2.4 CELL RECOGNITION AND THE IMMUNE SYSTEM 1 – QUESTIONS

Q1.

(a) What is an antigen?

_____

_____

(2)

(b) What is an antibody?

_____

_____

(2)

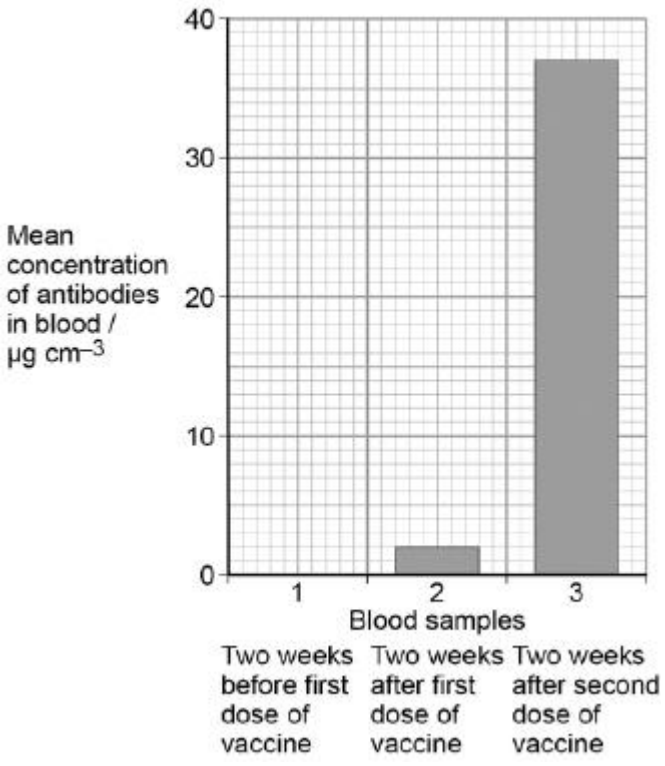
Poliomyelitis is an infection caused by a virus.

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

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

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

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



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

Answer = _____ %

(1)

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

_____

_____

_____

_____

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_____

(4)

(Total 9 marks)

Q2.

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?

(1)

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

(2)

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

Explain why.

(3)

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

(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.

(2)

(Total 10 marks)

Q3.

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

(3)

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

(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.

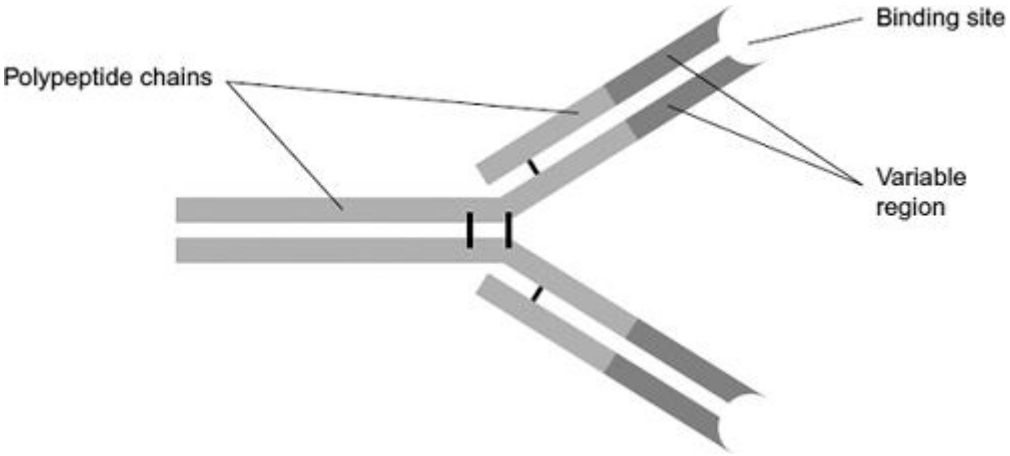
Suggest how the immune response to this viral protein can result in the development of RA.

(2)

(Total 8 marks)

Q4.

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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(*Extra space*)_____

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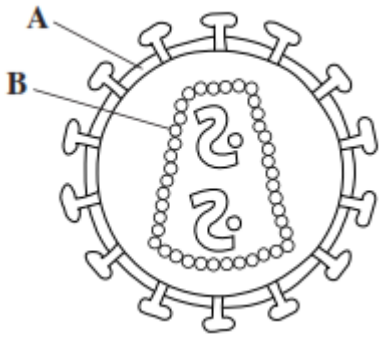
(3)

(Total 4 marks)

Q5.

The diagram shows the human immunodeficiency virus (HIV).



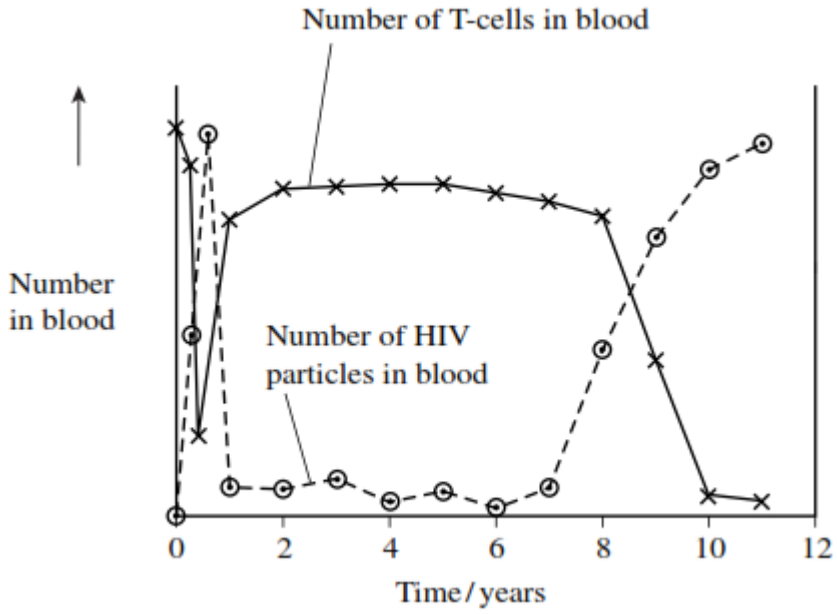
(a) Name

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.

(Extra space) _____

_____

_____

_____

(4)

(Total 9 marks)

Q6.

(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. _____

_____

2. _____

_____

3. _____

_____

(3)

(Total 8 marks)

Q7.

(a) Describe how bacteria are destroyed by phagocytes.

_____

_____

_____

_____

_____

_____

*(Extra space)*_____

_____

_____

(3)

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

1. _____

_____

2. _____

_____

(2)

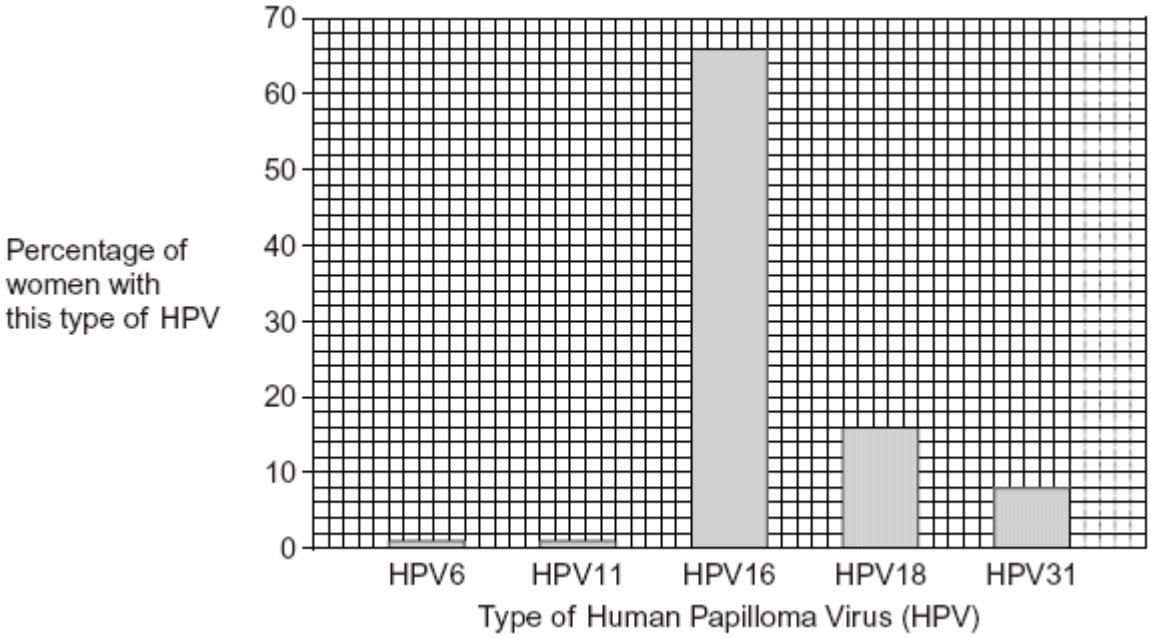
(Total 5 marks)

Q8.

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)

Q9.

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

Explain how.

(2)

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

Explain why.

(1)

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

Scientists have produced a monoclonal antibody that stops this stimulation.

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

[Extra space]

(3)

(Total 6 marks)

Q10.

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)

Q11.

(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 _____

_____

_____

_____

(4)

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

_____

(1)

(Total 7 marks)

Q12.

(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)

Q13.

(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.

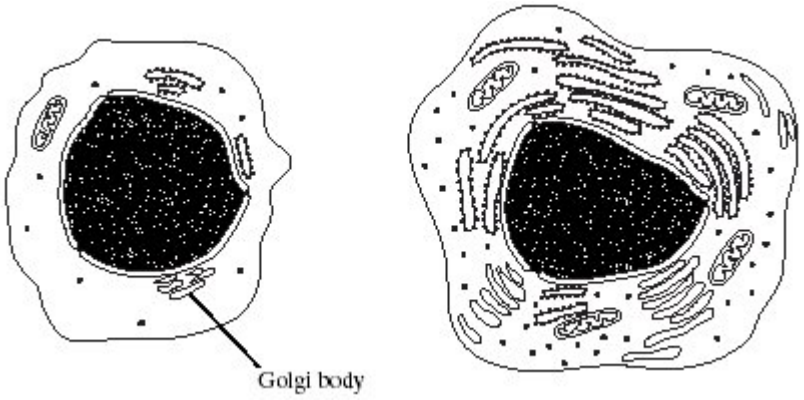
_____

_____

_____

(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)

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

(4)

(Total 7 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?

_____

_____

_____

_____

(2)

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

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

_____

_____

(1)

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

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

_____

_____

(Extra space) _____

(4)

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

Suggest why they can be destroyed by the immune system.

