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Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Thursday 4 June 2020

Morning (Time: 1 hour 45 minutes) | Paper Reference **WBI14/01**

Biology

International Advanced Subsidiary / Advanced Level
Unit 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- **Show all your working in calculations and include units where appropriate.**

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

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Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Chloroplasts are involved in both the light-dependent reactions and light-independent reactions of photosynthesis.

(a) Which row of the table shows where the light-dependent reactions and light-independent reactions take place?

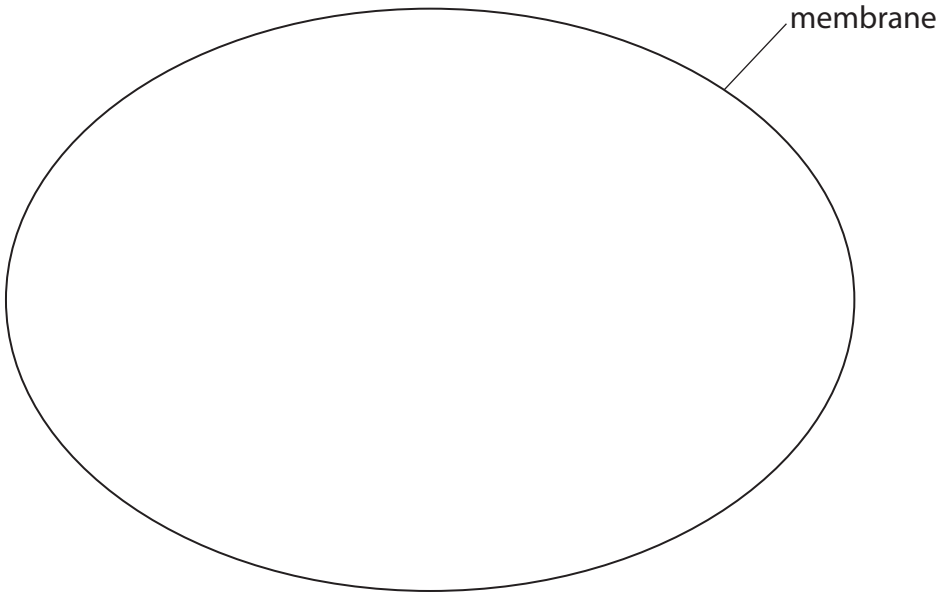
(1)

		Light-dependent reactions	Light-independent reactions
☒	**A**	stroma	stroma
☒	**B**	stroma	thylakoid membranes
☒	**C**	thylakoid membranes	stroma
☒	**D**	thylakoid membranes	thylakoid membranes

(b) The diagram shows the outline of a chloroplast.

Draw **three** labelled features on this diagram that are found in a chloroplast, other than the stroma and the thylakoid membranes.

(3)



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(c) An absorption spectrum shows how much light is absorbed by chloroplasts at different wavelengths of light.

The table shows the colour of light at four wavelengths.

Wavelength of light / nm	460	520	600	680
Colour of light	blue	green	yellow	red

Which wavelength of light is absorbed the **least** by chloroplasts?

(1)

☒ **A** 460 nm

☒ **B** 520 nm

☒ **C** 600 nm

☒ **D** 680 nm

(d) State what is meant by the term **action spectrum**.

(1)

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(e) Chloroplast pigments can be separated and then identified by their Rf values.

(i) Which process can be used to separate chloroplast pigments?

