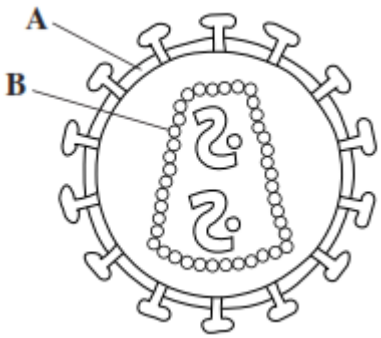
EXAM PAPERS PRACTICE

Cell recognition and the immune system 2

Level: CIE A Level 9700
Subject: Biology
Exam Board: Suitable for all boards
Topic: Cell recognition and the immune system 2
Type: Questionnaire

To be used by all students preparing for CIE Biology A Level 9700 foundation or higher tier but also suitable for students of other boards.

1 The diagram shows the human immunodeficiency virus (HIV).



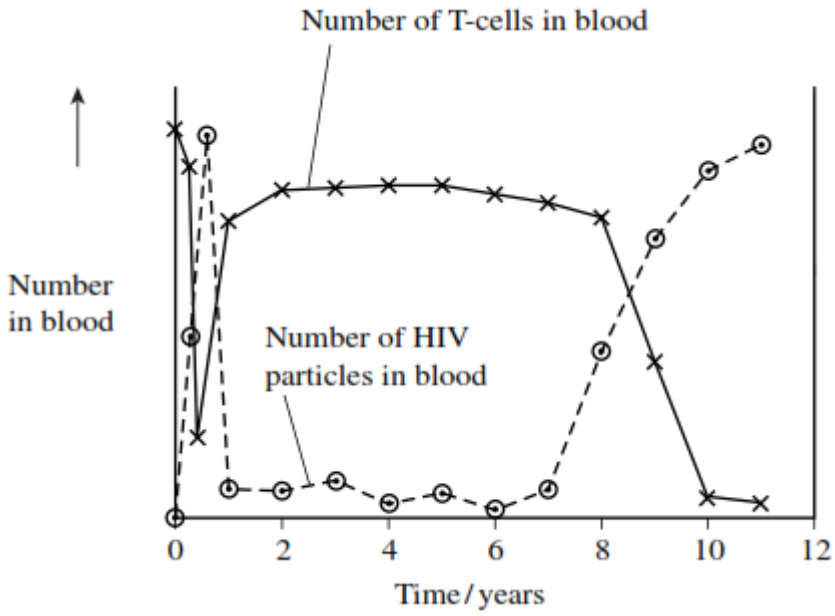
(a) Name

A _____

B _____

(2)

The graph shows changes in the number of T-cells and HIV particles in the blood of a person following infection.



(b) Explain why the number of HIV particles in the blood

(i) rises during the first few months after infection

_____

_____

_____

_____

(2)

(ii) remains low between 1 and 7 years after infection.

_____

_____

(1)

(c) This person developed a large number of infections about 9 years after he first became infected with HIV. Using information from the graph, explain why.

_____

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(Extra space) _____

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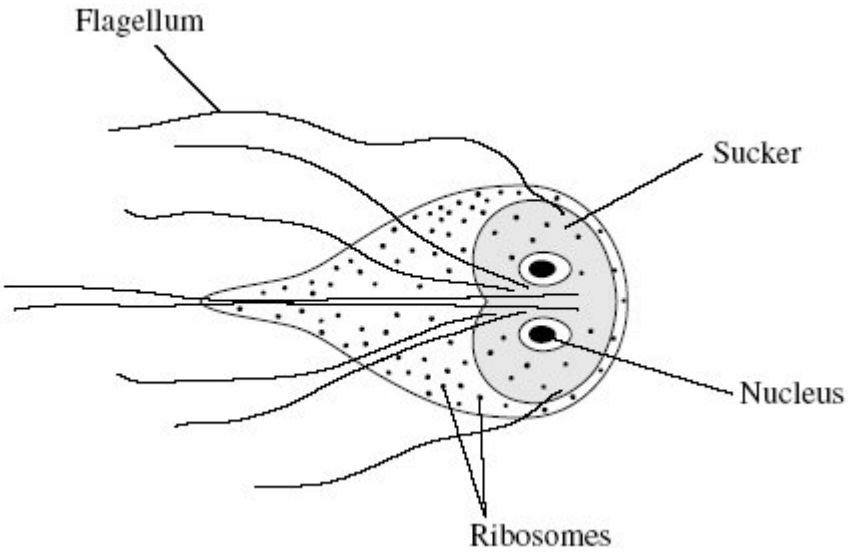
(4)

(Total 9 marks)

2 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)

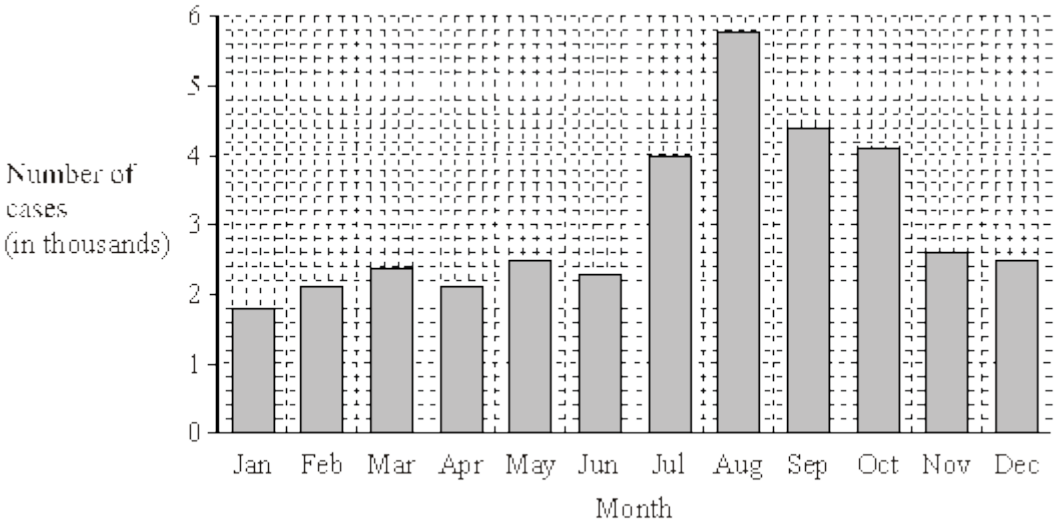
(b) *G. lamblia* can attach itself with its sucker. Explain how this is an adaptation to living in the intestines.