(Extra space) _____

(3)

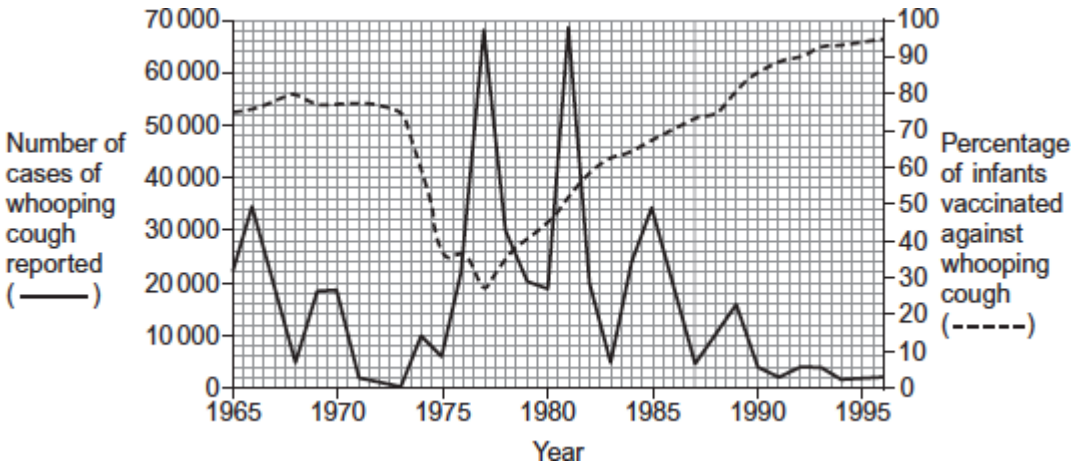
(Total 10 marks)

Q15.

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

They collected data for:
- the number of cases of whooping cough reported
- the percentage of infants vaccinated against whooping cough.

The graph shows the data collected by the doctors.



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

1. _____

_____

_____

2. _____

_____

_____

(2)

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

Use the information from the graph to suggest why.

_____

_____

_____

_____

_____

[Extra space] _____

_____

(2)

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

Suggest why.

_____

[Extra space] _____

(2)

(Total 6 marks)

Q16.

(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)

(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)

(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)

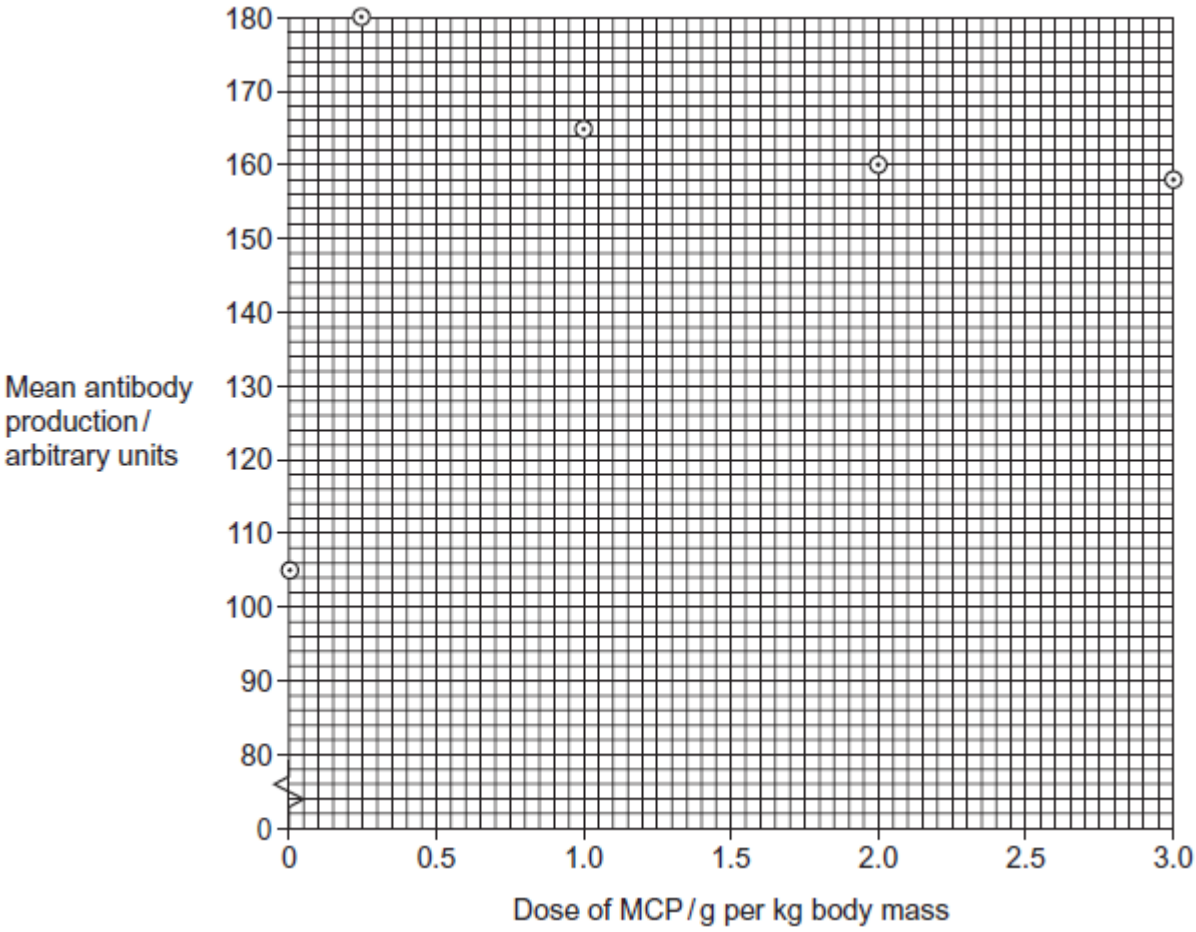
(Total 9 marks)

Q17.

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

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

The results are shown in the graph.



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

(1)

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

(2)

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

Answer _____%

(2)

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

_____

_____

(1)

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

_____

_____

_____

_____

_____

_____

(Extra space)_____

_____

_____

(3)

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

1. _____

_____

2. _____

_____

(2)

(Total 11 marks)

Q18.

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

_____

(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.

(3)

(Total 7 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.

[Extra space] _____

(3)

(Total 5 marks)

Q20.

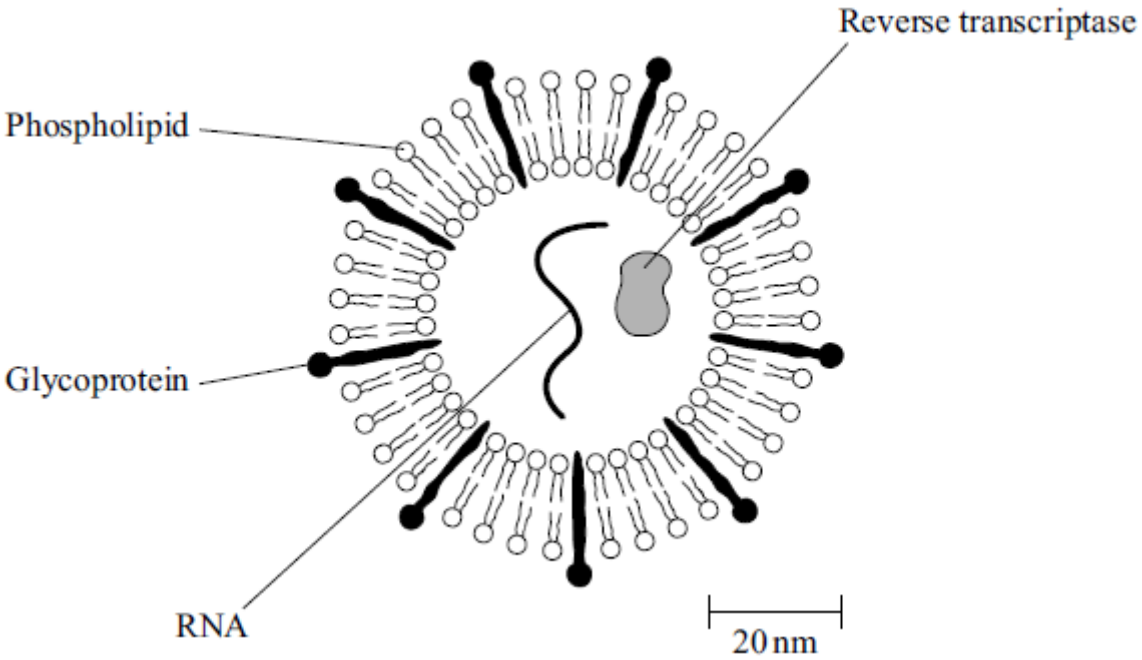
(a) What is an antigen?

(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)

Q21.

(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)

Q22.

(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)

Q23.

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.

_____

_____

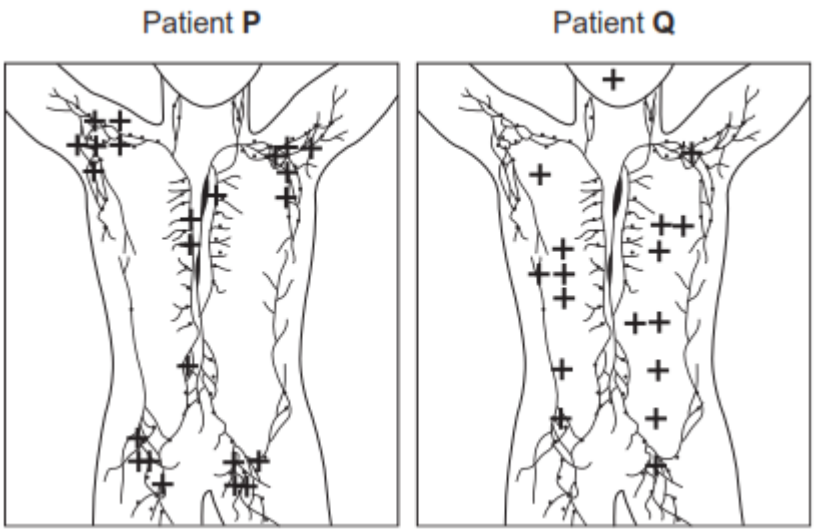
_____

_____

(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)

Q24.

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

_____

_____

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_____

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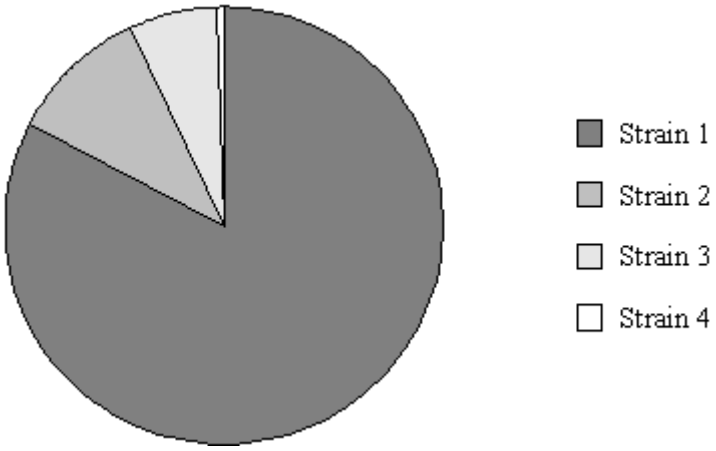
_____

(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)

Q25.

(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.

