PEARSON EDEXCEL IAL BIOLOGY · YBI11

BIOLOGY



EXAM QUESTION PACK

UNIT 4: MICROBIOLOGY, IMMUNITY AND FORENSICS

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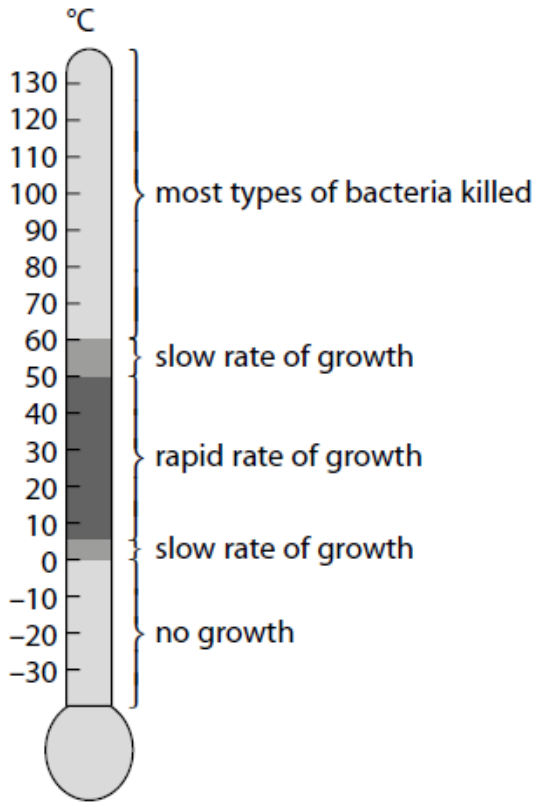
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Q1.

Temperature affects the rate of growth of bacteria.

The diagram shows some information about the growth of bacteria in different ranges of temperature.



(a) Explain why most types of bacteria are killed at temperatures above 60 °C, but bacteria can grow slowly in a temperature range of 50 °C to 60 °C.

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(b) (i) The growth rate constant will be at its highest in the temperature range of 5 °C to 50 °C.

Calculate the growth rate constant (k) of bacteria that have increased from 5×10^3 cells per cm^3 to 1.3×10^5 cells per cm^3 in 4 hours.

(3)

$$k = \frac{\log_{10} N_t - \log_{10} N_0}{0.301 \times t}$$

Answer .....

(ii) The formula used to calculate the growth rate constant can only be applied to one phase of bacterial growth.

To which phase of bacterial growth can the formula be applied?

(1)

☒ **A** death

☒ **B** exponential

☒ **C** lag

☒ **D** stationary

(c) (i) Explain why some foods are kept in refrigerators at a temperature between 0 °C and 5 °C.

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(ii) Explain why there is no growth of bacteria in a freezer at a temperature of −18 °C.

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(Total for question = 13 marks)

Q2.

Human serum albumin is a globular protein found in blood plasma.

Albumin has a molecular mass of 66 300 daltons.

It consists of 585 amino acids.

At pH 7.4 albumin has over 200 negative charges on the surface of each molecule.

(a) (i) Calculate the mean molecular mass of an amino acid in albumin.

Give your answer to an appropriate number of significant figures.

(1)

Answer ..... daltons

(ii) Explain why albumin is soluble in blood plasma.

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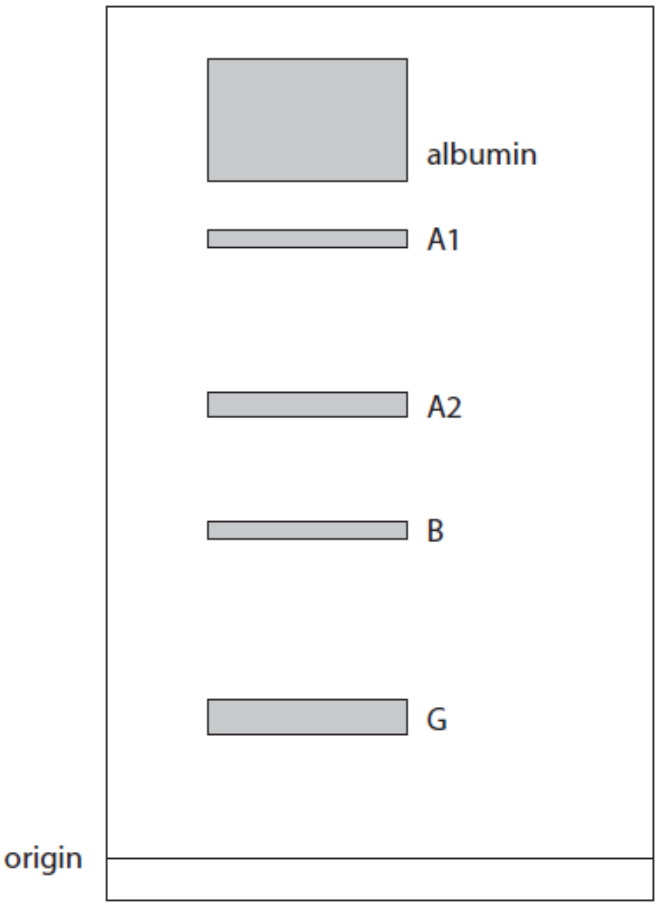
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(b) Albumin can be separated from other proteins in blood plasma, A1, A2, B and G, by gel electrophoresis.

The diagram shows the banding pattern produced on separation of these proteins by gel electrophoresis.



(i) Protein G has a concentration in blood plasma in the range 0.700 g dm^{-3} to 1.700 g dm^{-3}.

Albumin has a concentration in blood plasma in the range 0.525 g dm^{-3} to 1.275 g dm^{-3}.

Calculate the maximum difference in the concentration of these two proteins.

(1)

Answer ..... g dm^{-3}

(ii) Describe the conclusions that can be made about albumin, compared with the other four proteins present in blood plasma.

Use the information in the diagram to support your answer.

(3)

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(c) Albumin binds to and activates a proton channel, hHv1.

This proton channel is present in the membranes of sperm cells. When the channel is activated, sperm cells have the ability to penetrate and fertilise egg cells.

Sperm cells are released in a liquid called seminal fluid. Seminal fluid has an albumin concentration of 15 μmol dm^{-3}.

The fluid inside the uterus of the female has an albumin concentration of 500 μmol dm^{-3}.

Explain the role of albumin concentration in controlling fertilisation.

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(Total for question = 11 marks)

Q3.

Patients with cystic fibrosis may develop serious bacterial infections.

A patient with cystic fibrosis developed bacterial infections including *Mycobacterium*.

(a) (i) This patient was given a combination of antibiotics for several months.

Explain why a combination of antibiotics had to be given for several months.

(2)

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(ii) This patient did not respond to the combination of antibiotics, and later needed a lung transplant.

Suggest why this patient needed a lung transplant.

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(iii) Following the transplant, the patient was given immunosuppressive drugs.

Immunosuppressive drugs weaken the immune system. Some of these drugs work by preventing DNA synthesis in the patient.

As a result of the immunosuppressive drug treatment, the infection with *Mycobacterium* developed faster.

Explain why the infection with *Mycobacterium* developed faster when the patient was taking immunosuppressive drugs.

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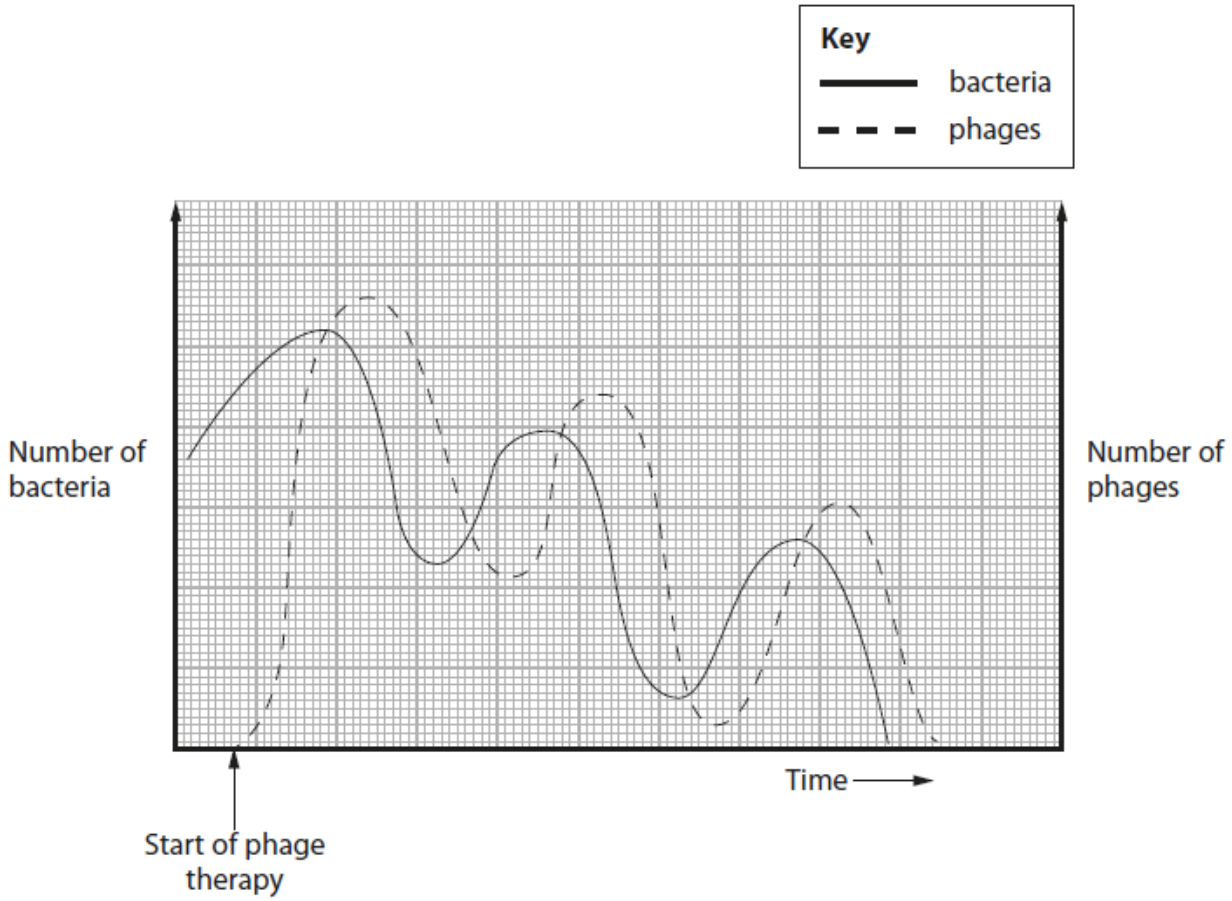
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*(b) Phage therapy was used to treat the *Mycobacterium* infection in this patient.

Phages are viruses that target bacterial cells.

The graph shows how the number of *Mycobacterium* and the number of phages changed following the start of phage therapy.



Explain the changes in the number of bacteria and phages following the start of the phage therapy.

Use the information in the graph to support your answer.

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(Total for question = 15 marks)

Q4.

Madagascar is a large island off the southeast coast of mainland Africa.

Lemurs are endemic to Madagascar.

(a) There are many different species of lemur, all of which evolved from one common ancestor.

This common ancestor is thought to be a primate that was carried across the sea from mainland Africa on a raft of vegetation.

The photographs show two different species of lemur, Sifaka and Indri, found in the same region of Madagascar.



Sifaka



Indri

The diet of Sifakas is mostly seeds but also includes fruits, flowers and some types of leaves. The diet of Indri is mainly leaves.

Explain the types of speciation that have taken place in the evolution of Sifakas and Indri in this region of Madagascar.

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(b) Lemurs have been found on another island close to Madagascar.

Scientists have used DNA profiling to show that these lemurs originated from those on Madagascar.

(i) Explain the role of the polymerase chain reaction (PCR) in DNA profiling.

(2)

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(ii) Explain how DNA profiling could show that these lemurs originated from the lemurs on Madagascar.

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(Total for question = 8 marks)

Q5.

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

The time of death of a person can be estimated in a number of ways.

(a) The time of death can be estimated using the length of insect larvae.

What is the name of the method that uses insect larvae to estimate the time of death?

(1)

☒ **A** dendrochronology

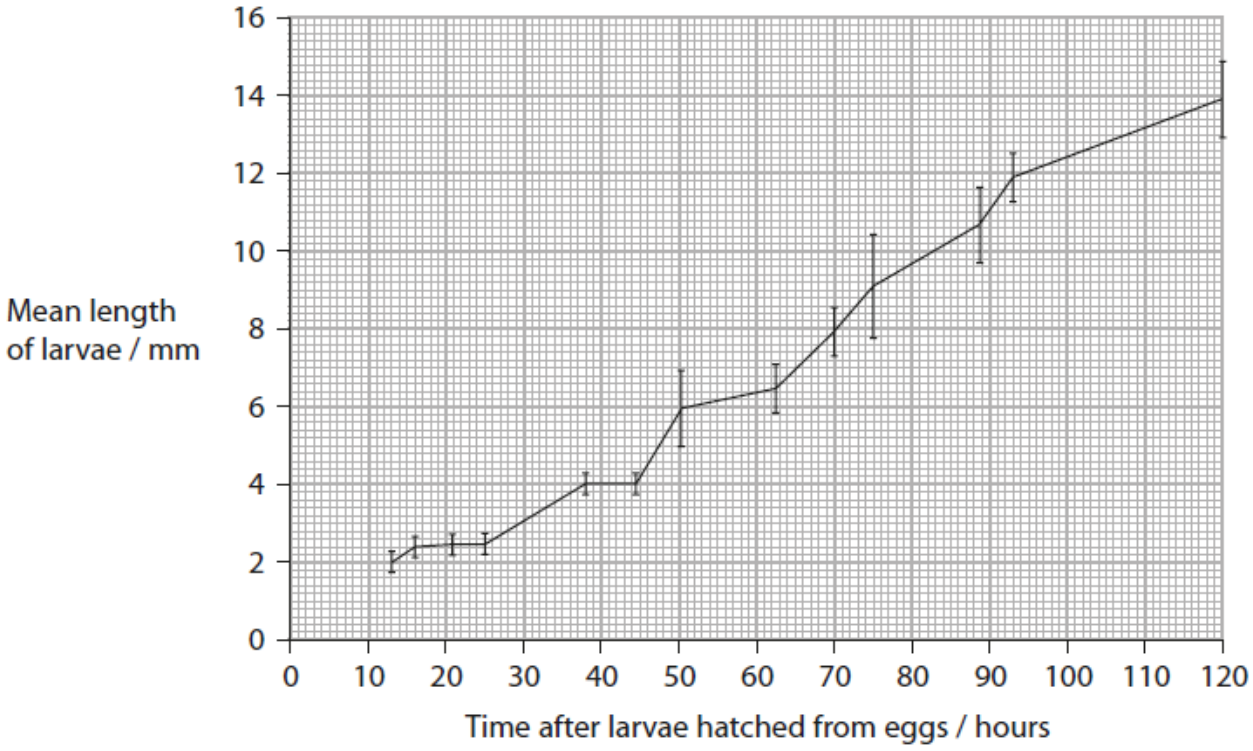
☒ **B** epigenetics

☒ **C** forensic entomology

☒ **D** species diversity

(b) The larvae of one species of blowfly can be used to estimate the time of death.

The graph shows the mean length of larvae from this species incubated at 10.62 °C.



(i) Calculate the mean growth rate of these larvae from 25 to 120 hours.

Include the units with your answer.

(2)

Answer. .....

(ii) Comment on the suitability of using this data to estimate the time of death.

Use the information in the graph to support your answer.

(3)

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(iii) Describe how the data shown in this graph could have been collected.

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(c) The time of death can be estimated using the body temperature of the corpse.

Evaluate the use of the body temperature of a corpse to estimate the time of death.

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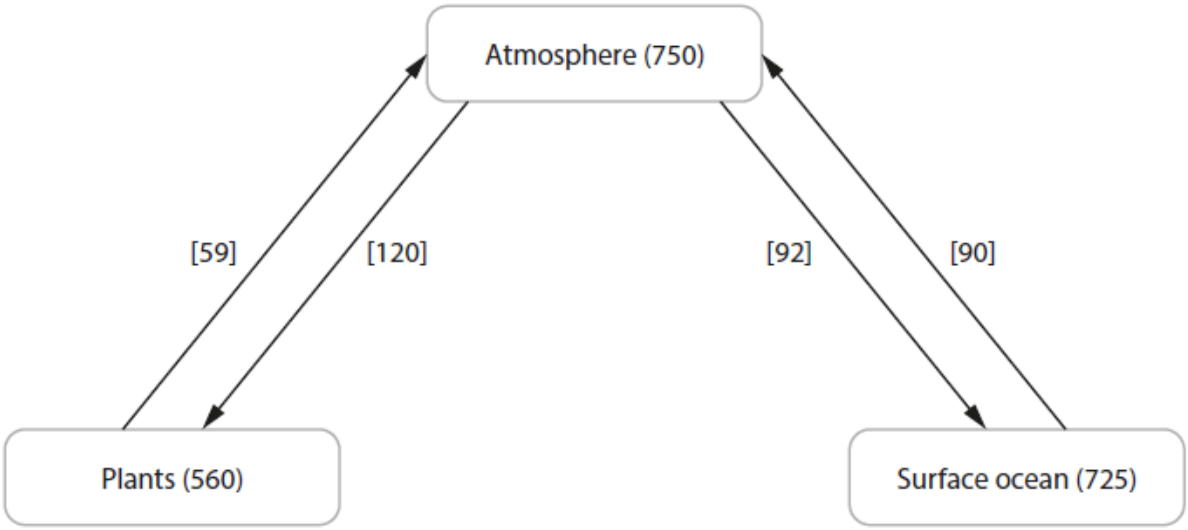
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Q6.

The diagram shows part of the carbon cycle.



Key

The numbers in smooth brackets ( ) show the mass of carbon in petagrams found in either the atmosphere, plants or surface ocean.