(1)

☒ **A** chromatography

☒ **B** dendrochronology

☒ **C** osmosis

☒ **D** PCR

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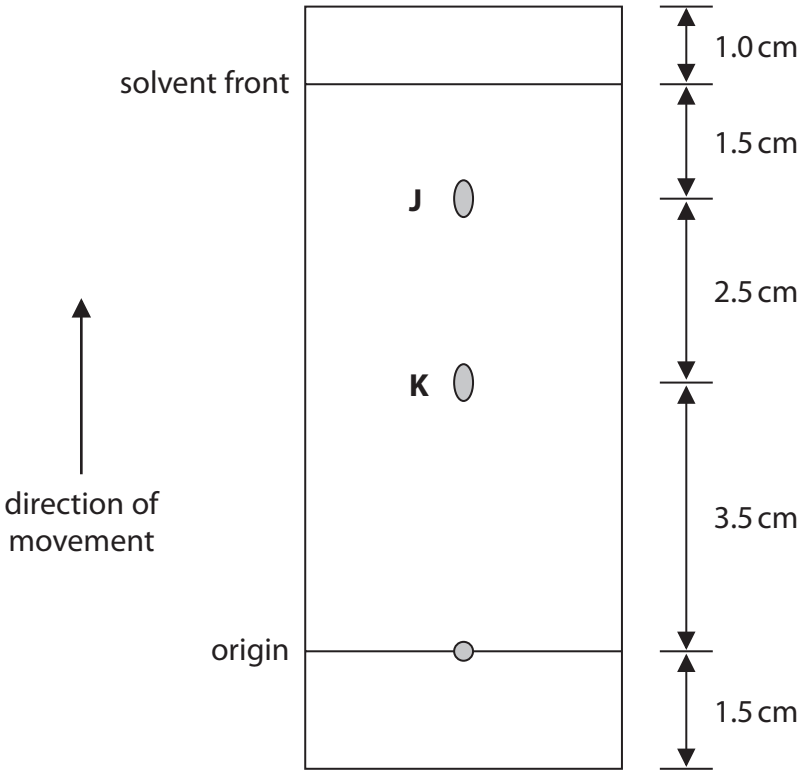
(ii) The diagram shows separated chloroplast pigments, **J** and **K**.



What is the Rf value for chloroplast pigment **J**?

(1)

- ☒ **A** 0.625
- ☒ **B** 0.800
- ☒ **C** 0.830
- ☒ **D** 1.714

(Total for Question 1 = 8 marks)

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2 Body temperature and the degree of muscle contraction can be used to determine the time since death of a person.

The table shows how body temperature and body stiffness, due to muscle contraction, change with time since death.

Time since death / hours	Body temperature	Body stiffness
< 3	warm	not stiff
3 to 8	warm	stiff
8 to 36	cold	stiff
> 36	cold	not stiff

(a) State how the temperature of a dead body should be measured.

(1)

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.....

(b) (i) Body temperature can be used to estimate the time since death using the following information:

- loss of 0.78 °C per hour for the first 12 hours after death
- after 12 hours, loss of 0.4 °C per hour.

Estimate the time since death of a person whose body temperature had fallen 11.5 °C.

Give your answer to the nearest hour.

(2)

Answer ..... hours

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(ii) Explain why this estimate would be different if the body had been left in a colder place.

(2)

(c) Explain why using body stiffness only, as shown in the table, is insufficient to estimate the time since death accurately.

(3)

(Total for Question 2 = 8 marks)

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3 The following equation summarises photosynthesis.

$$6CO_2 + 6H_2O \longrightarrow C_6H_{12}O_6 + 6O_2$$

The diagrams show the bonds in carbon dioxide, water and oxygen.

carbon dioxide	water	oxygen
O═C═O	H—O—H	O═O

Energy is needed to break chemical bonds, and to form new chemical bonds. This is called the bond energy.

The table shows some bond energies for the bonds in carbon dioxide, water, glucose and oxygen.

Type of bond	Bond energy / kJ per bond
C═O	785
O—H	462
O═O	487

(a) (i) In photolysis, one of the bonds in each water molecule is broken.

Using the equation for photosynthesis, calculate how much energy is released by photolysis in order for one molecule of glucose to be made.

(1)

Answer ..... kJ

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(ii) Explain how light energy is converted into chemical energy in the form of ATP.

