EDEXCEL

UNIT 4 QP

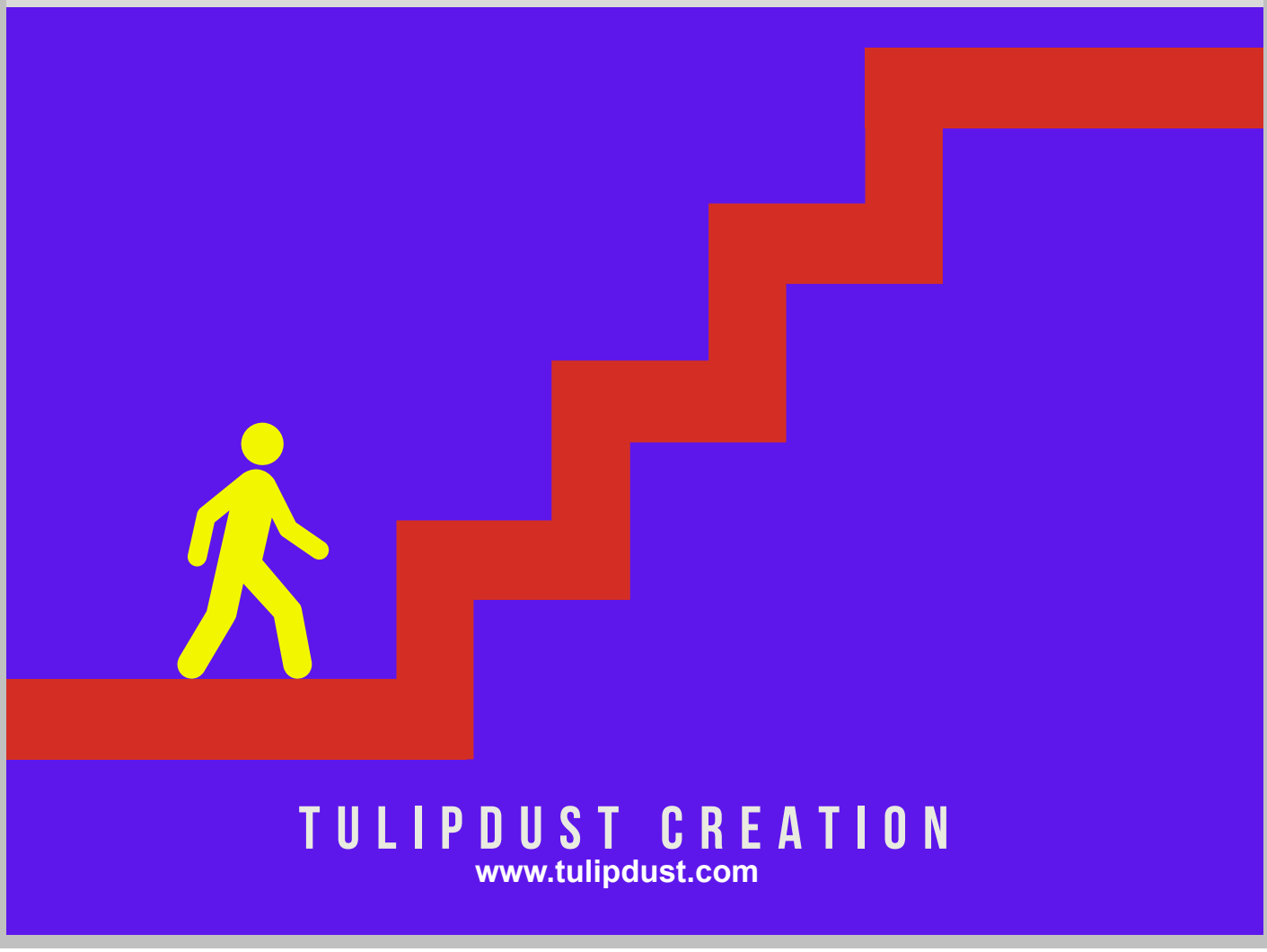
BIOLOGY

PAST PAPERS

2019 - 2024

14 Papers |410 Pages| Spiral book

Hard cover | HQ Print



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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

Wednesday 8 January 2020

Afternoon (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

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- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
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Turn over ▶

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P 6 0 5 6 6 A 0 1 3 2

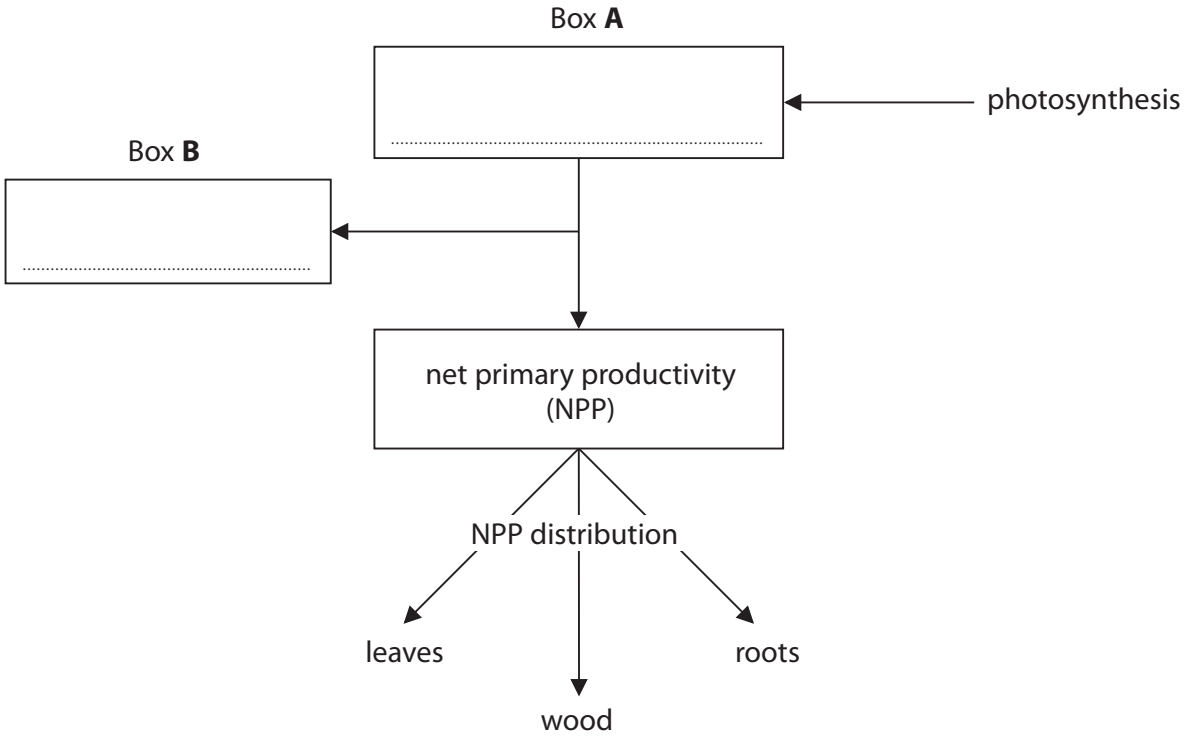
Pearson

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 The diagram shows some processes linking photosynthesis to productivity and the distribution of biomass in the trees in a forest.



(a) Complete the diagram by writing the appropriate word or words in box **A** and in box **B**.

(1)

(b) In a healthy forest ecosystem, the NPP should be distributed equally to the leaves, wood and roots.

(i) State the meaning of the term **ecosystem**.

(1)

.....

.....

.....

(ii) Which of the following are the units for NPP?

(1)

☒ **A** $kg\,m^{-1}\,yr^{-1}$

☒ **B** $kg\,m^{-2}\,yr^{-2}$

☒ **C** $kJ\,m^{-1}\,yr^{-1}$

☒ **D** $kJ\,m^{-2}\,yr^{-1}$

(iii) In this forest, the total NPP was 11 700 units.

The leaves contained 34% of the NPP and the wood contained 39% of the NPP.

Calculate the NPP content in the roots.

(2)

Answer ..... units

(Total for Question 1 = 5 marks)

2 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)

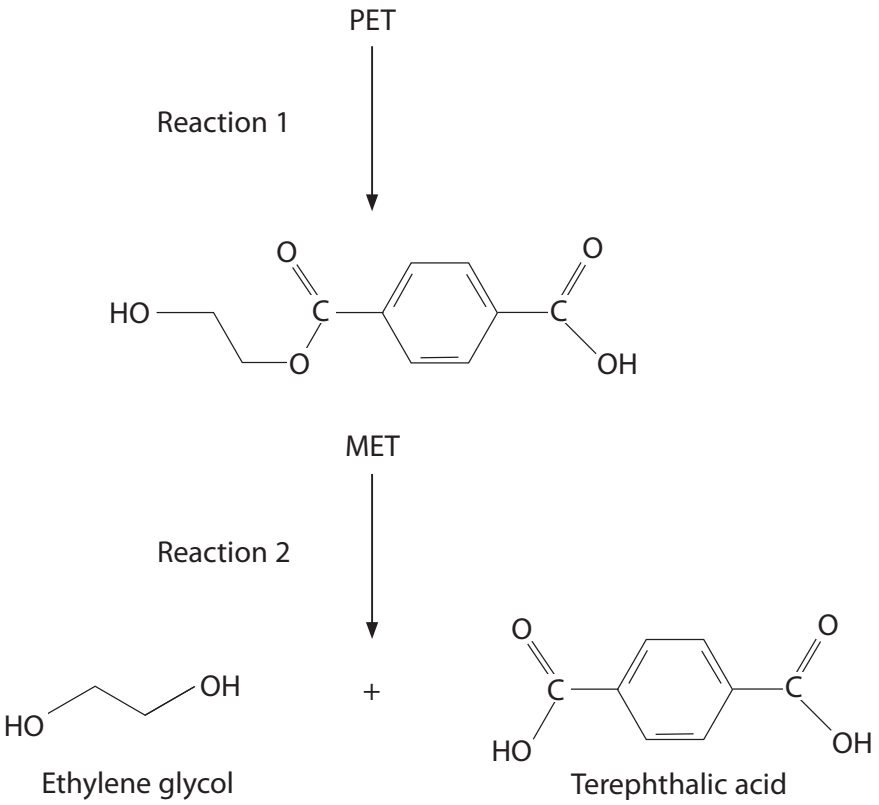
(ii) Explain how microorganisms could evolve to break down plastics.

(3)

(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.



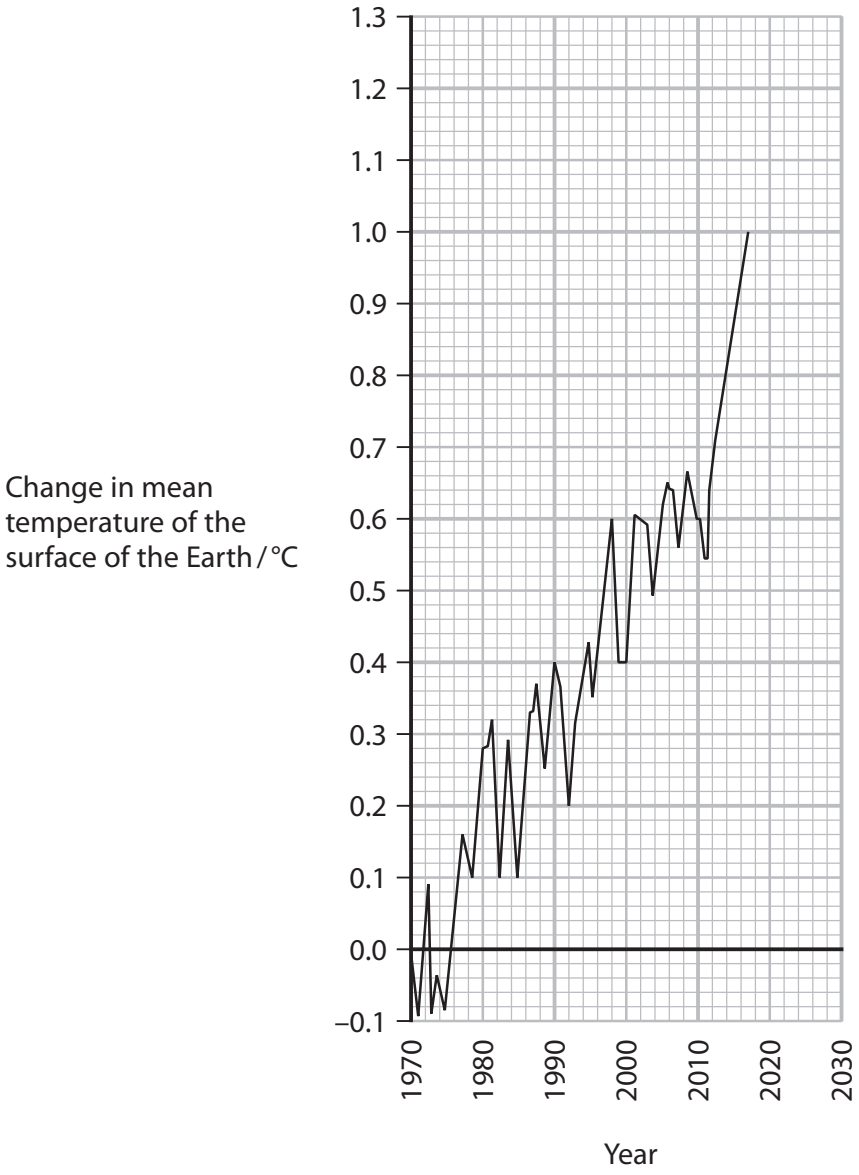
Which row of the table describes reaction 1 and reaction 2?

(1)

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

(Total for Question 2 = 6 marks)

3 The graph shows the changes in mean temperature of the surface of the Earth from 1970 to 2017.



(a) Which of the following gases could be responsible for these temperature changes?

(1)

☒ **A** carbon dioxide and methane

☒ **B** carbon dioxide and oxygen

☒ **C** carbon dioxide, methane and oxygen

☒ **D** methane and oxygen

(b) What is the estimated change in the mean temperature of the surface of the Earth in 2030?

(1)

☒ **A** 1.3

☒ **B** 1.1

☒ **C** 0.8

☒ **D** 0.2

(c) Ultraviolet light has a shorter wavelength than infrared radiation.

Which row of the table describes the passage of ultraviolet light and infrared radiation, reflected from the surface of the Earth, through gases in the atmosphere?

(1)

	Ultraviolet light	Infrared radiation
☒ **A**	passes through	passes through
☒ **B**	passes through	does not pass through
☒ **C**	does not pass through	passes through
☒ **D**	does not pass through	does not pass through

(d) Studying the width of tree rings provides evidence for climate change.

(i) Which of the following involves the study of tree rings?

(1)

☒ **A** dendrochronology

☒ **B** entomology

☒ **C** epigenetics

☒ **D** proteomics

(ii) Explain why the width of tree rings produced in 1970 would be different from the width of tree rings produced in 2010.

(3)

(Total for Question 3 = 7 marks)

4 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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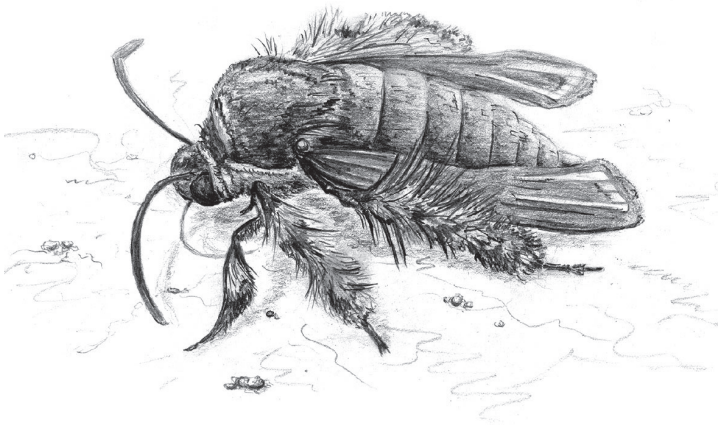
(b) The diagram shows an Oriental blue clearwing, a species of moth found in the rainforests of Malaysia.



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)

(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.

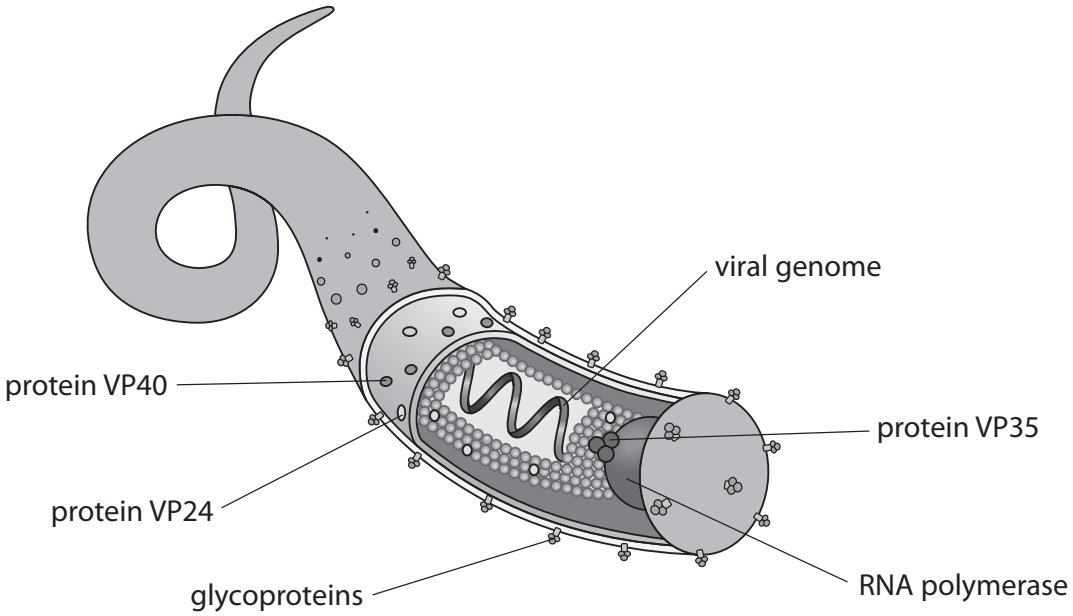
Describe how this comparison could be made.

(3)

(Total for Question 4 = 12 marks)

5 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

(2)

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

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

(2)

(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)

(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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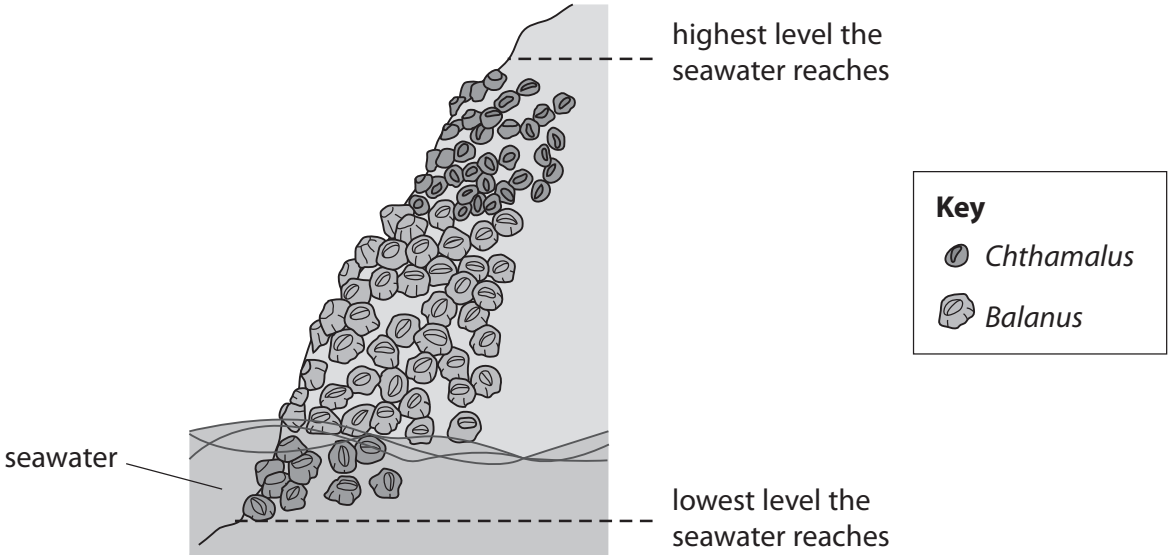
(Total for Question 5 = 10 marks)

6 The photograph shows barnacles attached to a rock on a seashore.

The list gives some facts about barnacles:

- barnacles are marine animals that live inside their shells
- the shells are permanently attached to a solid surface
- barnacles feed on food particles that they filter from the water
- barnacles reproduce sexually and produce larvae that swim in the seawater
- larvae settle on suitable surfaces such as rocks.

(a) The diagram shows the distribution of two types of barnacle, *Chthamalus* and *Balanus*, on a rock.



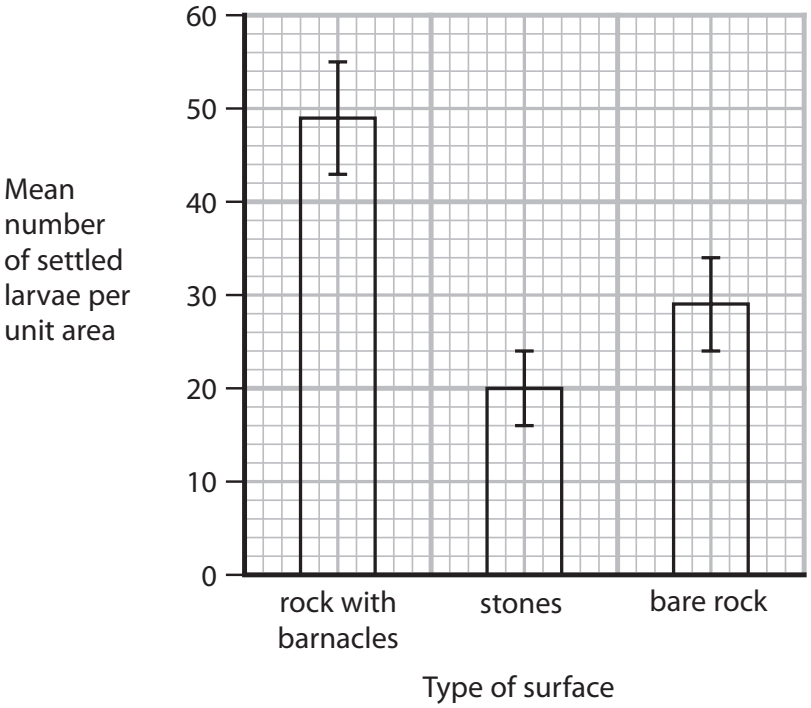
These two types of barnacle occupy different niches.

Explain how the distribution and abundance of these two types of barnacle on this rock show that these barnacles occupy different niches.

(3)

(b) The types of surface that the larvae settled on were studied.

The graph shows the results of this study.



(i) Comment on the reliability of the conclusions that can be drawn from this study.

(4)

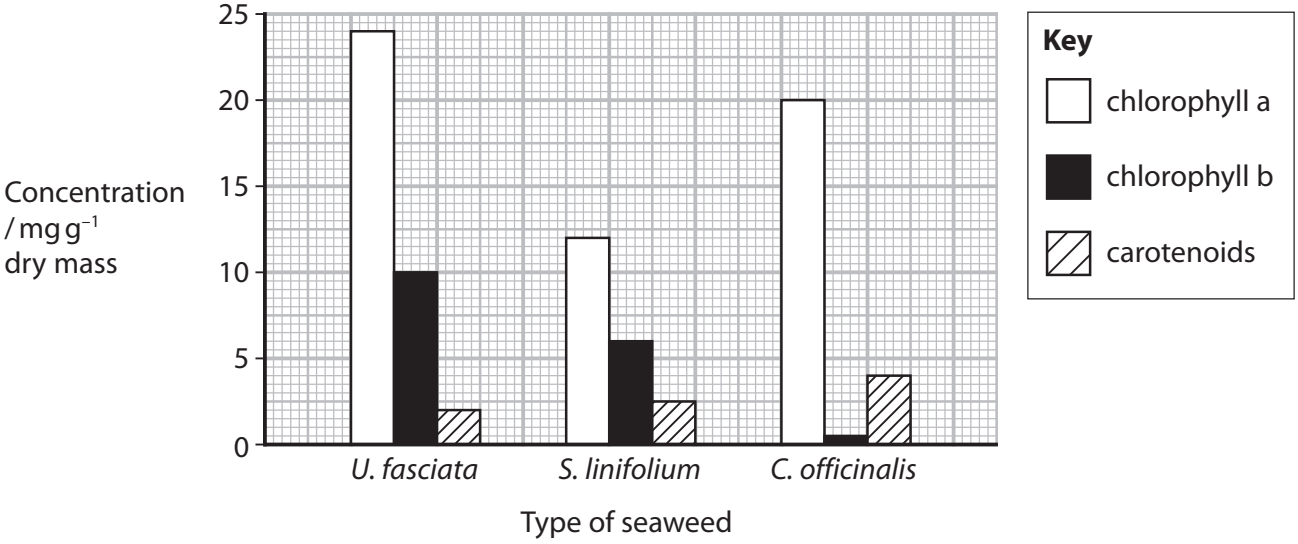
(ii) Describe how this study could be carried out in a laboratory.

(4)

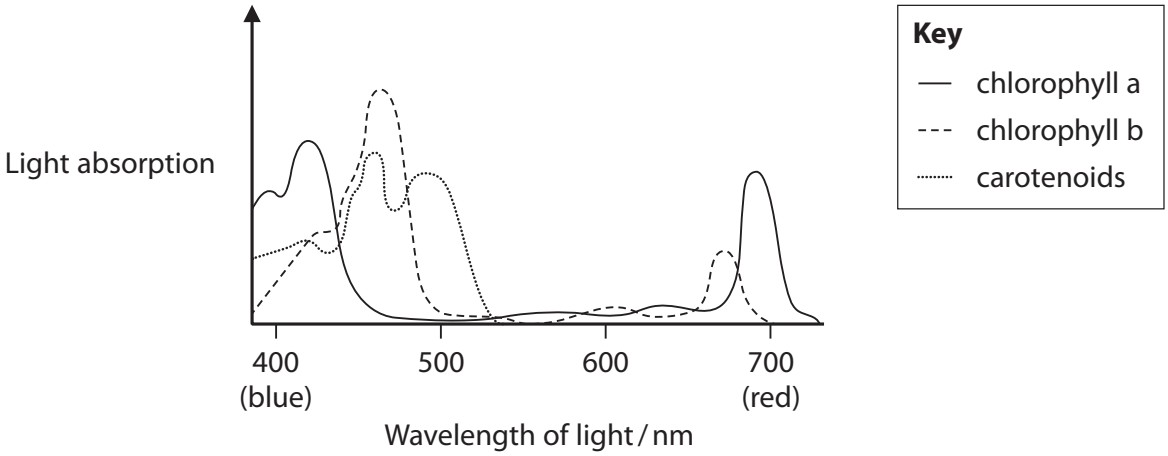
(Total for Question 6 = 11 marks)

7 The composition of three seaweeds, *U. fasciata*, *S. linifolium* and *C. officinalis*, collected from a beach in Egypt, was determined.

(a) The graph shows the chloroplast pigments extracted from these seaweeds.



The graph shows the absorption spectrum for these three chloroplast pigments.



(i) Which row of the table shows the colour of each of these seaweeds?

(1)

	U. fasciata	*S. linifolium*	*C. officinalis*
☒ **A**	green	brown	red
☒ **B**	green	red	green
☒ **C**	red	brown	red
☒ **D**	red	green	green

(ii) Explain the role of chloroplast pigments in the light-dependent reactions of photosynthesis.

(2)

(b) The table shows some of the compounds found in two of these seaweeds.

Compound	*U. fasciata*	*S. linifolium*
*carotenoids / mg g^{-1} dry mass	2.00	3.00
*phenols / a.u. g^{-1} dry mass	11.95	10.35
*flavonoids / a.u. g^{-1} dry mass	7.04	4.53
carbohydrates / percentage of dry mass	23.70	25.03
proteins / percentage of dry mass	9.56	14.89
lipids / percentage of dry mass	2.96	2.16

* antioxidants

(i) Describe how GALP, produced in chloroplasts, is converted into protein.

(3)

*(ii) These seaweeds are considered to be a healthy, environmentally-friendly and economic food source.

Comment on this statement.

Use the information in the table and your own knowledge to support your answer.

(6)

(Total for Question 7 = 12 marks)

8 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

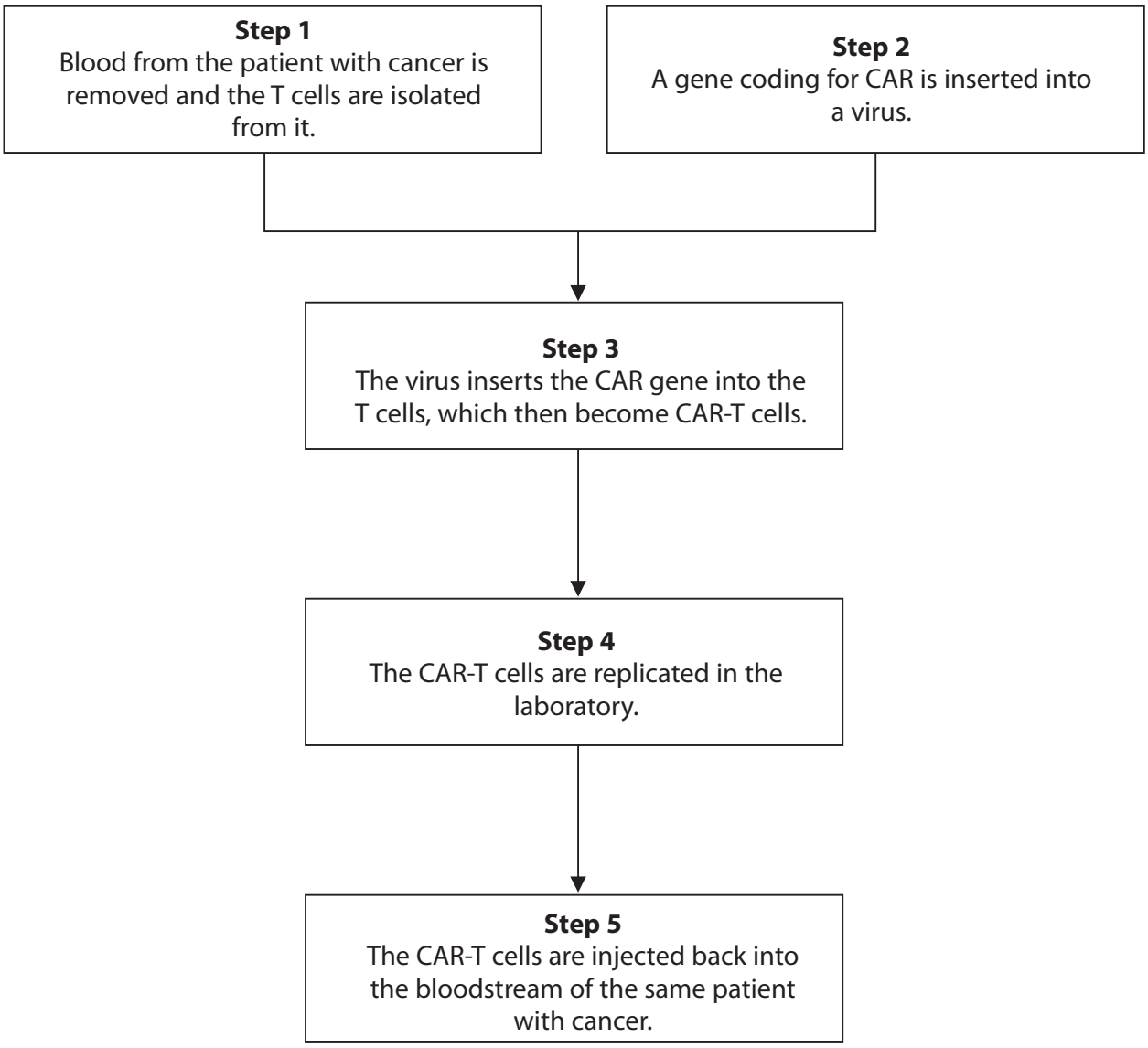
(b) Immunotherapy, using genetically-modified T cells, is being developed to treat blood cell cancers.

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)

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

(3)

(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**.

(3)

(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)

(Total for Question 8 = 12 marks)

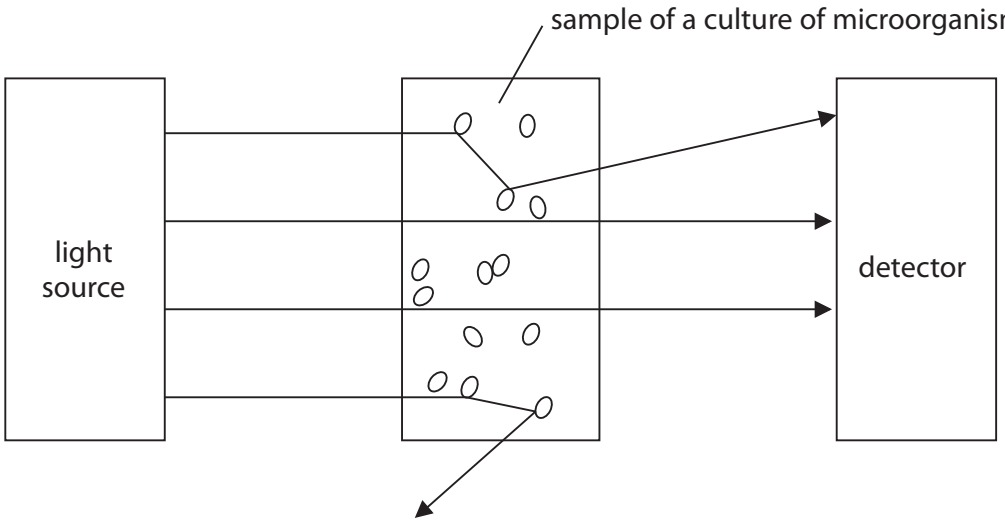
9 The growth of microorganisms can be studied using optical methods (turbidity).

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.

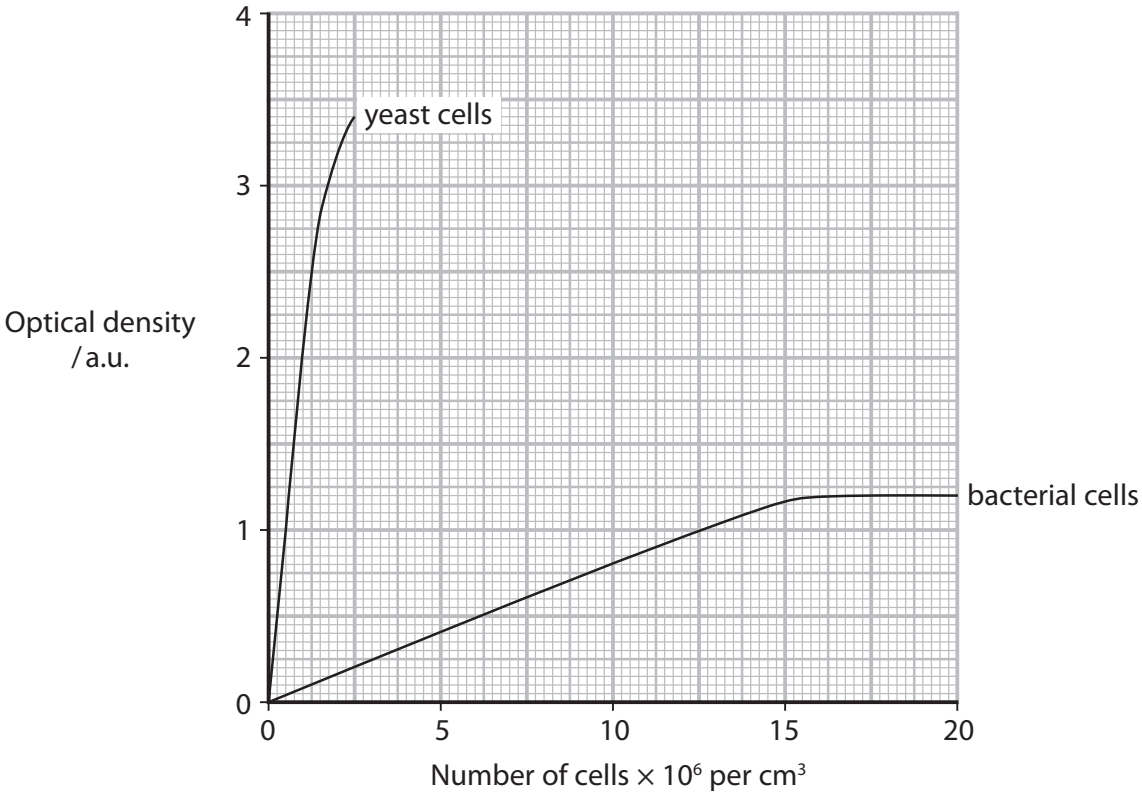
The more light absorbed by the culture, the higher the optical density.

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

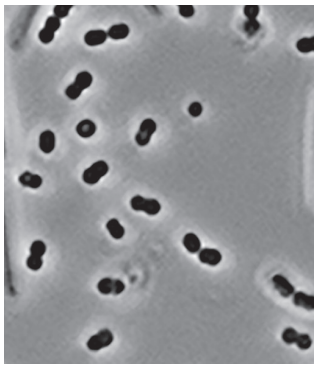


The number of cells in the sample is determined using a calibration curve.

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

(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.

(6)

(Total for Question 9 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

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International Advanced Level

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International Advanced Level

Unit 4 : Energy, Environment, Microbiology and Immunity

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P 6 6 1 5 6 A 0 1 3 2

Pearson

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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?

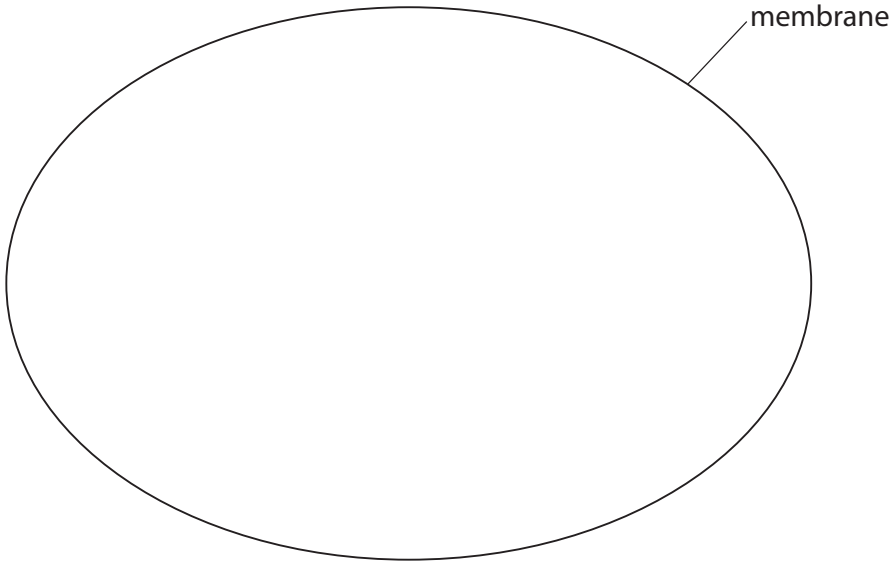
(1)

		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)



(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)

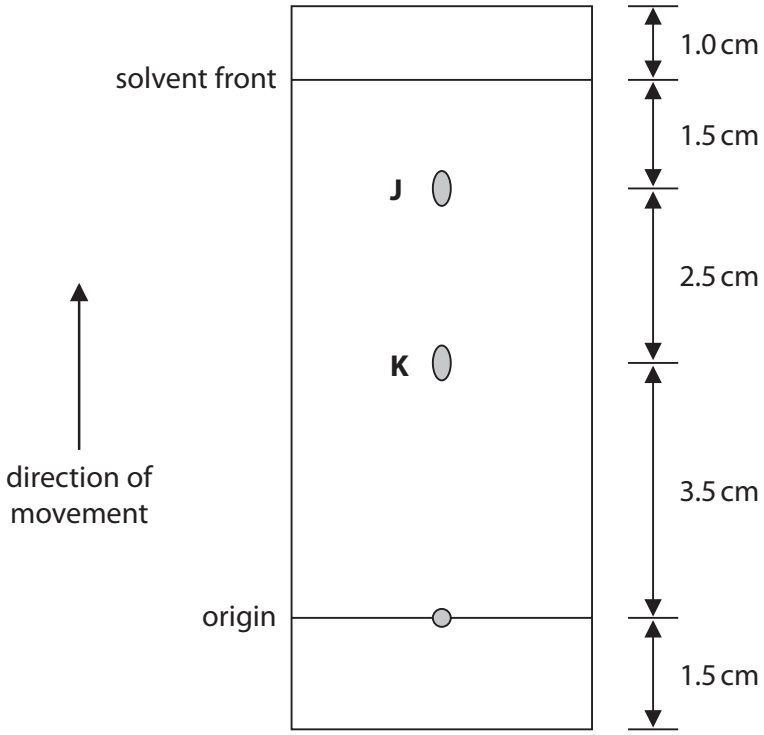
☒ **A** chromatography

☒ **B** dendrochronology

☒ **C** osmosis

☒ **D** PCR

(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)

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

(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)

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.

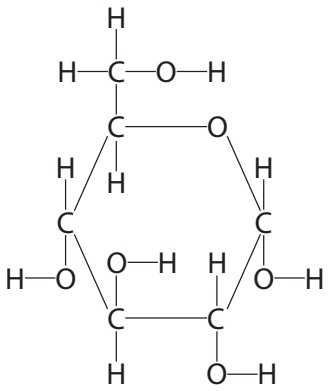
(1)

Answer ..... kJ

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

(4)

(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

(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)

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)

.....