The numbers in square brackets [ ] show the mass of carbon in petagrams transferred between the atmosphere and the plants or surface ocean per year.

A petagram is equal to 10^{15} grams.

(a) Carbon is found in carbohydrates.

The table shows some carbohydrates that may be found in plants and animals.

For each carbohydrate, put **one** cross ☒ in the appropriate box, in each row, to show where these carbohydrates are produced.

(4)

Carbohydrate	Carbohydrate produced by			
	both plants and animals	plants but **not** animals	animals but **not** plants	neither plants nor animals
Amylose	☒	☒	☒	☒
Glucose	☒	☒	☒	☒
Glycogen	☒	☒	☒	☒
Starch	☒	☒	☒	☒

(b) The mass of carbon recycling between the atmosphere and the plants, and the atmosphere and the oceans, are roughly balanced.

(i) State how carbon is exchanged between the atmosphere and the oceans.

(1)

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(ii) Calculate the increase in the mass of carbon in plants as a result of carbon exchange between the plants and the atmosphere in one year.

Give your answer in kilograms.

(1)

Answer ..... kg

(iii) Describe how the carbon present in sugars in the plants is returned to the atmosphere in the carbon cycle.

(3)

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(c) Anthropogenic climate change is a result of an increase in the mass of carbon in the atmosphere.

(i) State what is meant by the term **anthropogenic climate change**.

(2)

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(ii) Explain **one** way in which the effects of anthropogenic climate change can be reduced.

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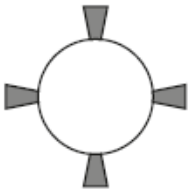
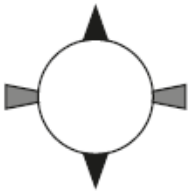
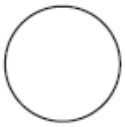
(Total for question = 13 marks)

Q7.

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

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

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(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)

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

(2)

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(Total for question = 11 marks)

Q8.

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

There are four types of immunity.

(a) Artificial immunity develops when a person is immunised by an injection.

The table gives some statements about artificial immunity.

For each statement, put **one** cross ☒ in the appropriate box, in each row, to show which statements are correct for the types of artificial immunity.

(3)

Statement	Type of artificial immunity			
	both active and passive	active only	passive only	neither active nor passive
Antibodies are injected into the person	☒	☒	☒	☒
B cells differentiate into plasma cells	☒	☒	☒	☒
Memory cells are formed	☒	☒	☒	☒

(b) Natural active immunity can develop when a person is infected with a virus.

(i) Describe the role of macrophages in the development of natural active immunity to a virus, following infection.

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(ii) Explain why both T helper cells and T killer cells are needed in the immune response to a virus.

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(Total for question = 10 marks)

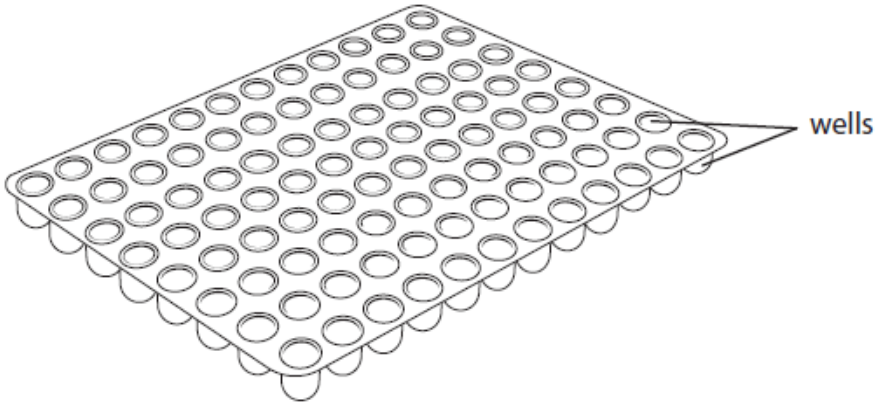
Q9.

Antimicrobial substances can be tested using a Minimum Inhibitory Concentration (MIC) assay.

This assay determines the lowest concentration of an antimicrobial substance that prevents visible growth of bacteria.

A microdilution plate is used in these assays. It is made of plastic and contains small wells that the antimicrobial substance and the bacteria can be added to.

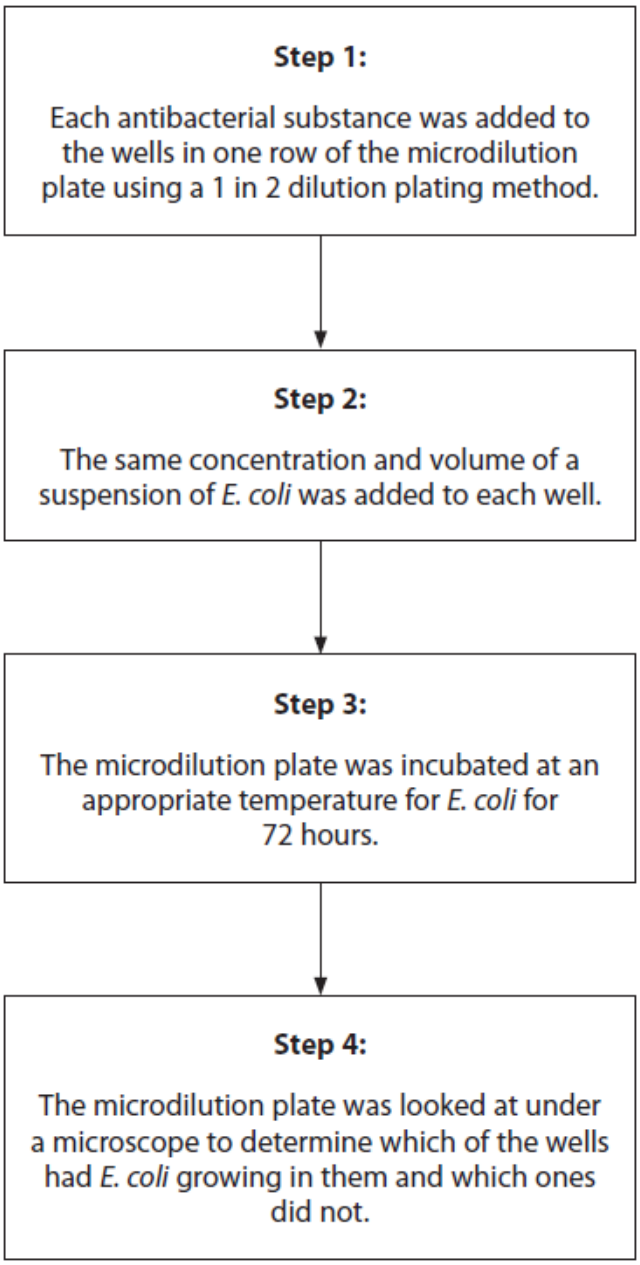
The diagram shows a microdilution plate.



An investigation tested eight antimicrobial substances on one type of bacteria, *E. coli*.

Appropriate controls were included in this investigation.

The diagram shows the steps involved.



(a) All steps in this investigation had to be carried out using aseptic technique.

(i) State the meaning of the term **aseptic technique**.

(1)

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(ii) Describe two aseptic techniques that could be used in this investigation.

(2)

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(iii) Explain why using aseptic technique in this investigation is important.

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(b) Explain why the microdilution plate had to be incubated at an appropriate temperature for *E. coli* for 72 hours.

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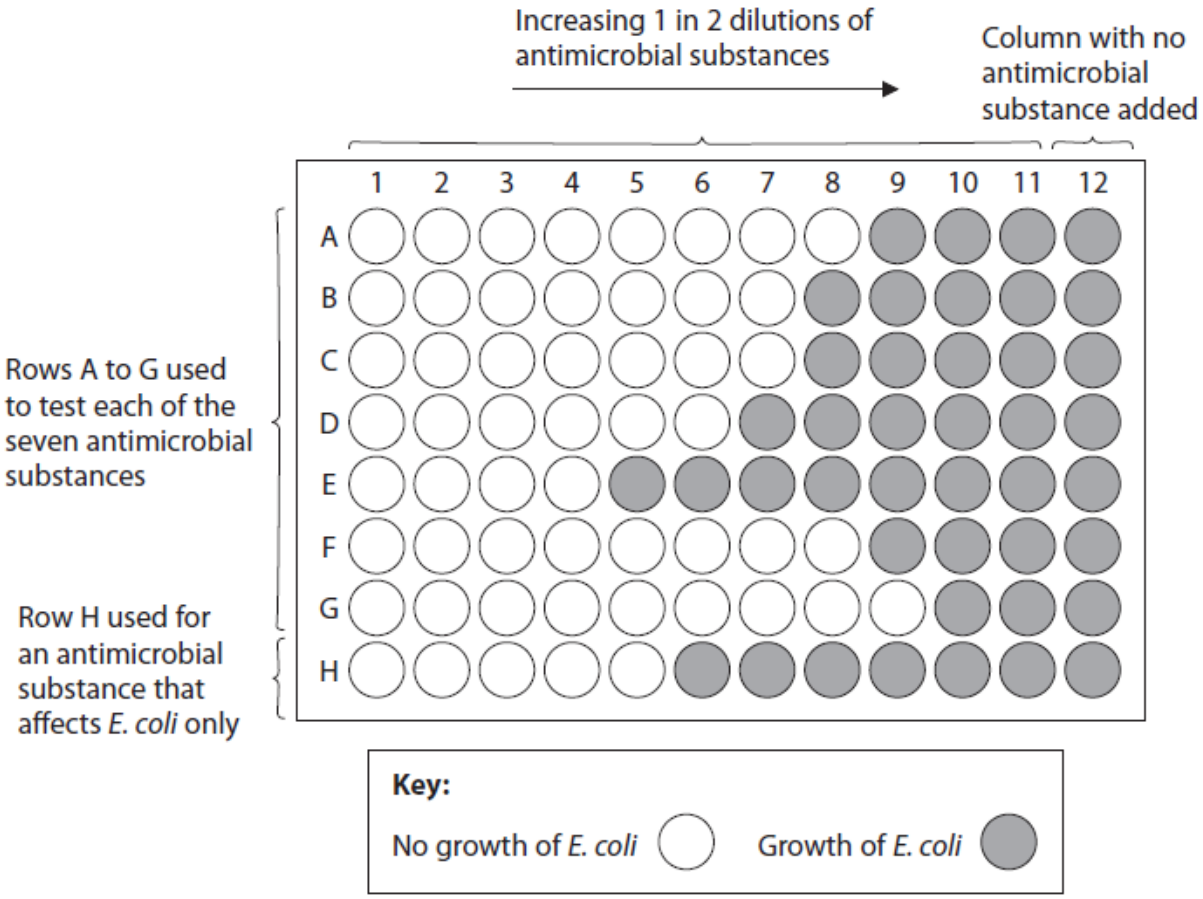
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(c) The diagram shows the results of the MIC assay from this investigation.



(i) Explain why an antimicrobial substance that affects *E. coli* only was included in this assay (row **H**).

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(ii) Explain why there was one column that had no antimicrobial substance added to it (column 12).

(2)

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(iii) The MIC for the antimicrobial substance used in row **E** was in column 4.

Describe how a 1 in 2 dilution plating method would have been carried out to achieve the dilution in this well.

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(iv) Calculate how many times more effective the antimicrobial substance used in row **G** is than the antimicrobial substance used in row **E**.

(2)

Answer .....

(Total for question = 15 marks)

Q10.

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 (☒).

A student grew a bacterial culture in a liquid medium for 20 hours.

Every hour, a sample of the culture was removed.

This sample was added to some fresh medium and mixed thoroughly.

This mixture was spread onto agar in a Petri dish, so that the number of bacteria in the culture could be determined.

(a) Which method is being used to determine the number of bacteria in this culture?

(1)

☒ **A** dilution plating

☒ **B** latency

☒ **C** mass method

☒ **D** optical method (turbidity)

(b) Explain how the Petri dish should have been sealed after the mixture was spread onto the agar.

(2)

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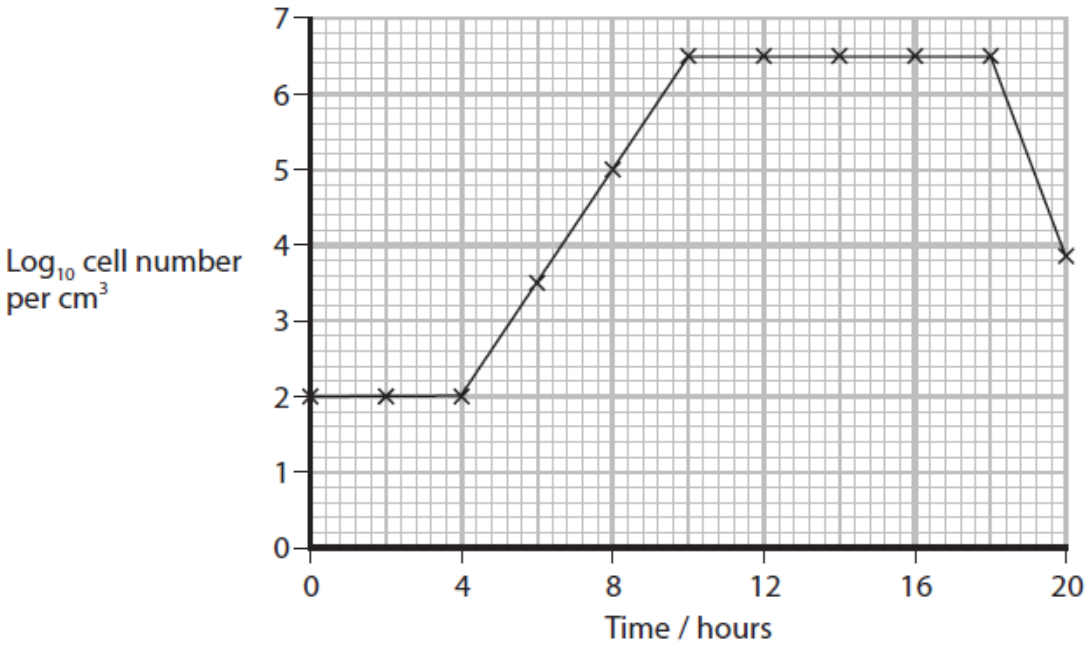
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(c) The graph shows the bacterial growth curve for this culture.



(i) Which shows the order of the phases of a bacterial growth curve?

(1)

☒ **A** exponential → lag → death → stationary

☒ **B** lag → stationary → death → exponential

☒ **C** lag → exponential → stationary → death

☒ **D** stationary → exponential → lag → death

(ii) The bacteria were not growing at their fastest rate in the conditions the student used.

How many of the following changes could result in a faster growth rate?

- decrease in pH
- decrease in temperature
- increase in pH
- increase in temperature

(1)

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

(iii) Calculate the growth rate constant (k) of these bacteria between 4 hours and 10 hours.

(2)

Use the equation: $k = \frac{\log_{10} N_t - \log_{10} N_0}{0.301 \times t}$

Give your answer to two decimal places.

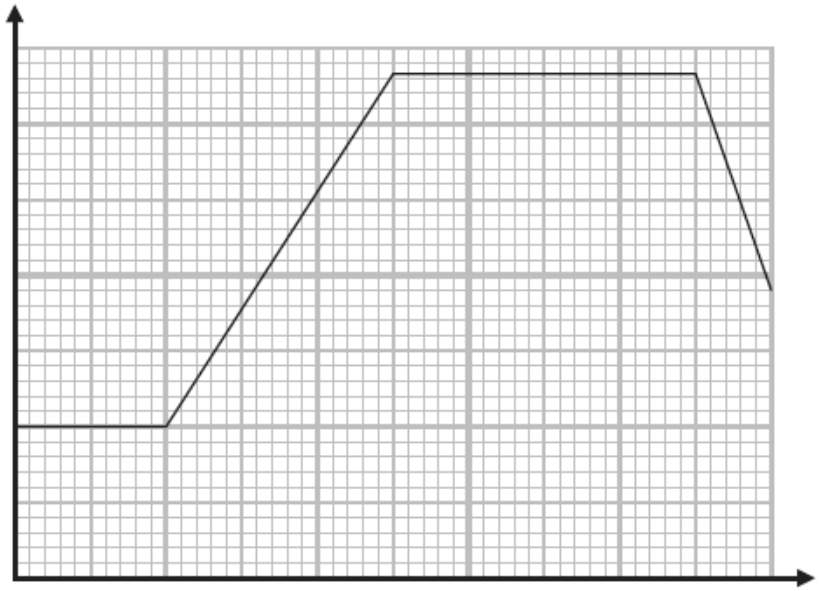
Answer .....

(Total for question = 7 marks)

Q11.

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

The graph shows a bacterial growth curve, produced by counting the number of bacterial colonies using the dilution plating technique.



(a) Which label should be used for the y-axis of this graph?

(1)

☒ **A** $\log_{10}$ number of living bacterial cells

☒ **B** $\log_{10}$ total number of bacterial cells

☒ **C** number of living bacterial cells

☒ **D** total number of bacterial cells

(b) When culturing microorganisms, it is important that an aseptic technique is used.

(i) Explain the importance of using an aseptic technique.

(2)

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(ii) Explain **two** aseptic techniques that should be used in dilution plating.

(2)

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(Total for question = 5 marks)

Q12.

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 (☒).

Bacteriostatic and bactericidal antibiotics are used to treat bacterial infections.

(a) Give the meaning of the term **bactericidal antibiotic**.

(1)

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(b) State why antibiotics affect bacteria and usually not the person taking them.

(1)

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(c) Codes of practice advise doctors and patients about the use of antibiotics.

Describe **two** pieces of advice given to patients.

