

1. Question part 1/3 | 9700 May-June 2016 P2 V1 Q2

2 Macrophages synthesise intracellular enzymes.

Fig. 2.1 is a summary diagram of events that occur in a macrophage.

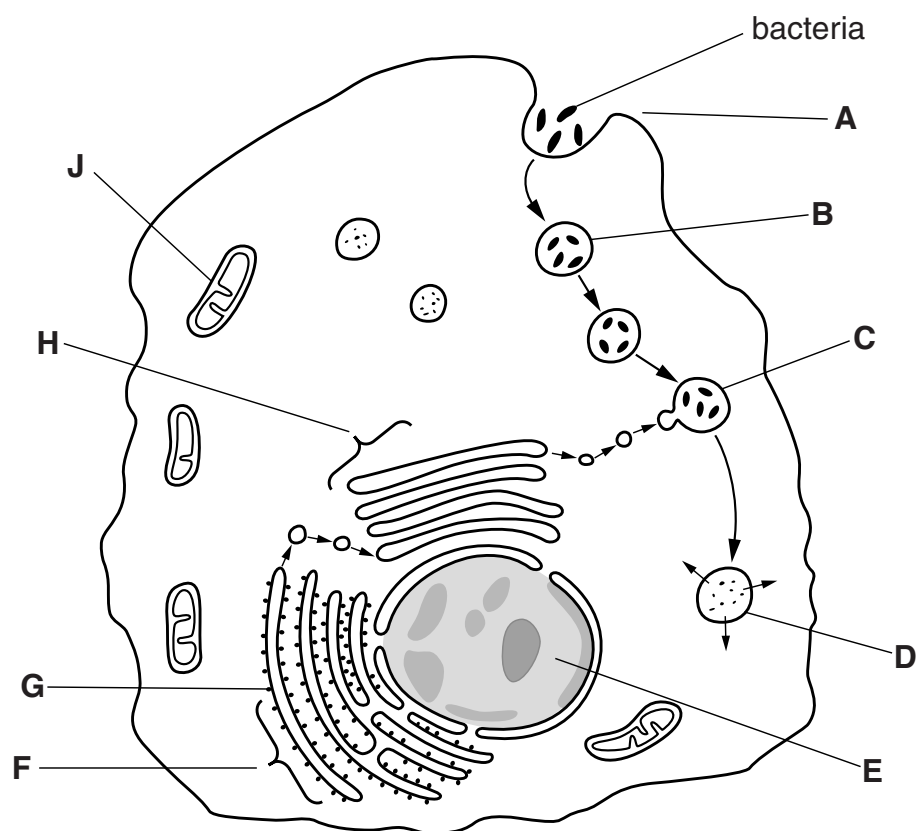


Fig. 2.1

(a) (i) Name the process at **A**.

.....[1]

(ii) Name the stages of protein synthesis that occur at **E** and at **F**.

E

F[2]

(iii) Name organelles **B**, **G**, **H** and **J**.

B

G

H

J[4]

(b) Describe what happens to the bacteria between **C** and **D**.

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- (c) Macrophages are antigen presenting cells (APCs). Antigens from pathogens such as the bacteria shown in Fig. 2.1 are presented to helper T-lymphocytes as shown in Fig. 2.2.

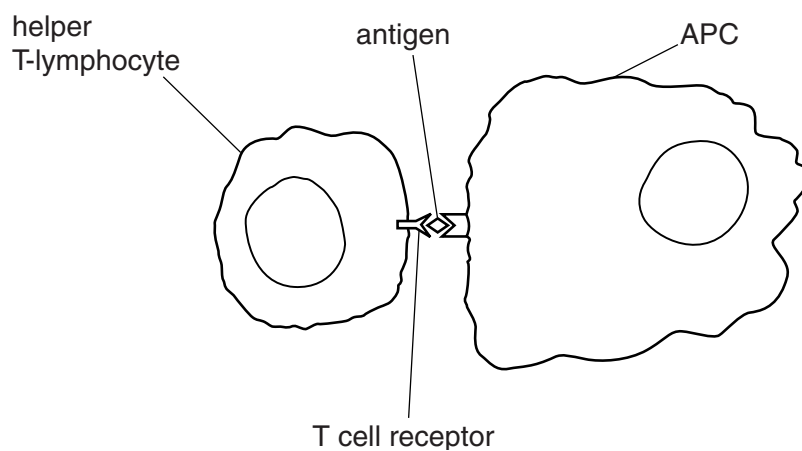


Fig. 2.2

Very few helper T-lymphocytes respond to the presence of APCs by binding in the way shown in Fig. 2.2.

Suggest why this is so.

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[Total: 12]

3 Rheumatoid arthritis (RA) is a disease of the joints in the human body.

- (a)** RA is classed as an auto-immune disease where the immune system treats some self antigens as non-self.

Explain what is meant by the term *non-self antigens*.

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- (b)** The symptoms of RA include inflammation of the joints which causes pain and difficulty in movement of the joint.

The inflammation is triggered by a chemical known as $\text{TNF-}\alpha$, produced by macrophages.

One approach to the treatment of RA is by the use of monoclonal antibody against $\text{TNF-}\alpha$.

Fig. 3.1 is a diagram of an antibody molecule.

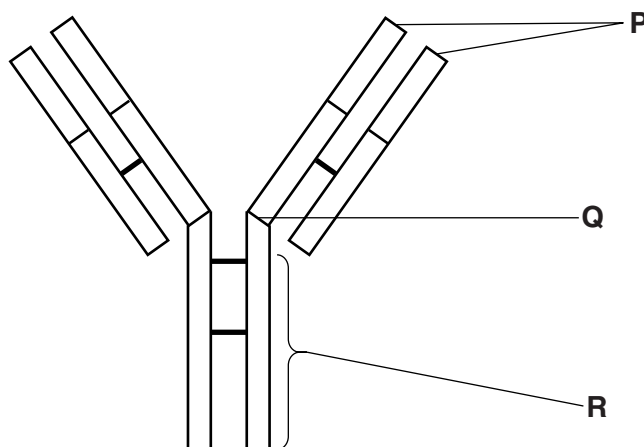


Fig. 3.1

- (i)** Name the parts of the antibody molecule labelled **P**, **Q** and **R**.

P

Q

R

[3]

(ii) Name the type of bonds that hold the polypeptide chains together in the antibody structure.

.....[1]

(c) (i) Outline how monoclonal antibody against TNF- α is produced.

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(ii) Suggest how monoclonal antibody against TNF- α can reduce the symptoms of RA.

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[Total: 12]

3. Question | 9700 Oct-Nov 2016 P2 V1 Q5

5 (a) Monoclonal antibodies (MAbs) have been used in the treatment of some non-infectious diseases.

MAbs can be designed to bind to a protein on diseased cells, so causing their destruction by cells of the person’s immune system.

(i) Name the part of an antibody molecule that will bind to a protein on diseased cells.

.....[1]

(ii) Suggest how the binding of monoclonal antibody to the diseased cells causes their destruction by cells of the person’s immune system.

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(b) Myasthenia gravis is an auto-immune disease.

Explain the term *auto-immune disease*.

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.....[1]

[Total: 6]

- 3 Fig. 3.1 is a diagram that shows the structure of an antibody molecule.

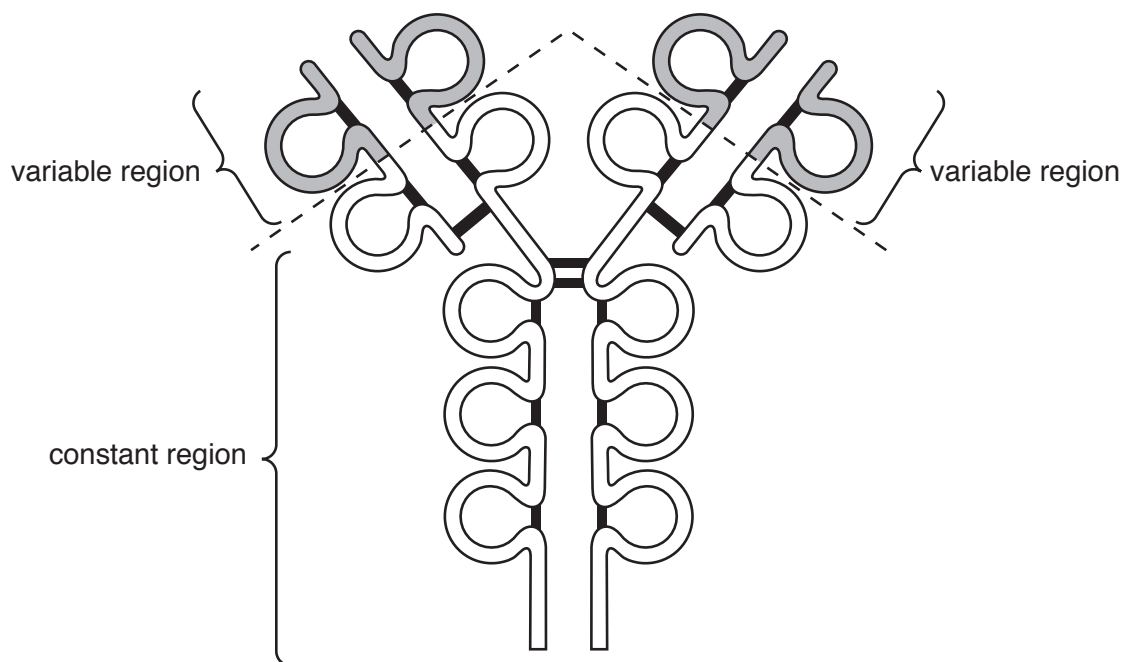


Fig. 3.1

- (a) State why the antibody molecule shown in Fig. 3.1 has quaternary structure.