(4)

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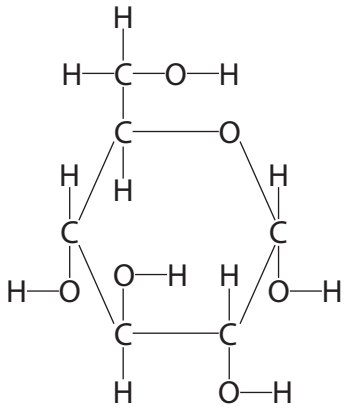
(b) The diagram shows the structure of glucose.



The energy needed to form the bonds in one molecule of glucose is 9164 kJ.

(i) State what other information is needed in the table of bond energies for this value to be calculated.

(1)

.....

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.....

(ii) Where in the chloroplasts are these bonds formed?

(1)

☒ **A** cytoplasm

☒ **B** matrix

☒ **C** stroma

☒ **D** thylakoid membrane

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(c) Glucose is used by plants in the production of amino acids.

(i) Which row of the table describes how two amino acids join together?

(1)

	Bond formed between	Type of reaction
☒ **A**	carbon and nitrogen	condensation
☒ **B**	carbon and nitrogen	hydrolysis
☒ **C**	oxygen and nitrogen	condensation
☒ **D**	oxygen and nitrogen	hydrolysis

(ii) Explain why amino acids cannot be produced from glucose alone.

(2)

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(Total for Question 3 = 10 marks)

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4 Rheumatoid arthritis is an inflammatory condition caused by the overactivity of the immune system.

(a) The photographs show the hand of a person with rheumatoid arthritis and the hand of a person without rheumatoid arthritis.





(Source: © Mediscan/Alamy Stock Photo)

Hand with rheumatoid arthritis

Magnification × 0.2

Hand without rheumatoid arthritis

Magnification × 0.2

(i) Give **one** piece of evidence, shown in the photographs, that rheumatoid arthritis is an inflammatory condition.

(1)

.....

.....

(ii) Give **two other** signs of inflammation that are experienced in the hand of a person with rheumatoid arthritis.

(1)

.....

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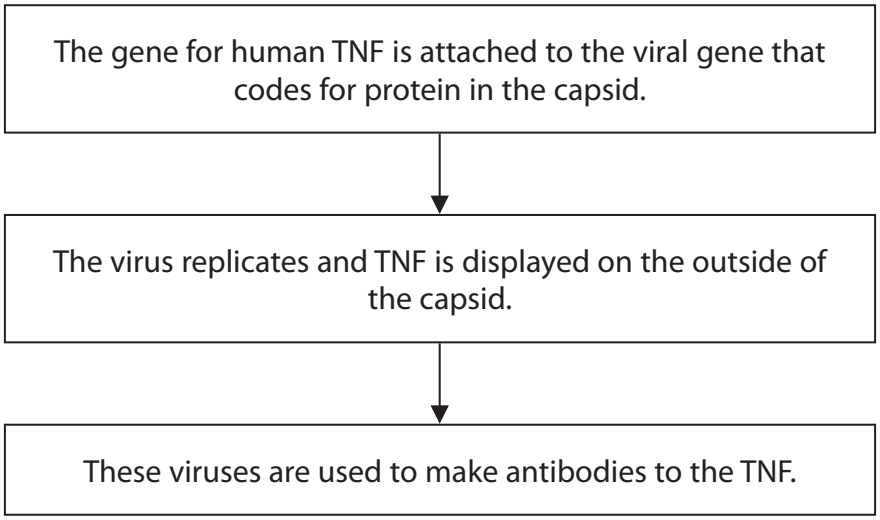
(b) Tumour necrosis factor (TNF) is a protein that can be released by several types of cell. It plays an important part in the immune response.

This protein binds to specific receptors on the surface of cell membranes stimulating chemical reactions inside the cell. As a result, a number of responses may occur that include inflammation and the stimulation of phagocytosis by macrophages.

Antibodies to TNF are used to treat rheumatoid arthritis.

Scientists have used a virus that infects bacteria to produce antibodies to human TNF.

The diagram summarises this process.



