OCR A-LEVEL BIOLOGY A · H420

# BIOLOGY



## EXAM QUESTION PACK

### 4.1.1 COMMUNICABLE DISEASES, DISEASE PREVENTION AND THE IMMUNE SYSTEM

| SCORE | PERCENTAGE |
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Answer **all** the questions.

1. Tuberculosis is an infectious disease that affects humans. It is caused by a pathogen.

Pathogens can also cause diseases in plants.

Which of the following plant diseases is caused by the same **type** of pathogen that causes tuberculosis in humans?

**A** black sigatoka in bananas
**B** 'mosaic' leaf discolouration in tobacco plants
**C** ring rot in tomatoes
**D** late blight in potatoes

Your answer ☐

**[1]**

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2(a). Fig. 25.1 shows the concentration of antibodies in a patient's bloodstream following a vaccination against a common pathogen and subsequent infection with the same pathogen.

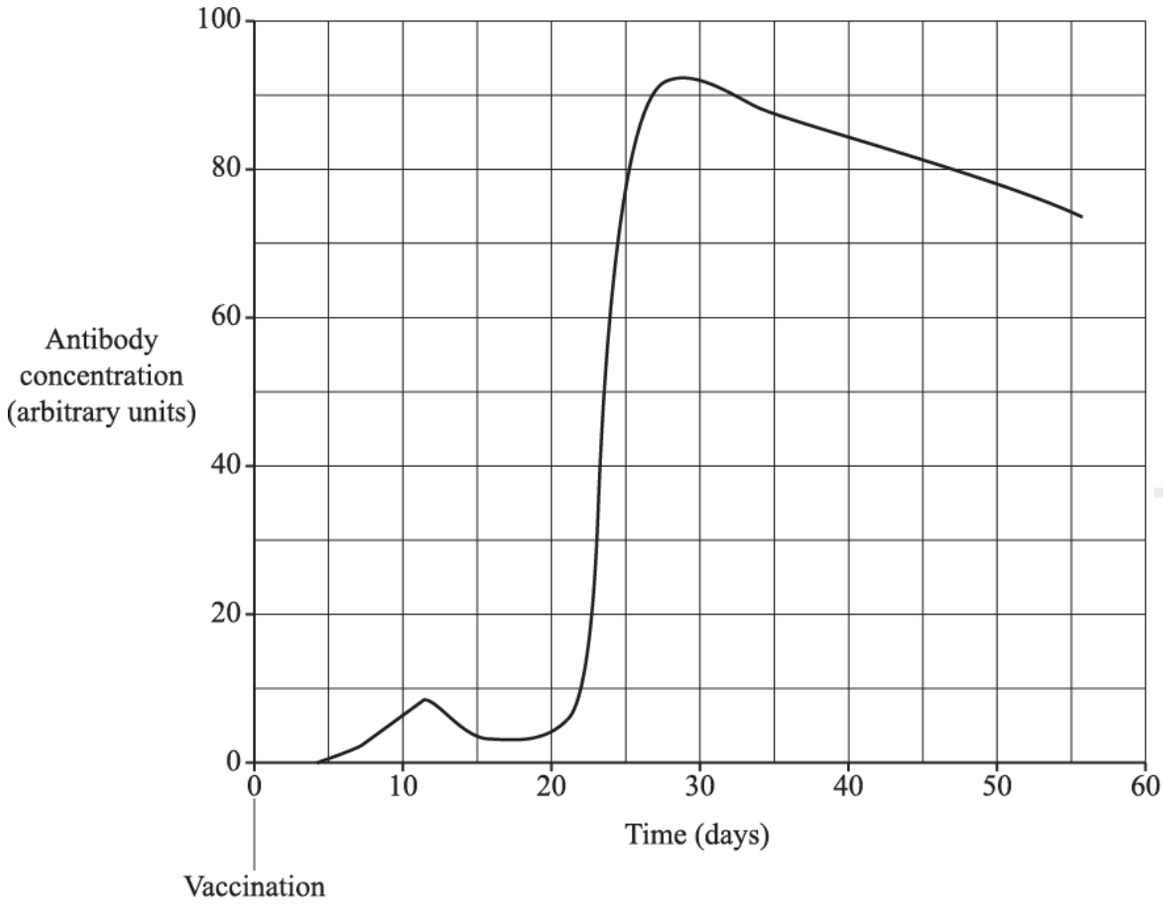



**Fig. 25.1**

Calculate the rate of antibody production at day 10 in arbitrary units per day.

Answer_____ au day$^{-1}$ **[2]**

(b). Explain why the response to the subsequent infection is much bigger than the response to vaccination, as shown in Fig. 25.1.

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**[3]**

(c). Antibodies have a number of mechanisms of action. For example, agglutinins cause pathogens to be rendered inactive by clumping them together.

Outline the action of opsonins.

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**[2]**

3. Young mammals receive antibodies in their mother's milk.

This is an example of which type of immunity?

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

Your answer ☐

**[1]**

4. Which of the following descriptions is correct?

A Vaccination gives long-term protection, immunisation gives short-term protection.
B Vaccination involves injection of antigenic material and immunisation is the process of developing immunity.
C Vaccination involves injection of antigenic material, immunisation is injection of antibodies.
D Vaccination and immunisation have the same meaning.

Your answer ☐

**[1]**

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5. Which formula would you use to estimate the volume of a neutrophil?

A $4\pi r^2$

B $2\pi r$

C $\pi r^2 h$

D $\frac{4}{3}\pi r^3$

Your answer ☐

**[1]**

6(a). The concept of molecules with complementary shapes can be used to explain many processes in living things.

Another molecule that relies on a specific shape to bind to a specific compound is an antibody.
**Fig. 23.1** shows the generalised structure of an antibody.

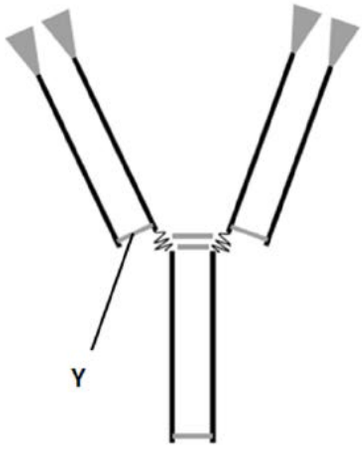



**Fig. 23.1**

(i) Draw a ring on **Fig. 23.1** to show a part of the molecule that has a shape complementary to the shape of an antigen.

**[1]**

(ii) The component labelled **Y** on the antibody is a bond.

State what type of bond is found here and give its function.

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**[2]**

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(b). Lupus is an autoimmune disease. Lupus occurs when nuclear proteins are exposed and the immune system makes antibodies against these proteins. As a result the proteins clump together. These clumps stick to surfaces such as the blood vessel walls and cause fatigue, joint pain and skin rashes.

(i) What is meant by the term *autoimmune disease*?

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---**[2]**

(ii) Suggest why antibodies specific to nuclear proteins are not normally made.

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---**[1]**

(c). Scientists often use natural substances to help them develop specific new medicines.

State two possible sources of such natural substances.

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---**[2]**

7. If a person is bitten by a venomous snake, the immediate treatment is normally to inject the person with the appropriate antibodies.

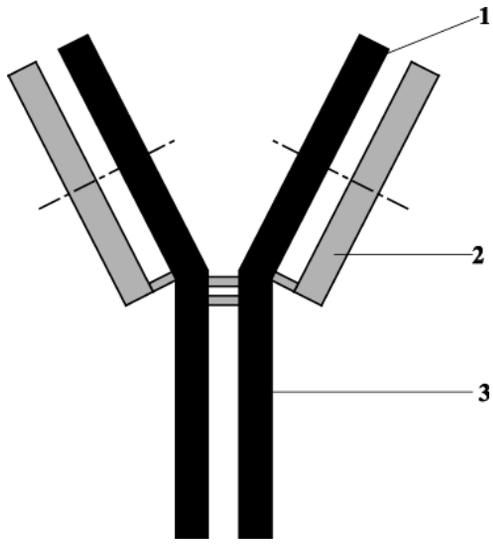
This is an example of which type of immunity?

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

Your answer ☐

**[1]**

8. The diagram represents the general structure of an antibody.




Which of the following numbered part(s) of the diagram represent the part of the antibody that has the same sequence of amino acids in all antibodies?

A 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer ☐

**[1]**

9(a). There will be outbreaks of new infectious diseases in the future. They will arise from mutations in the genomes of existing organisms. The mutating organisms may not at present be pathogenic, or they may be animal pathogens that mutate to become able to infect humans.

What feature of a pathogen such as *Mycobacterium tuberculosis* could be altered by a mutation, making a vaccine ineffective?

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**[1]**

(b).

(i) Outline the processes that lead to the production of antibodies against an unfamiliar bacterium.

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**[3]**

(ii) Explain how helper T cells act to speed up these processes.

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**[2]**

(c). **Fig. 16.1** shows the concentration of new antibodies in the blood of a person infected for the first time by a pathogen, on day 0. This is their 'primary response'.

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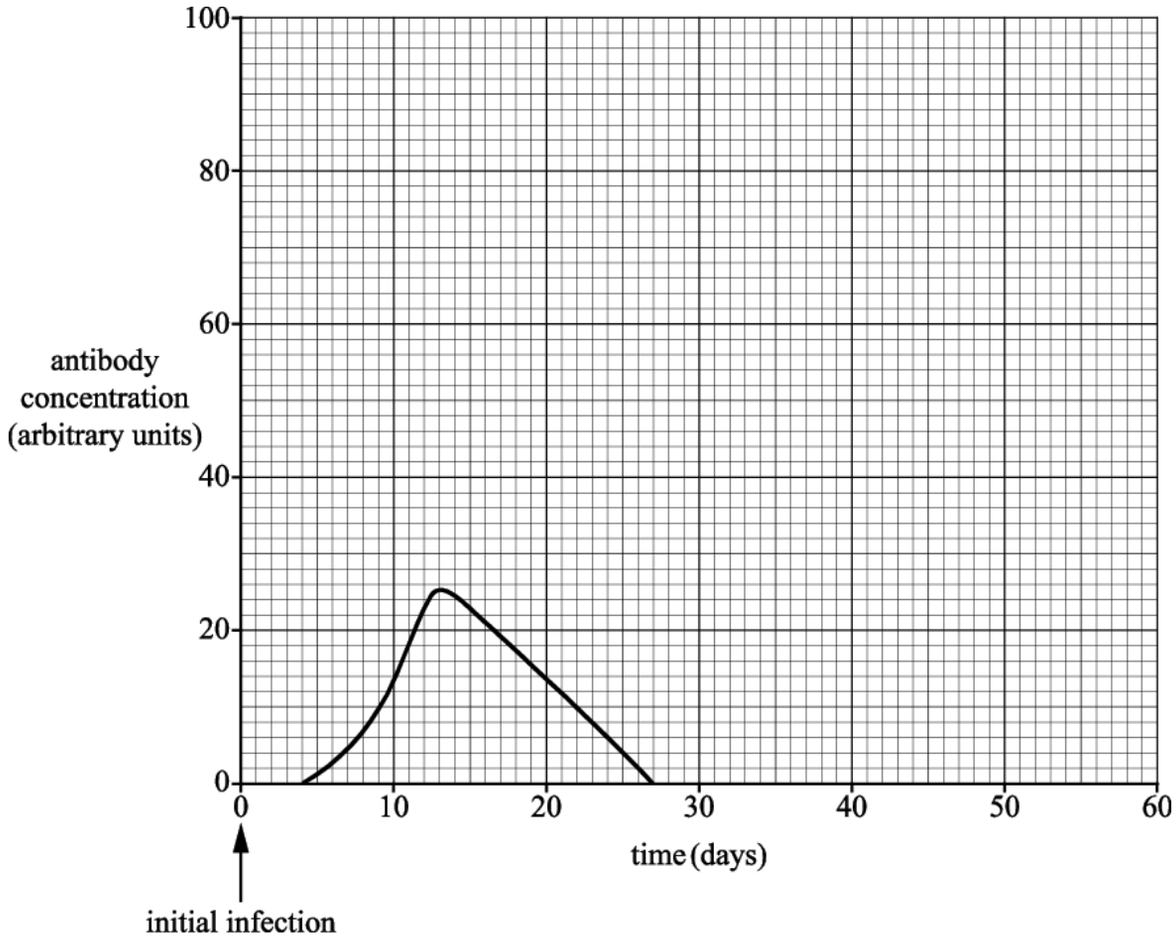



**Fig. 16.1**

(i) On day 30, this individual was again infected with the same pathogen. Sketch a line **on Fig. 16.1** to show the antibody concentration from day 30 onwards.