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.....[1]

- (b) (i) Use Fig. 3.1 to explain how the structure of the variable region of an antibody molecule is related to its function.

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- (ii) State the role of the constant region of an antibody.

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(c) Monoclonal antibodies are used both in diagnosis and in treatment of disease.

(i) Outline how monoclonal antibodies are produced.

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(ii) Suggest the advantages of using monoclonal antibodies in diagnosis of disease.

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[Total: 11]

5 Some pathogens can enter the human body through the gas exchange system.

(a) The epithelial lining of the gas exchange system is adapted for defence against pathogens.

(i) List the structures in the gas exchange system that have a ciliated epithelial lining.

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.....[1]

(ii) Name the cells in the ciliated epithelium that synthesise and secrete mucus.

.....[1]

Alveolar macrophages are cells of the immune system. They have an important role in defence against respiratory infections.

(b) The infectious lung disease, pneumonia, can be caused by *Streptococcus pneumoniae*.

Most healthy people inhaling air containing these bacteria do **not** become ill because of the action of the alveolar macrophages.

Outline the mode of action of an alveolar macrophage in response to the presence of *S. pneumoniae*.

You may use diagrams with notes to help your answer.

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.....[3]

Irritants in tobacco smoke can contribute to emphysema, one of the chronic obstructive pulmonary disorders (COPD). In emphysema, the alveoli lose their ability to recoil on expiration and can burst.

(c) Suggest how the structure of the alveolar wall changes so that an alveolus bursts.

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.....[2]

(d) Some alveolar cells produce a surfactant that helps to prevent the collapse of alveoli on exhalation. Too much surfactant decreases the efficiency of gas exchange in the alveoli.

A glycoprotein known as GM-CSF is released by some cells of the immune system when there is too much surfactant in the alveoli. Excess surfactant is then broken down by alveolar macrophages.

Receptors for GM-CSF are on the cell surface membranes of alveolar macrophages.

Explain how maintaining the correct quantity of surfactant in the alveoli is the result of a cell signalling mechanism.

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.....[4]

3 Cells of the immune system function to protect the body against infectious diseases.

(a) (i) Name the type of cell that produces antibodies.

.....[1]

(ii) The virus that causes the infectious disease influenza has two antigens, **H** and **N**. Antibodies are produced in response to an infection by this virus. The antibodies are specific for either antigen **H** or for antigen **N**.

Describe how the structure of an antibody molecule allows it to be specific for **one** antigen, such as **H** or **N**.

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.....[3]

(b) Cholera is a disease caused by a bacterial pathogen.

(i) Name the pathogen that causes cholera.

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(ii) Describe how the pathogen that causes cholera is transmitted.

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.....[2]

(c) Viruses that infect bacteria are called bacteriophages. Some bacteriophages that infect the cholera pathogen cause lysis of the bacterium.

(i) Suggest what happens to the structure of a bacterial cell to cause lysis.

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(ii) Some scientists believe that bacteriophages could be used to treat people who are infected with cholera.

Suggest the properties of the bacteriophages that would make this possible.

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(iii) Antibiotics can be used to treat people with cholera.

State why antibiotics are **not** effective against measles.

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.....[1]

[Total: 12]

Topical questions | 27 questions

5 (a) The toxins released by some pathogenic bacteria can be altered chemically so that they are harmless. These harmless toxins are called toxoids.

Describe the response of the immune system to the injection of a toxoid.

[5]

[5]

(b) Myasthenia gravis (MG) is described as an autoimmune disease. It is a long-term condition that results from a failure of the immune system.

(i) Explain why MG is known as an autoimmune disease.

[3]

[3]

(ii) Suggest why MG is a long-term condition.

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.....[2]

[Total: 10]

Question 6 starts on page 14

8. Question part 1/2 | 9700 Oct-Nov 2018 P2 V1 Q4

- 4 Fig. 4.1 is a photomicrograph of a cross-section of a tubular structure in the kidney made from epithelial cells.

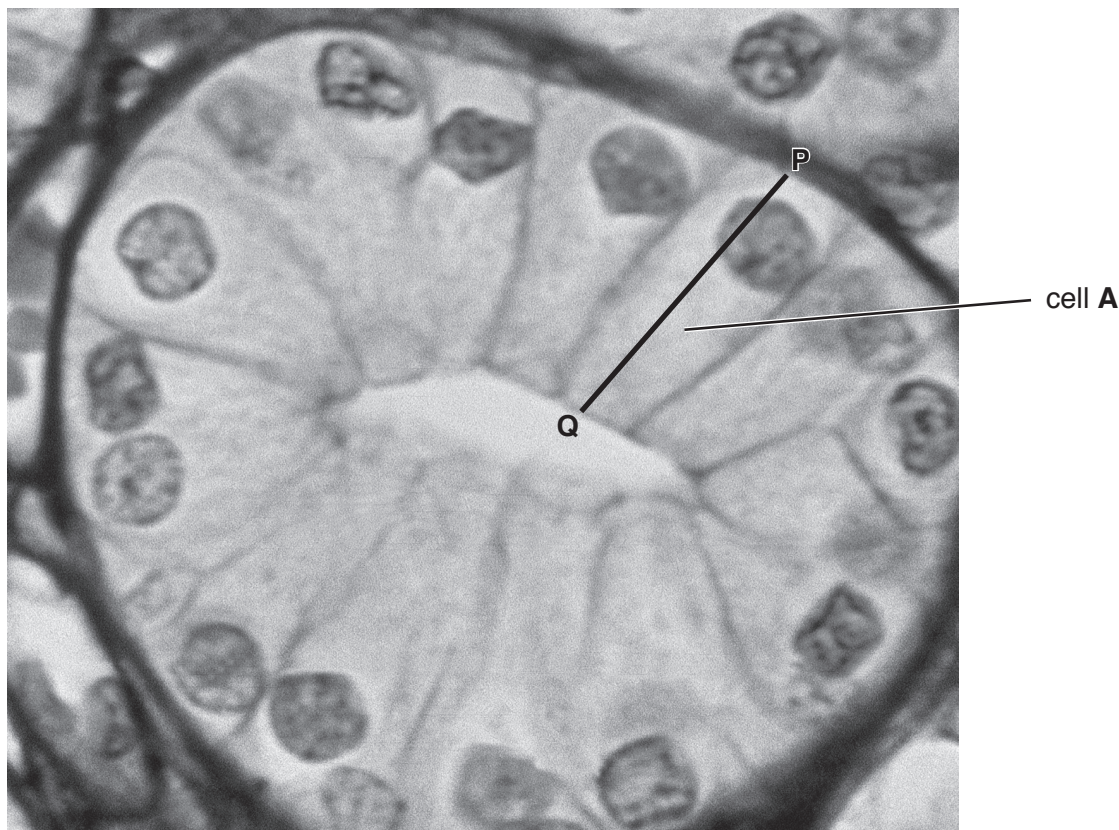


Fig. 4.1

- (a) The actual length of epithelial cell **A** along the line **P–Q** is $35\mu\text{m}$.

Calculate the magnification of the image shown in Fig. 4.1. Write down the formula and use it to make your calculation. Show your working.

formula

magnification $\times$ [2]

(b) Some epithelial cells in the kidney release the protein vascular endothelial growth factor (VEGF). This protein is a cell signalling molecule that stimulates cell division in endothelial cells in blood vessels.

(i) State what occurs during interphase to prepare a cell for division.

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..... [2]

(ii) Explain how a cell signalling molecule, such as VEGF, can lead to a response in a cell.

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..... [2]

(c) Uncontrolled cell division may result in a tumour. Tumour cells in the kidney respond to VEGF.

Kidney cancer can be treated with monoclonal antibodies. These monoclonal antibodies bind to VEGF.

Outline the hybridoma method for the production of monoclonal antibodies that will target the VEGF protein.

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..... [4]

(d) Monoclonal antibodies used as a treatment need to be given more than once. Repeated treatment can cause side effects to the person or can become less effective.

Suggest why repeated treatment with monoclonal antibodies may have these effects.

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..... [1]

- 1 (a) Antibody molecules are proteins that show primary structure, secondary structure, tertiary structure and quaternary structure.

Fig. 1.1 shows a ribbon diagram of an antibody molecule.