_____

_____

(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)

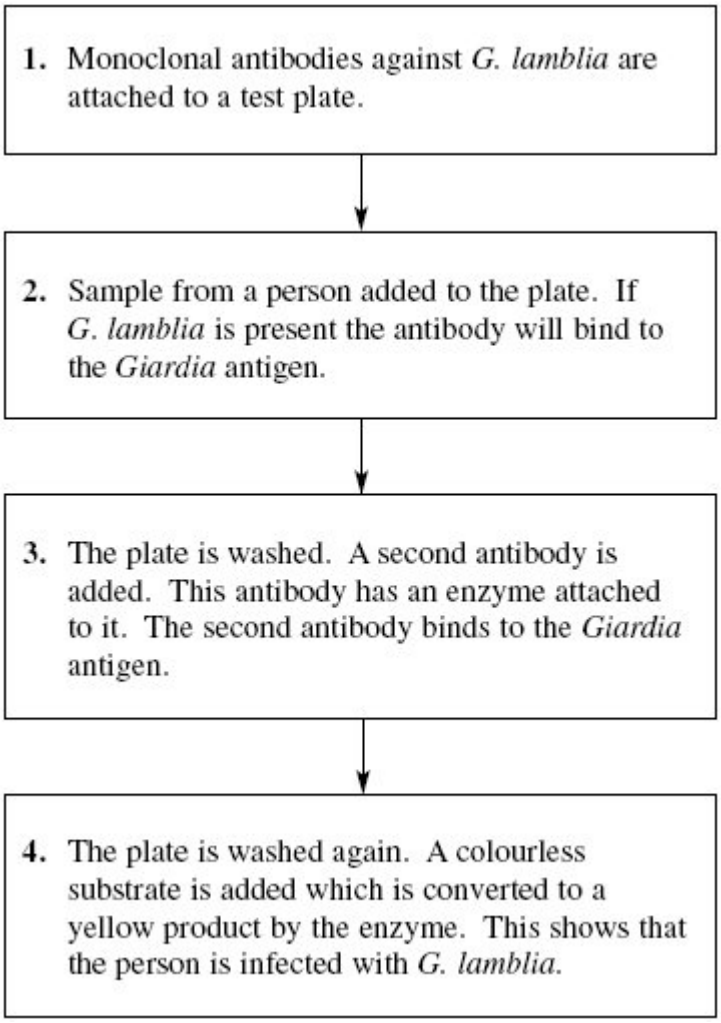
(ii) Suggest **one** reason for the number of cases being highest in the late summer months.

_____

_____

(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)

3 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.

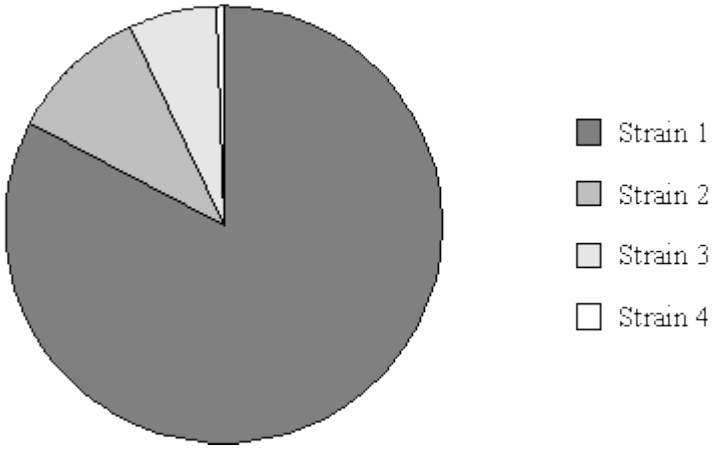
(1)

(Total 10 marks)

4 (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)

5 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)

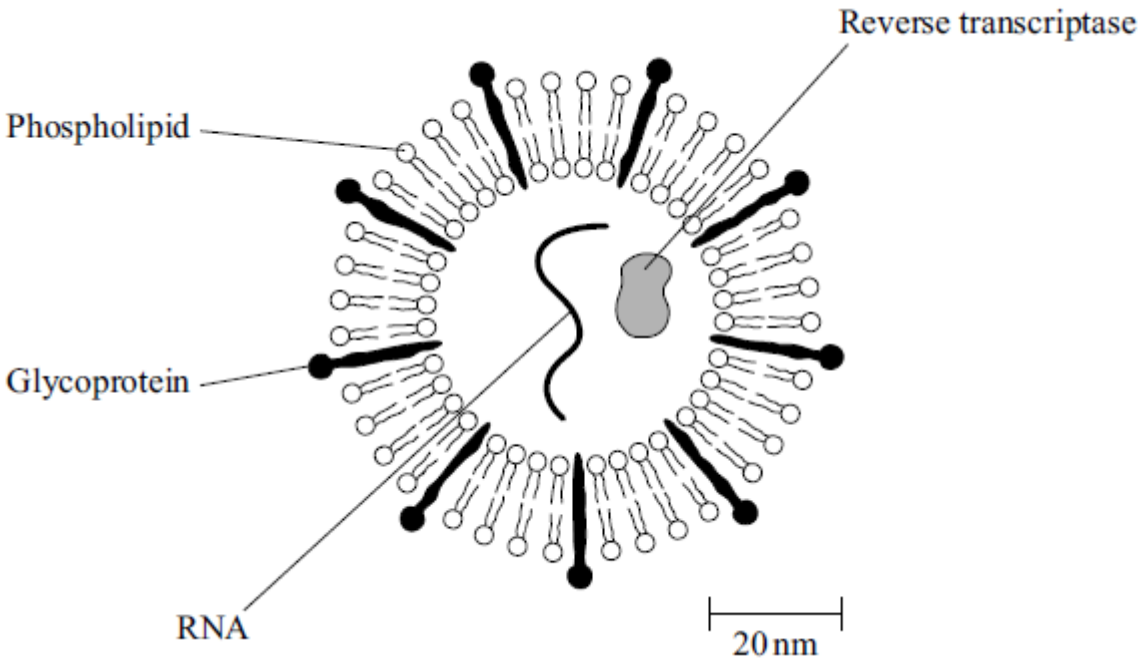
6 (a) What is an antigen?