**[2]**

(ii) Explain how memory cells caused the differences between the two lines on the graph.

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**[2]**

(d).

(i) It takes time for an effective vaccine to be prepared in quantity for a new strain of bacterium.

List two vulnerable groups of people for whom you would advise doctors to prescribe antibiotics although they are **not** yet showing symptoms of the new disease.

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**[2]**

(ii) Discuss the implications of the over-use of antibiotics when people do not show symptoms.

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**[4]**



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10(a). Vaccinations are effective in preventing the spread of a range of diseases.

Explain why vaccinations are an example of active immunity.

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**[2]**

(b). Measles is a potentially fatal disease.

- Since 1988 children in the UK have been vaccinated against measles using the MMR vaccine.
- In 1998 a study was published which linked the MMR vaccine to the development of a condition known as autism. Some parents refused to have their children vaccinated with MMR.
- The study linking MMR to autism has since been discredited.

**Table 3.1** shows some data about the percentage of children vaccinated with MMR and the incidence of measles in England and Wales.

| Year | Proportion of children vaccinated with MMR (%) | Confirmed cases of measles |
|---|---|---|
| 1997 | 92 | 177 |
| 1998 | 91 | 56 |
| 1999 | 88 | 92 |
| 2000 | 88 | 110 |
| 2001 | 87 | 70 |
| 2002 | 84 | 319 |
| 2003 | 82 | 437 |
| 2004 | 80 | 188 |
| 2005 | 81 | 78 |
| 2006 | 84 | 740 |
| 2007 | 85 | 990 |
| 2008 | 85 | 1370 |
| 2009 | 85 | 1144 |
| 2010 | 88 | 380 |

**Table 3.1**

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(i) Between 1997 and 1999 the mean percentage of children vaccinated with MMR was 90.3.

Calculate the mean number of confirmed cases of measles between 1997 and 1999.

Give your answer to one decimal place.

Answer_____________________________ **[1]**

(ii) In 2005, despite relatively low vaccination rates, the number of confirmed cases of measles was only 78.

Use your answer to part **(i)** to calculate the percentage change in the number of confirmed cases of measles from the mean value of 1997–1999 to 2005.

Give your answer to one decimal place.

Answer_____________________________ **[2]**

(iii) In early 2006, a newspaper claimed that the drop in MMR vaccination rates had not led to the predicted increase in measles cases.

Evaluate the validity of the newspaper's claim. Use processed data to support your argument.

________________________________________________________________________________

________________________________________________________________________________

________________________________________________________________________________

________________________________________________________________________________ **[3]**

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(c). The MMR injection is actually a combination of three different vaccines.

It protects children against measles, mumps and rubella pathogens.

Explain why it is not possible to protect against the different pathogens using only one vaccine.

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**[3]**

11(a). The English elm tree, *Ulmus procera,* was once widespread in Britain. The English elm is much less common now because of a disease known as Dutch elm disease.

- The disease is caused by a fungus that first arrived in Britain in 1967.
- Beetles living under the bark pick up fungal spores while feeding.
- Within a few years approximately 25 million trees were dead.

Suggest two reasons for the **rapid** spread of the fungus in the elm population.

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2

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**[2]**

(b). Malaria is a disease that affects many millions of people.

Identify one similarity in the way malaria is transmitted compared with the way Dutch elm disease is spread.

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**[1]**

(c). Complete the passage using the most appropriate terms.

The pathogen that causes malaria is called _____ . This organism belongs to the kingdom _____ . The pathogens that cause malaria and Dutch elm disease are both in the domain _____ .

**[3]**

(d). Explain how the malarial parasite is able to bypass the body's primary defences.

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**[2]**

12. Which statement, **A** to **D**, correctly describes a process that provides artificial active immunity?

A an injection of active antibodies for tetanus
B antigens for polio given in a sugar cube
C antibodies provided in milk from a breast-feeding mother
D antigens received on flu viruses via water droplets in the air

Your answer ☐

**[1]**

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13(a). Fig. 19.1 shows a neutrophil responding to a pathogenic bacterium.

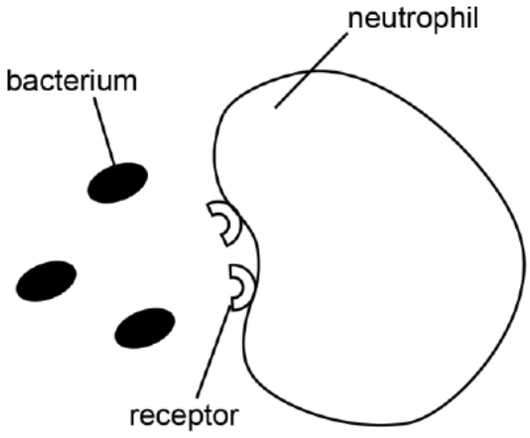



**Fig. 19.1a**

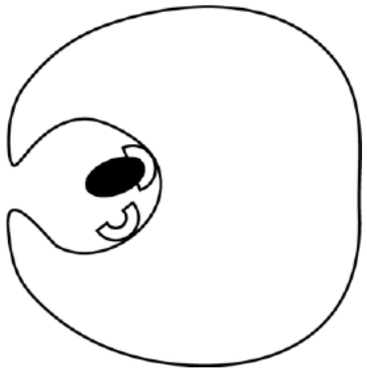


**Fig. 19.1b**

(i) What is the role of an opsonin during this process?

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**[1]**

(ii) Other than having specific receptors, describe **one** way in which the structure of the neutrophil is specialised.

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**[1]**

(b). When their bark is damaged, trees in the genus *Boswellia* release the aromatic resin frankincense which soon hardens to cover the wound.

(i) Suggest **two** ways in which frankincense contributes to defending the tree from pathogens.

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**[2]**

Frankincense is collected by cutting the bark of a tree and allowing the resin released to harden.

It can be used to relieve the pain of rheumatoid arthritis.

Frankincense works by blocking receptors for molecules called leukotrienes which cause inflammation. Leukotrienes are released by cells from the immune system.

(ii) What type of disease is rheumatoid arthritis?

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**[1]**

(iii) Trees that are overused for harvesting frankincense do not live long and are becoming increasingly rare.

Explain how traditional remedies, such as the use of frankincense, provide a strong argument for conservation of biodiversity.

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**[2]**

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14. Plague is caused by the bacterium, *Yersinia pestis.*

(i) The bacterium is a rod-shaped cell that is approximately 3 μm long.

*Yersinia pestis* is viewed using a light microscope with a magnification of 1250.
What would be the length of the cell in the image produced by this microscope?

Answer _____ mm **[2]**

(ii) Photographs taken of the image obtained by the light microscope could be further enlarged using a projector.

Why might the enlarged image be unable to tell us more about the structure of *Yersinia pestis?*

_____

_____ **[1]**

(iii) Outbreaks of plague still occur occasionally. Plague is transmitted by several methods including droplet infection, close contact between people and fleas moving between infected rats and people.

Suggest **two** ways to minimise the spread of an outbreak of plague.

_____

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_____

_____ **[2]**

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15. * There are a number of different strains of the *Clostridium botulinum* bacterium. Different strains produce immunologically distinct forms of the toxin.

Explain why the toxins produced by the different strains are described as being 'immunologically distinct' and how they will be dealt with by the immune system.

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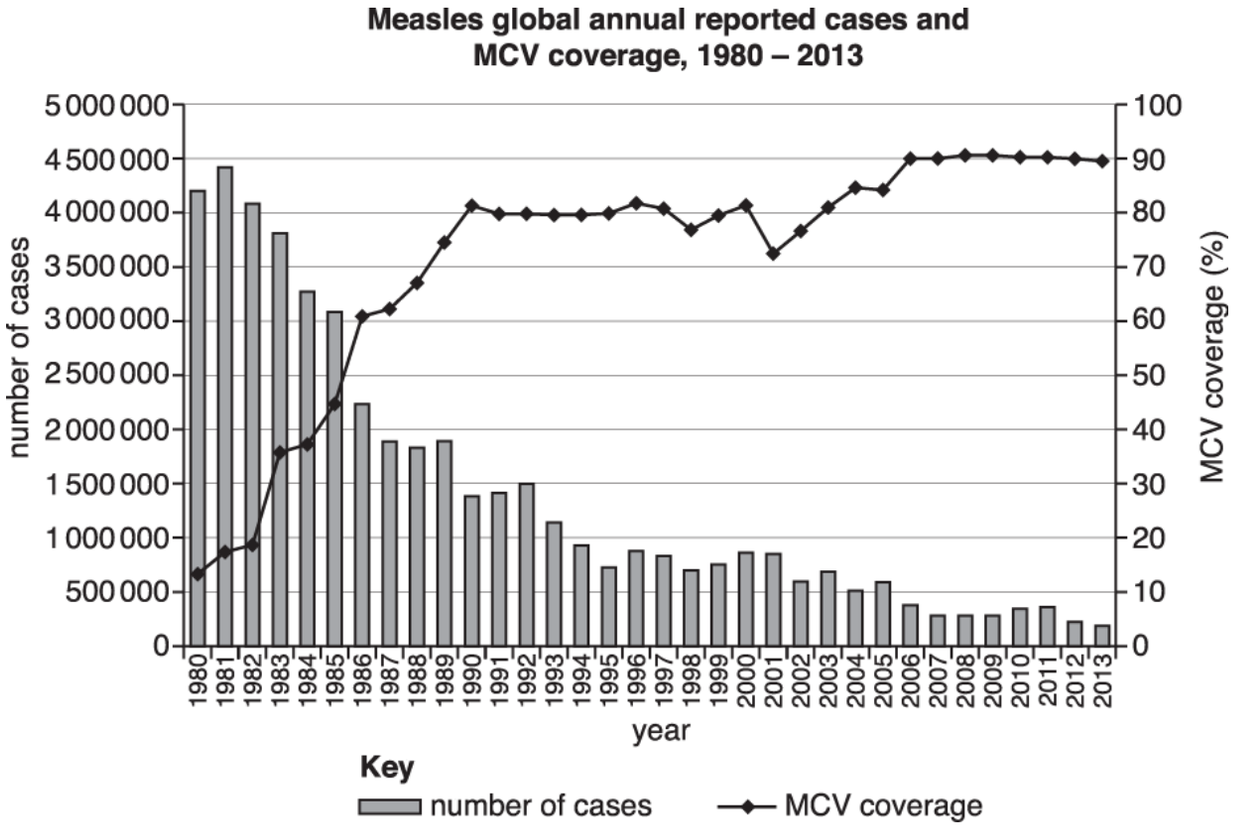
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**[6]**

16. Measles is a serious disease that can be prevented by vaccination. The chart below shows the Measles-containing Vaccine (MCV) coverage and annual reported cases of measles between 1980 and 2013.