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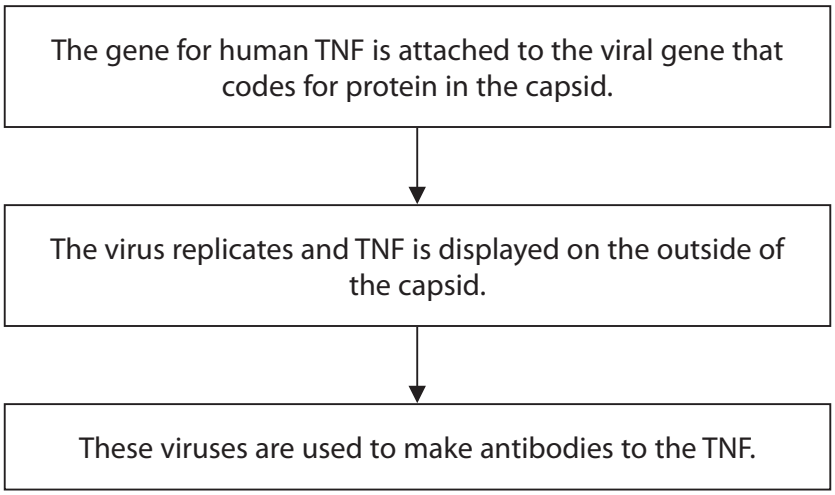
(b) Tumour necrosis factor (TNF) is a protein that can be released by several types of cell. It plays an important part in the immune response.

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)

(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)

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)

6 The photograph shows a ground squirrel.

(Source: Caroline Wilcox)

magnification × 0.5

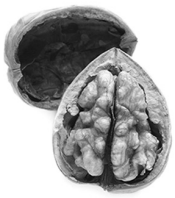
Ground squirrels feed on a variety of foods including nuts.

Ground squirrels have evolved food pouches.

The photograph shows the food pouches of a ground squirrel.

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

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

(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)

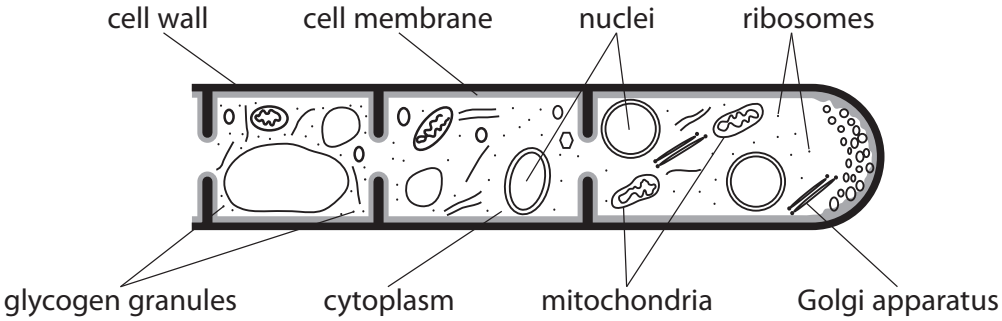
(c) Suggest how ground squirrels evolved pouches.

(3)

(Total for Question 6 = 10 marks)

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

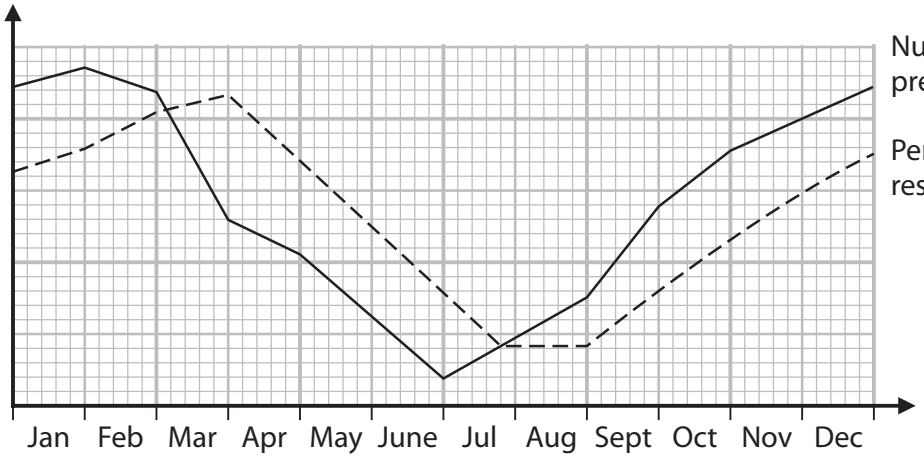
(ii) Explain why fungi are not classified as bacteria, plants or animals.

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

(3)

(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.



Number of aminopenicillin prescriptions issued

Percentage of *E. coli* resistant to aminopenicillin

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)

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

90%
of doctors have felt under pressure from a patient to prescribe antibiotics

70%
of doctors prescribe antibiotics when they are unsure if they are treating a viral or bacterial infection

49%
of doctors prescribe antibiotics once a week or more without knowing whether they are medically necessary

44%
of doctors prescribed antibiotics to get a patient to leave the surgery

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

(3)

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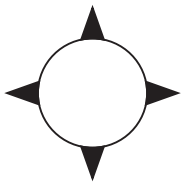
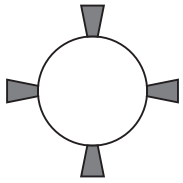
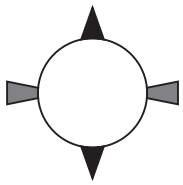
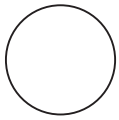
(Total for Question 7 = 11 marks)

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

(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)

(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 8 = 11 marks)

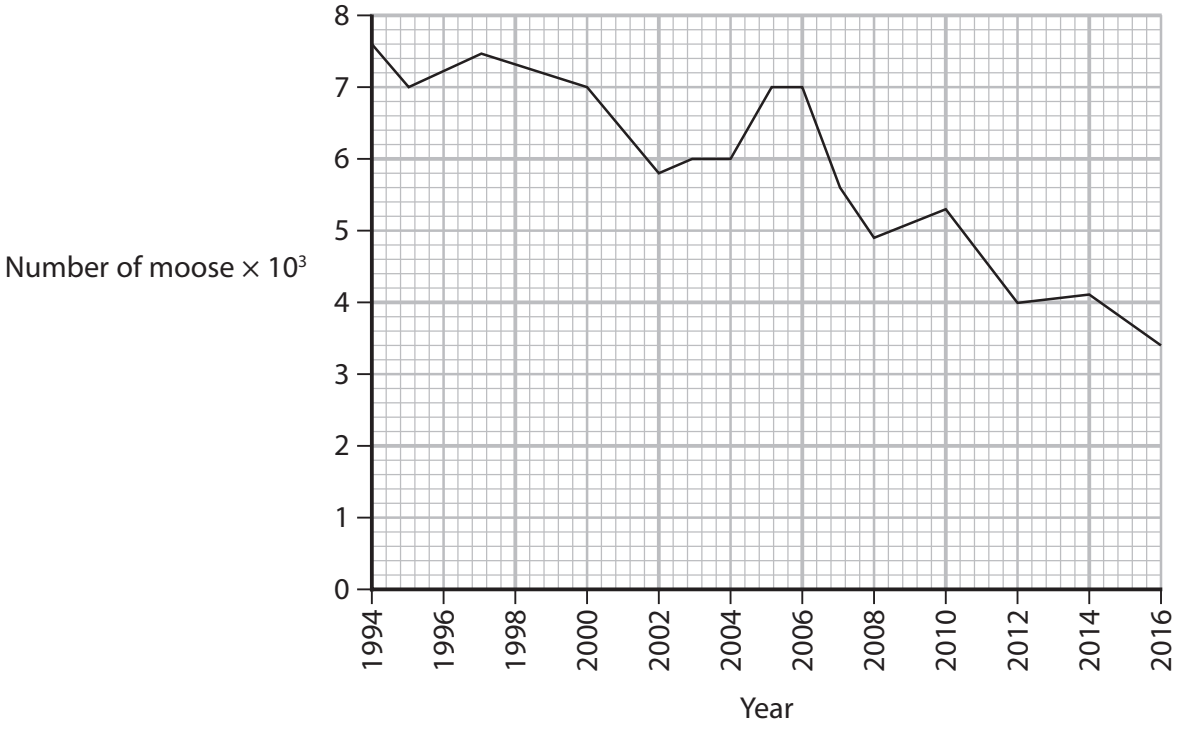
9 The photograph shows a moose.

(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)

(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.

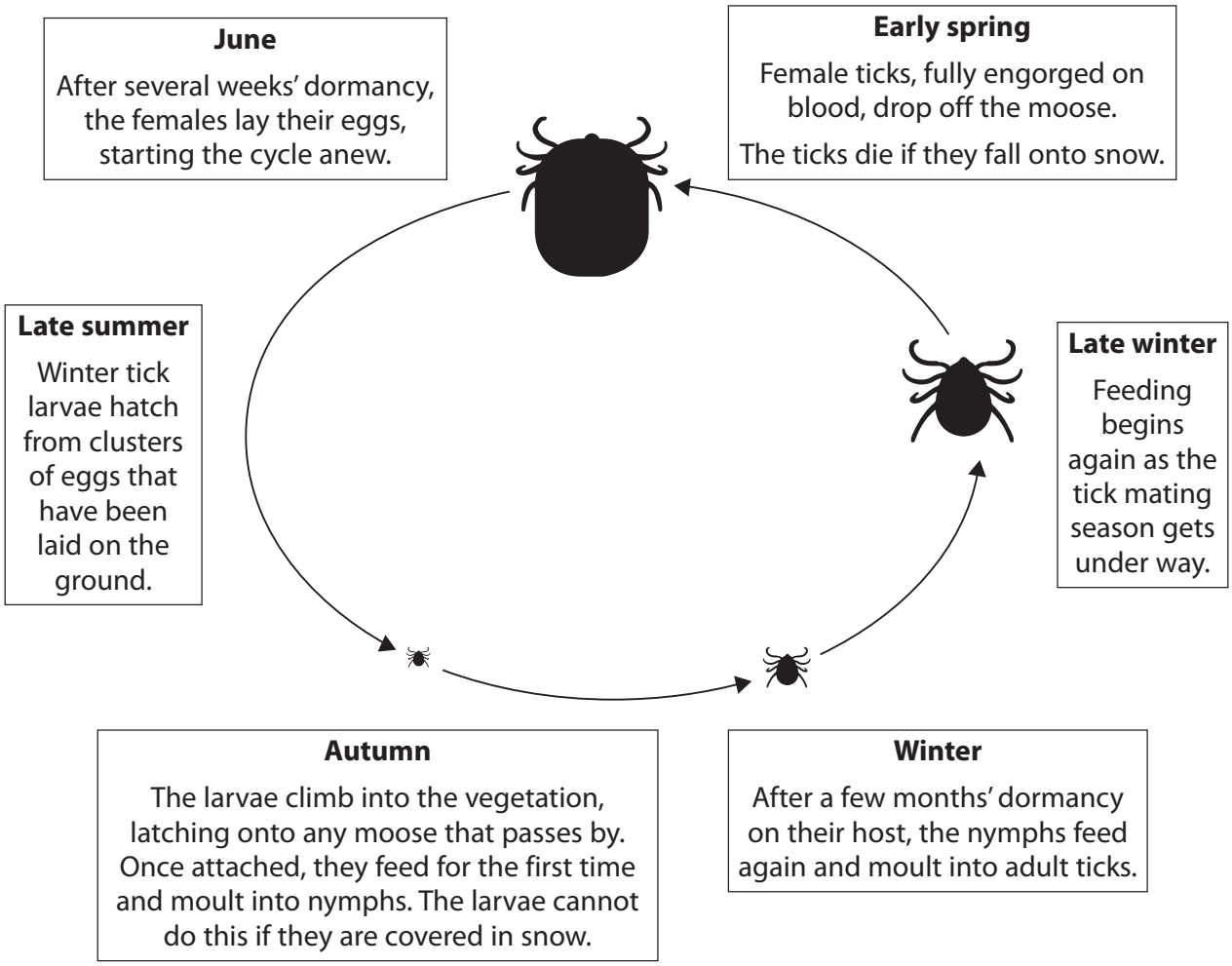
Number of ticks	Number of moose
1 to 9 999	32
10 000 to 19 999	46
20 000 to 29 999	41
30 000 to 39 999	32
40 000 to 49 999	22
50 000 to 59 999	15
60 000 to 69 000	9
70 000 to 79 999	4
80 000 to 89 999	4
90 000 to 99 999	3
100 000 or more	6

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

(2)

Answer ..... %

*(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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(Total for Question 9 = 14 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | Candidate Number

Time 1 hour 45 minutes

Paper reference **WBI14/01**

Biology

International 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.
- Good luck with your examination.

Turn over ▶

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P 6 7 7 9 2 A 0 1 3 2

Pearson

Answer ALL questions.

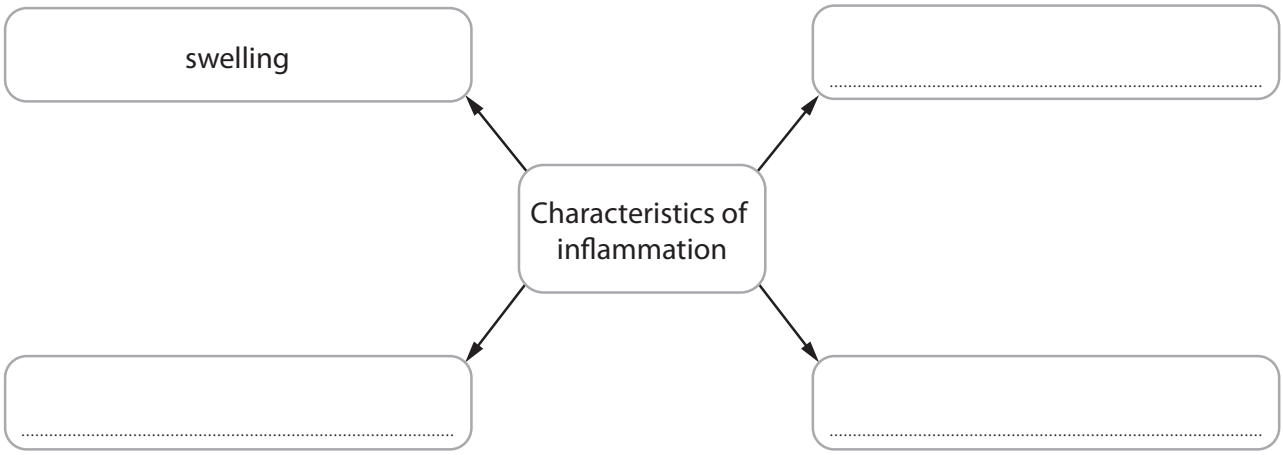
Write your answers in the spaces provided.

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 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.

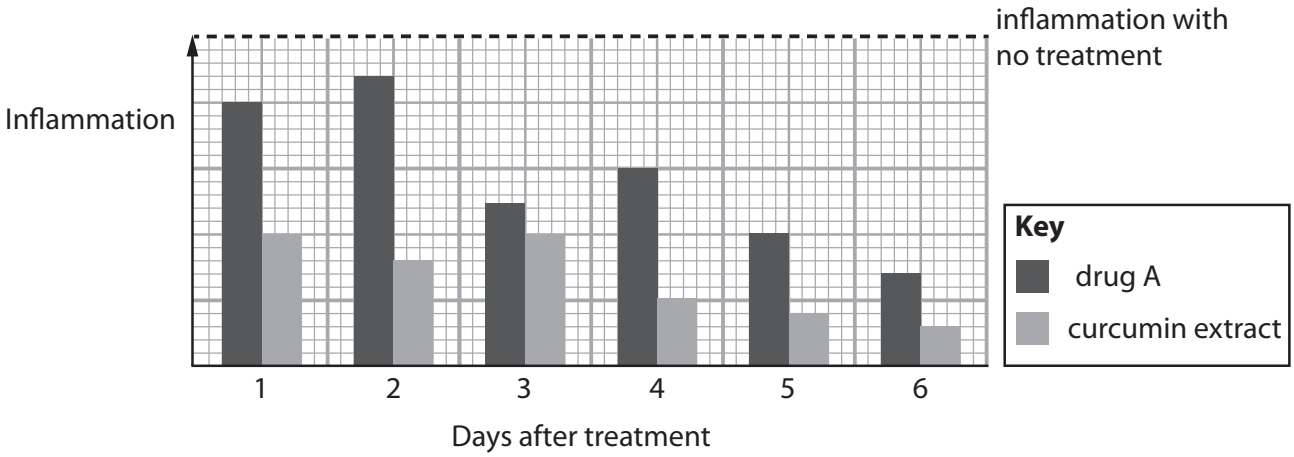
(2)

(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 1 = 8 marks)

2 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.

(2)

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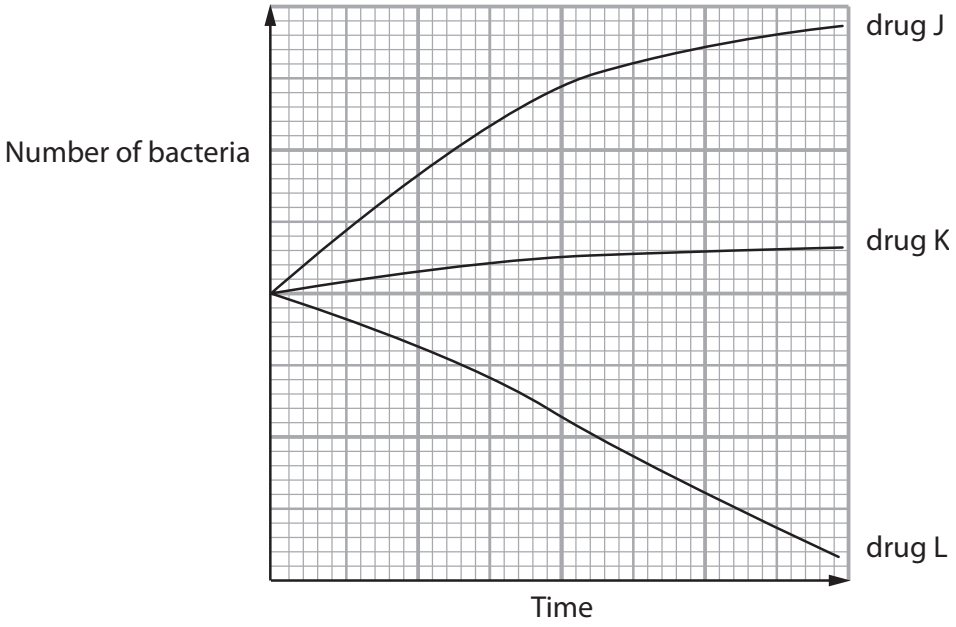
(b) The graph shows the effect of three drugs, J, K and L, on the number of bacteria in a culture.



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

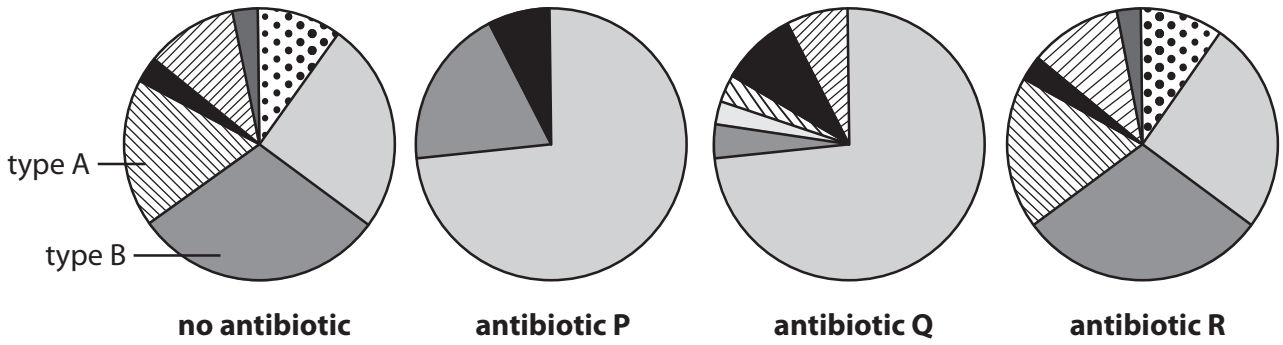
(1)

		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)

(ii) Explain why antibiotics can affect gut flora.

(2)

(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 2 = 11 marks)

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

Vaccines provide artificial active immunity.

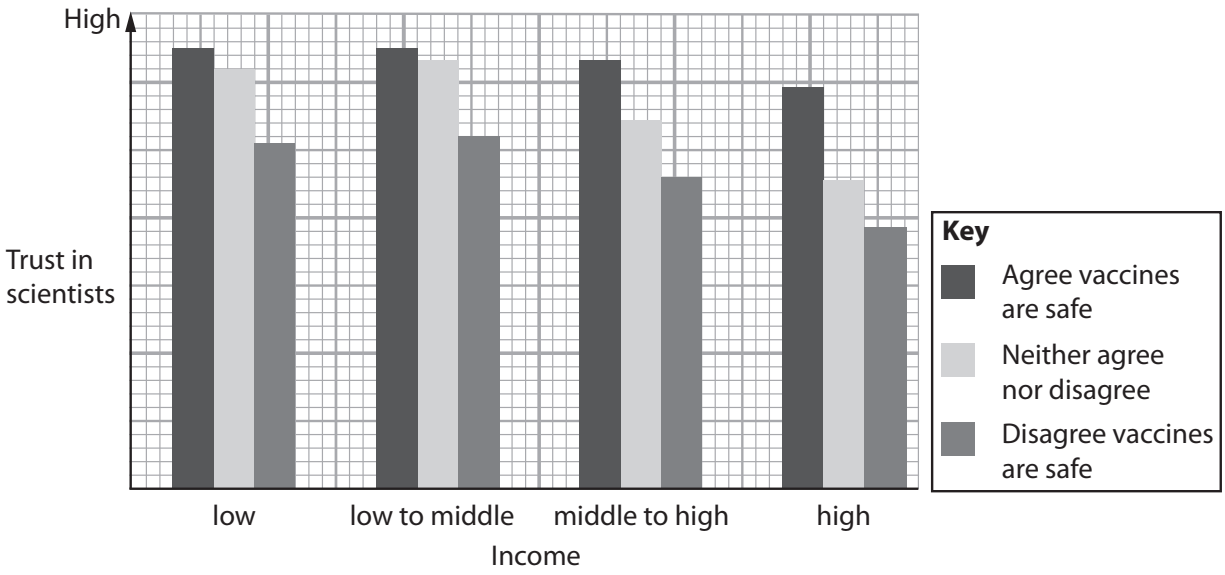
(a) Describe how a vaccine results in active immunity.

(4)

(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)

(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 3 = 10 marks)

4 Greenhouse gases are involved in anthropogenic climate change.

(a) (i) Which of the following are greenhouse gases?

(1)

- ☒ **A** carbon dioxide and oxygen
- ☒ **B** methane and water vapour
- ☒ **C** carbon dioxide, oxygen and water vapour
- ☒ **D** methane, carbon dioxide and oxygen

(ii) State what is meant by **anthropogenic climate change**.

(2)

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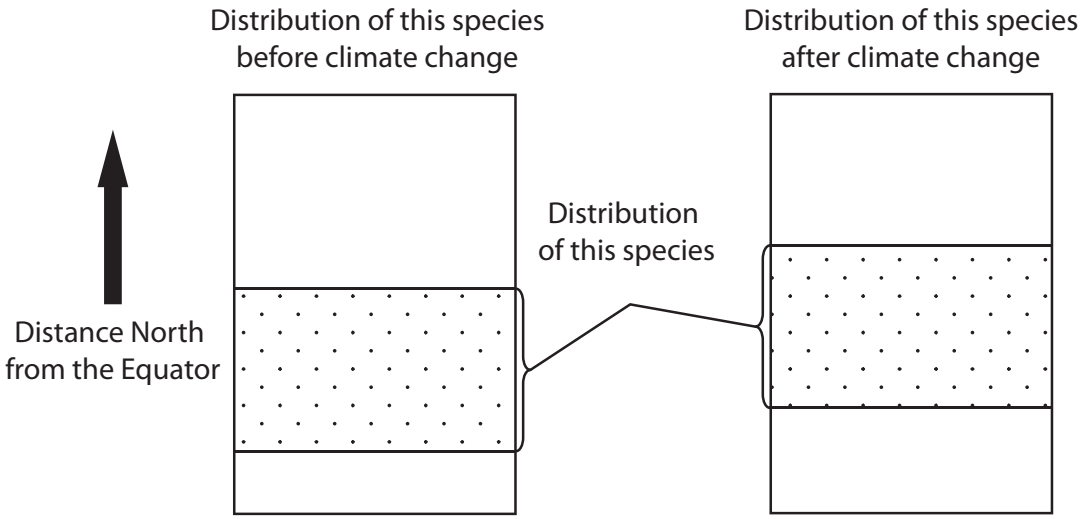
(b) The distribution of species has been affected by climate change.

The diagrams show how the distribution of one species, in a country in the Northern Hemisphere, could change as a result of climate change.



Explain the changes in the distribution of this species in this country.

(3)

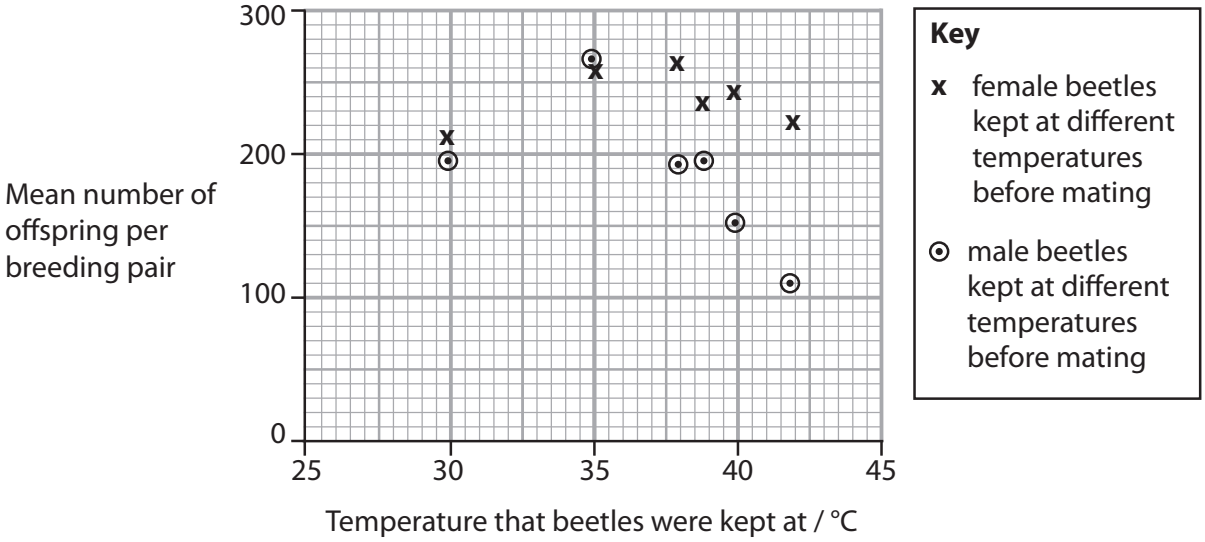
(c) The effect of temperature on reproduction in a species of beetle was studied.

Groups of male and groups of female beetles were each kept at different temperatures for five days.

The beetles were then mated with beetles, of the opposite sex, that had been kept at 30°C for five days.

The mean number of offspring per breeding pair was then determined.

The graph shows the results of this study.



(i) Identify **two** conclusions that can be drawn from this study.

(2)

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(ii) Explain the differences in the results obtained for the male and female beetles kept at different temperatures.

(3)

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(Total for Question 4 = 11 marks)

5 Photosynthesis consists of the light-dependent reactions and the light-independent reactions.

(a) In the light-dependent reactions, light energy is converted into energy stored in ATP.

(i) Explain why light energy is converted into energy stored in ATP.

(2)

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(ii) An equation can summarise the production and breakdown of ATP.

Complete this equation, by writing the names of the substrates and the type of reaction on the three dotted lines provided.

(2)

(iii) Explain the role of light energy in the light-dependent reactions.

(3)

(b) The light-independent reactions use products of the light-dependent reactions to produce simple sugars.

(i) Which row of the table shows the products of the light-dependent reactions that are used in the light-independent reactions?

(1)

	ATP produced by	NADP
☒ **A**	cyclic photophosphorylation	oxidised
☒ **B**	cyclic photophosphorylation	reduced
☒ **C**	non-cyclic photophosphorylation	oxidised
☒ **D**	non-cyclic photophosphorylation	reduced

(ii) Simple sugars have the formula $C_nH_{2n}O_n$.

Name the inorganic molecule from which each element in a simple sugar originated.

(2)

C .....

H .....

O .....

(iii) Simple sugars are used in the synthesis of new biological molecules.

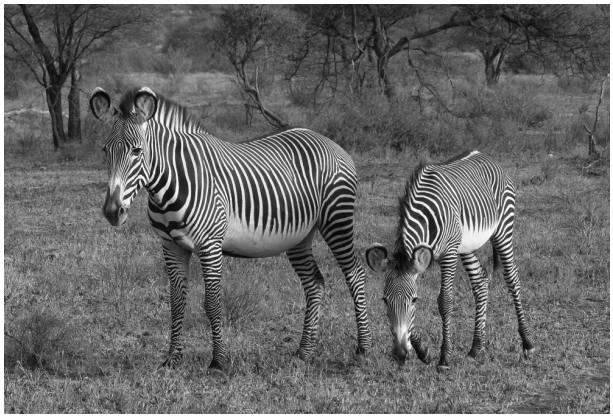
Which row of the table shows the inorganic ions that are needed to synthesise these new biological molecules?

(3)

New biological molecule	Nitrates	Phosphates	Both nitrates and phosphates	Neither nitrates nor phosphates
protein	☒	☒	☒	☒
RNA	☒	☒	☒	☒
triglyceride	☒	☒	☒	☒

(Total for Question 5 = 13 marks)

6 The photograph shows two zebras.



(Source: Caroline Wilcox)

The stripes of zebras are thought to reduce attack by biting flies.

Biting flies cause stress and disease to cattle, reducing food production and causing financial losses for farmers.

(a) Farmers use chemicals to kill the flies.

Flies often evolve resistance to a new chemical within about 10 years.

(i) Explain how flies evolve resistance to new chemicals.

(3)

(ii) Suggest why the evolution of resistance to these chemicals occurs so quickly in flies.

(1)

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*(b) An investigation was carried out to see if the presence of stripes on cattle reduced the number of biting flies on their bodies.

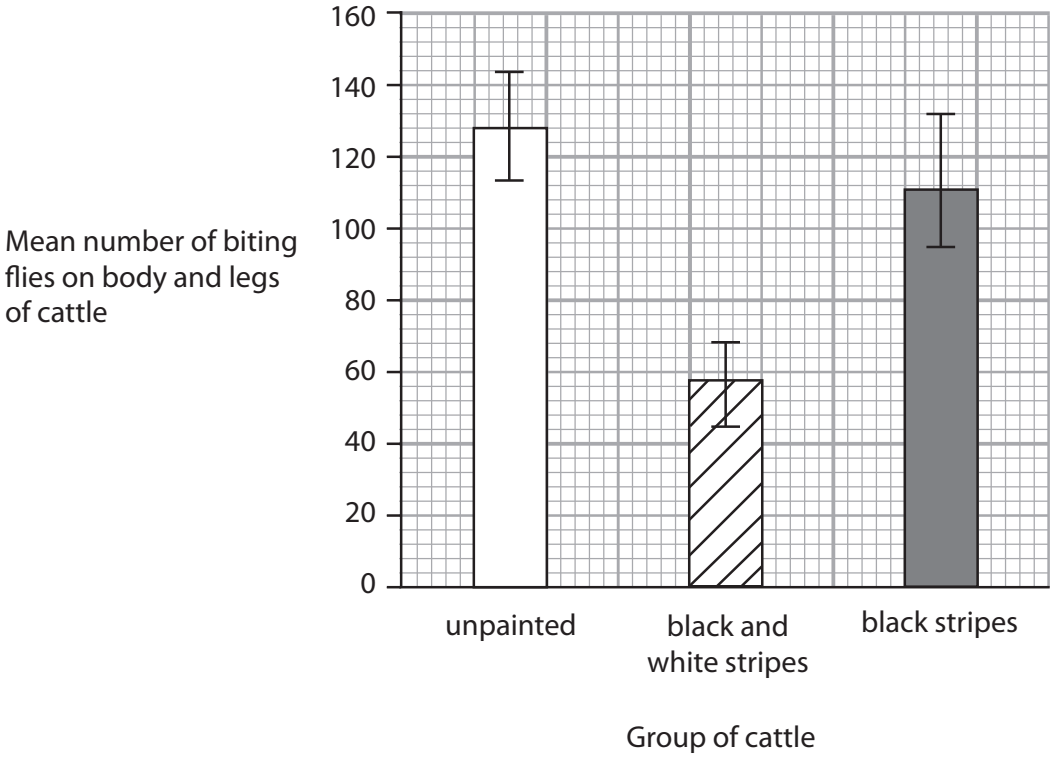
Three groups of black cattle were compared:

- unpainted cattle
- cattle painted with black and white stripes
- cattle painted with black stripes only.

Cattle repel flies by flicking their tails, stamping their feet and skin twitching.

The frequencies of these fly-repelling behaviours were recorded.

The graph and tables show some of the results of this investigation.



Group of cattle	Number of flies on the body	Number of flies on the legs
unpainted	662	1309
black and white stripes	231	710
black stripes	677	1030

Table 1

Group of cattle	Mean frequencies of fly-repelling behaviours / number per hour		
	Flicking their tails	Stamping their feet	Skin twitching
unpainted	54	16	5
black and white stripes	42	10	8
black stripes	55	16	5

Table 2

Determine the effectiveness of painting stripes on cattle in reducing the number of biting flies on them.

Use the information in the graph and both tables to support your answer.

(6)

(Total for Question 6 = 10 marks)

7 Gel electrophoresis is used to separate DNA fragments of different lengths.

The rate at which the DNA fragments move through the gel depends on several factors including:

- molecular size of the DNA fragment
- shape of the DNA fragment
- concentration of the gel.

(a) (i) Which enzyme is used to cut the DNA into fragments?

(1)

- ☒ **A** DNA polymerase
- ☒ **B** integrase
- ☒ **C** restriction enzyme
- ☒ **D** reverse transcriptase

(ii) Explain why the use of an enzyme to cut the DNA results in fragments, of different lengths, that can be separated by gel electrophoresis.

(3)

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(b) Fragments of double-stranded DNA move through the gel at a relative rate (M_r) that is inversely proportional to the log of their molecular weight (MW).

(i) Complete the table using the equation:

$$M_r = \frac{1}{\log_{10} MW}$$

(2)

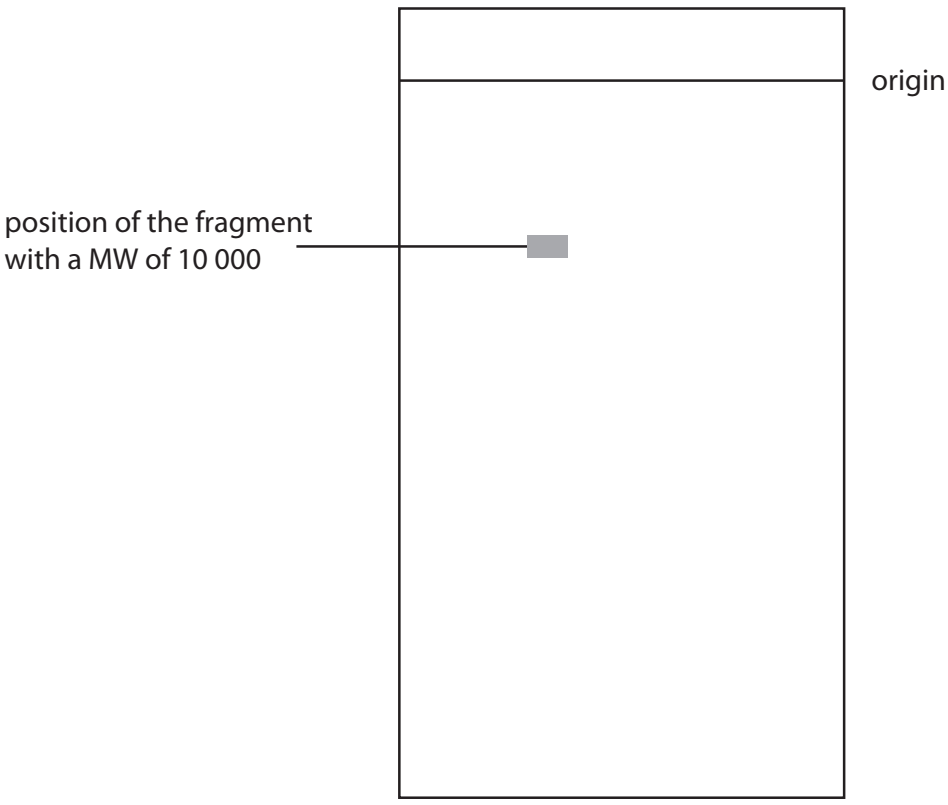
Molecular weight of DNA fragment (MW)	Relative rate of movement (M_r)
100 000	
10 000	0.25
	0.34

(ii) The diagram shows the position of a DNA fragment with a MW of 10 000, after gel electrophoresis.

Complete the diagram to show the position of a DNA fragment with a MW of 100 000.

Use the information in the question.

(1)



(c) The fragments move more slowly through a higher concentration of gel.

Suggest why the fragments move more slowly through a higher concentration of gel.

(1)

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(d) Circular DNA moves at a faster rate through the gel than linear DNA.

(i) Give **two** examples of circular DNA found in cells.

(2)

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(ii) Give **two** differences between the structure of circular DNA and that of linear DNA, other than their shapes.

(2)

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(Total for Question 7 = 12 marks)

8 Quince are fruit that grow on trees.

When a quince falls from the tree, two processes take place: browning and decomposition.

(a) Browning takes place when the fruit is cut and exposed to the air. The browning is catalysed by the enzyme polyphenol oxidase (PPO).

The photographs show browning in a quince cut in half.

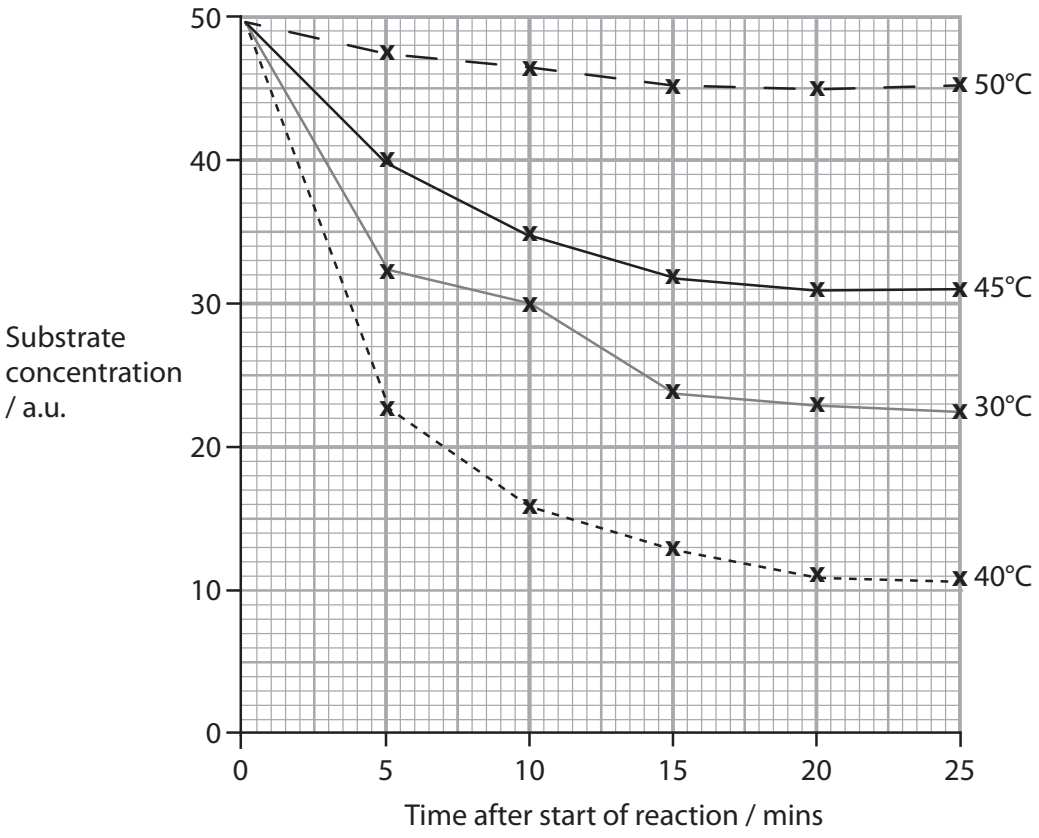
Freshly-cut quince showing some browning

Cut quince exposed to the air showing extensive browning

(Source: John Adds)

Activity of the enzyme PPO at different temperatures was investigated.

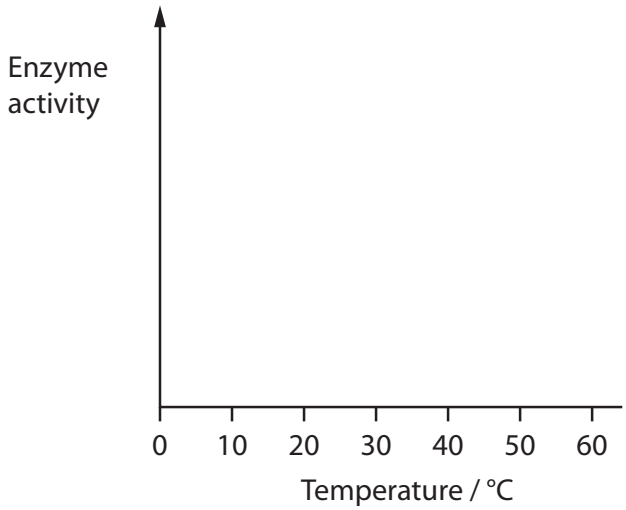
The graph shows the results of this investigation.



