# Immunity, Infection and Forensics -4

Name: _____

Class: _____

Date: _____

Time:

Total Marks Available:

Total Marks Archived:

Level: Edexcel A level Biology

Subject: Biology

Exam Board: Pearson Edexcel Level 3 GCE AS and A level Biology A (Salters-Nuffield) and also Pearsons Edexcel AS and A Level Biology B (9BI0) - Is however suitable for use by AS and A level Biology Students of other Boards

Topic: Immunity, Infection and Forensics -4

Type: Topic Question

To be used by all students preparing for Edexcel AS and A level Biology A and Biology B - Students of other Boards may also find this useful

# Questions

Q1.

The extent of decomposition is important in helping to determine the time of death of a mammal.

Body farms are outdoor laboratories where experiments take place to investigate the changes that take place after death in a range of conditions. Body farms use the bodies of pigs or donated human bodies.

The effects of factors such as temperature, moisture and position of the body on the rate of decomposition can be studied.

Explain the effect of ambient temperature on the rate of decomposition.

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**(Total for question = 3 marks)**

Q2.

The time of death of a person can be estimated in a number of ways. One method is to use a Henssge nomogram.

The Henssge nomogram relates the time of death to the ambient (surrounding) temperature, the core temperature and the mass of the body.

Explain why the ambient temperature and the core temperature of the body are used to determine the time of death of a person.

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Q3.

A dead human body can supply a variety of evidence to support the time of death.

The table shows the relationship between the mean rectal temperature, calculated from a number of human bodies, and time after death. All bodies were at the same ambient temperature.

| Time after death / hours | Mean rectal temperature / °C | Range of rectal temperature / °C |
|---|---|---|
| 4 | 36 | ±1.8 |
| 8 | 31 | ±2.5 |
| 12 | 28 | ±3.3 |
| 16 | 26 | ±4.3 |
| 20 | 24 | ±5.1 |
| 24 | 22 | ±5.6 |

(a) Deduce the maximum ambient temperature.

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(b) Analyse the data to explain why a more reliable estimate of time of death could be given if the dead body has a higher rectal temperature.

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(c) State **two** features of these bodies that could account for the variation in the data.

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(d) Explain why recording rectal temperature is more reliable than measuring skin temperature.

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(e) In addition to body temperature, forensic scientists would look for other evidence of time of death.

Give **two** other pieces of evidence from a body that allow for an estimation of the time of death.

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**(Total for question = 10 marks)**

Q4.

**Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

Farmers use fertilisers to increase the growth of crops such as wheat.

(i) Fertilisers contain phosphate ion compounds.

Plants need phosphate in order to synthesise

**(1)**

☐ **A** both cellulose and phospholipids

☐ **B** both phospholipids and polysaccharides

☐ **C** both polynucleotides and phospholipids

☐ **D** both polynucleotides and polysaccharides

(ii) After the grain is harvested, farmers plough the stems (straw) from wheat plants into the soil.

This improves the quality of the soil. These stems contain polysaccharides.

Explain how microorganisms in the soil break down the stems.

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**(Total for question = 4 marks)**

Q5.

Researchers carried out a study on the prey of predatory ground beetles. They removed the contents of the guts of beetles which had been feeding and analysed them to see if they could identify the species they had fed on.

In one study, to see if the method worked, they fed the beetles on earthworms of the species *Allolobophora chlorotica* only.

DNA was extracted from the gut contents and analysed.

(a) The quantity of worm DNA in the beetle gut was very small.

Describe how sufficient DNA was produced to carry out the analysis.

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(b) (i) The DNA in the samples from the beetle guts was cut into fragments. The fragments were different for each species and had to be separated by gel electrophoresis.

Which of the following describes the movement of the DNA fragments in gel electrophoresis?

**(1)**

☒ **A** large fragments move further than small fragments towards the anode

☒ **B** large fragments move further than small fragments towards the cathode

☒ **C** small fragments move further than large fragments towards the anode

☒ **D** small fragments move further than large fragments towards the cathode

(ii) The picture shows one set of results in which four samples have been separated.




(Source: Evaluation of temperature gradient gel electrophoresis for the analysis of prey DNA within the guts of invertebrate Sheppard et al. Cardiff School of Biosciences)

Explain what these results show you about the diet of the ground beetles.

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**(Total for question = 6 marks)**

Q6.

Acetylcholinesterase is an enzyme involved in regulating the transmission of nerve impulses across some synapses.