Which of the following statements, **A** to **D**, is a correct interpretation of the chart?

A An increase in herd immunity resulted in fewer deaths from measles.
B The highest number of measles cases occurred when MCV coverage was at its lowest.
C A 90% MCV coverage resulted in fewer than half a million cases of measles each year.
D There is a positive correlation between the number of measles cases and the MCV coverage.

Your answer

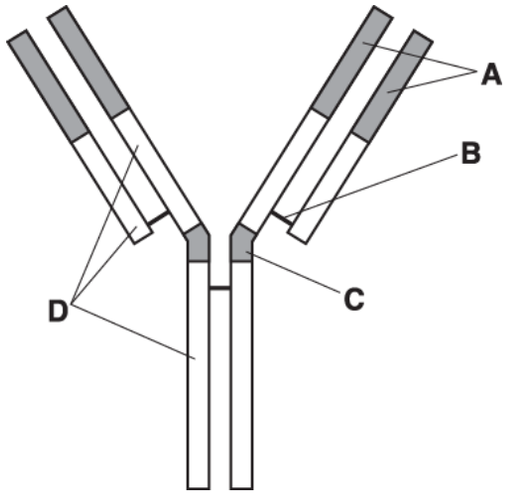
**[1]**

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17. The diagram below shows the simplified structure of an antibody.

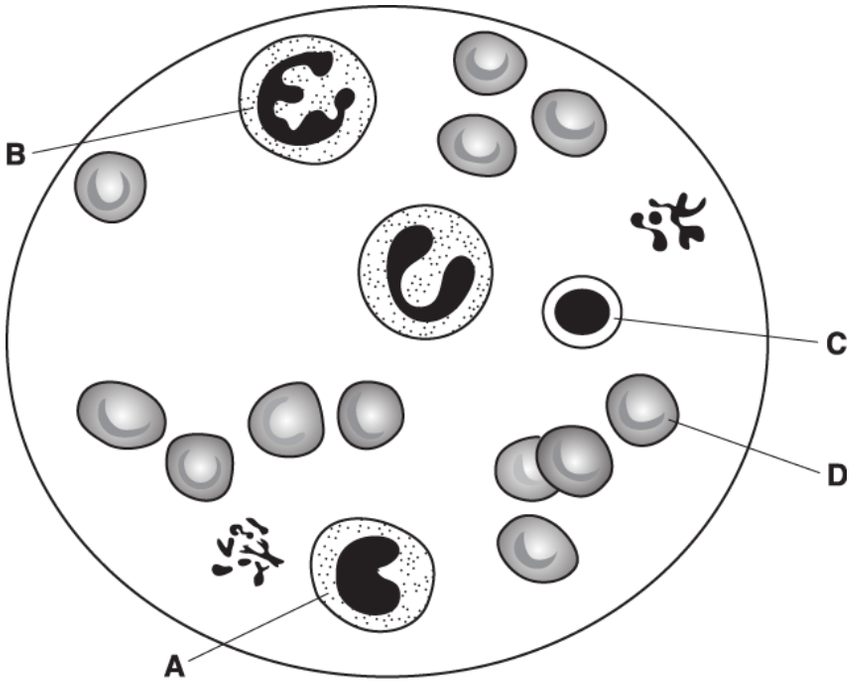



Which of the letters, **A** to **D** identifies the region of the antibody that allows the distance between the antibody binding sites to vary.

Your answer

**[1]**

18. A diagram of a stained blood smear observed under a light microscope is shown below.




Which of the structures labelled **A** to **D** in the diagram is a neutrophil?

Your answer

**[1]**

19. Which of the following options, **A** to **D**, is a primary defence mechanism against pathogens?

A neutralisation
B agglutination
C phagocytosis
D blood clotting

Your answer

**[1]**

20. Pathogens cause disease and are transmitted from individual to individual in a variety of ways.

Which of the rows, **A** to **D**, in the table below is correct?

| | **Disease** | **Type of pathogen** | **Means of transmission** |
|---|---|---|---|
| **A** | Athlete's foot | Fungus | Direct and indirect contact |
| **B** | HIV/AIDs | Virus | Indirect contact |
| **C** | Malaria | Bacterium | Vector |
| **D** | Tuberculosis | Protoctist | Direct contact |

Your answer

**[1]**

21. Haemoglobin is found in erythrocytes. Unlike other vertebrates, the mature erythrocytes of mammals lack nuclei and other membrane-bound organelles.

(i) Explain **one** advantage and **one** disadvantage of the lack of nuclei and other membranebound organelles to mammalian erythrocytes.

Advantage _____

_____

Disadvantage _____

_____ **[2]**

(ii) Viruses do not use erythrocytes as host cells, whereas the malarial pathogen *Plasmodium* spends part of its life cycle inside erythrocytes.

Suggest why.

_____

_____

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_____

_____ **[2]**

(iii) Explain why erythrocytes do **not** make use of any of the oxygen that they are transporting.

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_____

_____ **[2]**

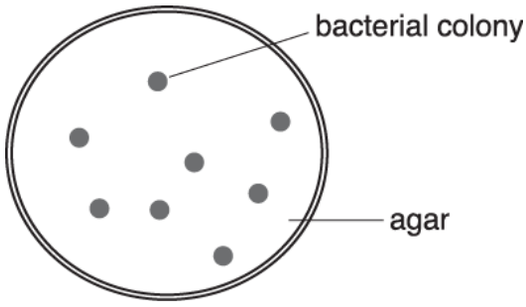
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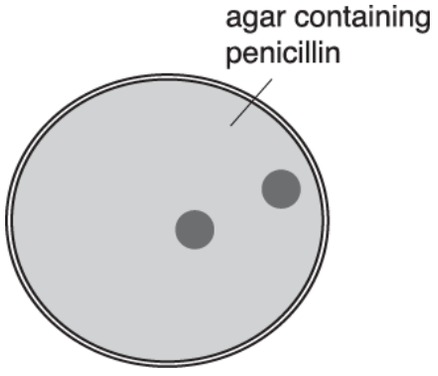
22(a). An experiment was carried out to investigate the resistance of a species of bacterium to the antibiotic penicillin.

Bacteria were allowed to grow into colonies on an agar plate.

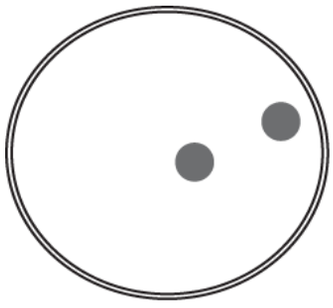



A cloth was placed onto the bacteria and then the pattern of bacterial colonies was transferred to an agar plate that contained penicillin.

Only two colonies survived and continued to grow on the agar that contained penicillin.
The bacteria in these colonies possessed a mutation that gave them resistance to the penicillin.




The original plate was flooded with a solution containing penicillin and the same two colonies continued to grow.



(i) A student made the following suggestion:

> I think that the colonies on the agar containing penicillin that survived and grew did so because those bacteria evolved resistance.
> They evolved resistance as a result of being exposed to the penicillin.

Another student commented:

But some of the bacteria in the population were already resistant, so they can't have evolved resistance because they were exposed to the penicillin.

What evidence indicates that the penicillin-resistant bacteria already existed in the population?

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**[1]**

(ii) Name the process that increases the proportion of penicillin-resistant bacteria in the population.

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**[1]**

(b). One role of the Office for National Statistics (ONS) is to collate data about the causes of death in England and Wales. Deaths involving *Staphylococcus aureus* and MRSA statistics have been produced by the ONS for each year since 1993.

*S. aureus* can be mentioned on a death certificate and *S. aureus* may also be specified as being methicillin resistant (MRSA).

Table 6 shows the data for the years 1993 to 2012.

| **Year** | **Number of death certificates mentioning *S. aureus*** | | |
|---|---|---|---|
| | ***S. aureus* not specified as resistant** | ***S. aureus* specified as MRSA** | **Total** |
| 1993 | 379 | 51 | 430 |
| 1994 | 358 | 90 | 448 |
| 1995 | 409 | 198 | 607 |
| 1996 | 445 | 298 | 743 |
| 1997 | 395 | 386 | 781 |
| 1998 | 451 | 409 | 860 |
| 1999 | 484 | 480 | 964 |
| 2000 | 476 | 666 | 1036 |
| 2001 | 473 | 731 | 1204 |
| 2002 | 421 | 794 | 1215 |
| 2003 | 448 | 968 | 1516 |
| 2004 | 461 | 1138 | 1599 |
| 2005 | 450 | 1649 | 2099 |
| 2006 | 498 | 1652 | 2150 |
| 2007 | 459 | 1593 | 2052 |
| 2008 | 270 | 1230 | 1500 |
| 2009 | 472 | 781 | 1253 |
| 2010 | 475 | 485 | 960 |
| 2011 | 274 | 364 | 638 |
| 2012 | 265 | 292 | 557 |

**Table 6**

(i) Calculate the percentage increase in the number of death certificates that mention MRSA from 1993 to the year when the numbers reach a peak.

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Show your working and give your answer to **three significant figures**.

Answer =_____ % **[2]**

(ii) The proportion of death certificates that mention MRSA in 1993 is 12%.

Compare this figure with the proportion of death certificates that mention MRSA in 2012.

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**[2]**

(iii) What can you conclude from these data about the deaths involving S. aureus and MRSA since 2007?

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**[2]**

23(a). Influenza (flu) is a disease that affects millions of people worldwide. Many vulnerable people receive vaccinations against flu each year.

A flu vaccination consists of a suspension of antigenic material from the flu virus, which is then injected into patients.

Tick the box that best describes the type of immunity provided by the flu vaccination.

| | |
|---|---|
| active and natural | |
| active and artificial | |
| passive and natural | |
| passive and artificial | |

**[1]**

(b). Fig. 2.1 represents an influenza virus. Various protein antigens are attached to the outer surface of the virus.