(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)

7 (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)

8 (a) What is vaccination?

_____

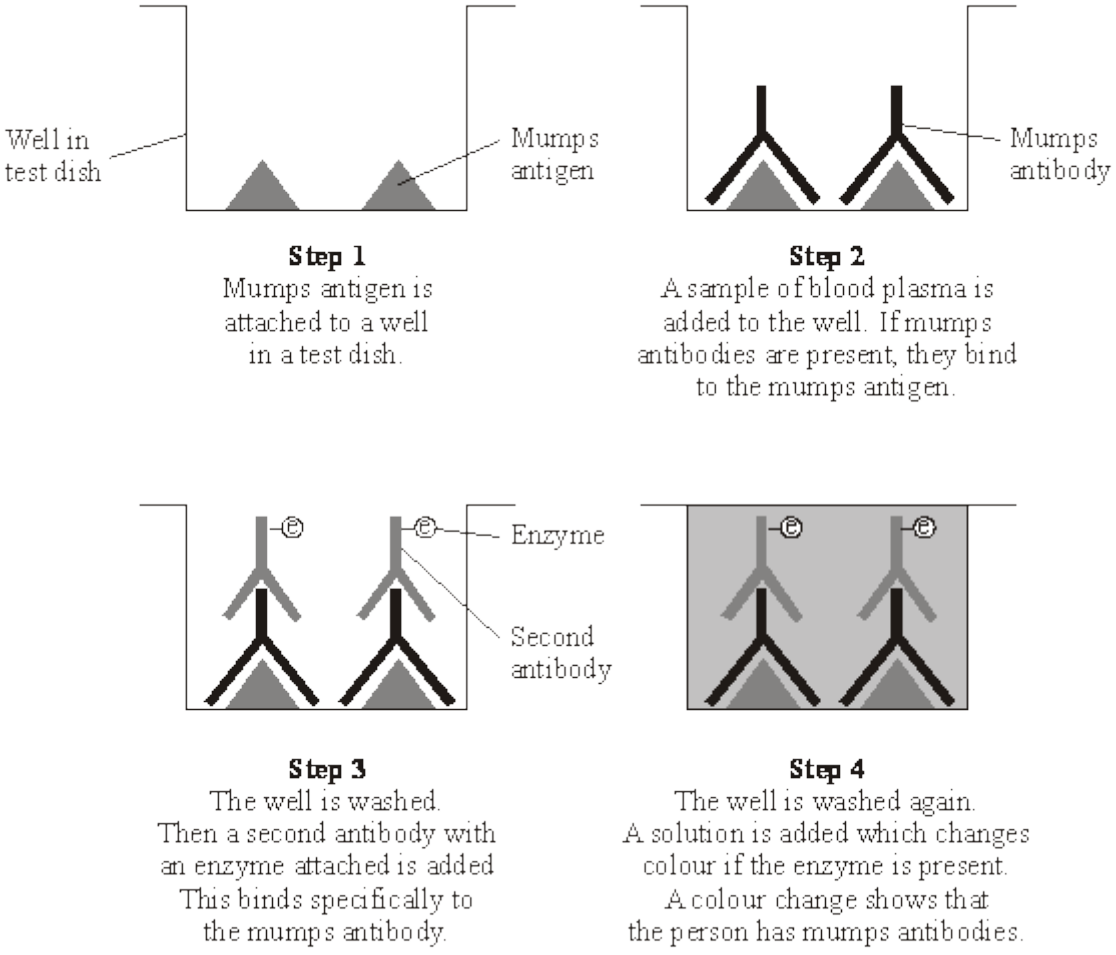
_____

_____

_____

(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)

9 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.

_____

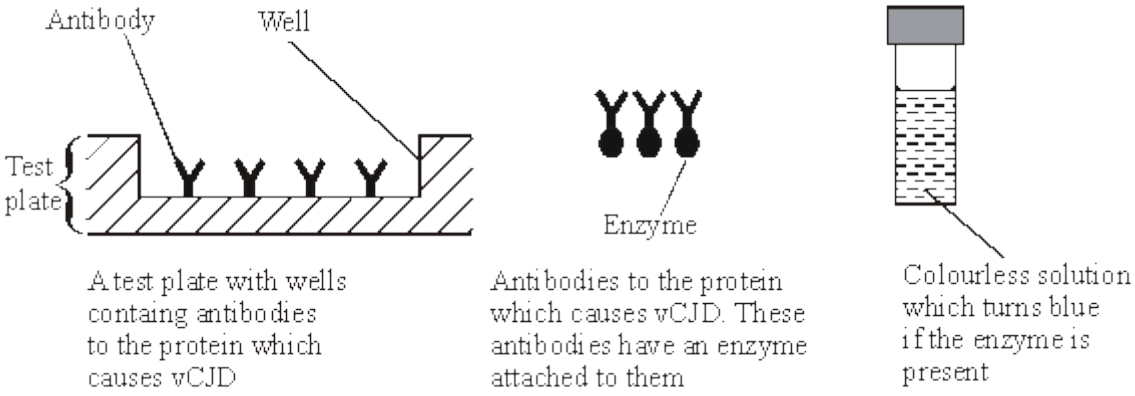
_____

(1)