_____

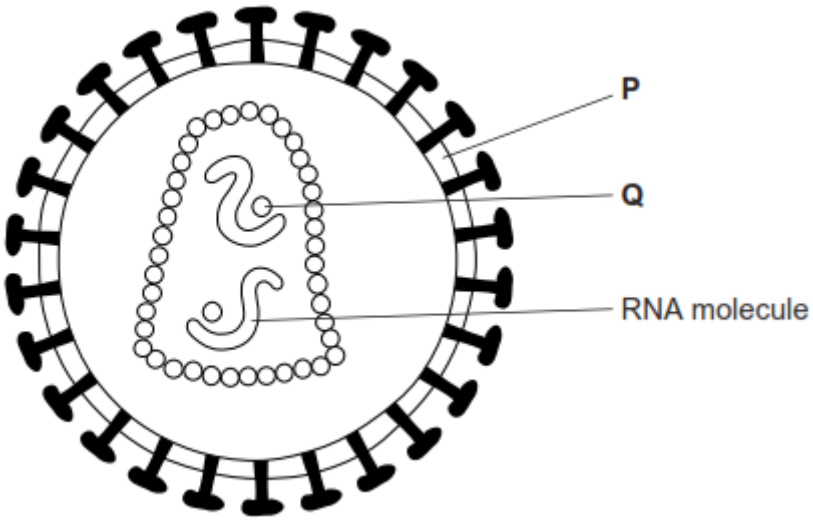
_____

(1)

(Total 7 marks)

Q26.

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)

Q27.

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

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

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

_____

_____

_____

_____

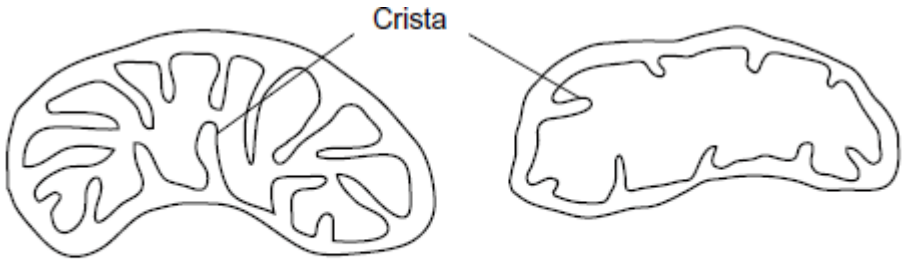
_____

_____

(3)

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

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



Mitochondrion with normal ultrastructure

Mitochondrion with unusual ultrastructure

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

_____

_____

_____

_____

_____

_____

(3)

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

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

Type of microscope_____

Reason _____

_____

_____

(1)

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

_____

_____

_____

_____

_____

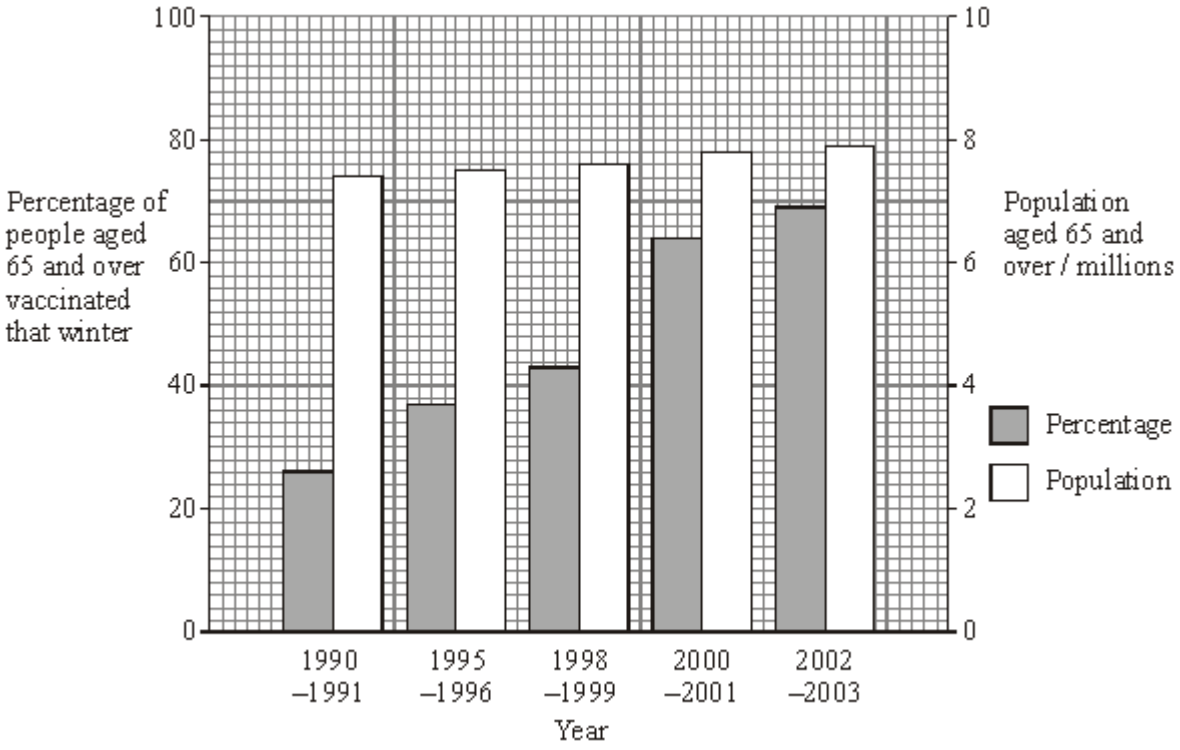
_____

(3)

(Total 10 marks)

Q28.

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.

_____

_____

_____

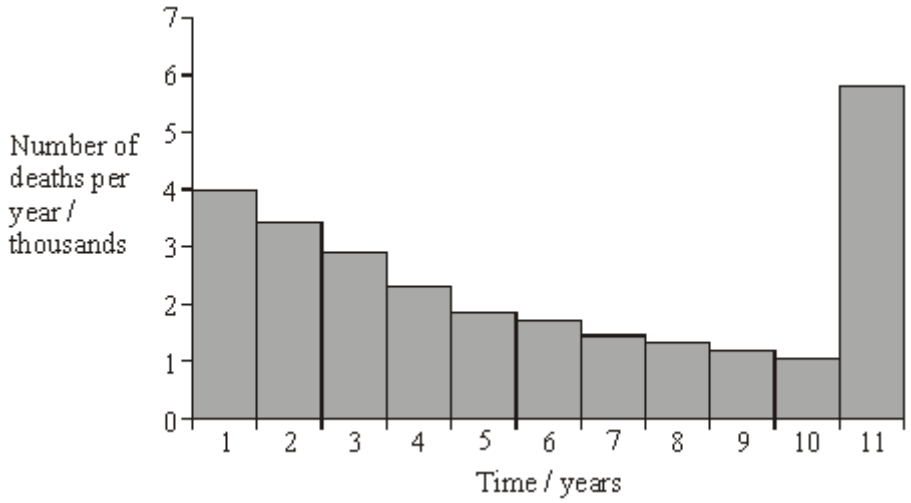
_____

(2)

(Total 9 marks)

Q29.

(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.

_____

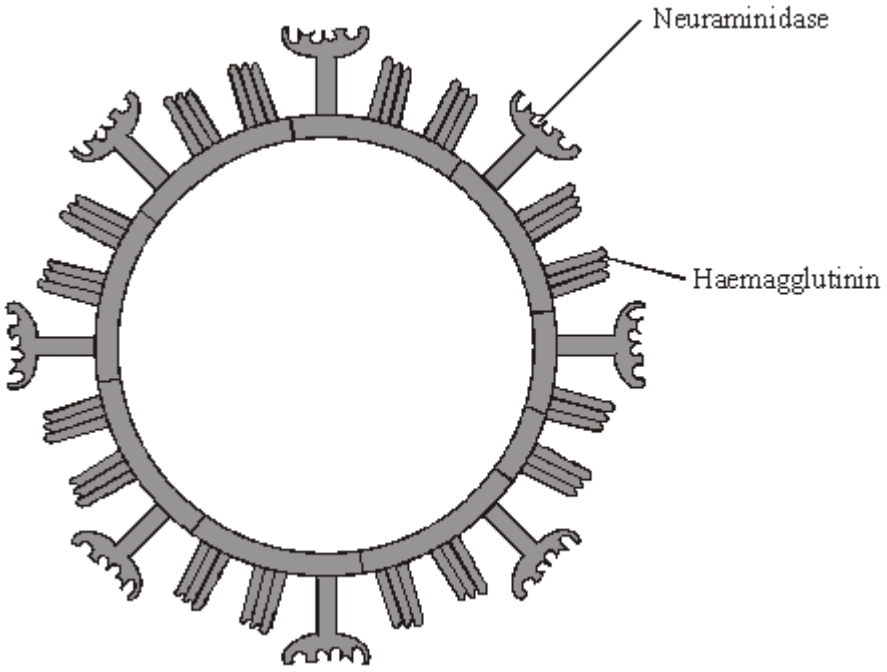
_____

(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)

Q30.

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)

Q31.

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)

Q32.

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.

_____

_____

_____

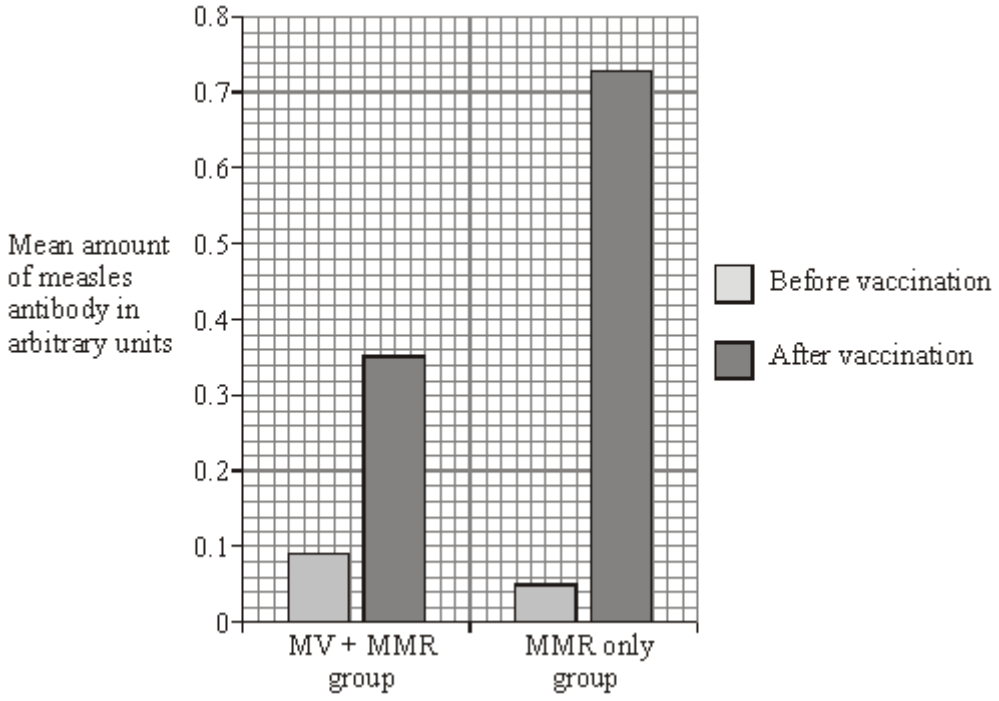
_____

(2)

(Total 9 marks)

Q33.