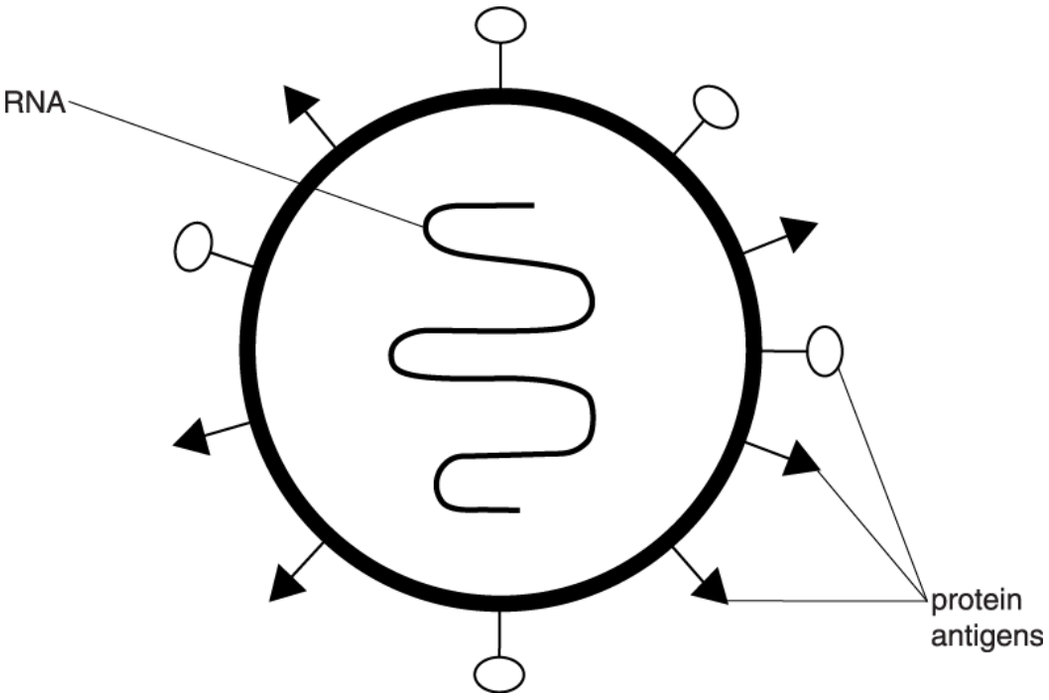



Fig. 2.1

When a virus infects a human host, it causes the host's cells to produce many new copies of the virus.

(i) The influenza vaccination must be given each year because there are frequent mutations in the RNA of the virus.

The antigens on the surface of the virus are made of protein.

The virus uses the organelles and enzymes in the host's cells to produce new copies of itself.

Suggest the role of the viral RNA in the production of viral proteins.

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**[2]**

(ii) Explain why a mutation in the viral RNA leads to a change in the 3-D shape of the protein antigens.

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**[3]**

(iii) The head teacher of a school decided to offer teachers free influenza vaccinations every year.

Suggest why the head teacher thought this would be a good use of the school's money.

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**[1]**

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(c). Compare the primary and secondary immune response by filling in the table below.

| | Primary response | Secondary response |
|---|---|---|
| **Relative concentration of antibodies produced** | | |
| **Relative duration of response** | | |

**[2]**

(d). Name **two different** types of T-lymphocytes **and** describe their roles in the immune response.

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**[2]**

24(a). Malaria is a disease that is estimated to kill around 80 people every hour worldwide.

The symptoms of malaria are caused by a single-celled organism belonging to the genus *Plasmodium*.

(i) *Plasmodium* is described as a parasite.

Define the term *parasite*.

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**[3]**

(ii) Explain why the human body's primary defences do **not** prevent the entry of *Plasmodium* into the body.

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**[2]**

(iii) Suggest why malaria is much more common in tropical areas than in other parts of the world.

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**[1]**

(iv) Suggest **two** reasons why governments in parts of the world other than tropical areas are also becoming increasingly concerned about malaria.

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**[2]**

(b). People with the disease known as iron-deficient anaemia (IDA) are resistant to malaria. This resistance is not well understood but is thought to involve phagocytosis.

Fig. 2.1 shows the process of phagocytosis of a pathogen by a phagocyte.

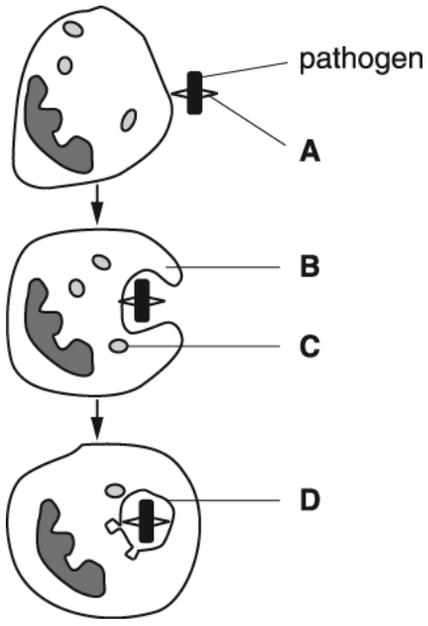



**Fig 2.1**

(i) Identify the structures represented by the letters **A**, **B**, **C** and **D**.

**A**

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**B**

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**C**

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**D**

---**[4]**

(ii) In patients with IDA, anaemia is caused by the destruction of erythrocytes (red blood cells) by phagocytosis.

Suggest why erythrocytes that contain *Plasmodium* are more likely to be destroyed by phagocytosis than

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healthy erythrocytes.

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**[1]**

25. In the past, roe deer's main natural predator in Britain was a large carnivore of the cat family, the Eurasian lynx, *Lynx lynx*. The lynx became extinct in Britain around 1000 years ago.

Populations of Eurasian lynx still survive in parts of mainland Europe.

Plans are being considered to re-introduce the Eurasian lynx from these European populations to the wild parts of Britain to improve biodiversity.

(i) Suggest **one** reason why some people might object to this re-introduction.

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**[1]**

(ii) A small population of Iberian lynx, *Lynx pardinus*, exists in parts of Spain. The Iberian lynx is critically endangered and, with around 100 individuals left, it is the world's most endangered species of cat.

The Iberian lynx and Eurasian lynx were once classified within the same species, based on their observable features.

In the last 10 years, the Iberian lynx has been re-classified as a separate species within the genus *Lynx*, on the basis of its phylogeny.

Define the term *phylogeny* and explain how phylogeny is related to classification. Use the two lynx species as examples.

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**[4]**

(iii) Suggest why it is only in the last 10 years that the Iberian lynx has been classified as a separate species.

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**[1]**

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(iv) Outline **three** reasons why it is important to conserve the Iberian lynx.

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2

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3

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**[3]**



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26(a). Antibodies are important biological molecules.

Describe how the structure of antibodies allows them to perform their function.



*In your answer you should clearly link structure to function.*

**[7]**

(b). Antibodies can defend the body against pathogens in a number of ways.

Outline the mode of action of antibodies in defending the body against pathogens by describing the processes of **neutralisation** and **agglutination**.

neutralisation _____

_____

_____

_____

_____

agglutination _____

_____

_____

_____

_____ **[4]**

27(a). Vaccination can provide immunity to disease.

Complete the following passage by using the most appropriate term from the list.

| | | | | |
|---|---|---|---|---|
| **active** | **antigen(s)** | **double-helix** | **membrane(s)** | **memory** |
| **mutation** | **passive** | **phagocytic** | | **receptor(s)** |
| **species** | **specific** | **strand** | **strain** | **white blood** |

Some vaccines contain a dead or weakened form of a pathogen. The _____ on the cell surface of the pathogen are still able to trigger the production of _____ antibodies in the person being vaccinated. Cells called _____ cells are also produced, which retain the ability to divide and produce the antibodies quickly, should the pathogen return.

A new _____ of pathogen can arise if there is a _____ in the DNA of the pathogen. If this happens, the original vaccine is not likely to be effective.

**[5]**

(b). The term *immunity* is often used when describing how vaccines work.

In a piece of school homework a student wrote:

"Bacteria can evolve quickly and many are now immune to antibiotics."

Explain why the student's use of the word 'immune' was incorrect.

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**[3]**

28. Nicotine is a toxic chemical. Smokers take in low doses of nicotine that are not toxic in the short term, but these low doses affect cardiovascular health in the longer term.

Nicotine increases blood pressure and increases the likelihood of a thrombosis (formation of a blood clot). Either of these effects can lead to a stroke, which is when cells in part of the brain die, leading to loss of function.

(i) Suggest how each of these stated effects of nicotine could contribute to cell death in the brain.

increased blood pressure _____

_____

_____

_____

thrombosis _____

_____

_____

_____ **[4]**

(ii) It is important that the correct treatment is given when a stroke is suspected.

Research has led to the ability to identify whether a stroke has resulted from a thrombosis or from increased blood pressure.

The standard emergency treatment for a suspected stroke is to give a drug that will counteract a thrombosis. If, however, the cause of the stroke is found to be high blood pressure, an alternative treatment would be more appropriate.

Explain why.

_____

_____

_____

_____ **[1]**

(iii) The effects of a stroke will depend on which part of the brain has been affected.

Some possible effects of a stroke are listed below.

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- Problems with coordination of movement.
- Loss of memory and speech.
- Paralysis of the body below the neck.

With reference to named parts of the brain, explain how each of these specific effects is caused.

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**[4]**

29. A patient has been diagnosed with an autoimmune disease.

Which of the treatments, **A** to **D**, is most likely to relieve the symptoms?

**A** a course of antibiotics
**B** a vaccination containing antibodies
**C** drugs to suppress the immune system
**D** surgery to remove the affected parts

Your answer ☐

**[1]**



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30. The following statements are about organisms that cause disease.

1 Athletes foot and ringworm are caused by fungi.
2 Malaria and tuberculosis are caused by protoctistans.
3 Ring rot and black sigatoka are caused by bacteria.

Which of the statement(s) is/are correct?

**A** 1, 2 and 3
**B** only 1 and 2
**C** only 2 and 3
**D** only 1

Your answer

**[1]**

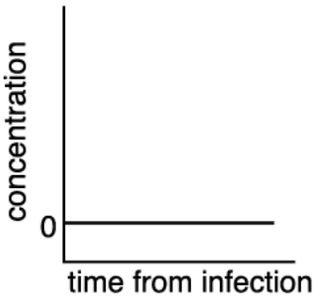


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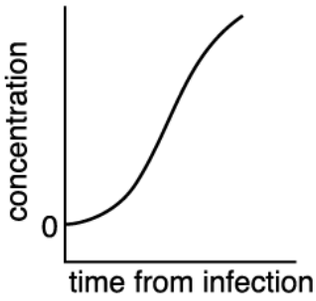
31. The graphs below show the concentration of antibodies in the blood of four people after a first natural exposure to an antigen. One of the people had been vaccinated against this antigen previously.

Which of the graphs, **A** to **D**, represents the person who had been vaccinated?

**A**




**B**




**C**




**D**




Your answer

**[1]**

32(a). Phagocytes are white blood cells that are involved in non-specific immune responses against pathogens.

The following passage describes the mode of action of a phagocyte.

Complete the passage using the most appropriate words or phrases.

Receptors on the cell membrane of a phagocyte recognise antibody molecules known as _____, which are bound to pathogens and enhance phagocytosis.

Once engulfed by a phagocyte, a pathogen is contained in a vacuole called a _____ . Organelles called _____ produce enzymes that digest the pathogen.

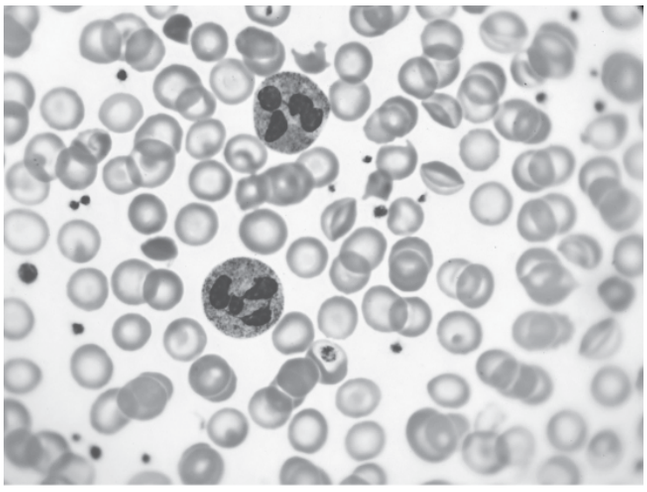
**[3]**

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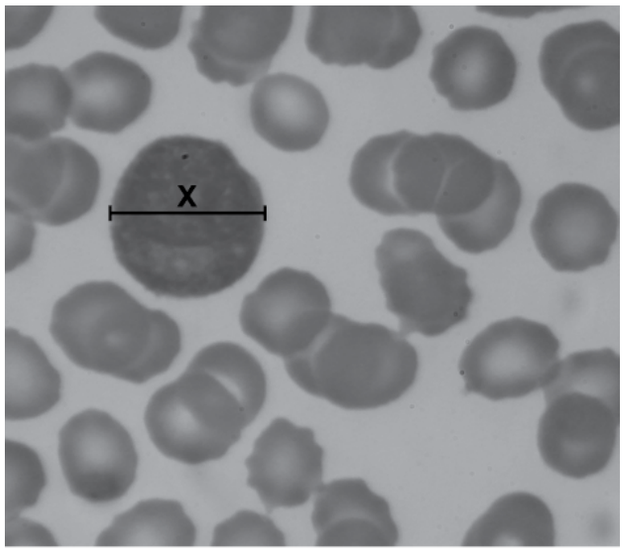
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(b). Fig. 1 shows two blood smears, **A** and **B**.