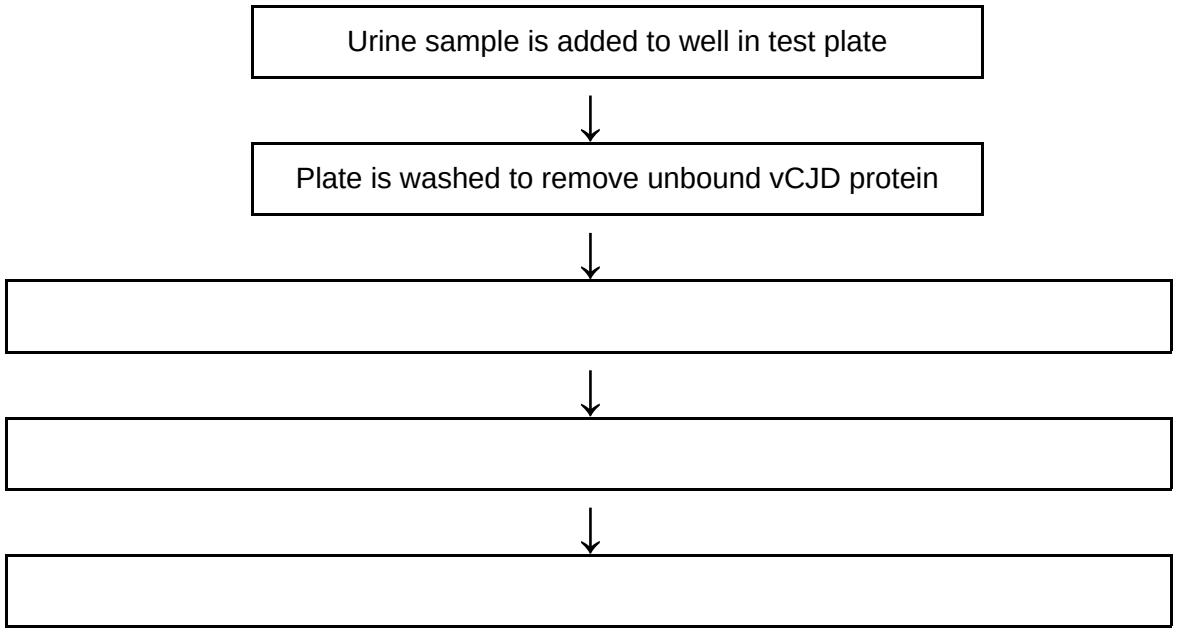
(Total 5 marks)

10 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)

11 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)

12 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 _____

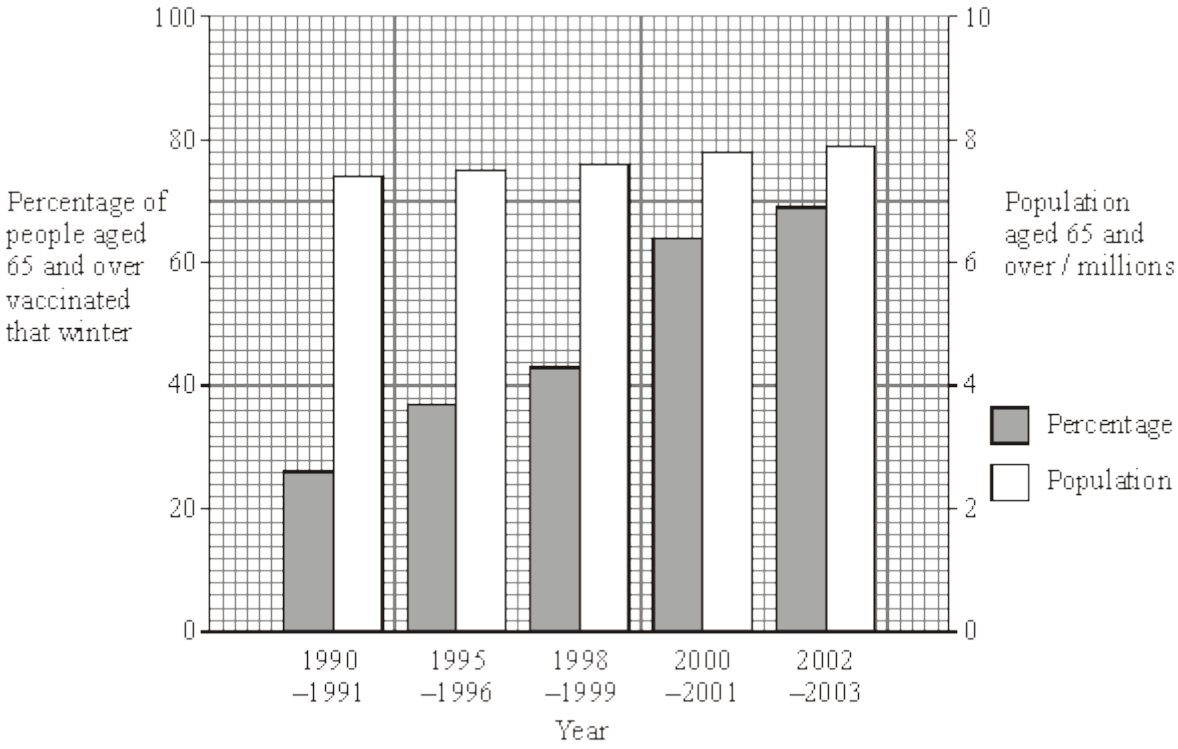
Explanation _____

_____

(2)

(Total 5 marks)

13 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.