Acetylcholinesterase is found on the cell surface membranes of neurones and red blood cells. These acetylcholinesterase molecules have different primary structures. In humans, a single gene codes for acetylcholinesterase.

(i) Explain how a single gene can give rise to acetylcholinesterase molecules with different primary structures.



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(ii) Explain how the acetylcholinesterase gene can be expressed in some tissues but not others.

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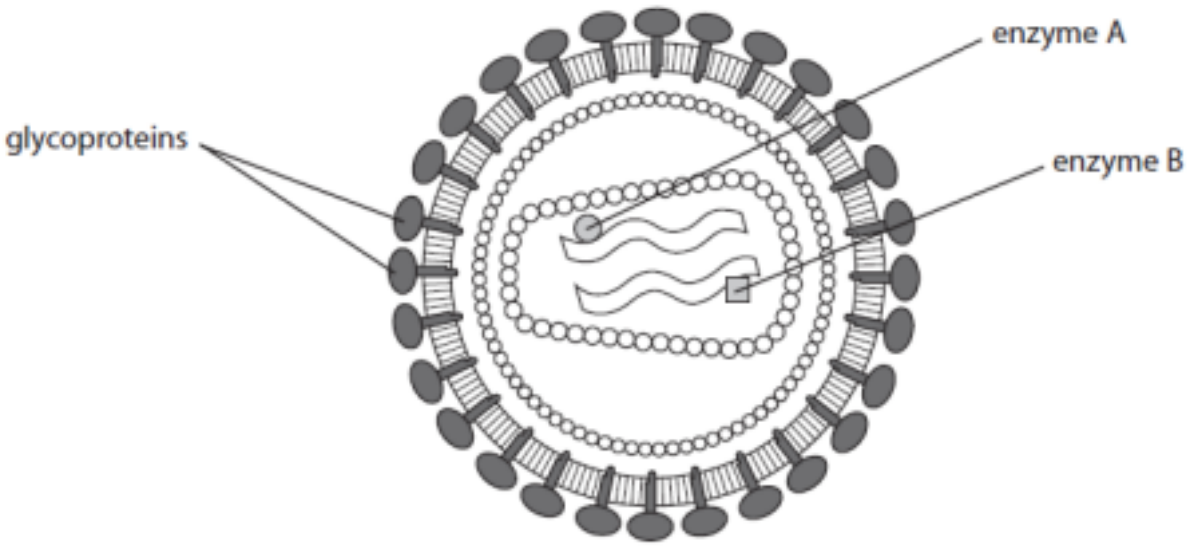
**(Total for question = 5 marks)**

Q7.

Anti-viral drugs have been developed to treat patients infected with Human Immunodeficiency Virus (HIV).

The diagram below shows the structure of HIV.



(a) A glycoprotein has a carbohydrate attached to a protein molecule.

Describe the three-dimensional structure of a glycoprotein.

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(b) Some anti-viral drugs prevent HIV entering the host cells.

Suggest how these anti-viral drugs could prevent HIV entering the host cells.

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*(c) Describe how the enzymes shown in the diagram are involved in HIV infection.

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**(Total for question = 11 marks)**

Q8.

The Human Immunodeficiency Virus (HIV) infects cells of the human immune system.

(a) (i) Place a cross ( ☒ ) in the box next to the name of the type of cell in the human immune system that is infected by HIV.

**(1)**

- ☐ **A** B effector cell
- ☐ **B** B memory cell
- ☐ **C** T helper cell
- ☐ **D** T killer cell



(ii) Place a cross ( ☐ ) in the box next to the name of the enzyme used to produce DNA from viral RNA in an infected cell.

**(1)**

- ☐ **A** DNA polymerase
- ☐ **B** RNA polymerase
- ☐ **C** restriction endonuclease
- ☐ **D** reverse transcriptase

(b) An antibody, known as 2G12, has been isolated from the blood of an HIV patient. (i) State **two** characteristic features of antibodies.

**(2)**

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*(ii) The antibody 2G12 is produced in response to part of a glycoprotein found on the surface of HIV. Synthetic molecules have been made that resemble this part of the glycoprotein. The antibody 2G12 binds to these synthetic molecules.

Using the information, suggest how this may enable scientists to develop a means of producing **active** immunity to HIV infection.