(i) Sketch the graph for enzyme activity plotted against temperature for this enzyme.

Use the data from this investigation.

(2)



(ii) Calculate the Q_{10} for this enzyme, using the data from this investigation, shown in the first graph.

Use the formula

$$Q_{10} = \frac{R_{t+10}}{R_t}$$

where R_t is the initial rate of reaction at t °C

and R_{t+10} is the initial rate of reaction at t + 10 °C.

(4)

Answer .....

(b) A quince fruit is made up of cells and contains a lot of juice.

The table shows the composition of carbohydrates in the juice of one species of quince.

Type of carbohydrate	Name of carbohydrate	Concentration of carbohydrate / mg per 100 cm^3 juice
monosaccharide	fructose	817.2
	glucose	308.3
	inositol	8.3
	rhamnose	12.4
	sorbitol	121.1
	xylose	94.0
disaccharide	sucrose	57.0
trisaccharide	raffinose	8.3
tetrasaccharide	stachyose	9.5

(i) Complete the table to show the ratio of the concentrations of the four types of carbohydrate.

(2)

Type of carbohydrate	Ratio
monosaccharide	
disaccharide	
trisaccharide	
tetrasaccharide	

(ii) Which row of the table shows the carbohydrates with the median concentration and modal concentration in quince juice?

(1)

	Median	Mode
☒ **A**	raffinose	fructose
☒ **B**	raffinose	sucrose
☒ **C**	sucrose	fructose
☒ **D**	sucrose	raffinose

***(iii)** Explain the role of decomposition in returning the carbon present in the carbohydrates in the quince fruit back into the atmosphere.

Use the information given in part (b) to support your answer.

(6)

(Total for Question 8 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | Candidate Number

Time 1 hour 45 minutes

Paper reference **WBI14/01**

Biology

International 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.
- Good luck with your examination.

Turn over ▶

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P 6 7 7 9 2 A 0 1 3 2

Pearson

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 ☒.

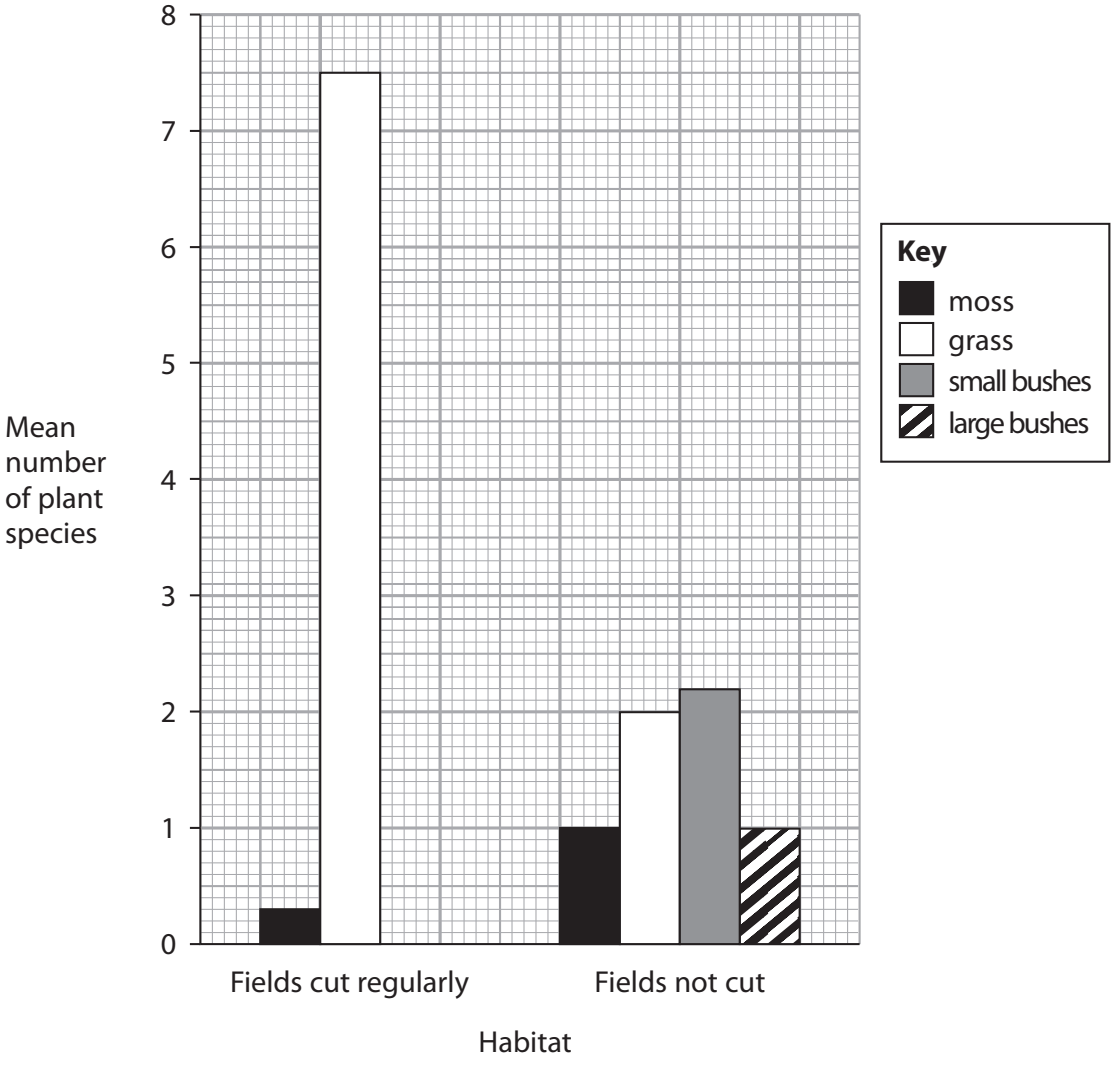
1 Mosses are species of plants that have genomes that enable them to survive in their habitats.

(a) A group of students investigated the mean number of plant species in four habitats.

The habitats that they investigated were:

- fields that were cut regularly
- fields that were not cut
- the middle of woods
- the edge of woods.

The graph shows some of the results from this investigation.



(i) Which row of the table shows the type of factor that affected the plant species in two of these habitats?

(1)

		Cutting the field regularly	Competition with trees for water
☒	**A**	abiotic factor	abiotic factor
☒	**B**	abiotic factor	biotic factor
☒	**C**	biotic factor	abiotic factor
☒	**D**	biotic factor	biotic factor

(ii) What is the percentage increase in the number of species of moss between the fields cut regularly and the fields not cut?

(1)

☒ **A** 23.3

☒ **B** 70.0

☒ **C** 233.3

☒ **D** 333.3

(iii) Suggest reasons for the differences in the mean number of plant species in fields cut regularly and in fields not cut.

(2)

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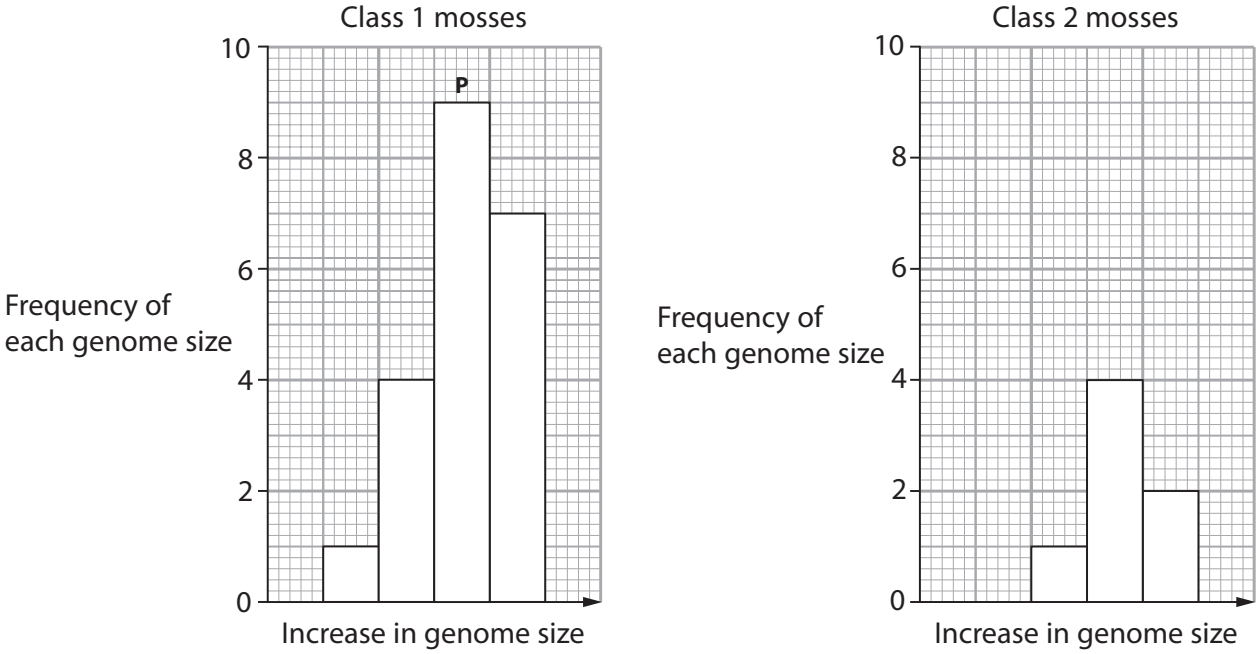
(b) In another investigation, the genome size of 30 species of moss was determined. Each species of moss belonged to one of two classes of moss.

The graphs show the frequency of each genome size in the class 1 mosses and some of the class 2 mosses.



(i) Which does **P** represent?

(1)

- ☒ **A** the maximum genome size on a bar chart
- ☒ **B** the maximum genome size on a histogram
- ☒ **C** mode genome size on a bar chart
- ☒ **D** mode genome size on a histogram

(ii) One genome size is missing from the graph for class 2 mosses.

Calculate the frequency of this genome size.

(1)

Answer .....

(iii) The mean value for the genome size of class 1 mosses was 0.449 a.u. and the mean value for class 2 mosses was 0.920 a.u.

Calculate the ratio of the genome size of class 1 mosses to the genome size of class 2 mosses.

(1)

Answer .....

(iv) It was suggested that the chromosomes in class 2 mosses were found in pairs.

Give the evidence that supports this suggestion.

(1)

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(Total for Question 1 = 8 marks)

2 Chloroplasts and mitochondria are two organelles found in some plant cells.

(a) Compare and contrast the structure of a chloroplast with the structure of a mitochondrion.

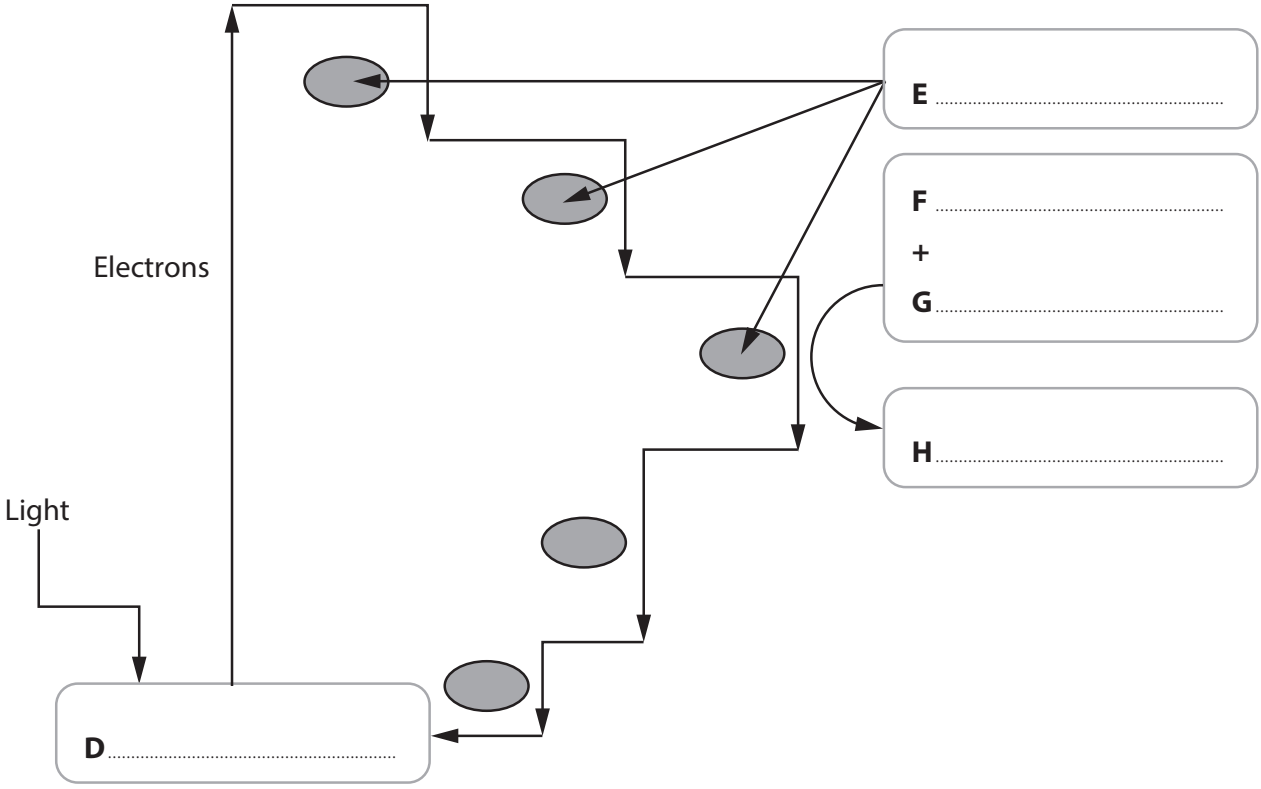
(3)

(b) The light-dependent reactions of photosynthesis can result in either cyclic or non-cyclic photophosphorylation.

(i) The diagram shows cyclic photophosphorylation.

Complete the diagram by writing the correct word or words on the dotted lines, labelled D, E, F, G and H.

(3)



(ii) Name **one** molecule that is produced in non-cyclic photophosphorylation that is **not** produced in cyclic photophosphorylation.

(1)

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(iii) Describe the role of photolysis in non-cyclic photophosphorylation.

(2)

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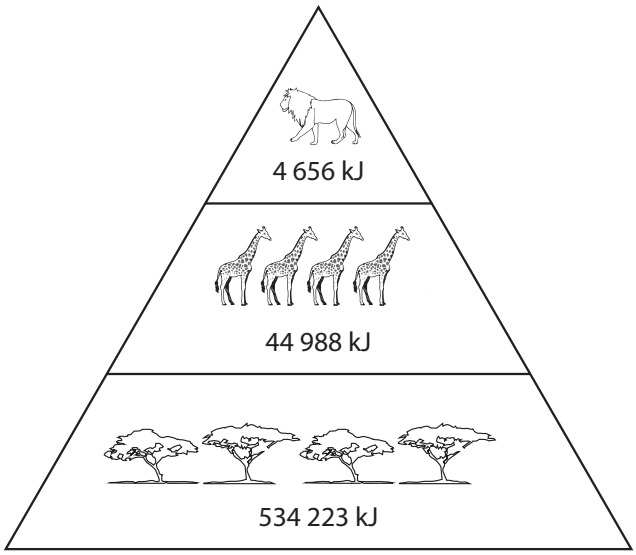
(Total for Question 2 = 9 marks)

3 Lions, giraffes and acacia trees are found on the African Plains.

The diagram shows the energy in the trophic levels that these organisms occupy.



(a) Give the meaning of each of the following terms, using the information in the diagram to illustrate your answer.

(i) Habitat

(2)

(ii) Population

(2)

(iii) Community

(2)

(iv) Niche

(2)

(b) Calculate the efficiency of energy transfer between trophic level one and trophic level two.

(1)

Answer ..... %

(Total for Question 3 = 9 marks)

4 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.

(4)

(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)

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

(2)

(Total for Question 4 = 8 marks)

5 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.

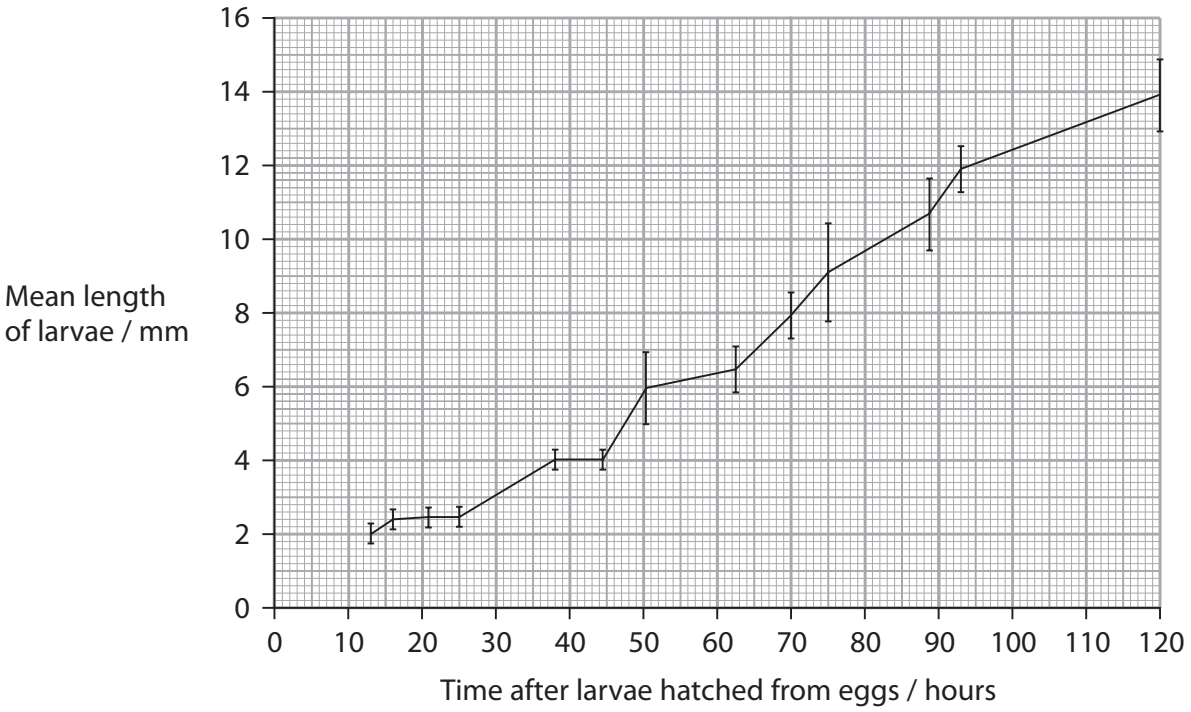
What is the name of the method that uses insect larvae to estimate the time of death?

(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)

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

(3)

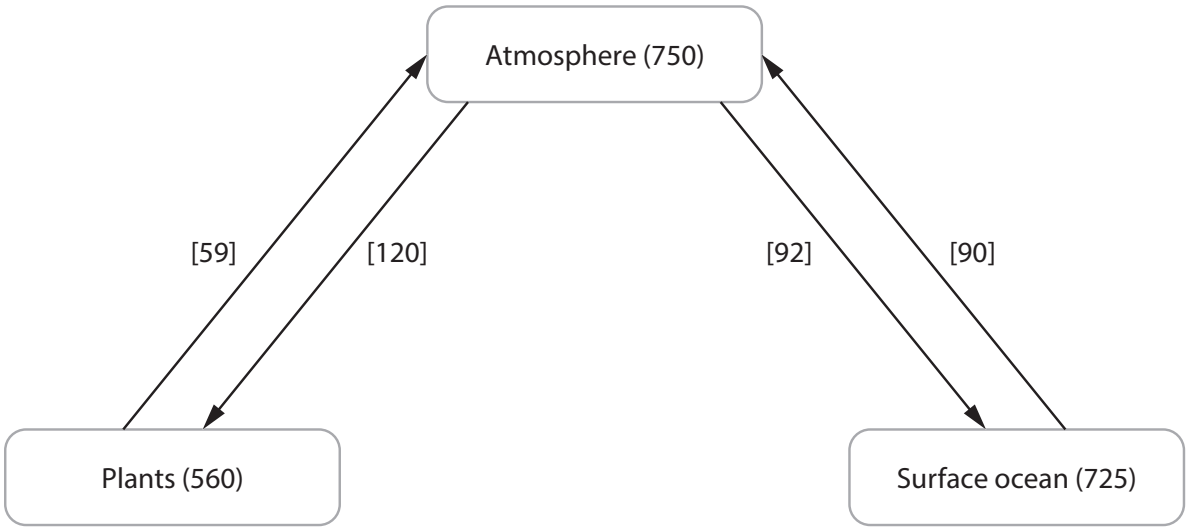
(c) The time of death can be estimated using the body temperature of the corpse.

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

(4)

(Total for Question 5 = 13 marks)

6 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.

(2)

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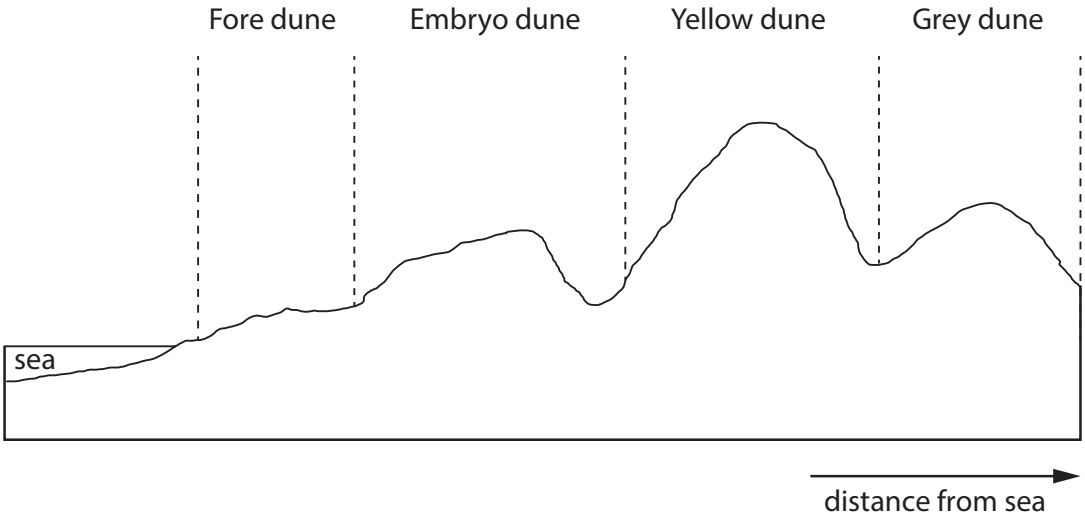
(Total for Question 6 = 13 marks)

7 Stages of succession can be seen on different parts of a sand dune system.

The greater the distance of the sand dune from the sea, the later the stage of succession.

The diagram shows a sand dune system and the table gives some information about the different types of sand dune in this system.



Information	Fore dune	Embryo dune	Yellow dune	Grey dune
Soil depth / cm	<0.5	0.5	1.0	8.0
Percentage of organic matter (%)	<1.0	1.0	2.5	5.0
pH	8.5	8.0	7.0	6.5
Percentage of bare ground (%)	>97	97	70	10
Number of different plant species	2	3	6	15
Typical plant species	sea rocket saltwort	sea couch grass lyme grass marram grass	marram grass red fescue grass sea holly	range of different meadow plants

(a) (i) The pH of a solution is a measure of the concentration of hydrogen ions in that solution.

It is a log scale e.g. a solution of pH 5 contains 10^{-5} mol dm^{-3} of hydrogen ions.

What is the difference in concentration of hydrogen ions in a fore dune compared with a grey dune?

(1)

☒ **A** a fore dune has 2 times more hydrogen ions than the grey dune

☒ **B** a fore dune has 2 times fewer hydrogen ions than the grey dune

☒ **C** a fore dune has 100 times more hydrogen ions than the grey dune

☒ **D** a fore dune has 100 times fewer hydrogen ions than the grey dune

(ii) Calculate the percentage increase in the number of plant species on the grey dune compared with the fore dune.

(1)

Answer.....%

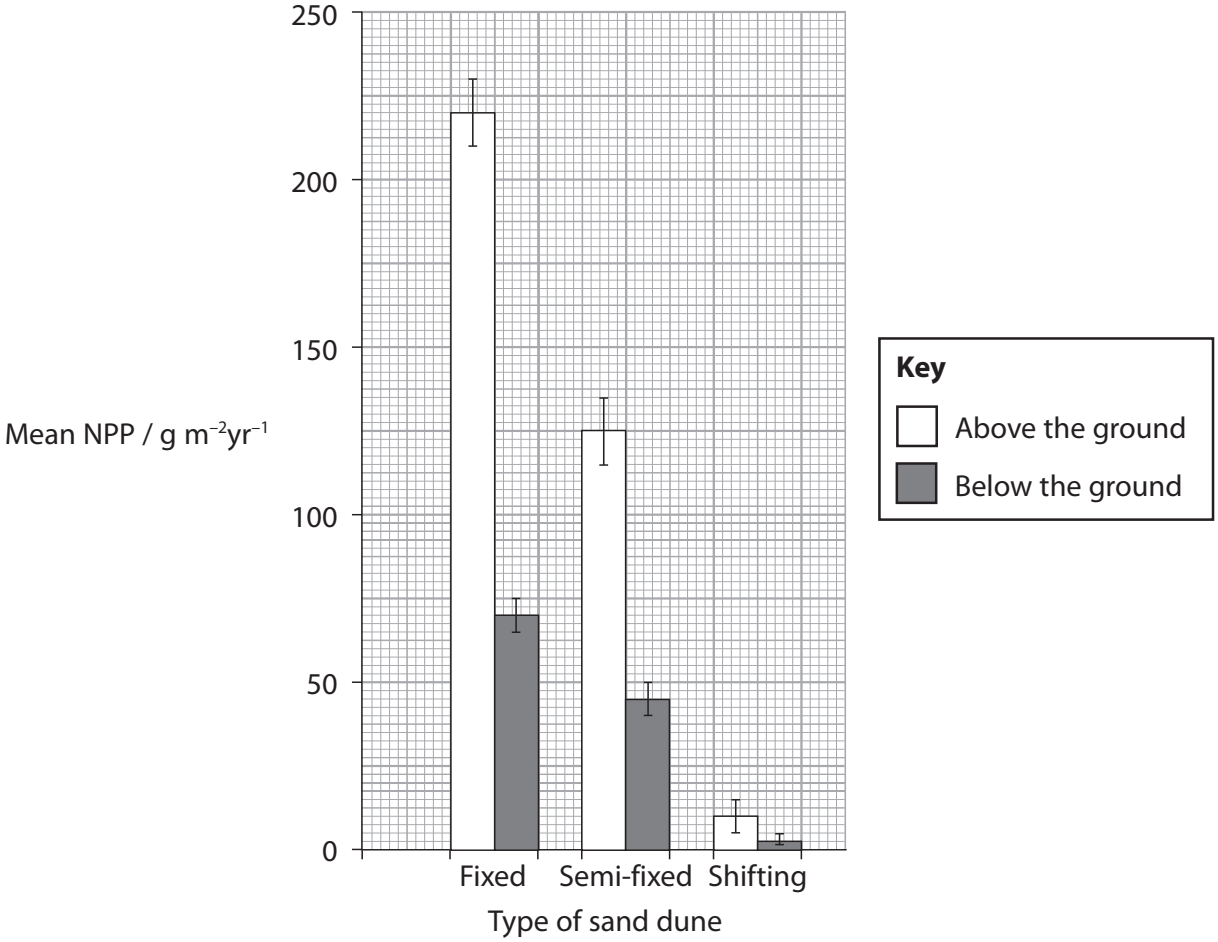
*(iii) Explain the changes in these sand dunes with distance from the sea.

Use the information in the table to support your answer.

(6)

(b) Sand dunes can be classified as fixed dunes, semi-fixed dunes and shifting dunes.

The graph shows the mean net primary productivity (NPP) above the ground and below the ground for these three types of sand dune.



(i) Describe the conclusions that can be drawn from this graph.

(3)

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(ii) Explain how the products of the light-independent reactions become NPP below the ground.

(4)

(Total for Question 7 = 15 marks)

8 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)

(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.

(3)

(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.

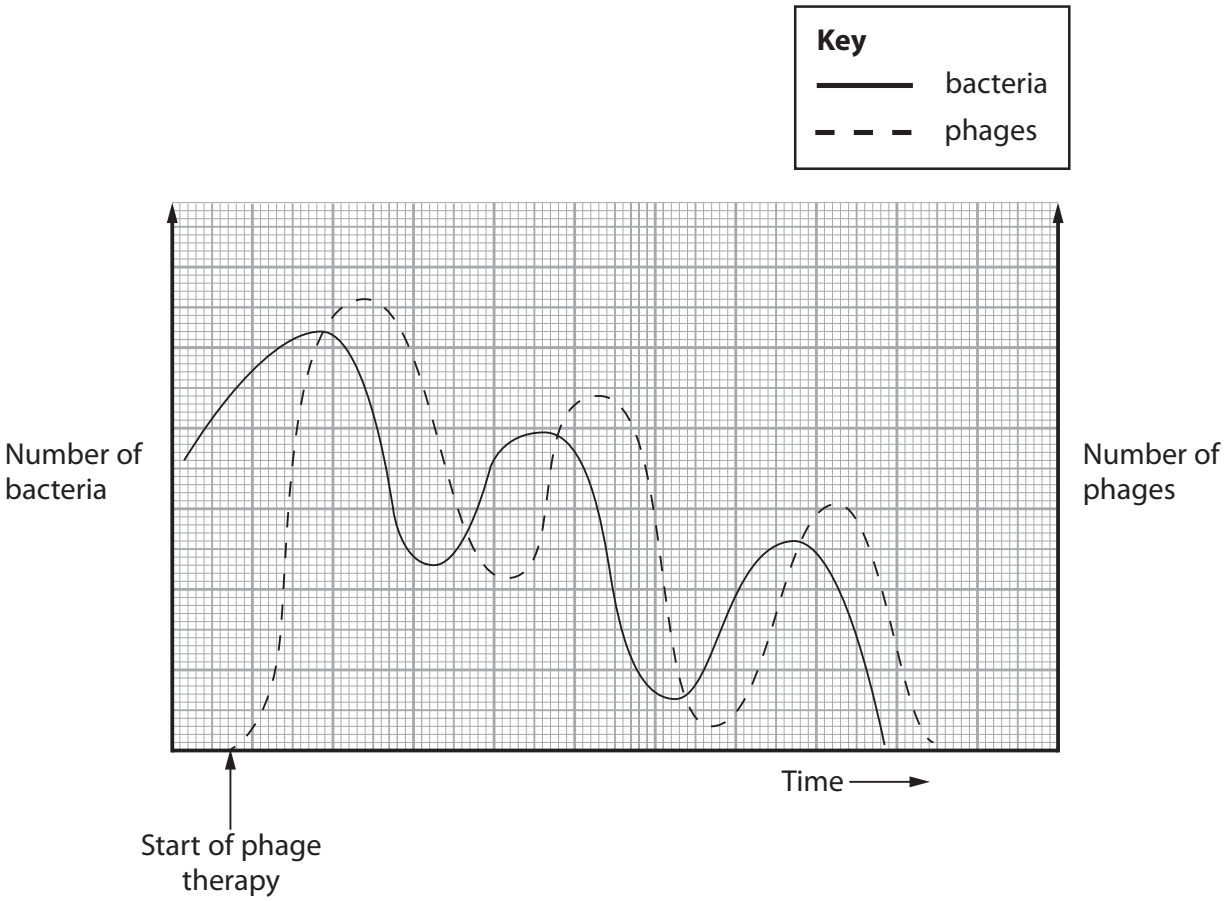
Explain why the infection with *Mycobacterium* developed faster when the patient was taking immunosuppressive drugs.

(4)

*(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.

(6)

(Total for Question 8 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 45 minutes

Paper reference **WBI14/01**

Biology

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

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and learner registration number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- Calculators may be used.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

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.*
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- 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.

Turn over ▶

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P 6 7 1 0 5 A 0 1 3 6

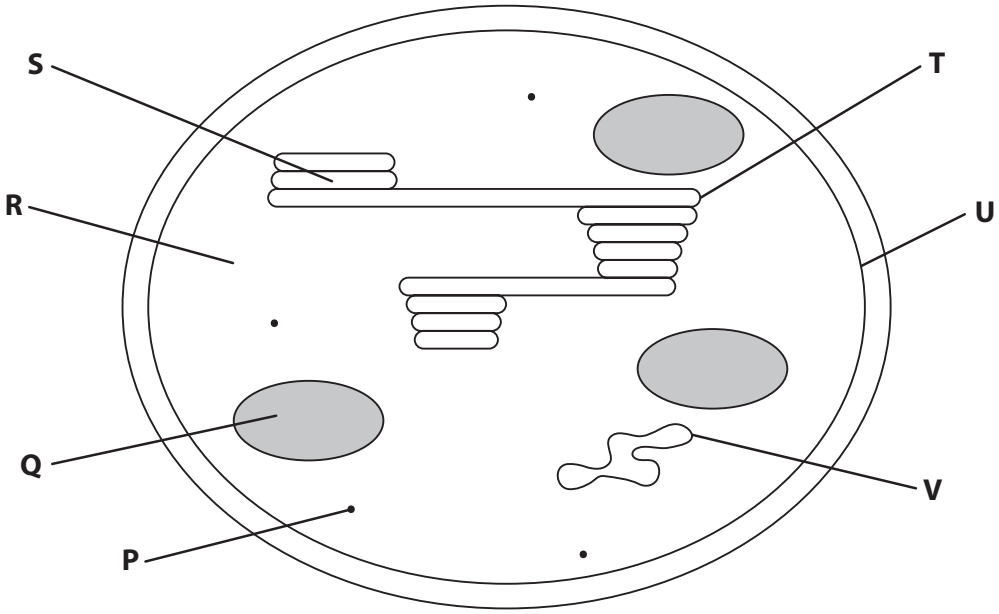
Pearson

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 The structure of a chloroplast is related to its role in photosynthesis.

The diagram shows a chloroplast.



(a) (i) Which row in the table identifies the structures labelled **P**, **Q** and **V**?

(1)

		P	Q	V
☒	**A**	DNA	starch grain	ribosome
☒	**B**	starch grain	DNA	ribosome
☒	**C**	starch grain	ribosome	DNA
☒	**D**	ribosome	starch grain	DNA

(ii) Which structure contains GALP?

(1)

- ☒ **A** **Q**
- ☒ **B** **R**
- ☒ **C** **U**
- ☒ **D** **V**

(iii) The length of this chloroplast is 7.5 μm.

Calculate the magnification of this diagram.

(1)

Answer .....

(iv) Structures **T** and **U** are membranes.

Compare and contrast the structure of these two membranes.

(3)

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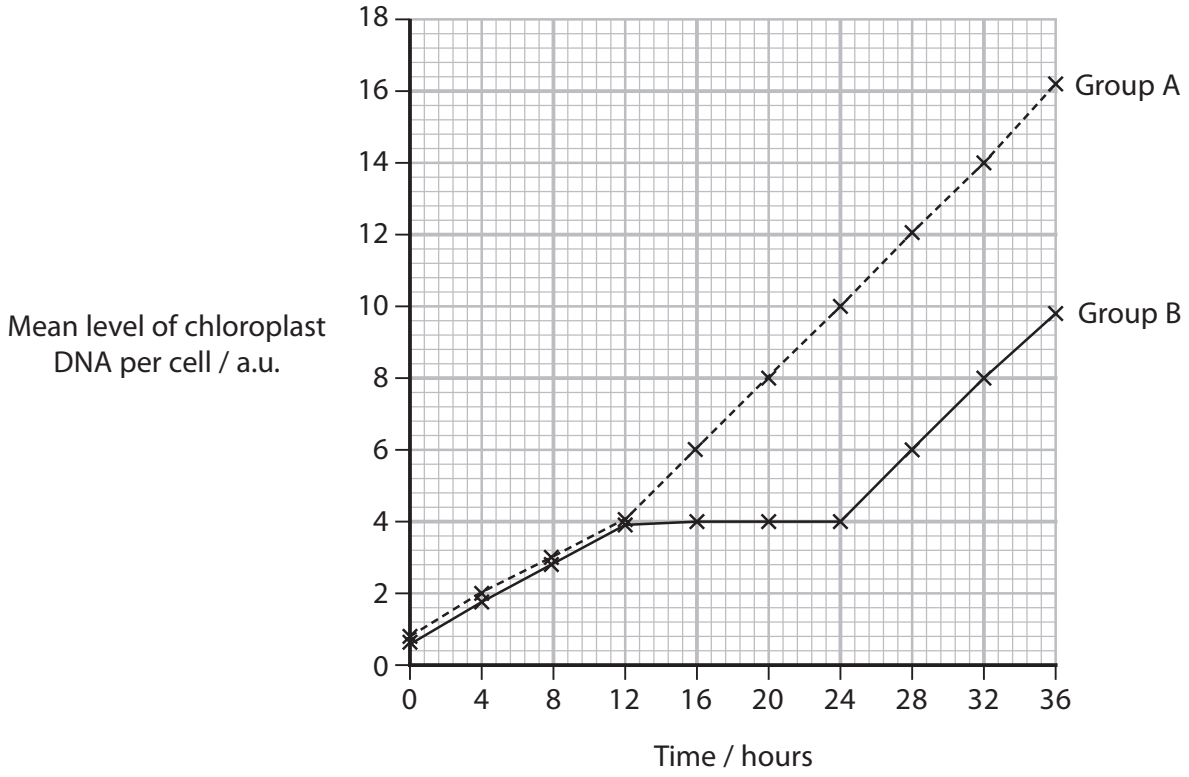
(b) An investigation studied the effect of periods of light and dark on the levels of chloroplast DNA in one species of a single-celled organism.

One group of these organisms, group A, was exposed to 36 hours of continuous light.

The other group of these organisms, group B, was exposed to 12 hours of light, followed by 12 hours of darkness, followed by 12 hours of light.

The graph shows the results of this investigation.



These organisms divide by mitosis followed by cell division, during the dark.

Describe two conclusions that can be made about the replication of chloroplast DNA.

(2)

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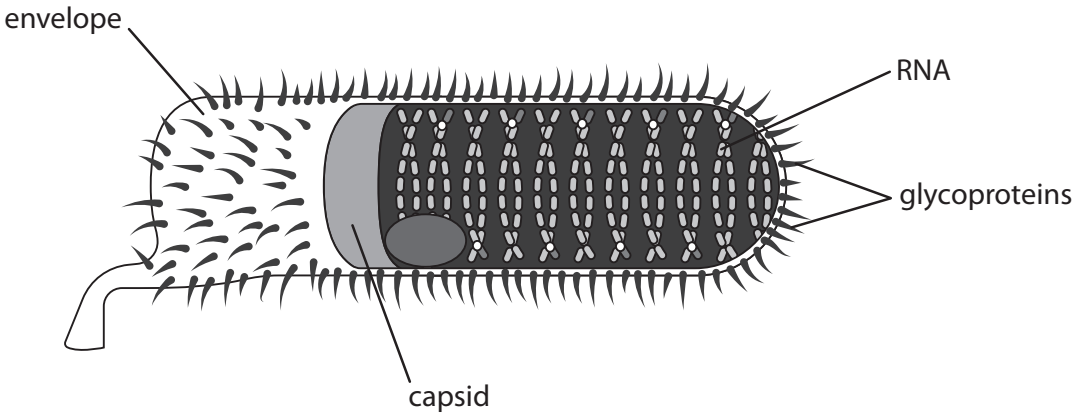
(Total for Question 1 = 8 marks)

2 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

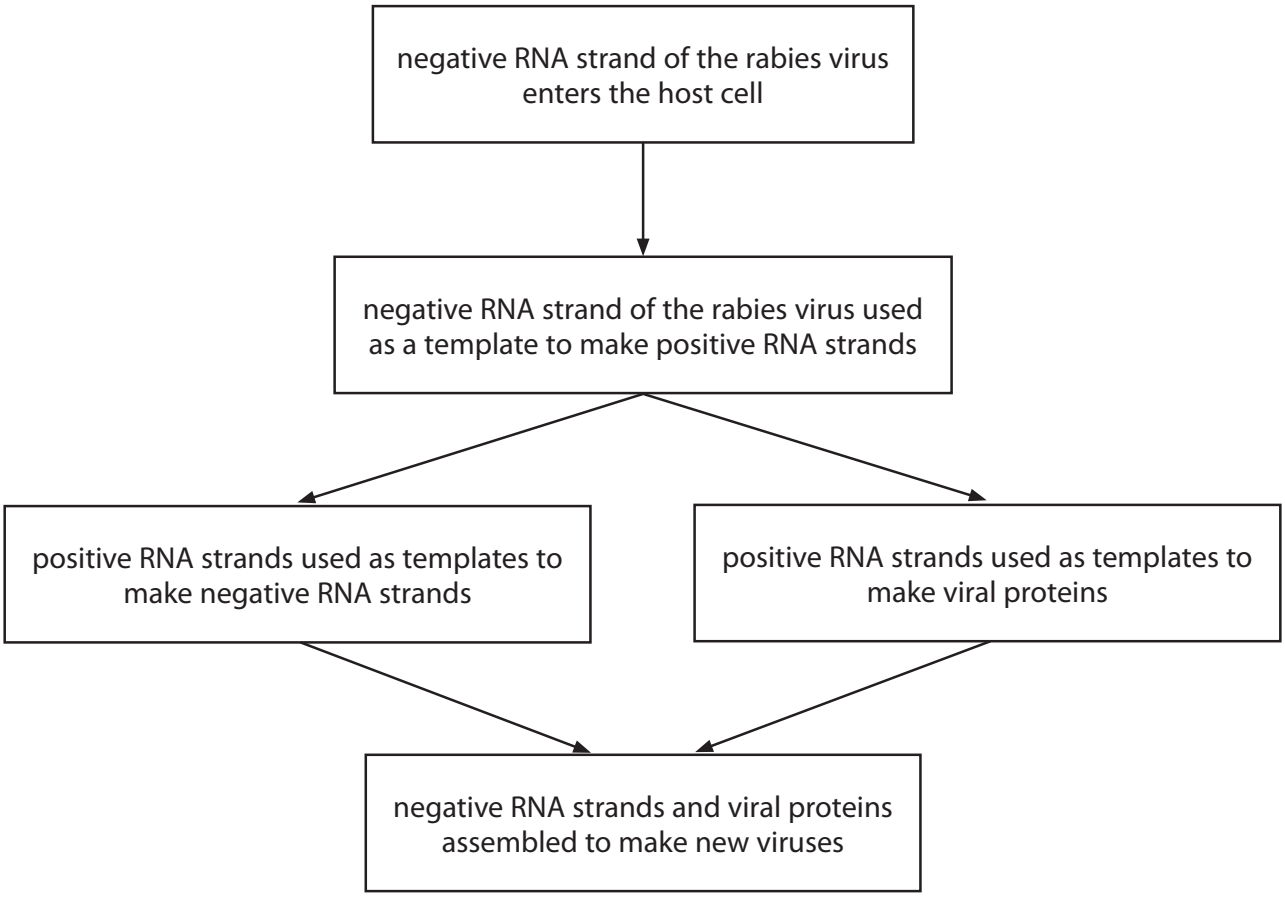
☒ **C** 3

☒ **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)

(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.