_____

_____

_____

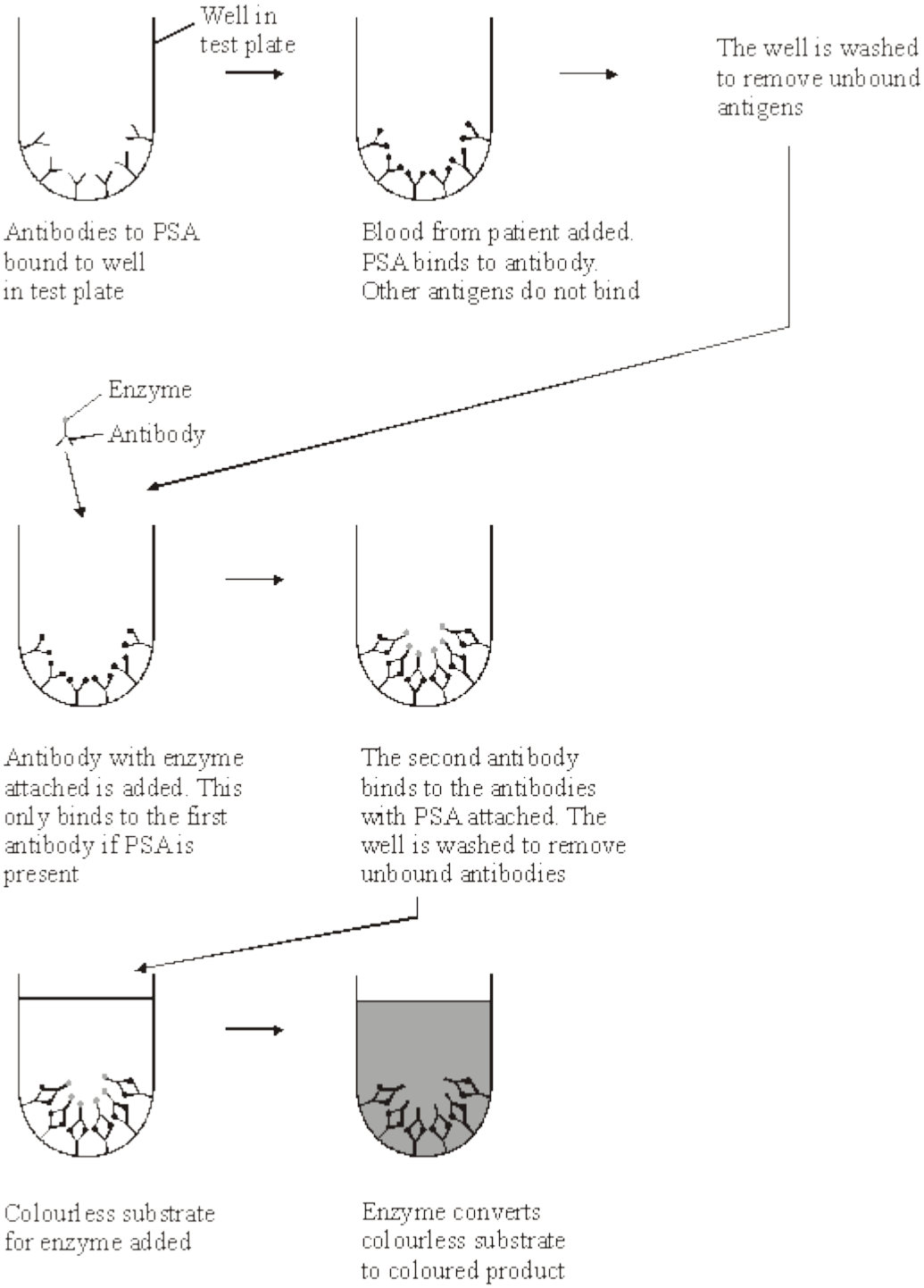
_____

(2)

(Total 9 marks)

14 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)

15 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)

16 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)

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

1. _____

_____

2. _____

_____

(2)

S (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 _____

_____

_____

_____

(4)

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

_____

(1)

(Total 7 marks)

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

_____

_____

_____

_____

_____

_____

_____

(4)

S (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.

(3)

(Total 7 marks)

19 (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.

(2)

S (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.

(2)

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

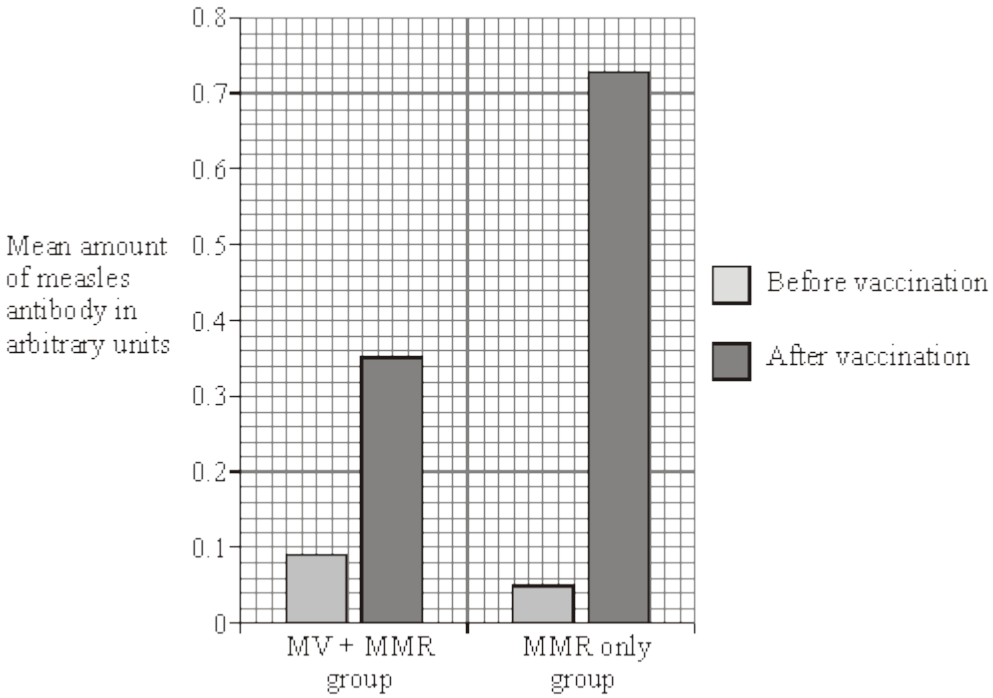
(1)

(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.

(4)

(Total 9 marks)

20 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.

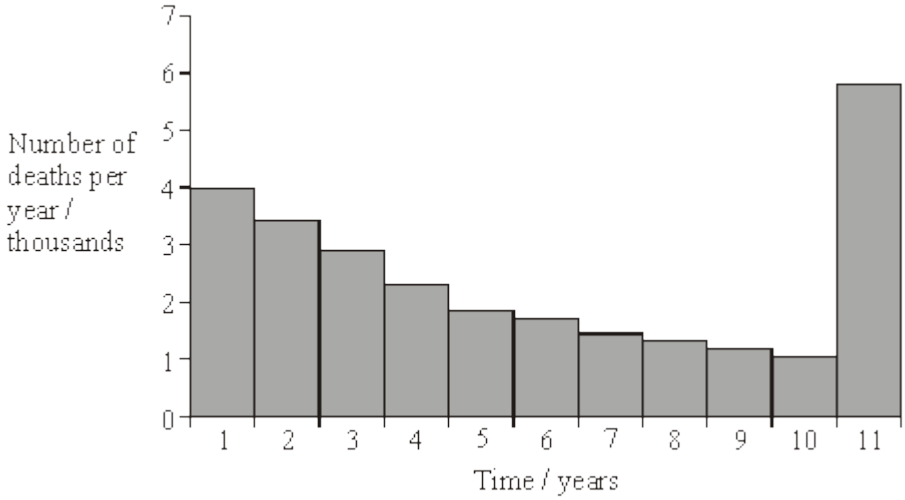
_____

_____

(1)

(Total 3 marks)

21 (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.