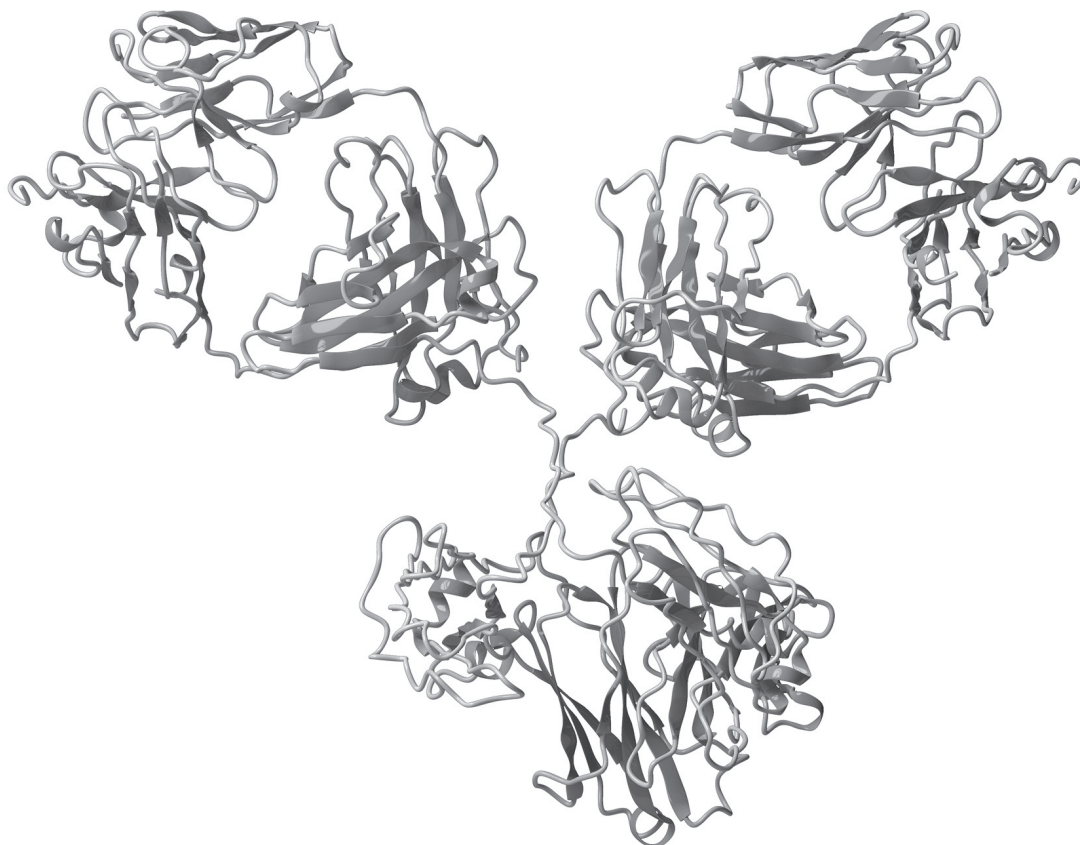


Fig. 1.1

Describe how Fig. 1.1 shows the secondary structure **and** tertiary structure of the antibody molecule.

secondary structure

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tertiary structure

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(b) Fig. 1.2 is a transmission electron micrograph of a hybridoma cell.

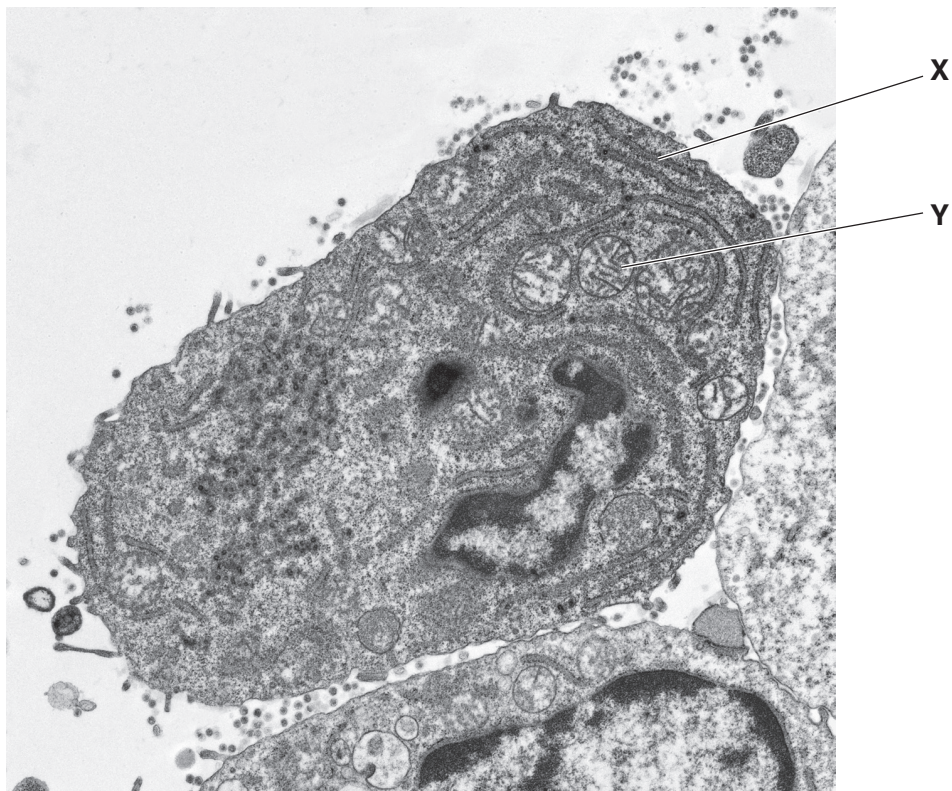


Fig. 1.2

- (i) The hybridoma cell in Fig. 1.2 synthesises and secretes molecules of a monoclonal antibody.

State the roles of the structures labelled **X** and **Y** in the production of antibody molecules in the hybridoma cell.

X

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Y

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.....

[2]

- (ii) The hybridoma method for the production of monoclonal antibodies involves a number of stages. One of these stages is the formation of hybridoma cells.

Outline the stage in which hybridoma cells are formed.

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..... [3]

- (iii) Outline the use of monoclonal antibodies in the treatment of disease.

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10. Question part 1/2 | 9700 Oct-Nov 2019 P2 V1 Q5

5 Myasthenia gravis is a condition that results in muscle weakness by affecting the immune response.

(a) Explain what is meant by the term *immune response*.

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..... [2]

(b) Myasthenia gravis is an autoimmune disease which disrupts a cell signalling pathway involving muscle cells.

(i) Suggest how the immune system acts to disrupt this cell signalling pathway.

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..... [3]

Enzyme **Y** is found in the cell surface membrane of muscle cells. Enzyme **Y** acts to break down the cell signalling molecules which trigger muscle contraction when they are no longer needed.

(ii) Using the induced fit hypothesis of enzyme action, explain how enzyme **Y** breaks down the cell signalling molecules.

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..... [4]

(c) Rituximab is a monoclonal antibody used in the treatment of myasthenia gravis.

Rituximab acts against the cell surface membrane protein CD20. This protein is found on the surface of the B-lymphocytes that cause myasthenia gravis.

Explain the advantages of using monoclonal antibodies in the treatment of diseases such as myasthenia gravis.

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..... [3]

[Total: 12]

- 5 Influenza is an infectious disease caused by the influenza A virus. This virus causes influenza in birds and mammals.

Fig. 5.1 is a diagram of an influenza A virus.

Haemagglutinin allows the virus to attach to host cells by binding to receptors on the cell surface membrane of the host cells.

Neuraminidase is an enzyme that helps the virus to leave host cells after the virus has replicated.

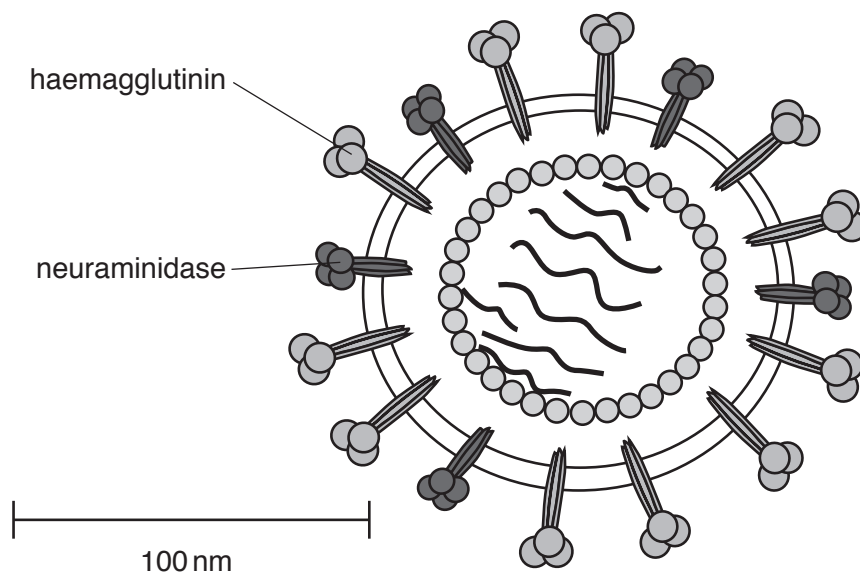


Fig. 5.1

- (a) State **two** features of all viruses that are visible in Fig. 5.1.

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2 [2]

- (b) Neuraminidase removes parts of the host cell receptors that bind to haemagglutinin. This helps newly-formed viruses to leave host cells.

Drugs have been developed to act on neuraminidase. These drugs prevent viruses from leaving host cells.

Suggest **and** explain how these drugs act to prevent viruses leaving cells.

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..... [3]

11. Question part 2/2 | 9700 Oct-Nov 2019 P2 V3 Q5

- (c) The human immune system produces antibodies in response to the presence of antigens, such as neuraminidase and haemagglutinin.

Outline the events that occur during an immune response leading to the production of antibodies against an antigen, such as haemagglutinin.

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- (d) Researchers are developing methods to produce antibodies to give artificial passive immunity to influenza.

- (i) Suggest the advantages **and** disadvantages of artificial passive immunity.

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..... [3]

- (ii) State **two** ways in which mammals can acquire **natural** passive immunity to infectious diseases, such as influenza.

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2 [2]

12. Question part 1/3 | 9700 Feb-March 2020 P2 V2 Q5

5 Myasthenia gravis and HIV/AIDS both involve disorders of the immune system.

(a) Outline why myasthenia gravis is described as a disorder of the immune system.

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..... [2]

A person with HIV/AIDS has a weakened immune system. This is because HIV infects cells of the immune system, in particular T-helper lymphocytes (T_h cells). The pathogen can remain inactive within host cells. In some people, the pathogen becomes active and causes the number of T_h cells to decrease.

Antiretroviral therapy (ART) is used to treat people who are infected with HIV (living with HIV). ART aims to keep the number of T_h cells at a healthy level.

(b) State the full name of the pathogen known as HIV.

..... [1]

(c) Explain why it is important that ART maintains a healthy number of T_h cells in a person living with HIV.