(4)

(Total for Question 2 = 10 marks)

3 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.

(3)

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

(4)

(Total for Question 3 = 10 marks)

4 Redwood trees are the tallest living organisms on Earth. Some of the older trees are more than 2 000 years old.

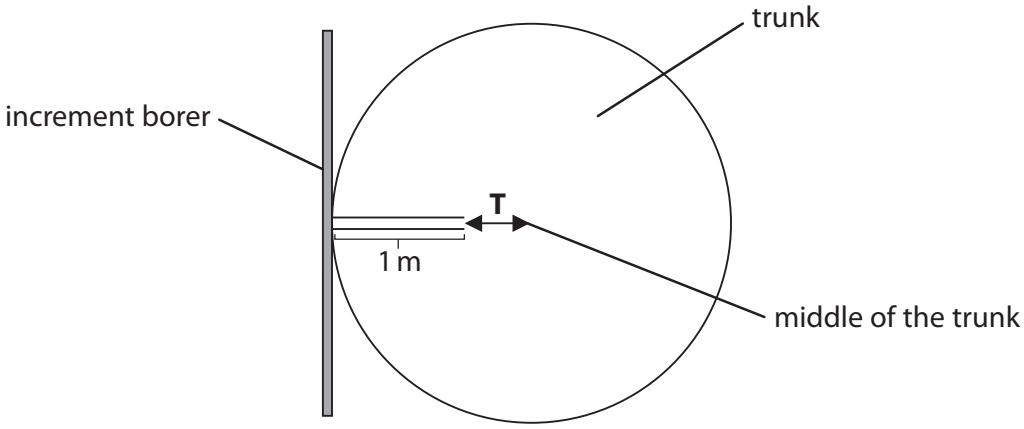
Dendrochronology can be used to work out how old a tree is and how much it has grown each year.

A sample of the tree trunk core can be taken using an increment borer.

The photograph shows an increment borer being used to take a sample of a tree trunk core.

(Source: © Custom Life Science Images / Alamy Stock Photo)

(a) The diagram shows an increment borer pushed into the trunk of a large Redwood tree.



An increment borer 1 m long was inserted into a Redwood tree. The borer did not reach the middle of the trunk. The distance from the end of the borer to the middle of the trunk is **T** cm.

(i) Calculate the radius (r) of a tree with a circumference (C) of 8 m.

Use the formula: $r = \frac{C}{2\pi}$

Give your answer to **two** decimal places.

(1)

Answer ..... m

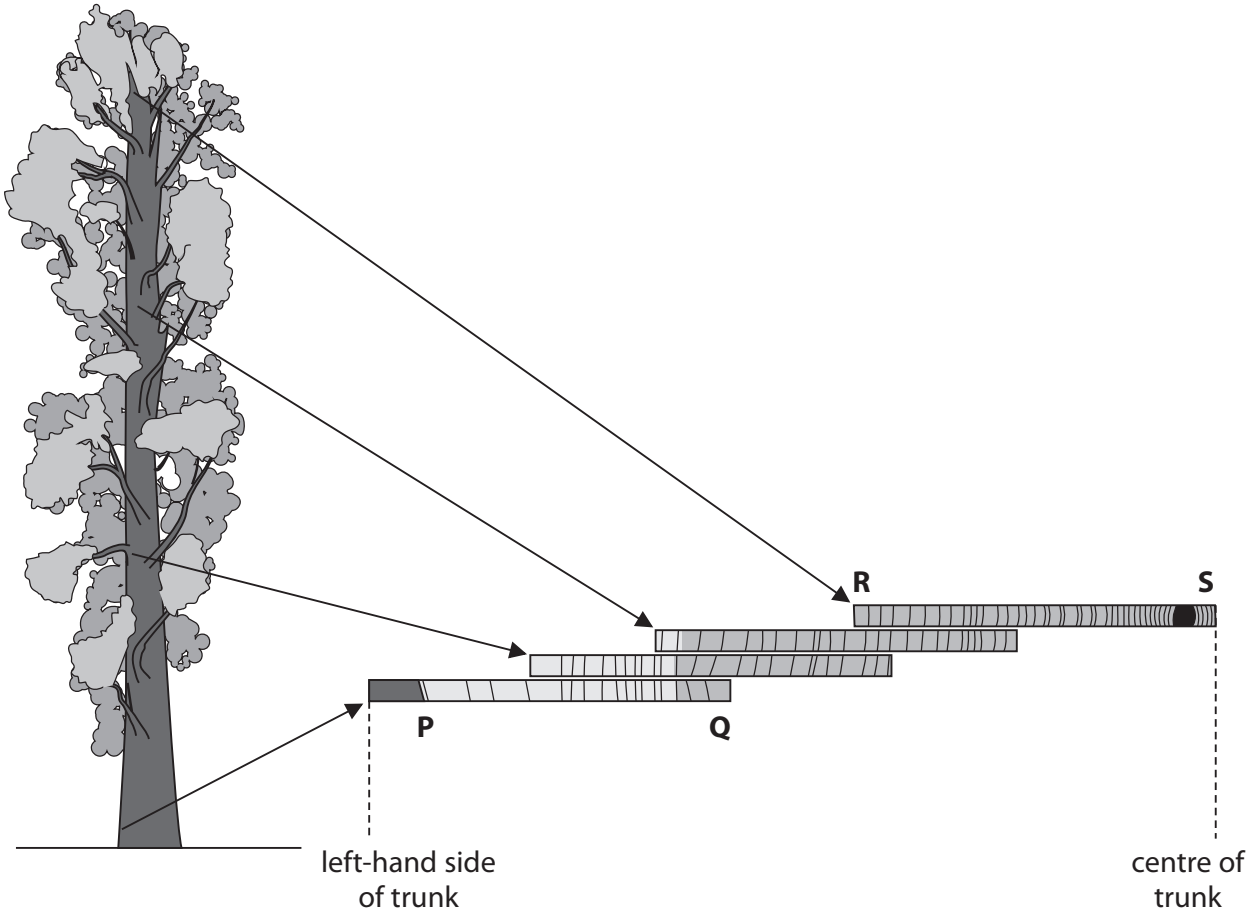
(ii) Calculate the distance **T** as a percentage of this radius.

(1)

Answer ..... %

(b) To calculate how old a tree is and how much it has grown, core samples are taken at different heights up the tree.

These core samples are then aligned by matching the rings, as shown in the diagram.



(i) Which row of the table shows the newest and oldest rings in this tree?

(1)

		newest ring	oldest ring
☒	**A**	**P**	**Q**
☒	**B**	**P**	**S**
☒	**C**	**S**	**R**
☒	**D**	**S**	**P**

(ii) Explain how these core samples can be used to calculate the age of this tree.

Use the information in the question and the diagram to support your answer.

(3)

(iii) Describe how the growth rate of this tree can be calculated.

(2)

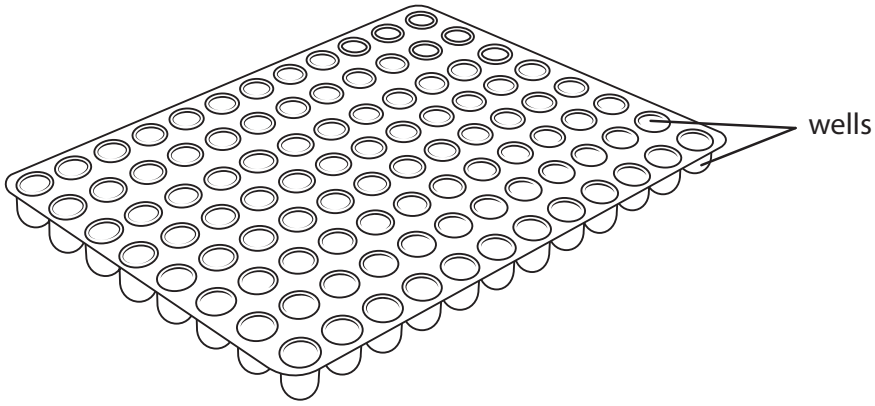
(Total for Question 4 = 8 marks)

5 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.

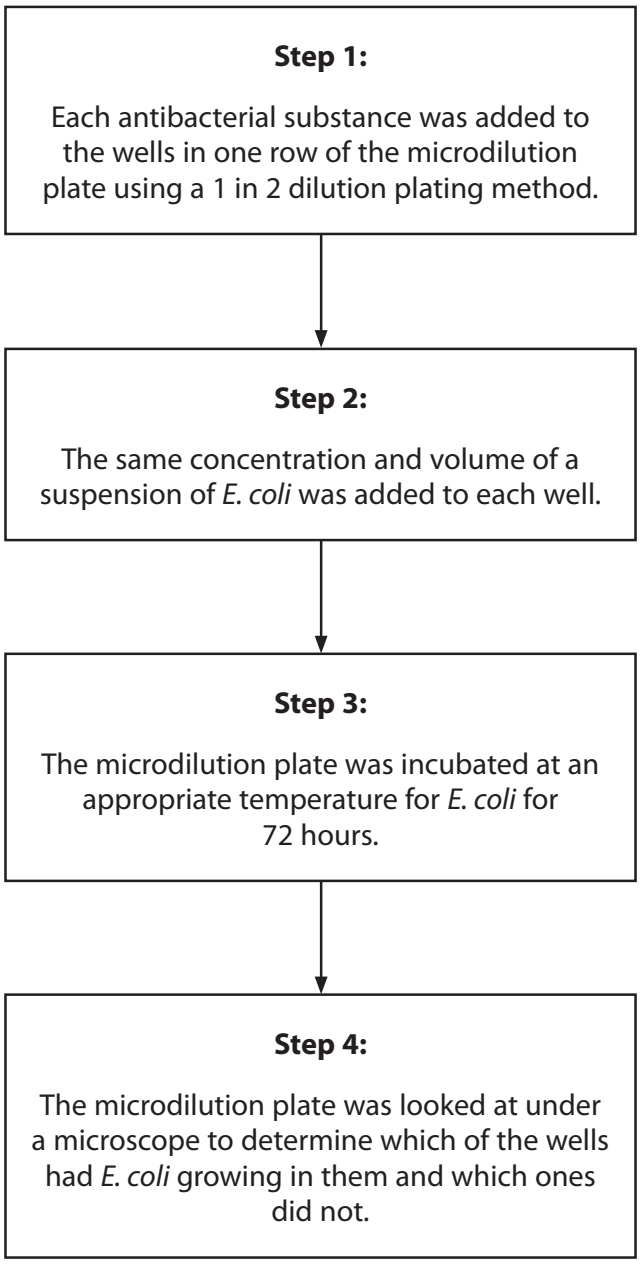
The diagram shows a microdilution plate.



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)

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

(2)

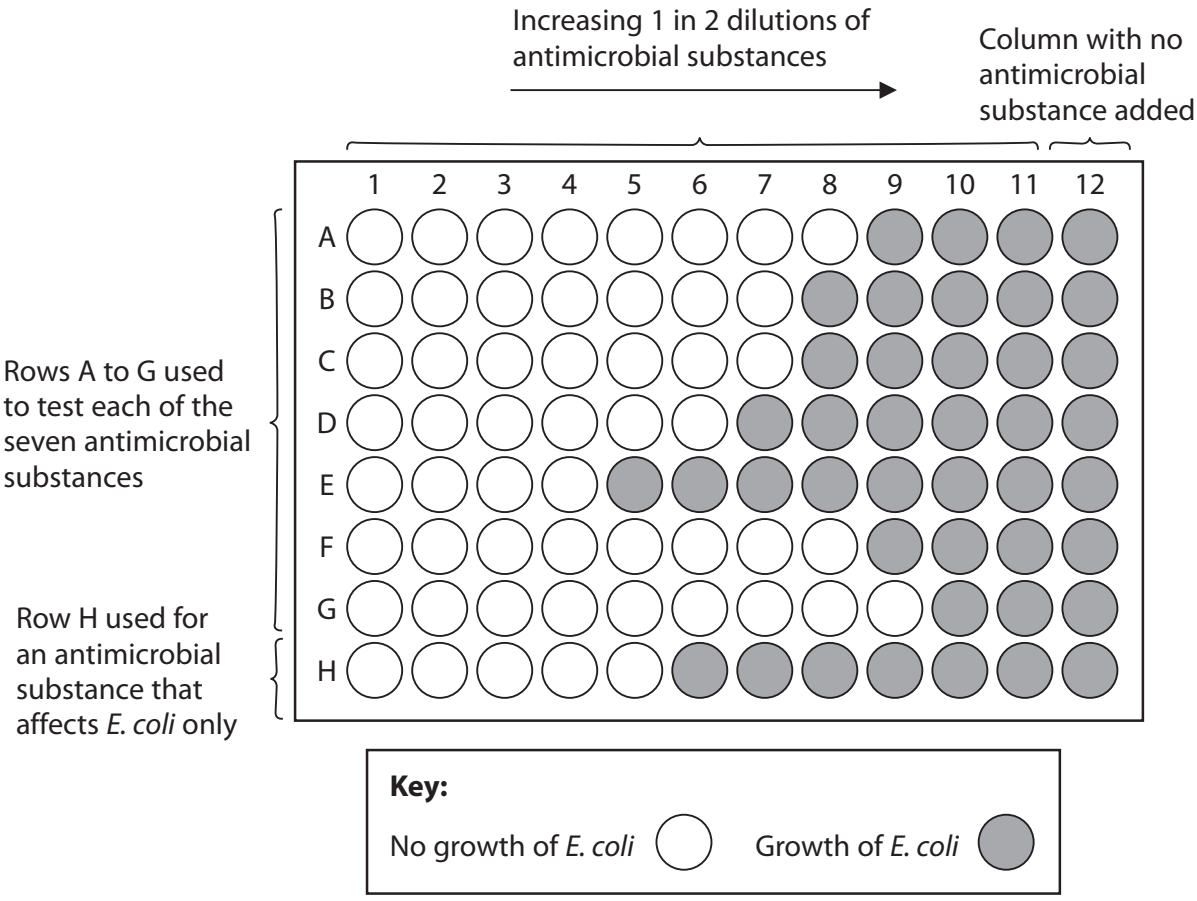
(iii) Explain why using aseptic technique in this investigation is important.

(2)

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

(2)

(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**).

(2)

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

(2)

(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.

(2)

(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 5 = 15 marks)

6 Seaweeds are a group of organisms that carry out photosynthesis.

Identifying the types and proportions of chlorophyll pigments is important in the classification of seaweeds and biodiversity studies.

(a) State the meaning of the term **biodiversity**.

(2)

(b) Explain the role of chlorophyll in the light-dependent reactions of photosynthesis.

(2)

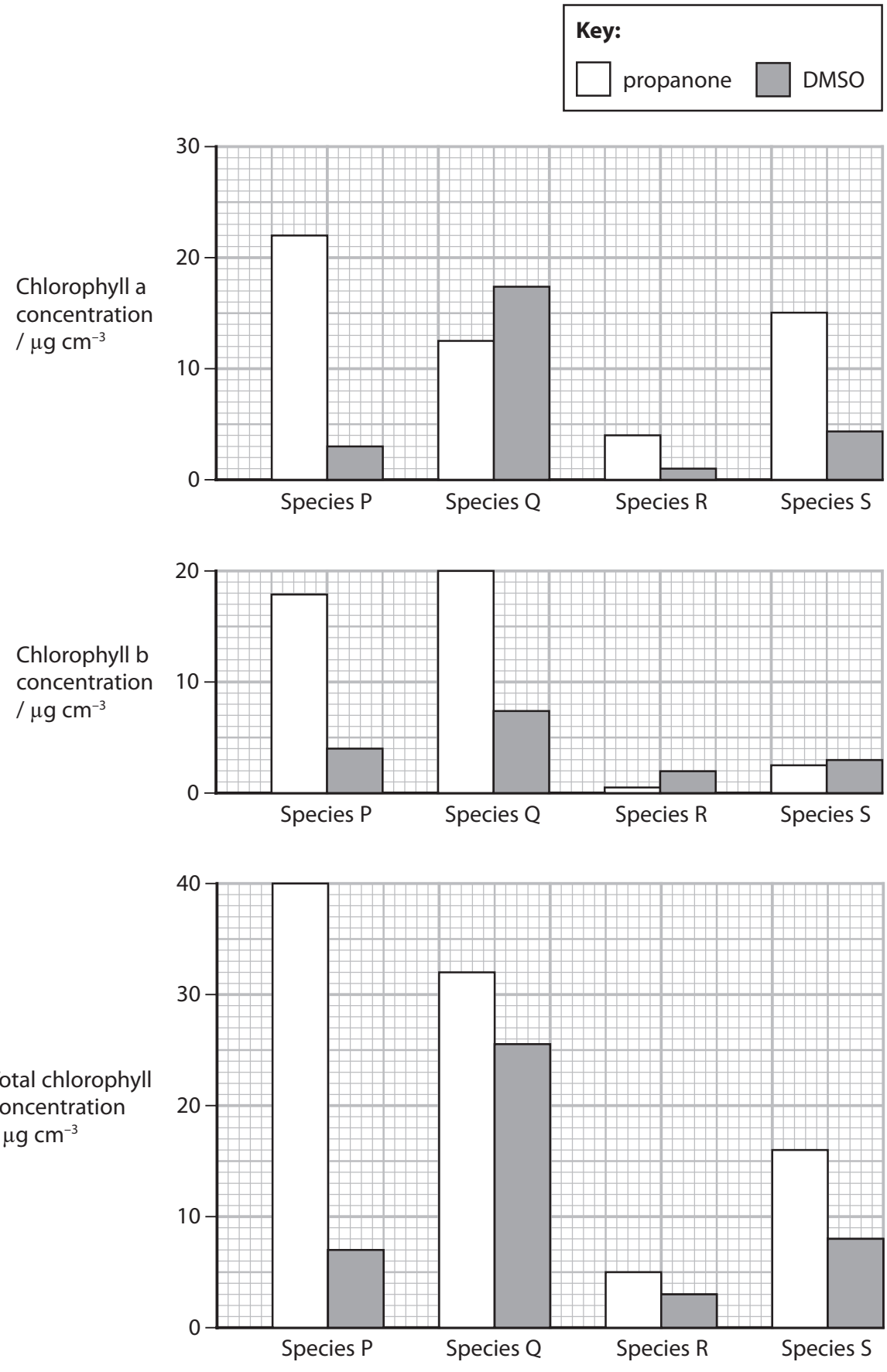
(c) An investigation compared the effectiveness of two solvents, propanone and DMSO, in extracting photosynthetic pigments.

Four species of seaweed were collected from the Indian coast of Tamil Nadu and taken to the laboratory where the species were identified.

Each species of seaweed was split into two samples of equal mass.

The photosynthetic pigments were extracted from each sample using one of the two solvents and their concentrations determined.

The graphs show some of the results of this investigation.



*(i) Discuss the effectiveness of these extraction methods in the identification of these species.

Use the information in the graphs to support your answer.

(6)

(ii) Suggest why different concentrations of chlorophyll were obtained using these two different solvents.

(2)

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(Total for Question 6 = 12 marks)

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

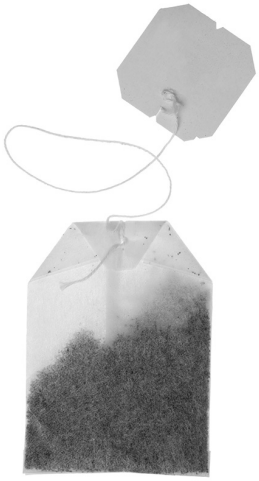
Some ecosystems are better than others at storing carbon in their soil, releasing less back into the atmosphere.

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.

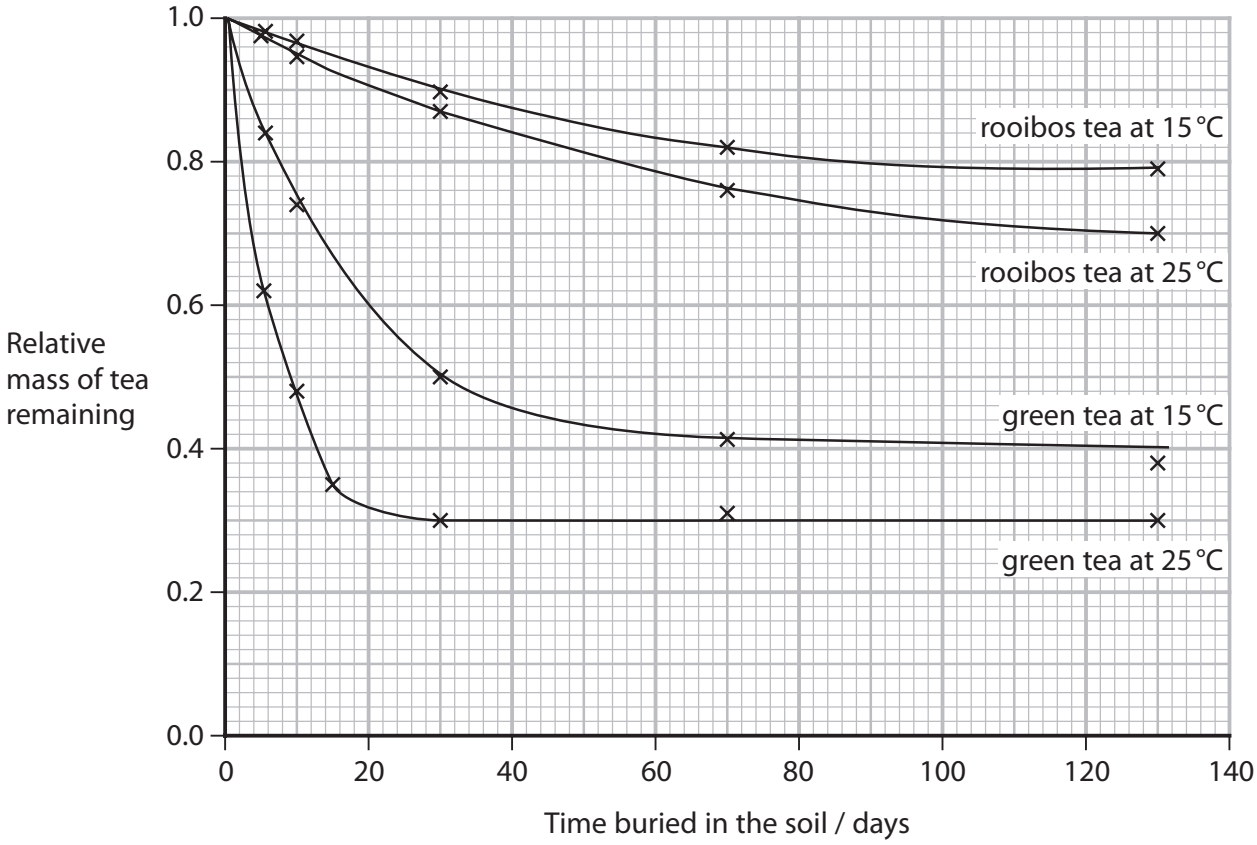
Two types of tea were used, green tea and rooibos tea.

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.

(4)

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

(2)

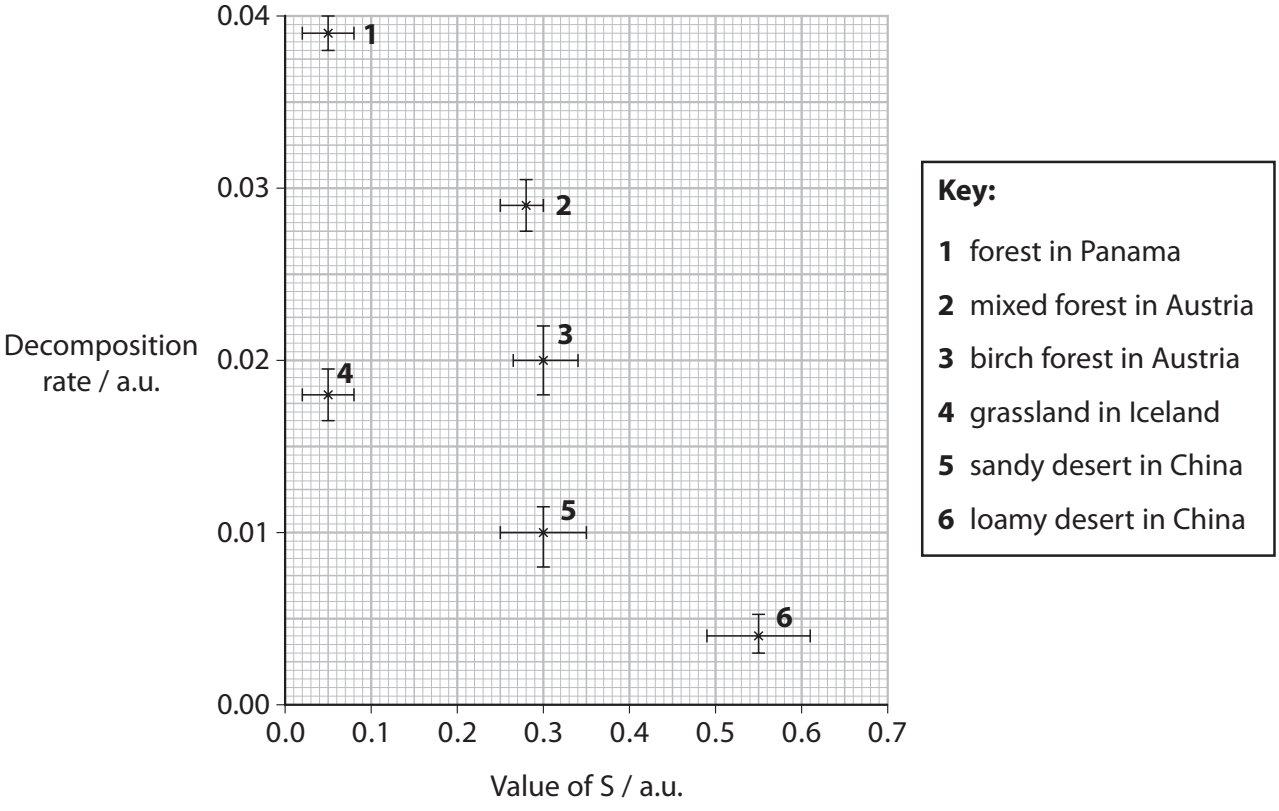
(b) In the second part of this study, several teabags were buried in different ecosystems.

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 7 = 13 marks)

8 Scientists studied the distribution of biomass in organisms on Earth.

(a) State the meaning of the term **biomass**.

(1)

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(b) Voronoi diagrams were used to present some of the data.

Two Voronoi diagrams are shown.

Diagram A shows the biomasses of groups of organisms.

Diagram B shows the biomasses of the organisms in the animals group.

The biomass is given in gigatons of carbon (Gt C), where 1 Gt C = 10^{15} g of carbon.

Diagram A

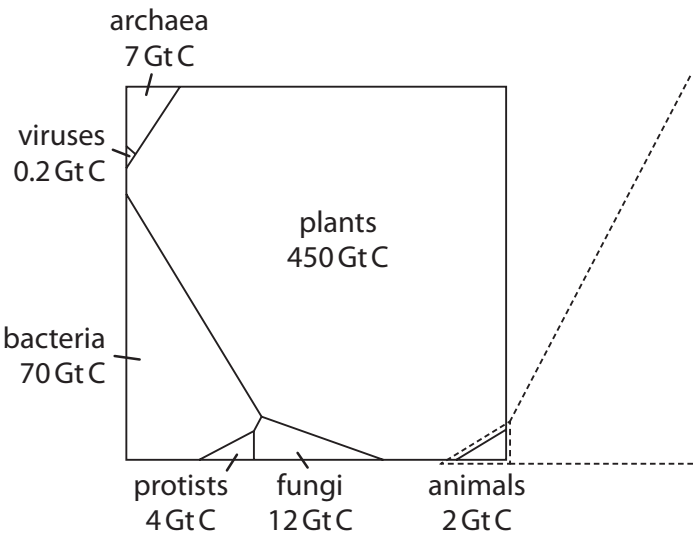
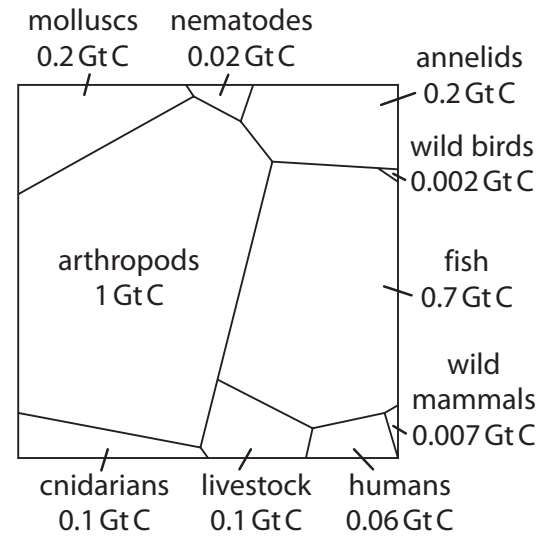


Diagram B



The area of each polygon is proportional to the biomass of that organism. The shape of each polygon has no meaning.

(i) Calculate the percentage of biomass in organisms belonging to the domain Eukarya.

Use the information in diagram A.

(2)

Answer ..... %

(ii) Suggest why the scientists studied the distribution of biomass in groups of organisms and not the number of individual organisms.

Use the information in diagram A.

(2)

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(iii) Discuss the advantages and disadvantages of presenting data in Voronoi diagrams.

Use diagram B to support your answer.

(3)

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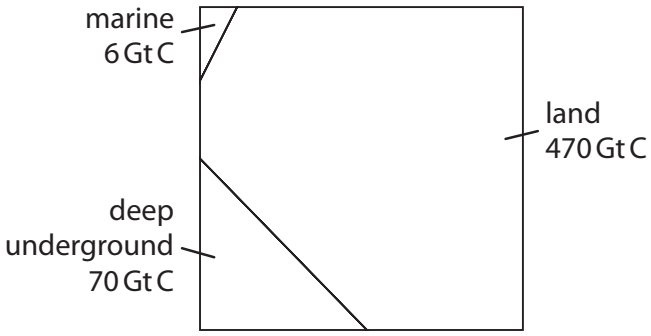
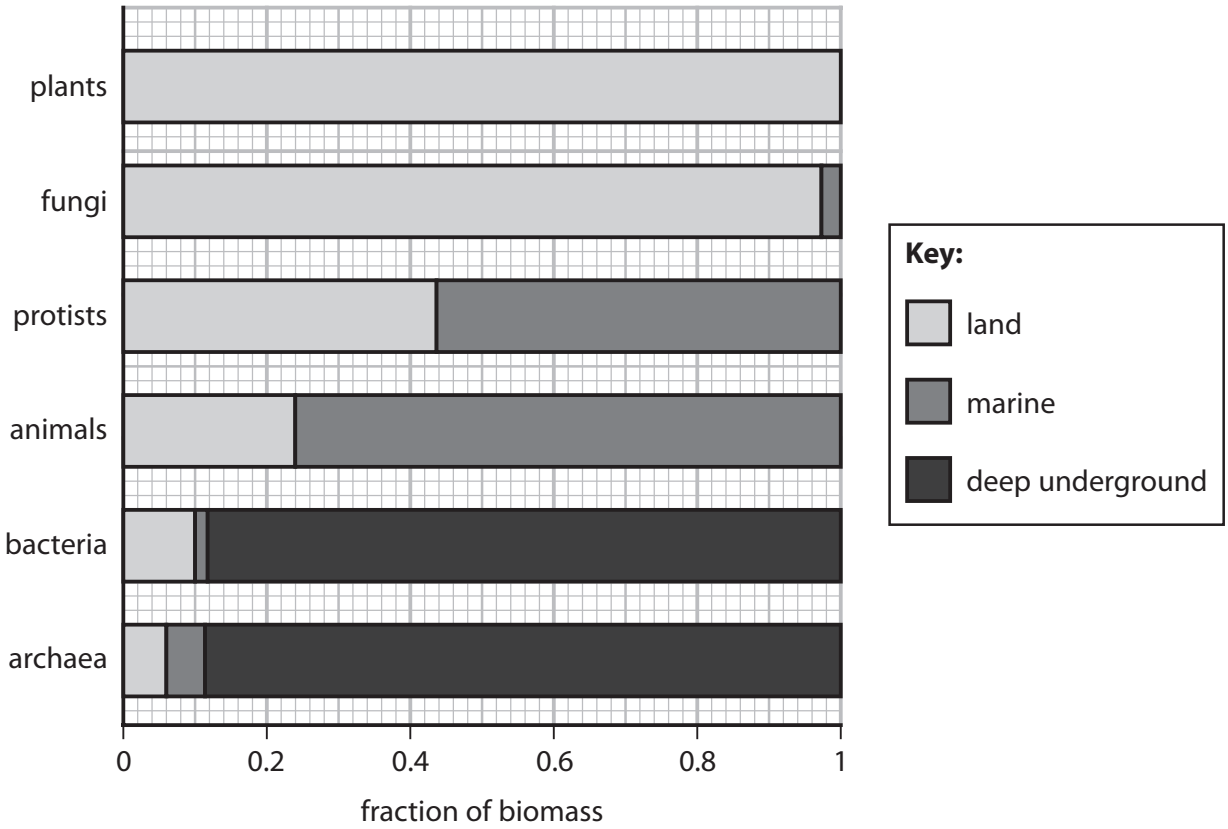
*(c) The same study also determined the distribution of biomass in three different environments: marine, deep underground and land.

The Voronoi diagram shows the distribution of biomass in each environment.

The graph shows the proportion of biomass in different groups of organisms.





Explain the distribution of biomass in these three environments.

Use the information in the Voronoi diagram and the graph to support your answer.

(6)

(Total for Question 8 = 14 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 45 minutes

Paper reference **WBI14/01**

Biology

International Advanced Level
UNIT 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or 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.*
- Calculators may be used.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

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.*
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- 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.

Turn over ▶

L:1/1/1/1/1/1/

P 6 9 5 0 2 A 0 1 2 8

Pearson

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 The photograph shows a polar bear.

(Source: © Burcu Gultekin / Alamy Stock Photo)

Polar bears are adapted to live in the Arctic Circle.

Polar bears have a layer of fat beneath their skin. This fat insulates them from the cold and can be used to supply the polar bear with water (metabolic water).

They have a thick fur coat which also insulates them from the cold.

Polar bears feed on seals. The polar bear sits on the ice and waits for a seal to come to the surface of the water to breathe.

(a) Which row of the table describes the types of adaptation of polar bears?

(1)

		Anatomical	Behavioural	Physiological
☒	**A**	produces metabolic water	hunting by sitting on ice	thick fur coat
☒	**B**	hunting by sitting on ice	thick fur coat	produces metabolic water
☒	**C**	thick fur coat	produces metabolic water	hunting by sitting on ice
☒	**D**	thick fur coat	hunting by sitting on ice	produces metabolic water

(b) What is the niche of a polar bear?

(1)

- ☒ **A** produces metabolic water
- ☒ **B** the Arctic Circle
- ☒ **C** controls the population size of seals
- ☒ **D** uses the layer of fat beneath the skin

(c) Suggest why the polar bear needs to rely on the store of fat to provide it with water.

(2)

(d) Climate change is resulting in habitat fragmentation. Habitat fragmentation causes groups of polar bears to become separated from one another.

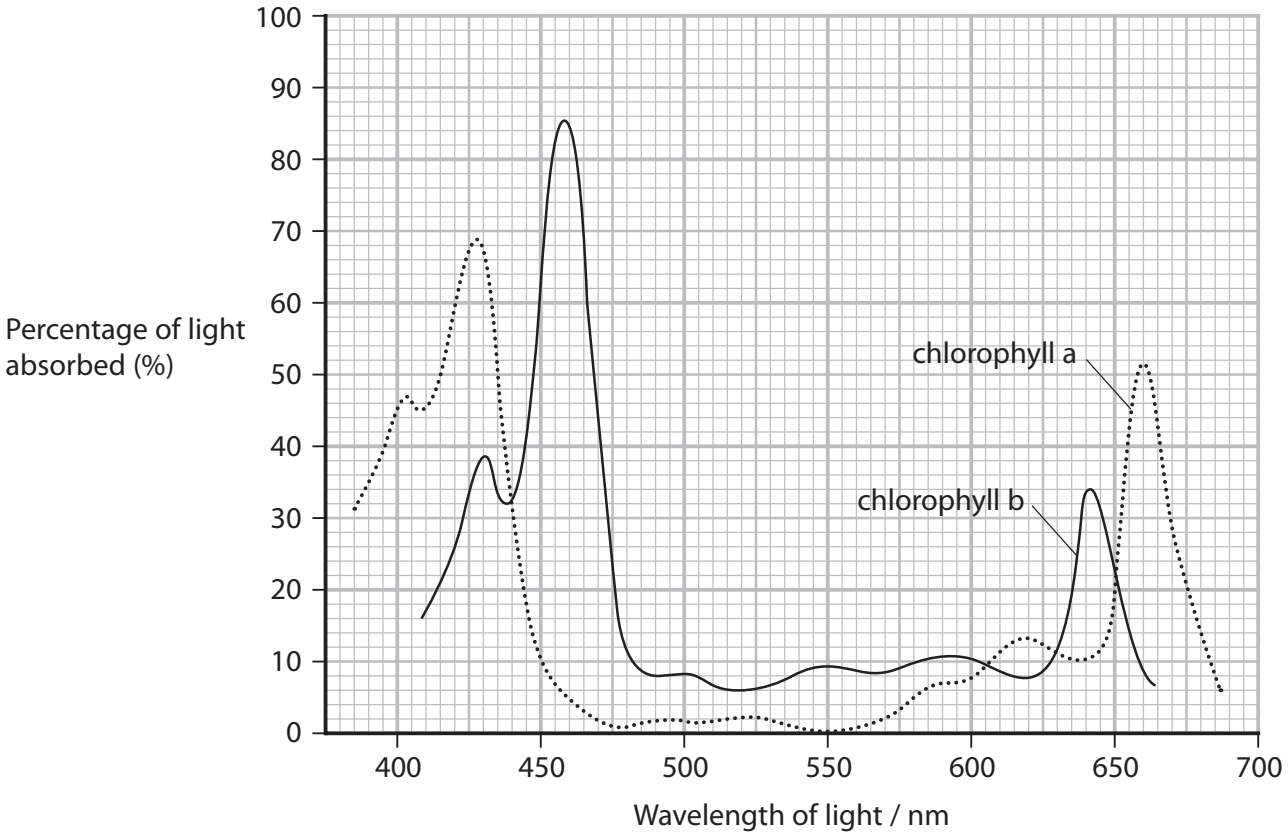
Explain the effect that habitat fragmentation could have on the genetic diversity of polar bears.

(3)

(Total for Question 1 = 7 marks)

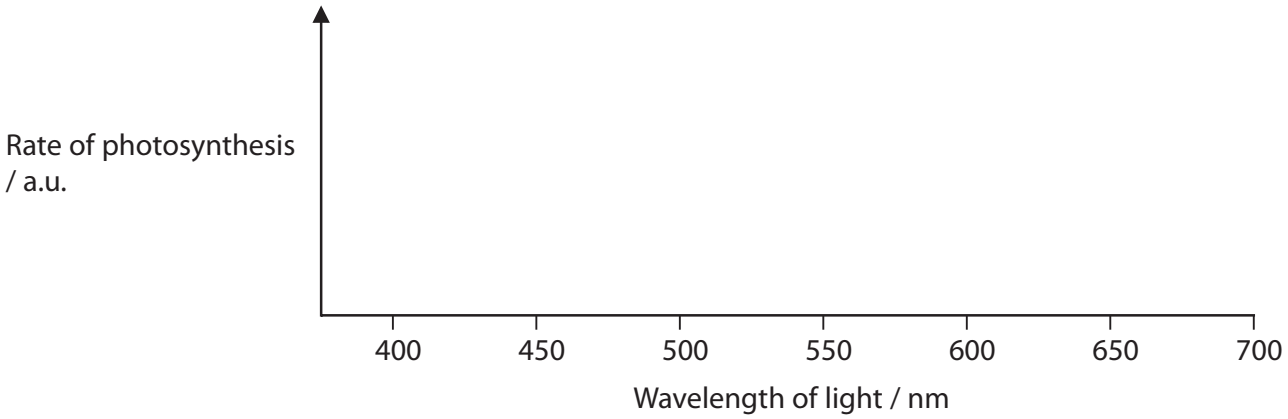
2 Thylakoid membranes contain chloroplast pigments and molecules of ATP synthase. These membranes are the site of the light-dependent reactions.