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)

Q34.

(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)

Q35.

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

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

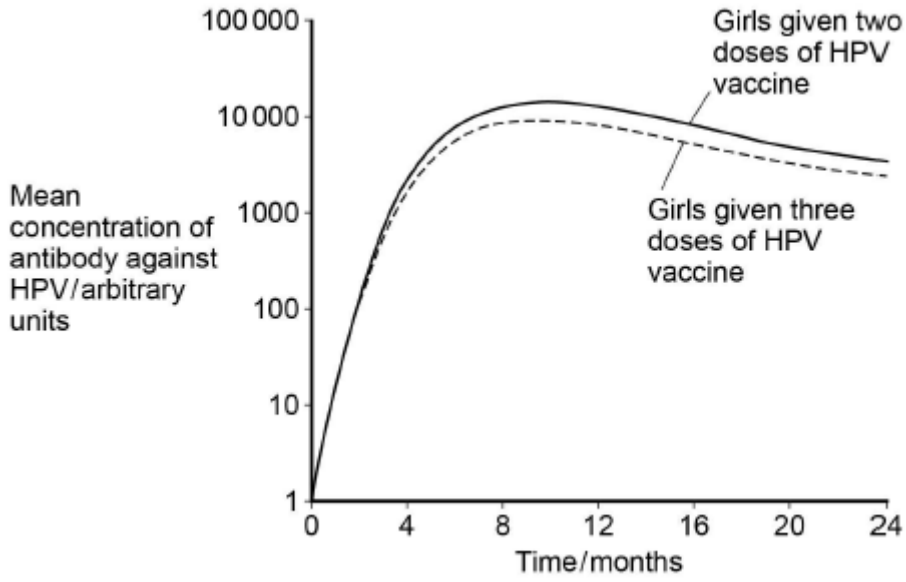
(4)

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

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

The doctors measured the concentration of antibody each month.

The results are shown below.



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

(2)

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

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

Test _____

Reason _____

_____

(1)

(d) There is genetic diversity within HPV.

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

1. _____

_____

2. _____

_____

(2)

(Total 9 marks)

Q1.

(a) 1. Foreign protein;

Accept glycoprotein / glycolipid / polysaccharide

2. (that) stimulates an immune response / production of antibody;

2

(b) 1. A protein / immunoglobulin specific to an antigen;

2. Produced by B cells

OR

Secreted by plasma cells;

2

(c) 1750(%);

1

(d) 1. Sample 1 / before vaccination no antibody released because patients not yet encountered vaccine / antigen / virus;

Accept 'produced' for 'released'

2. (Sample 2 / primary response / after first dose) activation / clonal selection / expansion of B cells into plasma cells;

3. Plasma cells release antibodies;

4. (Sample 3 / secondary response / after second dose) memory cells produce more antibodies / produce antibodies more quickly;

4

[9]

Q2.

(a) 1. Replacement of a base by a different base (in DNA);

1

(b) 1. (Depends on) size / mass (of protein);

2. (Depends on) charge (of protein);

Accept for 2 marks 'Smaller / more highly charged move further'

2 max

(c) 1. Each protein has a different tertiary structure;

2. (Each) antibody has a specific antigen / binding / variable region / site;

3. So, (each antibody) forms different antigen-antibody complex
OR
(each antibody) only binds to complementary (protein);

3

(d) 1. Less NL3;

2. More NR2A **and** NR2B;

2

(e) 1. Higher ratio NR2B to NR2A with mutation;

Accept 'more' as equivalent to 'ratio'

2. (Perhaps) better memory in mice with mutation;

2

[10]

Q3.

(a) 1. Phagosome / vesicle fuses with lysosome;
2. (Virus) destroyed by lysozymes / hydrolytic enzymes;
3. Peptides / antigen (from virus) are displayed on the cell <u>membrane</u>;

1. Accept vacuole fuses with lysosome

1. Reject virus fuses with lysosome

3

(b) 1. Helper T cell / TH cell binds to the antigen (on the antigen-presenting cell / phagocyte);
2. This helper T / TH cell stimulates a specific B cell;
3. B cell clones
OR
B cell divides by mitosis;
4. (Forms) <u>plasma cells</u> that release antibodies;

*1. and 2. 'Helper' is required **once** only.*

2. Accept 'This (helper) T cell stimulates a competent B cell'

'T cell stimulates B cell to undergo clonal selection'. This statement achieves mp2 and mp3.

3 max

(c) 1. The antibody against virus (antigen) will bind to collagen;
2. This results in the destruction of the (human) cells / collagen;

2. Ignore 'attacks'

2

[8]

Q4.

(a) Has more than one / four polypeptide chains / made up of polypeptide chain<u>s</u>;

1

(b) 1. Antibody / variable region has specific amino acid sequence / primary structure;

2. The shape / tertiary structure of the binding site is complementary to / fits / binds with these antigens;

2. Do not accept active site for this point.

3. Forms complex between antigen and antibody;

3

[4]

Q5.

(a) A = envelope/membrane/phospholipid (bilayer);
B = capsid / nucleocapsid / capsomere / protein;

2

(i) (HIV is) invading cells which make new viruses;
Cells release viruses into blood;

2

(ii) Virus remains dormant/exists as provirus/exists as DNA in host DNA;
Accept virus stays in cells

1

(c) HIV destroys T cells;
More (free) viruses produced leads to fall in T-cells;
(So fewer) T-cells activate B-cells/memory cells;

Reduced/no antibody production;
Immune system not working properly/inability to fight infection;
Opportunistic infections;

4 max

[9]

Q6.

(a)

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

1 mark for each correct vertical column

2

(b) 1. (Complementary) nucleotides/bases pair
OR
A to T **and** C to G;
Ignore '(DNA polymerase) forms base pairs/nucleotide pairs'
2. DNA polymerase;
3. Nucleotides join together (to form new strand)/phosphodiester bonds form;
Ignore '(DNA polymerase) forms base pairs/nucleotide pairs'
If clearly writing rote answer about DNA replication ***2 max***
e.g. helicase or separating strands

3

(c) 1. DNA double stranded/double helix **and** mRNA single-stranded;
Contrast requires both parts of the statement
2. DNA (very) long **and** RNA short;
*Accept 'RNA short**er**' or 'DNA bigg**er**/long**er**'*
3. Thymine/T in DNA **and** uracil/U in RNA;
4. Deoxyribose in DNA **and** ribose in RNA;
***R** Deoxyribonucleic/ ribonucleic acid*

Ignore *ref. to histones*

Ignore *ref. to helix and straight chain alone*

5. DNA has base pairing **and** mRNA doesn't/ DNA has hydrogen bonding and mRNA doesn't;
6. DNA has introns/non-coding sequences **and** mRNA doesn't;

Ignore *ref to splicing*

3 max

[8]

Q7.

(a) *QWC*

1. (Phagocyte engulfs) to form vacuole / vesicle / phagosome;
   Accept surrounds bacteria with membrane
2. Lysosome empties contents into vacuole / vesicle / phagosome;
   Accept joins / fuses
3. (Releasing) enzymes that digest / hydrolyse bacteria;
   Ignore breakdown / destroy / lytic enzymes

3

(b) Two suitable structures;;

Examples,

1. Cell wall;
2. Capsule / slime layer;
3. Circular DNA;
   Reject "circular chromosome"
4. Naked DNA / DNA without histones;
5. Flagellum;
6. Plasmid;
7. Pilus;
8. 70s / smaller ribosomes;
9. Mesosome;

2 max

[5]

Q8.

(a) (yes):
Many women (with cervical cancer) have HPV 16 (18 &31);

(no):
Few women (with cervical cancer) have HPV 6 / 11;

(HPV infection does not mean causation because):
Could be caused by another factor / example given / may be due to coincidence;

No control group / did not study HPV in healthy women / did not study all HPV types / having cancer may increase susceptibility to HPV / does not add up to 100% / not all women with cancer have HPV / individual may have more than one HPV type;

Neutral: correlation between HPV (16) and cervical cancer

Reject: many women with HPV 16 (18 &31) have cervical cancer / not all women have cancer

Accept: figures from graph for 'many' and 'few'

Accept: minor errors in reading HPV frequencies from graph

Reject: does not mean HPV vaccine causes cancer;

Neutral: refs. to sample size and factors that should have been kept constant

3 max

(b) (i) Protein / glycoprotein / glycolipid / polysaccharide;

Causes immune response / antibody production;

Accept: B / T cell production

2

(ii) Memory cells produced / remain / stored (from previous infection);

Neutral: antibodies produced / remain

(When individual) comes into contact with virus / antigen (again);

Neutral: 'cell' instead of 'virus'
Reject: 'bacteria' once only

Rapid / secondary / greater response / many or more antibodies produced;

Accept: B cells / T cells

Destroys virus / antigen before it can cause harm / symptoms / cancer;

Reject: if destroys the virus / antigen in the vaccine before it can cause harm

***Q** Do not allow 'fights HPV'*

***Q** Do not allow 'memory cells remember'*

3 max

(c) HPV destroyed in males / prevents males being carriers of HPV;

Neutral: prevents males catching HPV

Prevents males passing on HPV (to unvaccinated females) / HPV may cause (other) cancers in males;

Accept: reference to herd effect protecting the population

2

[10]

Q9.

(a) (i) 1. (Tumour suppressor) gene inactivated / not able to control / slow down

cell division;

Ignore: references to growth

2. Rate of cell division too fast / out of control.

1 and 2 Accept: mitosis

1 and 2 Reject: meiosis

2

(ii) 1. (Genetic) code degenerate;

Accept: codon for triplet

Accept description of degenerate code, e.g. another triplet codes for the same amino acid

2. Mutation in intron.

Accept: mutation in non-coding DNA

1 max

(b) 1. Antibody has specific tertiary structure / binding site / variable region;

Do not accept explanations involving undefined antigen

2. Complementary (shape / fit) to receptor protein / GF / binds to receptor protein / to GF;

Ignore: same shape as receptor protein / GF

3. Prevents GF binding (to receptor).

3

[6]

Q10.

(a) Stimulates memory cells;

Secondary response, so antivenom / antibodies produced quicker;

2

(b) Passive immunity; so no memory cells produced;

Antivenom breaks down / destroyed;

2

(c) Could transfer disease / Allergy / Immune response to antibodies from animal;

1

[5]

Q11.