(i) Explain how attaching the gene for TNF to the viral gene results in TNF being displayed on the outside of the capsid.

(2)

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(ii) Explain why antibodies to TNF are used in the treatment of rheumatoid arthritis.

(2)

(iii) Patients being treated with antibodies to TNF are more susceptible to tuberculosis (TB), which can be fatal.

Explain why patients being treated with antibodies to TNF can die from TB.

(4)

(Total for Question 4 = 10 marks)

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5 Viruses can infect bacteria.

(a) Which virus can infect bacteria?

(1)

☒ **A** Ebola virus

☒ **B** human immunodeficiency virus (HIV)

☒ **C** lambda phage (λ phage)

☒ **D** tobacco mosaic virus (TMV)

(b) Some viruses that infect bacteria cause the production of molecules called holins.

Holins form protein channels in the cell membranes of bacteria. This allows polar molecules called lysins to reach the cell wall by facilitated diffusion.

The DNA of these viruses codes for lysins.

(i) Describe the role of channel proteins in the facilitated diffusion of lysins.

(2)

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(ii) Explain how the primary structure and the tertiary structure of holins determine the properties of these channel proteins.

(3)

(iii) Lysins break down the cell wall of bacteria.

Explain the role of lysins in the lytic cycle.

(2)

(Total for Question 5 = 8 marks)

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6 The photograph shows a ground squirrel.



(Source: Caroline Wilcox)

magnification × 0.5

Ground squirrels feed on a variety of foods including nuts.

Ground squirrels have evolved food pouches.

The photograph shows the food pouches of a ground squirrel.



(Source: © All Canada Photos/Alamy Stock Photo)

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The table shows some information about three types of nut: acorns, hazelnuts and walnuts.

Type of nut	Photograph	Description	Energy content / kJ per 100 g
acorn		1.0 to 3.0 cm long 0.8 to 2.0 cm wide	1619
hazelnut		1.5 to 2.5 cm long 1.0 to 1.5 cm wide hard covering	2788
walnut		3.0 to 5.0 cm long 2.0 to 4.0 cm wide hard shell	2822

(Source: © Science photo library, Source: © Jon Stokes/Science photo library, Source: © Science photo library)

(a) The volume of the smallest walnut is approximately 50 cm^3.

Calculate the approximate volume of the largest hazelnut, using the formula

$$\text{volume} = \frac{4}{3}\pi l w^2$$

where $\pi = 3$, l = length of the hazelnut and w = width of the hazelnut.

(1)

Answer ..... cm^3

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(b) A student investigated the feeding preferences of ground squirrels.

(i) Design a laboratory investigation to find out which of these three types of nut ground squirrels prefer to eat.

(3)

(ii) Predict the results of this investigation, giving reasons.

Use the information in the table to support your answer.

(3)

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(c) Suggest how ground squirrels evolved pouches.

(3)

(Total for Question 6 = 10 marks)

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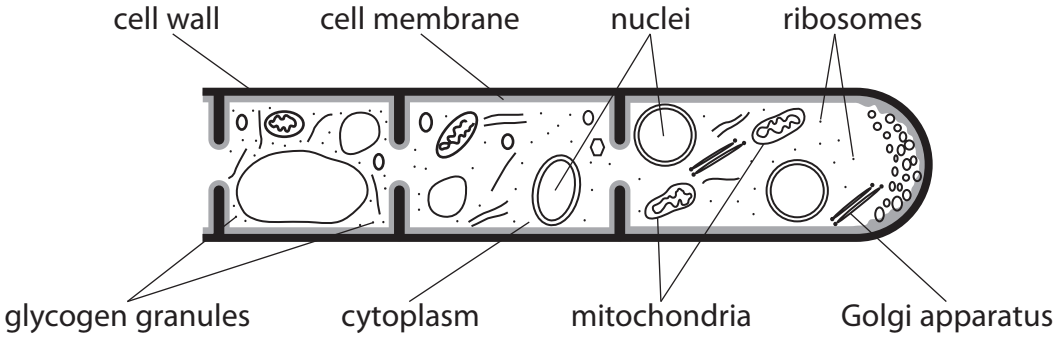
7 Bacteria and fungi can both cause infections.