(a) The graph shows the absorption spectrums of two chloroplast pigments from one plant.



(i) Draw the action spectrum for this plant on the axes below.

(2)



(ii) Calculate how many times greater the percentage of light absorbed by chlorophyll b is than that absorbed by chlorophyll a, at their maximum absorptions.

(1)

Answer .....

(iii) Thylakoid membranes contain different types of chlorophyll pigment.

Explain the advantage of this for a plant.

(2)

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(b) The ATP synthase molecules are proteins.

(i) Which row of the table describes the bonds that form between amino acids in a protein?

(1)

		Name of bond	Parts of the amino acid that the bond forms between
☒	**A**	peptide	amino group and carboxyl group
☒	**B**	peptide	carboxyl group and R group
☒	**C**	phosphodiester	amino group and carboxyl group
☒	**D**	phosphodiester	carboxyl group and R group

(ii) Products of the light-independent reactions are used to synthesise amino acids.

Describe how plants synthesise amino acids.

(2)

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(Total for Question 2 = 8 marks)

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

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

(4)

(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)

(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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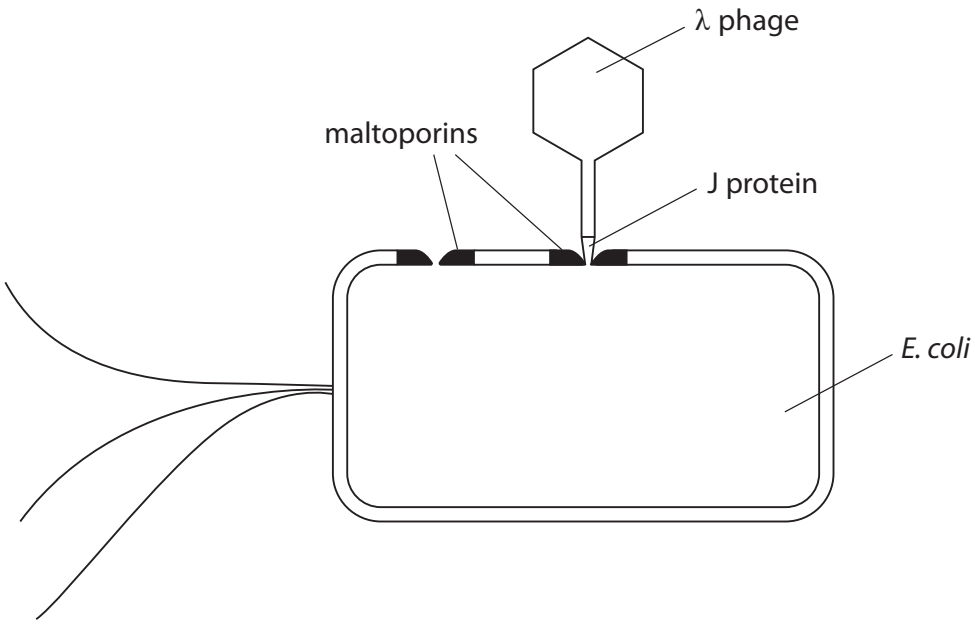
(Total for Question 3 = 10 marks)

4 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)

(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)

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

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

(6)

(Total for Question 4 = 10 marks)

5 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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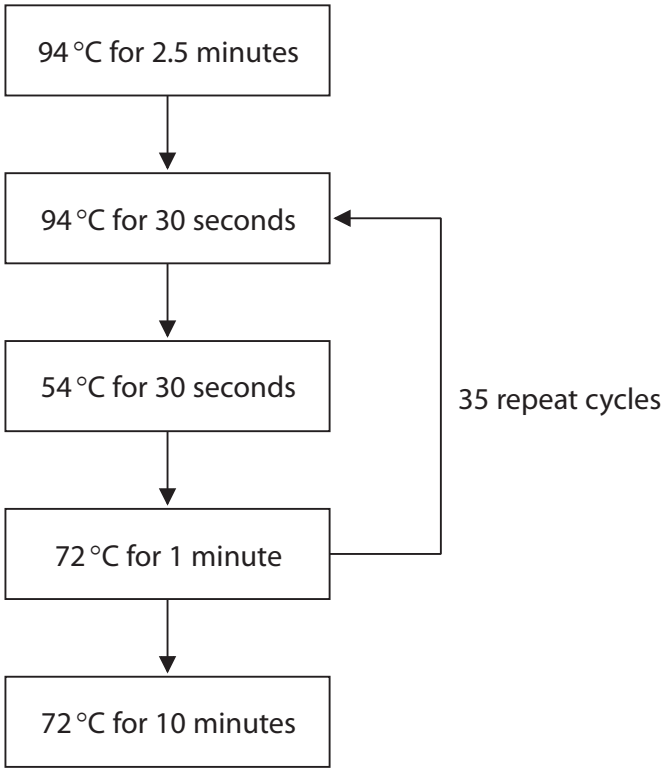
(b) The mtDNA was isolated from these two species of crow and amplified using the polymerase chain reaction (PCR).

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)

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

(3)

(Total for Question 5 = 12 marks)

6 (a) The table gives some information about structures found in chloroplasts.

Structure	Function	Other information
P	protein synthesis	some are 20 nm in size
Q	site of light-independent reactions	colourless
R	compartment for accumulation of hydrogen ions	largest are 4.35×10^{-4} mm long
S	storage granule	1 to 35 μm in size

(i) Where in the chloroplast is RUBISCO active?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(ii) What is stored in S?

(1)

- ☒ **A** GALP
- ☒ **B** lipid
- ☒ **C** starch
- ☒ **D** sucrose

(iii) Where is GP formed?

(1)

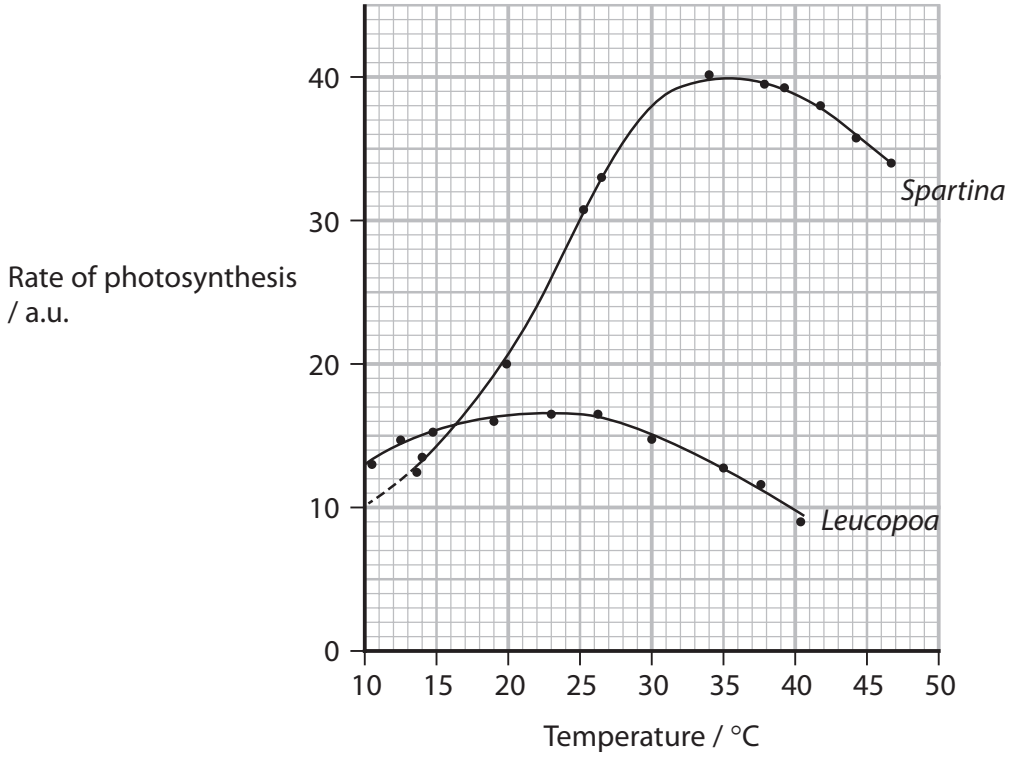
- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(iv) Which is the correct order of size, smallest to largest?

(1)

- ☒ **A** P R S
- ☒ **B** P S R
- ☒ **C** R S P
- ☒ **D** S R P

(b) The graph shows the rate of photosynthesis in two types of plant, *Spartina* and *Leucopoa*, at different temperatures.



(i) Which could be the units for rate of photosynthesis?

(1)

- ☒ **A** mg CO_2 produced $mm^{-2}\,hr^{-1}$
- ☒ **B** mg CO_2 produced $mm^{-1}\,hr^{-2}$
- ☒ **C** mg CO_2 used $mm^{-2}\,hr^{-1}$
- ☒ **D** mg CO_2 used $mm^{-1}\,hr^{-2}$

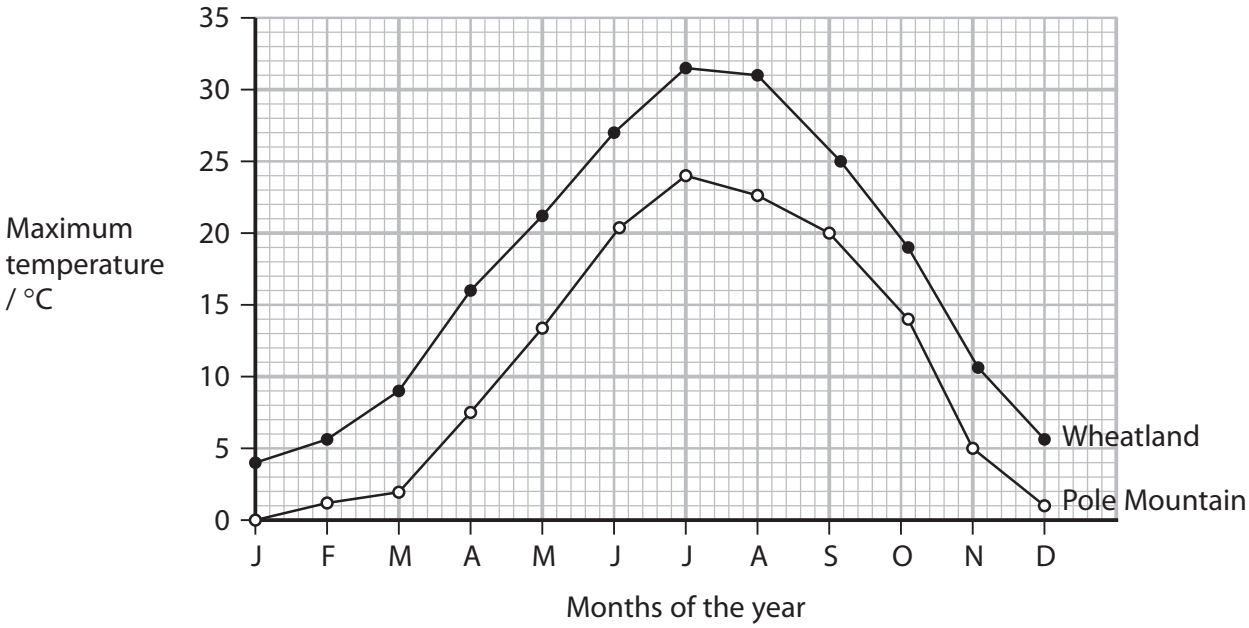
(ii) Compare and contrast the rate of photosynthesis of these two species of plant, at different temperatures.

(3)

(iii) Describe how a Q_{10} value for the rate of photosynthesis can be calculated, using this graph.

(2)

(iv) The graph shows the maximum temperature, for each month, in two regions of North America: Wheatland and Pole Mountain.



Explain in which of these two regions of North America *Spartina* is most likely to grow.

Use the information in both graphs to support your answer.

(3)

(Total for Question 6 = 13 marks)

7 As the human population in the world has increased, the demand for food has increased.

The production of food has an impact on the environment, unless it can be done in a sustainable way.

(a) (i) State the meaning of the term **population**, as it has been used in this context.

(1)

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(ii) State the meaning of the term **sustainable**, as it has been used in this context.

(1)

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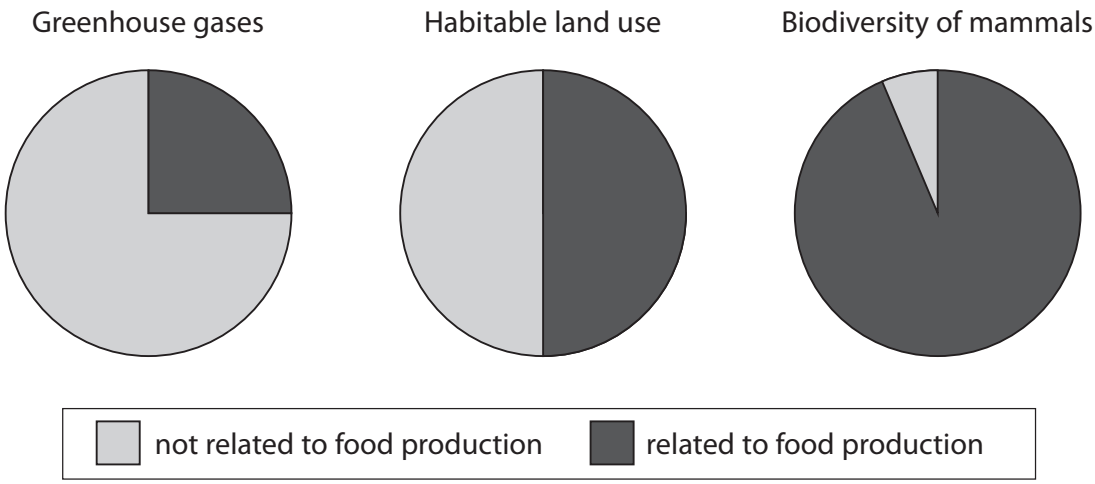
(b) The diagram shows the impact of food production on three environmental factors.



(i) Explain how food production could contribute to the greenhouse effect.

(3)

(ii) Land occupies 149 million km^2 of the surface of the Earth.

Habitable land is 71% of this area and some of it is used for food production.

Calculate the area of the surface of the Earth used in food production.

Express your answer in standard form.

(3)

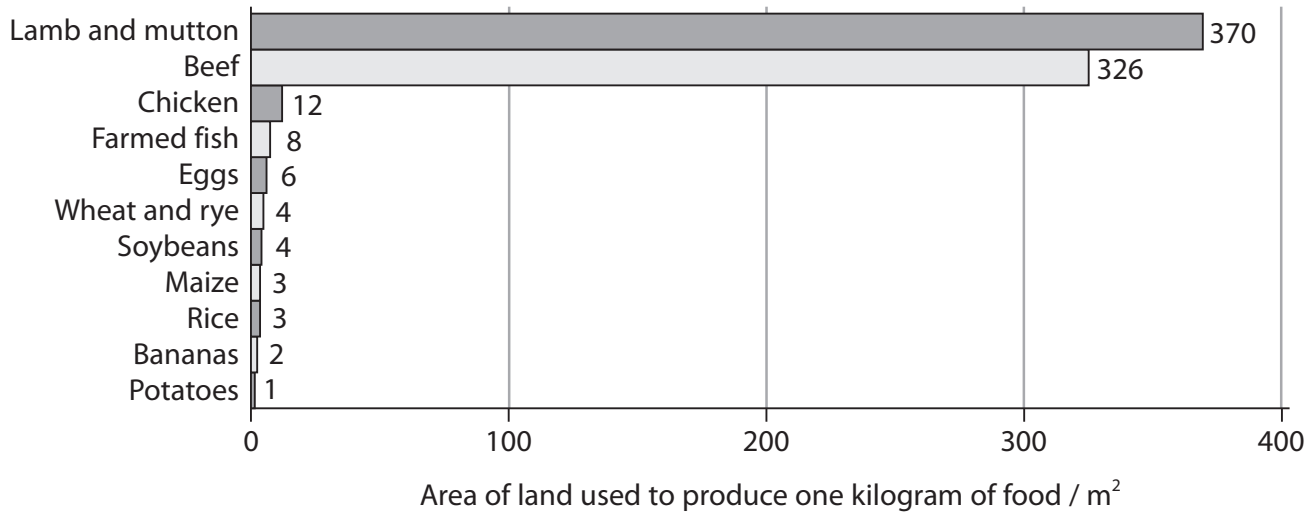
Answer ..... km^2

(iii) Estimate the effect of food production on the ratio of biodiversity of mammals.

(1)

Answer .....

*(c) The diagram shows the area of land used to produce one kilogram of some food products.



Explain how food production could be made more sustainable.

Use the information in the diagram and your own knowledge to support your answer.

(6)

(Total for Question 7 = 15 marks)

8 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)

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

(2)

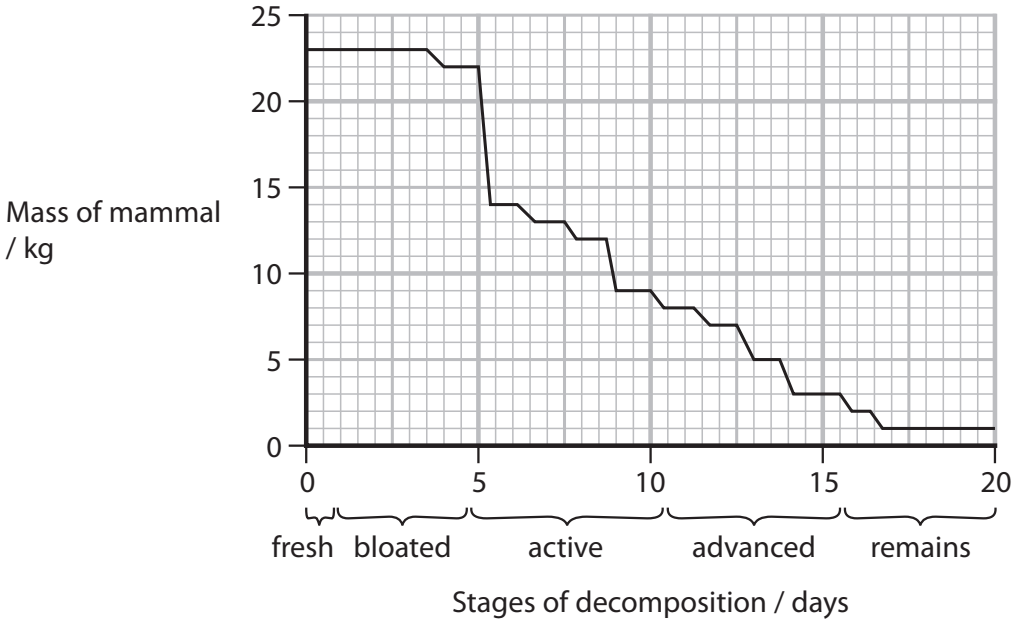
(b) A study looked at the succession of insects associated with the decomposition of a dead mammal in the Andean Coffee region.

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.

(3)

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(Total for Question 8 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 45 minutes

Paper reference **WBI14/01**

Biology

International Advanced Level
UNIT 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or 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 out** 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

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- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Q:1/1/1/1/1/1/

P 7 0 9 6 3 A 0 1 3 2

Pearson

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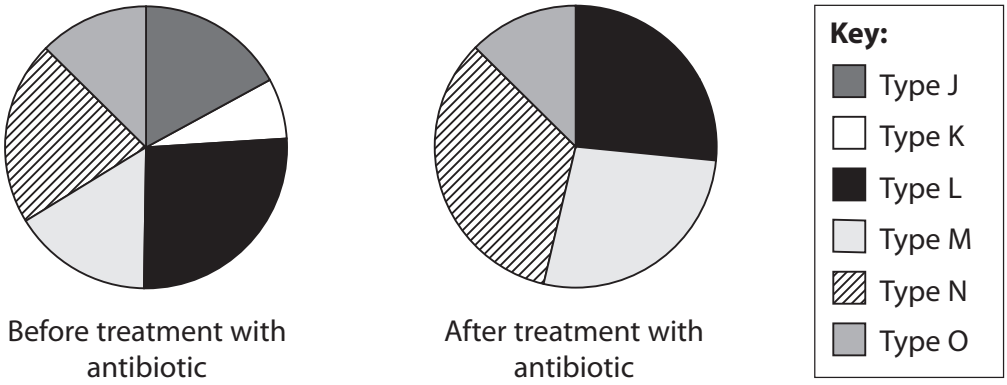
(d) The charts show the types of bacteria present in the throat of a patient, before and after treatment with an antibiotic.



Before treatment with antibiotic

After treatment with antibiotic

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

(3)

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(Total for Question 1 = 7 marks)

2 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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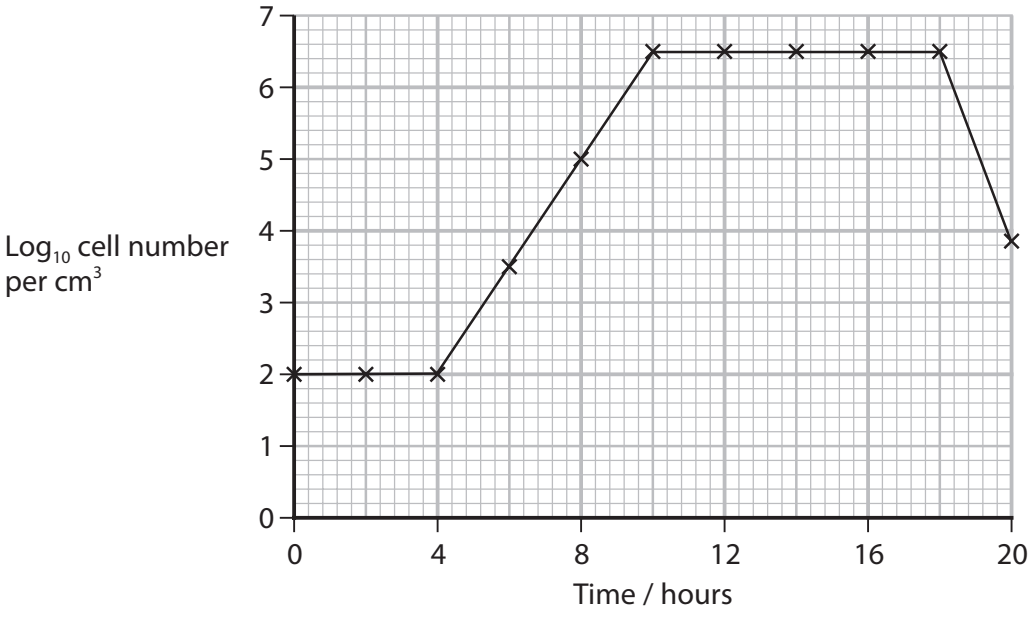
(c) The graph shows the bacterial growth curve for this culture.



(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 2 = 7 marks)

3 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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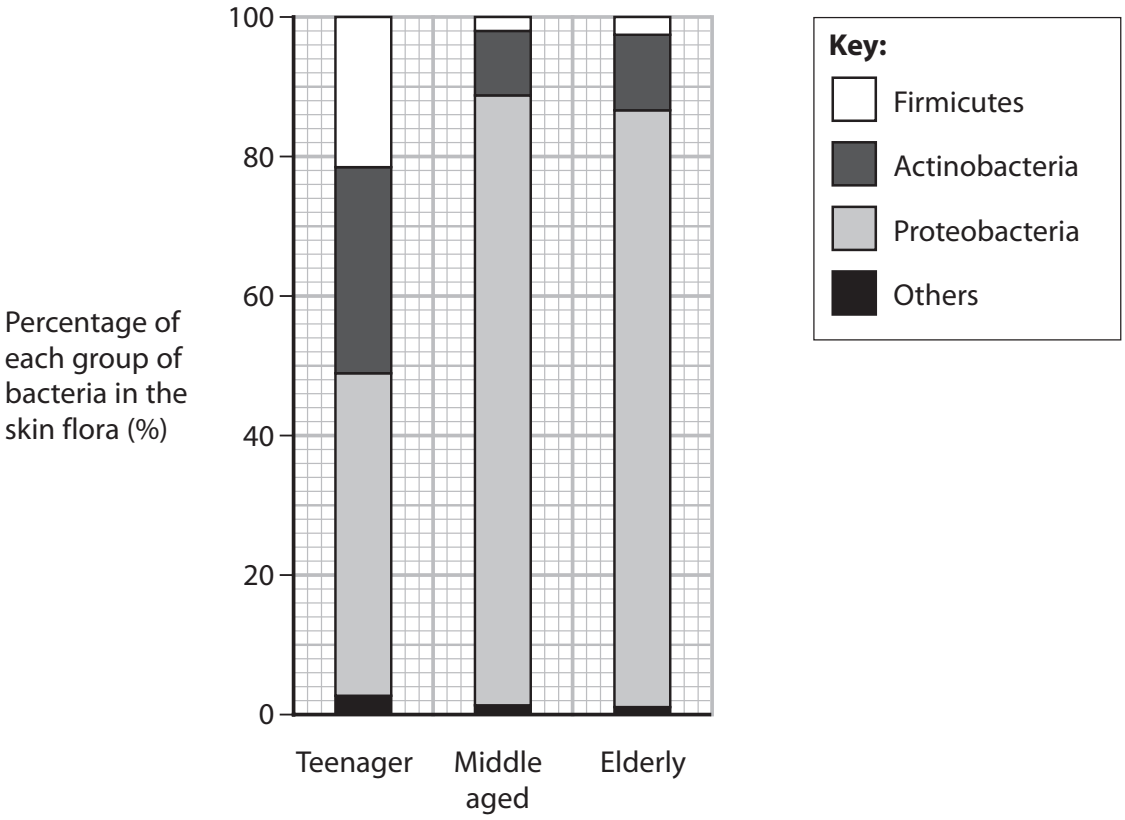
(b) The groups of bacteria present on the skin of men of different ages was investigated.

The graph shows some of the results of this investigation.



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

(3)

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

(2)

(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)

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

(2)

(Total for Question 3 = 12 marks)

4 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)

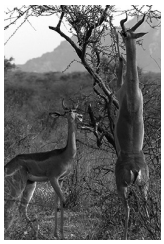
(b) Genetic studies indicate that the regent honeyeater is related to wattlebirds.

Describe how genetic studies could show this.

(4)

(Total for Question 4 = 10 marks)

5 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 	8 825
1	Tree 	90 480

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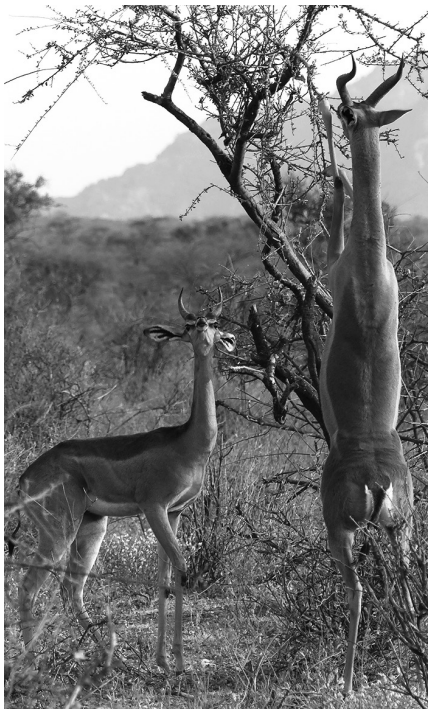
(v) Describe the role of microorganisms in recycling carbon present in this food chain.

(3)

*(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.

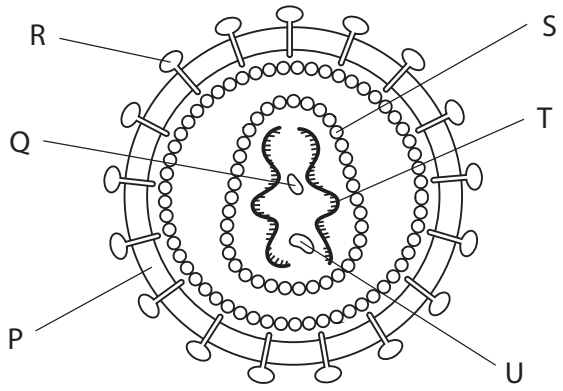
Deduce how the gerenuk evolved to occupy a different niche from a springbok.

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

(6)

(Total for Question 5 = 14 marks)

6 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)

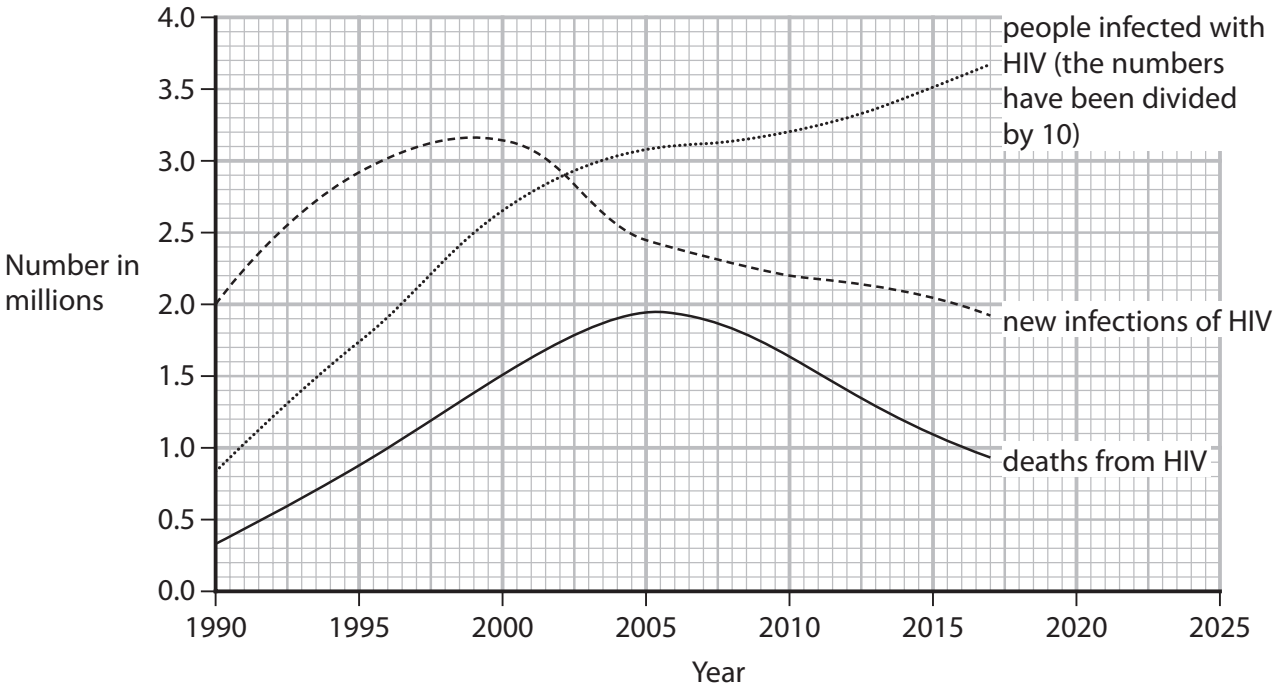
(iv) The diameter of HIV is 120 nm.

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)

(Total for Question 6 = 14 marks)

7 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.

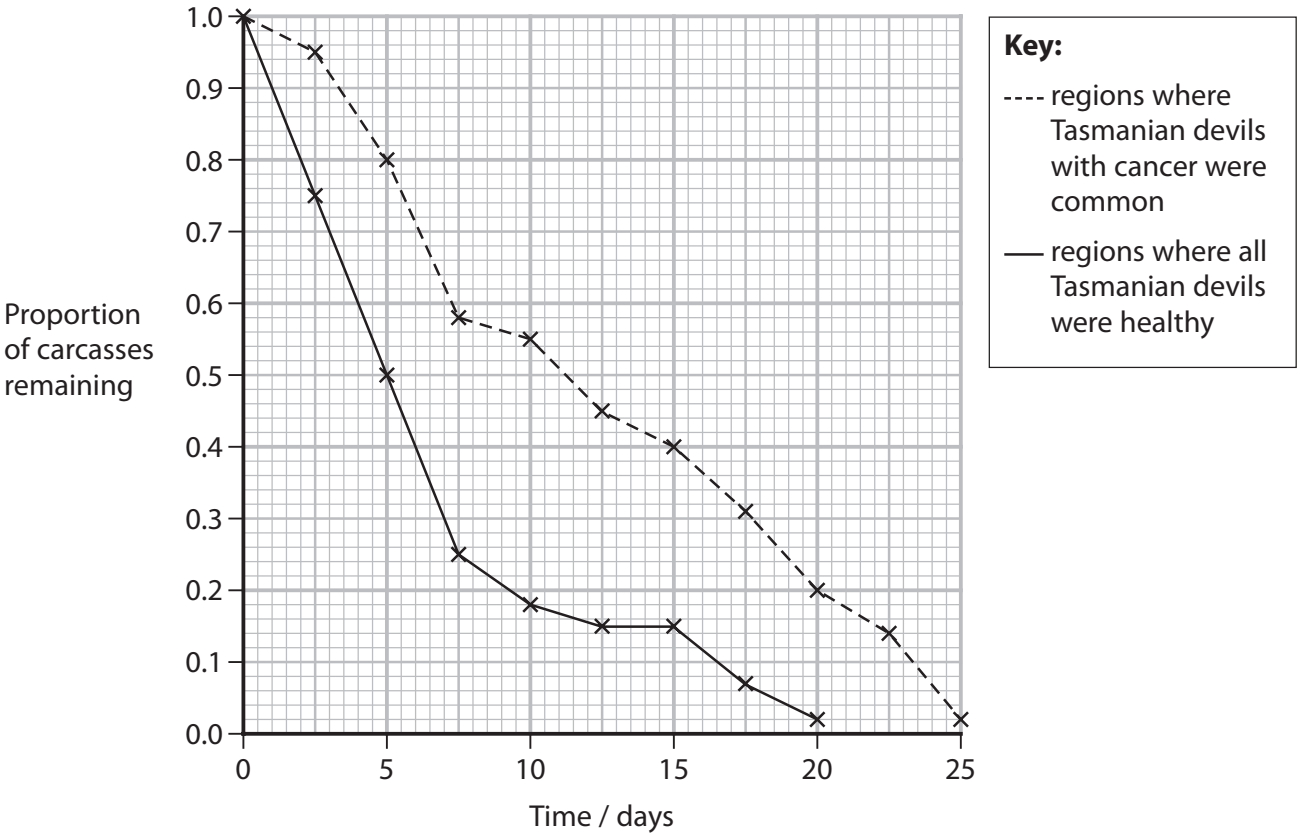
The length of time Tasmanian devils and three other scavenging animals spent feeding on carcasses was investigated.

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.

(6)

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

(4)

(Total for Question 7 = 11 marks)

8 The eruption of a volcano can devastate the surrounding countryside and cause climate change.

(a) The photograph shows the devastation that can result from a volcanic eruption.

(Source: © Zoonar GmbH / Alamy Stock Photo)

Succession occurs in the devastated areas.

Pioneer species are the first to colonise these areas.

Several stages follow, which may result in a climax community.

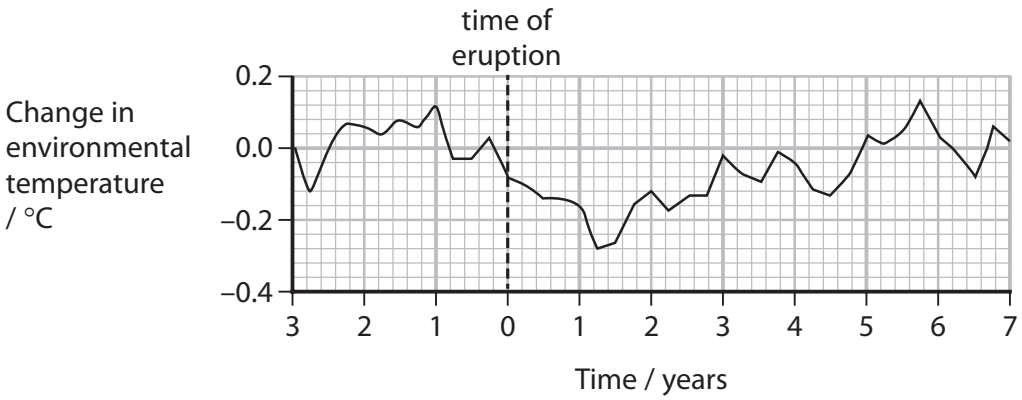
(i) Describe **three** characteristics of pioneer species.

(3)

(ii) Explain why succession occurs in stages.

(2)

(b) (i) The graph shows the changes in environmental temperature before and after a volcanic eruption.



Determine the effect of the volcanic eruption on environmental temperature.

Use the information in the graph to support your answer.

(2)

(ii) When this volcano erupted, sulfur dioxide and particles of ash were released into the atmosphere.

Sulfur dioxide and particles of ash cause less light to pass through the atmosphere.

Explain the results shown in the graph.

(4)

(iii) The eruption of one volcano resulted in 5×10^7 metric tons of carbon dioxide entering the atmosphere in one year.

The mass of carbon dioxide released into the atmosphere in one year by anthropogenic activities was 3.5×10^{10} metric tons.

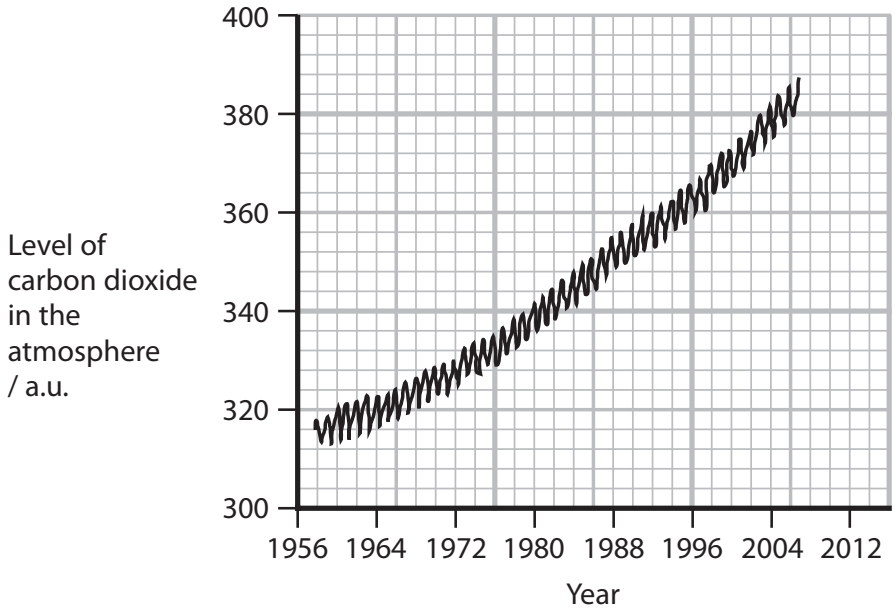
Calculate how many volcanic eruptions would need to occur, in one year, to produce as much carbon dioxide as anthropogenic activities.

(1)

Answer .....

(iv) The graph shows the levels of carbon dioxide in the atmosphere in one region of the world from 1958 to 2004.

During this period there were volcanic eruptions in 1963, 1980, 1982 and 1991, in this region.



Discuss the possible effects of volcanic eruptions on climate change.

Use all the information in part (b) to support your answer.

(3)

(Total for Question 8 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 45 minutes

Paper reference **WBI14/01**

Biology

October 2022

International Advanced Level

UNIT 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or 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 out** in calculations and **include units** where appropriate.

Information

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Turn over ▶

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B:1/1/1/1/1/

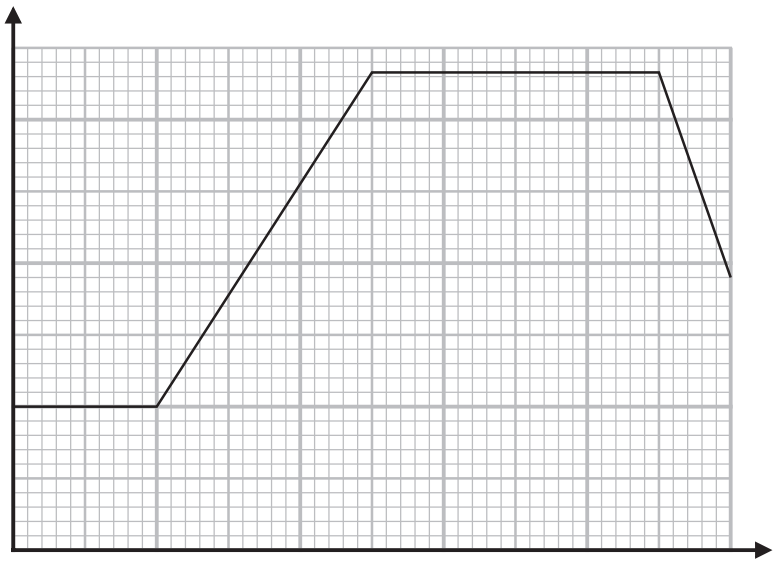
P 7 1 8 4 8 A 0 1 3 2

Pearson

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



Time / hours

(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)

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

(2)

(Total for Question 1 = 5 marks)

2 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)

.....