(2)

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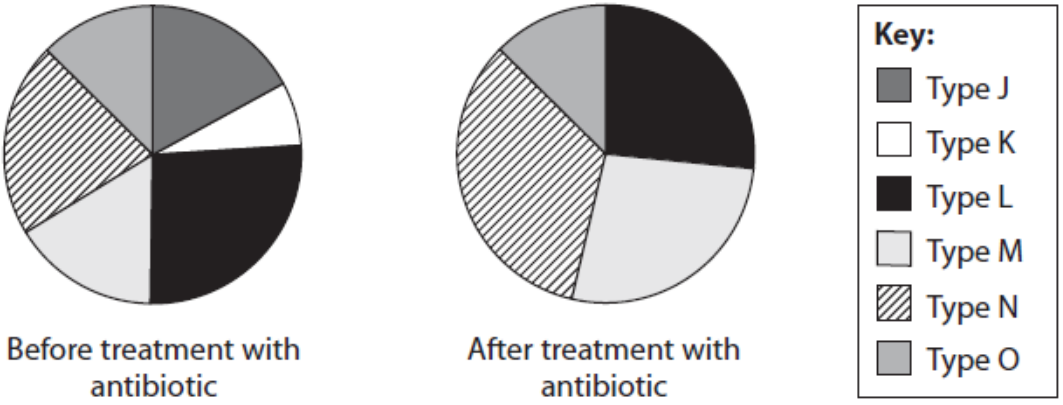
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(d) The charts show the types of bacteria present in the throat of a patient, before and after treatment with an antibiotic.



Describe the effects of this antibiotic on the bacteria present in the throat.

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(Total for question = 7 marks)

Q13.

Climate change is dependent on the balance of carbon released into the atmosphere and carbon removed from the atmosphere.

Some ecosystems are better than others at storing carbon in their soil, releasing less back into the atmosphere.

Conserving these ecosystems could be an important way of reducing climate change.

One study investigated the extent of decomposition in different ecosystems.

This study used tea in teabags as the source of organic matter for decomposition.

The photograph shows a teabag.



(Source: © Hugh Threlfall / Alamy Stock Photo)

(a) The first part of the study was carried out in a laboratory.

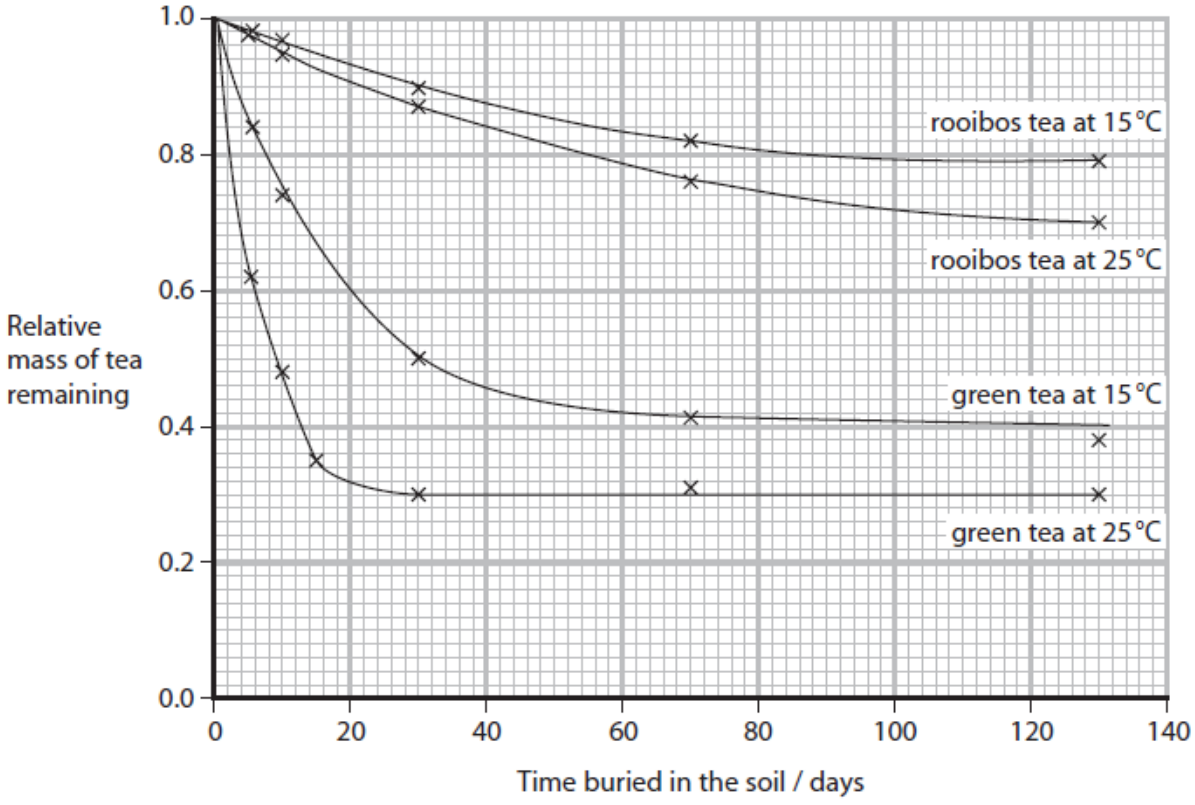
Two types of tea were used, green tea and rooibos tea.

A number of unused teabags containing each type of tea were buried in soil at two different temperatures, 15 °C and 25 °C.

The mass of tea in each teabag had been determined before they were buried.

At regular intervals teabags were dug up, dried, and the remaining tea reweighed.

The graph shows the results of this study.



(i) The teabags had to be dried before weighing to remove water.

One teabag contained 28 g of tea when it was buried. When it was dug up it had a wet mass of 42 g. The water content of this teabag was calculated to be 50 %.

Calculate the mass of organic matter lost during this study.

(1)

Answer ..... g

(ii) Calculate the rate at which the relative mass of the green tea decreases in the teabags buried at 15 °C at day 30.

(2)

Answer .....

(iii) Explain the difference in the decrease in relative mass of green tea in teabags buried at 15 °C and 25 °C.

Use the information in the graph to support your answer.

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(iv) Suggest why the rate of decomposition of green tea was different from that of rooibos tea.

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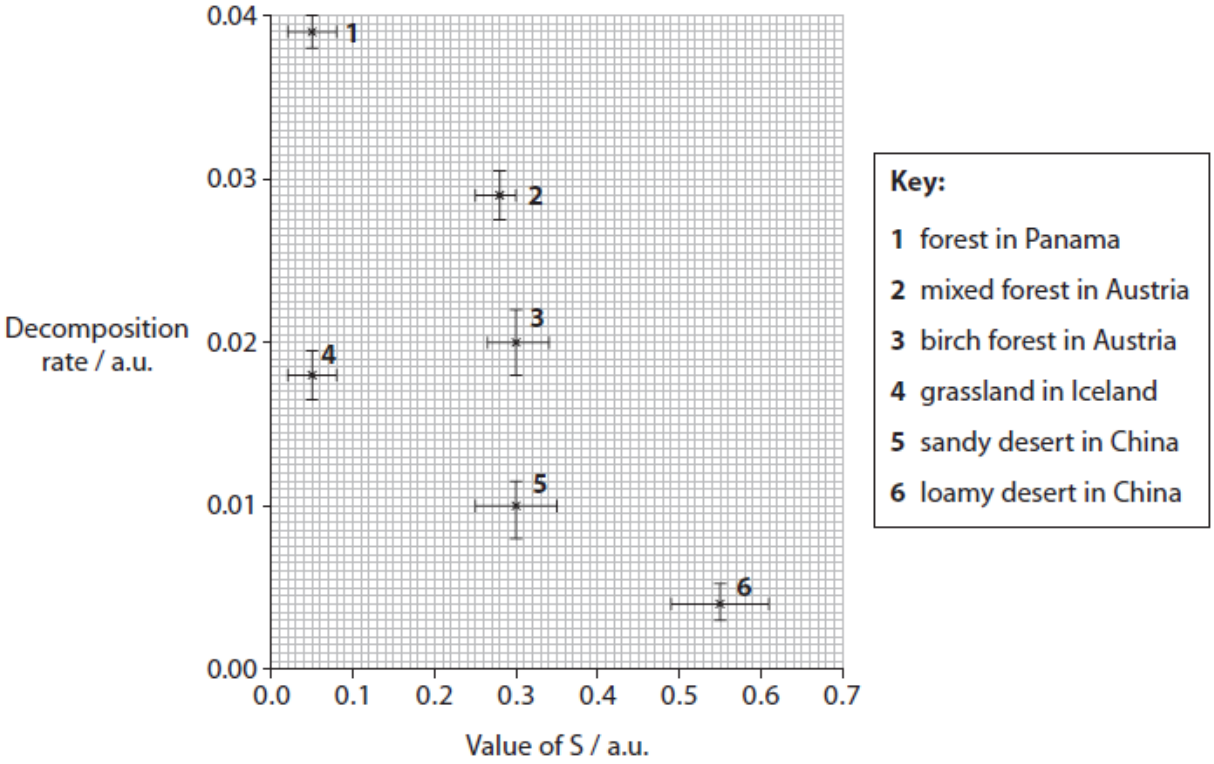
(b) In the second part of this study, several teabags were buried in different ecosystems.

The teabags were left buried for three months and then dug up.

A number of measurements were taken from the tea in these teabags and the mean decomposition rate and the mean stabilisation factor (S) calculated.

The higher the value of S, the more carbon is stored in the ecosystem.

The graph shows some of the results from this study.



(i) Suggest why each point on the graph has both a horizontal and a vertical error bar plotted with it.

(1)

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(ii) Explain which ecosystems should be conserved to have the greatest impact on climate change.

Use the information in the graph to support your answer.

(3)

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(Total for question = 13 marks)

Q14.

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

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

(2)

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

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(Total for question = 8 marks)

Q15.

Alzheimer's disease is a cause of dementia in older people.

The neurones in the brain are damaged and eventually destroyed.

Abnormal plaques are seen in the brains of people with Alzheimer's disease. These plaques are made of a protein called ß-amyloid.

Drug ATD is a new drug used to treat people with Alzheimer's disease.

This drug is an antibody that is specific for ß-amyloid.

(a) Drug ATD was recently approved for the treatment of Alzheimer's disease.

Describe the information that had to be collected by scientists before this drug could be approved.

(3)

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(b) (i) Explain the phrase: 'an antibody that is specific for ß-amyloid'.

(2)

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(ii) Drug ATD reduces the build-up of ß-amyloid in the brains of people with Alzheimer's disease.

Suggest how drug ATD could result in the reduction of the build-up of ß-amyloid.

(3)

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(c) Drug ATD was derived from a B memory cell taken from an elderly person who showed no signs of Alzheimer's disease.

(i) Suggest why this person did not have Alzheimer's disease.

(2)

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(ii) Explain why this drug could be produced only from B memory cells taken from a person who did not have Alzheimer's disease.

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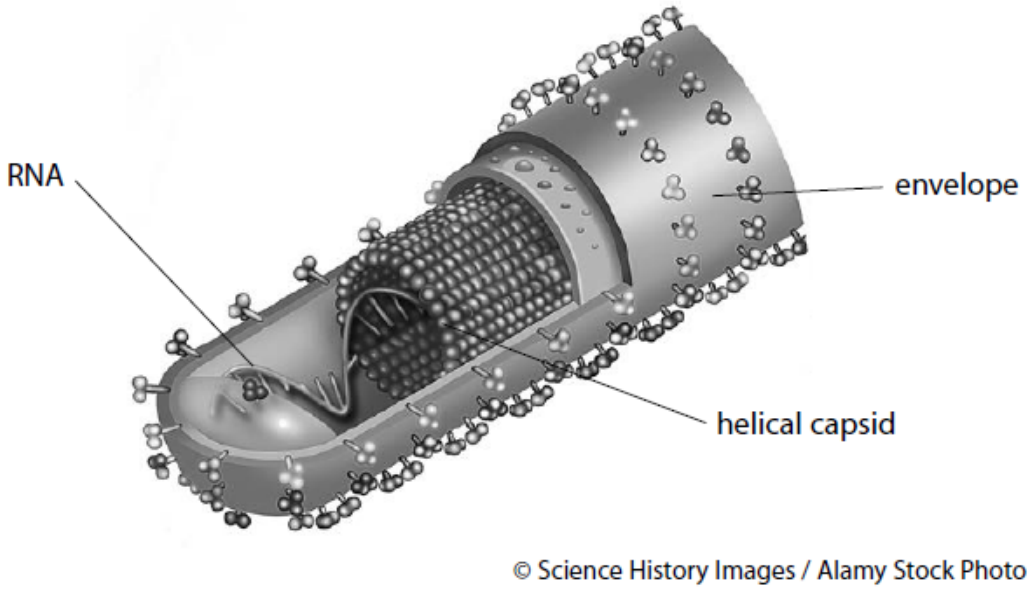
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(Total for question = 12 marks)

Q16.

(a) The diagram shows the structure of an Ebola virus.



© Science History Images / Alamy Stock Photo

(i) Which of the following viruses contain the same type of nucleic acid as the Ebola virus?

(1)

☒ **A** human immunodeficiency virus (HIV) only

☒ **B** human immunodeficiency virus (HIV) and tobacco mosaic virus (TMV)

☒ **C** lambda phage (λ phage) only

☒ **D** lambda phage (λ phage) and tobacco mosaic virus (TMV)

(ii) Which of the following viruses have a helical capsid?

(1)

☒ **A** human immunodeficiency virus (HIV) and lambda phage (λ phage)

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

☒ **C** lambda phage (λ phage) and tobacco mosaic virus (TMV)

☒ **D** tobacco mosaic virus (TMV) only

(iii) What type of molecule makes up the capsid of a virus?

(1)

☒ **A** carbohydrate

☒ **B** lipid

☒ **C** nucleic acid

☒ **D** protein

(iv) The volume of an Ebola virus is approximately 7.76×10^4 nm^3.

Tobacco mosaic virus (TMV) is approximately 300 nm long and 80 nm in diameter.

Calculate how many times larger Ebola virus is than TMV.

Assume that TMV is a cylinder in shape.

The volume of a cylinder is calculated using the formula

$$V = \pi r^2 l$$

(2)

Answer .....

(b) Human immunodeficiency virus (HIV) contains two enzymes that are **not** found in most other types of virus.

(i) Name these two enzymes.

(1)

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(ii) Explain why HIV contains these two enzymes.

(3)

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(Total for question = 9 marks)

Q17.

The photograph shows a regent honeyeater.



(Source: © Dave Watts / Alamy Stock Photo)

(a) Regent honeyeaters are critically endangered, with fewer than 300 birds left in the wild.

A study found that a large proportion of the male birds no longer sing the characteristic songs of their own species.

Some of the birds had learnt the songs of other species.

(i) Suggest why a large proportion of these male birds no longer sing the characteristic songs of regent honeyeaters.

(1)

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(ii) Explain the effect that this could have on the future of this species.

(3)

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(iii) Suggest how zoos could increase the number of birds in the wild that can sing the songs characteristic of this species.

(2)

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(b) Genetic studies indicate that the regent honeyeater is related to wattlebirds.

Describe how genetic studies could show this.

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(Total for question = 10 marks)

Q18.

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 (☒).

The table shows the energy content in the three trophic levels of a food chain from an African plain.

Trophic level	Organism	Energy content
3	Lion 	920
2	Gerenuk 	8825
1	Tree 	90480

(a) (i) Which are the units for the energy content of these organisms?

(1)

☒ **A** kJ m^{-1} $year^{-1}$

☒ **B** kJ m^{-1} $year^{-2}$

☒ **C** kJ m^{-2} $year^{-1}$

☒ **D** kJ m^{-2} $year^{-2}$

(ii) The energy content of the tree is the net primary productivity (NPP).

What is the relationship between NPP, gross primary productivity (GPP) and respiration (R)?

(1)

☒ **A** NPP = GPP + R

☒ **B** NPP = GPP – R

☒ **C** NPP = GPP × R

☒ **D** NPP = GPP ÷ R

(iii) Calculate the ratio of the energy contents shown in these trophic levels:

trophic level 1 : trophic level 2 : trophic level 3

(1)

Answer .....

(iv) Explain why there is no fourth trophic level in this food chain.

(2)

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(v) Describe the role of microorganisms in recycling carbon present in this food chain.

(3)

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*(b) The photographs show gerenuk and a springbok to the same magnification.



gerenuk



(Source: © David Havel / Alamy Stock Photo)

springbok

The table gives some information about gerenuk and springbok.

Information	Gerenuk	Springbok
Diet	leaves from a range of different trees, often spiny trees, up to 2 m from the ground	short grass and bushes
Water requirements	met by water content of food	will drink water when available
Height / cm	80 to 105	69 to 87
Mass / kg	male 45 female 30	male 41 female 37
Colour of fur	light brown with a white underbelly	light to mid brown with large areas of white
Length of horns / cm	25 to 44 in males only	35 to 49 in both males and females but narrower horns in females

Gerenuk and springbok evolved from a common ancestor.

Deduce how the gerenuk evolved to occupy a different niche from a springbok.

Use the information in the table and the photographs to support your answer.

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(Total for question = 14 marks)

Q19.

Forensic entomology is a method for estimating the time of death of a mammal.

(a) Seventy-two hours or more after death, forensic entomology is the most accurate method for estimating the time of death.

Forensic entomology can also provide information about the place of death and indicate if the body has been moved.

(i) Explain why forensic entomology is the most accurate method for estimating the time of death, if this is greater than 72 hours.

(2)

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(ii) Explain how forensic entomology can indicate if a body has been moved from the place of death.