(a) side effects / allergic reactions / low toxicity to cells;
interaction with other drugs / effective in conditions of use / reasonably stable;
should only act on the problem bacteria / narrow spectrum;
how much resistance the bacteria have built up;

2 max

(b) (i) tetracycline
prevents tRNA binding to ribosomes / amino acid / mRNA;

1

amino acids not available / brought / picked up;

1

chloramphenicol
prevents <u>amino acids</u> being joined / prevents primary structure forming;

1

no enzymes / no structural proteins formed;

(accept cell wall formation if qualified) (prevents protein synthesis gains one mark in either section, once only)

1

(ii) only prevents tRNA binding to 70S / prokaryotic / bacterial <u>ribosomes</u> / human <u>ribosomes</u> are different sizes / shapes / structure;

1

[7]

Q12.

(a) Microorganism alive/active;
But does not cause symptoms of disease/Avirulent;

Accept does not make you ill/harm

2

(b) (i) (Takes time for) antigen to be recognised;

Accept reference to presentation by macrophage for first marking point

(Takes time for) T cells to be activated;

Accept primary (immune) response

B-cell activation/clonal selection/expansion;
Plasma cells to make (specific) antibodies;
Time for enough antibodies to measure;

2 max

(ii) Memory cells (present);

Accept secondary (immune) response

Respond immediately / can produce antibodies immediately;

2

[6]

Q13.

(a) <u>memory</u> <u>B</u> / <u>T</u> cells do not recognise (new antigens);
antibodies previously produced are not effective
as shape not complementary to new antigen;

2

(b) (i) <u>antigen</u> in <u>membrane</u> presented to lymphocytes /
produce cytokinins;

1

(ii) mitochondria provide (more) ATP / energy;
(more) RER / ribosomes synthesise proteins;
(more) Golgi body secretes / modifies or packages proteins /

produces glycoproteins;
(B lymphocytes) produces antibodies;

4

[7]

Q14.

(a) 1. Rank all STs in ascending order;
2. Find value with same number (of people) above and below.

Accept find middle value

2

(b) Not ethical to fail to treat cancer.

1

(c) Yes since with ipilimumab:

1. Median ST increased by 2.1 months;
2. Percentage of patients showing reduction in tumours increased from 10.3% to 15.2%;

No because:
3. No standard errors shown / no (Student) t- test / no statistical test carried out;
4. (So) not able to tell if differences are (statistically) significant / due to chance (alone);
5. Improvement might only be evident in some patients / no improvement in some patients;
6. Quality of (extra) time alive not reported;

If answers relate only to 'Yes' or ∂No', award 2 marks max

4 max

(d) 1. Faulty protein recognised as an antigen / as a 'foreign' protein;
2. T cells will bind to faulty protein / to (this) 'foreign' protein;
3. (Sensitised) T cells will stimulate clonal selection of B cells;
4. (Resulting in) release of antibodies against faulty protein.

3 max

[10]

Q15.

(a) Any **two** from:
1. (Decrease linked to) few(er) cases of whooping cough;
2. (Decrease linked to) risk of / fear of side effects;
3. Insufficient vaccine available / too expensive to produce / distribute.

3. Too expensive unqualified is insufficient for mark

2 max

(b) 1. Vaccination rate increases;
2. Fewer people to spread the disease / whooping cough / more people immune / fewer susceptible.

2. Neutral − greater herd effect

2. Allow description of immune

***Q** Reject 'resistant'.*

2

(c) 1. More people are immune / fewer people carry the pathogen;

If neither point 1 or 2 awarded

Herd immunity = 1 mark

Unvaccinated does not mean infected

*1. **Q** Do not accept disease for pathogen*

2. So susceptible / unvaccinated people less likely to contact infected people.

2

[6]

Q16.

(a) bacteria have ligands / antigens / proteins / glycoproteins / polysaccharides (on membrane / wall);

1

complementary to receptors / fits / binds / attaches to specific receptor

1

(b) enzymes denatured / tertiary / secondary structure altered / altered active sites / breaks hydrogen bonds;

1

prevents named chemical reactions / metabolic pathways;

1

(c) inhibits / kills other bacteria / fungi / decomposers / reduces competition;

1

(d) 1 prepare a bacterial lawn / culture / sample;
(accept mix bacteria with agar / medium)
2 with oil and one with control / water / range of concentrations;
3 appropriate method of standardising how sample applied, e.g. discs / wells;
4 appropriate measure of effectiveness / size / diameter of clear zone;
5 the larger the zone the greater the effectiveness;
6 use of aseptic technique;

(ignore haemocytometer)

4 max

[9]

Q17.

(a) Straight lines point to point as not possible to predict intermediate values / values between points;

1

(b) Increases then levels / falls;
Maximum antibody production 180 units / at dose of 0.25 g per kg;

2

(c) Two marks for correct answer of 57.14 / 57.1;;
One mark for incorrect answer in which candidate clearly divides difference in antibody production / 60 by 105;

2

(d) Takes into account different masses of mice / allows comparison;

Accept different weights of mice.
Do not accept different size.

1

(e) Sheep red blood cells have antigens (on their surface);
Antigens are proteins foreign to mice / are non-self;
Stimulate B cells to produce antibodies;

3

(f) Response only observed in mice;
Disease organisms not investigated;
Not all disease caused by pathogens / cured by antibodies;

i.e. not tested on humans

2 max

[11]

Q18.

(a) 1 macrophages present antigens to B lymphocytes;
2 antigen binds to / is complementary to receptors on lymphocyte;
3 binds to a specific lymphocyte;
4 lymphocytes become competent / sensitised;
5 (B) lymphocytes reproduce by mitosis / (B) lymphocytes cloned;
6 plasma cells secrete antibodies;

4 max

(b) 1 restriction enzyme / endonuclease;
2 to cut plasmid / to form sticky ends in plasmid;
3 (use) ligase(to join) gene to plasmid;
4 culture bacteria with (in medium containing) plasmids
5 to allow uptake of plasmids / transformation;
6 use of cold shock / chemical treatment (to enhance uptake) / heat shock;
(ignore bullets / electroporation / microinjection)

3 max

[7]

Q19.

(a) 1. (Releases) toxins;
2. Kills cells / tissues.

2. Accept any reference to cell / tissue damage
Ignore infecting / invading cells

2

(b) 1. Water potential in (bacterial) cells higher (than in honey) / water potential in honey lower (than in bacterial cells);

Q candidates must express themselves clearly
1. Must be comparative e.g. high WP in cell and low WP in honey

2. Water leaves bacteria / cells by osmosis;
3. (Loss of water) stops (metabolic) reactions.

3. Needs a reason why lack of water kills the cell

3

[5]

Q20.

(a) molecule / part of molecule / protein / glycoprotein / named molecule;
that stimulates an immune response / eq;

2

(b) divide by mitosis / form clones; produce plasma cells; (plasma cells) make antibodies;
(plasma cells) produce memory cells;

4

(c) (i) glycoprotein AND
different shape to body proteins / RNA and reverse transcriptase inside virus / phospholipids same as body's / on the surface of the virus;

1

(ii) 187.5;;
Accept 187 – 188
1 mark for HIV = 80nm;

2 max

[9]

Q21.

(a) divide by mitosis / form clones;
produce plasma cells;
(plasma cells) make antibodies;
(plasma cells) produce memory cells;

4

(b) glycoprotein;
different shape to body proteins / body phospholipids are the same / located on the outside of the cell / the haemoglobin is located inside the cell;

2

[6]

Q22.

(a) Reverse transcriptase;
Accept integrase/description of action of

Enzyme uses (HIV) RNA to make DNA (copy);

DNA joined to (host) cell's DNA/chromosome;

DNA used to make HIV RNA (copies);
Accept (HIV) DNA replicated when (T) cell divides

And HIV capsid proteins/enzymes;

Made at (host) ribosomes;

Assembly of new virus particles;

Budding off from membrane (of host cell);

4 max

(b) Not enough/no T-cells to activate B-cells/lead to antibody production/ activate immune system;

Accept death of T-cells weakens the immune system

Person unable to fight /more prone to (opportunistic) infections/cancer;

Accept diseases

Example of infection/cancer;

E.g. TB, pneumonia, cryptosporidium

2 max

[6]

Q23.

(a) Zevalin/antibody binds to specific receptor/cell surface protein/antigen;

(Only found) on B-cells;

2

(b) Patient **P** treated with Zevalin/yttrium (no mark);

Assume 'Zevalin' means 'with yttrium' unless they state otherwise

Where indium/antibody (only) on lymphatic system/groin and armpits;

So only (cancerous) B-cells killed;

In patient **P** high concentration of radioactivity/antibodies high enough to kill cancer cells;

Patient **Q** – radioactivity in places where other body cells could be killed/ organs damaged/named example;

Could harm patient more than cancer;

Patient **Q** cancer has spread;

So too late to treat;

3 max

(c) Patient **Q** – (cancerous) B-cells outside of lymphatic system/metastasis;

So antibody bound in other parts of the body (as well);

Patient **Q** – has different receptors/distribution of receptors compared to patient **P**;

Other body cells (than B-cells) have receptors for antibody;

2 max

(d) Might be allergic to mouse antibody/protein;

(Mouse) antibody acts as an antigen;

Causes an immune response/antibody production;

Antibody destroys Zevalin;

Releases radioactivity into body/prevents activity against the cancer;

2 max

[9]

Q24.

(a) Phagocytes engulf pathogens / microorganisms;

Enclosed in a vacuole / vesicle / phagosome;

Lysosomes have enzymes;

That digest / hydrolyse molecules / proteins / lipids / microorganism;

3 max

(b) (i) Get another strain / there are different strains;

Therefore does not have memory cells against second strain;

Q *The second marking point should only be awarded in the context of memory cells.*

2

(ii) Vaccines only work against certain strains because the antigens they possess are different;

Enables company to target strain likely to be prevalent later / most common strain;

2

[7]

Q25.

(a) Damage / destruction of cells / tissues;
Production of toxins;

2

(b) Contains antigen / proteins / dead / weakened microorganism / pathogen / virus / bacteria;
Stimulates production of antibodies / plasma cells / memory cells;

Q *Do not credit immune response unless qualified.*

2

(c) (i) Age;

Sex;

Ethnicity;

All healthy / not on other medication;

Not previously vaccinated / infected with TB;

Q *Do not credit sample size.*

Q *Allow any suitable reference to health not being affected for fourth marking point e.g. smoking, 'depressed immune system' etc.*

2 max

(ii) Contain the same antigens;

1

[7]

Q26.

(a) (i) P = membrane / lipid envelope / phospholipid bilayer;
Q = reverse transcriptase;

Accept (host) cell membrane;

2

(ii) Carries genetic information / to make DNA;

***Q** Do not accept 'information' on its own*
Accept genes, alleles,
to make (viral) protein;

1

(b) DNA copy made (of viral RNA);
Inserted into host DNA / chromosomes;
(Uses viral DNA to) make viral proteins/particles;
Makes viral RNA;
(Host) cell makes new viruses;
"Budding off" / wrapped in cell membrane;

Accept reverse transcriptase makes DNA for 2 marks in correct context;

3 max

[6]

Q27.