_____

_____

(1)

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

_____

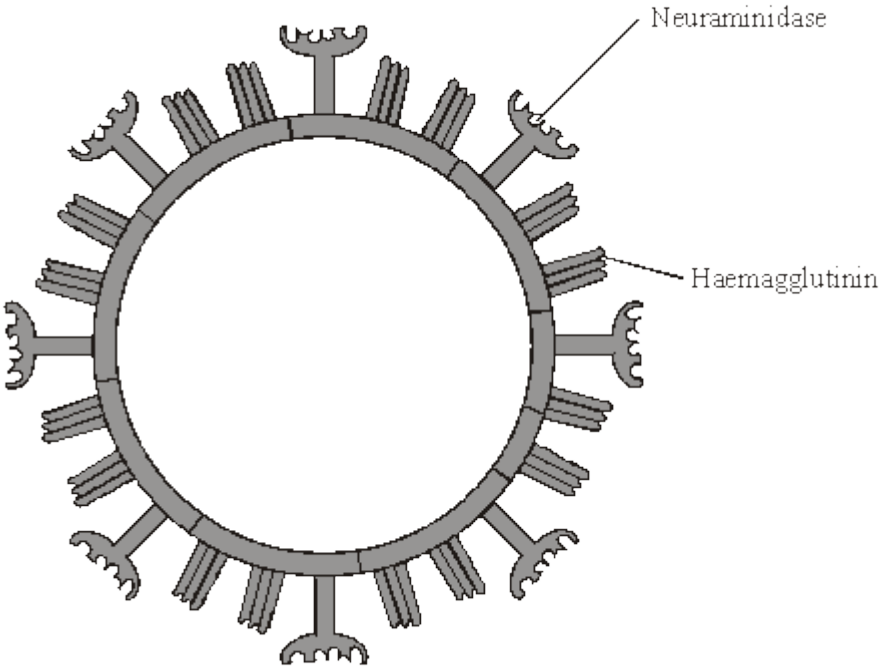
_____

_____

_____

(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.

_____

_____

_____

_____

(2)

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

(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.

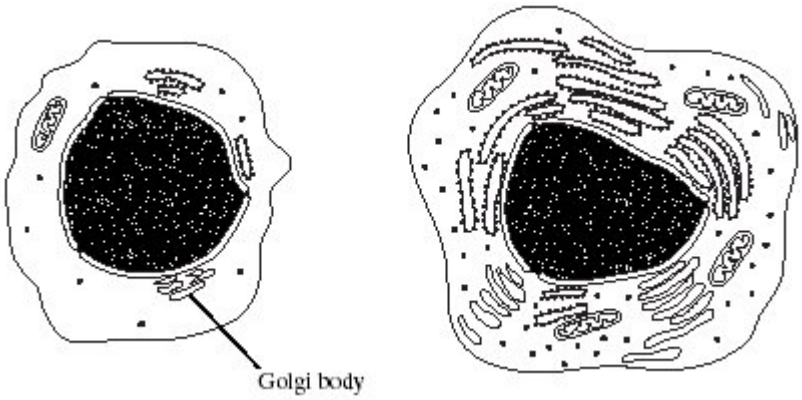
(2)

(Total 9 marks)

22 (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.

(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.

_____

_____

(1)

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

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 7 marks)

23 **S** 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)

24 (a) The MMR vaccine contains *attenuated* microorganisms.
What is an *attenuated* microorganism?

_____

_____

_____

_____

(2)

(b) A child was given the MMR vaccine and was given a second dose of the vaccine as a booster later.

(i) It took more than a week for antibodies to appear in the child's blood after the first vaccination. Explain why.

_____

_____

_____

_____

(2)

(ii) The concentration of antibodies increased immediately after the second vaccination. Explain why.

_____

_____

_____

_____

(2)

(Total 6 marks)

25 (a) Describe how HIV is replicated after it has entered a human cell.

(Extra space)

(4)

(b) The destruction of T-cells by HIV leads to the death of an infected person.
Explain how.

(2)

(Total 6 marks)

26 Doctors use Zevalin to kill cancerous B-cells. Zevalin is a monoclonal antibody which has a highly radioactive substance called yttrium attached to it. The antibody binds to the surface of B-cells and the radioactivity kills the cells.

(a) Only B-cells are killed by Zevalin.

Explain why.

_____

_____

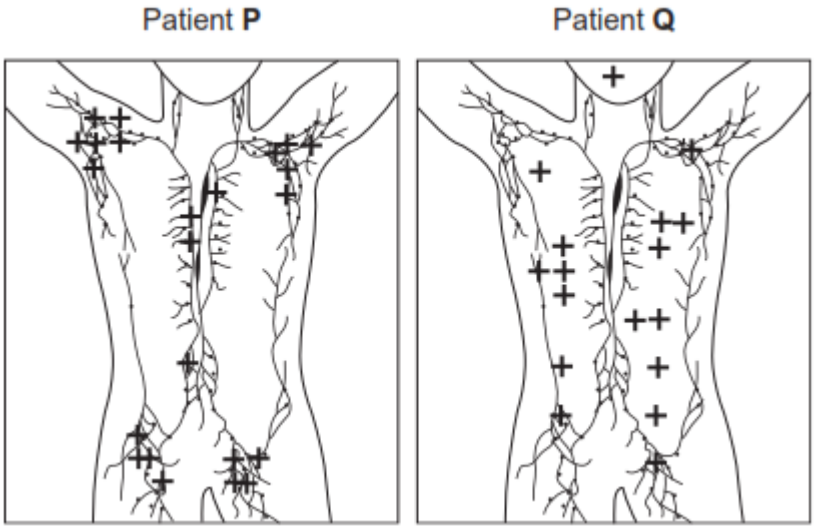
_____

_____

(2)

The cancerous B-cells are found mainly in the lymphatic system of patients. Before treating any patient with Zevalin containing yttrium, doctors test the patient with a different form of Zevalin. This form has radioactive indium attached to the antibody instead of yttrium. The radioactivity from indium is strong enough for doctors to detect but not strong enough to kill a patient's cells.

The diagram shows the lymphatic systems of two patients, **P** and **Q**, after being given Zevalin with indium. The crosses (**+**) show where indium was detected.



