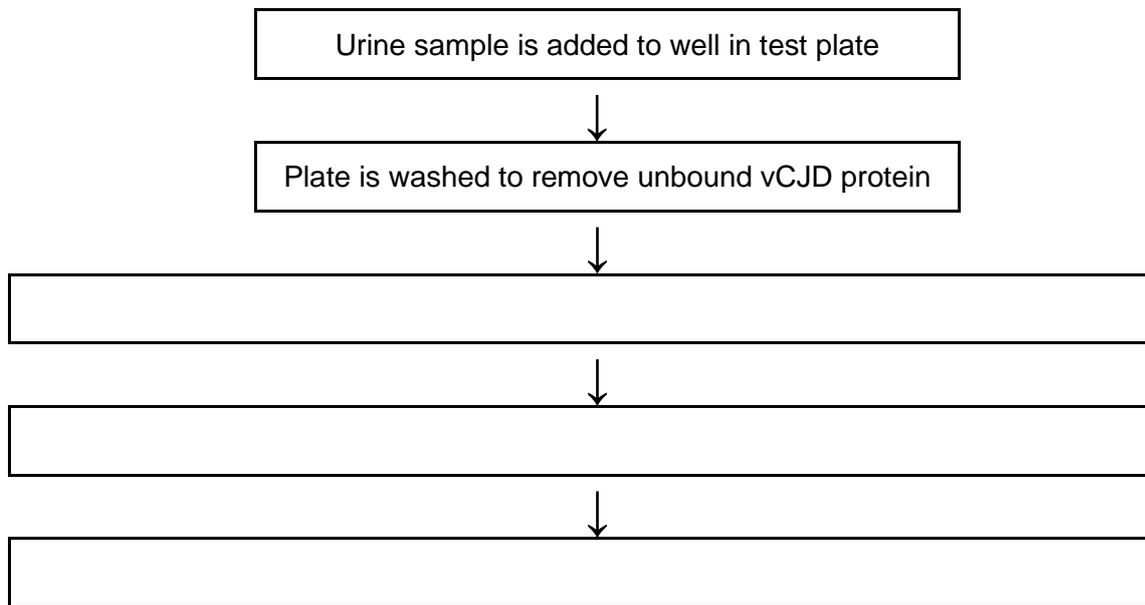
(Total 10 marks)

Q24. 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) 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)

Q25. 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.

(2)

- (c) 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)

Q26. 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.

(Extra space) _____

(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.

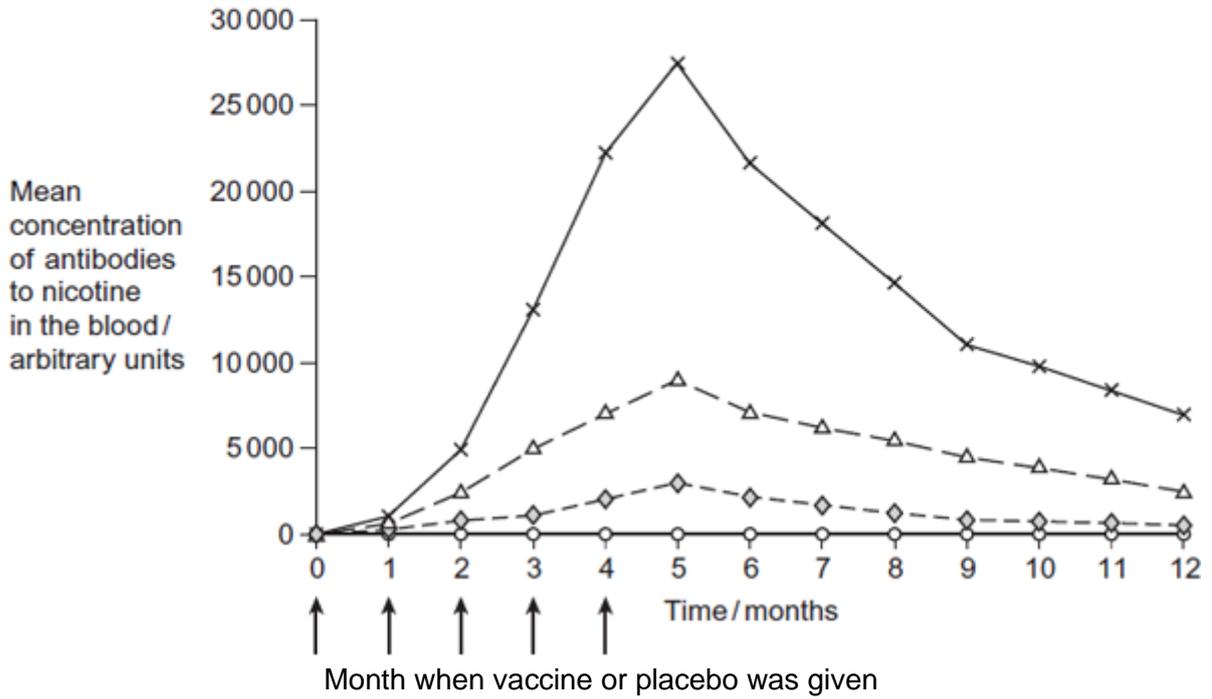
The figure below shows their results.

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.

Key

- x— High antibody responders —△— Medium antibody responders
- ◇— Low antibody responders —○— Placebo



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.

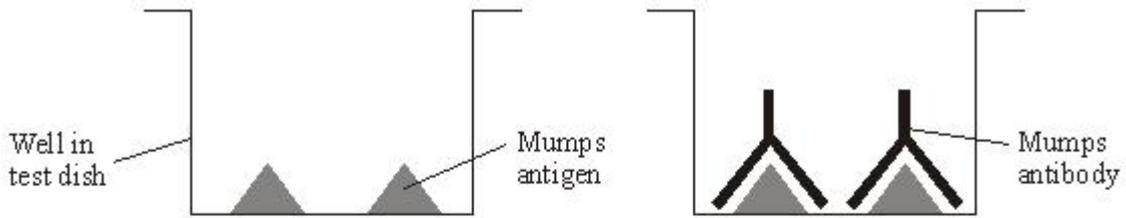
(Extra space) _____

(5)
(Total 15 marks)

Q27. (a) What is vaccination?

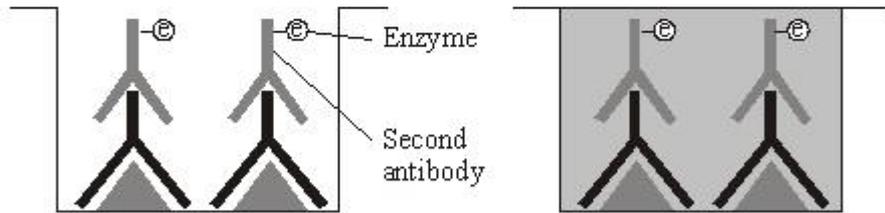
(2)

(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.



Step 1
Mumps antigen is attached to a well in a test dish.

Step 2
A sample of blood plasma is added to the well. If mumps antibodies are present, they bind to the mumps antigen.



Step 3
The well is washed. Then a second antibody with an enzyme attached is added. This binds specifically to the mumps antibody.

Step 4
The well is washed again. A solution is added which changes colour if the enzyme is present. A colour change shows that the person has mumps antibodies.

- (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)

Q28. 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)

Q29. 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.

5

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.

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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.

(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.

(Extra space)

(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)

Q30. 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.

- 5 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.

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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.

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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.

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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)