(a) 1. Antigen stimulates immune response / activates B/T cells;
2. B/T cells divide OR antibodies produced;
3. Antibodies/T cells attack myelin sheaths;

Ignore references to antigen binding to myelin

3

(b) 1. Fewer cristae/smaller surface area (of cristae);
2. So less electron transport/oxidative phosphorylation;
3. (So) not enough ATP produced
OR
Not enough energy to keep neurones alive;

1. Accept 'inner membrane' as 'cristae'

2. Accept fewer ATP synthase enzymes

2. Accept lower rate of electron transfer/oxidative phosphorylation

3. Accept less use/stimulation of neurone leads to death of cell

3. Accept no/less ATP produced/no energy to keep neurones alive

3. Ignore references to glycolysis/ Krebs cycle

3

(c) (i) (Transmission) electron (microscope) – **no mark**

Need high resolution (to see structure of mitochondria)

Accept 'scanning electron microscope' /TEM/SEM

Accept – optical microscope not high enough resolution

1

(ii) 1. Took photographs/areas at random;
2. Counted total number (of normal) and number of unusual mitochondria;
3. Divided number of unusual mitochondria by total number and multiplied by 100;

1. Accept (very) large number of areas/photos/samples

MP 3 = 2 marks (includes MP2)

3

[10]

Q28.

(a) Publicity about vaccination / better health education / risks of 'flu epidemics;

(Accept: now free on NHS (though only since 2000) / better awareness / more commonly available)

1

(b) (i) 1990: 26% of 7.4million = 1.92million *and* 2000: 64% of 7.8 million = 4.99million;
increase = 3.07 million;

2

(Correct reading of all 4 figures from graph = 1)

(Correct answer but no 'millions' = 1)

(Correct method resulting from wrong graph reading = 1)

(ii) Over 50% of population being vaccinated;
But only from 2000 onwards;
(Principle of more people being vaccinated each year = 1)

2

(iii) Different strain / type of virus each year / virus mutates;
With different antigens;
Influenza antibodies / memory cells (rapidly) destroyed / need replacing;

max 2

(c) (Protein coat) carries antigens which stimulates B-cells / production of antibodies;
Production of memory cells;

2

[9]

Q29.

(a) (i) fall in deaths due to rise in number of people with immunity / better care / targeting vaccination at vulnerable;

1

(ii) mutation of virus / new strain;
mutant form not recognised by memory cells (*allow antibodies*);

2 max

(b) (i) T lymphocyte receptors recognise shape of haemagglutinin /

neuraminidase / viral antigen;
clone (*once only*);
destroy virus;

2 max

(ii) clone (*once only*);
produce antibodies;
effect of antibody e.g. stimulation of phagocytosis / precipitation of toxins;

2

(c) alter shape of active site of neuraminidase / block active site;
virus unable to leave host cells;

2

[9]

Q30.

(a) 47 213;

1

(b) (i) there is no difference in the proportion / number of influenza cases between the 5 vaccines;

(reject vaccinated versus no vaccinated)

1

(ii) significant difference in proportion / number of cases of influenza between the vaccines / the null hypothesis should be rejected;

1

(c) sample size small;
possible differences in exposure to infection;
exposure to different strains / mutants;
possible differences in existing immunity;
possible differences in sex / age;
possible differences in socio-economic status;

2 max

[5]

Q31.

(a) Cotinine is an antigen;
Antigen/cotinine binds to (specific) T-cell/activates T-cell;
T-cell activates B-cells;
Specific B cell becomes activated;
(Specific) B cell divides/ clonal expansion;
Forms (clone of) plasma cells;
(Plasma) cell produces antibodies;

Accept macrophage presents antigen for one mark

Ignore references to memory cells and secondary immune response

4 max

(b) Antibodies are proteins with tertiary structure/specific shape/binding sites;
Antibodies specific shape for cotinine;
Only cotinine fits;

Do not credit active site

2

[6]

Q32.

(a) (i) To show whether immune response occured / because cats are (genetically) related to cheetahs;

Ignore reference to control.

1

(ii) To show that rejection did not normally occur / skin could (successfully) be grafted;

1

(b) (i) Rapid rejection between unrelated (domestic) cats / cats are **not** genetically similar;
Rapid rejection between (domestic) cat and cheetah / cats and cheetahs are not genetically similar;
Slow / no rejection in cheetahs / cheetahs are genetically similar;

3

(ii) Sample size small;
Time observed was short;

1 max

(iii) Similar (antigens on all cheetahs);

Accept same / not very different

1

(iv) Protein / antigen production determined by alleles / genes / base sequence on DNA;
The more similar the proteins the more similar their alleles / genes / base sequence on DNA / the more they are genetically similar;

2

[9]

Q33.

(i) 1360 = 2 marks
(general principle 0.68 ÷ 0.05 x 100 gains 1 mark)

2

(ii) still have maternal antibodies;

1

[3]

Q34.

(a) Protein / molecule/glycoprotein;
On surface of cell/microorganism;
Stimulates immune response/production of antibodies;

2 max

(b) Zookeeper is not producing antibodies/passive immunity;
No memory cells made;

OR
Antivenom is an antigen/stimulates production of (anti-antivenom) antibodies;

(Antivenom) destroyed by zookeeper's own antibodies;

OR
Antibody destroys antigen/venom;
Before immune response/no immune response;

2

[4]

Q35.

(a) 1. Vaccine/it contains antigen (from HPV);

Term 'antigen' may be first mentioned with point 2

2. Displayed on antigen-presenting cells;

Accept named example, e.g. macrophage/phagocyte/B cells

3. Specific helper T cell (detects antigen and) stimulates specific B cell;

Accept 'helper T cell with receptor on surface' for 'specific' and B cells with receptor/antibody on surface that bind to antigen for 'specific'

4. B cell divides/goes through mitosis/forms clone to give plasma cells;
5. B cell/plasma cell produces antibody;

4 max

(b) 1. Two (doses) because got more antibody;

Accept more effective in producing antibody

2. With three doses, second dose/dose at 1 month doesn't lead to production of any more antibody (than the two-dose group)/get same/similar response;
3. Three doses would be more expensive/less popular with parents/girls (and serves no purpose);

Accept 'less painful'

2 max

(c) t-test, because comparing two means;

Mark for correct test and explanation correct

Accept 'comparing the mean'

Reject 'to show that the results/means are significant'

1

(d) 1. Compare (base sequences of) DNA;

2. Look for mutations/named mutations (that change the base sequence);
3. Compare (base sequences of) (m)RNA;

1 and 3 accept triplet/codon sequences for comparisons

Ignore references to 'introns/non-coding DNA'

2 max

[9]

Q3.

Both questions (a) and (b) were about specific events within the immune response; many students gave lengthy answers, only small parts of which were relevant to the specific question asked. Some forgot that these two questions were about viruses and started to write about bacteria. Having said this, there were some extremely good answers to both questions, with over half of students achieving at least 2 marks for each.

(a) Many students did not refer to the antigen being presented on the surface membrane of the phagocyte, so could not be awarded mark point 3.

(b) Some students described, once again, how the virus would be presented. Mark points 3 and 4 were more often awarded than mark points 1 and 2, suggesting better understanding of the actions of B cells in the immune response than T cell involvement. Mark point 1 could be awarded if the student stated that a T cell binds to the antigen and then differentiates into a T helper cell.

(c) The responses to this question revealed much misunderstanding of the immune response as a whole, with many references to 'thinking' immune systems. Many students simply repeated phrases from the question stem; for example, "since the virus protein and the human collagen have a similar shape, the immune system will attack the human collagen". Students needed to identify that the part of the immune response which would 'attack' the collagen would be the binding of specific antibodies, and then to use their knowledge of how an antigen-antibody complex leads to the destruction of the antigen (section 3.2.4 of the specification), i.e., human collagen in this case. Credit could be gained for reference to agglutination or phagocytosis as methods of 'attacking' the human collagen, since these are the methods of antigen destruction named in the specification.

Q4.

(a) Most students correctly identified the evidence as relating to four polypeptide chains. Incorrect answers usually centred on the presence of variable regions or of hydrogen bonds. There was some evidence of the difficulties that students find in interpreting diagrams with numerous references to two polypeptide chains.

(b) Most students clearly appreciated that an antigen is able to bind to an antibody to form an antigen-antibody complex. Not all, however, were able to identify the binding site of the antibody as having a complementary shape to the antigen. Many of the less able students confused antibodies with enzymes. Use of the term active site rather than binding site was perhaps understandable, but many went considerably beyond this in writing of substrates and enzyme-substrate complexes. There were also many students who failed to maintain the necessary focus and wrote at length of plasma cells, memory cells and vaccines.

Q5.

(a) This was not well answered by most candidates. Many candidates offered suggestions such as 'cell wall' and 'nucleus'.

(b) In this question many candidates confined their answers to descriptions of the curve, instead of following the instruction to 'explain'. Some candidates did relate the increase in particles in (i) to replication within T-cells, but it was unusual to find a reference to the virus remaining latent, inactive or dormant in (ii).

(c) Answers here mainly focused on the body's immune system being unable to 'fight' the infection. Weak candidates gave a simple description of the graph. Only the better candidates understood that T-cells were being destroyed as HIV particles were released from them, leaving the body exposed to opportunistic infections as the immune system was functioning less effectively.

Q6.

The factual recall question, (a), proved far more challenging than intended. Only 5% of students obtained both marks and 54% failed to score. There was no particular pattern to the wrong answers.

Question (b) discriminated very well, with 15% obtaining three marks and 21% scoring zero. There were good, concise answers that scored three marks for including complementary base pairing and the role of DNA polymerase in joining nucleotides together to form the new DNA strand; often in two or three lines.

Many students failed to read the question carefully and did not answer the question as set. They wrote at length about DNA replication, starting with DNA helicase. These answers were awarded a maximum of two marks, because the question specifically asked how the complementary strand of HIV DNA is made. Many students appeared to believe that DNA actively pulls free nucleotides into place and makes them base pair; some even wrote about condensation reactions. There were students who confused transcription with replication and gave accounts of mRNA production.

Some students appeared to focus on 'HIV' and 'replication' and gave an extended account of how HIV infects cells, uses reverse transcriptase to make DNA, incorporates its DNA into host DNA, takes over the cell, is replicated by the host cell, infects new cells and leads to AIDS. They often went onto an additional page, or wrote their answer under (c) on the next page, in breach of instructions given on the front of the exam paper. Many of these students may have found themselves short of time for later questions.

In (c), it was pleasing to find that many students did obey the command word to 'contrast' and gave full statements about the differences between DNA and RNA. Many students knew enough about the structures of DNA and mRNA to give correct contrasting features and 47% obtained all three marks.

Q7.

(a) It was pleasing to see many good answers to this part that focused on how bacteria are destroyed by phagocytes. Some students drifted into general accounts of the immune response and others began by writing at length about how phagocytes find bacteria. About 30% obtained all three marks. It was common for students to be vague or wrong about the role of lysosomes. It was not uncommon to see references to lysosomes fusing with bacteria, rather than with the vacuole containing the bacteria. The examiners were looking for references to hydrolytic or digestive enzymes destroying the bacteria, rather than just enzymes breaking down bacteria.

(b) 80% obtained both marks. Those who failed to score usually included features of eukaryotic cells in their answers.

Q8.