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(d) Fig. 5.1 shows global estimates of:

- the percentage of people living with HIV who received treatment with ART in each year from 2000 to 2015
- the number of people who died from HIV/AIDS in each year from 2000 to 2015.

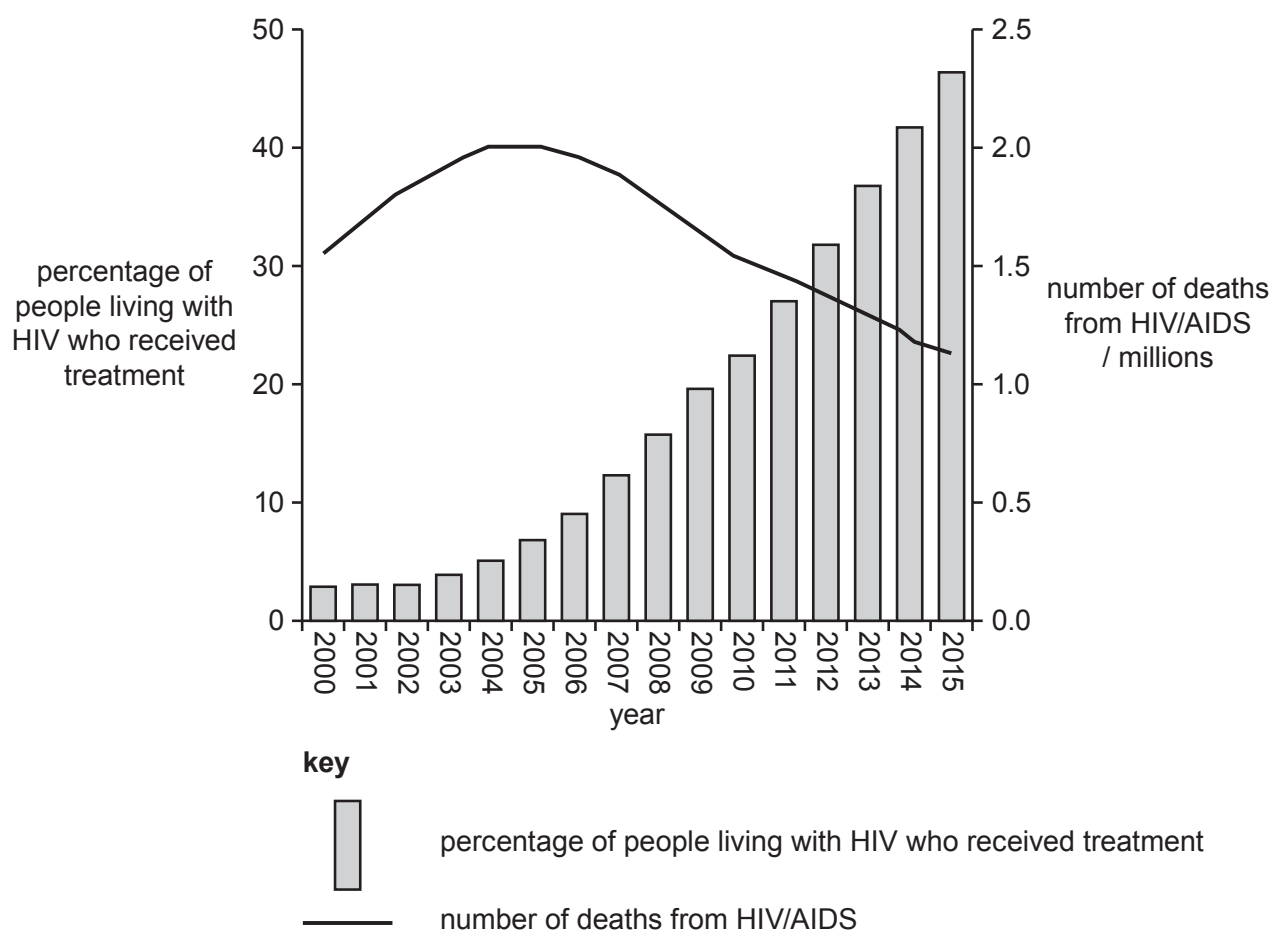


Fig. 5.1

(i) Describe the trends shown in Fig. 5.1.

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12. Question part 3/3 | 9700 Feb-March 2020 P2 V2 Q5

(ii) It is recommended that ART is given to all people living with HIV.

Some countries that support this recommendation find it difficult to provide ART to everyone living with HIV.

Other than the high cost of treatment, suggest **two** reasons why it is difficult to provide ART to everyone living with HIV.

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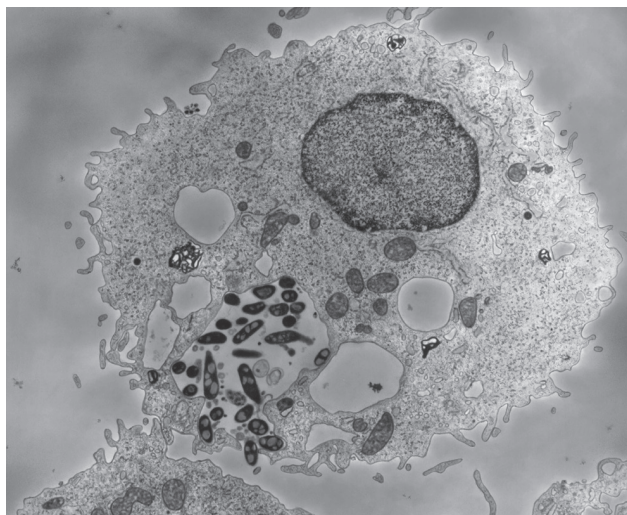
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..... [2]

[Total: 11]

- 5 The vaccine used to control tuberculosis (TB) is known as *Bacillus Calmette-Guérin* (BCG). The vaccine contains live bacteria that have been selected so that they do not cause disease in humans.

Fig. 5.1 shows a macrophage that is in the process of engulfing the bacteria in the vaccine.



magnification $\times 4400$

Fig. 5.1

- (a) (i) Name the pathogen that causes TB.

..... [1]

- (ii) Describe how this pathogen is transmitted.

.....

 [2]

9700 Biology Paper 2 - Immunity

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13. Question part 2/3 | 9700 May-June 2020 P2 V1 Q5

- (b)** Describe the events that occur in the body after the macrophage has engulfed the bacteria until the production of antibodies in response to the BCG vaccine.

[5]

- (c)** Vaccines, such as BCG, stimulate the formation of memory cells.

Explain the role of memory cells in the body's defence against the TB pathogen.

..... [3]

(d) Suggest why vaccination with BCG has not yet eradicated TB.

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[Total: 14]

6 (a) Mutations in body cells can sometimes result in a tumour. Some tumours are cancerous.

(i) Outline how mutations can result in the development of a tumour.

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..... [2]

(ii) Tumour cells have antigens on their cell surface that are not present on non-tumour cells.

These antigens are the result of gene mutations and are known as tumour specific antigens (TSA).

One type of TSA differs in structure from the protein found on the cell surface of non-tumour cells by a single amino acid.

Explain how a gene mutation could result in the production of this TSA.

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..... [2]

(b) Immunotherapy is a form of treatment for cancer which aims to stimulate the immune system to destroy tumour cells.

One form of immunotherapy for cancer uses a vaccine which contains one specific type of TSA.

(i) Describe how vaccination with a specific type of TSA could lead to the destruction of tumour cells by T-lymphocytes in the body.

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..... [3]

(ii) Vaccines that contain tumour cells instead of a TSA are being developed for use during immunotherapy. Tumour cells are removed from a patient’s body and used in a vaccine for the patient.

Suggest **one** advantage and **one** disadvantage of using a patient’s tumour cells in a vaccine rather than a TSA.

advantage

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disadvantage

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..... [2]

[Total: 9]

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15. Question part 1/2 | 9700 Feb-March 2021 P2 V2 Q3

3 T-helper lymphocytes and Leydig cells are two types of mammalian cells. The main role of T-helper lymphocytes and Leydig cells is to synthesise and secrete cell-signalling molecules.

- T-helper lymphocytes synthesise proteins known as cytokines.
- Leydig cells synthesise the steroid (lipid) hormone testosterone from cholesterol. Leydig cells also synthesise cholesterol.

(a) State **one** way in which cytokines are involved in an immune response.

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..... [1]

(b) Fig. 3.1 shows part of a mammalian cell.



Fig. 3.1

(i) State, with reasons, whether Fig. 3.1 shows part of a Leydig cell or part of a T-helper lymphocyte.

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..... [2]

(ii) Underline the correct name for the type of image shown in Fig. 3.1 **and** explain your choice.

photomicrograph

scanning electron micrograph

transmission electron micrograph

explanation

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[2]

(c) Testosterone molecules and cytokine molecules are transported in the circulatory system to reach their target cells. Testosterone molecules are able to enter their target cells and bind to receptors within the cytoplasm.

(i) Outline **one** way in which testosterone molecules could enter their target cells.

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..... [2]

(ii) Cytokine molecules are not able to enter their target cells.

Suggest **and** explain why cytokine molecules are **not** able to cross the cell surface membrane to enter their target cells.

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..... [2]

[Total: 9]

6 The diseases myasthenia gravis (MG) and HIV/AIDS both involve disorders of the immune system.

(a) The cause of MG involves a response by B-lymphocytes.

Explain why MG is called a disorder of the immune system.

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..... [2]

(b) Studies have indicated that T-lymphocytes are involved in stimulating the B-lymphocyte response that causes MG.

Research has been carried out on a vaccine that will provide a person with **active immunity** against these T-lymphocytes and B-lymphocytes.

Suggest **and** explain how this vaccine will provide a person with active immunity against the T-lymphocytes and B-lymphocytes responsible for causing MG.