(b) The doctors decided they could treat Patient **P** with Zevalin containing yttrium but **not** Patient **Q**.
Suggest why Patient **P** could be treated with Zevalin containing yttrium and Patient **Q** could not.

(Extra space) _____

(3)

(c) Suggest **one** reason for the difference in distribution of the radioactivity detected in these patients.

(2)

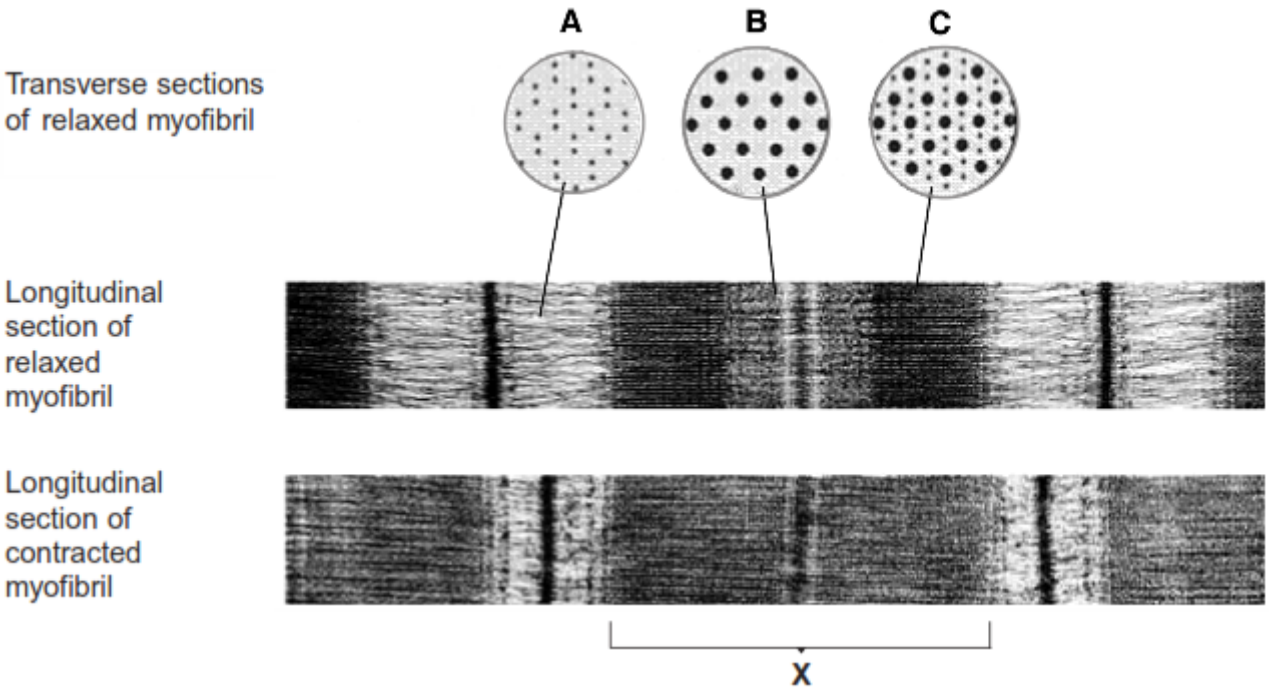
(d) The antibody in Zevalin comes from mice. Patients are tested for antibodies against Zevalin before treatment for their cancer.
Suggest why.

(2)

(Total 9 marks)

27 **Figure 1** shows sections through relaxed and contracted myofibrils of a skeletal muscle. The transverse sections are diagrams. The longitudinal sections are electron micrographs.

Figure 1



(a) (i) The electron micrographs are magnified 40 000 times.
Calculate the length of band **X** in micrometres.
Show your working.

Length of band **X** = _____ µm

(2)

(ii) Explain the difference in appearance between transverse sections **A** and **C** in **Figure 1**.

_____

_____

(1)

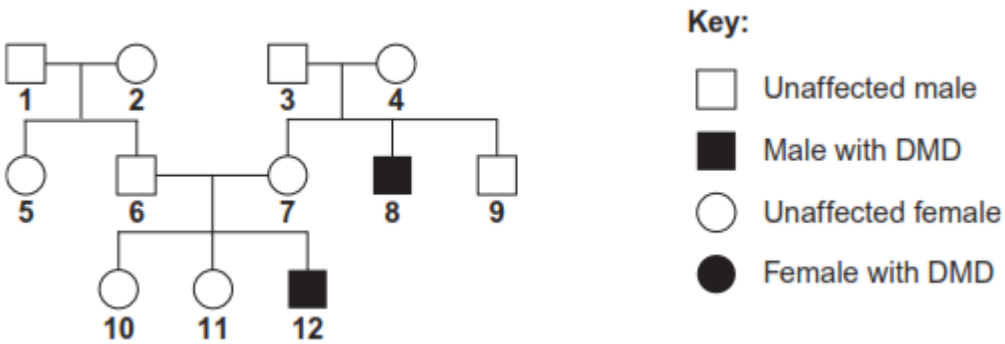
(b) Explain what leads to the differences in appearance between the relaxed myofibril and the contracted myofibril.

(*Extra space*) _____

(4)

(c) Duchenne muscular dystrophy (DMD) is a condition caused by the recessive allele of a sex-linked gene. A couple have a son with DMD. They want to know the probability that they could produce another child with DMD. They consulted a genetic counsellor who produced a diagram showing the inheritance of DMD in this family.
This is shown in **Figure 2**.

Figure 2



The couple who sought genetic counselling are persons **6** and **7**.

(i) Give the evidence to show that DMD is caused by a recessive allele.

_____

_____

(1)

(ii) Give the numbers of **two** people in **Figure 2** who are definitely carriers of muscular dystrophy.

_____

(1)

(iii) Complete the genetic diagram to find the probability that the next child of couple **6** and **7** will be a son with muscular dystrophy. Use the following symbols:

$\mathbf{X}^{D}$ = normal X chromosome
$\mathbf{X}^{d}$ = X chromosome carrying the allele for muscular dystrophy
Y = normal Y chromosome

	6	**7**
Parental phenotypes	Unaffected	Unaffected
Parental genotypes	_____	_____
Gametes	_____	_____

Offspring genotypes _____

Offspring phenotypes _____

Probability of having a son with DMD _____

(4)

(d) DMD is caused by a deletion mutation in the gene for a muscle protein called dystrophin. A deletion is where part of the DNA sequence of a gene is lost. People in different families may inherit mutations in different regions of this gene.