(a) Only the most able candidates gained full credit on this question. However, most candidates gained one mark for the idea that cervical cancer could be caused by other factors. Unfortunately, some candidates misinterpreted the graph and considered it to show the percentage of women with cervical cancer, rather than the

percentage of women with a specific type of HPV. It was very clear that these candidates did not realise that all women in the investigation had cervical cancer. Consequently, this led to responses that were out of context such as that '66% of women with HPV16 have cervical cancer'. Better candidates were able to criticise the data. They usually referred to the absence of a control group or suggested that cervical cancer may increase susceptibility to HPV. Weaker candidates often gave vague answers that were not qualified e.g. 'it does not prove that HPV causes cervical cancer'. Similarly, they did not usually refer to specific types of HPV.

(b) (i) Approximately 40% of candidates gained one mark. This was almost always for stating that an antigen stimulates an immune response. Relatively few candidates made reference to the chemical nature of antigens.

(ii) Just over a third of candidates scored full marks but 60% scored at least two marks. A number of candidates were aware that vaccination causes the production of memory cells or that memory cells remain. However, many candidates had the idea that memory cells ensure a rapid response to the same virus if encountered again. Unfortunately, these points were often poorly expressed by weaker candidates such as in stating that 'memory cells remember the antigen' or that 'they fight the germ quicker'.

(c) Most candidates suggested that vaccinating young men would reduce the spread of HPV to females. However, it was usually only better candidates who explained this in terms of vaccinated males destroying the virus or not acting as carriers. Weaker candidates usually expressed this idea poorly e.g. 'vaccinated males cannot be infected'. A number of creditworthy references to herd immunity were made, although it should be noted that this term is not a requirement of this unit. Some candidates suggested that HPV may cause other cancers in males and this was also credited. The most common misconception involved vaccinated males passing on immunity to their children.

Q9.

(a) (i) The examiners wanted a statement that a mutation could make the gene inactive and that this would lead to uncontrolled, or very rapid, cell division. About half of students obtained both marks. Some students did not mention cell division but just stated that a tumour would grow; apparently taking 'growth' to mean cell division. The examiners did not accept these terms as equivalent. Some students got into long explanations of how a mutation could lead to a faulty protein and eventually got the first mark point for an inactive gene. Some of these failed to score because they wrote about mutations leading to the production of faulty amino acids.

(ii) A large majority of students managed to convey the idea of the genetic code being degenerate.

(b) Very few students obtained all three marks in this part. This was because they didn't address the reference to 'this antibody' in the stem. The examiners were looking for an observation that 'this antibody' will have a specific tertiary structure, or binding site, or variable region. Some of those who did consider this aspect, failed to score because they referred to a specific 'active site'. Many students obtained two marks for suggesting that the antibody binds either to the receptor (protein), or growth factor, and this prevents growth factor binding to its receptor.

Q10.

(a) Generally answered quite well, though, because the stem clearly indicated the yield

of antibodies was higher with the secondary response, answers that simply stated ”more antibodies produced’ were not credited. Examiners were looking for the faster rate of production as this was not given in the stem.

(b) Although this question was attempted by most candidates it showed that some thought antibodies can die.

(c) The better candidates tended to respond in terms of eliciting an immune response to the antivenom and gained the mark. Some candidates responded in terms of ethical issues and vegetarianism. Examiners found many of these responses were too vague or below the level needed to gain credit.

Q11.

Many candidates gained at least five marks in this question with weaker candidates scoring at least three.

(a) Most candidates gained one mark. Cost was rarely mentioned. Answers were often vague and lacked precision.

(b) (i) Most identified protein synthesis. Candidates tended to just give the sequence of events rather than what would happen if they stopped. Weaker candidates just repeated the question. Some candidates were confused between transcription and translation and others wrote about DNA replication and mRNA production.

(ii) There were many good answers but some just said ‘different sizes’.

Q12.

(a) This was very poorly known. Many candidates think that an attenuated microorganism is dead or inactive. Some who were aware that it is a weakened form of the microorganism went on to spoil their answer by describing it as ‘weakened or dead’. A few knew that the microorganism had been weakened, or repeatedly sub-cultured, but did not say that this means they do not cause the symptoms of the disease.

(b) This section was well known by most candidates. In (i)most candidates could give an explanation for the time delay, such as it takes time for the B cells to become activated, or for plasma cells to produce antibodies. Part (ii) was also well known, though there were fewer right answers here. Nevertheless, the majority of candidates were able to make some relevant reference to memory cells.

Q13.

This question produced a wide range of marks and proved to be an effective discriminator.

(a) Answers to this question were rather disappointing, often lacking the precise details expected at Advanced level. Although some candidates referred to ‘memory cells’, many did not specify that these are T or B cells (lymphocytes). Better candidates did mention antibodies but they often failed to explain that antibodies previously produced were ineffective or that it takes time to produce new effective antibodies following infection by a new strain of the influenza virus.

(b) In part (c)(i), although many candidates appreciated that macrophages engulf pathogens, few candidates precisely described that the antigen is then displayed on the macrophage cell membrane. An alternative mark point credited was the role of macrophages in producing cytokinins which stimulate B lymphocytes. Part (c)(ii) was generally well answered with most candidates obtaining at least two marks. Many candidates explained that the mitochondria provide ATP and that the RER or ribosomes are involved in protein synthesis. Although some candidates then linked protein synthesis to antibody production, only the best candidates provided a correct function of the Golgi body in terms of packaging and/or secreting proteins or glycoproteins.

Q15.

(a) Most students successfully used the graph to link the decrease in the percentage of infants vaccinated to fewer cases of whooping cough, with many correctly noting figures from the graph. Fewer students gave a second reason: the most common answer was the fear of side effects with many students linking the vaccine to potential side effects.

(b) 93% of the students scored one mark usually for correctly interpreting the graph and stating that the vaccination rate was increasing. Many then went on to discuss herd immunity in general terms rather than being specific and writing about more people being immune or fewer being susceptible as a result of the vaccination. Examiners expected students to use the correct terminology and students who wrote about ‘resistance’ to whooping cough did not gain credit.

(c) Two-thirds of the students scored one mark here, for realising that herd immunity was involved, but very few explained clearly how it worked. Examiners were looking for the ideas that there were fewer people in the population in which the pathogen could survive, because many were immune, having been vaccinated, and secondly that contact between infected people and unvaccinated people was therefore less likely. Students confused the terminology with some assuming that all unvaccinated people were infected. Many incorrectly expressed the idea that infants did not need to be vaccinated because they had inherited immunity from their parents and a significant number simply restated the information in the question stem.

Q16.

(a) Answers were generally good but some candidates confused the position of ligands and receptors. Some candidates did not know that humans are mammals.

(b) Most candidates gained the mark for enzymes being deactivated but then failed to describe a specific relevant effect.

(c) Some candidates appreciated the use of exotoxins. Incorrect responses suggested that they digested organic material as an aid to nutrition.

(d) This question was well answered across the whole ability range. Most candidates had seen or done a similar experiment and described the method well.

Q17.

(a) Relatively few candidates appeared to be aware that points on a graph should be

joined with straight lines if it is felt that the position of intermediate points cannot be predicted reliably. Given that this decision had been made by candidates in drawing their graphs in stage 2, this was somewhat surprising.

(b) Although many candidates were able to describe how the curve rose to a maximum value at 180 units or a dose of 0.25 g per kg, a significant number missed the point plotted for a zero dose. Other candidates misread the second point as representing a dose of 0.5 g per kg.

(c) It remains disappointing that so few candidates can calculate percentage increase or decrease. There were many incorrect answers to this question, frequently from otherwise sound candidates.

(d) Most candidates appeared to appreciate that calculating the dose per unit mass allowed differences in mass to be considered and a comparison to be made. Many responses, however, failed to gain credit because of the vague use of terms such as “bigger mice” and “size” rather than mass.

(e) It would appear that some candidates had been taught about the immune response in much greater detail than required by the specification. This additional detail tended to confuse rather than help the candidates and reduced their marks for this question. It was relatively uncommon to see three marks awarded for what should have been a straightforward account. Common errors made by less able candidates involved the confusion of antibody and antigen or failing to identify the antigens as being on the surface of the sheep red blood cells.

(f) Most candidates correctly pointed out that this investigation was carried out on mice and, therefore, the results might not apply to humans but only the better candidates were able to suggest a second valid reason.

Q18.

Most candidates gained at least four marks in this question.

(a) The majority of answers lacked detail and a clear understanding of the correct sequence of events. Candidates had to select the facts needed to answer the question. Many gained a mark for replication by mitosis/cloning. All the other marking points were seen, with stronger candidates gaining all the marks. Few mentioned the importance of specific B lymphocytes, or differentiation resulting in plasma cells that release antibodies.

Antigen, antibody and receptor were often confused. Many mentioned memory cells and T cells.

Many candidates gained more than half the marks because there were six points on the mark scheme.

(b) A large number of students wasted time describing how to isolate the gene. The gene had already been isolated. Marks were gained for references to restriction endonuclease, plasmid and ligase. Few suggested how to transfer plasmid into bacteria.

Q19.

(a) Almost 80% of students scored both marks, in a question which tested straightforward recall. Some described pathogens entering cells and reproducing without going on to clarify the damage that would have been caused to the cells. A minority misinterpreted the question and described two ways in which pathogens were transmitted.

(b) The context of this question proved difficult for many students with fewer than half the students explaining that water would move out of the bacterial cell by osmosis because of the water potential gradient. A large number incorrectly wrote about water being drawn out of the blood and washing away the bacteria and many argued that water would enter the bacteria causing osmotic lysis. Few students went on to explain why the loss of water would kill the bacteria

Q20.

(a) This generally proved a good opening question, but weaker responses were less specific about the nature of the 'chemical', or just referred to a 'substance' that stimulates an immune response.

(b) It was not uncommon to see all marks achieved. Better candidates appreciated that the B-lymphocytes would divide by mitosis, or produce clones, and then produced an accurate description of the production of antibody-secreting plasma cells and memory cells. Weaker responses discussed the role of T-lymphocytes, pathogens, plasmids or assumed that memory cells already existed.

(c) While many could correctly identify the glycoprotein as the component, the reason provided was often unconvincing. At a simple level, glycoproteins were on the surface of the virus -not the cell - but few identified that difference in shape, from body proteins, would enable recognition of the antigen. An accurate calculation was rarely seen with few able to achieve both marks and some did not attempt it. Lack of clear working meant that it was not possible to award any credit in many cases.

Q21.

(a) This part of the question attracted some very detailed descriptions of everything to do with the immune system, including T-lymphocytes, suppressor cells and the role of macrophages. However, in some of these accounts the main points were missed. Many candidates appeared of the opinion that plasma cells made memory cells. Others considered that lymphocytes were antibodies. In a few cases, plasma cells sometimes unfortunately became plasma or even plasmids. The idea that the B cells clone and these differentiate into plasma cells or memory cells seemed to elude quite a few candidates.

(b) Most candidates correctly identified the glycoprotein and gave an acceptable reason.

Q22.

Some very good answers were seen to each part of this question. However, for a topic which has been so well covered by the media and educational programmes, and been a familiar part of A level for many years, it was disappointing to find many candidates scoring very poorly.