(a) The diagram shows part of the structure of a fungus.



(i) How many of the organelles labelled in this diagram have membranes?

(1)

- ☒ **A** 1
- ☒ **B** 3
- ☒ **C** 5
- ☒ **D** 7

(ii) Explain why fungi are not classified as bacteria, plants or animals.

Use the information in the diagram and your knowledge of cell structure to support your answer.

(3)

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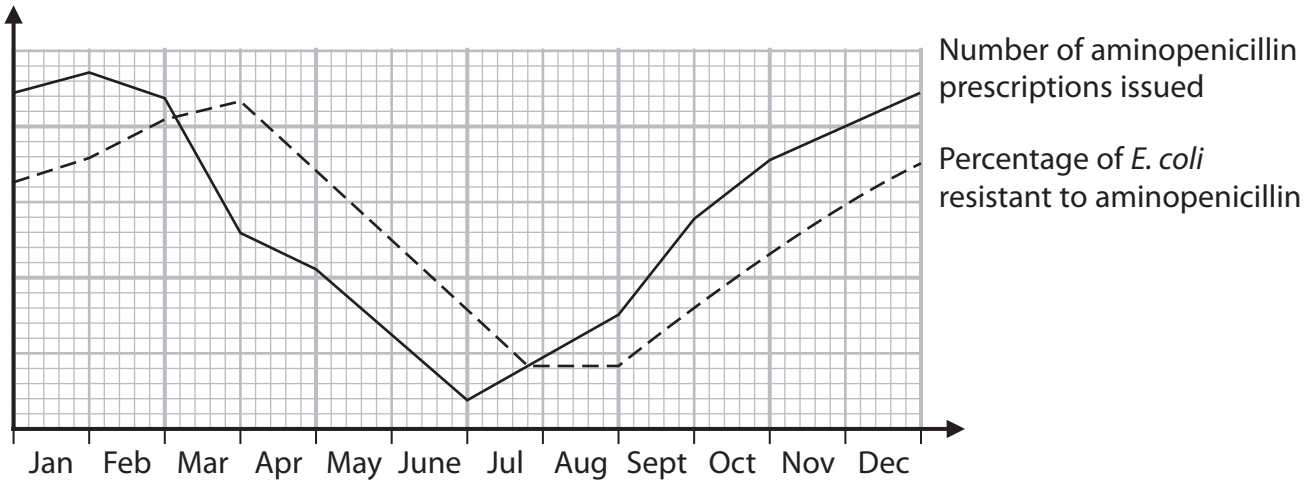
(b) The graph shows the number of prescriptions of the antibiotic, aminopenicillin, issued in one year.

The graph also shows the percentage of *E. coli* bacteria that were resistant to aminopenicillin during the same year.



Explain the relationship between the number of aminopenicillin prescriptions issued and the percentage of *E. coli* resistant to aminopenicillin during this one-year period.

Use the information in the graph to support your answer.

(4)