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(c) The table below shows some data about groups of people with HIV infection, in the United Kingdom in 2010.

| Group | Numbers in the United Kingdom |
|---|---|
| People newly-diagnosed with HIV infection | 6 630 |
| People unaware of their HIV infection | 21 625 |
| People receiving treatment for HIV infection | 65 000 |

Some of the figures shown in the table are estimates.

Suggest why data about HIV infections are often estimates.

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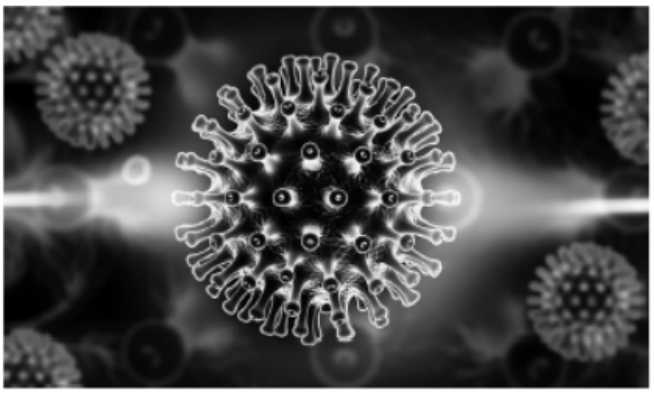
**(Total for question = 11 marks)**

Q9.

**Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒and then mark your new answer with a cross ☒.**

The human immunodeficiency virus (HIV), shown in the image, causes acquired immunodeficiency syndrome (AIDS).



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HIV particles contain

(1)

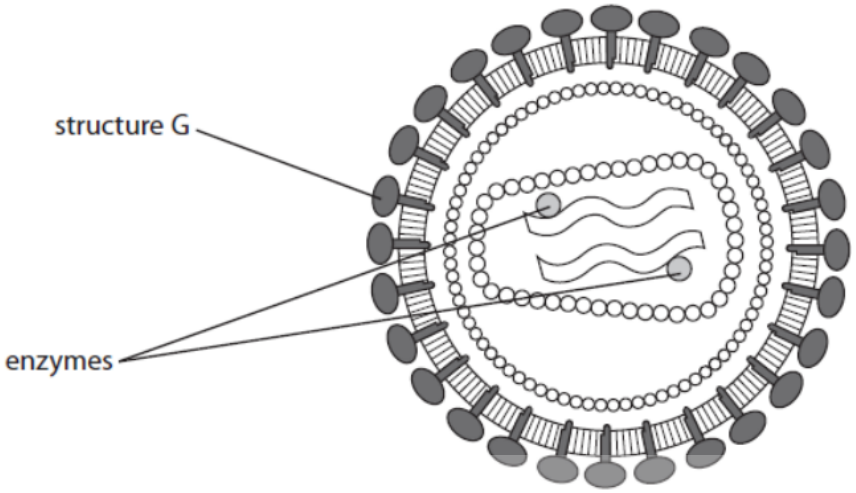
- **A** DNA and DNA polymerase
- **B** DNA and reverse transcriptase
- **C** RNA and DNA polymerase
- **D** RNA and reverse transcriptase

**(Total for question = 1 mark)**

Q10.

Anti-viral drugs have been developed to treat patients infected with Human Immunodeficiency Virus (HIV).

The diagram below shows the structure of HIV.




(a) Explain how **structure G** enables HIV to infect human cells.

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(b) Some anti-viral drugs used to treat patients infected with HIV are inhibitors of enzymes found within HIV.

(i) Describe the structure of an enzyme.

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*(ii) Suggest how these anti-viral drugs would work in the treatment of patients infected with HIV.

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**(Total for question = 11 marks)**

Q11.

The scientific article you have studied is adapted from *Scientific American*.

Use the information from the scientific article and your own knowledge to answer the following question.

Describe how a cell that is 'a key player in the body's immune system' differs from a stem cell (paragraph 14).

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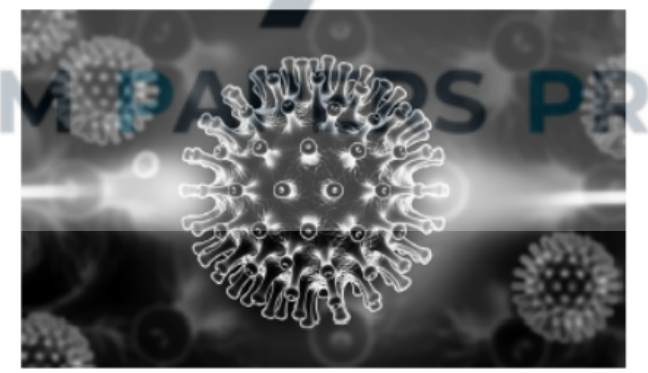
**(Total for question = 4 marks)**

Q12.