Scientists isolated the dystrophin gene from DNA samples taken from children **10**, **11** and **12**. They cut the gene into fragments using an enzyme. The scientists then used two DNA probes to identify the presence or absence of two of these fragments, called **F** and **G**. This allowed them to find the number of copies of each fragment in the DNA of a single cell from each child.

The table shows their results.

(i) The number of copies of gene fragments **F** and **G** shows that person **12** has DMD. Explain how.

_____

_____

(1)

(ii) The number of copies of gene fragments **F** and **G** shows that person **12** is male. Explain how.

_____

_____

_____

_____

(2)

(iii) The genetic counsellor examined the scientists' results. He concluded that person **10** is a carrier of DMD but her sister, **11**, is not.

Describe and explain the evidence for this in the table.

_____

_____

_____

_____

_____

_____

(*Extra space*) _____

_____

_____

(3)

(e) Person **12** took part in a trial of a new technique to help people with DMD.

Doctors took muscle cells from person **12**'s father and grew them in tissue culture.

They suspended samples of the cultured cells in salt solution and injected them into a muscle in person **12**'s left leg. They injected an equal volume of salt solution into the corresponding muscle in his right leg. Person **12** was given drugs to suppress his immune system throughout the trial.

Four weeks later, the doctors removed a muscle sample from near the injection site in each leg. They treated these samples with fluorescent antibodies. These antibodies were specific for the polypeptide coded for by gene fragment **G** of the dystrophin gene.

The results are shown in the table.

(i) Why was it necessary to treat person **12** with drugs to suppress his immune system?

_____

_____

(1)

(ii) Explain why salt solution was injected into one leg and cultured cells suspended in salt solution into the other.

_____

_____

_____

(1)

(iii) This technique is at an early stage in its development. The doctors suggested that further investigations need to be carried out to assess its usefulness for treating people with DMD.

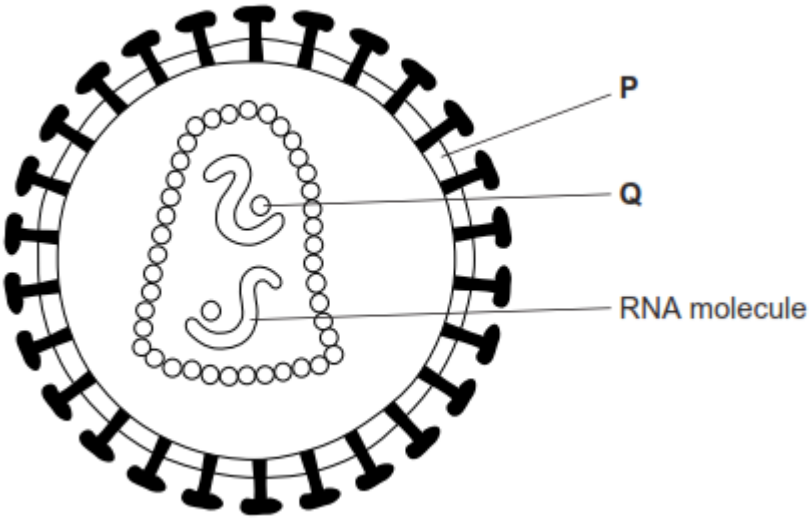
Explain why they made this suggestion.

(*Extra space*) _____

(4)

(Total 25 marks)

28 The diagram shows a human immunodeficiency virus (HIV).



(a) (i) Name structure **P** and enzyme **Q**.

Structure **P** _____

Enzyme **Q** _____

(2)

(ii) What is the function of the RNA molecules in this virus?

_____

_____

(1)

(b) Describe how new viruses are produced after HIV has infected a T cell.

_____

_____

_____

_____

_____

_____

(*Extra space*) _____

_____

_____

(3)

(Total 6 marks)

29 Read the following passage.

An anti-gal antibody is a type of antibody that helps to fight infections caused by bacteria. If a person has a bacterial infection, for example *Salmonella*, anti-gal antibodies bind to antigens on the surface of the *Salmonella*. Not all the anti-gal antibodies are used to fight the infection. Even after the infection, anti-gal antibodies remain in the blood.

Scientists have made adaptor molecules to try to use the anti-gal antibodies against viruses such as HIV. The adaptor molecules are proteins. Each adaptor molecule had a receptor site to which the HIV binds. This receptor site was similar to the receptor site on human cells to which the HIV binds. The adaptor molecule has another site to which an anti-gal antibody will bind.

The scientists then investigated whether adding adaptor molecules and anti-gal antibodies can prevent HIV entering cells. They added adaptor molecules and anti-gal antibodies to a culture of human cells. They then added HIV to the culture. Their results showed that 90% of the virus particles failed to infect cells.

The scientists are hoping to develop a different type of adaptor molecule to use against MRSA.

(a) (i) What is an antigen? (line 3)

_____

_____

_____

_____

(2)

(ii) Explain why antibodies against *Salmonella* do not normally bind to HIV.

_____

_____

_____

_____

(2)

(iii) Explain how the adaptor molecule allows anti-gal antibodies to associate with HIV.

(2)

(b) Describe how humans produce antibodies against a pathogen such as *Salmonella*.

(Extra space)

(6)

(c) (i) HIV infects some human cells, such as T-cells, but not others. Suggest why.

(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)

30 (a) What is an antigen?

_____

_____

_____

_____

(2)

(b) A zookeeper was bitten by a snake. The bite contained venom which is a poison.
He was given an injection of antivenom. This antivenom contained antibodies against this snake venom.

The antivenom did not give the zookeeper lasting protection against this snake venom.
Explain why.

_____

_____

_____

_____

(Extra space) _____

_____

(2)

(Total 4 marks)

31 Scientists have developed a new technique that can identify whether people smoke tobacco. Tobacco contains nicotine, which is broken down to cotinine. Cotinine is found in fingerprints. The new technique uses antibodies against cotinine.

(a) These scientists injected laboratory mice with cotinine. Describe how this injection stimulates mice to produce antibodies against cotinine.

(Extra space) _____

(4)

(b) The antibodies bind only to cotinine, and not to any other substance in the fingerprint. Explain why.

(2)

(Total 6 marks)

32 (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)