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

(1)

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(Total for Question 2 = 5 marks)

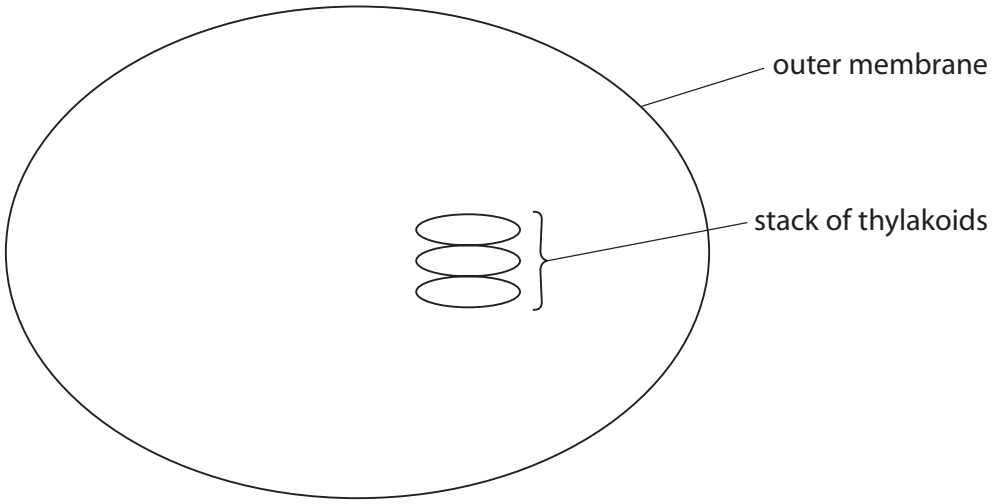
3 Chloroplasts are involved in both the light-dependent reactions and the light-independent reactions of photosynthesis.

(a) Which row of the table is correct for these two reactions?

(1)

	Light-dependent reactions	Light-independent reactions
☒ **A**	ADP is phosphorylated, releasing energy	ATP is hydrolysed, requiring energy
☒ **B**	ADP is phosphorylated, requiring energy	ATP is hydrolysed, releasing energy
☒ **C**	ATP is hydrolysed, releasing energy	ADP is phosphorylated, requiring energy
☒ **D**	ATP is hydrolysed, requiring energy	ADP is phosphorylated, releasing energy

(b) The diagram shows part of a chloroplast.



(i) Complete this diagram to show **three** other labelled structures found in a chloroplast.

(3)

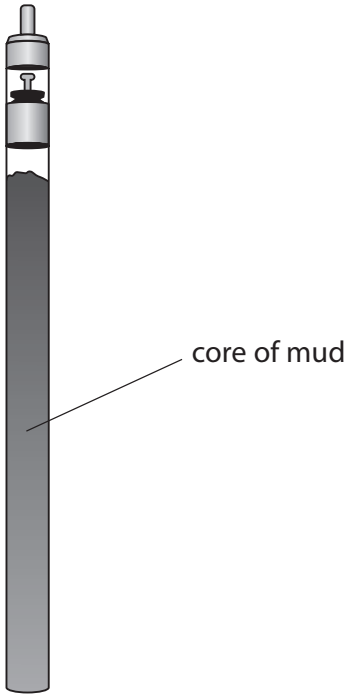
(ii) Compare and contrast the structure of the outer membrane of a chloroplast with that of a thylakoid membrane.

(4)

(Total for Question 3 = 8 marks)

4 Scientists have used specialised apparatus to remove cores of mud from a tropical rainforest in the Republic of the Congo.

The diagram shows the apparatus containing a core of mud.



(a) The core of mud removed has a diameter of 80 mm and a length of 900 mm.

Which is the volume of this core of mud?

Use the formula: $V = \pi r^2 l$

Use $\pi = 3.142$

(1)

☒ **A** 4524 cm^3

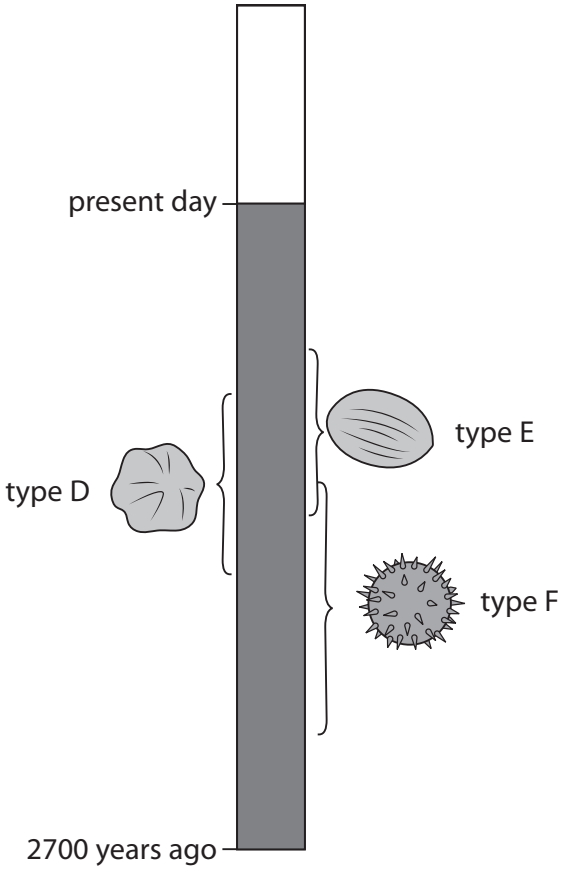
☒ **B** 4525 cm^3

☒ **C** 18 097 cm^3

☒ **D** 18 098 cm^3

(b) The scale diagram shows where three types of pollen grain were found in a core of mud.

The depth of the mud is proportional to how long ago the mud was deposited.



(i) Calculate how many years the plants producing type D pollen grains were present in this rainforest.

(2)

Answer ..... years

(ii) Explain the distribution of these three types of pollen grain in this mud column.

Use the information in this diagram to support your answer.

(4)

(Total for Question 4 = 7 marks)

5 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.

(2)

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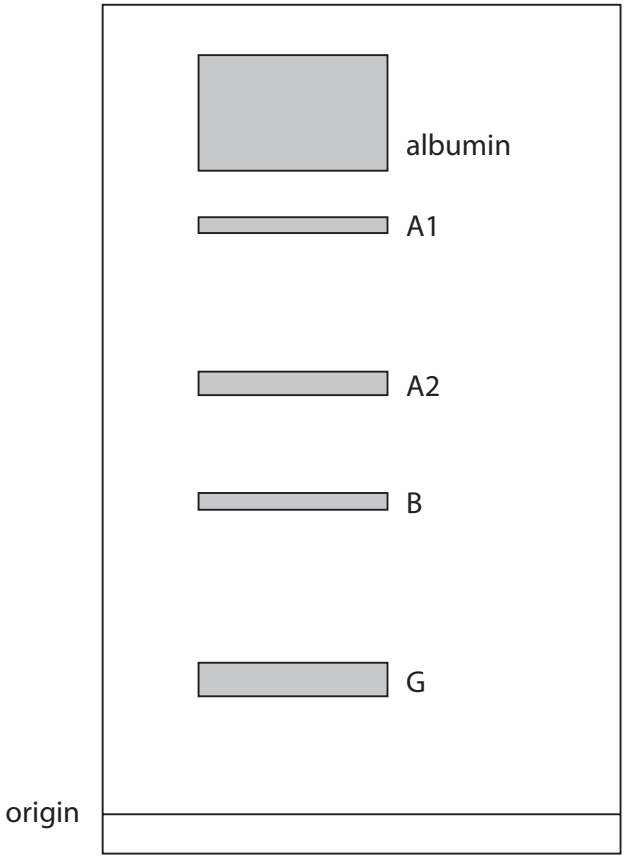
(b) Albumin can be separated from other proteins in blood plasma, A1, A2, B and G, by gel electrophoresis.

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)

(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.

(4)

(Total for Question 5 = 11 marks)

6 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)

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

(2)

(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)

(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)

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

(2)

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(Total for Question 6 = 12 marks)

7 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)

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

(2)

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

(2)

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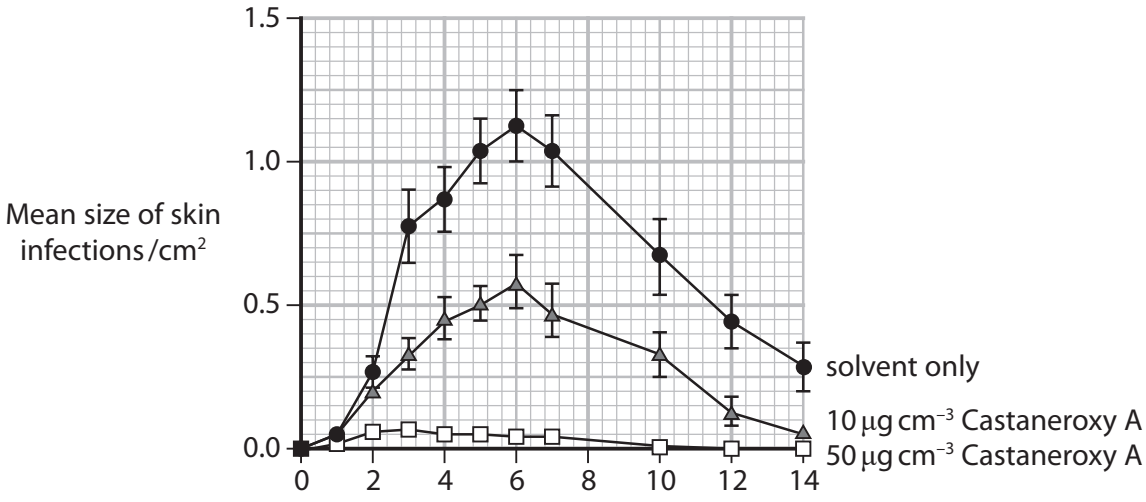
(d) In an investigation, patients who had developed skin infections were divided into three groups.

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)

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

(3)

(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 $\mu g\, cm^{-3}$.

Give your answer to the nearest kilogram.

(3)

Answer ..... kg

(Total for Question 7 = 14 marks)

8 There has been an increase in the number of forest fires in many areas of the world.

Climate change caused by humans is claimed to be responsible for this.

The photograph shows the devastation caused by a forest fire in Myanmar.

(Source: © robertharding/Alamy Stock Photo)

(a) (i) State the term used to describe climate change caused by human activity.

(1)

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(ii) Explain why some people consider this claim to be controversial.

(2)

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*(b) Discuss the effects that forest fires have on the local atmosphere and local biodiversity, in the short term and the long term.

(6)

(c) Reforestation is one way to repair the damage caused to forests by climate change.

Explain why the changes to the environment caused by climate change need to be considered when selecting the species of trees to use in reforestation.

(4)

(Total for Question 8 = 13 marks)

9 Plants store biomass both above and below ground.

(a) Scientists have found that on average, 24 % of plant biomass is underground in the roots.

The total plant biomass underground contains 113 gigatonnes of carbon. This is equivalent to the mass of carbon dioxide emissions produced by humans in 10 years.

One gigatonne is 1×10^{12} kg.

Calculate the mass of carbon dioxide, in kilograms, produced by humans in one year.

Give your answer in standard form.

(2)

Answer ..... kg

(b) Describe how GALP, produced in the leaves, becomes incorporated into biomass in the roots.

(4)

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(c) Inorganic ions are used by plants to make molecules.

The table shows some molecules made by plants.

For each molecule, put one cross ☒ in the appropriate box, in each row, to show which inorganic ion provides an atom found in the molecule.

(3)

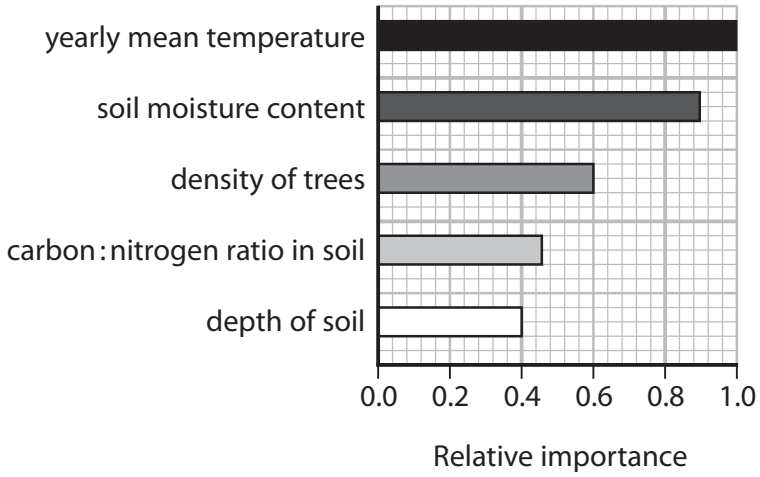
Molecule	Inorganic ion			
	nitrate only	**phosphate only**	**both nitrate and phosphate**	**neither nitrate nor phosphate**
cellulose	☒	☒	☒	☒
nucleic acid	☒	☒	☒	☒
triglyceride	☒	☒	☒	☒

*(d) Forests, shrublands and grasslands are three types of ecosystem.

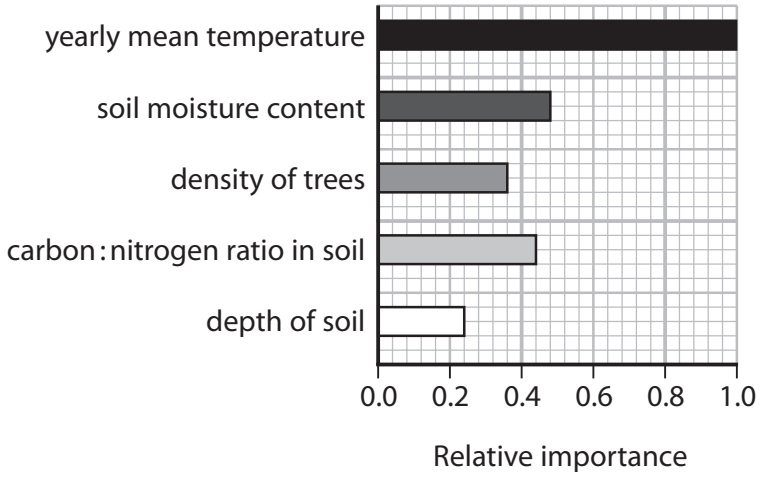
Biotic and abiotic factors affect how much biomass is stored in the roots of plants.

The graphs show the importance of some abiotic factors in determining how much biomass is stored in the roots in these ecosystems.

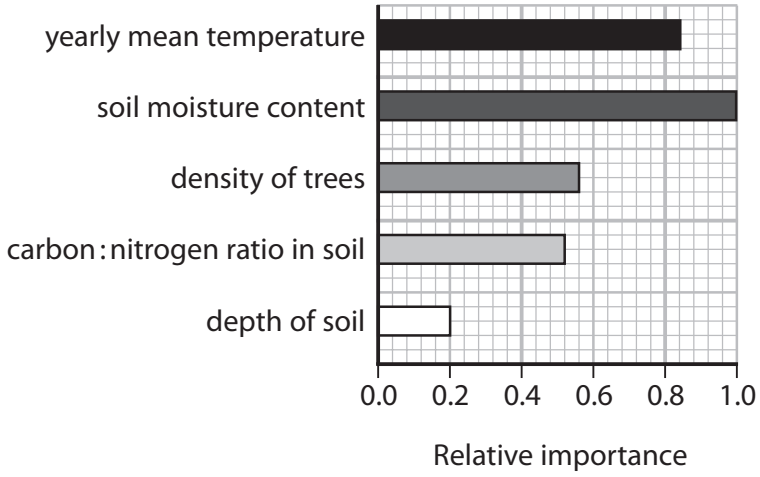
Forests



Shrublands



Grasslands



Discuss how these factors could affect the proportion of biomass stored in the roots of plants growing in these three ecosystems.

(6)

(Total for Question 9 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 45 minutes

Paper reference **WBI14/01**

Biology

January 2023

International Advanced Level
UNIT 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or 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 out** 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 the question 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.

Turn over ▶

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P 7 1 8 8 3 R A 0 1 3 2

Pearson

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 ☒.

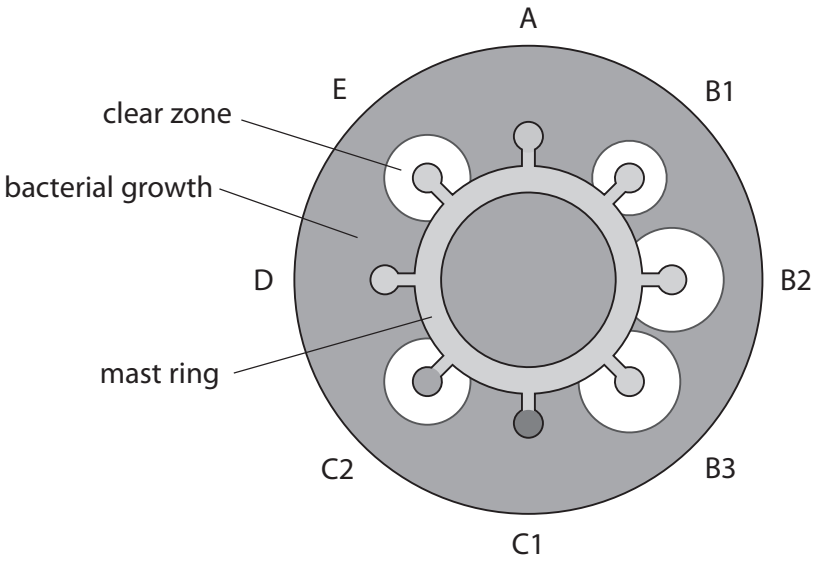
1 The resistance of bacteria to antibiotics can be studied using a mast ring.

A mast ring is made of filter paper.

Each part of the mast ring contains a different type of antibiotic or different mass of the same antibiotic.

The diagram shows a mast ring placed on agar in a Petri dish that has been spread with bacteria.

The table shows the mass of each antibiotic in the mast ring.



Part of mast ring	Antibiotic and its mass
A	100 μg antibiotic A
B1	1 μg antibiotic B
B2	10 μg antibiotic B
B3	0.5 mg antibiotic B
C1	20 μg antibiotic C
C2	200 μg antibiotic C
D	100 μg antibiotic D
E	100 μg antibiotic E

Clear zones around the mast ring indicate that the growth of the bacteria has been inhibited.

The greater the diameter of the zone of inhibition, the more effective the antibiotic.

(a) State **two** precautions that should be taken to ensure that only one type of bacteria is grown in this culture.

(2)

(b) How much more antibiotic is in part B3 than in part B2?

(1)

- ☒ **A** 0.5 times
- ☒ **B** 5.0 times
- ☒ **C** 50.0 times
- ☒ **D** 500.0 times

(c) Explain how the results shown in the diagram can help a doctor decide how to prescribe antibiotics to a patient who is infected with this type of bacteria.

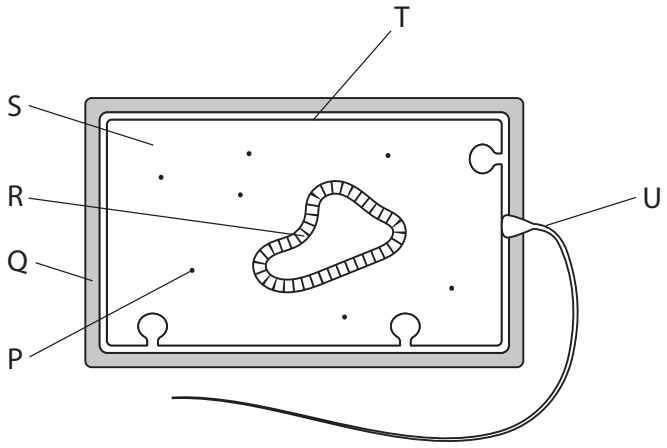
(3)

(Total for Question 1 = 6 marks)

2 Some bacteria are photosynthetic.

Bacteria do not have chloroplasts.

(a) The diagram shows a photosynthetic bacterium.



(i) Which labelled structure contains the genes coding for the enzymes involved in photosynthesis?

(1)

☒ **A** P

☒ **B** Q

☒ **C** R

☒ **D** T

(ii) Where do the light-dependent reactions take place?

(1)

☒ **A** Q

☒ **B** S

☒ **C** T

☒ **D** U

(iii) Where do the light-independent reactions take place?

(1)

☒ **A** Q

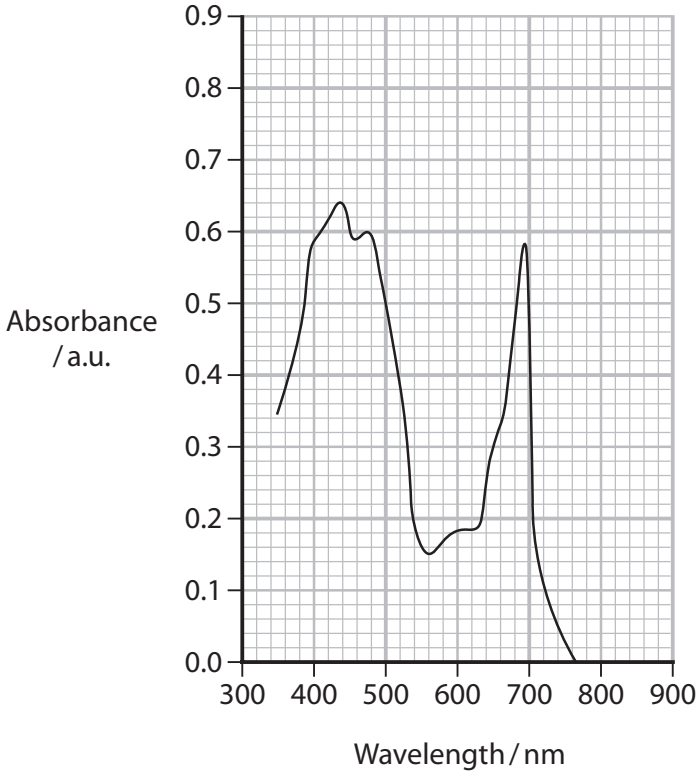
☒ **B** S

☒ **C** T

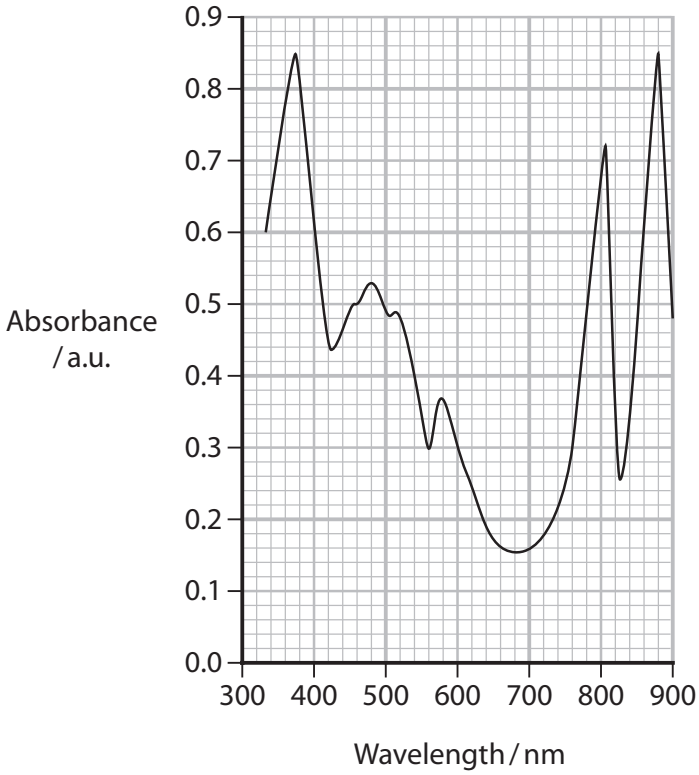
☒ **D** U

(b) The graphs show the absorption spectrum of the photosynthetic pigments in a plant and in a bacterium.

Plant



Bacterium

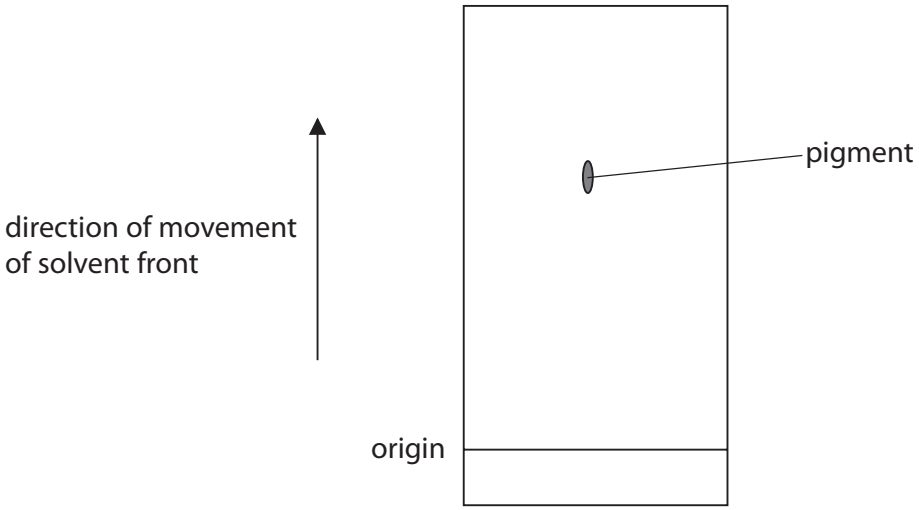


Describe **two** conclusions that can be made about the differences in absorption spectra shown in these two graphs.

(2)

(c) Photosynthetic pigments can be identified using chromatography.

The diagram shows part of a chromatogram.



Measurements are taken from a chromatogram to determine the Rf value for a photosynthetic pigment.

Describe the measurements taken and how they can be used to calculate the Rf value for this pigment.

(3)

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(Total for Question 2 = 8 marks)

3 The photograph shows part of a vanilla plant, grown in tropical areas along the Indian Ocean.

(Source: © Babelon Pierre-Yves/Alamy Stock Photo)

Vanilla is an expensive spice to produce due to labour costs and damage to crops by pests.

(a) Viruses such as the vanilla mosaic virus damage the leaves of vanilla plants.

The vanilla mosaic virus has a similar structure to tobacco mosaic virus (TMV).

Which describes TMV?

(1)

☒ **A** DNA virus with an envelope

☒ **B** DNA virus without an envelope

☒ **C** RNA virus with an envelope

☒ **D** RNA virus without an envelope

(b) Disposing of plastic waste is a global problem as it is very difficult to recycle.

(i) In 2018, 8.3×10^{12} kg of plastic was produced.

Only 8.7 % of this plastic was recycled.

Calculate the mass of plastic that was **not** recycled.

Express your answer in standard form to one decimal place.

(2)

Answer ..... kg

(ii) Scientists are developing methods that use microorganisms to break down plastics.

Some of the products produced are being used for other purposes, such as vanilla flavouring.

Explain why some microorganisms can break down plastics.

(2)

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(iii) One type of bacteria, *Pseudomonas*, uses half of the plastic it breaks down to produce its own biomass, with the rest released as carbon dioxide.

Explain how the breakdown products become biomass and carbon dioxide.

(3)

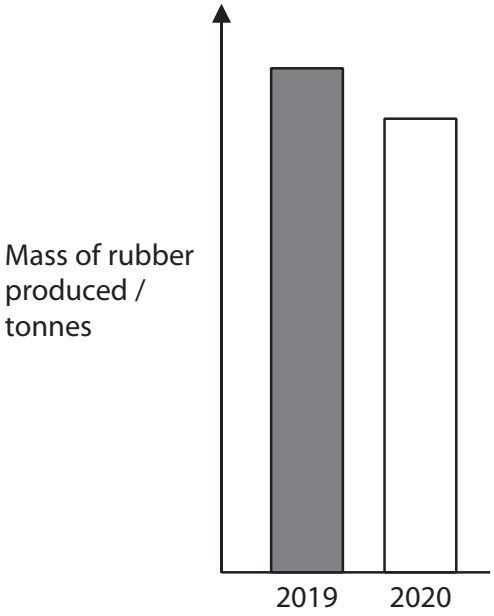
(Total for Question 3 = 8 marks)

4 Natural rubber is harvested from rubber trees.

The photograph shows rubber being collected from the trunk of a rubber tree in Thailand.

(Source: © Tong Patong/Alamy Stock Photo)

(a) The graph shows the mass of rubber produced in Thailand in 2019 and 2020.



In 2020, Thailand produced 4.37 million tonnes of rubber.

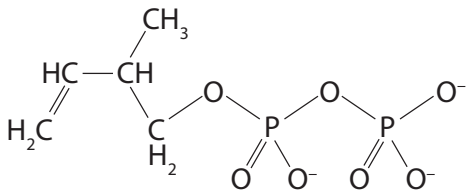
Estimate the mass of rubber produced in Thailand in 2019.

(1)

Answer ..... tonnes

(b) Rubber is synthesised by specialised cells in the trunks of rubber trees.

The diagram shows the structure of one molecule that these cells use to synthesise rubber.



GALP is produced in the light-dependent reactions in the leaves.

Explain how the cells in the trunk are able to synthesise the molecule in the diagram using GALP produced in the leaves.

Use the information in the diagram and your own knowledge to support your answer.

(4)

(c) A rubber tree can be used to harvest rubber until it is about 32 years old.

Explain how dendrochronology could be used to determine the age of a tree that is still producing rubber.

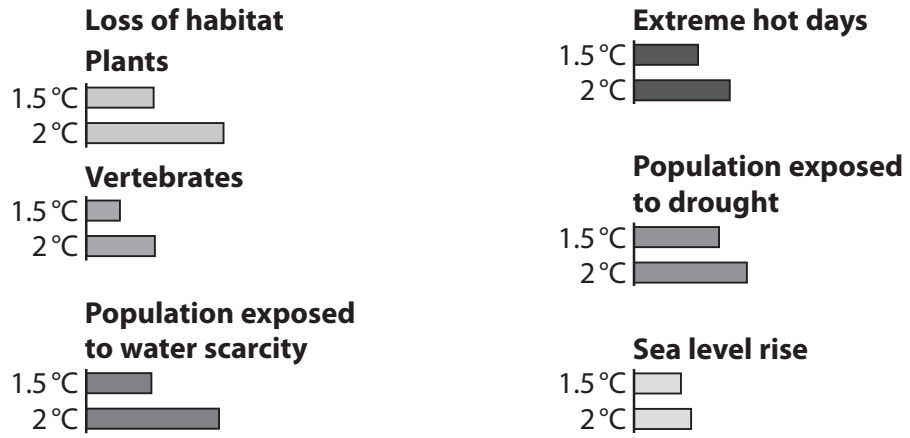
(3)

(Total for Question 4 = 8 marks)

5 Global warming is one consequence of anthropogenic climate change.

The diagram shows a model of some of the effects an increase in temperature of either 1.5 °C or 2 °C could have on the environment.

Increasing impacts from 1.5 °C to 2 °C



(a) (i) Explain why this diagram is described as a model of the effects of an increase in temperature.

(2)

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(ii) Calculate the percentage increase in the population exposed to drought if the temperature increased by 2 °C and not 1.5 °C.

Assume the bars in the diagram are drawn to scale.

(1)

Answer ..... %

*(b) It has been estimated that because humans have planted more trees and crops, the leaf area increased by 0.5 million km^2 between 2019 and 2000.

China accounts for 25% of this increase. It planted forests and crops, in equal proportions.

India accounts for 7% of this increase. It planted mostly crops.

Discuss the possible impacts of planting forests or crops on global warming, biodiversity and the local population.

(6)

(Total for Question 5 = 9 marks)

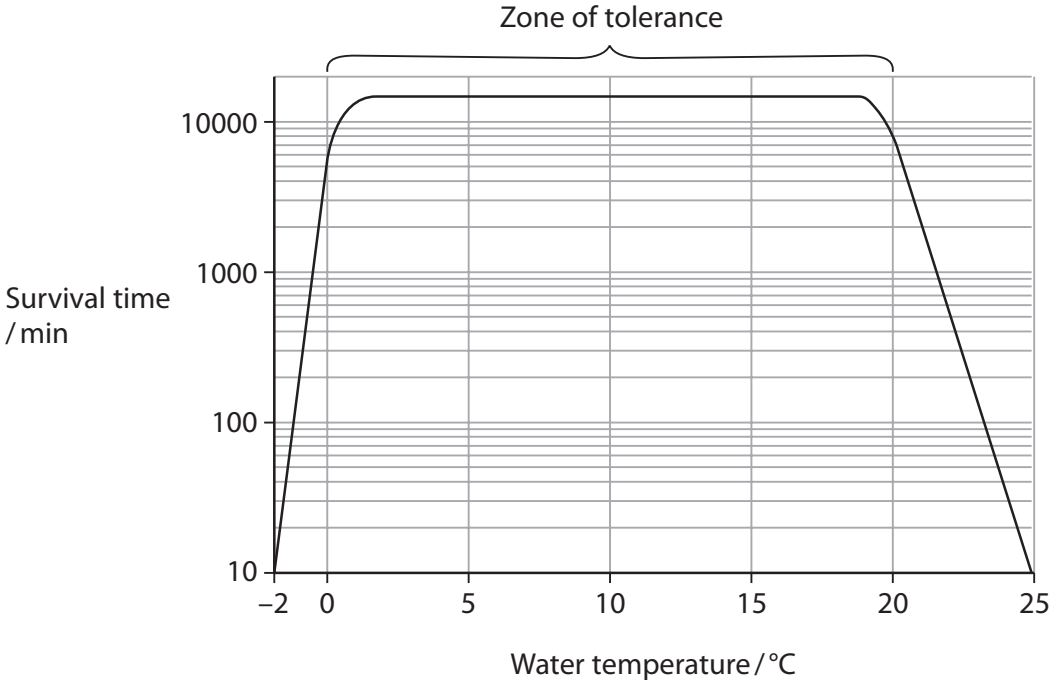
6 Changes in temperature affect the rate of enzyme activity and the survival of living organisms.

(a) Which describes an enzyme in a living organism?

(1)

- ☒ **A** inorganic substance that decreases activation energy
- ☒ **B** inorganic substance that increases activation energy
- ☒ **C** organic substance that decreases activation energy
- ☒ **D** organic substance that increases activation energy

(b) The graph shows the survival time of one species of fish in water at different temperatures.



(i) Name the type of scale that has been used on the y axis.

(1)

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(ii) The zone of tolerance is the range of temperatures that a fish could survive at for longer than 5000 minutes.

Which **two** biotic factors could cause the fish to die in this range of temperatures?

(1)

- ☒ **A** level of salt in the water and wave action
- ☒ **B** pathogens and wave action
- ☒ **C** predators and pathogens
- ☒ **D** predators and level of salt in the water

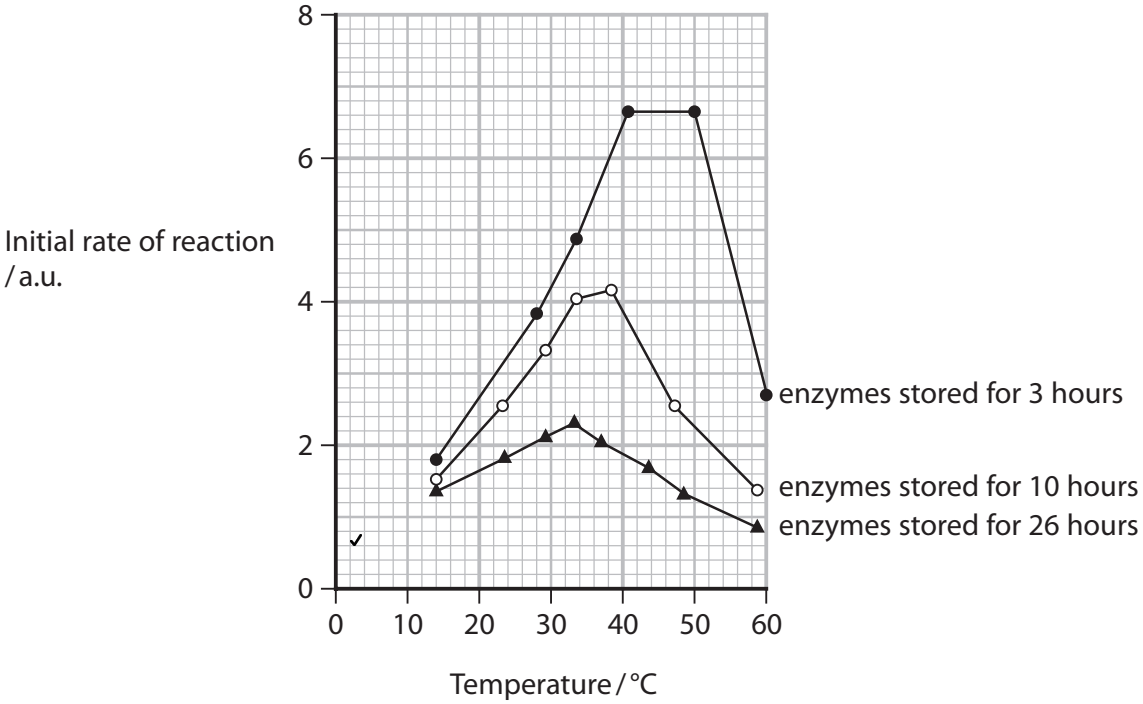
(iii) The body temperature of a fish changes with the temperature of its surroundings.

Explain why the survival time of fish is reduced at temperatures lower and higher than those in the zone of tolerance.

(3)

(c) Enzymes were stored for different lengths of time.
The effect on the initial rate of reaction was investigated.

The graph shows the results of this investigation.



(i) Calculate the Q_{10} for this enzyme stored for 3 hours.

Use the formula

$$Q_{10} = \frac{R_{(t+10)}}{R_t}$$

where R_t is the initial rate of reaction at 20 °C.

(3)

Answer.....

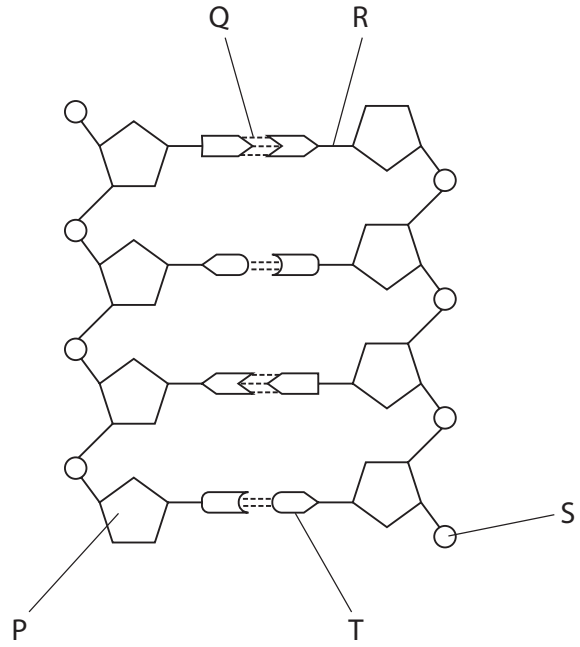
(ii) Explain why the optimum temperature for this enzyme is affected by storage time.

(3)

(Total for Question 6 = 12 marks)

7 Analysis of DNA samples taken from endangered species can be used in the conservation and management of these species.

(a) The diagram shows part of a molecule of DNA.



(i) Which row of the table identifies the bonds **Q** and **R**?

(1)

		Bond Q	Bond R
☒	**A**	covalent	hydrogen
☒	**B**	hydrogen	covalent
☒	**C**	hydrogen	phosphodiester
☒	**D**	phosphodiester	covalent

(ii) Which is a negatively charged part of a DNA molecule?

(1)

☒ **A** P

☒ **B** R

☒ **C** S

☒ **D** T

(b) The Maleo is an endangered bird endemic to Indonesia.

The photograph shows a Maleo, digging a hole in sand to lay her egg.

(Source: © Avalon.red/Alamy Stock Photo)

Maleos live in the forest and only come to the beaches to lay their eggs. Once the eggs are laid and buried in the sand, the birds return to the forest.

When the egg hatches the young bird digs its way out of the sand and can fly straightaway.

Habitat fragmentation is thought to be partly responsible for this species being endangered. The forests are separated from the beaches by the activities of humans.

(i) State the meaning of the term **endemic**, as used in the context of this question.

(1)

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(ii) Give **one** reason why habitat fragmentation could endanger these birds.

(1)

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(iii) Suggest the advantages of:

- laying the egg in the sand
- the adults leaving the site
- the young birds being able to fly.

(3)

(iv) In a genetic study of these birds, DNA from the developing chick was isolated from the remains of the eggshell and amplified using PCR.

To amplify a DNA molecule using PCR, two different primers are needed.

Explain why two different primers are needed to amplify one molecule of DNA in a PCR.

(2)

(v) These birds are thought to be monogamous, which means that they only mate with one bird of the opposite sex.

Birds are only monogamous if the ratio of male to female birds is 1 : 1.

In one genetic study, DNA from 23 eggshells was analysed.

This study found that 8 of the chicks were female and 15 chicks were male.

Comment on the claim that Maleos are monogamous.

(3)

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(Total for Question 7 = 12 marks)

8 Dengue fever is caused by infection with the dengue virus. This virus is transmitted by mosquitoes.

The virus replicates inside the mosquito and is then passed onto a person in the saliva of the mosquito. The virus then replicates inside the infected person and causes the symptoms of the infection.

Symptoms include fever, headache and a rash. Complications include bleeding, low levels of platelets and low blood pressure.

It is estimated that globally, there are 390 million new cases of dengue infections per year. The infection rate is rising. This disease can be fatal.

Groups of scientists are working to develop vaccines, treatments and methods to reduce the spread of this virus.

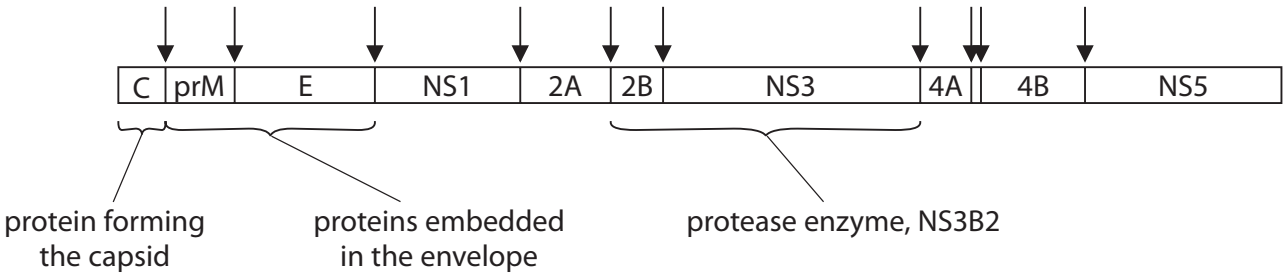
(a) The dengue virus is an RNA virus. The RNA is translated on the endoplasmic reticulum of the host cell into one polyprotein.