(2)

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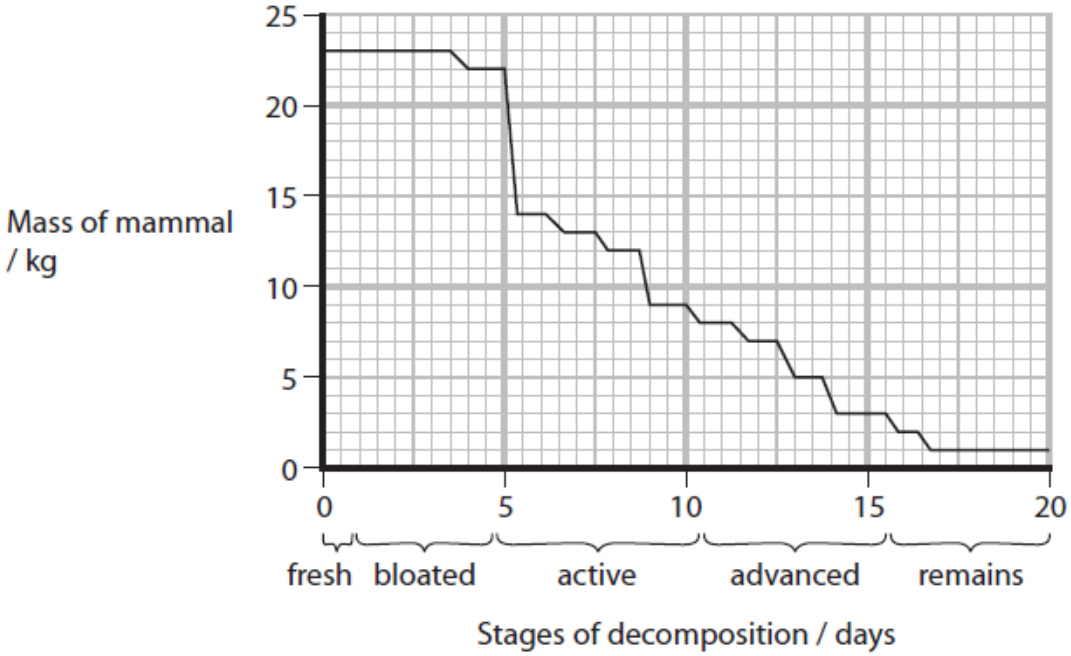
(b) A study looked at the succession of insects associated with the decomposition of a dead mammal in the Andean Coffee region.

In this study, a mammal was killed, placed inside a metal cage in this region and left until it had completely decomposed.

The body of this mammal was monitored regularly.

The stages of decomposition were identified and various measurements were taken and recorded. Insects in the different stages of their lifecycle were collected and identified.

The graph shows the changes in mass of this mammal during the decomposition period.



(i) Suggest why the mammal was placed inside a metal cage to decompose.

(1)

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(ii) Calculate the rate of change in mass between day 5 and day 15 of decomposition.

Express your answer in kg hr^{-1}.

Give your answer to two decimal places.

(2)

Answer ..... Kg hr^{-1}

(iii) Explain the changes in mass of this mammal during decomposition.

(4)

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(iv) Suggest why some of the insect eggs, collected from the decomposing mammal, were taken back to the laboratory and kept for a few days.

(1)

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(v) The table shows data on some of the insects collected from this decomposing mammal.

Type of insect	Percentage of some of the insect found at each stage of decomposition (%)				
	Fresh	Bloated	Active	Advanced	Remains
Lucilia	100.0	61.4	1.8	3.7	0.0
Cochliomyia	0.0	15.5	68.4	35.1	0.0
Chrysomya	0.0	6.4	9.8	1.2	0.0
Ophyra	0.0	0.0	0.6	30.9	83.9
Fannia	0.0	0.0	0.0	0.1	0.0
Other types of insects	0.0	16.7	19.4	29.0	16.1

Explain how these results illustrate succession.

Use the information in the table to support your answer.

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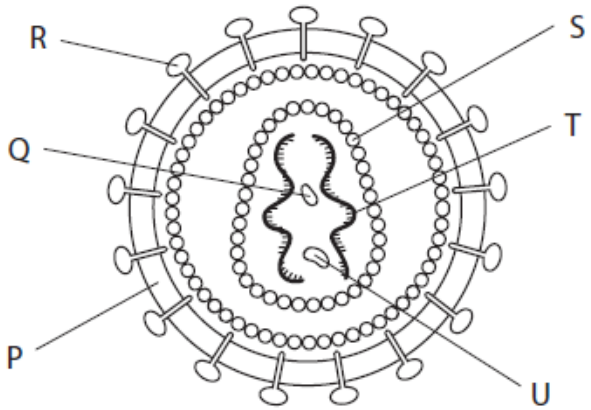
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(Total for question = 15 marks)

Q20.

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 (☒).

The diagram shows a human immunodeficiency virus (HIV).



(a) (i) Which structure is RNA?

(1)

☒ **A** R

☒ **B** Q

☒ **C** S

☒ **D** T

(ii) How many of the following structures contain protein?

- structure Q
- structure R
- structure S

(1)

☒ **A** 0

☒ **B** 1

☒ **C** 2

☒ **D** 3

(iii) Which virus has structure P and contains RNA?

(1)

☒ **A** Ebola virus only

☒ **B** Ebola virus and tobacco mosaic virus (TMV)

☒ **C** Tobacco mosaic virus (TMV) only

☒ **D** Neither Ebola virus nor tobacco mosaic virus (TMV)

(iv) The diameter of HIV is 120 nm.

Which is the approximate magnification of this drawing?

(1)

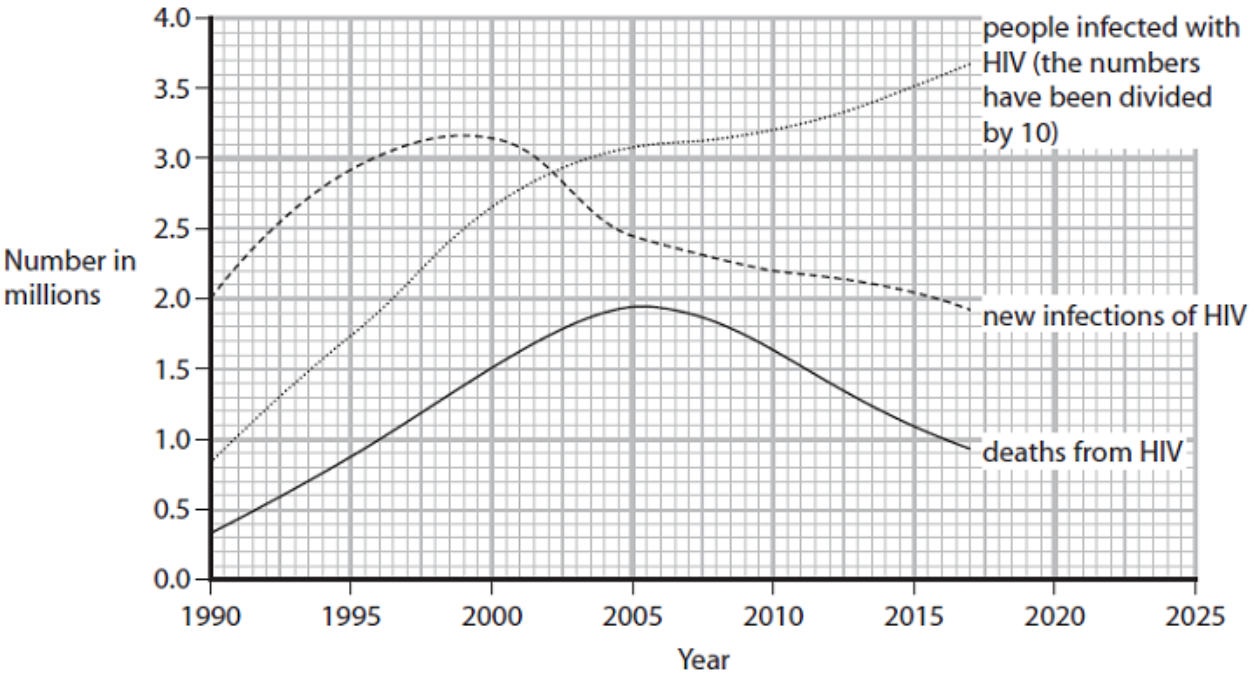
☒ **A** × 500

☒ **B** × 5 000

☒ **C** × 50 000

☒ **D** × 500 000

(b) The graph shows the number of HIV infections and the number of deaths from HIV in the world from 1990 to 2017.



(i) The data plotted for the number of people infected with HIV has been divided by 10.

Explain why these numbers were divided by 10.

(2)

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(ii) Calculate the mean rate of increase in the number of people infected with HIV from 2005 to 2010.

Express your answer in standard form to an appropriate number of significant figures.

(2)

Answer ..... mean number of infections year^{-1}

(iii) Explain why the number of people infected with HIV is going up although the number of new infections and deaths is going down, after 2005.

(2)

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(iv) State how the graph can be used to estimate the number of deaths in 2025.

(1)

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(v) Explain why this estimate would be lower if a vaccine for HIV became available in 2023.

(3)

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(Total for question = 14 marks)

Q1.

The immune response to cancer involves both T helper and T killer cells.

(a) Which row of the table shows the cells that present antigens to each of these T cells?

(1)

	T helper cells	T killer cells
☒ **A**	host-infected cells	host-infected cells
☒ **B**	host-infected cells	macrophages
☒ **C**	macrophages	host-infected cells
☒ **D**	macrophages	macrophages

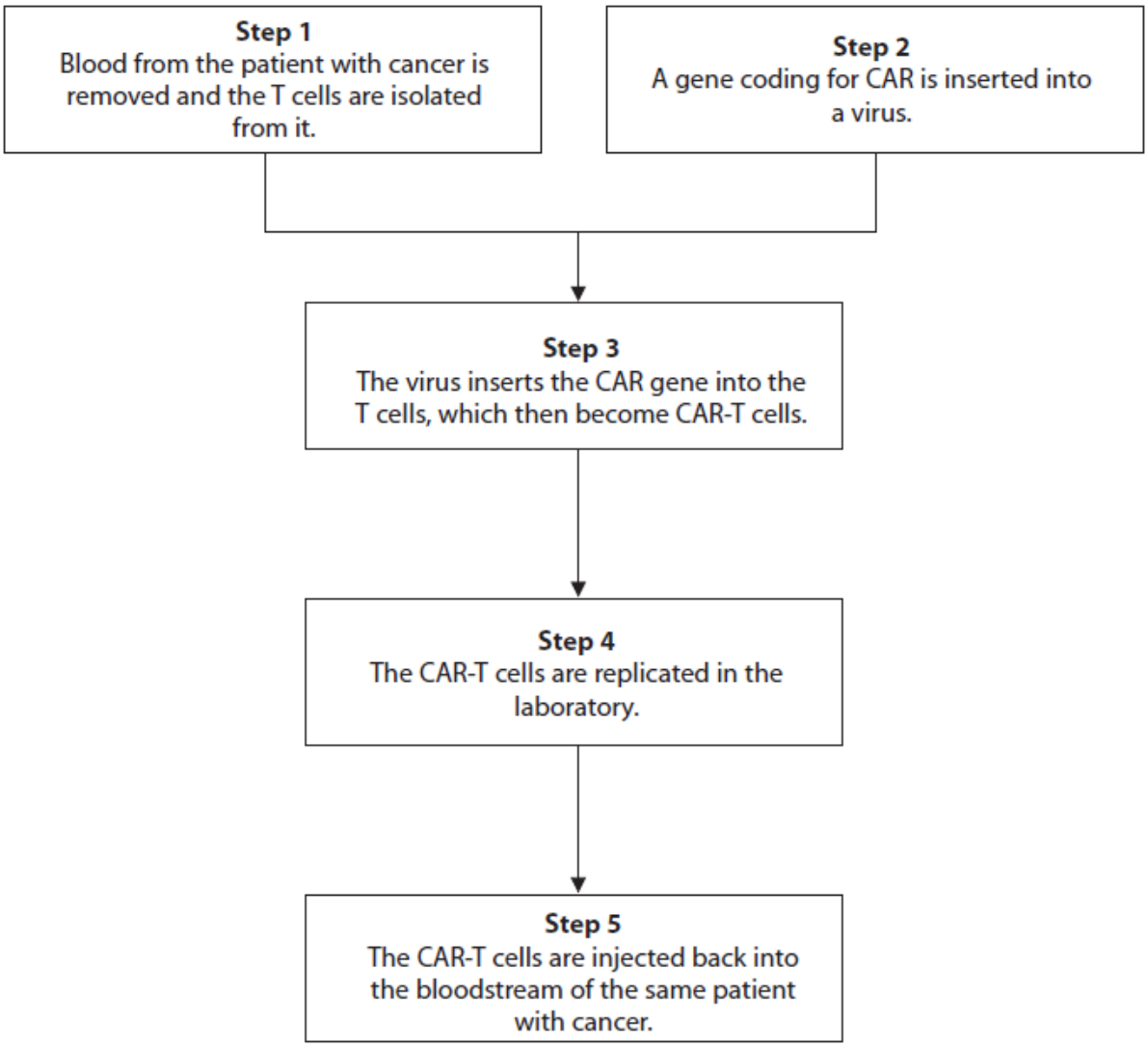
(b) Immunotherapy, using genetically-modified T cells, is being developed to treat blood cell cancers.

Cancer cells have a specific antigen on their surface.

The T cells have to possess a receptor (CAR) on their surface that binds to this antigen.

A gene coding for CAR has to be inserted into the T cells. These genetically-modified T cells are called CAR-T cells.

The diagram shows some steps in this procedure.



(i) The virus used in this procedure is modified so that it is not pathogenic.

Which virus would be suitable to use in **Step 2**?

(1)

☒ **A** Ebola virus

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

☒ **C** lambda phage (*λ* phage)

☒ **D** tobacco mosaic virus (TMV)

(ii) Explain why the CAR gene is inserted into the T cells in **Step 3**.

(2)

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(iii) Explain the importance of mitosis in the replication of the CAR-T cells in **Step 4**.

(3)

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(iv) In **Step 1**, T cells are removed from a patient with cancer.

Explain the advantages of injecting CAR-T cells into the same patient in **Step 5**.

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(v) Currently, the use of CAR-T cells has been effective against blood cell cancers only.

Suggest why CAR-T cells are not effective against cancer cells in solid tumours growing in other tissues in the body.

(2)

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(Total for question = 12 marks)

Q2.

Human Immunodeficiency Virus (HIV) infects human cells, causing symptoms that may result in death.

(a) Explain why the virus is an immunodeficiency virus.

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(b) A number of antiretroviral drugs are given to patients with HIV.

These include reverse transcriptase inhibitors and integrase inhibitors.

(i) Explain how these two drugs reduce the development of HIV.

(2)

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(ii) These two drugs are often given in combination with other antiretroviral drugs.

Suggest why patients are given combinations of drugs.

(2)

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(iii) If a patient stops taking the antiretroviral drugs, the number of virus particles increases again.

Suggest why this increase occurs.

(2)

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(Total for question = 10 marks)

Q3.

Antibodies play an important role in the immune response.

(a) Explain the importance of antibodies.

(4)

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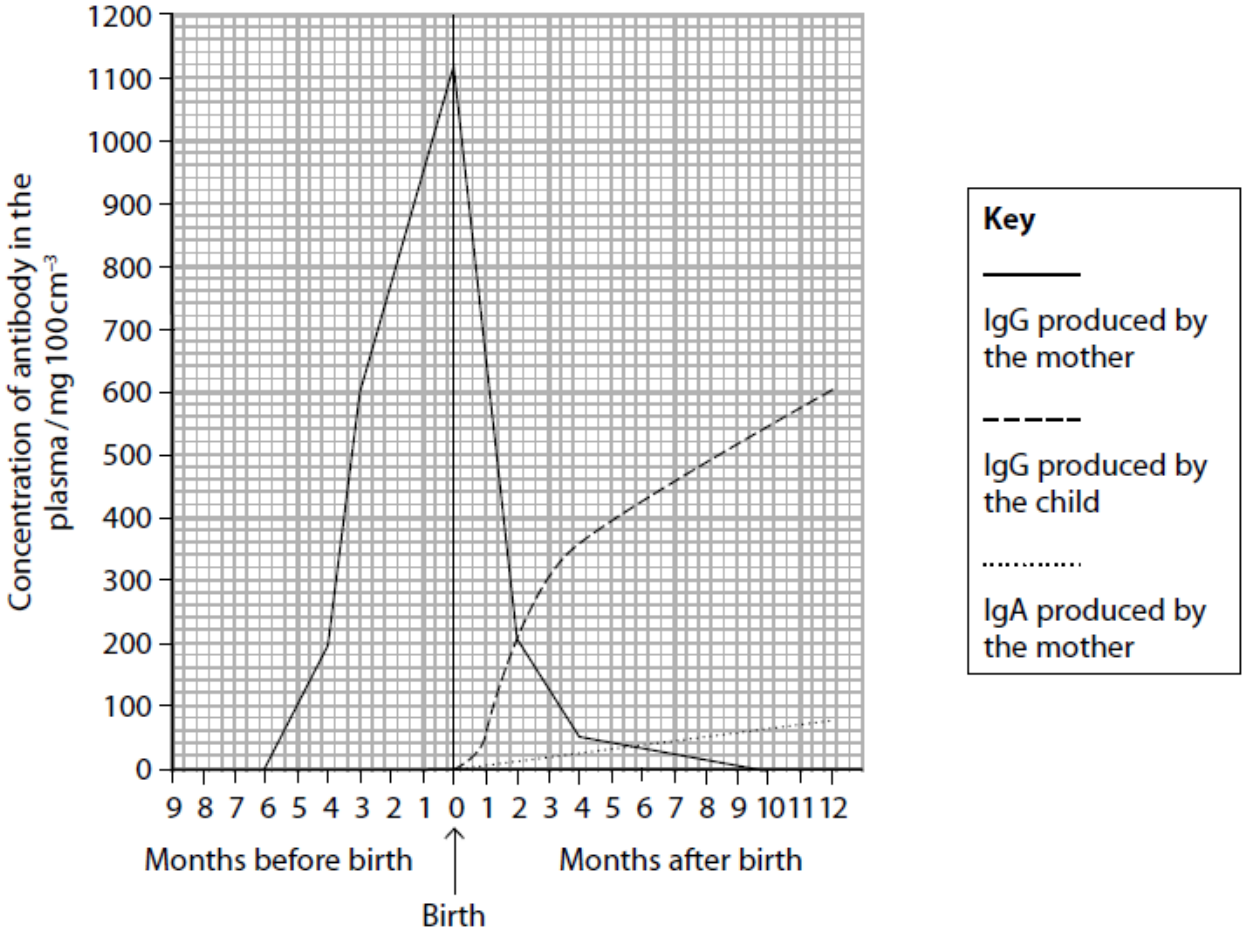
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(b) There are different classes of antibody, including IgA, IgG and IgM.