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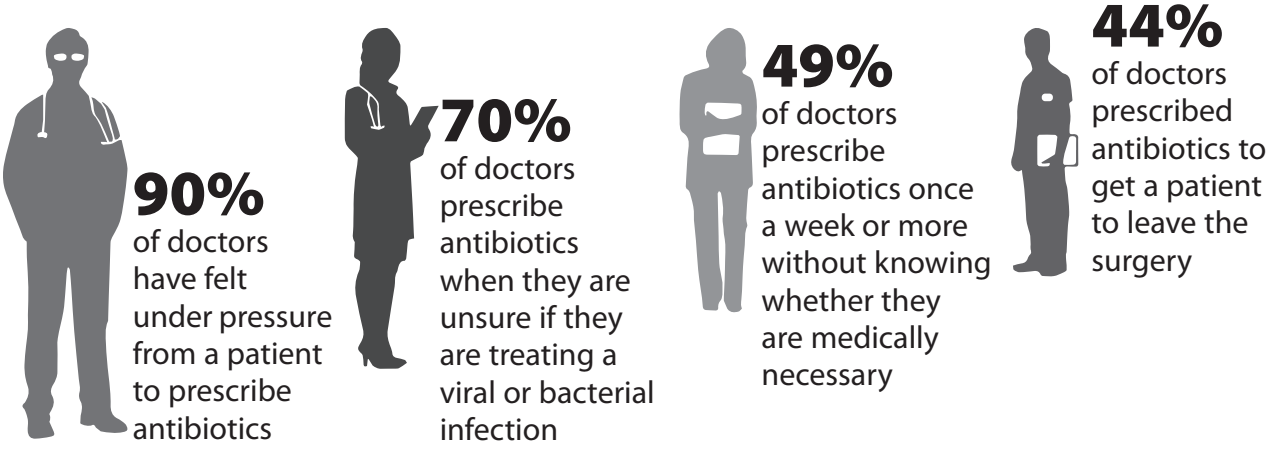
(c) The results of a survey are shown in the diagram.



Explain why the results of this survey are a cause for concern.

(3)

(Total for Question 7 = 11 marks)

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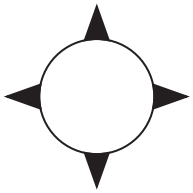
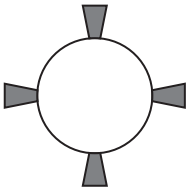
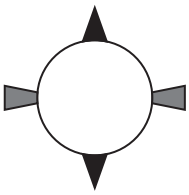
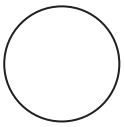
8 Humans can have one of four different blood types: A, B, AB or O.

Blood type is determined by antigens present on the membranes of red blood cells.

The table shows which antigens are present in each blood type.

Blood type	Antigens on the membrane of red blood cells	Diagram of one red blood cell
A	antigen A only	
B	antigen B only	
AB	both antigens A and B	
O	neither antigen A nor B	

Blood transfusions are used in the treatment of some diseases.

A blood transfusion involves taking blood from a healthy person and putting it into the person needing the treatment.

(a) (i) Which blood type can be used for all blood transfusions?

(1)

- ☒ **A** blood type A
- ☒ **B** blood type B
- ☒ **C** blood type AB
- ☒ **D** blood type O

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(ii) Explain what will happen if a person with blood type A is given a transfusion of blood type AB.

(4)

(b) Bacteria live in our intestines (gut flora).

The membranes of cells lining our intestines have molecules similar to the antigens on red blood cells.

(i) Explain why bacteria living in our intestines are important.

(2)

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(ii) Both the molecules on the membranes of the cells lining our intestines and the antigens on red blood cells have sugars attached to protein molecules.

Bacteria living in our intestines secrete an enzyme that separates the sugars from the protein molecules.

Suggest why bacteria living in our intestines secrete this enzyme.

(2)

(iii) Explain why this enzyme may be useful in blood transfusions.

(2)

(Total for Question 8 = 11 marks)

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9 The photograph shows a moose.