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..... [3]

(c) Many people who are living with HIV (infected with HIV) develop tuberculosis (TB). If a person does not have any symptoms of TB, one preventive measure is to prescribe antibiotics. This reduces the overall number of cases of TB and deaths from TB.

State the **disadvantage** of prescribing antibiotics as a preventive measure against TB.

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..... [1]

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graph TD; A[\"globally, 36.9 million people were living with HIV\"] --> B[\"35.1 million adults and 1.8 million children (under 15 years)\"]; A --> C[\"1.8 million people became infected with HIV\"]; A --> D[\"21.7 million were provided with ART (antiretroviral therapy)\"]; A --> E[\"940 000 people died from HIV/AIDS\"]; D --> F[\"47% of the people provided with ART, while still living with HIV, do not have detectable levels of the virus in their blood\"];
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globally, 36.9 million people were living with HIV

35.1 million adults and 1.8 million children (under 15 years)

1.8 million people became infected with HIV

21.7 million were provided with ART (antiretroviral therapy)

940 000 people died from HIV/AIDS

47% of the people provided with ART, while still living with HIV, do not have detectable levels of the virus in their blood

One other statistic published by UNAIDS indicated that, in 2017, only 75% of the estimated 36.9 million people living with HIV knew that they had been infected with the virus.

[3]

[3]

17. Question part 1/3 | 9700 May-June 2022 P2 V1 Q2

2 B-lymphocytes are activated to form plasma cells during immune responses.

Fig. 2.1 is a drawing of a plasma cell made from a transmission electron micrograph.

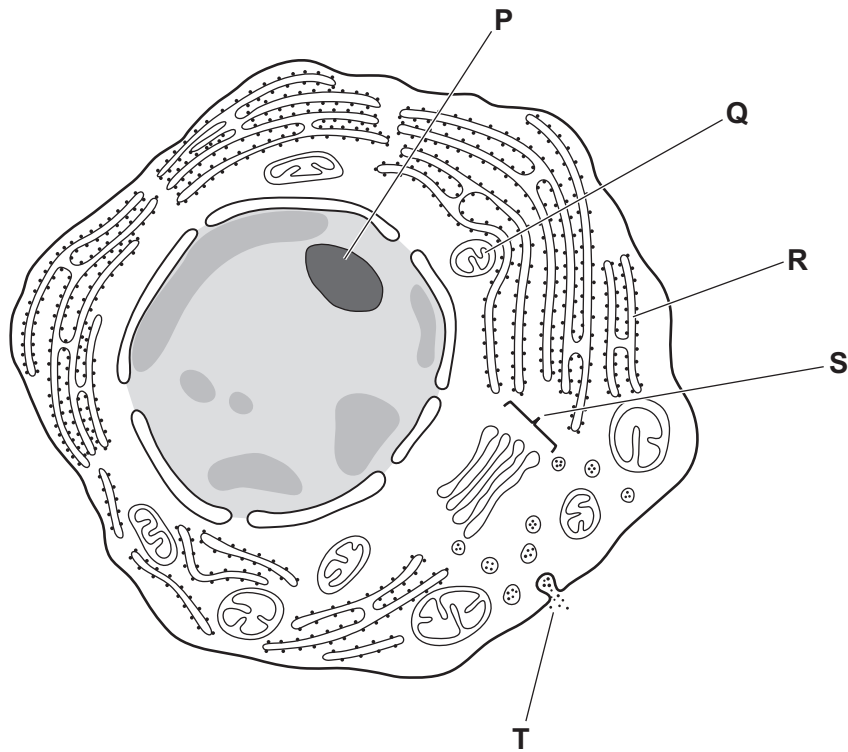


Fig. 2.1

- (a) (i) State the name of the process that is occurring at T.
- [1]
- (ii) Complete Table 2.1 to show the names and functions of the cell structures labelled P, Q, R and S in the plasma cell shown in Fig. 2.1.

Table 2.1

cell structure in Fig. 2.1	name of cell structure	function of cell structure in plasma cell
P		
Q		
R		
S		

(b) Plasma cells can be used in the commercial production of some monoclonal antibodies.

The method of production is known as the hybridoma method.

Outline the steps in the production of monoclonal antibodies by the hybridoma method.

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..... [3]

(c) Antibodies can be collected from human blood donors and used to treat people that may have been infected with a pathogen. This prevents them becoming ill with the disease.

Explain why this treatment does not prevent people becoming ill if they are infected again with the same pathogen.

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..... [4]

[Total: 12]

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17. Question part 3/3 | 9700 May-June 2022 P2 V1 Q2

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- 4 (a) Scientists have produced structures known as virosomes, which are used in certain vaccines. Virosomes do **not** cause disease.

Fig. 4.1 is a diagram of a section through a virosome used in some vaccinations to protect against the virus which causes influenza.

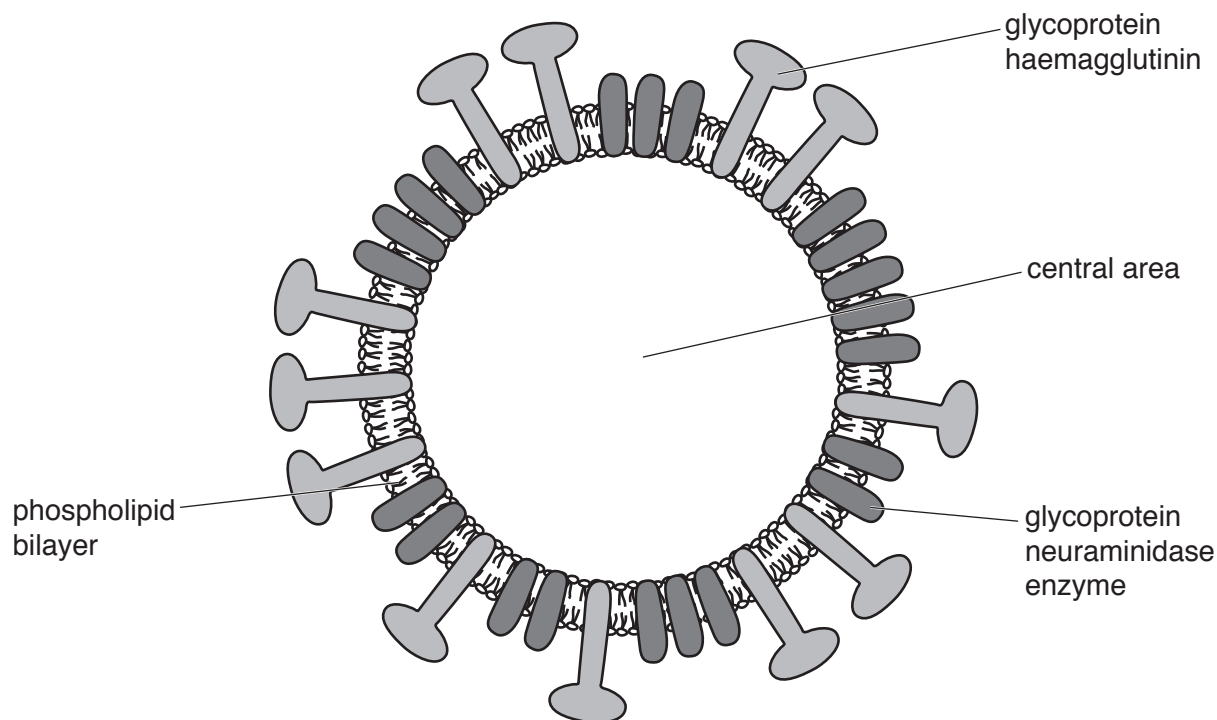


Fig. 4.1

- (i) State the differences between the structure of a virosome and a virus.

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..... [2]

- (ii) Explain how the structure of the virosome shown in Fig. 4.1 suggests that the central area of the virosome is aqueous.

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- (b) The glycoproteins haemagglutinin and neuraminidase are found in the influenza virus and in the virosomes used in a vaccine against the influenza virus.

Haemagglutinin binds to a receptor in the cell surface membrane of phagocytes.

Suggest why haemagglutinin is present in virosomes used in the vaccine for influenza.

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..... [2]

- (c) Different strains of the influenza virus have formed as a result of mutations. Each strain of the virus contains the enzyme neuraminidase. Neuraminidase helps the virus to leave host cells after the virus has replicated. In each strain of the influenza virus, the primary structure of the active site of the neuraminidase enzyme remains unchanged.

Suggest why the primary structure of the active site of neuraminidase remains unchanged in each strain of the influenza virus.

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..... [2]

[Total: 8]

19. Question part 1/2 | 9700 May-June 2023 P2 V2 Q3

3 Cells of the immune system respond to the presence of non-self antigens.

(a) Outline the features of non-self antigens.

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..... [3]

(b) Four different types of cells of the immune system are shown in Table 3.1.

Complete Table 3.1:

- use a tick (✓) if the description applies to the named cell of the immune system
- use a cross (X) if the description does **not** apply.

Table 3.1

description of cell	cell of the immune system			
	B-lymphocyte	plasma cell	T-helper cell	T-killer cell
able to go through a number of cell cycles (clonal expansion)				
main role is to secrete cytokine during an immune response				
present during a primary immune response to a virus				

[4]

(c) The cell cycle can be divided into different parts.

Complete sentences **A**, **B** and **C** to provide more information about the mitotic cell cycle.

A The part of the cell cycle that occurs immediately after mitosis is

.....

B The part of the cell cycle in which the S phase occurs is

.....

C The main event that occurs during the S phase is

.....

[3]

[Total: 10]

4 Food crops such as barley and wheat contain gluten. Gluten contains two proteins, glutenin and gliadin.

(a) (i) Table 4.1 contains descriptions of the structures of glutenin and gliadin.