The graph shows the changes in the concentration of IgA and IgG in the plasma of a fetus before birth and in a child after birth.



(i) Describe the changes in the classes of antibody in a fetus before birth and in a child after birth. Use the information in the graph to support your answer.

(3)

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(ii) Which type of immunity explains the presence of IgA?

(1)

☒ **A** artificial active

☒ **B** artificial passive

☒ **C** natural active

☒ **D** natural passive

(iii) Suggest why the concentration of antibodies is less in a child 12 months after birth than in an adult.

(2)

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(Total for question = 10 marks)

Q4.

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)

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

(1)

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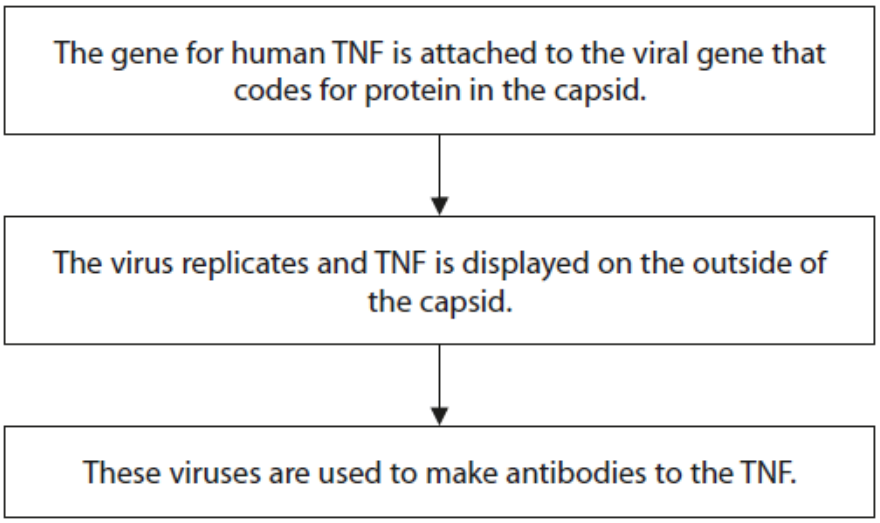
(b) Tumour necrosis factor (TNF) is a protein that can be released by several types of cell. It plays an important part in the immune response.

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)

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(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)

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(Total for question = 10 marks)

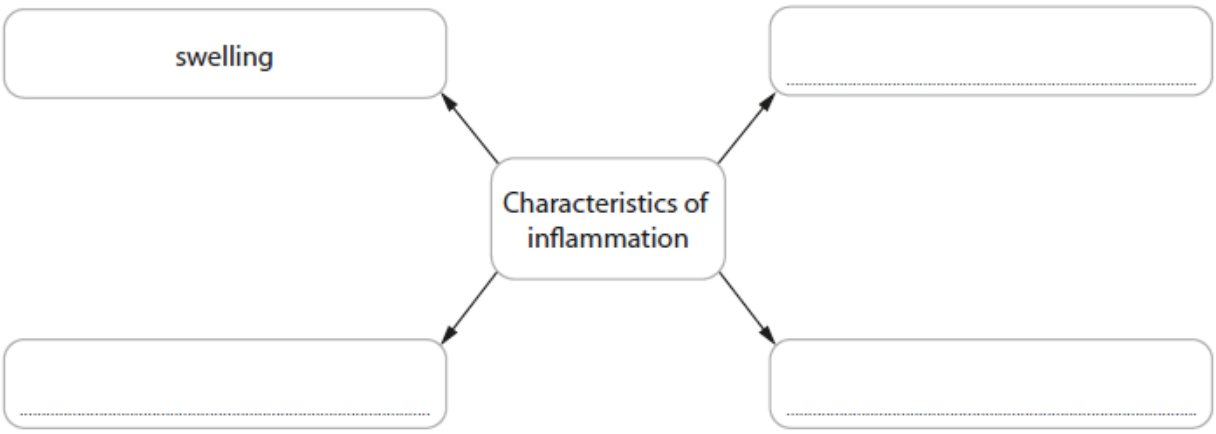
Q5.

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

Inflammation is involved in the non-specific response of the body to infection and injury.

(a) (i) Complete the diagram to show the four characteristics of inflammation.

(2)



(ii) Inflammation occurs following a cut to the skin.

Describe the role of **two** of these characteristics of inflammation in response to a cut to the skin.

(2)

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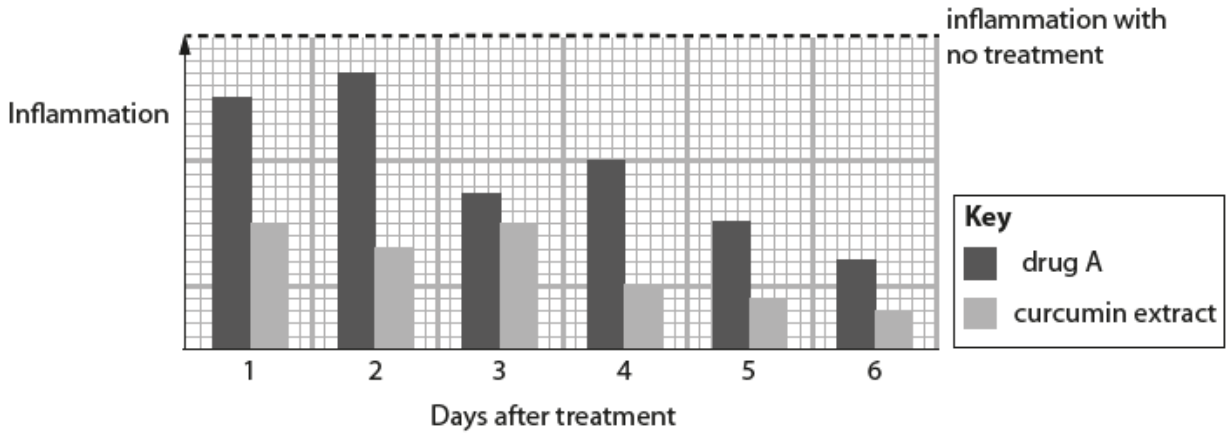
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(b) Anti-inflammatory drugs reduce inflammation.

Turmeric is a spice that is added to food.

Curcumin is a chemical in turmeric that has been shown to reduce inflammation.

(i) The graph shows the effect of treating inflammation with curcumin extract and an anti-inflammatory drug, drug A.



Compare and contrast the effect of treating inflammation with curcumin extract and with drug A.

(3)

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(ii) Many treatments use 1 g curcumin extract.

A sample of turmeric contains 3 % curcumin.

Which is the mass of turmeric for one treatment?

(1)

- ☒ **A** 0.03 g
- ☒ **B** 3.33 g
- ☒ **C** 33.3 g
- ☒ **D** 33.4 g

(Total for question = 8 marks)

Q6.

Some disorders are caused by mutations in the mitochondrial DNA and can be inherited.

Three-parent embryos have been developed to prevent the inheritance of these disorders.

Diagram 1 shows how three-parent embryos are made.

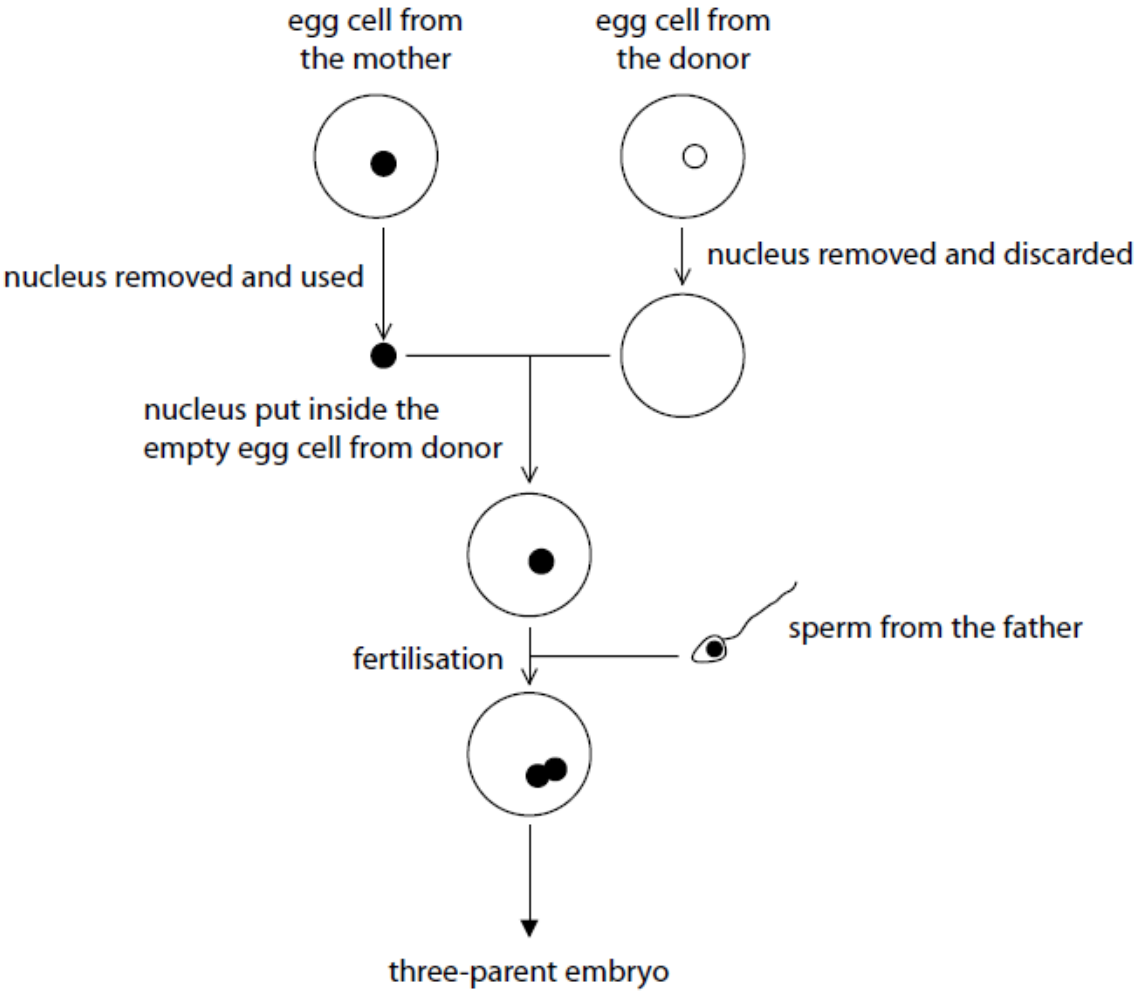


Diagram 1

(a) The cells in the three-parent embryo are totipotent stem cells.

State what is meant by the term **totipotent stem cells**.

(2)

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(b) Diagram 2 shows the results of separating the DNA from the three-parent embryo, the mother and the father, using gel electrophoresis.

The bands from the DNA of the embryo are labelled from 1 to 12.

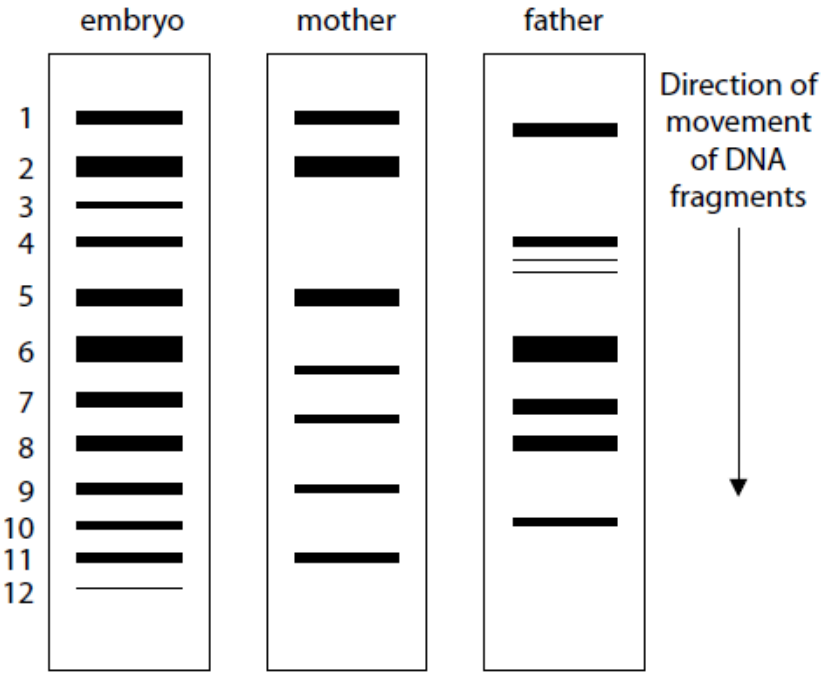


Diagram 2

(i) Which of the following is the reason for the movement of the DNA fragments?

(1)

☒ **A** negatively-charged fragments move towards the negative end of the gel

☒ **B** negatively-charged fragments move towards the positive end of the gel

☒ **C** positively-charged fragments move towards the negative end of the gel

☒ **D** positively-charged fragments move towards the positive end of the gel

(ii) Which band on the gel contains the heaviest DNA fragments?

(1)

☒ **A** 1

☒ **B** 3

☒ **C** 6

☒ **D** 9

*(iii) Explain the banding pattern of this three-parent embryo. Use information in Diagram 1 and Diagram 2 to support your answer.

(6)

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(Total for question = 10 marks)

Q7.

Malaysia is covered by large areas of rainforest. These rainforests have one of the highest biodiversities in the world.

However, the rate of loss of rainforest in Malaysia is one of the highest in the world.

(a) (i) From 2000 to 2012, Malaysia lost 14.4% of its rainforest. This is equivalent to 47 278 km^2.

Calculate the area of Malaysia covered by rainforest in 2000.

Give your answer in standard form.

(3)

Answer ..... km^2

(ii) A decrease in the area covered by rainforest results in both a decrease in biodiversity and a decrease in populations.

Explain why a decrease in the area covered by rainforest reduces both biodiversity and populations within the rainforest.

(2)

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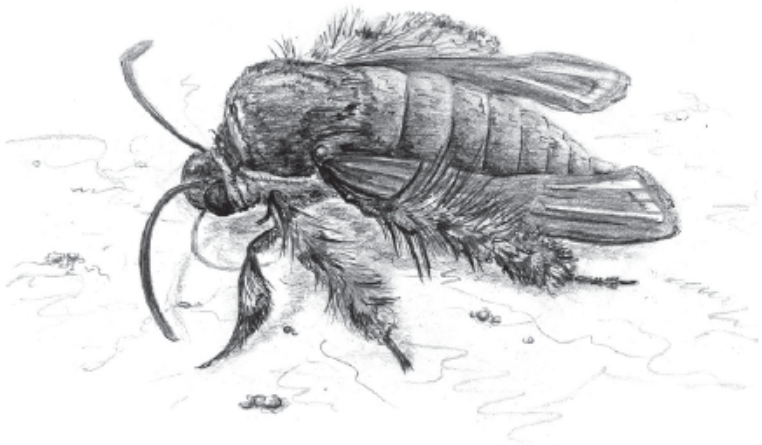
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(b) The diagram shows an Oriental blue clearwing, a species of moth found in the rainforests of Malaysia.



Magnification ×5

The Oriental blue clearwing has blue bands on its body. It resembles a bee by having transparent wings and fur on its body. It drinks in puddles of water where a number of species of bee also drink.

(i) Explain which examples of adaptation are illustrated by this moth.

(2)

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(ii) Suggest **two** advantages to the Oriental blue clearwing of resembling bees.

(2)

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(iii) This moth was seen and a specimen collected in 1887. It was not seen again in the rainforests of Malaysia until 2017.

The DNA of these recently rediscovered Oriental blue clearwings was compared with the DNA of the moth collected in 1887.

Describe how this comparison could be made.

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(Total for question = 12 marks)

Q8.

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

Antibiotics are medicines used to treat some medical conditions.

(a) The table shows some medical conditions and whether or not antibiotics are needed to treat the condition.

Medical condition	Are antibiotics needed to treat the condition?
Impetigo	yes
Whooping cough	yes
Middle ear infections	sometimes
Sinus infections	sometimes
Multiple sclerosis	no
Rheumatoid arthritis	no

Explain the use of antibiotics to treat these conditions.

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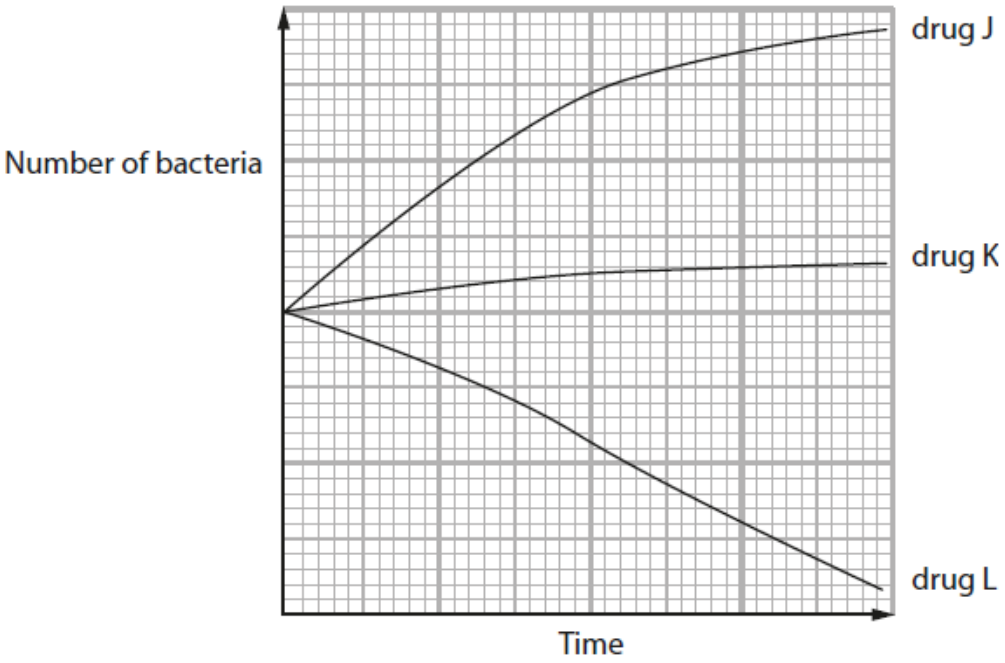
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(b) The graph shows the effect of three drugs, J, K and L, on the number of bacteria in a culture.