In (a), half of candidates failed to score any marks. The mark scheme only required candidates to know basic facts about replication of HIV. For example, the ideas that there

is an enzyme that makes a DNA copy of the HIV RNA, this DNA is inserted into the host cell's DNA and is used to make new HIV RNA and proteins. The statements in this sentence would have obtained all four marks.

Part (b) was better answered and the majority of candidates expressed the idea that people die from infections they are unable to suppress because of their compromised immune system.

Q23.

Part (a) proved difficult for many candidates and nearly two-thirds scored nought. Many candidates simply re-stated the information in the stem of the question that the antibody binds to B cells. Others got very confused between antibodies, antigens and cells and appeared to use all three interchangeably. Good answers included the deduction that the antibody must bind to an antigen found on the surface of B cells (only).

Part (b) discriminated across the whole range. Weaker candidates had a lot of trouble expressing themselves clearly and got confused between cancerous B cells and the normal functions and functioning of B cells. The best answers were in terms of the cancer having spread in patient Q and radioactivity doing damage to vital organs.

On reflection, part (c) was either too difficult, or not worded clearly enough. Very few candidates gave good responses to this question.

There were many good answers to (d). Many candidates obtained both marks for answers along the lines that existing antibodies would destroy the Zevalin before it became bound to cancerous B cells, thus making the treatment ineffective.

Q24.

(a) There were many excellent answers to this part of the question that described phagocytes engulfing microorganisms and the subsequent role of lysosomes. Where difficulties arose, they not infrequently stemmed from too much, rather than too little, knowledge and there were some extremely involved and often confused answers that wrote in great depth about antigen presentation, opsonisation, b cells and t cells, none of which were relevant in the context of this question. The treatment of immunology should be confined to the principles set out in section 3.1.6 of the specification. Candidates will only be required to recall information explicitly described in this section.

(b) From the evidence in the answers to part (i), most candidates appeared to appreciate that a person might be infected with different strains of the influenza virus. Only the better candidates, however, were able to explain this in terms of memory cells. Less convincing answers were seldom expressed in appropriate scientific terminology.
Antigen, antibody and antibiotic were often used interchangeably in these responses, and there were many references to 'attacking while the immune system was still weak'.
In part (ii), candidates frequently ignored the instruction to 'Use your knowledge of antigens' and merely identified Strain 1 as the most frequent. There were however some excellent answers.

Q25.

(a) Most candidates had little difficulty obtaining at least one mark by referring to the production of toxins by pathogens. However, a significant number of candidates did not specifically refer to cells or tissues being damaged but instead described how

pathogene enter the body or wrote about damage in general terms.

(b) It was disappointing to find a significant number of candidates describing a vaccine as ‘a weakened form of a disease’. However, most candidates did refer to the production of antibodies or memory cells following vaccination. Some candidates did suggest that a vaccine contains antibodies and provides passive rather than active immunity.

(c) (i) This question caused little difficulty with the vast majority of candidates able to provide at least one valid factor, often age or gender. Other common correct responses related to obtaining healthy volunteers and individuals who had not been infected with TB or had been previously vaccinated.

(ii) This proved very difficult. Only a small percentage of candidates obtained this mark by suggesting that the two vaccines have similar antigens. Most candidates simply stated that the two vaccines were most effective when used together.

Q26.

(a) Most candidates were able to identify structure **P** correctly in (i), although a few thought it was a capsule or a cell wall. Fewer candidates were successful in identifying **Q**, and despite being told that it is an enzyme, gave answers such as ‘ribosome’ or ‘nucleus’. In (ii), many candidates knew that this carries genetic information, but others simply guessed and gave answers such as ‘supplies energy’.

(b) This question showed that there is widespread lack of understanding of how HIV affects infected cells. Many described the viral RNA pairing with a single strand of DNA to become double-stranded DNA. More worryingly, many candidates think that the helper-T cell becomes HIV once the HIV has invaded it.

Q27.

(a) There were some good answers but there were also a lot of confused answers. Many started incorrectly, with statements about the injected antigen attacking myelin. These statements were common amongst the 38% who failed to obtain any marks. Only 10% wrote about the antigen causing an immune response, leading to the production of antibody that then attacks myelin. Some good answers scored all three marks in two lines. There was considerable confusion about what T cells and B cells do.

(b) This part was a very good discriminator. Most students noted that the unusual mitochondria had fewer cristae, or a lower surface area (of cristae) for one mark (23%). Many then went on to associate this with too little ATP production (to keep the neuron alive) for a second mark (45%). Fewer went on to link loss of cristae to less electron transfer/oxidative phosphorylation (26%).

(c) (i) The vast majority correctly stated that an electron microscope would be required but only 43% then gave high resolution as the correct reason. There were many vague references to magnification and scale and a few suggested an optical microscope.

(ii) It was pleasing to see that many gave the correct formula to find percentage and suggested counting normal and unusual mitochondria. This resulted in 34% getting two marks. Only 8% also included a statement that photographs would have to be taken at random, or from a large number of different areas. Those who scored one mark usually just wrote about counting each type of

mitochondrion; others forgot to multiply by 100. Incorrect approaches included finding percentage cover, centrifugation to isolate each type and measurements of respiration.

Q28.

Part (a) was well known by most candidates. However, in (b)(i), very few gained both marks for the correct answer. Many gave a percentage instead of a number. Where the answer was wrong, it was very difficult for examiners to give credit for correct methodology because most candidates showed little organised working. Many candidates misread the graph, for example reading 74 million instead of 7.4. In (ii), most candidates could see that the percentage being vaccinated was rising each year, while the population was growing more slowly. In (iii), there were many vague answers referring to building up immunity, without any detail of how. Some simply stated that it was a good idea for elderly people to be vaccinated because they are the most at-risk age group. In part (c), there were many good answers, though many candidates referred to this being an attenuated vaccine.

Q29.

(a) (i) Build up of immunity in the community or advances in care were examples of acceptable responses. Again, 'vaccination', unqualified, was the most common answer and, again, this received no credit.

(ii) Most candidates gained one mark for stating that a mutant form or new strain was involved. Relatively few went on to complete the explanation in terms of non-recognition by memory cells.

(b) Weaker candidates continue to confuse the actions of T and B lymphocytes. However, even these candidates know that both types of cell clone in response to infection. References to phagocytosis by T lymphocytes were, unfortunately, quite common.

(c) Few candidates read the information given and therefore answered in terms of viruses being unable to enter cells. Those who answered correctly in terms of leaving the cell could rarely explain inhibition, rather merely re-stating that it would occur.

Q30.

Whilst a full range of marks was seen on this question, five marks were very rarely awarded. Most candidates' powers of expression were not up to the task of explaining what they meant in part (b). Most candidates scored between one and three marks.

(a) The majority of candidates obtained this mark.

(b) Relatively few obtained the mark in part (i). Most candidates misunderstood the basic purpose of the study and wrote about vaccination (versus no vaccination) having no effect on the number of influenza cases. Many merely turned the stem of the question around and stated 'there is no difference in effectiveness of the vaccines'. More candidates scored a mark in part (ii) by writing about the rejection of the null hypothesis.

(c) This discriminated quite well. Good candidates usually obtained two marks, average candidates often failed to gain one mark for vague references along the lines of 'it not being a fair test', and weak candidates gave answers such as 'there were a different number of people in each group'.

Q31.

(a) It was unusual for candidates to score full marks here. Many thought that cotinine was a pathogen. The role of T-cells and B-cells was confused by many, and those who did have some understanding of the immune system frequently focused on the production of memory cells, which was not relevant to this question.

(b) Many candidates scored a single mark here, but few gained both marks. The idea of complementary shapes and antigens fitting into receptor/binding sites on the antibody were not well known. A few incorrectly used the term 'active site', while many simply confined their answer to the statement that 'antibodies are specific'.

Q32.

(a) Candidates' knowledge of classification allowed many to make valid statements in their answers to part (a) about cats and cheetahs being from the same family or both being feline. Occasional candidates incorrectly referred to cats and cheetahs belonging to the same species. In part (b), some candidates were able to interpret the grafting of skin from one part of an animal to another as a test to see whether rejection would occur in these circumstances. The word 'reaction' was not considered to be synonymous with the specific biological meaning of rejection.

(b) Candidates could have taken one of two approaches in answering part (a). They could either have concentrated on the speed of rejection or on the closeness of the genetic relationship between relevant animals. Despite this, this part of the question was not answered well and responses tended to lack the necessary precision to gain credit. Most candidates responded to the word reliable in part (b) with a suitable comment about the size of sample, but there were a few responses that were correctly worded in terms of the duration of the observation. Although many of the answers to part (c) were correctly based on the inference that cheetahs must share similar antigens as skin grafts were tolerated between animals, responses to part (d) were often poor. There were many confused accounts that failed to reflect the fundamental idea that proteins such as antigens are coded for by DNA and so any variation in the amino acid sequence of the protein implied a variation in the DNA coding. Candidates rarely answered in these simple terms.

Q33.

(i) Only a minority of candidates was able to perform a percentage increase calculation. The most common error was to divide the final mean amount (0.73) by the original amount (0.05), failing to subtract.

(ii) Only the more able could suggest antibodies in the mother's milk, or placental transfer of antibodies as methods. Weaker candidates frequently stated that the antibodies were inherited.

Q34.

(a) This question was not as well answered here as it has been on previous papers. Many candidates confused antigens with antibodies, and thought that they were produced by the body in response to an infection. While quite a large number of students gained one mark here, only the better candidates scored two.

(b) Better candidates answered this well, but weaker candidates produced confused answers. Again, it was apparent that the immune system is not well understood by weaker candidates.

Q35.

Question (a) was a very good discriminator. 19% obtained all four marks, 14% failed to score and equal percentages obtained one, two or three marks. Many students had the idea that a vaccine contains antigen and knowledge of antigen-presenting cells was common. There were also many correct statements about plasma/B cells releasing antibodies. Fewer students had the idea of a B cell dividing to form plasma cells. Not many students were able to express clearly the idea of a specific helper T cell or B cell detecting, or responding to, a specific antigen. Quite a few students got confused between the roles of T cells and B cells. Some students wrote at length about memory cells and secondary responses, neither of which was required to answer the question. As in some other questions, this inclusion of irrelevant material often generated additional pages and wasted time that could have been spent on other questions.

Most students obtained one mark in (b) for suggesting greater antibody production with two vaccinations. Almost none went on to make any other suggestion.

In the mathematical requirements section of the specification (pages 62-66), selection and use of a statistical test is not emboldened and so is required content for both AS level and full A-level. This is different from the legacy specification and answers to (c) indicated that most students had not learnt this. Only 6% of students could name the t-test and give the reason as testing the difference between means. Further guidance about teaching statistics is provided in the support materials on the AQA website.

The examiners were expecting statements from the specification in answers to (d). In ‘Investigating diversity’ (section 3.4.7), genetic diversity is compared (amongst other ways) by looking at base sequences of DNA and base sequences of mRNA. Very few students (3%) came up with both of these but some (27%) managed to express one of them.