Complete Table 4.1 by writing the level of protein structure that applies to each description.

Table 4.1

description	level of protein structure
a gliadin protein is a single polypeptide that forms a compact structure	
20% of the amino acids in a glutenin molecule are glycine	
gliadin and glutenin molecules contain regions of β -pleated sheets	

[3]

(ii) Many genes in eukaryotic cells contain introns. The genes that code for gliadin do **not** contain introns.

Explain how a lack of introns in a gliadin gene affects the production of mRNA from the primary transcript.

.....

.....

..... [1]

(b) Coeliac disease is a condition in which the immune system of a person responds to gluten in their diet.

In coeliac disease, there is a response to the presence of peptides (short chains of amino acids) that are produced as a result of gliadin digestion.

(i) The gliadin peptides produced as result of digestion are often as large as 33 amino acids in length. Intestinal cells take up large numbers of these peptides at the same time.

Suggest **and** explain how gliadin peptides are transported into intestinal cells.

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..... [2]

- (ii) The presence of gliadin causes the immune system of a person with coeliac disease to respond by producing anti-gliadin antibodies.

Describe the sequence of events that results in the immune system producing anti-gliadin antibodies.

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..... [4]

[Total: 10]

21. Question part 1/4 | 9700 Oct-Nov 2023 P2 V2 Q3

3 The liver receives blood from the hepatic artery and from the hepatic portal vein. The hepatic portal vein transports blood from the digestive system.

Hepatocytes are the main cell type of the liver. They have a wide range of functions, including:

- the synthesis of triglycerides and plasma proteins
- detoxifying waste
- energy storage.

(a) The hepatic artery branches from the main artery that transports blood from the heart.

Name the main artery that transports blood to the hepatic artery.

..... [1]

(b) Blood arriving at the liver enters specialised blood vessels known as sinusoids.

Fig. 3.1 is a diagram of part of a sinusoid and surrounding hepatocytes. A second type of cell found in the liver, a Kupffer cell, is also shown.

Kupffer cells are phagocytic cells of the immune system.

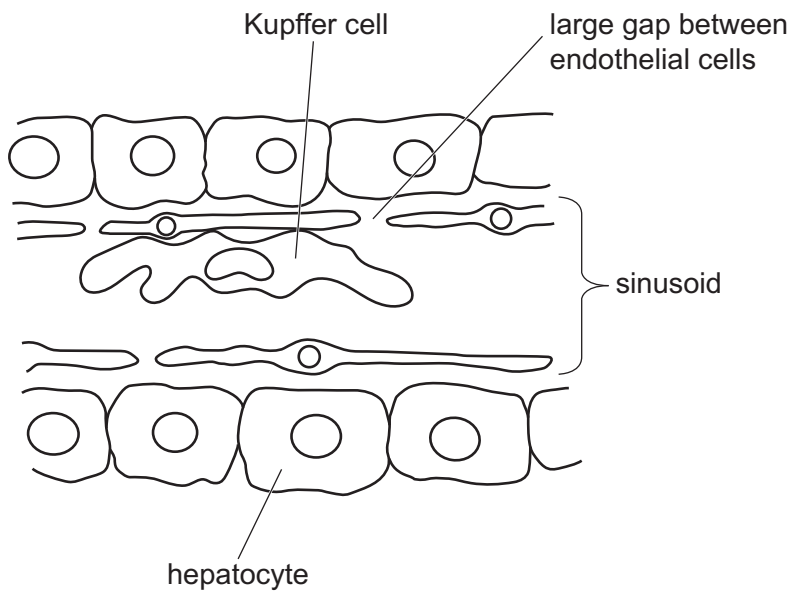


Fig. 3.1

(i) Suggest **one** advantage of having large gaps between the endothelial cells of the sinusoid, as shown in Fig. 3.1.

.....
.....
..... [1]

9700 Biology Paper 2 - Immunity

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21. Question part 2/4 | 9700 Oct-Nov 2023 P2 V2 Q3

- (ii) In addition to removing bacteria present in the blood inside the sinusoid, Kupffer cells are also able to remove old or damaged red blood cells.

Describe the mode of action of a Kupffer cell in removing and breaking down a damaged red blood cell.

[4]

[4]

(c) Fig. 3.2 is a transmission electron micrograph of part of a hepatocyte showing some cell structures.

The peroxisome shown in Fig. 3.2 is a spherical organelle bound by a single membrane. It carries out a variety of enzyme-catalysed metabolic reactions, including detoxification. Some of these reactions require oxygen.

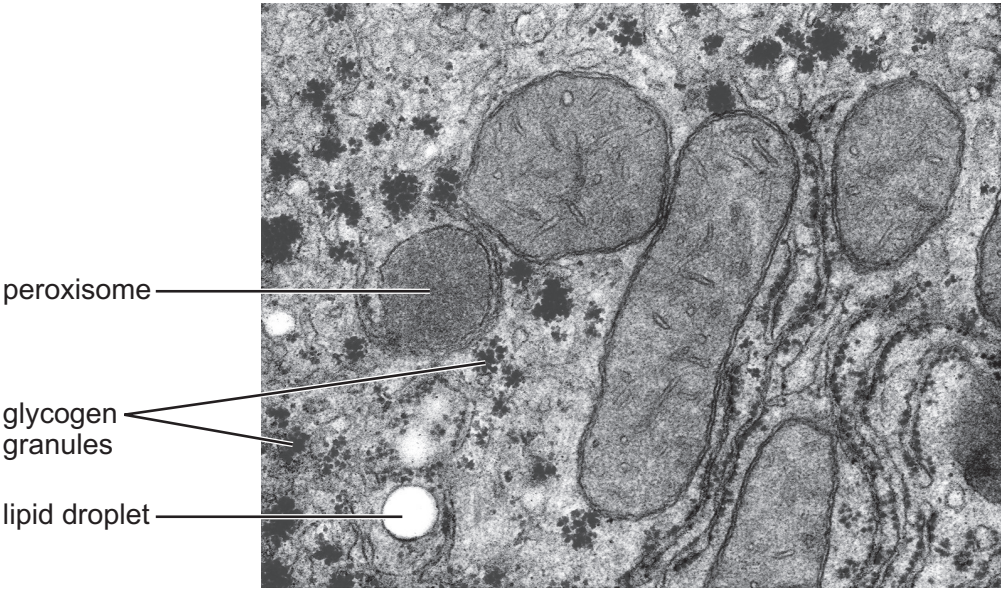


Fig. 3.2

(i) Describe the evidence **visible** in Fig. 3.2, apart from the presence of a peroxisome, that indicates some of the functions of a hepatocyte.

Add labels to Fig. 3.2 to identify the location of any cell structures, if not already labelled, that are part of your evidence.

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..... [3]

(ii) The mitochondria in Fig. 3.2 are larger than the peroxisome.

State **one other** difference, **visible** in Fig. 3.2, between a peroxisome and a mitochondrion.

.....

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.....

..... [1]

(iii) Some of the enzymes used within mitochondria can be synthesised by the organelle. Peroxisomes cannot synthesise any of the enzymes that they contain.

Suggest why a mitochondrion can synthesise enzymes, but a peroxisome cannot synthesise enzymes.

.....

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..... [2]

(iv) One of the enzymes present in peroxisomes is catalase. This enzyme catalyses the breakdown of hydrogen peroxide to harmless products.

Suggest why it is useful to the cell for this reaction to take place within peroxisomes.

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..... [2]

6 Antibodies are produced by plasma cells.

Fig. 6.1 shows antigens bound to antigen-binding sites of an antibody molecule.

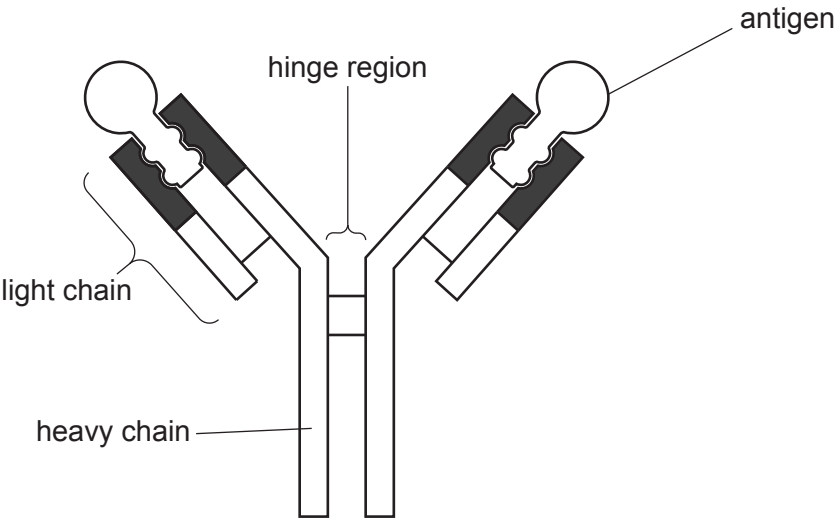


Fig. 6.1

(a) (i) Explain how the structure of an antigen-binding site makes it specific to a particular antigen, as shown in Fig. 6.1.

.....

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.....

..... [2]

(ii) State the function of the hinge region of the antibody shown in Fig. 6.1.

..... [1]

(iii) Antibodies can bind to membrane receptors on cells of the immune system, such as macrophages.

Suggest an advantage of antibodies binding to receptors on macrophages.

.....

.....

..... [1]

- (b) It is estimated that the immune system of each person can make enough antibodies to bind to over 10^{12} different antigens.

When plasma cells make antibody molecules they combine the polypeptides produced by the expression of genes for heavy chains and the genes for light chains.