Which row of the table describes each of these three drugs?

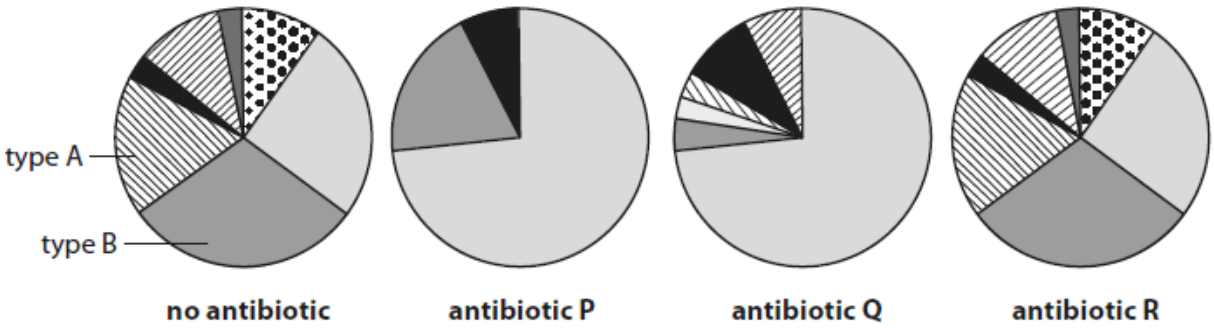
(1)

		drug J	drug K	drug L
☒	**A**	not an antibiotic	bactericidal antibiotic	bacteriostatic antibiotic
☒	**B**	not an antibiotic	bacteriostatic antibiotic	bactericidal antibiotic
☒	**C**	bactericidal antibiotic	not an antibiotic	bacteriostatic antibiotic
☒	**D**	bacteriostatic antibiotic	not an antibiotic	bactericidal antibiotic

(c) One problem of taking antibiotics is their effect on gut flora.

The diagrams show the effects of three antibiotics, P, Q and R, on the proportion of different types of gut flora.

Each section in each of the diagrams represents a different type of gut flora.



(i) Explain the role of gut flora in protecting the body from infection.

(2)

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(ii) Explain why antibiotics can affect gut flora.

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(iii) The number of type A in gut flora in the absence of antibiotics is 6 000 000.

Estimate the number of type B in gut flora in the absence of antibiotics.

Give your answer in standard form.

(1)

Answer .....

(iv) Deduce the effects of antibiotics P, Q and R on gut flora.

(3)

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(Total for question = 11 marks)

Q9.

Methicillin-resistant Staphylococcus aureus (MRSA) is a disease causing worldwide concerns.

Methicillin is one of the antibiotics to which this pathogen has developed resistance.

Castaneroxy A is a molecule extracted from the European chestnut tree, endemic to Southern Europe and Turkey.

The effects of Castaneroxy A have been investigated.

The investigations have found that Castaneroxy A:

- does not affect the natural skin flora
- prevents MRSA from producing toxins
- weakens the MRSA bacteria
- reduces the size of skin infections caused by MRSA.

(a) Explain why the development of this drug is an example of an 'evolutionary race' between humans and this pathogen.

(2)

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(b) Explain why it is important that Castaneroxy A does not affect skin flora.

(2)

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(c) Suggest how weakening the MRSA bacteria could help the recovery of a patient infected with this bacteria.

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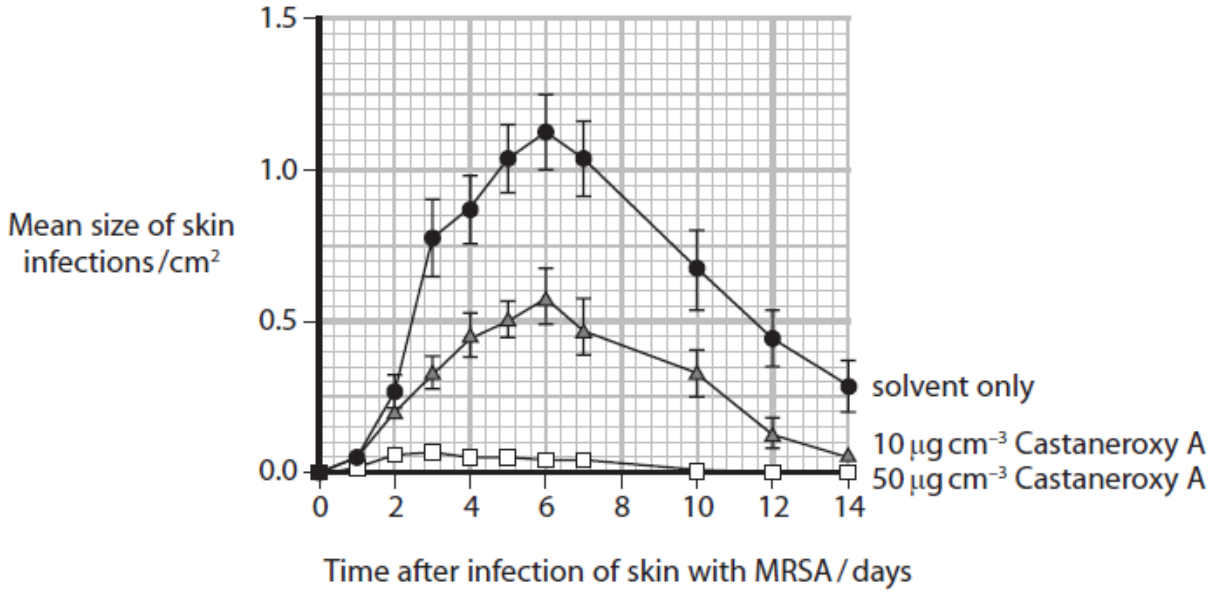
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(d) In an investigation, patients who had developed skin infections were divided into three groups.

Two groups were each treated with a different concentration of Castaneroxy A. The other group was treated with only the solvent that was used in the treatment.

The graph shows the results of these treatments on the mean size of the skin infections.



(i) Explain why this investigation included treatment with the solvent only.

(2)

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(ii) Determine the effect that Castaneroxy A has on the mean size of skin infections.

(3)

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(iii) The leaves of the chestnut tree contain 0.0019 %, by mass, of Castaneroxy A.

Calculate the mass of leaves, in kilograms, that would be needed to produce 1 dm^3 of Castaneroxy A at a concentration of 50 µg cm^{-3}.

Give your answer to the nearest kilogram.

(3)

Answer ..... kg

(Total for question = 14 marks)

Q10.

The photographs show a Northwestern crow and an American crow.



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



(Source: © MichaelGrantBirds / Alamy Stock Photo)

These two crows look very similar and are therefore difficult to distinguish as two separate species.

Scientists have studied the nuclear DNA and the mitochondrial DNA (mtDNA) of these two species of birds.

(a) Give **two** differences between the structure of nuclear DNA and mtDNA.

(2)

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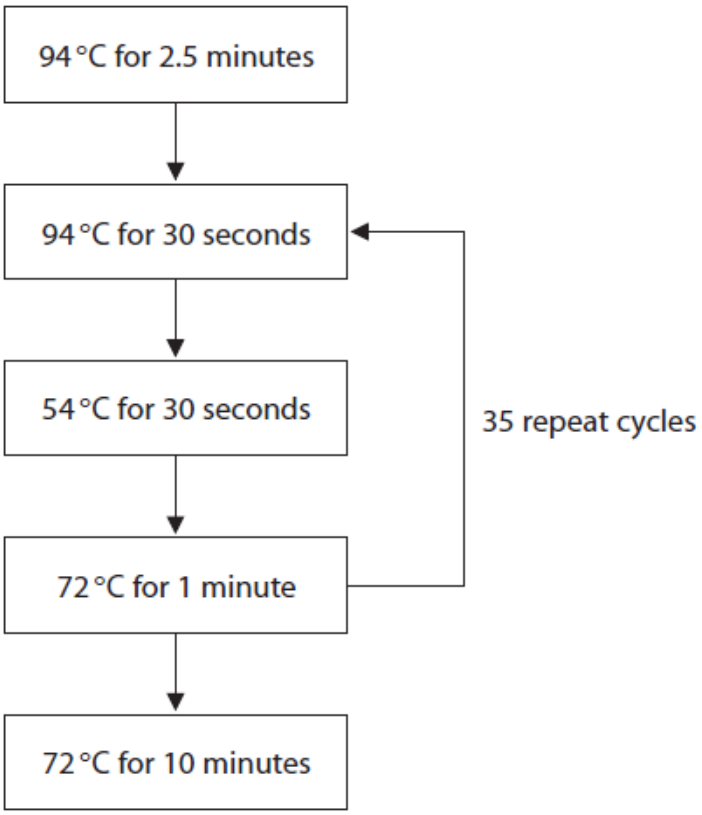
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(b) The mtDNA was isolated from these two species of crow and amplified using the polymerase chain reaction (PCR).

The diagram shows details of the process used.



(i) Name **three** molecules, other than the mtDNA and water, that would be needed in this process.

(2)

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(ii) Calculate the total length of time, in hours, that this process would take.

Give your answer to two decimal places.

(2)

Answer ..... hours

(iii) Explain how this process amplifies the DNA.

Use information in the diagram to support your answer.

(3)

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(c) Explain how the amplified mtDNA could be used to determine the genetic relationships between these two species of crow.

(3)

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(Total for question = 12 marks)

Q11.

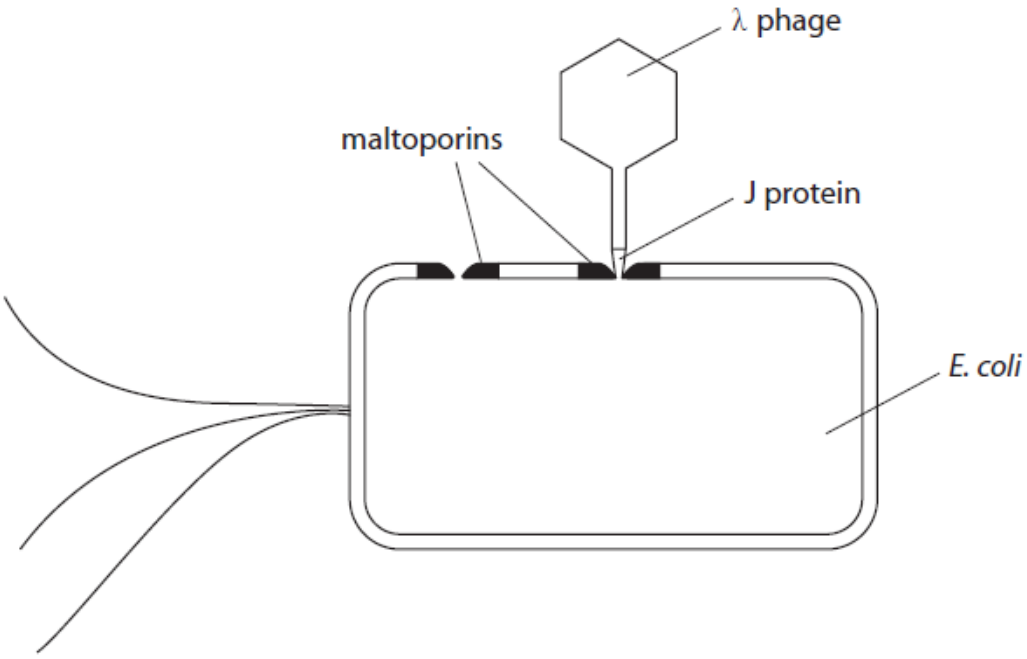
Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Pathogens continuously adapt to invade their host cells.

Host cells continuously adapt to avoid infection by pathogens.

This is an example of an 'evolutionary race'.

The diagram shows the pathogen lambda phage (*λ* phage) attached to its host cell, *E. coli*.



(a) How many of the following statements are correct for *λ* phage?

- the genetic material is DNA
- the capsid structure is described as complex
- the genetic material codes for the J protein

(1)

☒ **A** 0

☒ **B** 1

☒ **C** 2

☒ **D** 3

(b) Describe the role of the *λ* phage J protein.

Use the information in the diagram to support your answer.

(2)

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(c) Maltoporin is coded for by the *lamβ* gene of *E. coli*.

Maltoporin is involved in the transport of some sugars into *E. coli*.

(i) Give **one** reason why sugars are important to *E. coli*.

(1)

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*(ii) Discuss how E. coli and λ phage could interact and develop in their evolutionary race for existence.

Use the information in this question to support your answer.

(6)

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(Total for question = 10 marks)

Q12.

Plastics are carbon-based polymers made from repeating monomers.

Many plastics do not break down naturally and their disposal is causing a lot of damage to the environment.

(a) Plastics have been around for about 70 years.

Scientists think that microorganisms could evolve the ability to break down plastics to obtain nutrients.

(i) Explain why scientists think that plastics could be broken down by microorganisms.

(2)

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(ii) Explain how microorganisms could evolve to break down plastics.

(3)

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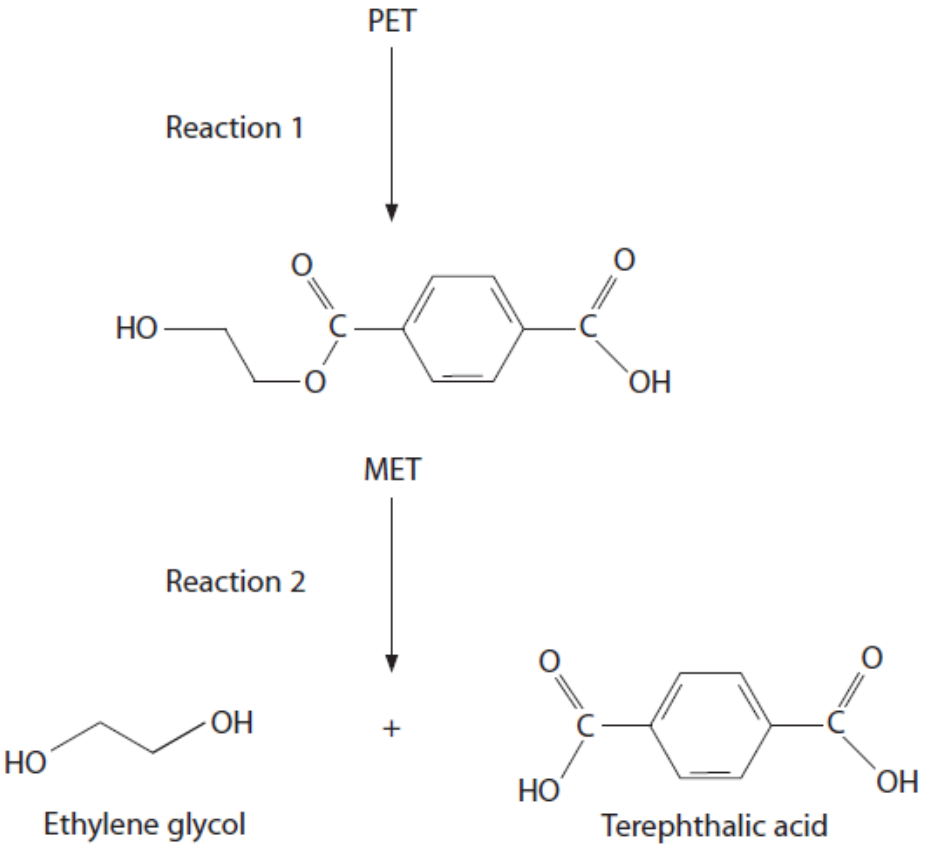
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(b) Some bacteria have been discovered that can break down one type of plastic, the polymer polyethylene terephthalate (PET).

This polymer is made from the monomer ethylene terephthalate (MET).

The diagram shows how PET can be broken down.



Which row of the table describes reaction 1 and reaction 2?

(1)

	Reaction 1	Reaction 2
☒ **A**	condensation	condensation
☒ **B**	condensation	hydrolysis
☒ **C**	hydrolysis	condensation
☒ **D**	hydrolysis	hydrolysis

(Total for question = 6 marks)

Q13.

The presence of skin flora is one way that the skin protects the body from infection.

(a) (i) Describe how skin flora protect the body from infection.

(2)

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(ii) Give **one** other way in which the skin protects the body from infection.