**A**




**B**

**Fig. 1**

(i) Which of the two images, **A** or **B**, shows a non-specific immune response?

Explain your answer.

_____

_____ **[1]**

(ii) The actual width of **X** in Fig. 1 image **B** is 15 $\mu$m.

Calculate the magnification used to produce image **B** in Fig. 1.

Give your answer to **two** significant figures.

Answer = _____ **[2]**

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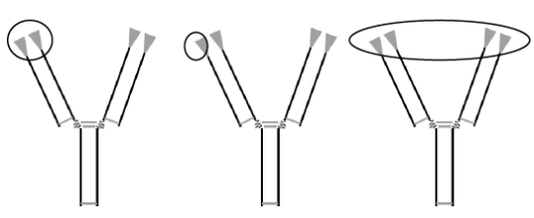
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**END OF QUESTION PAPER**

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 1 | | | C | 1 | |
| | | | **Total** | **1** | |
| 2 | a | | 1.5 (1) (1) | 2 | If answer is incorrect **ALLOW** one mark for clear attempt to calculate gradient of a tangent to the line<br><br>**ALLOW** 1.47 ± 0.02 for two marks |
| | b | | *Max 2 if the idea of parts of the vaccination response taking time is not explicitly stated.*<br><br>*vaccination involves*<br>clonal selection / antigen presentation (1)<br>clonal expansion / proliferation (1)<br>differentiation (1)<br><br>memory cells already present in response to infection (1) | 3 | **ALLOW** primary response for vaccination<br>**ALLOW** secondary response for response to infection |
| | c | | increase likelihood of phagocytosis (1)<br>*idea that* binds to pathogen and phagocyte / macrophage (1) | 2 | |
| | | | **Total** | **7** | |
| 3 | | | D | 1 | |
| | | | **Total** | **1** | |
| 4 | | | B | 1 | |
| | | | **Total** | **1** | |
| 5 | | | D | 1 | |
| | | | **Total** | **1** | |
| 6 | a | i | ring drawn around variable region (1) | 1 | **ALLOW**<br>  |
| | | ii | disulfide (1)<br>to hold polypeptides / light chain and heavy chain together (1) | 2 | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | b | i | abnormal immune response (1)<br>against tissues normally in the body (1) | 2 | |
| | | ii | nuclear proteins normally, hidden in nucleus / not exposed to tissue fluids (1) | 1 | |
| | c | | plants (1)<br>microorganisms (1) | 2 | **ALLOW** named examples, e.g. St John's Wort, frog skin, *Penicillium,* etc. |
| | | | **Total** | **8** | |
| 7 | | | B | 1 | |
| | | | **Total** | **1** | |
| 8 | | | C | 1 | |
| | | | **Total** | **1** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 9 | a | | (shape of), proteins / glycoproteins / glycocalyx / antigens of the plasma / cell surface, membrane (1) | 1 | Look for (change to) that aspect of antigenic configuration that the immune system would recognise as foreign. |
| | b | i | *three from*<br>B cells / lymphocytes, have, antigen receptor / carry antibody, on surface, specific / complementary to, only one antigen (1)<br>selected / activated, B cell, proliferates / clones / divides by mitosis (1)<br>forms / differentiates into, plasma / effector, cells (1)<br>which secrete antibodies specific / complementary, to antigen (1) | 3 | |
| | | ii | *two from*<br>(helper T cells) stimulated by antigen-presenting cells (1)<br>release, cytokines / interleukin 2 (1)<br>stimulate B-cell, proliferation / mitosis / clonal expansion (1) | 2 | |
| | c | i | *Drawn line should show:*<br>higher peak **and** steeper initial rise (1)<br><br>line departs *x* axis between days 30 and 33 **and** concentration at 60 days above peak of printed line (1) | 2 | Peak should be at least 40 AU.<br>**ALLOW** if nearly vertical.<br>**DO NOT ALLOW** if actually vertical.<br><br>**ALLOW** line start at 30 or 33 days. |
| | | ii | *one from*<br>(memory cells) not acting in, first line / primary response (1)<br>(memory cells) remained in blood after primary response (1)<br>*one of the above linked to*<br>so no wait for / faster, clonal selection (1) | 2 | |
| | d | i | *two from*<br>babies / infants (1)<br>elderly / infirm (1)<br>immuno-compromised / on immunosuppressant drugs / HIV positive (1)<br>known to have been exposed (to the infection) (1) | 2 | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | ii | *two from*<br>(antibiotic is) selective pressure (1)<br>(bacterial) gene pool / AW, has variation (1)<br>(only) some bacteria have resistance / some bacteria are more resistant than others (1)<br>*two from*<br>when exposed (to antibiotic) most-resistant survive (1)<br>surviving bacteria continue to reproduce to make a resistant population (1)<br>*idea that* over many generations there is an increase in proportion of resistant bacteria (under continued antibiotic pressure) (1)<br>antibiotic becomes ineffective / new antibiotic needed (1) | 4 | **IGNORE** increase in number of resistant bacteria. |
| | | | **Total** | **16** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 10 | a | | *two from*<br>antibodies produced (by person being vaccinated) (1)<br>activation of (named) lymphocytes (of person being vaccinated) (1)<br>(specific) memory cells remain (in person being vaccinated) (1) | 2 | |
| | b | i | 108.3 | 1 | **IGNORE** all other responses. |
| | | ii | 28.0 (1)(1) | 2 | **ALLOW** 1 mark if correct answer given to incorrect number of decimal places.<br>*If answer is incorrect*<br>**ALLOW** 1 mark for any number divided by the candidate's answer to part **(i)**.<br>*If the candidates answer to part **(i)** is incorrect apply ecf.* |
| | | iii | *max two from:*<br>*idea that* lowest year has been cherry-picked (1)<br>*idea that* average of several years would have been a better indicator (1)<br>*idea that* level might fluctuate (1)<br><br>*plus:*<br>use of processed data to support any of the above (1) | 3 | |
| | c | | *two from*<br>different pathogens have different antigens (1)<br>antigens have specific shape (1)<br>shape of antibody must be complementary to (specific) antigen (1)<br>*any of the above linked to*<br>different antibody needed for each pathogen (1) | 3 | |
| | | | **Total** | **11** | |

| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 11 | a | | mobile vector / insect, moving / flying from tree to tree AW (1)<br>low genetic diversity / lack of resistance (1)<br>fungal spores carried by the wind AW (1)<br>climate favouring fungal growth / spread of vector (1)<br>overcrowding of trees / small distance between trees (1) | 2 | |
| | b | | vector (1) | 1 | **ALLOW** carried by insects |
| | c | | *Plasmodium* (1)<br>Protista / Protoctista (1)<br>Eukaryota / Eukarya (1) | 3 | **ALLOW** *falciparum* |
| | d | | mosquito mouthparts pierce skin / AW (1)<br>pathogen injected (directly) into blood (1) | 2 | |
| | | | **Total** | **8** | |
| 12 | | | B | 1 | |
| | | | **Total** | **1** | |
| 13 | a | i | (opsonin) binds to antigen on pathogen and, assists binding / binds, to phagocyte | 1 | |
| | | ii | *any one:*<br><br>well-developed cytoskeleton (1)<br>many lysosomes (1)<br>many mitochondria (1)<br>lobed nucleus (1) | 1 | |
| | b | i | prevents pathogens entering wound (1)<br>aromatic compound is antibacterial (1) | 2 | |
| | | ii | autoimmune | 1 | |
| | | iii | many, plants / microorganisms, produce molecules that may have medical benefits<br>OR<br>many modern medicines have been developed from traditional remedies (1)<br><br>many such, plants / molecules, yet to be discovered (1) | 2 | |
| | | | **Total** | **7** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 14 | | i | 3.75 (1)(1) | 2 | **ALLOW** 3,750 µm or 0.375 cm for **one** mark.<br>**ALLOW** 1 mark for correct working e.g. 3 x 1250 |
| | | ii | (with light microscope) no further resolution (at × 1250) (1) | 1 | **IGNORE** ref to further detail, as implied in question.<br>**ALLOW** ref to resolution not the same as magnification. |
| | | iii | *two from*<br>stay keep indoors / increase ventilation / wear masks (1)<br>measures to, exclude / not attract / kill, rats / fleas (1)<br>strict / immediate quarantine for persons with symptoms (1) | 2 | **ALLOW** (longer term) measures to reduce overcrowding. |
| | | | **Total** | **5** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 15 | | | * **Level 3 (5–6 marks)**<br>A full explanation of why strains are immunologically distinct **AND** a description of more than one method of action of the immune system.<br><br>*There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*<br><br>**Level 2 (3–4 marks)**<br>A full explanation of why strains are immunologically distinct **AND** an attempt to describe a method of action of the immune system.<br>**OR**<br>A description of more than one method of action of the immune system **AND** an attempt to explain why strains are immunologically distinct.<br><br>*There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.*<br><br>**Level 1 (1–2 marks)**<br>An attempt to explain why strains are immunologically distinct **AND** an attempt to describe a method of action of the immune system.<br><br>*The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.*<br><br>**0 marks**<br>No response or no response worthy of credit. | 6 | **Relevant points include:**<br>**immunologically distinct**<br><br>• toxins produced by each strain will be (slightly) different<br>• each (botulinum) toxin will have different, 3D shape / amino acid sequence / DNA nucleotide coding sequence<br>• toxin, acts as / is, antigen<br>• immune response determined by shape of antigen<br>• different compounds will have different shapes<br><br>**immune system**<br><br>• antigen presenting cells ingest antigen and display antigen on their surfaces<br>• interaction between APCs and T-helper cells causes production of interleukins<br>• B cells activated by T-helper cells<br>• clonal selection and clonal expansion<br>• B cells differentiate into plasma cells<br>• plasma cells produce, antibodies / immunoglobulins<br>• by protein synthesis antibodies bind to and neutralise toxins. |
| | | | **Total** | **6** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 16 | | | C | 1 | **Examiner's Comments**<br><br>This question required candidates to study the chart, make their own deductions and then see which of the options was a correct statement. This, understandably, was found to be more difficult. Option A was a popular incorrect answer, but the data had no evidence of death by measles, only the number of cases. Option B, also a common suggestion, was not true for 1980. Those candidates who suggested option D had recognised that there was a correlation, but it is negative and not positive. |
| | | | **Total** | **1** | |
| 17 | | | C | 1 | **Examiner's Comments**<br><br>This is another instance where the question should be read carefully. It was clear that many candidates homed in on the 'antibody binding sites' and suggested region A. Careful reading would have revealed that the region was C, the part that flexed and changed the distance between the antibody binding sites. |
| | | | **Total** | **1** | |
| 18 | | | B | 1 | **Examiner's Comments**<br><br>Some candidates were unable to distinguish between the various white blood cells, although a few did suggest the erythrocyte. |
| | | | **Total** | **1** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 19 | | | D | 1 | **Examiner's Comments**<br><br>Some candidates confused ‘primary defence mechanism’ with ‘primary response’ and suggested various actions of the immune system rather than blood clotting. |
| | | | **Total** | **1** | |
| 20 | | | A | 1 | **Examiner's Comments**<br><br>In this question candidates needed to process quite a lot of information about pathogens. While many chose the correct option, the most common error was to think that malaria is caused by a bacterium and therefore choose the incorrect option C. This type of question is one of those that highlight popular misconceptions. |
| | | | **Total** | **1** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 21 | | i | *advantages*<br>A1 more space for / can contain more / can carry more, haemoglobin / oxygen ☐<br><br>A2 can squeeze through capillaries easily ☐<br><br>*disadvantages*<br>D1 limited life span / cannot divide / cannot reproduce / cannot undergo mitosis ☐<br>D2 no, protein synthesis / repair ☐<br>D3 no respiration, in / by, mitochondria<br>**or**<br>no mitochondria for respiration<br>**or**<br>limited respiration / no aerobic respiration / only anaerobic respiration ☐ | max 2 | Mark **first answer** only for advantage and disadvantage.<br><br>A1 **DO NOT CREDIT** in context of larger surface area<br>**ACCEPT** 'Hb' for haemoglobin<br><br>D1 max time of 120 days / 4 months<br><br>D3 **DO NOT CREDIT** 'no mitochondria so no respiration' (as some respiration will still take place)<br><br>**ACCEPT** 'ATP release' or 'energy provided' instead of 'respiration' e.g. no energy being provided from mitochondria<br>ATP is not released by mitochondria<br><br>**DO NOT CREDIT** ref to producing / creating, energy<br><br>**Examiner's Comments**<br><br>Most candidates stated that lack of a nucleus left more space for oxygen/haemoglobin but a significant number referred wrongly to an increase in surface area. The short life span of erythrocyte was commonly stated as a disadvantage but very few candidates realised their inability to carry out protein synthesis. Many candidates simply re-stated that erythrocytes had no membrane-bound organelles or a nucleus without any further qualification. A common misunderstanding was that the erythrocyte would be unable to respire, failing to realise that anaerobic respiration does still take place. A significant number said that erythrocytes would be unable to defend themselves from infection without a nucleus, or could not control cell activities |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | | | | or what entered or left the cell. |
| | | ii | *virus*<br><br>virus is unable to / cannot, replicate / reproduce, on its own / outside a host cell<br>**or** virus requires host cell, machinery / DNA / RER / ribosomes, for protein synthesis<br>**or**<br>virus does not contain, RER / ribosomes, for protein synthesis ☐<br><br>– – – – – – – – – – – – – – – – – – – – –<br><br>*Plasmodium*<br><br>*idea that Plasmodium is* using the host cell to hide from the immune system<br>**or**<br>for *Plasmodium* to complete its life cycle<br>**or**<br>for *Plasmodium* to use as a source of food (for, growth / reproduction) ☐ | 2 | **IGNORE** ref to the erythrocyte not having membrane-bound organelles without ref to the need of the virus to use them inside the cell<br><br>Must be a clear statement<br>**ACCEPT** needs / has to use, host cell to, replicate / reproduce<br><br>**ACCEPT** 'malarial pathogen' for *Plasmodium*<br>**IGNORE** eukaryotic / protoctist<br>**IGNORE** it has its own, DNA / nucleus / protein synthesis apparatus<br><br>**IGNORE** ref to just, part / stage, of life cycle<br><br>**IGNORE** ref to organelles<br><br>**Examiner's Comments**<br><br>This was a challenging question for many, and several failed to specify which organism they were talking about. Candidates often understood that viruses couldn't use erythrocytes for reproduction but failed to make the link that viruses must use the host cell to replicate. Candidates restated the question describing that part of the Plasmodium life cycle took place in the red blood cell but failed to realise it did not complete its life cycle. Commonly, candidates said that the Plasmodium used the erythrocyte for transport and as a source of oxygen. Many candidates spoke of Plasmodium using the erythrocyte |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | | | | because it is injected directly into the blood by the mosquito. Only the most able candidates described how Plasmodium could evade the immune response within the red blood cell. |
| | | iii | 1 oxygen is bound to haemoglobin (while being transported) □<br><br>2 lack mitochondria □<br><br>3 (therefore) no aerobic respiration □<br><br>4 (moved by mass flow so) doesn't need, energy / ATP, to move<br>**or** needs less, energy / ATP (for metabolic processes) □ | 2 | 1 **ACCEPT** 'it' for 'oxygen'<br>**ACCEPT** 'Hb' for haemoglobin<br><br>3 **ACCEPT** only respires anaerobically<br>**IGNORE** ref to energy<br><br>4 **DO NOT CREDIT'** does not need, energy / ATP' unqualified<br>**DO NOT CREDIT** 'makes / produces, energy'<br><br>**Examiner's Comments**<br><br>Most candidates scored 1 mark for lack of mitochondria although some candidates just referred to no organelles or no organelles for respiration. Very few candidates made the connection with aerobic respiration and the majority of candidates believed that erythrocytes could not respire at all and just had a completely passive role. Many candidates referred to the pointless nature of using the oxygen that they are supposed to be carrying to other tissues, more of a philosophical attitude than biological one. |
| | | | **Total** | **6** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 22 | a | i | *idea that*<br>the third diagram shows that the resistant, bacteria / colonies, were already present (on the original plate)<br>**or**<br>these (resistant) bacteria on the original plate continued to grow when flooded with penicillin ☐ | 1 | **IGNORE** penicillin will kill them so in order for them to survive the mutation must have already happened<br>**IGNORE** no time for natural selection to take place<br>– as these are explanations and not evidence<br><br>**Examiner's Comments**<br><br>Most candidates found this question challenging, tending to repeat or rephrase the stem of the question. Vague or ambiguous references to being exposed to penicillin were insufficient as they needed to clearly refer to the original colonies that survived when the original petri dish was flooded with penicillin. The candidates needed to take careful note of the diagrams and the information provided in order to make an informed statement. |
| | | ii | natural <u>selection</u> ☐ | 1 | **CREDIT** directional <u>selection</u><br>**IGNORE** evolution / survival of the fittest / binary fission / mutation<br><br>**Examiner's Comments**<br><br>This question elicited the following incorrect answers on a frequent basis: binary fission, mutation, evolution and mitosis. Some misunderstood the question and referred to antibiotic resistance, immunity or vaccination. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | b | i | 3140 □ □ | 2 | **Correct answer = 2 marks**, even if no working shown.<br><br>• If the answer is incorrect or has not been rounded to 3 sig. figs., then **award 1 mark** for seeing **either**<br><br>$\frac{1652 - 51}{x}$ or $\frac{1601}{x}$<br>where $x$ = any number<br><br>**or** an unrounded answer (e.g. 3139.2156 or 3139)<br>• If the incorrect peak has been chosen, then **award 1 mark only for a correct answer which is correctly expressed to 3 sig. figs.**<br>Using 1649 the correct answer is 3130<br>Using 1593 the correct answer is 3020<br><br>**Examiner's Comments**<br><br>Candidates should be encouraged to always show their working for calculations. Those who did were frequently able to be awarded a mark for working despite having the incorrect answer. Most were able to select the correct figures but were unable to manipulate them correctly. Calculation of percentage increase, decrease or change proves to be challenging for candidates. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | ii | was lower (in 1993)<br>**or**<br>has increased / is higher (in 2012) □<br><br>*(in 2012)*<br>52% or 0.52 □ | 2 | **IGNORE** ref to raw data<br><br>**ACCEPT** 'over 4 x greater in 2012'<br><br>**ACCEPT** 52.4%<br><br>**Examiner's Comments**<br><br>In contrast, most candidates performed this calculation correctly and were able to make a suitable comment relating to its increase since 1993. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | iii | *two of*<br>1 (trend is) decrease in (number of) deaths (since 2007) □<br><br>2 consistent / steady / large / dramatic, decrease in (deaths from *S. aureus* specified as) MRSA (from 2007) □<br><br>3 ref to better specific cross-infection control measure in health care □<br><br>4 any correct processed data comparing either years or cause of death using figures from table 6 □ | 2 | **IGNORE** raw data quotes<br><br>2 *idea that* non-specified fluctuates<br>**Note** 'a large decrease in the number of deaths from MRSA' = 2 marks (mps 1 & 2)<br><br>3 e.g. isolating MRSA cases / dress code for health professionals / hygiene measures / pre operation screening<br><br>4 *MRSA*<br>e.g. decrease of, 1301 / approx. 260 per year 2012 value is, 18.3% / approx. 20% / approx. □, of 2007 value a drop of, 82% / approx. 80%, from 2007 to 2012<br><br>*total*<br>e.g. decrease of, 1495 / approx. 39 per year 2012 value is, 27.1% / approx. 25% / approx. ¼, of 2007 value a drop of, 73% / approx. 70% / approx. 75%, from 2007 to 2012 |

| Year | % death certificates mentioning *S. aureus* | | Total number of death certificates mentioning *S. aureus* |
|---|---|---|---|
| | *S. aureus* not specified as resistant | *S. aureus* specified as MRSA | |
| 2007 | 22 or 22.4 | 78 or 77.6 | 2052 |
| 2008 | 18 | 82 | 1500 |
| 2009 | 38 or 37.7 | 62 or 62.3 | 1253 |
| 2010 | 49 or 49.5 | 51 or 50.5 | 960 |
| 2011 | 43 or 42.9 | 57 or 57.1 | 638 |
| 2012 | 48 or 47.6 | 52 or 52.4 | 557 |

**Examiner's Comments**

Most candidates observed the correct trend but did not clearly distinguish between total certificates mentioning *S. aureus*, those mentioning *S. aureus* specified as MRSA and those mentioning *S. aureus* not specified as resistant. Data quoted was frequently raw data rather than processed. Measures to prevent cross-infection were only credited if they were specific rather than vague references to 'better hygiene'.