Research has shown that producing this very large number of antibodies is only possible by modifying the primary transcripts of the genes that code for heavy chains and the genes that code for light chains.

Suggest how this modification of the primary transcripts occurs in plasma cells.

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..... [2]

[Total: 6]

23. Question part 1/2 | 9700 May-June 2024 P2 V2 Q2

2 Alveolar macrophages are cells of the immune system that remain in the alveolar region of the gas exchange system. The macrophages protect against infection caused by pathogens that have been inhaled.

- (a) Alveolar macrophages have the same cell structures as typical animal cells.
- (i) Complete Table 2.1 to **name** the cell structures that match the functions stated.

Do **not** use abbreviations.

Table 2.1

cell structure	function
.....	manufactures ribosomal subunits from proteins and ribosomal RNA
.....	synthesises triglycerides and other lipids
pair of	organise microtubules of the cell cytoskeleton

[3]

- (ii) Fig. 2.1 is a diagram of an alveolar macrophage showing:
- some of the cell structures that would be visible using an electron microscope
 - a newly formed phagocytic vacuole (phagosome) containing two cells of *Mycobacterium tuberculosis*.

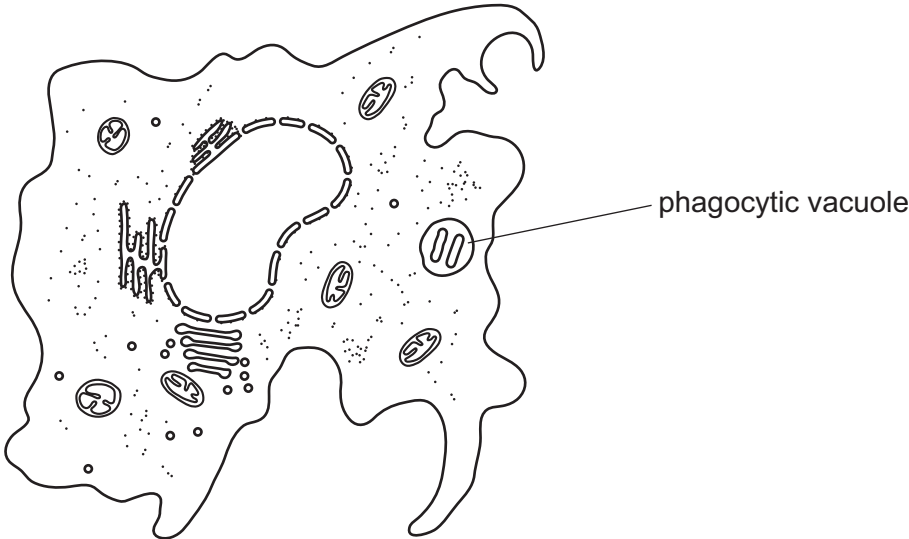


Fig. 2.1

The cell structures with the functions described in Table 2.1 are **not** shown in Fig. 2.1.

Complete Fig. 2.1 by drawing **and** labelling the cell structures described in Table 2.1. [2]



(b) Tuberculosis (TB) can be prevented if the bacterial cells that have reached the alveoli are rapidly destroyed. Alveolar macrophages can detect the presence of *M. tuberculosis* in the alveolar space and can carry out phagocytosis to form phagocytic vacuoles, such as the one shown in Fig. 2.1.

(i) Outline the sequence of events that leads to the formation of a phagocytic vacuole after detection of the bacterial cells by an alveolar macrophage.

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..... [2]

(ii) Name the cell structures that fuse with the phagocytic vacuole and release hydrolytic enzymes to destroy the bacterial cells.

..... [1]

(c) Research has shown that vaccination programmes are cost effective and are very helpful in the prevention and control of TB. The programmes may be aimed at particular groups of people that are at a high risk of getting the disease, or they may be aimed at an entire population because the country has a high number of cases of TB.

The Bacillus Calmette-Guérin (BCG) vaccine is freeze-dried and contains live, weakened (attenuated) *Mycobacterium bovis*.

Apart from being cost effective, suggest **and** explain the advantages of using the BCG vaccine for the prevention and control of TB.

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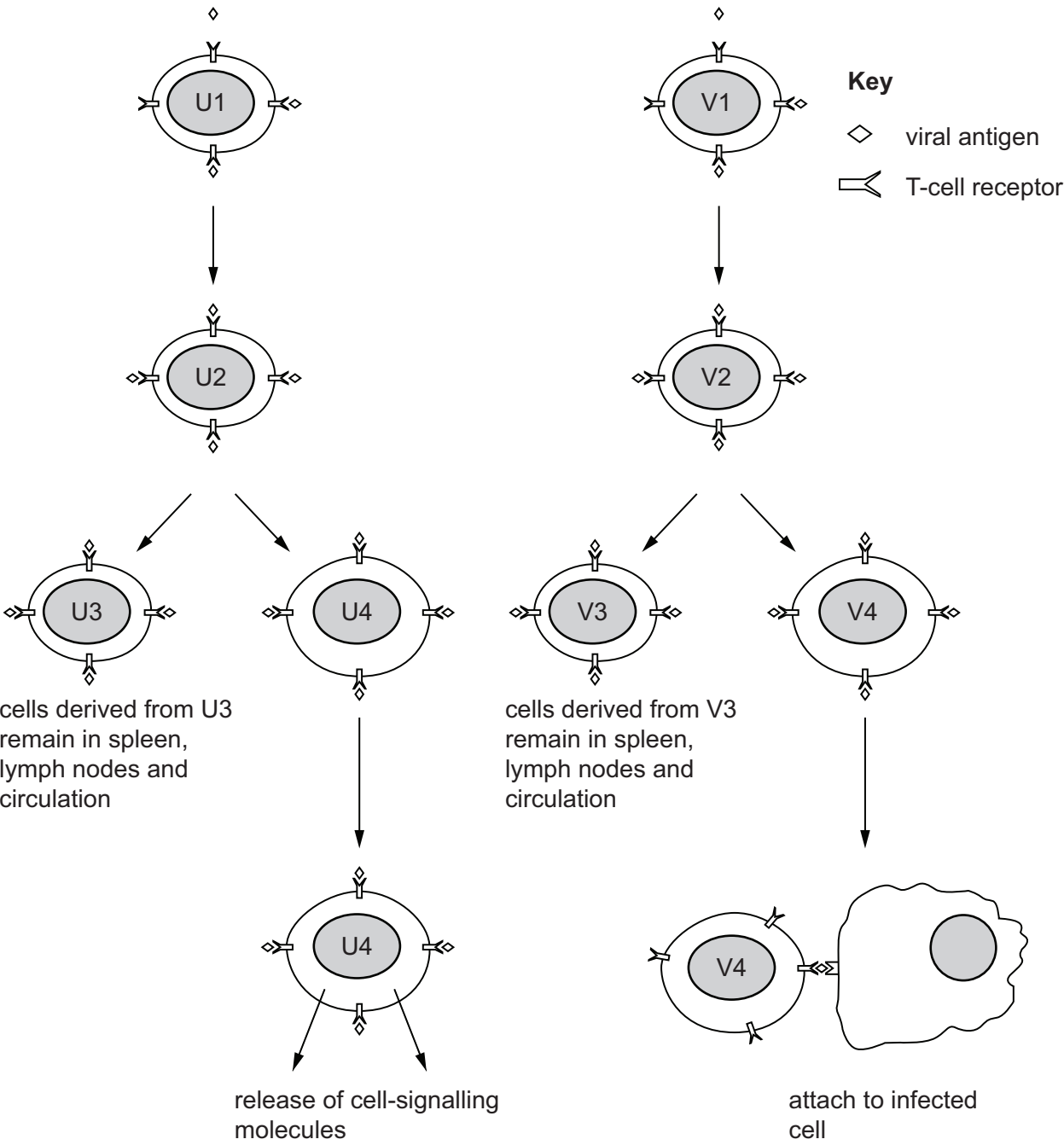
.....

..... [4]

5 T-lymphocytes are produced in bone marrow and mature in the thymus gland.

When mature, T-lymphocytes leave the thymus gland to travel throughout the body. They remain inactive inside organs, such as the spleen and lymph nodes, until activated by the presence of antigens.

Fig. 5.1 shows what happens to two inactive T-lymphocytes, **U1** and **V1**, in the presence of an antigen from a virus.



Not to scale

Fig. 5.1

24. Question part 2/2 | 9700 Oct-Nov 2024 P2 V3 Q5



(a) (i) **U4** and **V4** are types of active T-lymphocyte. State the names given to these types of T-lymphocyte.

U4

V4

[1]

(ii) Describe the roles of cells **U4** and **V4** in a primary immune response.

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..... [4]

(b) Polio is a highly infectious viral disease. The virus infects the nervous system of humans. The disease can cause total paralysis within hours and can be fatal.

The Global Polio Eradication Initiative (GPEI) was started in 1988 by the World Health Organization. In 2022, polio had been successfully eradicated from most of the world. However, cases of the disease have been recorded in some countries.

Discuss the steps that must be taken by health authorities during a vaccination programme if an infectious disease, such as polio, is to be eradicated from the whole world.

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..... [4]

25. Question part 1/6 | 9700 Feb-March 2025 P2 V2 Q4

4 (a) Vaccination programmes are widely used to help control the spread of infectious diseases.

(i) State why some diseases are described as infectious.

.....

.....

..... [1]

(ii) A person was given an injection to give protection against infectious disease **E**. The person had **not** previously been infected with disease **E**. 26 days later, a second injection to give protection against disease **E** was given.

The concentration in the blood of the antibody specific to disease **E** was measured over a period of 60 days from the time of the first injection.

Fig. 4.1 shows the concentration of the antibody in the blood over the period of 60 days.