The human immunodeficiency virus (HIV), shown in the image, causes acquired immunodeficiency syndrome (AIDS).



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HIV enters and destroys T helper cells. This can cause AIDS.

(i) Describe how HIV particles are able to enter T helper cells.

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(ii) Explain why the destruction of T helper cells causes the symptoms of AIDS.

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**(Total for question = 7 marks)**

Q13.

**Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

A bacteriostatic antibiotic works by

**(1)**

- ☐ **A** destroying bacteria
- ☐ **B** destroying viruses
- ☐ **C** preventing the multiplication of bacteria
- ☐ **D** preventing the development of antibiotic resistance



**(Total for question = 1 mark)**

Q14.

A newborn baby can respond to infections.

The mother of a baby will produce an immune response to any infections that she acquires.

Antibodies providing specific immunity to these infections are found in the milk produced by the mother.

(i) Which cell produces antibodies?

**(1)**

- **A** macrophage
- **B** plasma cell
- **C** red blood cell
- **D** T cell

(ii) The type of immunity that the newborn baby obtains from the milk produced by its mother is

**(1)**

- **A** artificial active immunity
- **B** artificial passive immunity
- **C** natural active immunity
- **D** natural passive immunity

**(Total for question = 2 marks)**

Q15.

Bacteria and viruses can cause human diseases.

(a) Distinguish between the structure of bacteria and viruses

**(3)**

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(b) Infection with a bacterium can result in the development of active immunity to that bacterium. This results in the production of antibodies by plasma cells.

(i) Describe how infection with a bacterium results in the production of plasma cells.

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(ii) Explain how antibodies help a person to recover from an infection.

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(iii) A person who has had an organ transplant has to take immunosuppressive drugs.

This prevents the immune system from destroying the organ transplant. Some of these drugs work by inhibiting the production of cytokines.

Suggest what effect these drugs could have on a person infected with a bacterium or a virus.

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**(Total for Question = 13 marks)**

Q16.

The scientific article you have studied is from *Scientific American*.

Use the information from the scientific article and your own knowledge to answer the following question.

'Innate immunity initiates the inflammatory response, in which white blood cells swarm the site of infection' (paragraph 5).

Explain how white blood cells 'swarm' to accumulate at the site of inflammation.

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**(Total for question = 4 marks)**



Q17.

The scientific article you have studied is adapted from *Scientific American*.

Use the information from the scientific article and your own knowledge to answer the following question.

Explain how inflammation and the immune response can cause damage to tissues (paragraph 4).

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**(Total for question = 3 marks)**

Q18.

The coffee husks, shown in the photograph, are a waste product of coffee plantations.

Composting has been suggested as an environmentally friendly way of decomposing these coffee husks.



The effect of adding cow dung to coffee husks, before they are composted, has been investigated.

The table shows the percentages of organic carbon and nitrogen in two compost heaps at the start of composting and after 90 days.

| | Husks alone | | Husks with added cow dung | |
|---|---|---|---|---|
| Days composting | 0 | 90 | 0 | 90 |
| Organic carbon (%) | 54.50 | 41.70 | 48.10 | 35.40 |
| Nitrogen (%) | 1.84 | 2.31 | 2.76 | 3.19 |

* The changes in the compost heaps are due to the activity of decomposers and other organisms.

Devise an investigation to determine the effect of the carbon to nitrogen ratio on the succession of species in these compost heaps.

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**(Total for question = 6 marks)**

Q19.

Measles is a contagious disease that can be controlled by vaccination.

Not all parents choose to have their children vaccinated.

The table shows the number of cases of measles and the percentage of children vaccinated in the UK between 2012 and 2017.

| Year | Number of cases of measles | Percentage of children vaccinated (%) |
|---|---|---|
| 2012 | 1564 | 91.2 |
| 2013 | 1855 | 92.3 |
| 2014 | 135 | 92.7 |
| 2015 | 71 | 92.3 |
| 2016 | 556 | 91.9 |
| 2017 | 216 | 91.6 |



(i) Calculate the percentage change in the number of cases of measles from 2013 to 2014. Give your answer to three significant figures.