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | | **Total** | **8** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 23 | a | | tick in second box<br><br>active and artificial ✓ ;<br><br>**Examiner's Comments**<br><br>The vast majority of candidates achieved this mark. | 1 | **DO NOT CREDIT** if there is a tick in any other box |
| | b | i | viral RNA, acts as, host cell / m, RNA;<br><br>RNA, carries, code / sequence (for viral protein);<br><br>(to) ribosomes;<br><br>**Examiner's Comments**<br><br>This question presented a challenge both to the candidates and examiners. Candidates often could not express the difference between viral RNA and host mRNA and many candidates thought that, contrary to the diagram provided, the virus contained DNA. Thus both host DNA and the supposed viral DNA became entangled. Examiners then had to unravel which RNA and DNA was being referred to by the candidates. A little less than half of candidates described RNA as carrying the code for protein, often viral protein, a slightly larger number identified ribosomes as the ultimate destination of RNA. A smaller number correctly suggested a specific role for the viral RNA. | 2 max | **ACCEPT** RNA / DNA, produced from viral RNA<br>**DO NOT CREDIT** tRNA<br><br>**ACCEPT** RNA is, translated into / used as a template to produce, (viral) protein (or description)<br>**ACCEPT** RNA codes for (viral) protein<br>**DO NOT CREDIT** tRNA<br><br>**ACCEPT** as a standalone mark |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | ii | altered base sequence (of viral RNA) means, altered, primary structure / (sequence of) amino acids;<br><br>R-groups / disulphide bonds / hydrogen bonds / ionic bonds, interact differently;<br><br>tertiary structure is determined by, bonds / R-groups / secondary structure / primary structure / sequence of amino acids;<br><br>3-D shape is tertiary structure; | 3 max | **ACCEPT** if a nucleotide (in RNA) is different the amino acid (in the protein) is different<br><br>**ACCEPT** changed as AW for interact differently<br><br>**ACCEPT** implication that 3D is tertiary structure<br><br>**Examiner's Comments**<br><br>The first marking point was not awarded often because most candidates failed to mention the link between base sequences and amino acid sequences. Close to half the candidates realised that an alteration in primary or secondary structure would lead to an altered tertiary structure and a similar number linked this to 3D shape. Less than a quarter of candidates gained the second marking point – usually for reference to bonds rather than R-groups. |
| | | iii | money would be saved / education improved / fewer sick days / reduced spread (of virus) / good example of health practice / few teachers will have immunity (to current strain); | 1 | **IGNORE** so they don't get the flu without further qualification<br>**IGNORE** because they are at risk of infection<br><br>**Examiner's Comments**<br><br>was fairly easy achieved by most candidates. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | c | | <table><tr><th></th><th>primary response</th><th>secondary response</th></tr><tr><td>concentration of antibodies produced</td><td>low(er)</td><td>high(er)</td></tr><tr><td>duration of response</td><td>short(er)</td><td>long(er)</td></tr></table> ; ; | 2 | **ACCEPT** unambiguous AW<br>**IGNORE** numbers<br><br>**ACCEPT** stated time periods where secondary response is longer than primary<br><br>**Examiner's Comments**<br><br>The top row was completed correctly by most candidates. Occasionally, candidates were let down by a poor choice of words that did not clearly convey a comparison. However, very few candidates gained full marks for this question mainly because they did not understand the term ‘duration’ - most appeared to think that ‘duration’ was a synonym for ‘speed of onset’. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | d | | helper cells, release, cytokines / interleukins<br>**or**<br>helper cells, activate / stimulate / AW, B cells;<br><br>**or**<br>helper cells, produce (T) memory cells;<br><br>killer / cytotoxic, cells, secrete / release, toxic substances / hydrogen peroxide / $H_2O_2$ / perforin<br>**or**<br>killer / cytotoxic, cells, kill / AW, infected cells;<br><br>**or**<br>killer cells, produce (T) memory cells;<br><br>memory cells, allow a, secondary / faster, (immune) response;<br><br>AVP; | 2 max | **CREDIT** cause B cells to, differentiate / proliferate<br>**IGNORE** B memory cells<br>**ACCEPT** involved in clonal selection<br><br>**AWARD** memory cells once only anywhere in the answer<br><br>**ACCEPT** lysins<br>**IGNORE** enzymes<br><br>**IGNORE** kill / attack / enter, pathogens<br>**ACCEPT** killer cells, target / attack, infected cells<br><br>**AWARD** memory cells once only anywhere in the answer<br><br>**AWARD** memory cells once only anywhere in the answer<br><br>**AWARD** 1 mark for suppressor cells / regulator cells, stop immune response<br><br>**Examiner's Comments**<br><br>was generally well done, with over half of candidates gaining full marks for this sub-question. T-helper cells with their correct role was most commonly awarded, followed by T-killer cells with their role appropriately given. Whilst the role of T-helper cells was solidly embedded, the role of the T-killer cells was less well understood and many weaker candidates lost the mark for saying that this T-lymphocyte acted as a phagocyte or in some way directly attacked the pathogen. Memory cells were occasionally put forward but often their role was poorly understood by those who offered it. Candidates often stated they were for immunological memory or remembering antigens. |
| | | | **Total** | **11** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 24 | a | i | <u>lives</u>, in / on / <u>host</u>;<br><br>gains nutrition / feeds, from (host);<br><br>at the expense of / harms (host); | 3 | The word 'host' must appear at least once in order to gain 3 marks<br><br>**IGNORE** lives off host<br>**IGNORE** binds to host<br><br>**ACCEPT** e.g. feeds on blood / get food from it / obtains nutrients from the larger organism<br><br>**DO NOT CREDIT** sometimes harm<br>**ACCEPT** causes disease<br><br>**Examiner's Comments**<br><br>This was often well answered with a well-rehearsed definition. Most candidates got 2 or 3 marks. Less good responses discussed living *off* a host rather than in or on. Some candidates were not clear that parasites always cause some degree of harm and statements like 'sometimes cause harm' were not credited. Vagueness often costs marks in definitions questions. A small minority thought the question was directed just at *Plasmodium* or thought all parasites were viruses or intracellular. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | ii | mosquito / vector / *Anopheles*, feeds on blood;<br><br>breaks <u>skin</u> / <u>skin</u> cannot act as barrier / mosquito pierces <u>skin</u> / mosquito bites <u>skin</u>; | 2 | **IGNORE** insect<br><br>**IGNORE** anticoagulant prevents clot formation (as primary defence has already been breached)<br><br>**Examiner's Comments**<br><br>Most candidates mentioned the role of *Anopheles* in penetrating the skin but far fewer mentioned that it did this in order to feed on blood. A few candidates thought that *Plasmodium* itself penetrated the skin. A small minority of responses were too general and discussed primary defences without ever mentioning the skin. There were some candidates who thought malaria was transmitted by infected needles or droplets. |
| | | iii | suitable / AW, climate / temperature, for, mosquito / vector / *Anopheles*; **ora**<br><br><u>more</u> mosquitoes live there / AW; **ora**<br><br>*idea of* relatively poor so methods of prevention less effective; | 1 | **ACCEPT** 'warm enough for mosquitoes'<br>**IGNORE** tropical as AW for 'warm'<br>**IGNORE** mosquito is adapted to survive there<br><br>**ACCEPT** e.g. can't afford, drugs / mosquito nets / habitat management / insecticides<br>**ACCEPT** lack of education<br><br>**Examiner's Comments**<br><br>Most responses correctly linked temperature or humidity to the ability of mosquitoes to survive, although some referred to the climate being more suitable for the *Plasmodium* and did not get the mark. Responses that added nothing to the stem of the question were not credited. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | iv | 1 climate change / global warming / AW, may result in <u>spread</u> to other parts of the world / AW;<br><br>2 *idea of* <u>increased</u> movement of (infected) people;<br><br>3 *idea* that (non-malaria) countries fund anti-malaria measures via international aid;<br><br>4 resistance of, parasite to drugs / mosquito to insecticides; | 2 max | **2 ACCEPT** increased tourism / easier to travel<br>**2 ACCEPT** inadvertent transport of mosquitoes<br><br>**4 IGNORE** 'resistance' without further qualification<br>**4 DO NOT CREDIT** immune<br><br>**Examiner's Comments**<br><br>Most candidates achieved one mark for this question, usually for an explanation about the implications of global warming on the range of *Anopheles* mosquitoes. Travel was commonly mentioned but not always qualified by 'more' or 'easier'. The idea of resistance was seen in some responses but was often not credited because of reference to antibiotics, vaccination or immunity. Examiners were surprised that, despite the apparent accessibility of the marks, very few candidates offered two reasons, even though they were told to give *two* reasons in the question. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | b | i | **A** antigen;<br><br>**B** (extension of) cytoplasm;<br><br>**C** lysosome;<br><br>**D** phagosome / phagocytic vesicle / phago-lysosome; | 4 | **Mark the first answer.** If the answer is correct and another answer is given that is incorrect or contradicts the original answer, then = **0 marks**<br><br>**B ACCEPT** pseudopod (ia / ium) or close spelling<br>**B IGNORE** neutrophil<br><br>**C IGNORE** lysome / lysozyme<br><br>**D ACCEPT** phagocytic vacuole / secondary lysosome<br><br>**Examiner's Comments**<br><br>This question differentiated well with B being the least common correct response. Many candidates identified B as 'phagocyte' or 'membrane', not appreciating the significance of the line extending beyond the membrane. D was sometimes identified as vesicle or vacuole rather than being qualified further. |
| | | ii | (different) chemicals that attract phagocytes (released from infected erythrocytes); | 1 | **ACCEPT** in the context of chemicals released by erythrocyte or *Plasmodium*<br>**ACCEPT** cytokines / histamine / interleukin, released<br>**IGNORE** references to antigens on surface<br><br>**Examiner's Comments**<br><br>This was a very challenging question. Less than one in twenty achieved a mark. A similar number of candidates had the right idea and mentioned cell signalling in some form but did not link this to chemicals and so could not be credited. Most candidates discussed antigen presentation, being unaware that this complex process could not be carried out by erythrocytes. |
| | | | **Total** | **13** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 25 | | i | *idea of* danger to, humans / local wildlife / domestic animals / deer;<br><br>environment may no longer be suitable for lynx / AW; | 1 | **ACCEPT** *idea of* danger to existing food chains<br>**IGNORE** could become a pest<br>**IGNORE** dangerous without further qualification<br>**IGNORE** competition<br><br>**Examiner's Comments**<br><br>The vast majority of candidates were able to access this mark with little problem. The minority who did not gain the mark discussed the lynx out-competing the native species or bringing disease into the country. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | ii | 1 (phylogeny is) the evolutionary, relationship between / history of, organisms / species;<br><br>2 phylogeny is the basis of classification;<br><br>3 example of molecular evidence used to classify;<br><br>4 species / organisms, within the same group have shared, phylogeny / evolutionary history / common ancestor; **ora**<br>5 *idea that* phylogeny of *L. lynx* and *L. pardinus* are sufficiently, different to have been placed in separate species / similar to have been placed in same genus; | 4 max | **1 ACCEPT** reasonable description of evolutionary, history / relationship, e.g. changes in ancestral organisms<br><br>**2** Must be a clear statement<br><br>**3 ACCEPT** base sequence / amino acid sequence / DNA / cytochrome C / haemoglobin / ATPase (used to classify)<br><br>**Examiner's Comments**<br><br>Candidates found this question challenging and it discriminated well between candidates of different abilities. Many students had learnt the definition of phylogeny and gained the first marking point. Definitions that failed to get a mark usually failed to mention evolution or species. Few candidates stated that phylogeny was the basis of classification with sufficient weight or clarity to gain a mark. A minority of candidates were able to gain ab mark by stating that certain biomolecules were used in classification as an indicator of phylogeny. The general marking point 4 was awarded even less often than the more specific marking point 5. Candidates tended to simply re-iterate the stem of the question without mentioning the lynx's phylogeny. Some candidates had the idea of marking point 5 but failed to use the term either species or genus and so could not be awarded the mark. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | iii | modern / new / better, technology (to distinguish between closely related species);<br><br>more, molecular / biochemical / DNA / genetic, evidence; | 1 | **ACCEPT** named example, e.g. DNA sequencing<br><br>**Examiner's Comments**<br><br>Most candidates gained the mark for new/better technology or reference to biochemical evidence. The most disappointing wrong answer, seen quite frequently, was that the lynx had recently evolved into a new species over a 10 year period. |