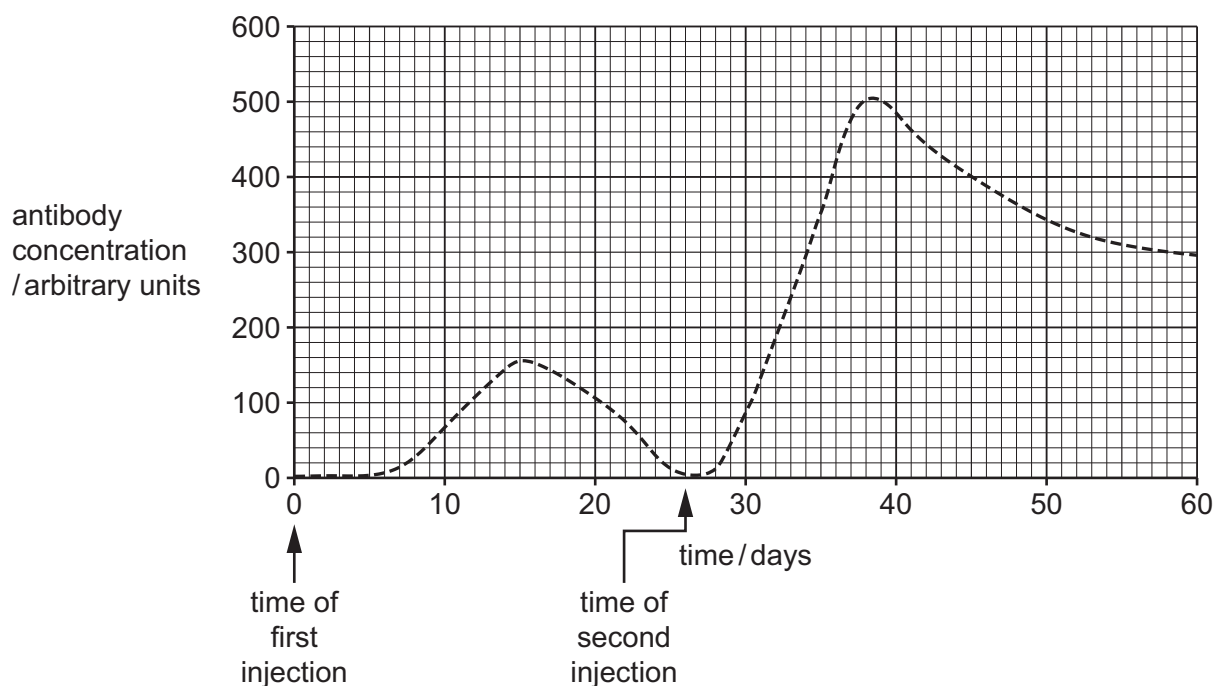


Fig. 4.1

25. Question part 2/6 | 9700 Feb-March 2025 P2 V2 Q4



The concentration of the antibody in the blood after the second injection was higher than the concentration after the first injection.

Explain why the concentration of the antibody in the blood was higher after the second injection than after the first injection.

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..... [3]

25. Question part 3/6 | 9700 Feb-March 2025 P2 V2 Q4



(b) A second person was given a different injection to give protection against another infectious disease, infectious disease **F**. The person had **not** previously been infected with disease **F**.

The concentration in the blood of the antibody specific to disease **F** was measured over a period of 60 days from the time of the injection.

Fig. 4.2 shows the concentration of the antibody in the blood over the period of 60 days.

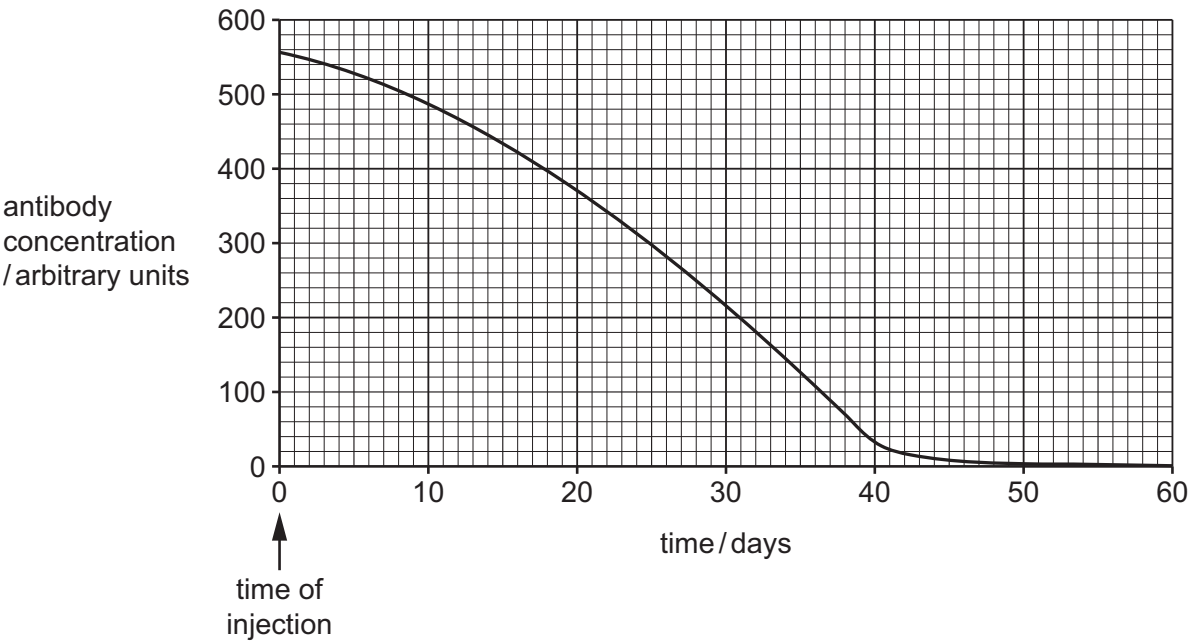


Fig. 4.2

(i) State the type of immunity that results from the injection given as protection against disease **F**.

..... [1]

(ii) Describe features of the type of immunity resulting from the injection given as protection against disease **F**.

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.....
..... [2]

25. Question part 4/6 | 9700 Feb-March 2025 P2 V2 Q4



Question 4 continues on page 18.

25. Question part 5/6 | 9700 Feb-March 2025 P2 V2 Q4



(c) In 2021, the number of new cases of tuberculosis (TB) was estimated to be 10.6 million.

(i) Name the bacterium that causes TB.

..... [1]

(ii) TB is often treated with several different drugs at the same time. This is necessary to kill multiple drug resistant (MDR) strains of bacteria. This treatment is usually lengthy, taking 6 months or more to make sure all bacteria are killed.

Researchers investigated how the bacteria that cause TB react to the presence of rifampicin. Rifampicin is an antibiotic often used in the successful treatment of TB.

- Researchers combined rifampicin with a coloured marker dye and added the coloured rifampicin to a culture of living bacteria.
- When initially viewed under the microscope, the researchers could see that the coloured rifampicin was present inside the cytoplasm of the bacterial cells.
- Hours later, the coloured rifampicin was **not** visible inside the bacterial cells but was visible in the medium surrounding the bacterial cells.
- The researchers concluded that rifampicin was being pumped out of the bacterial cells through the cell surface membrane.
- Further research showed that when some drugs commonly used to treat indigestion were added to bacterial cultures containing coloured rifampicin, the coloured rifampicin stayed inside the bacterial cytoplasm.

25. Question part 6/6 | 9700 Feb-March 2025 P2 V2 Q4



Suggest **and** explain how knowledge gained from this research could improve TB treatment **and** reduce the chance of rifampicin-resistant bacteria developing.

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..... [4]

[Total: 12]

26. Question | 9700 May-June 2025 P2 V2 Q5

5 There is a global shortage of blood for transfusions. Researchers can culture bone marrow stem cells in the laboratory to manufacture red blood cells for potential use as an artificial blood product.

The researchers collect bone marrow stem cells that are present in small quantities in blood, rather than extracting them from bone marrow.

- Antibodies, specific to bone marrow stem cells, are attached to tiny magnetic beads.
 - The beads are added to a sample of blood.
 - An electric field is applied to immobilise the beads so that the bone marrow stem cells can be collected.
- (a) The antibodies are attached to the beads so that the sites used for binding to specific molecules on the bone marrow stem cells are left exposed.

Name the term given to the specific molecules on the bone marrow stem cells that attach to the antibody binding sites.

..... [1]

(b) Suggest **and** explain the advantages of using bone marrow stem cells from the blood sample to manufacture artificial red blood cells.

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..... [3]

(c) One desirable feature of artificial blood products, such as artificial red blood cells, is that they should be economical to produce.

Suggest **other** desirable features of artificial blood products.

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.....
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..... [3]

..... [5]

Abciximab prevents blood clotting by stopping structures called platelets from binding together.

Fig. 6.1 shows platelets and abciximab in a coronary artery.



27. Question part 2/2 | 9700 May-June 2025 P2 V3 Q6



State the letter in Fig. 6.1 that represents:

- the target antigen for abciximab
- the constant region of abciximab
- one of the antigen binding sites of abciximab

[3]

(c) Coronary arteries supply oxygenated blood to the cells of the heart.

The passage outlines the cardiac cycle of the heart and the structures in the heart that control the cycle.

Complete the passage by using the most appropriate scientific terms.

The sinoatrial node is located in the wall of the,
one of four chambers of the mammalian heart. Electrical impulses from the sinoatrial node
reach the atrioventricular node, which transmits impulses towards the apex of the heart along
a series of specialised muscle fibres called
Pressure increases in the ventricles when they contract in the stage of the cardiac cycle
known as

[3]

[Total: 11]