(i) Describe how the viral RNA is translated.

(3)

(ii) The diagram shows this polyprotein and the function of some of the individual proteins it contains.

The arrows indicate where the individual proteins need to be separated by the protease enzyme NS3B2.



One group of scientists has found that an inhibitor to this protease enzyme reduces the number of viruses produced in infected cells.

Suggest how this inhibitor could result in fewer viruses being produced.

(3)

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(b) Another group of scientists showed that an extract from the leaves of the papaya plant helped in recovery from dengue virus infection.

They showed that the platelet and white blood cell counts were higher in people treated with the extract than in people given a placebo.

Explain how these changes may have helped in recovery from dengue virus infection.

(4)

(c) Another group of scientists infected the eggs of mosquitoes with *Wolbachia* bacteria.

The *Wolbachia* do not harm the mosquitoes but compete with the virus so that it is harder for it to replicate.

The bacteria can also be passed on to future generations of mosquitoes.

One study in Indonesia showed a 77% reduction in new cases of dengue infection after the introduction of *Wolbachia* into the mosquito population.

Describe **two** advantages of this method of disease control.

(2)

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(Total for Question 8 = 12 marks)

9 Infection with *Mycobacterium tuberculosis* results in tuberculosis (TB), which is one of the top ten causes of death in the world.

(a) In 2019, an estimated 1.2 million children, 3.2 million women and 5.6 million men developed TB.

Calculate the ratio of children to women to men who developed TB.

(1)

Answer .....

(b) Explain how infection with *Mycobacterium tuberculosis* may result in death.

(3)

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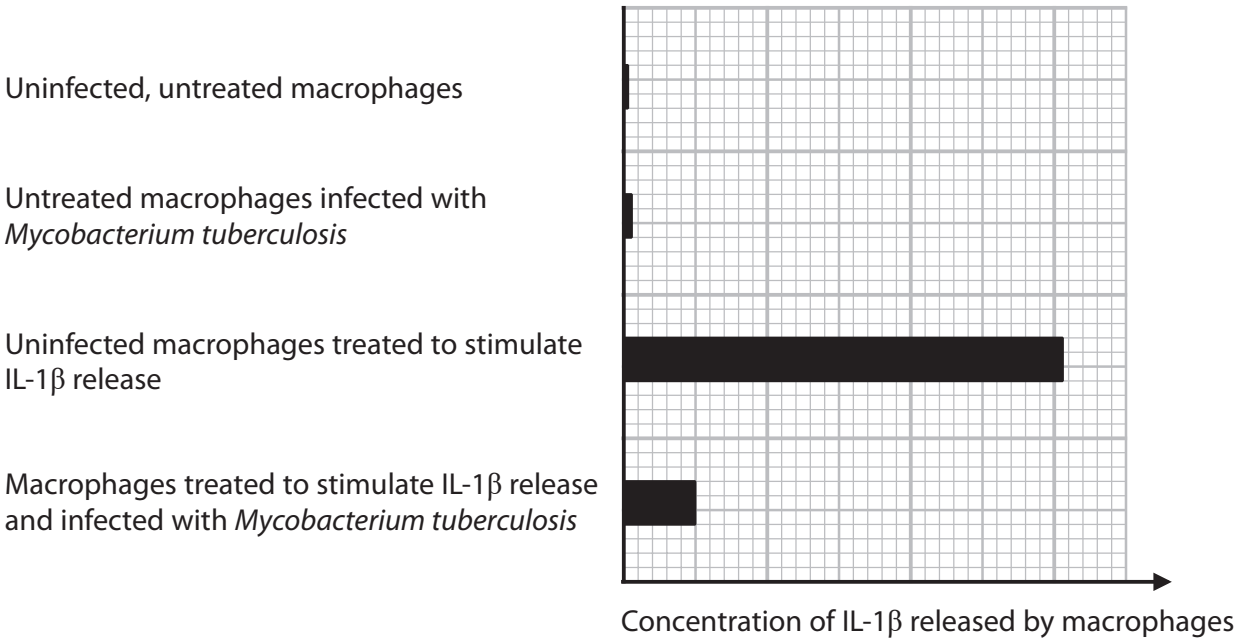
(c) *Mycobacterium tuberculosis* has evolved to evade host immunity by interfering with macrophage function.

In one investigation, scientists showed that *Mycobacterium tuberculosis* can inhibit the activation of a process in macrophages. This inhibition results in less of the chemical IL-1β being released.

(i) The graph shows some of the results of this investigation.



Explain why the macrophages had to be treated to stimulate IL-1β release in this investigation.

Use the information in the graph to support your answer.

(2)

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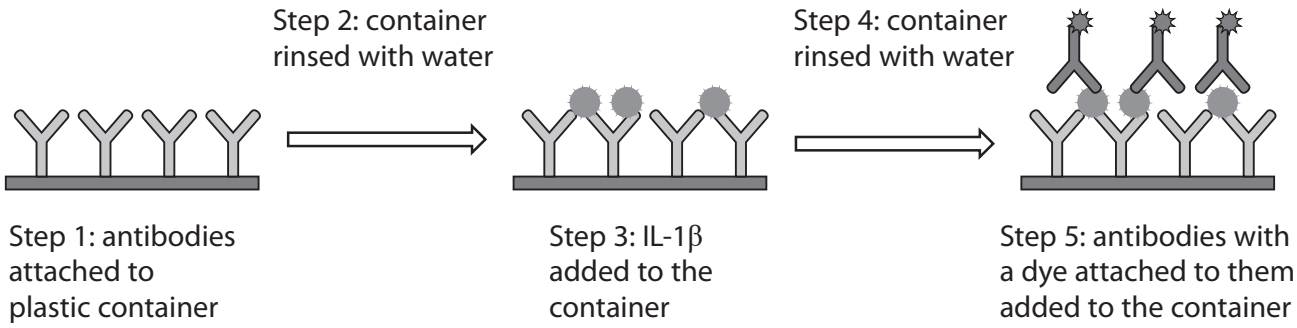
(ii) An ELISA is used to detect a specific antigen.

The IL-1β was detected using an ELISA.

The diagram shows an ELISA.



Explain how the steps in the ELISA result in the identification of IL-1β.

Use the information in the diagram to support your answer.

(4)

(iii) The scientists identified a protein that could be responsible for inhibiting the activation of the macrophages.

They used *Mycobacterium tuberculosis* with a mutation in the gene coding for this protein as part of their investigation.

This involved comparing the growth rate of these mutant bacteria with the unmutated bacteria.

Describe how optical methods (turbidity) can be used to compare the growth rates of these two populations of bacteria.

(4)

(iv) Suggest how this protein, released by the *Mycobacterium tuberculosis*, could be used to develop a treatment for TB.

(1)

(Total for Question 9 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Thursday 1 June 2023

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 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.*

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.

Turn over ▶

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P 7 1 9 3 7 A 0 1 3 2

Pearson

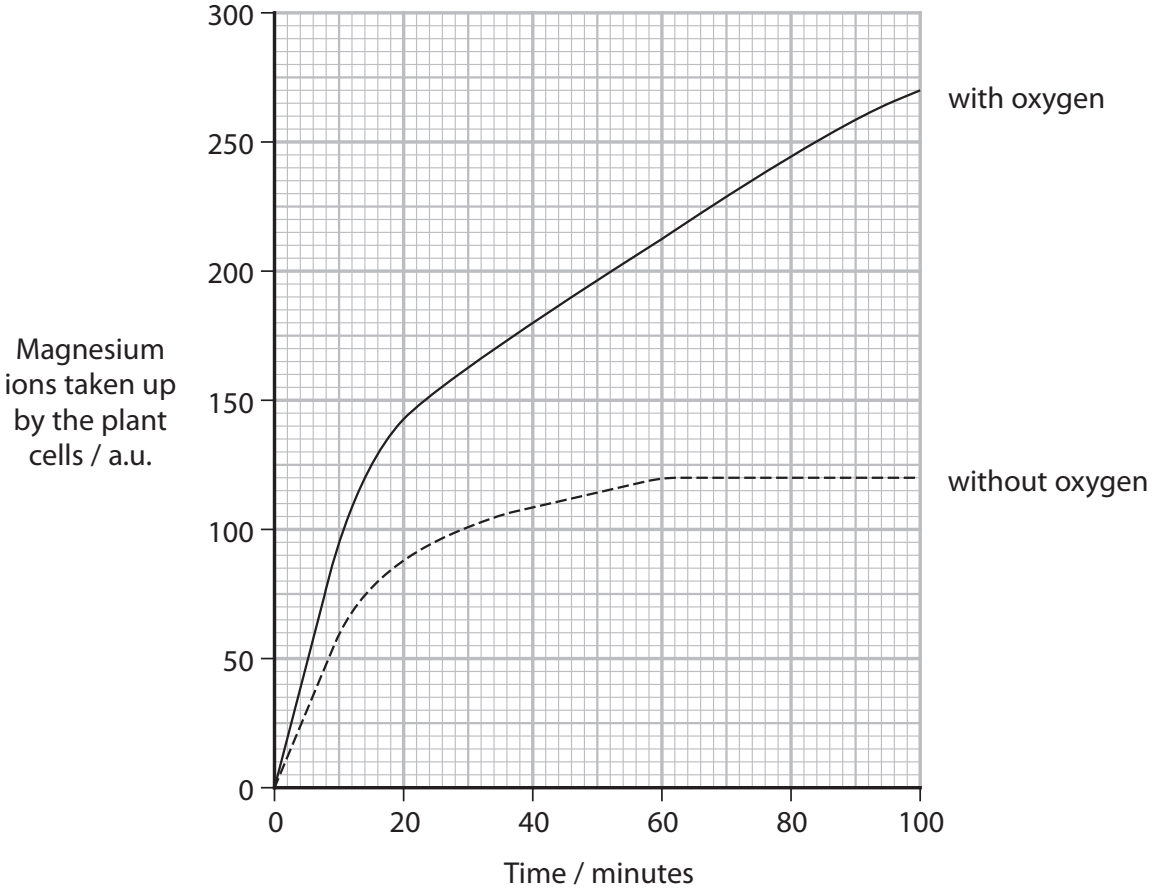
Answer ALL questions.

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 A student investigated the uptake of magnesium ions by some plant cells in the presence and absence of oxygen.

The graph shows the results of this investigation.



(a) Explain the importance of magnesium ions to a plant.

(2)

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(b) The student suggested that magnesium ions are taken up by active transport.

Explain why the student came to this conclusion.

Use the information in the graph to support your answer.

(4)

(Total for Question 1 = 6 marks)

2 The photograph shows a black bear.

(Source: © Cindy Hopkins/Alamy Stock Photo)

Most black bears have a diet consisting of ants and berries, and hibernate during the winter months.

One very large male black bear, called Hank, was suspected of raiding nearly 40 homes in the Lake Tahoe region of America for food. Some of these raids took place during the winter months.

(a) Hank weighed 227 kg, which is 1.7 times more than the mean mass of a typical large black bear and 5 times more than the mass of a typical small black bear.

(i) Calculate the difference in mass between a typical large black bear and a typical small black bear.

(2)

Answer ..... kg

(ii) Explain why Hank was much larger than typical black bears.

(2)

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(b) Samples of DNA were collected from the homes that Hank was suspected of raiding.

Analysis of the DNA showed that some of the raids were by two unrelated, female black bears.

(i) Which two procedures could have been used to analyse the DNA?

(1)

- ☒ **A** electron microscopy followed by PCR
- ☒ **B** entomology followed by electron microscopy
- ☒ **C** gel electrophoresis followed by entomology
- ☒ **D** PCR followed by gel electrophoresis

(ii) Describe how analysis of the DNA would show that these two other bears were female, and not related to each other or to Hank.

(3)

(Total for Question 2 = 8 marks)

3 Tetracycline is a bacteriostatic antibiotic and vancomycin is a bactericidal antibiotic.

(a) Compare and contrast bacteriostatic antibiotics with bactericidal antibiotics.

(2)

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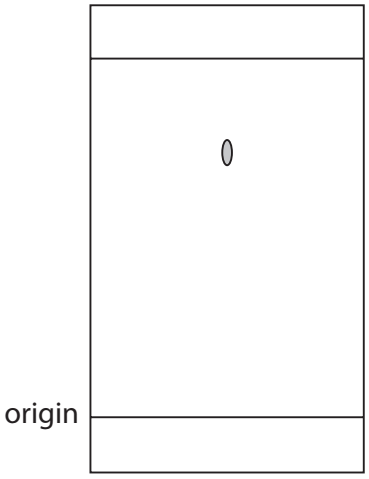
(b) Antibiotics can be identified using Rf values obtained from chromatography.

The table shows the Rf values for tetracycline and vancomycin, obtained using two different chromatography methods.

Antibiotic	Rf value	
	Method 1	Method 2
Tetracycline	0.51	0.75
Vancomycin	0.09	0.29

The diagram shows a chromatogram for one of these antibiotics using one of the methods.



(i) Describe how this chromatogram could be produced.

(3)

(ii) Which identifies the antibiotic in the diagram and the method used?

(1)

- ☒ **A** tetracycline, using method 1
- ☒ **B** tetracycline, using method 2
- ☒ **C** vancomycin, using method 1
- ☒ **D** vancomycin, using method 2

(iii) Explain why the four values in the table are all different from each other.

(2)

(Total for Question 3 = 8 marks)

4 The photograph shows a young giant panda feeding on bamboo.

(Source: © Cheryl Schneider/Alamy Stock Photo)

Giant pandas have evolved the ability to eat bamboo.

Genes that code for enzymes that digest the cellulose in the bamboo are not present in the genome of the giant panda.

The giant pandas depend on microorganisms in their intestines to produce enzymes that can digest the cellulose.

(a) Which type of glycosidic bonds are broken in the digestion of cellulose?

(1)

☒ **A** α 1-4

☒ **B** α 1-6

☒ **C** β 1-4

☒ **D** β 1-6

(b) The microorganisms in the intestines of giant pandas include both bacteria and fungi.

Fungi are eukaryotic organisms.

Put one cross [x] in the appropriate box, in each row, to show if genes are found in each of the structures in these microorganisms.

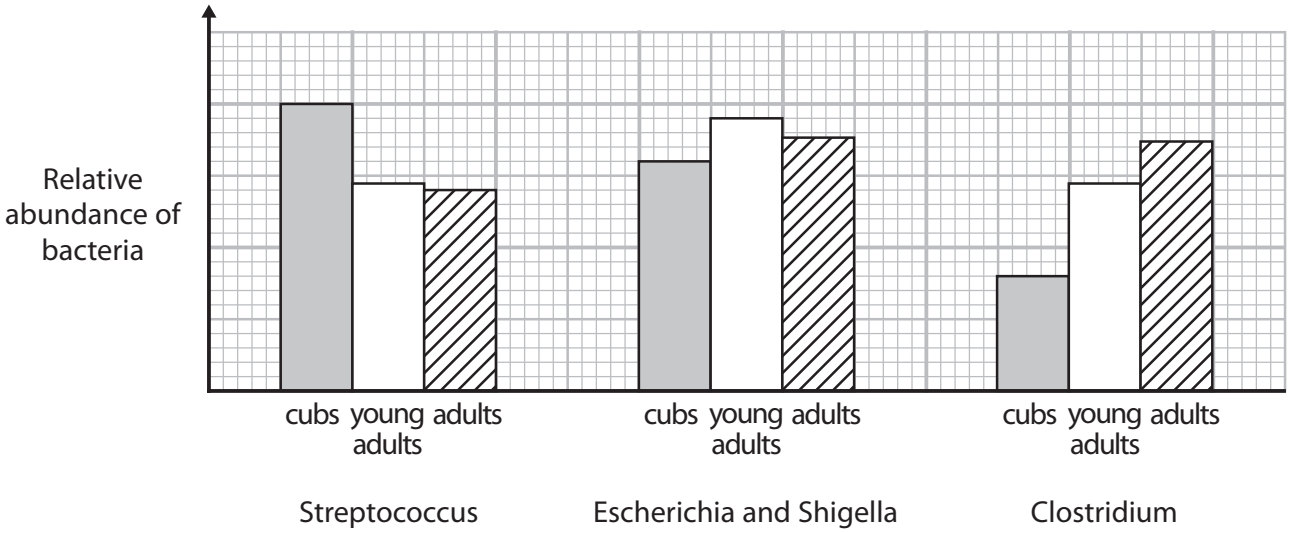
(3)

Structure	Microorganism			
	Bacteria only	**Fungi only**	**Both bacteria and fungi**	**Neither bacteria nor fungi**
mitochondria	☒	☒	☒	☒
nuclei	☒	☒	☒	☒
70S (small) ribosomes	☒	☒	☒	☒

(c) In one study, the succession of bacteria in the intestines of developing giant pandas was determined.

Three stages of development were studied: cubs, young adults and adults.

The graph shows the relative abundance of four types of bacteria in the three developmental stages of the giant panda.



(i) Which sequence shows the succession of bacteria during the development of a giant panda?

(1)

- ☒ **A** Clostridium → Streptococcus → Escherichia and Shigella
- ☒ **B** Escherichia and Shigella → Clostridium → Streptococcus
- ☒ **C** Escherichia and Shigella → Streptococcus → Clostridium
- ☒ **D** Streptococcus → Escherichia and Shigella → Clostridium

(ii) Describe one method that could be used in this study to determine the relative abundance of Streptococcus in a giant panda.

(4)

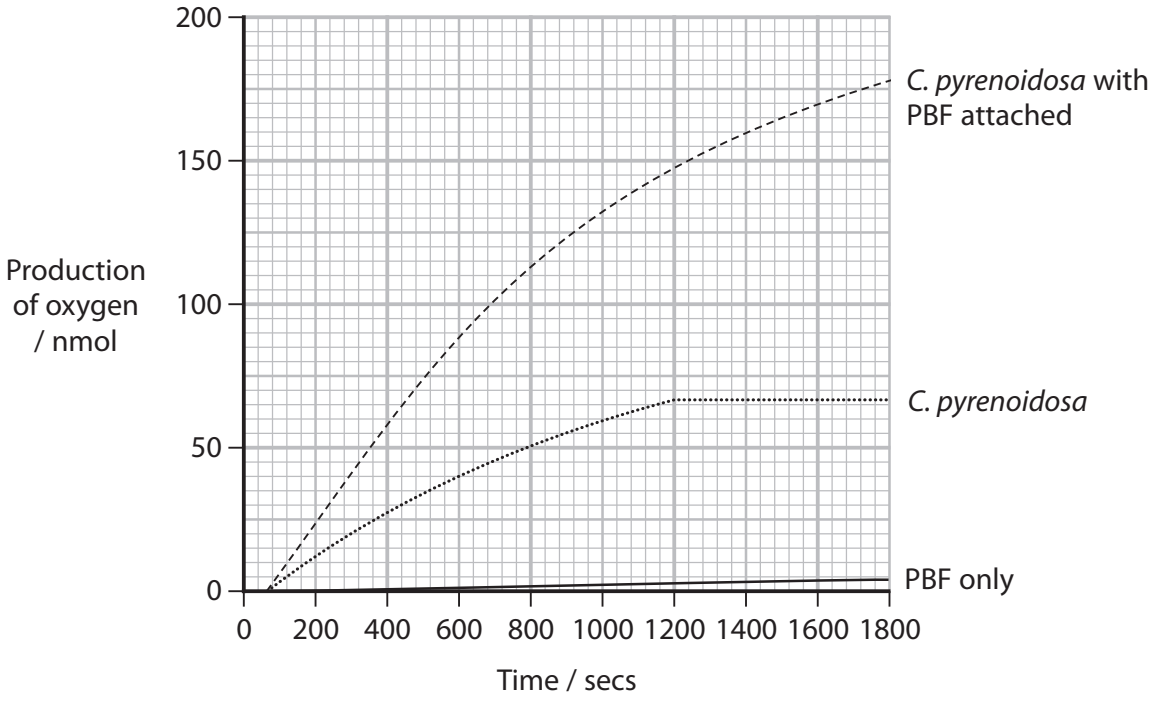
(Total for Question 4 = 9 marks)

5 (a) In an investigation, scientists attached a molecule called PBF to the cell surface of a species of green algae, *C. pyrenoidosa*.

These algae are photosynthetic organisms and PBF absorbs green light.

The scientists measured the production of oxygen by *C. pyrenoidosa*, *C. pyrenoidosa* with PBF attached and PBF only.

The graph shows the results of this investigation.



(i) Calculate the rate of production of oxygen at 1 200 seconds for *C. pyrenoidosa* with PBF attached.

(3)

Answer ..... nmol $secs^{-1}$

(ii) Explain the effect PBF has on the production of oxygen.

(3)

(b) These scientists also measured the mass of *C. pyrenoidosa*, with and without PBF attached, after a 20-day period.

They found that the increase in mass of *C. pyrenoidosa* with PBF attached was greater than the increase in mass of *C. pyrenoidosa* without PBF attached.

Explain these findings.

(3)

(Total for Question 5 = 9 marks)

6 Malaria is a life-threatening disease caused by the pathogen *Plasmodium*.

Plasmodium is transmitted into the blood plasma of a person through the bite of an infected mosquito.

The *Plasmodium* is a sporozoite that travels to the liver cells.

This sporozoite produces merozoites that infect red blood cells.

(a) State the meaning of the term **infection**.

(1)

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(b) In 2019, there were an estimated 229 million cases of malaria worldwide.

The number of deaths was estimated at 4.09×10^5 per year.

(i) Which is the approximate death rate from malaria in 2019?

(1)

- ☒ **A** 1 in 180
- ☒ **B** 1 in 600
- ☒ **C** 1 in 1 800
- ☒ **D** 1 in 6 000

(ii) In 2019, 274 000 young children died from malaria.

Which is the ratio of deaths in young children to deaths in other age groups?

(1)

- ☒ **A** 0.7 : 1.0
- ☒ **B** 1.0 : 0.5
- ☒ **C** 1.0 : 1.5
- ☒ **D** 2.0 : 1.0

(c) Scientists are trying to develop vaccines to protect against malaria.

One vaccine uses living sporozoites.

(i) Suggest why sporozoites are used in a vaccine against malaria.

(3)

(ii) In clinical trials of this vaccine, people were injected with the vaccine and two chemicals.

One chemical kills sporozoites and the other kills merozoites.

Deduce why these two chemicals were injected with the vaccine in these clinical trials.

(3)

(iii) Later in the clinical trials, people were infected with one of two strains of sporozoites, three months after the vaccination.

One strain was identical to the one used in the original vaccine and the other strain was a different one.

The trials found that the vaccine was effective against both strains.

Explain these findings.

(3)

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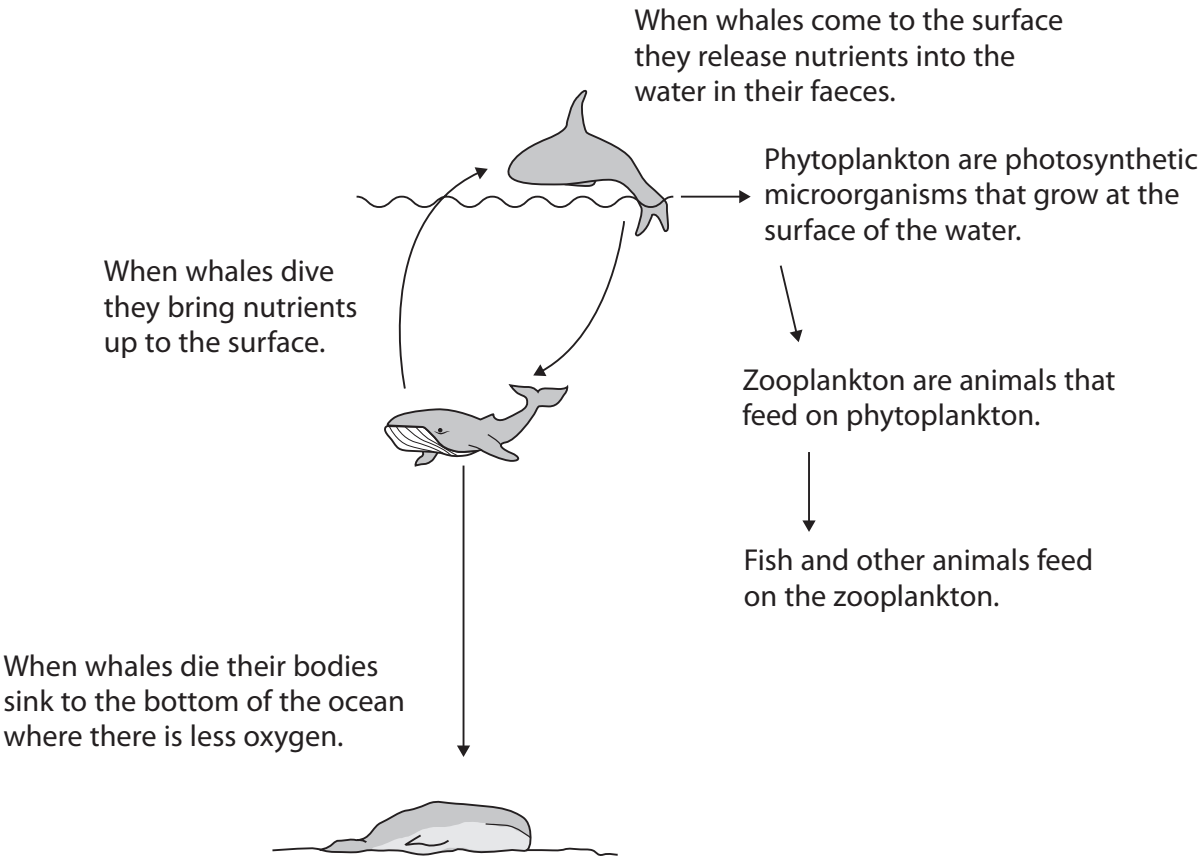
(Total for Question 6 = 12 marks)

7 Commercial whaling has resulted in a large decrease in the number of whales.

The diagram shows the relationships between whales and some other organisms in the ocean.



(a) Whale faeces add nutrients containing nitrogen to the water.

(i) There are 345 Right whales in the Gulf of Maine and together they release 15.9 kg of nitrogen per day.

Calculate the mass of nitrogen released by one Right whale in a year.

(1)

Answer ..... kg per year

(ii) Nitrates contain nitrogen.

Describe the importance of nitrates to plants.

(2)

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(b) There are 1.3 million whales in the oceans.

Scientists believe that if the number of whales could be restored to their original numbers, this would have a significant effect on climate change.

(i) There were approximately 5 million whales before modern commercial whaling.

Calculate the percentage decrease in the number of whales due to commercial whaling.

(1)

Answer ..... %

(ii) Calculations have shown that if numbers could be restored, 1.7×10^9 US tons of carbon dioxide could be removed from the atmosphere per year.

A US ton is equivalent to 907 kg.

Calculate the mass of carbon dioxide, in kg, that could be removed from the atmosphere in one year.

Give your answer in standard form.

(1)

Answer ..... kg

*(iii) Discuss the possible effects of increasing the number of whales on climate change.

Use the information in the diagram and the data given in this question to support your answer.

(6)

(Total for Question 7 = 11 marks)

8 Reforestation is an example of effective management of conflicts between human needs and conservation.

Organisations have put together a list of rules for responsible reforestation. These rules aim to improve absorbing and storing atmospheric carbon dioxide, biodiversity and human livelihoods.

Four of the rules are:

1. Protect existing forests first
2. Work together with local people
3. Select appropriate areas for reforestation
4. Select species to maximise biodiversity.

(a) Explain the importance of protecting existing forests first (rule 1).

(2)

(b) Suggest why it is important that organisations involved in reforestation work with the local people (rule 2).

(2)

(c) Explain **two** reasons why previously forested areas should be selected for reforestation instead of other wild areas (rule 3).

(4)

(d) Explain why a mixture of native species, including endangered and genetically diverse species, should be introduced (rule 4).

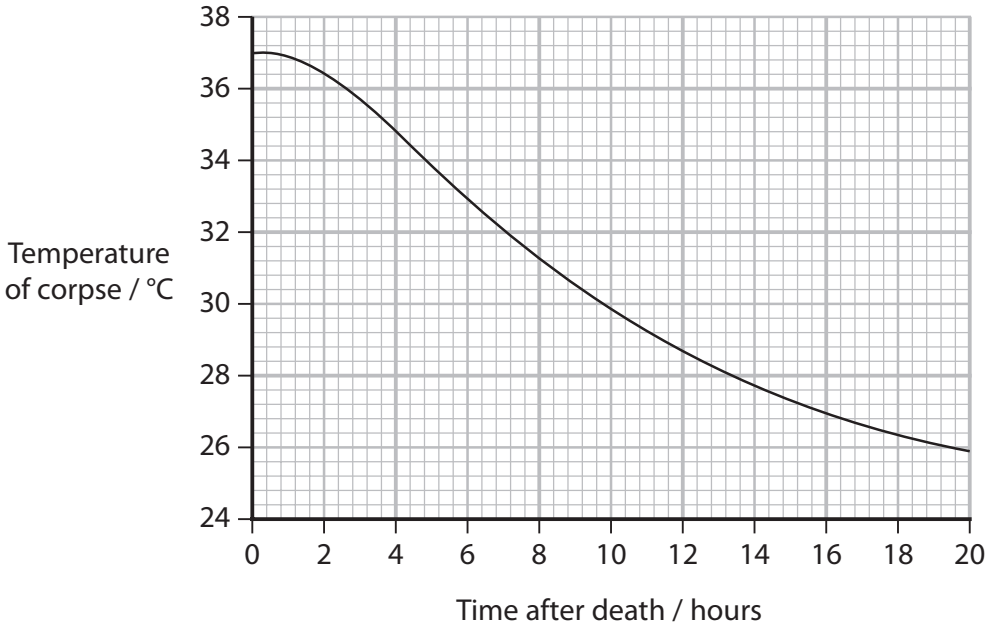
(4)

(Total for Question 8 = 12 marks)

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

(a) Measuring the body temperature of a corpse is one method used to estimate the time of death.

The graph shows a calibration curve that can be used in this method.



(i) Describe how the time of death of a person can be estimated using this method.

(3)

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(ii) Explain the limitations of this method.

(2)

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(b) Scientists are looking for other methods to estimate the time of death, using the presence of chemicals in the blood.

One study used blood taken from five rat corpses and two pig corpses at intervals after death.

(i) Suggest why this study used rat and pig corpses instead of human corpses.

(1)

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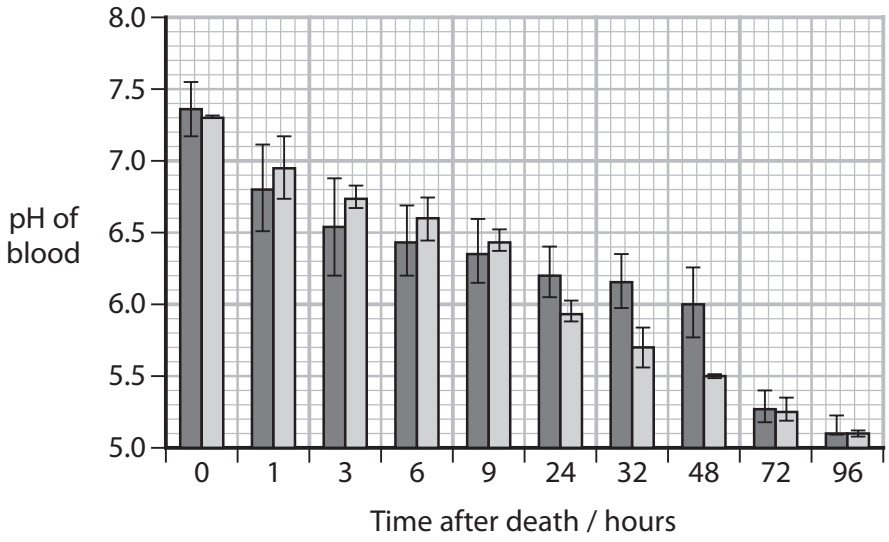
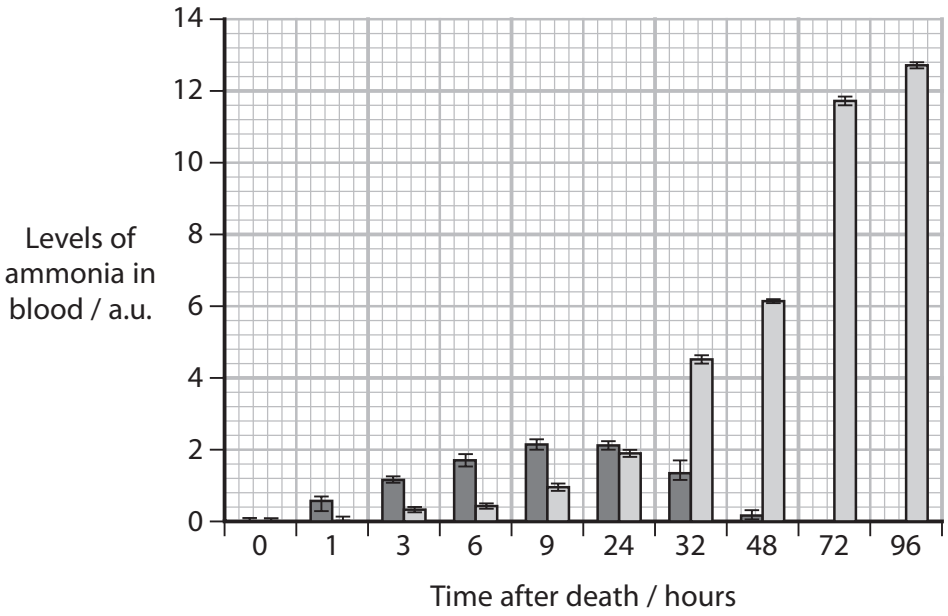
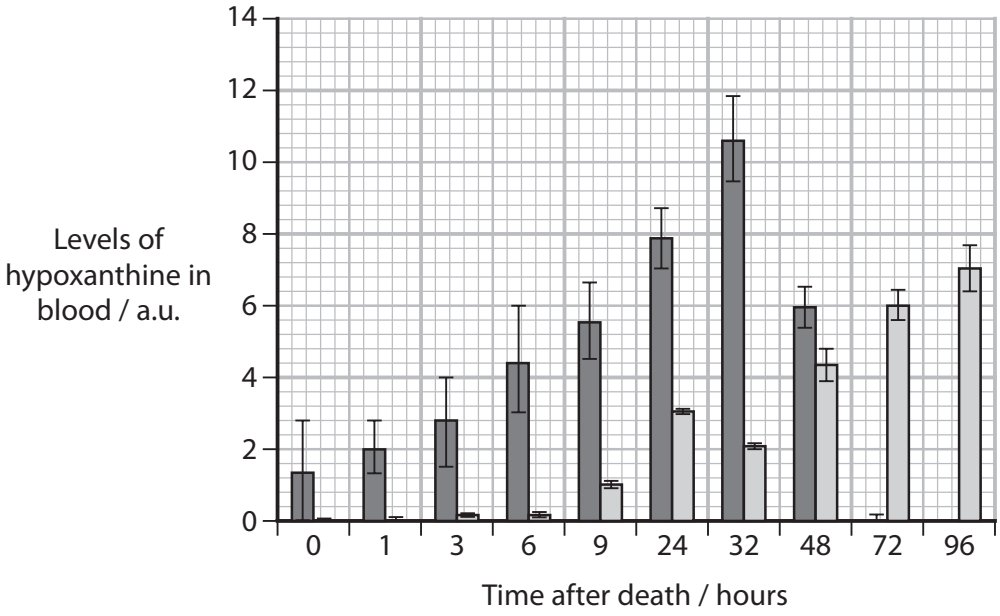
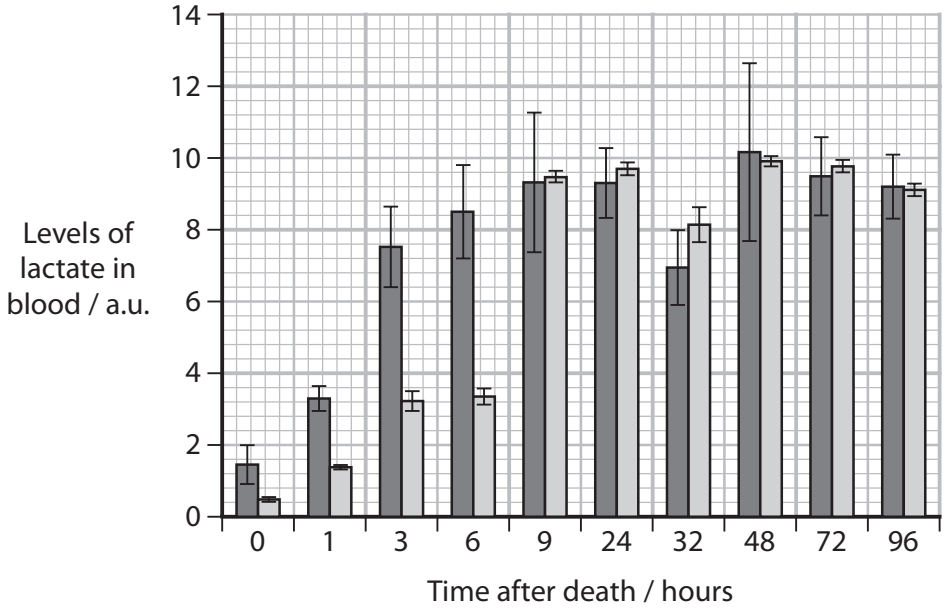
*(ii) The graphs show some of the results of this study.






Levels of hypoxanthine in blood / a.u.
14
12
10
8
6
4
2
0
0
1
3
6
9
24
32
48
72
96
Time after death / hours


Levels of lactate in blood / a.u.
14
12
10
8
6
4
2
0
0
1
3
6
9
24
32
48
72
96
Time after death / hours

Comment on the usefulness of using these chemicals for determining the time of death of rats and pigs.

Use the information in the graphs to support your answer.

(6)

(iii) Discuss whether these chemical tests are likely to be useful in determining the time of death of a human.

(3)

(Total for Question 9 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Thursday 19 October 2023

Morning (Time: 1 hour 45 minutes)

Paper reference **WBI14/01**

Biology

International Advanced Level
UNIT 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
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- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Z:1/1/1/1/1/1/

P 7 5 6 1 8 A 0 1 3 6

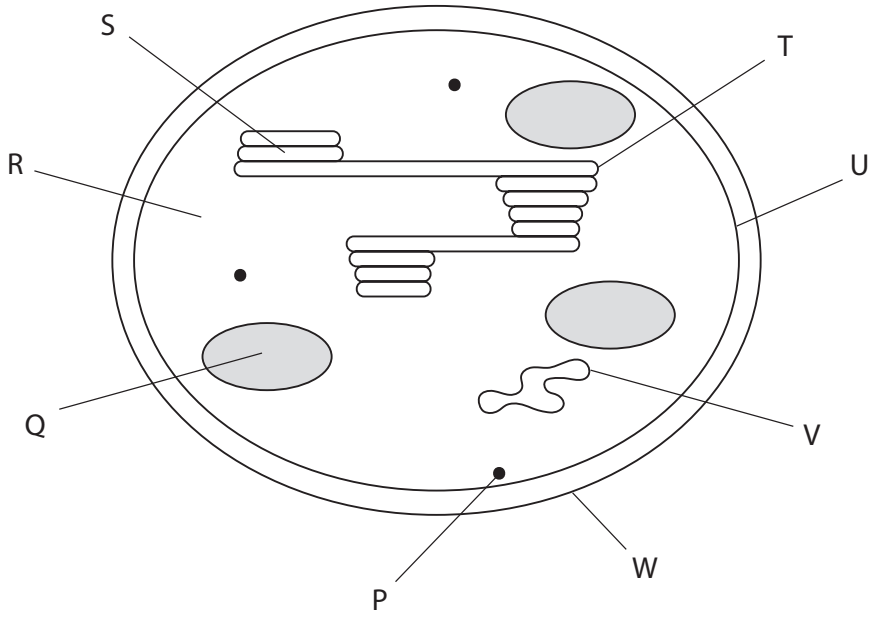
Pearson

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 The structure of a chloroplast is related to its role in photosynthesis.

The diagram shows a chloroplast.



(a) Which is the site of photolysis?

(1)

☒ **A** P

☒ **B** R

☒ **C** T

☒ **D** V

(b) Which contains a gene coding for RUBISCO?

(1)

☒ **A** P

☒ **B** Q

☒ **C** S

☒ **D** V

(c) Where do hydrogen ions accumulate for use in photosynthesis?

(1)

☒ **A** Q

☒ **B** R

☒ **C** S

☒ **D** V

(d) (i) How many of the structures labelled P, T, U and W are made of phospholipids?

(1)

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

(ii) Which describes a phospholipid?

(1)

☒ **A** glycerol attached to two fatty acids and one phosphate group

☒ **B** glycerol attached to two fatty acids and two phosphate groups

☒ **C** glycerol attached to three fatty acids and one phosphate group

☒ **D** glycerol attached to three fatty acids and two phosphate groups

(e) The length of a cell was measured. It was found to be 0.0085 cm long.

The ratio of the length of this cell to the length of a chloroplast was 11.7 : 1.

Calculate the length of this chloroplast.

Give your answer in μm to 2 significant figures.