| | | iv | 1 *idea of* impact on food chain(s);<br><br>2 *idea of* right to exist / duty of humans to care for other species / ethical reason / preserving species for future generations;<br><br>3 *idea of* aesthetic reason;<br><br>4 economic reason / tourism / might provide useful resource; | 3 max | **1 ACCEPT** controlling deer population<br>**1 ACCEPT** top carnivore / top predator / keystone species / it might compete with existing species<br>**1 IGNORE** other species might die<br><br>**2 IGNORE** 'playing God'<br>**2 IGNORE** refs to poaching / hunting<br><br>**3 ACCEPT** beautiful creatures / nice to look at / AW<br><br>**Examiner's Comments**<br><br>The vast majority of candidates gained at least 2 marks on this sub-question and many scored all 3. A variety of answers were allowed and the candidates offered a range of, often ingenious, valid responses ranging from the lynx possibly having useful hormones or enzymes to being of national significance to the heritage of Spain. The most frequently offered non-creditworthy answers referred to maintenance of biodiversity or genetic variation, or to prevent extinction. |
| | | | **Total** | **9** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 26 | a | | | 6 max | **CREDIT** marking points from a suitably annotated correctly labelled diagrams but read text first |
| | | | 1 2 light chains and 2 heavy chains / 4 <u>polypeptide</u> chains; | | **1 IGNORE** long / short<br>**1 CREDIT** implication from labelled diagram |
| | | | 2 variable region allows, binding / <u>attachment</u>, to <u>antigen</u>; | | **2 IGNORE** complementary<br>**2 ALLOW** AW for region |
| | | | 3 two variable regions allow binding of <u>more than one</u> (of the same) <u>antigen</u>; | | **3 ALLOW** AW for region |
| | | | 4 variable region on different antibodies allows <u>specific</u>ity to <u>different antigens</u>; | | **4 ALLOW** AW for region |
| | | | 5 <u>constant</u> region allows, recognition by / attachment to / binding to, (named) phagocytes; | | **5 ALLOW** AW for region<br>**5 IGNORE** complementary |
| | | | 6 hinge (region) allows flexibility; | | **6 ACCEPT** allows arms to, move / bend |
| | | | 7 disulfide, bonds / bridges, hold, polypeptides / light and heavy chains, together; | | |
| | | | **QWC** – statements linking structure and function for variable region and one other region | 1 | **AWARD** if one mark from 2 to 4 and one mark from 5 to 7 are given<br><br>**Examiner's Comments**<br><br>This extended answer question produced responses that varied widely in standard. The simplest and commonest mark to gain was for the hinge region allowing flexibility. Most candidates knew that there were variable and constant regions but their answers showed a lack of accurate knowledge in many. Of the two, the constant region was more commonly described correctly as for binding to phagocytes, although ‘white blood cells’ was sometimes seen from those who, presumably, couldn’t remember whether it was phagocytes or lymphocytes. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | | | | The variable region was poorly understood by many. Some thought it had an active site and many went on further to describe its shape as complementary to an antigen but stopped short of stating it bound to the antigen and so failed to get a mark. Others described it as the region for binding to pathogens, without mention of antigen and, again, no mark. Descriptions of specificity often fell short of the clarity required to be awarded a mark and, while candidates often mentioned binding to more than one antigen, they rarely attributed this ability to there being two variable regions. Reference to 4 polypeptide chains was more common than 2 light and 2 heavy chains. Disulphide bonds were often described but some candidates failed to state that they held polypeptides together. If drawn, diagrams were often inaccurate or lacking labels and so were rarely credited with marks for points not made in the text. Attempts were made by a significant number of candidates to reproduce a diagram from a popular text book. This diagram is unnecessarily complicated and teachers could use a simpler straight-sided Y shape.<br><br>A minority of candidates seemed to think that an antibody was a type of white blood cell, usually a phagocyte. |
| | b | | *neutralisation*<br>**N1** cover / block, binding site / antigen / receptor site (on pathogen);<br><br>**N2** bind to toxins;<br><br>**N3** prevent, binding / entry, to (host) cell; | 4 | If neutralisation is correctly described but labelled agglutination, **DO NOT CREDIT** the first mark but apply **ECF** thereafter **IGNORE** references to parts of antibody, e.g. variable / constant<br><br>**N1 IGNORE** binds<br><br>**N3 IGNORE** prevent pathogen reproduction<br>**N3 GNORE** 'harm / infect, host cell'<br><br>If neutralisation is correctly described but labelled agglutination, **DO NOT CREDIT** |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | | *agglutination*<br>**A1** clump / bind together, (many) pathogens;<br><br>**A2** (clump) too large to, enter (host) cell / cross membranes;<br><br>**A3** increase likelihood of being consumed by (named) phagocyte / more can be consumed by phagocyte at once; | | the first mark but apply **ECF** thereafter<br><br>**A2 IGNORE** move<br><br>**A3 IGNORE** 'white blood cell'<br>**A3 DO NOT CREDIT** lymphocyte<br>**A3 ACCEPT** eaten by phagocytes more easily<br><br>**Examiner's Comments**<br><br>Agglutination was generally better understood than neutralisation. However, many candidates just discussed antigens, or even antibodies, grouping together with no reference to pathogens. Many candidates then stated that the clump was consumed by phagocytes but without the idea that the process was made easier, or more likely. Candidates that described a clump of pathogens as a molecule were not credited.<br><br>Those candidates who gained 1 mark for neutralisation knew that something couldn't bind to or enter a host cell, but again there was a common misunderstanding about antigens, with many candidates assuming that they just existed freely rather than on the surface of the pathogen. Other candidates missed gaining the N1 mark by simply stating antibodies bind to antigens rather than the consequences of this – that they are covered and can no longer function as sites for attachment to host cells. Only a minority stated that antibodies bound to toxins; many simply stated that antibodies neutralised toxins, which did not add enough to the stem of the question. |
| | | | **Total** | **11** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 27 | a | | antigen(s);<br>specific;<br>memory;<br><br>strain;<br>mutation; | 5 | **Examiner's Comments**<br><br>This question was very well done, with most candidates getting at least 4 marks, and almost everyone getting at least 1. The commonest mistakes were 'receptor' for 'antigen', 'active for 'specific', 'phagocytes' for 'antibodies' and 'strand' or 'species' for 'strain'. |
| | b | | **1** immunity involves / bacteria do not have, lymphocytes / white blood cells / antibodies / memory cells / plasma cells / an immune system;<br><br>**2** (correct term is) resistant;<br><br>**3** bacteria are unicellular / only multicellular organisms (can) have an immune response; | 3 | **Examiner's Comments**<br><br>This question differentiated well between candidates. The vast majority of candidates knew that 'resistant' was the correct term. A few mentioned resistant, but were not awarded the mark because they went on to state that resistance was a form of partial or temporary immunity. Around half of candidates knew that immunity involved an immune response and were able to give enough detail to get a mark. Very few candidates referenced the fact that, in order to have an immune system, an organism needs to be multicellular. |
| | | | **Total** | **8** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 28 | | i | *increased blood pressure*<br>**B1** (small) blood vessels / capillaries, burst / break;<br><br>**B2** bleeding causes (localised) build up of pressure (leading to cell death)<br>**or**<br>blood / oxygen, supply, reduced / stopped;<br><br>**B3** cells cannot <u>respire</u> (leading to cell death);<br><br>*thrombosis*<br>**T1** thrombus / clot, interrupts / reduces, blood flow;<br>**T2** (cells) deprived of, oxygen / glucose;<br><br>**T3** cells cannot <u>respire</u> (leading to cell death); | 4 max | **B1 CREDIT** haemorrhage / aneurism / arterioles / arteries<br>**B1 IGNORE** veins / venules<br>**B1 IGNORE** destroys / damages blood vessels<br>**B2** e.g. bleeding leads to cell compression<br><br>**B2 ACCEPT** brain deprived of, oxygen / glucose<br><br>**B3 DO NOT ACCEPT** <u>respire</u> less<br><br>'Clot results in less oxygenated blood to cells' = **T1** and **T2**<br><br>**T2 ACCEPT** brain deprived of, oxygen / glucose<br>**T3 DO NOT ACCEPT** <u>respire</u> less<br><br>**Examiner's Comments**<br><br>This question was generally well answered by candidates, with the effects of thrombosis being best understood. A number of candidates did not link high blood pressure to a burst blood vessel in the brain, yet some of these were still able to gain marks by discussing atherosclerosis. Candidates most often lost marks by not including each logical step in their explanations (e.g. for thrombosis: blood clot – lack of blood flow – lack of oxygen – no respiration). Thrombosis (a process) was also incorrectly substituted for a thrombus / clot (a noun). Unusually in this question candidates could state the same things in both parts of the question and get maximum marks. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
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| | | ii | *idea that* (if the stroke has been caused by a bleed) then the drug will, increase the bleeding / be ineffective as a treatment (to prevent bleeding); | 1 | e.g. 'the drug makes the problem worse'<br><br>**DO NOT CREDIT** 'not effective in reduction of blood pressure'<br><br>**Examiner's Comments**<br><br>Few candidates were able to explain that the drug for counteracting thrombosis would increase bleeding or would be ineffective in treating the cause of the stroke. Many confused answers were seen describing the drug thinning the blood, with this being linked to an increase in blood pressure. |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| | | iii | *idea of* disruption of, oxygen / glucose, supply (to brain cells) for <u>aerobic respiration</u>;<br><br>*lack of oxygen / glucose / blood / damage to*<br><br><u>cerebellum</u> resulting in problems with coordination / movement;<br><br><u>cerebrum</u> / <u>cerebral</u> <u>hemisphere(s)</u> / <u>cerebral</u> <u>cortex</u>, resulting in loss of, memory / speech;<br><br><u>medulla</u> (oblongata) / <u>cerebrum</u> / <u>cerebellum</u>, resulting in paralysis (of body below the neck); | 4 | **Can be awarded at any point in the answer**.<br><br>**Effect must be correctly linked to the part of the brain responsible.**<br><br>**ACCEPT** Broca's / Wernicke's, area / hippocampus<br><br>**ACCEPT** cerebral hemisphere(s) / cerebral cortex / corpus callosum<br><br>**Examiner's Comments**<br><br>Many candidates were able to correctly describe the functions of different parts of the brain and understand the consequence of damage to each of these areas. However, several candidates simply stated these functions, and struggled to write an answer that was in the correct context. Cerebrum and cerebellum were sometimes confused. Both candidates and teachers need to focus their study of the brain on those anatomical structures named in the OCR specification. Attempts at detailed answers sometimes achieved no marks as smaller structures were named (e.g. frontal lobe, association area) with no link to the correct named parts. By far the majority of candidates focussed their answers on named parts of the brain and did not give the overview required by marking point 1. |
| | | | **Total** | **9** | |
| 29 | | | C ☐ | 1 | |
| | | | **Total** | **1** | |
| 30 | | | D ☐ | 1 | |
| | | | **Total** | **1** | |

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| Question | | | Answer/Indicative content | Marks | Guidance |
|---|---|---|---|---|---|
| 31 | | | B □ | 1 | |
| | | | **Total** | **1** | |
| 32 | a | | opsonins □<br><br>phagosome □<br><br>lysosomes □ | 3 | |
| | b | i | *A because*<br>nuclei (of white blood cells) are lobed □ | 1 | Mark is for the explanation |
| | | ii | (x) 1300 □□ | 2 | If answer is incorrect **ALLOW** 1 mark for evidence of 0.02 (m) / 0.000015 (m) or equivalent numbers in alternate units |
| | | | **Total** | **6** | |

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