(1)

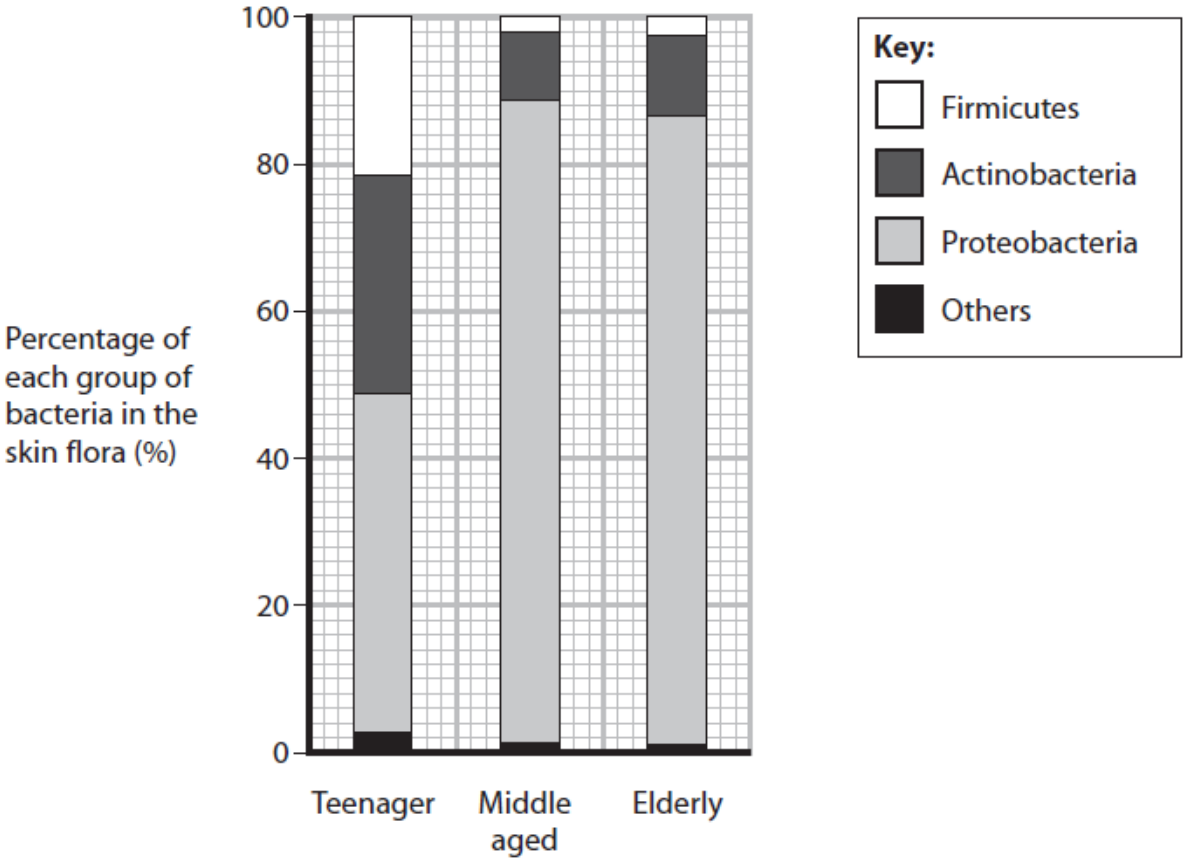
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(b) The groups of bacteria present on the skin of men of different ages was investigated.

The graph shows some of the results of this investigation.



(i) Describe **three** conclusions that could be made from this graph.

(3)

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(ii) Describe how this study should have been designed to collect valid data.

(2)

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(c) Some bacteria can get through the skin.

(i) Describe the role of macrophages in the non-specific response of the body to these bacteria.

(2)

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(ii) Describe the role of macrophages in the immune response of the body to these bacteria.

(2)

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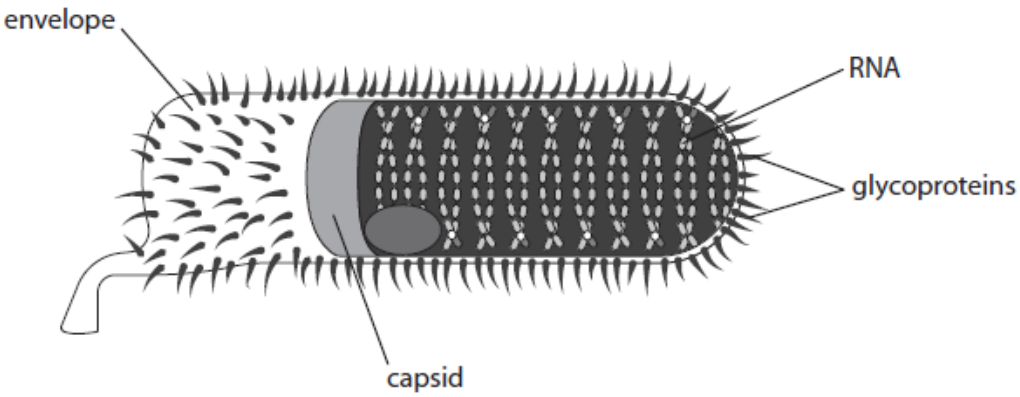
(Total for question = 12 marks)

Q14.

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

Rabies is a disease caused by a virus.

(a) The diagram shows the structure of the rabies virus.



(i) The rabies virus has an envelope.

Which of the following pairs of viruses have an envelope?

(1)

☒ **A** Ebola virus and human immunodeficiency virus (HIV)

☒ **B** human immunodeficiency virus (HIV) and tobacco mosaic virus (TMV)

☒ **C** lambda phage (λ phage) and Ebola virus

☒ **D** tobacco mosaic virus (TMV) and lambda phage (λ phage)

(ii) The structure of the rabies capsid is described as complex.

Which of the following has a complex capsid structure?

(1)

☒ **A** Ebola virus

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

☒ **C** lambda phage (λ phage)

☒ **D** tobacco mosaic virus (TMV)

(iii) Rabies virus is an RNA virus.

How many of the following viruses are RNA viruses?

- Ebola virus
- human immunodeficiency virus (HIV)
- lambda phage (λ phage)
- tobacco mosaic virus (TMV)

(1)

☒ **A** 1

☒ **B** 2

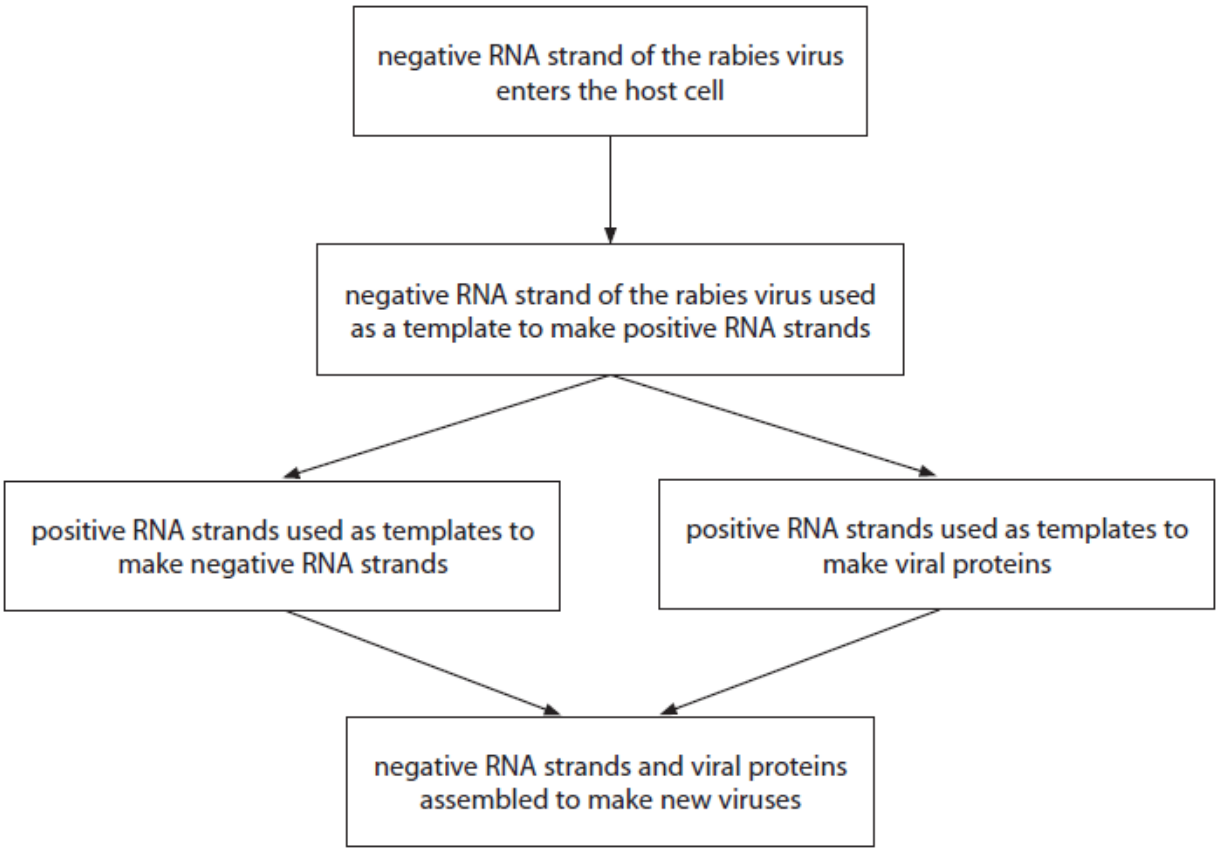
☒ **C** 3

☒ **D** 4

(b) The rabies virus replicates in a lytic cycle.

The RNA of the rabies virus is a negative RNA strand.

The diagram shows how the negative RNA strand of the rabies virus is used to make positive RNA and proteins.



(i) The diagram shows part of the base sequence in the negative RNA strand.

Complete the diagram to show the corresponding base sequence in the positive RNA strand.

(1)

Negative RNA strand	**A**	**C**	**C**	**A**	**A**	**G**	**G**	**C**	**G**
Positive RNA strand									

(ii) Explain why a positive RNA strand has to be made.

(2)

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(c) Lemurs are found in Madagascar. It is thought that they might carry rabies viruses.

The photograph shows a lemur.



(Source: Caroline Wilcox)

A person was bitten by a lemur.

This person did not receive any treatment for rabies until 18 days after being bitten.

Explain why doctors were worried that this person had left it too long for the treatment to be successful.

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(Total for question = 10 marks)

Q15.

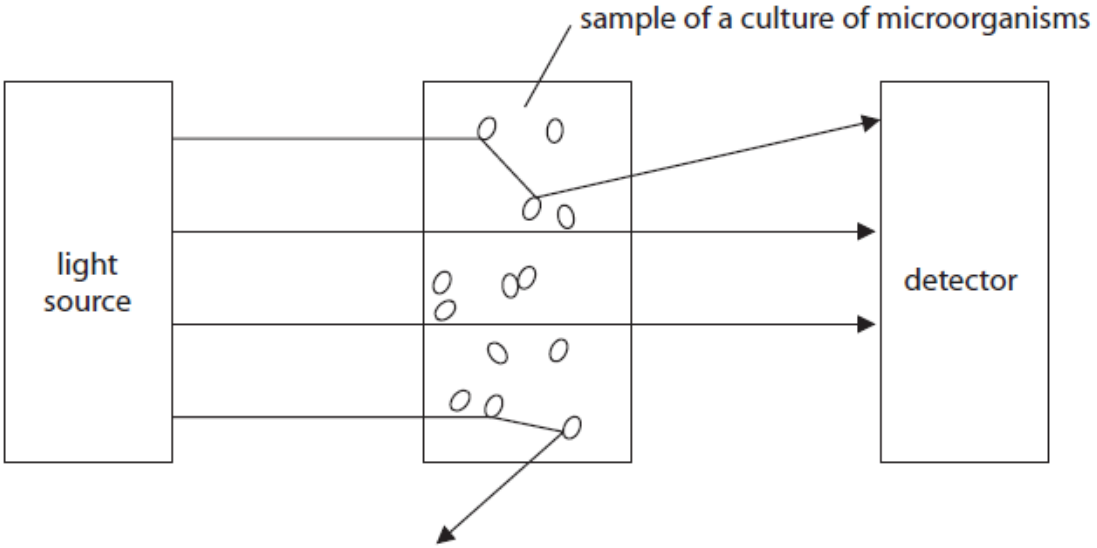
The growth of microorganisms can be studied using optical methods (turbidity).

The number of cells in 1 cm^3 of a culture can be estimated by using a photometer to measure the optical density of the culture.

Light is shone through a sample of the culture and a detector records the optical density.

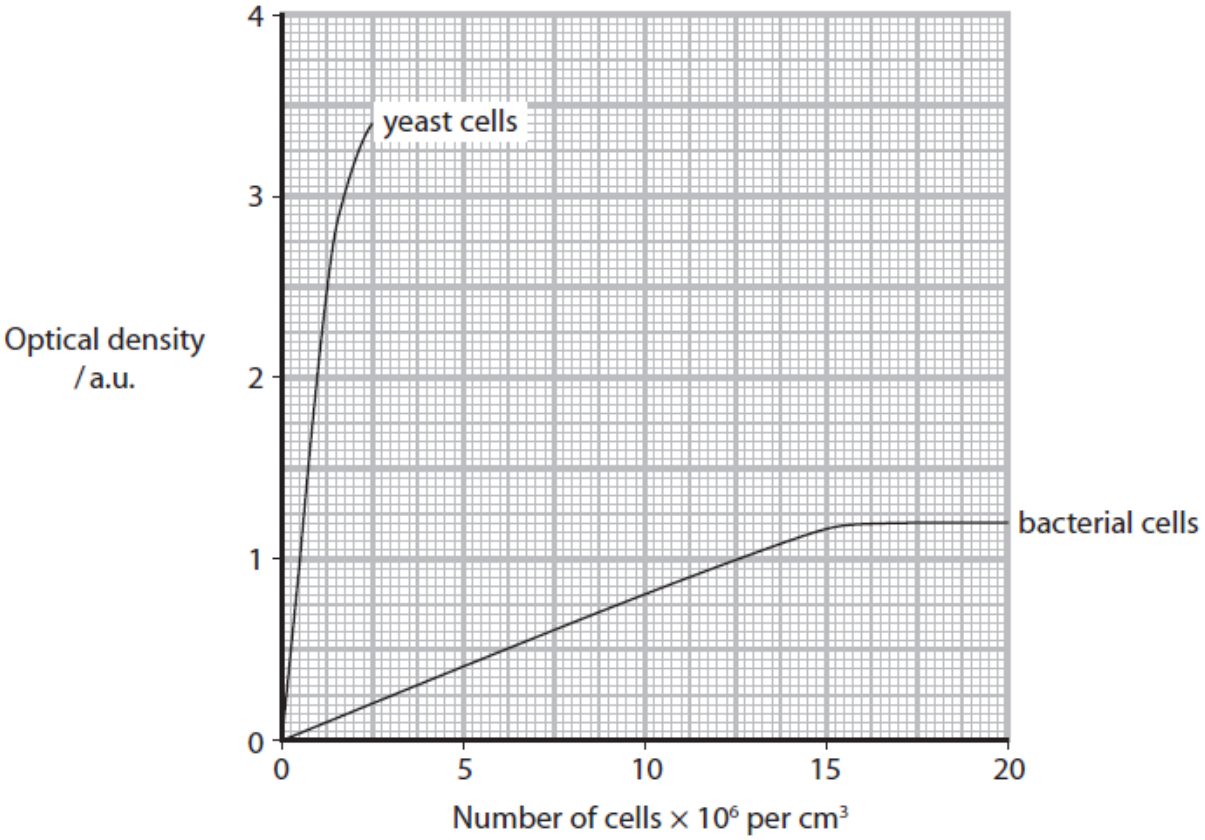
The more light absorbed by the culture, the higher the optical density.

The diagram shows what happens to light shone at a culture of microorganisms.

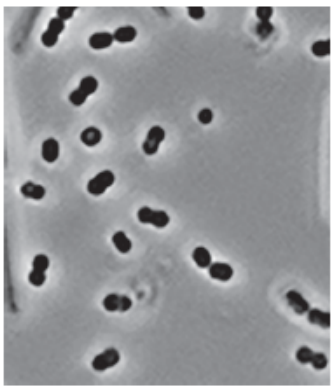


The number of cells in the sample is determined using a calibration curve.

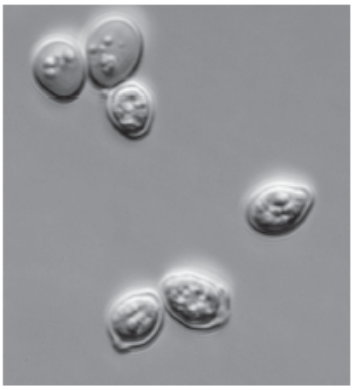
The graph shows a calibration curve for bacterial cells and yeast cells.



The photographs show bacterial cells and yeast cells, as seen using a light microscope.



bacterial cells



yeast cells

scale: 5 µm

© WIM VAN EGMOND/ SCIENCE PHOTO LIBRARY

©Uncia/Shutterstock

(a) State the relationship between optical density and the size of the microorganisms.

(1)

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(b) Calculate how many times more bacterial cells there are than yeast cells if both samples have an optical density of 1.0 a.u.

(2)

Answer .....

(c) (i) State the relationship between the number of bacterial cells and optical density.

(1)

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(ii) Suggest why using optical density to measure the concentration of microorganisms is more accurate at lower concentrations of cells.

Use the information in the diagram to support your answer.

(2)

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(d) A liquid medium was inoculated with 6×10^3 bacterial cells and the culture was incubated for a period of time.

At the end of this incubation period, there were 1.2×10^7 bacterial cells.

Calculate the time (t) of this incubation period.

Use a value of 0.963 for the growth rate constant (k) and the equation

$$k = \frac{\log_{10} N_t - \log_{10} N_0}{0.301 \times t}$$

(3)

Answer .....

*(e) Explain why one calibration curve cannot be used to determine the growth of all microorganisms.

Use all the information in this question and your own knowledge to support your answer.

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(Total for question = 15 marks)

Q16.

The photograph shows a Tasmanian devil.



(Source: © Walter 64 / Alamy Stock Photo)

Tasmanian devils are found in Tasmania.

The population of Tasmanian devils has fallen drastically due to a fatal cancer.
This cancer first appeared in the mid-1990s.

There are only a few regions in Tasmania left where healthy Tasmanian devils can still be found.

(a) The number of Tasmanian devils is estimated to have fallen from 150 000 in the mid-1990s to 25 000 in 2020.

Calculate the percentage decrease in the number of Tasmanian devils from the mid-1990s to 2020.

(1)

Answer ..... %

(b) Tasmanian devils feed on the dead bodies of animals (carcasses) and scare off other scavengers.

Scientists have studied the scavenging of carcasses in two regions of Tasmania: one region where all Tasmanian devils were healthy and one region where the cancer was common.