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(ii) One conclusion from the data is that it takes time for an increase in vaccination rate to reduce the number of cases of measles in children.

Explain why this is a valid conclusion.

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**(Total for question = 6 marks)**

Q20.

Measles is a contagious disease that can be controlled by vaccination.

The incidence of measles has risen by 300% worldwide in recent years.

A study has found that some B memory cells and antibodies are destroyed by the measles virus.

(i) Antibodies are released into the blood when

**(1)**

- **A** B cells are activated to become killer cells
- **B** B cells are activated to become plasma cells
- **C** macrophages are activated to become B cells
- **D** plasma cells are activated to become memory cells.

(ii) Vaccinations are carried out against many serious diseases.

Vaccination leads to the production of antibodies and memory cells.

Which kind of immunity is provided by this type of vaccination?

**(1)**

- **A** active artificial
- **B** active natural
- **C** passive artificial
- **D** passive natural

(iii) Explain why, following a measles infection, it may be advisable for children to repeat other vaccinations they have had.

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**(Total for question = 5 marks)**

Q21.

Humans are surrounded by microorganisms in the air, water and food.

Some microorganisms are pathogenic.

The human body has several barriers to prevent infection by pathogens.

Explain why the presence of microorganisms on the skin and in the gut helps to prevent pathogenic organisms multiplying in the body.

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**(Total for question = 3 marks)**

Q22.

Thalassaemia is a recessive genetic disorder that affects the production of haemoglobin. It is caused by a gene mutation.

Scientists are developing methods to repair gene mutations such as the one that causes thalassaemia.

The RNA produced during transcription is known as pre-mRNA. Pre-mRNA can be modified before being translated on the ribosome.

(i) Describe how the pre-mRNA may be modified before being translated on the ribosome.

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(ii) Explain why modification of pre-mRNA enables one gene to give rise to more than one protein.

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**(Total for question = 4 marks)**



Q23.

The neurones of the central nervous system contain TAU proteins. These proteins help to maintain cell structure.

In humans, six different TAU proteins can be produced from a single gene.

Parkinson's disease has been linked to the different forms of the TAU proteins present in neurones.

Scientists are studying the effect of these different TAU proteins in animal models. One model used is the fruit fly, *Drosophila*.

Describe how *Drosophila* flies could be genetically modified to produce one form of the human TAU protein.

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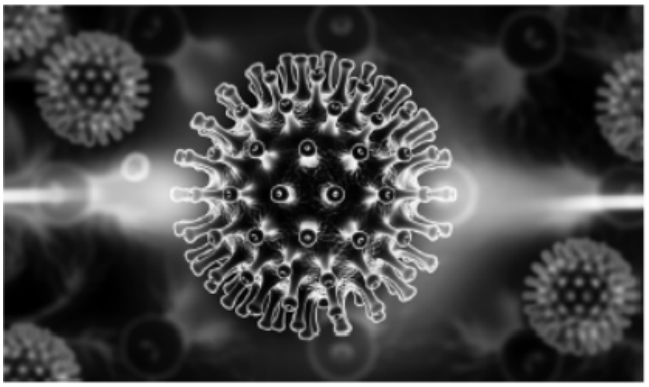
**(Total for question = 4 marks)**



Q24.

The human immunodeficiency virus (HIV), shown in the image, causes acquired immunodeficiency syndrome (AIDS).



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A small number of people have been identified who are resistant to HIV.

They have a mutation in a gene coding for a protein in the cell membrane.

(i) Deduce why this mutation makes these people resistant to HIV infection.

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(ii) Stem cell therapy can be used to treat patients infected with HIV.

The bone marrow of these patients can be destroyed using radiotherapy.

The patients can then be given stem cells from the bone marrow of a donor who has this mutation.

Explain why these stem cells may prevent HIV causing AIDS.

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**(Total for question = 6 marks)**

Q25.

The human body responds to infection by bacteria in a number of ways.

The non-specific response includes phagocytosis and lysozyme action, which can be followed by the specific immune response. The specific immune response requires antigen presentation by macrophages.

(a) Explain how phagocytosis and lysozyme action lead to antigen presentation by macrophages.

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(b) Explain how macrophages present antigens to T helper cells.

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(c) There is an 'evolutionary race' between some bacteria, such as *Mycobacterium tuberculosis* (TB), and their hosts.

Suggest how this could affect antigen presentation to T helper cells.

Give an explanation for your answer.



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**(Total for question = 9 marks)**