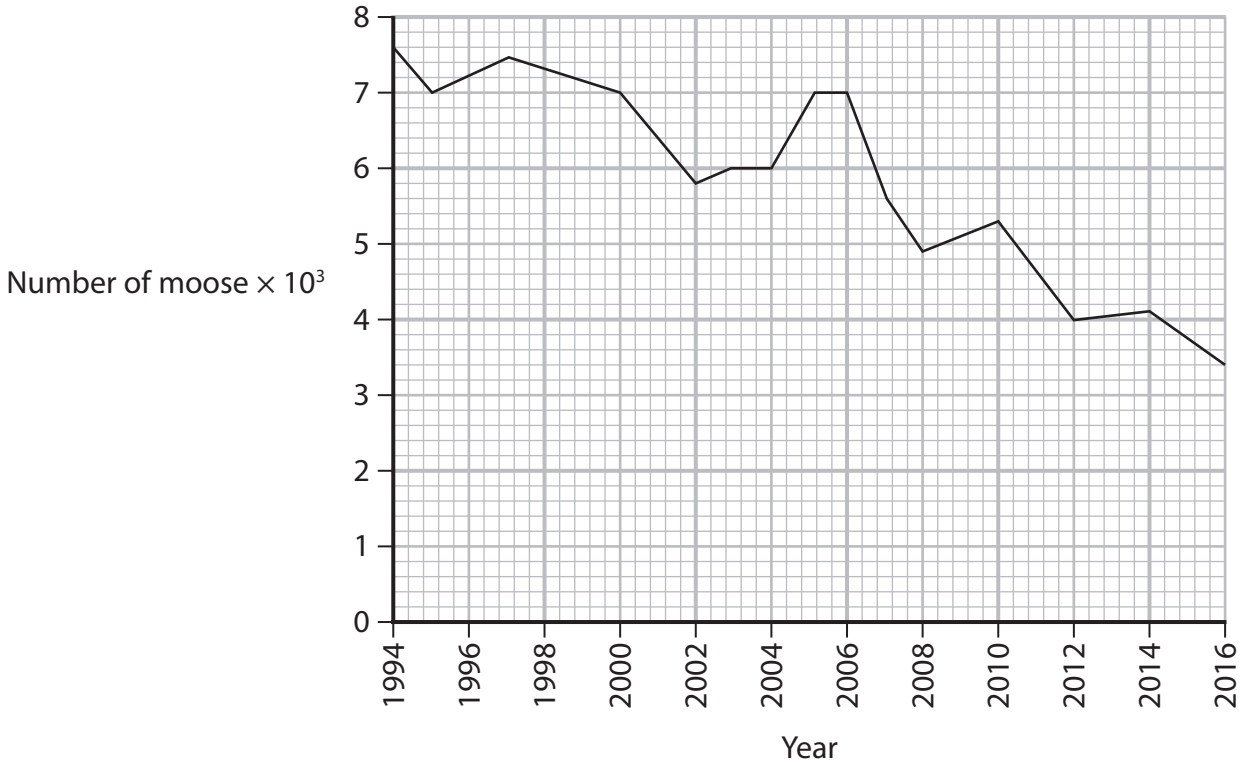


(Source: © blickwinkel/Alamy Stock Photo)

Moose are large mammals that eat grass and the shoots of plants.

The number of moose is declining in parts of America.

(a) The graph shows the number of moose in one part of America from 1994 to 2016.



(i) In 2016, the moose were not counted. The value shown on the graph is an estimate.

Describe how these data were used to estimate the number of moose in 2016.

(1)

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(ii) Calculate the percentage decrease in the number of moose from 1994 to 2016.

(2)

Answer ..... %

(iii) It has been suggested that global warming is responsible for the decrease in the number of moose from 1994 to 2016.

Sketch a graph to show this relationship.

(3)



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(b) Ticks are parasites that live in the fur of moose.

Ticks are thought to be responsible for the decline in the number of moose.

The table shows the frequency distribution of ticks in a population of moose.

Number of ticks	Number of moose
1 to 9 999	32
10 000 to 19 999	46
20 000 to 29 999	41
30 000 to 39 999	32
40 000 to 49 999	22
50 000 to 59 999	15
60 000 to 69 000	9
70 000 to 79 999	4
80 000 to 89 999	4
90 000 to 99 999	3
100 000 or more	6

(i) Calculate the percentage of moose that have 50 000 or more ticks on their bodies.