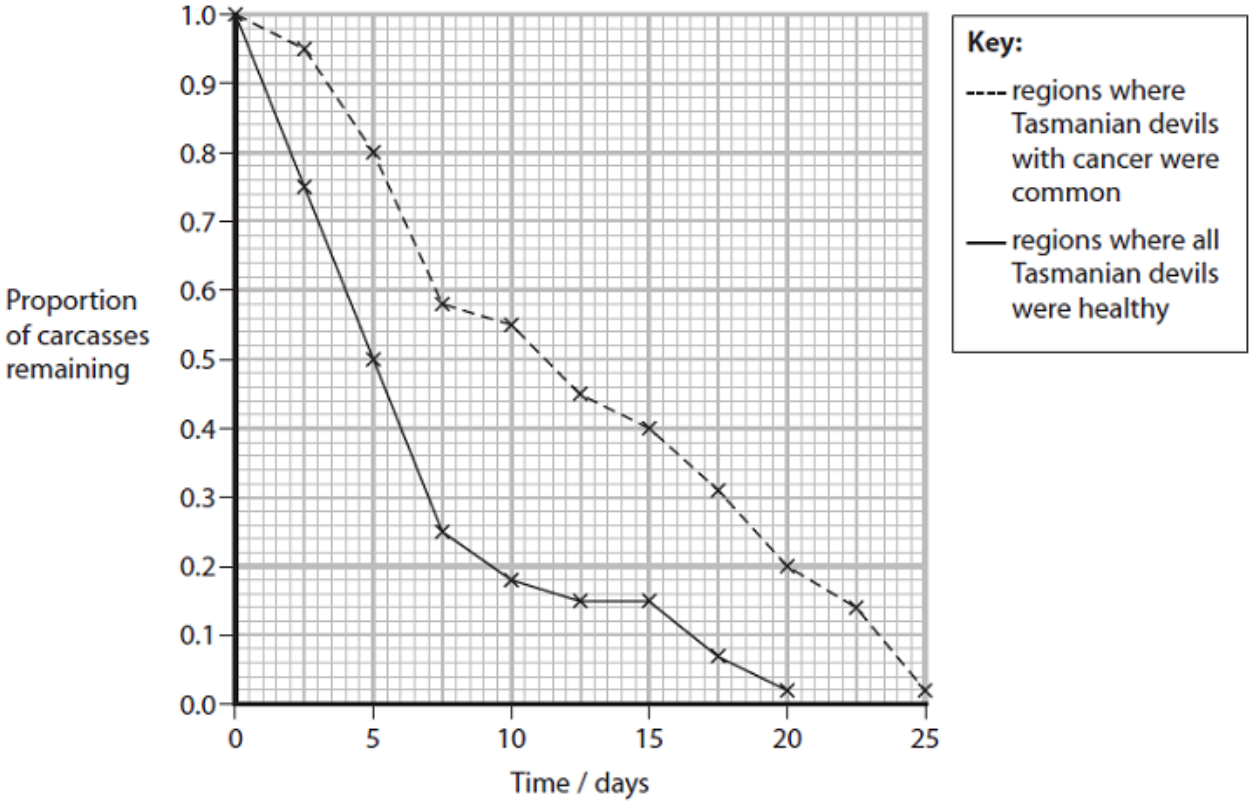
The length of time Tasmanian devils and three other scavenging animals spent feeding on carcasses was investigated.

The results are shown in the table.

Region	Proportion of time the scavengers spent feeding on each carcass			
	Tasmanian devil	Forest raven	Spotted-tailed quoll	Feral cat
Where all Tasmanian devils were healthy	0.76	0.13	0.06	0.05
Where Tasmanian devils with cancer were common	0.26	0.38	0.20	0.16

The length of time it took for the carcasses to be completely eaten was also investigated.

The results are shown in the graph.



*(i) Explain the results of these two studies.

Use the information in the table and the graph to support your answer.

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(ii) Explain what other **biotic** factors could have affected the results from the two different regions of Tasmania, in the second investigation.

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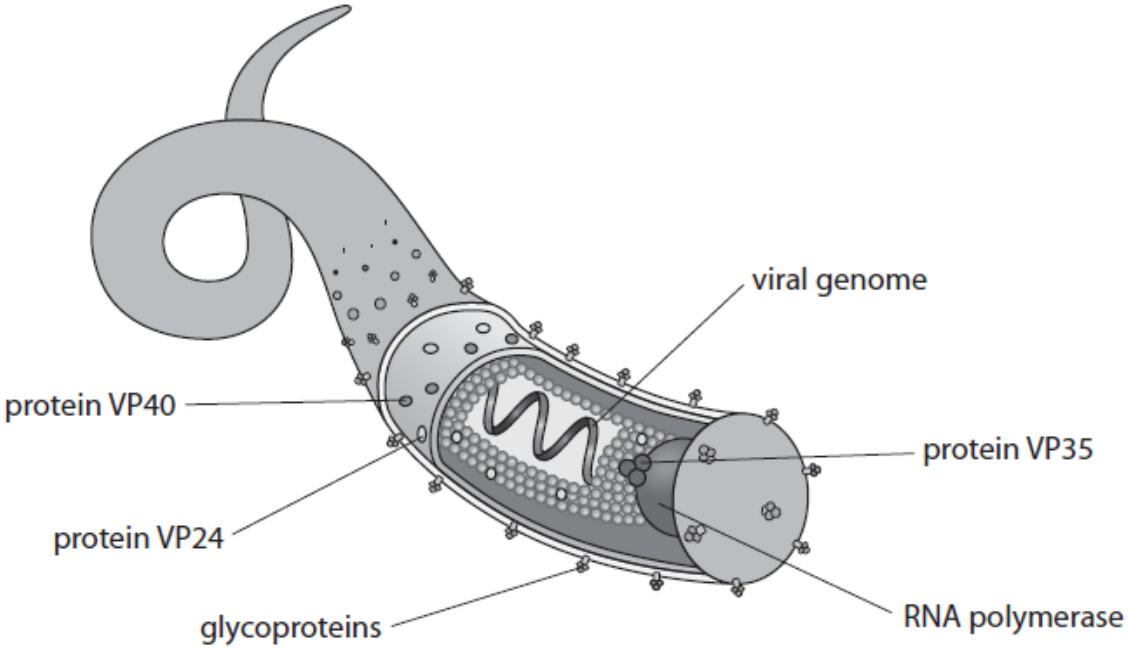
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(Total for question = 11 marks)

Q17.

In December 2018 there was an outbreak of Ebola, with 500 cases being reported.

The diagram shows the structure of an Ebola virus.



(a) Describe the role of each of the following.

(i) The viral genome

(2)

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(ii) The glycoproteins

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(b) The enzyme RNA polymerase is involved in RNA transcription.

Explain why the structure of the Ebola virus includes RNA polymerase.

(2)

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(c) The proteins VP24 and VP40 are involved in virus assembly.

State what is meant by the term virus assembly, using Ebola as an example.

(2)

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(d) The protein VP35 inhibits the production of interferon by host cells.

Explain why the structure of the Ebola virus includes VP35.

(2)

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(Total for question = 10 marks)

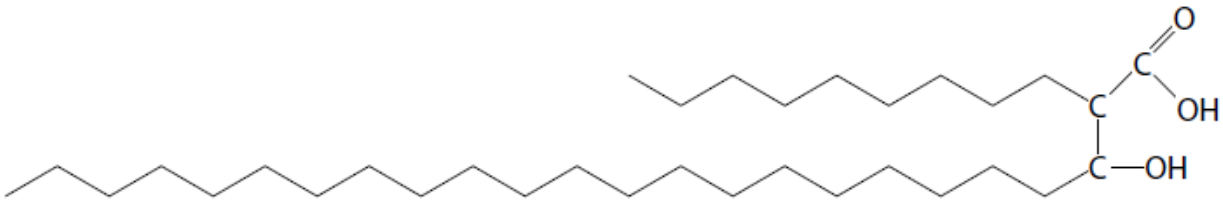
Q18.

Tuberculosis is a disease caused by infection with *Mycobacterium tuberculosis*.

The cell wall of *M. tuberculosis* is different from most other types of bacteria as it contains different types of mycolic acid.

Mycolic acid protects the bacteria from lysozyme action, dehydration and polar (hydrophilic) antibiotics.

The diagram shows part of one type of mycolic acid.



(a) What type of molecule is mycolic acid?

(1)

☒ **A** carbohydrate

☒ **B** fatty acid

☒ **C** nucleic acid

☒ **D** polypeptide

(b) Treatment for tuberculosis involves the use of different types of antibiotic, taken over several months.

The table gives details of four antibiotics used to treat tuberculosis.

Antibiotic	Mode of action
E	disrupts the formation of the cell wall
J	inhibits the synthesis of mycolic acids
P	activates an enzyme that inhibits the synthesis of fatty acids
R	binds to the active site of RNA polymerase

(i) Suggest why antibiotic E is effective only when *M. tuberculosis* bacteria are dividing.

(1)

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(ii) Explain why antibiotic J could result in an increase in antigen presentation by macrophages.

(2)

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(iii) Explain how antibiotic P could affect *M. tuberculosis*.

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(iv) Explain how antibiotic R could affect *M. tuberculosis*.

(3)

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(v) Explain why taking a combination of antibiotics for several months could increase the resistance of *M. tuberculosis* to these antibiotics.

(2)

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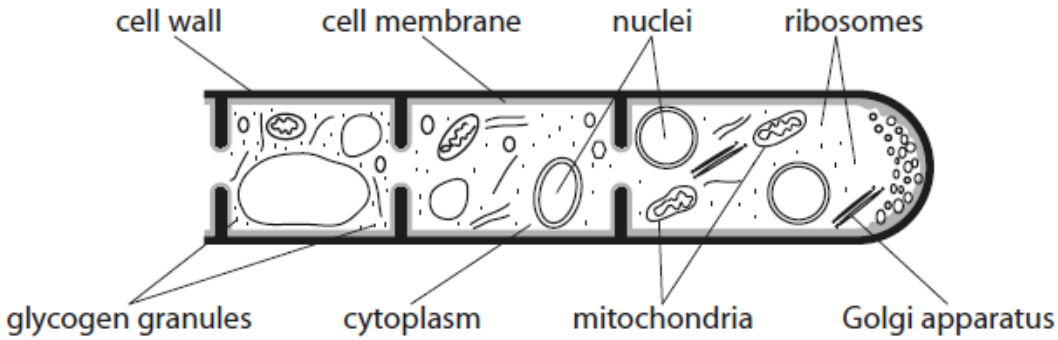
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(Total for question = 12 marks)

Q19.

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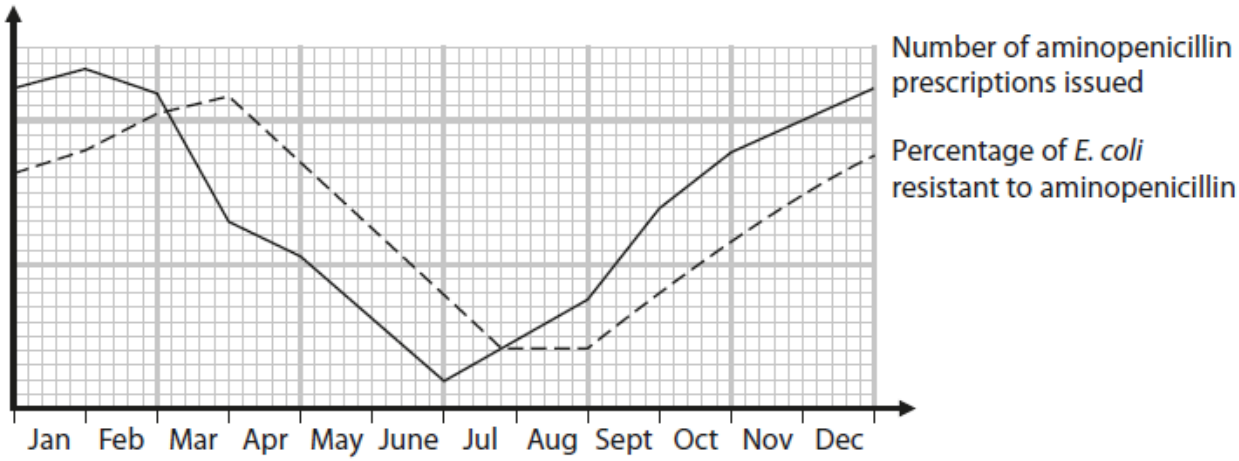
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(b) The graph shows the number of prescriptions of the antibiotic, aminopenicillin, issued in one year.

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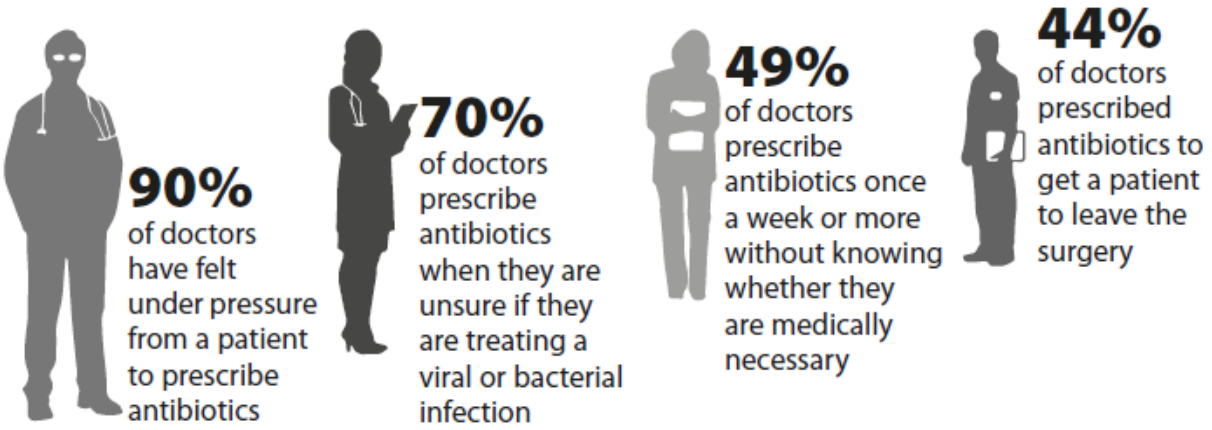
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(c) The results of a survey are shown in the diagram.



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

(3)

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(Total for question = 11 marks)

Q20.

In 2018, an organisation carried out a global survey into the attitudes of people towards vaccines.

Vaccines provide artificial active immunity.

(a) Describe how a vaccine results in active immunity.

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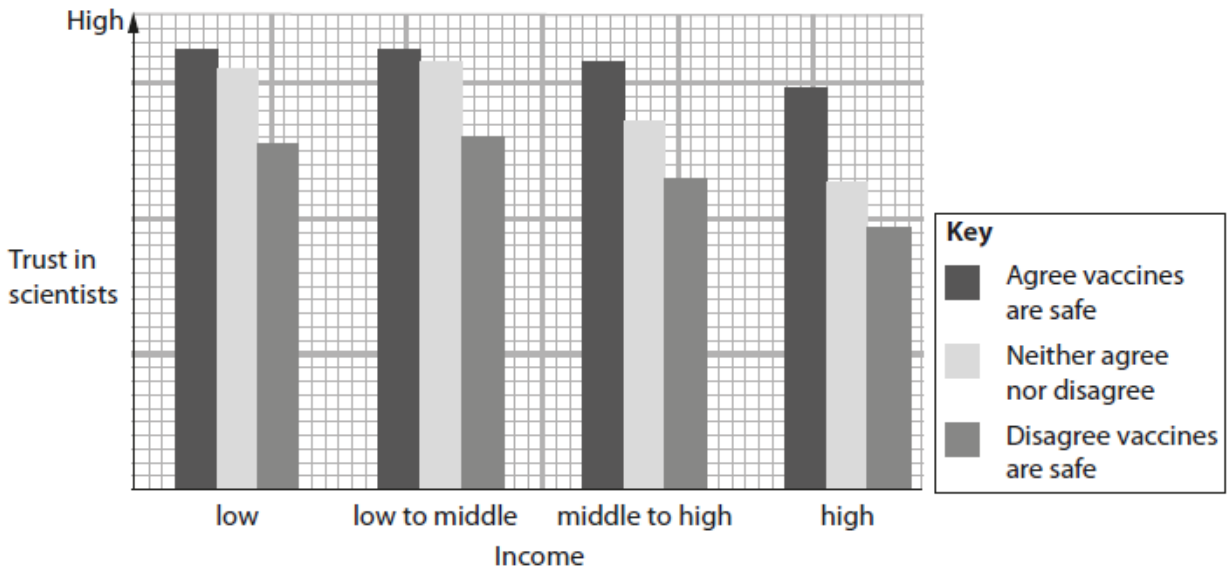
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(b) This survey included three aspects:

- the trust that people have in scientists
- their thoughts on the safety of vaccines
- their income.

The graph shows some of the results of this survey.



(i) Identify **three** conclusions that can be drawn from the results of this survey.

(3)

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(ii) Suggest **one** reason for the different attitudes of these people.

(1)

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(c) The more people in a population who are vaccinated against a disease, the less likely it is for non-vaccinated people
to become infected.

Suggest why vaccination is more successful when a greater proportion of people are vaccinated.

(2)

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(Total for question = 10 marks)

Q21.

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)

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

Explain the role of lysins in the lytic cycle.

(2)

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(Total for question = 8 marks)

Q22.

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

The following features of viruses can be used to classify them:

- the type of nucleic acid they contain
- the arrangement of the proteins in their capsid
- the presence or absence of an envelope
- the enzymes they contain.

(a) For each structure, put one cross ☒ in the appropriate box, in each row, to show which viruses have that structure.

(3)

Structure	Virus			
	Ebola only	HIV only	both Ebola and HIV	neither Ebola nor HIV
DNA	☒	☒	☒	☒
helical capsid	☒	☒	☒	☒
envelope	☒	☒	☒	☒

(b) Human cells contain several types of DNA polymerase.

One type of DNA polymerase, found in some cancer cells, has been shown to synthesise DNA from an RNA template.

(i) Name the enzyme, found in some types of virus, that can synthesise DNA from an RNA template.

(1)

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(ii) Suggest why this DNA polymerase may be a target for drugs used to treat cancer.

(1)

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(Total for question = 5 marks)