(2)

Answer ..... %

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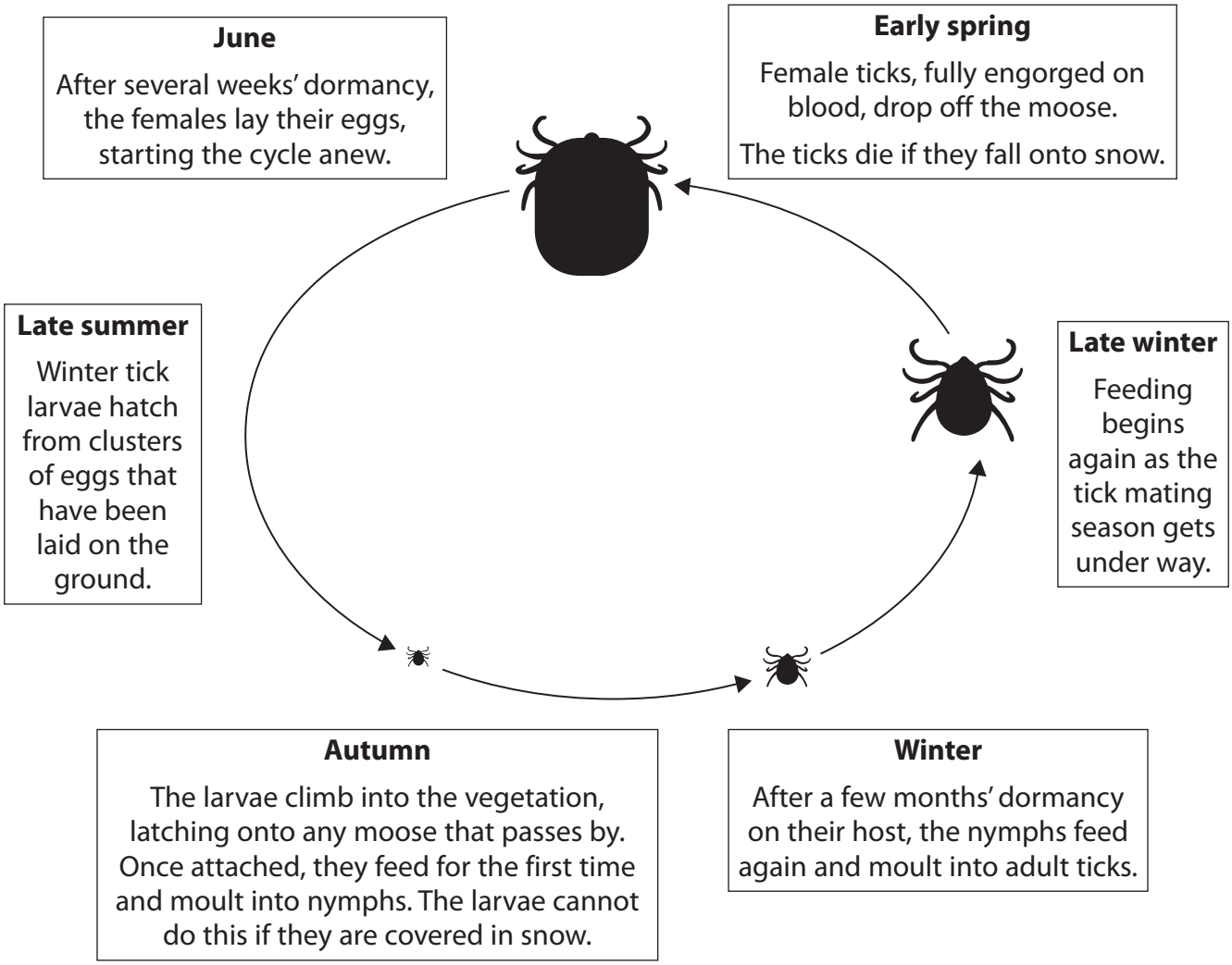
*(ii) The diagram shows the life cycle of the tick.



The ticks feed on the blood of the moose. One tick can remove 200 to 600 times its body mass.

The ticks irritate the moose. The moose will scratch against trees causing large clumps of fur to fall off.

Explain how global warming might affect the life cycle of ticks and result in the decline in the number of moose.

Use all the information in the question to support your answer.

(6)

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