(2)

Answer..... μm

(Total for Question 1 = 7 marks)

2 The body responds to infection with non-specific responses and the immune response.

(a) Inflammation is characterised by heat, redness and two other characteristics.

(i) Name the **two** other characteristics of inflammation.

(1)

(ii) Explain how heat helps the body respond to infection.

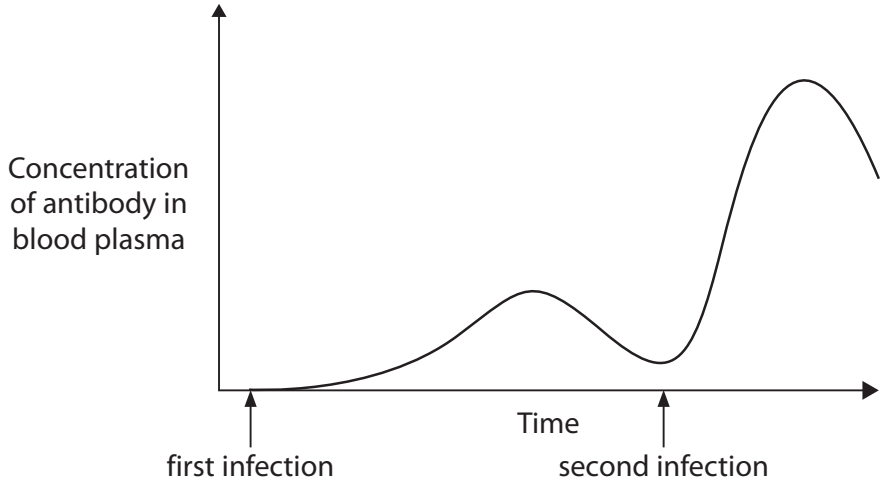
(2)

(b) Describe how interferon helps the body respond to infection.

(2)

(c) The immune response results in the production of antibodies following the first infection with a pathogen and on further infections with the same pathogen.

The graph shows the concentration of antibody in blood plasma following the first and second infection with the same pathogen.



Compare and contrast the changes in concentration of antibody in the blood plasma following the first infection and the second infection.

(3)

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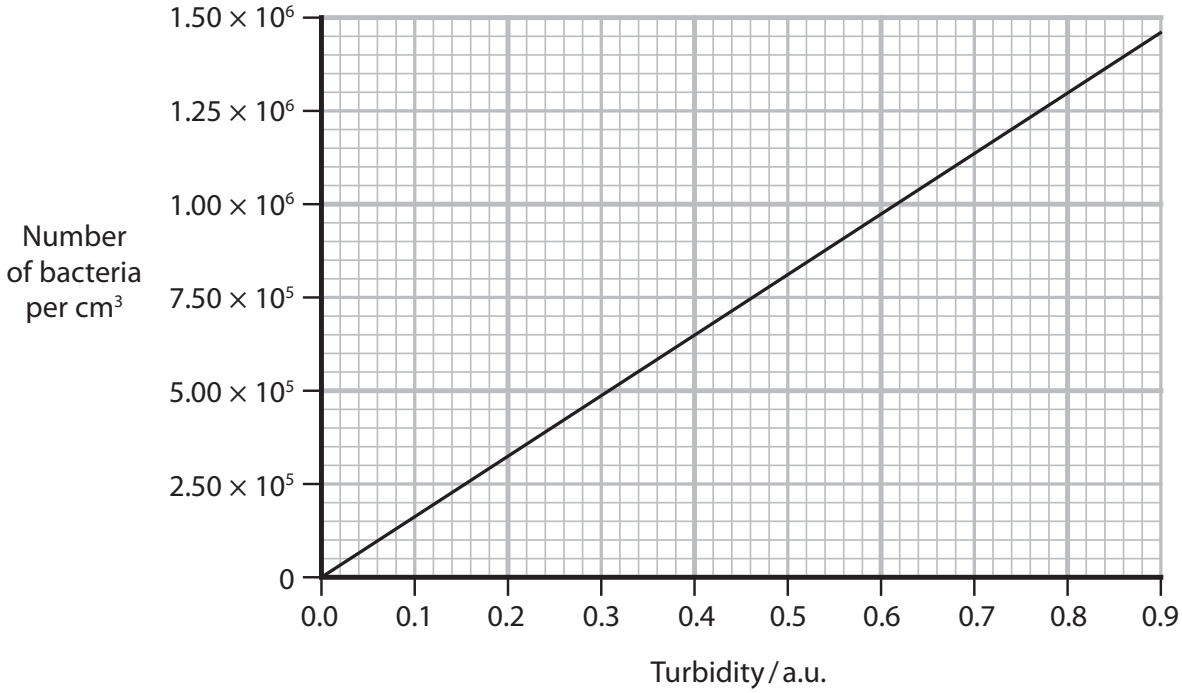
(Total for Question 2 = 8 marks)

3 The growth of bacteria in a liquid culture was investigated over a 14 hour period, using an optical method (turbidity).

A calibration curve was used to convert the turbidity readings into the number of bacteria per cm^3 of liquid culture.

The graph shows the calibration curve used.



The table shows the results for the first 10 hours of culture.

Time of culture / hours	Turbidity / a.u.	Increase in cell number in each two hour period
0	0.01	
2	0.01	0
4	0.04	5.0×10^4
6	0.56	
8	0.80	4.0×10^5
10	0.80	0

(a) Complete the table to show the increase in cell number between 4 and 6 hours of culture.

(1)

(b) Explain the changes during the first six hours of this culture.

(2)

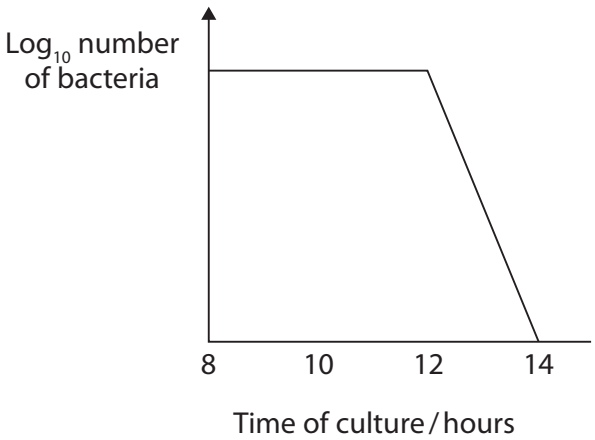
(c) The number of cells remained constant after 8 hours to the end of the 14 hour period of this culture.

Bacterial growth was also investigated using dilution plating and colony counts.

(i) Describe the method used in dilution plating.

(2)

(ii) The sketch shows the shape of the growth curve produced using dilution plating and colony counts between 8 and 14 hours of this culture.



There are differences in the numbers of bacteria between 8 and 14 hours measured using optical methods (turbidity) and measured using dilution plating and colony counts.

Explain the differences obtained by these two methods.

(3)

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(Total for Question 3 = 8 marks)

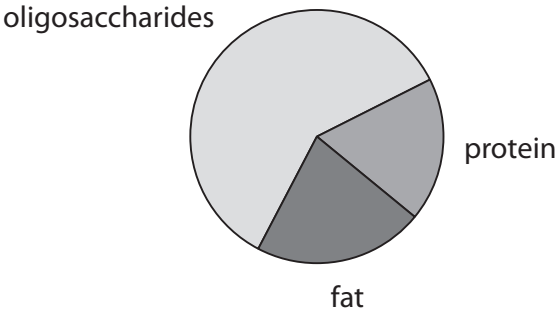
4 Human breast milk supports the growth and development of a baby.

One important component is a group of carbohydrates called oligosaccharides. These contain between three and ten monosaccharide units.

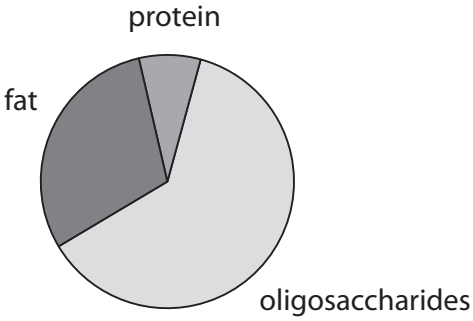
(a) During the first few days after birth, the milk produced is called colostrum. By two weeks, the composition of the milk has changed and it is called mature breast milk.

The charts show some of the nutritional components of colostrum and mature breast milk.

Colostrum



Mature breast milk



Estimate the percentage composition of oligosaccharides in the colostrum.

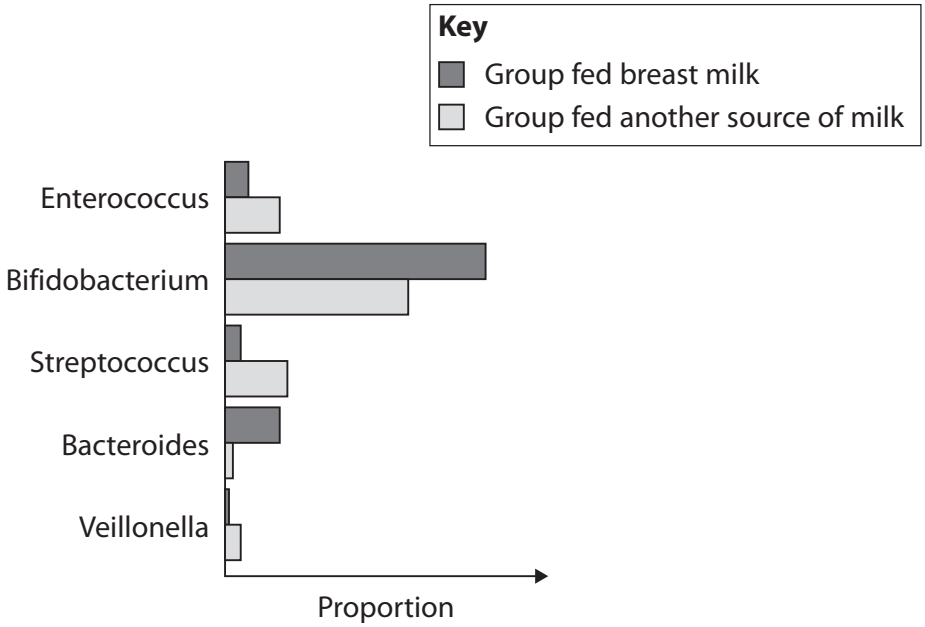
(1)

Answer ..... %

(b) Oligosaccharides in breast milk have been shown to be important in establishing a healthy gut flora in the developing baby.

(i) The effect on the types of bacteria in the guts of babies fed on breast milk or another source of milk was investigated.

The graph shows the proportion of five types of bacteria in the two groups of babies.



Describe **two** conclusions that can be made about the gut flora of babies fed these two types of milk.

(2)

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(ii) Explain the importance of healthy gut flora in preventing infection in a developing baby.

(2)

(c) Group B Streptococcus (GBS) bacteria are a common cause of infections in babies.

These bacteria are becoming increasingly resistant to antibiotics.

Scientists have shown that oligosaccharides isolated from breast milk have antimicrobial activity against GBS bacteria.

Explain the possible advantages of using these oligosaccharides, instead of antibiotics, to treat GBS bacterial infections.

(3)

(Total for Question 4 = 8 marks)

5 Cultivation of seaweed for food is well-established in Asia.

(a) In 2017, the global harvest of seaweed was 32.9 million tonnes. Of this, 96.6 % was cultivated.

Calculate the mass of cultivated seaweed.

Give your answer in standard form.

(1)

Answer..... tonnes

(b) Seaweeds are photosynthetic organisms.

Photosynthesis can be described as a reaction requiring light to split apart the strong bonds in water molecules, storing the hydrogen in a fuel by combining it with carbon dioxide and releasing oxygen into the atmosphere.

(i) Which type of bond is broken in a water molecule?

(1)

- ☒ **A** covalent
- ☒ **B** glycosidic
- ☒ **C** hydrogen
- ☒ **D** ionic

(ii) Which is a fuel that stores hydrogen in plants and seaweeds?

(1)

- ☒ **A** ATP
- ☒ **B** glucose
- ☒ **C** glycogen
- ☒ **D** RUBISCO

(iii) Which row of the table shows the reactions that combine hydrogen with carbon dioxide and release oxygen into the atmosphere?

(1)

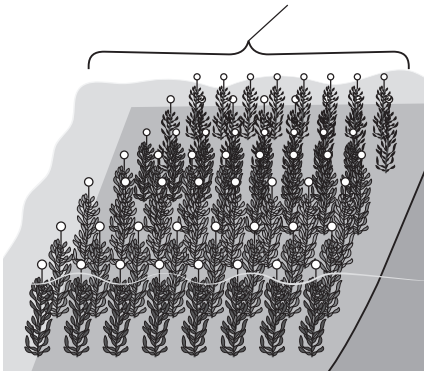
		Hydrogen is combined with carbon dioxide	Oxygen is released into the atmosphere
☒	**A**	light-dependent reactions	light-dependent reactions
☒	**B**	light-dependent reactions	light-independent reactions
☒	**C**	light-independent reactions	light-dependent reactions
☒	**D**	light-independent reactions	light-independent reactions

*(c) In Europe, cultivation of seaweed takes place on a small scale.
Large-scale cultivation of seaweed is now being considered.

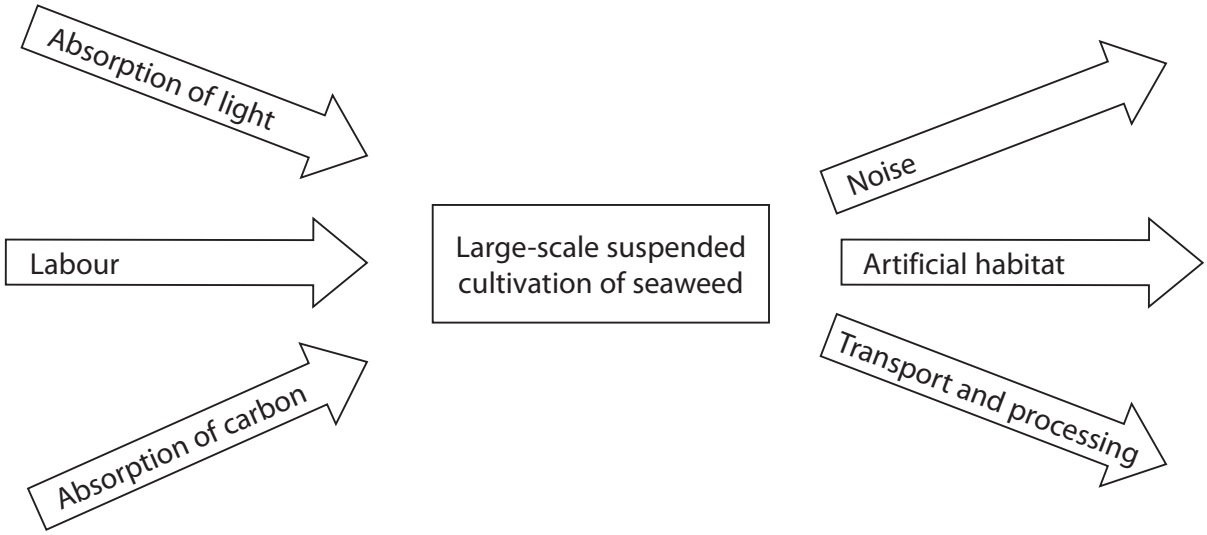
Effective management of the conflict between human needs and conservation is necessary before large-scale cultivation can be used.

The diagram shows seaweed grown by suspended cultivation, a method used in Asia.

Rows of seaweed suspended on wires in the sea



The diagram shows some of the factors that have to be considered when managing the conflict between human needs and conservation.



Discuss the considerations that need to be taken into account when deciding whether or not large-scale seaweed production is suitable in Europe.

Use the information in the two diagrams and your own knowledge to support your answer.

(6)

(Total for Question 5 = 10 marks)

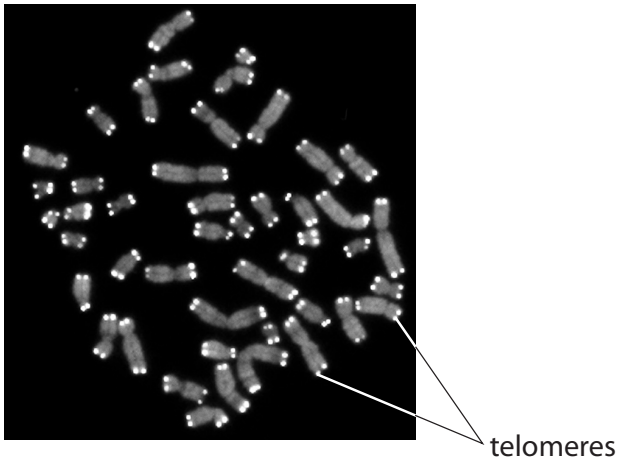
6 A telomere is a repetitive nucleotide sequence at the end of a chromosome.

The telomere protects the end of each chromosome from damage.

Each time DNA is synthesised the telomeres become shorter.

When the telomeres become too short the cell dies.

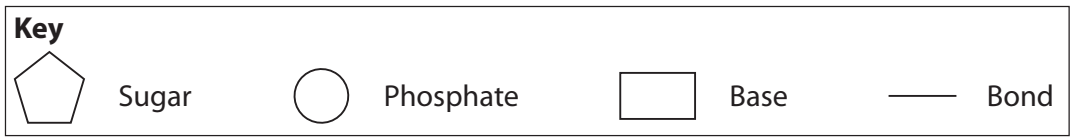
The photograph shows telomeres on the ends of chromosomes.



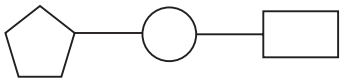
(Source: © Hesed Padilla-Nash and Thomas Ried, National Cancer Institute, National Institutes Of Health / Science Photo Library)

(a) (i) Which diagram shows a mononucleotide of DNA?

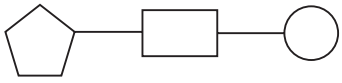
(1)



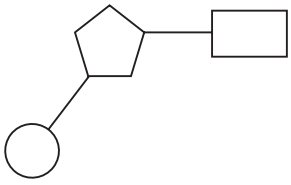
☒ **A**



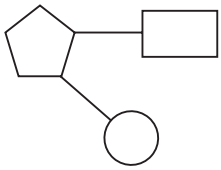
☒ **B**



☒ **C**



☒ **D**



(ii) Name the bond that joins nucleotides together in a strand of DNA.

(1)

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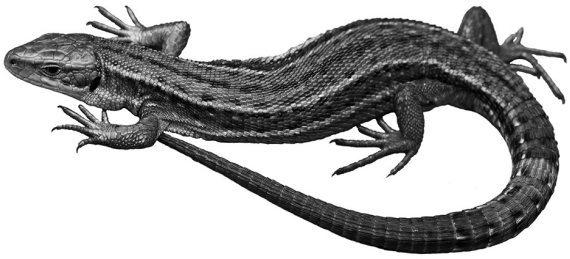
(b) The photograph shows a common lizard.



(Source: © 'Nature cutout's / Alamy Stock Photo)

Lizards cannot regulate their body temperature and are at risk of extinction due to global warming.

The effect of temperature on the length of young lizards was investigated.

The change in abundance of lizards of all ages, over a 12 year period, was also investigated.

(i) There was a positive correlation between temperature and length of young lizards. This could be due to enzyme activity.

Explain this correlation.

(3)

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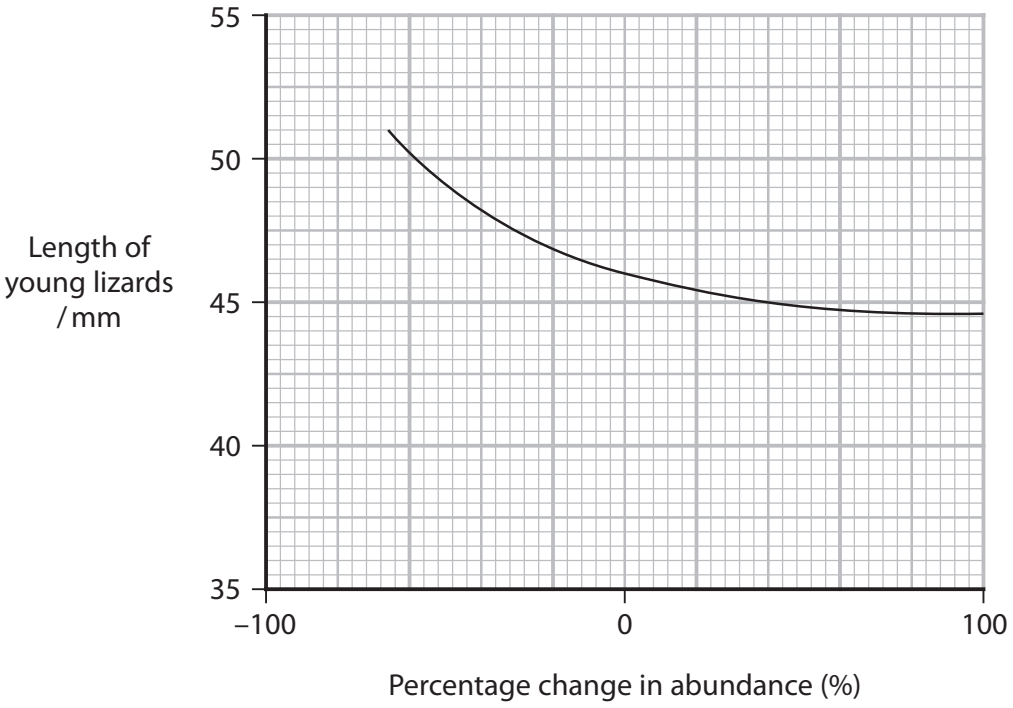
(ii) The scientists used the data to predict a relationship between the length of the young lizards and the percentage change in abundance of lizards over the 12 year period.

The graph shows this relationship.



Describe the relationship between percentage change in abundance of lizards and length of young lizards.

(2)

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(iii) These scientists also looked at the length of the telomeres in the cells of these young lizards.

Explain why the abundance of the longer lizards is affected by the number of cell divisions taking place as they grow.

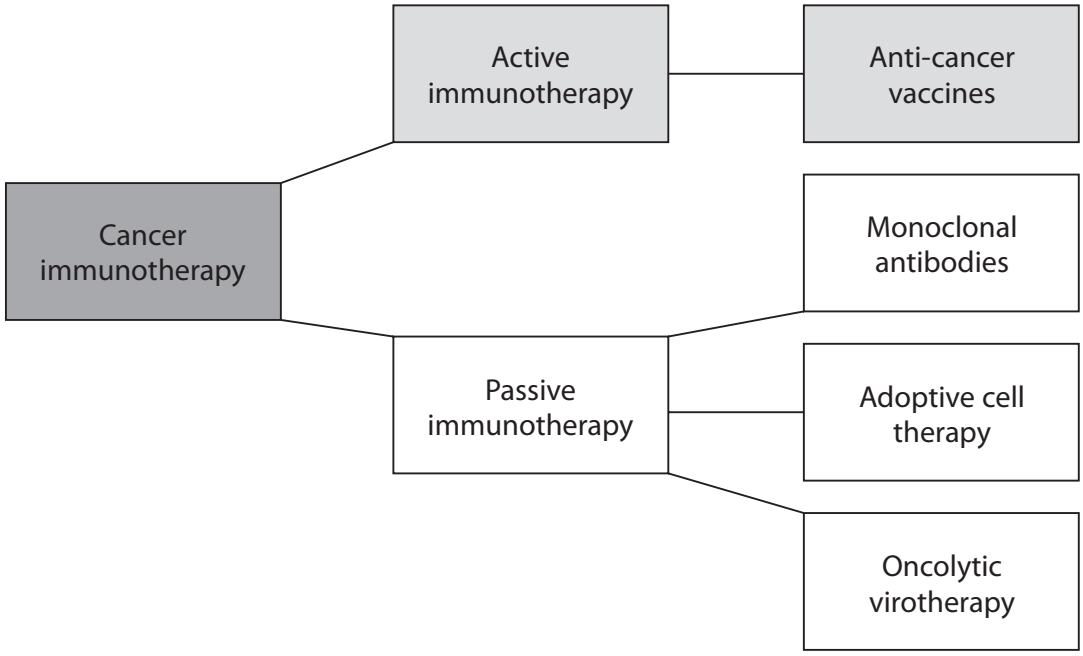
Use all the information in the question to support your answer.

(3)

(Total for Question 6 = 10 marks)

7 Cancer immunotherapy stimulates and strengthens an individual's active and passive immune systems to destroy cancer cells.

The diagram shows how different types of cancer immunotherapy can be classified.



(a) Suggest what the difference is between active immunotherapy and passive immunotherapy.

(2)

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(b) Cancer cells result from mutations.

Some of these mutations can result in the formation of altered membrane proteins called neoantigens.

The neoantigens are not present on the surface of normal cells.

(i) Explain how a mutation can result in the formation of a neoantigen.

(2)

(ii) Some active anti-cancer vaccines can contain the mRNA that codes for the neoantigens.

Explain how vaccines containing the mRNA coding for neoantigens stimulate the immune response.

(4)

(c) Monoclonal antibodies are made in a laboratory. Large numbers of identical antibodies specific to one type of antigen can be made.

Explain how these antibodies help the immune system to destroy cancer cells.

(2)

(d) In adoptive cell therapy, T cells are taken from the patient and large numbers of genetically identical cells are made in the laboratory.

These cells are then injected back into the patient.

Explain why it is necessary to produce large numbers of genetically identical cells to make this treatment effective.

(2)

(e) In oncolytic virotherapy, viruses that destroy cancer cells are injected into the patient.

Not all types of virus are suitable for this therapy.

Suggest **two** features of a virus that make it suitable for use in this type of therapy.

(2)

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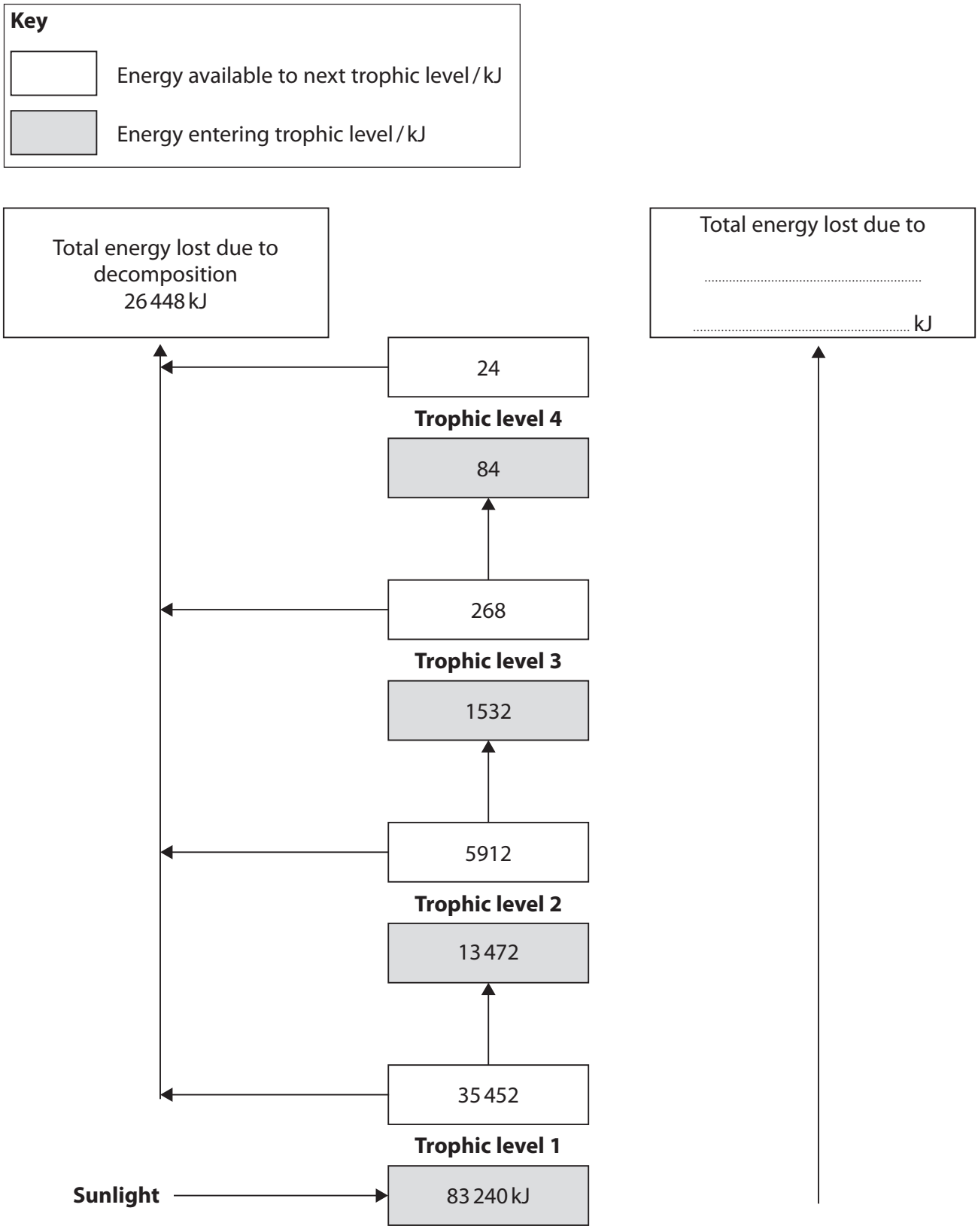
(Total for Question 7 = 14 marks)

8 The trophic level of an organism is the position it occupies in a food chain.

(a) The diagram shows the energy flow between trophic levels of a food chain.



(i) Calculate the net primary productivity (NPP) as a percentage of the gross primary productivity (GPP) in this food chain.

(2)

Answer ..... %

(ii) Complete the right-hand side of the diagram by adding:

- arrows
- the missing information in the box.

(3)

(iii) Explain the importance of enzymes produced by microorganisms in decomposition.

(3)

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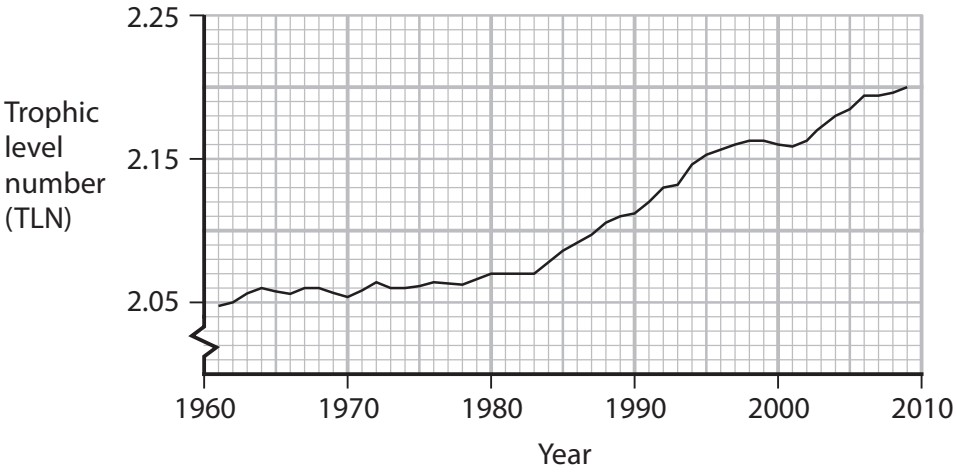
(b) Some animals eat a diet of meat and plant material.

These animals can be given a trophic level number (TLN) based on a scale of 1 to 5.

Animals that eat only plants have a TLN of 1 and animals that eat only meat and are at the top of the food chain have a TLN of 5.

Humans are an example of animals that eat both plants and animals.

The graph shows the change in the TLN for the total population of China and India from 1960 to 2010.



Explain what the information in the graph indicates about the diet of this population during this time period.

(3)

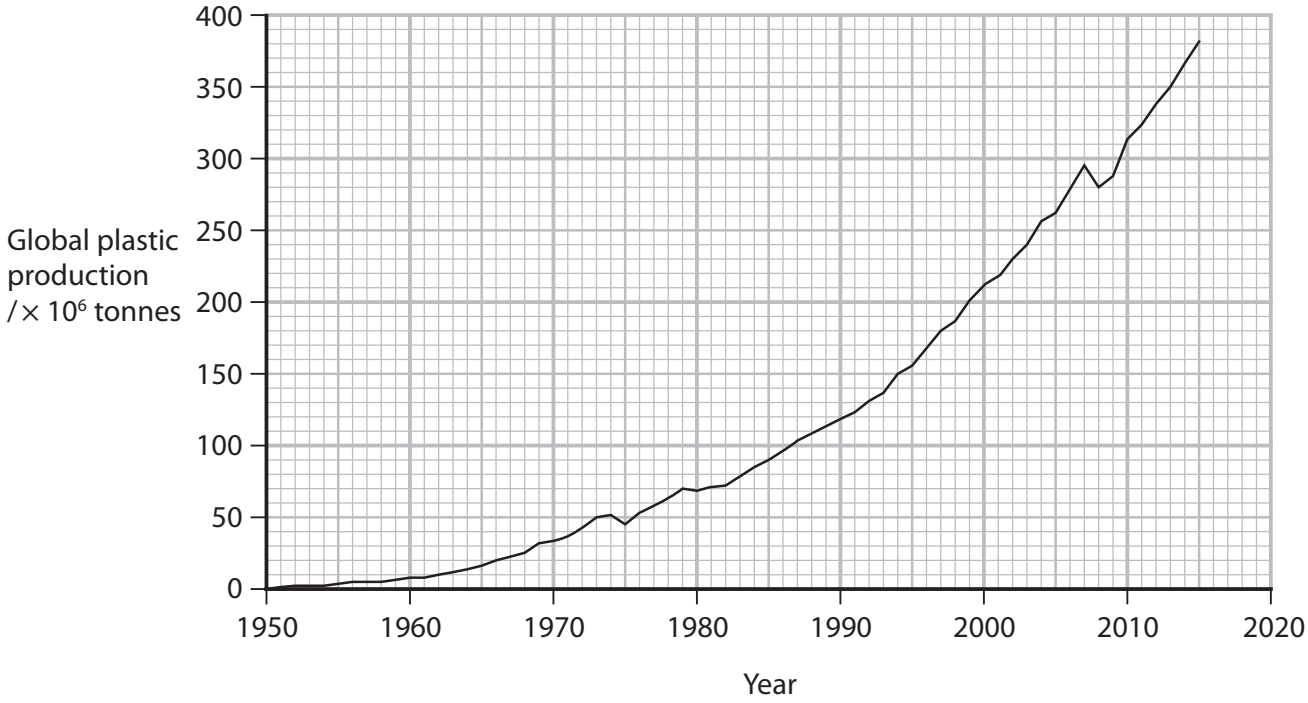
(Total for Question 8 = 11 marks)

9 The photograph shows a sea turtle.

(Source: © M Swiet Productions/Getty Images)

Sea turtles can take in plastic debris when they eat. This plastic can harm the turtles.

(a) The graph shows the global production of plastics per year from 1950 to 2015.



(i) Calculate the mean rate of global plastic production from 2000 to 2015.

Give your answer to 3 significant figures.

(2)

Answer ..... million tonnes per year

(ii) Estimate the global plastic production in 2023.

Use your calculated value from part (i).

(1)

Answer ..... million tonnes

(iii) Suggest why this value may be an underestimate.

Use the information in the graph to support your answer.

(1)

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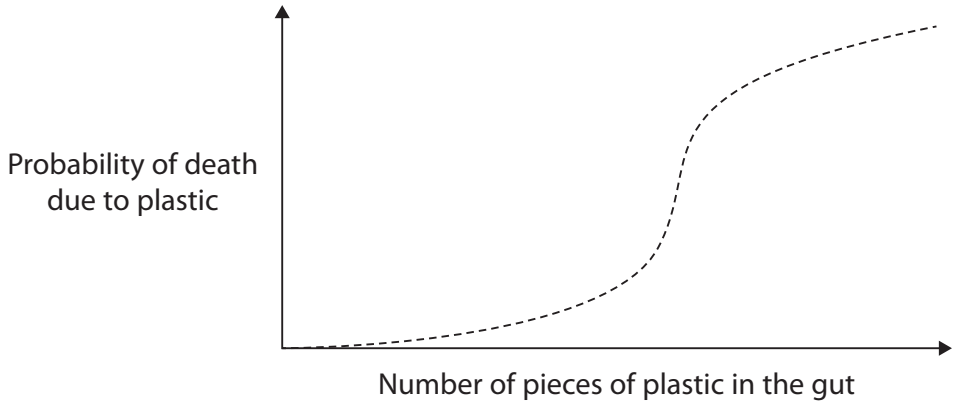
(b) One group of scientists determined the number of pieces of plastic in the guts of individual sea turtles.

They then modelled this data to estimate the probability of death due to plastic.

The graph shows the results of this modelling.



(i) Describe how the probability of death due to plastic increases with the number of pieces of plastic in the gut.

(2)

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(ii) Describe **two** limitations of using this graph to determine the probability of death due to the ingestion of plastic.

(2)

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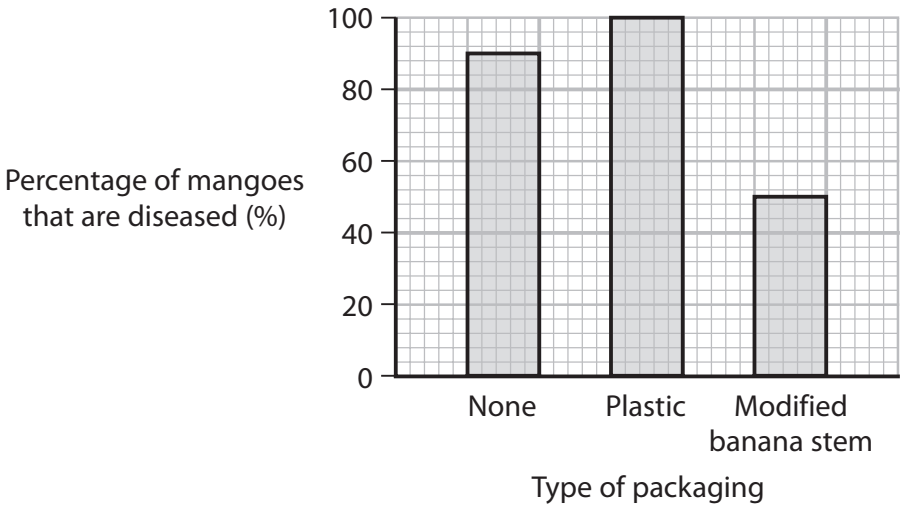
*(c) Mangoes are tropical fruits that are harvested before they are ripe.

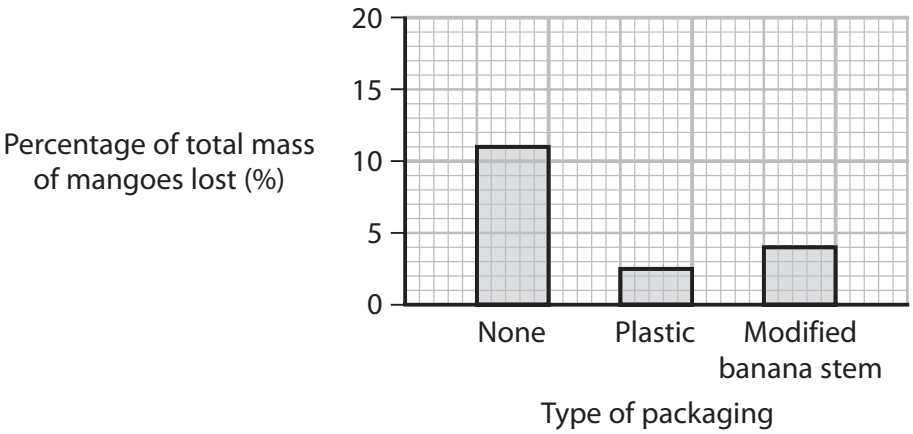
Plastic packaging is used to wrap mangoes after they have been picked. This preserves the fruit during transportation and storage.

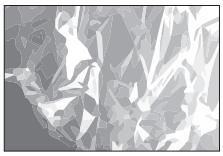
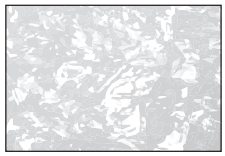
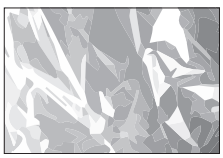
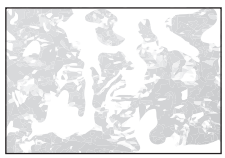
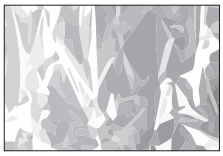
Banana stalks have a high content of cellulose and have been modified to use as packaging material for mangoes.

A study compared the use of these two types of material and their decomposition.

The graphs and the table show the results of this study.





Time of decomposition of packaging / weeks	Appearance of packaging	
	Plastic packaging	Modified banana packaging
0		
2		
4		

Discuss the advantages of using packaging made from modified banana stalks.

Use the information in the graphs, the table and your own knowledge to support your answer.

(6)

(Total for Question 9 = 14 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Thursday 11 January 2024

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 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.*

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.*
- Questions labelled 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.

Turn over ▶

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P 7 3 4 5 2 A 0 1 2 8

Pearson

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 Skin flora provide a barrier, protecting the body from infection by bacteria.

(a) Which of the following also act as barriers, protecting the body from **infection** by bacteria?

(1)

☒ **A** antigens and stomach acid

☒ **B** antigens and interferon

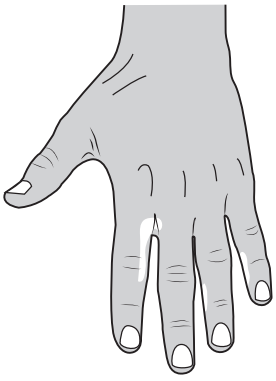
☒ **C** interferon and skin

☒ **D** skin and stomach acid

(b) The diagrams show the effects of different methods of washing hands on skin flora.

The dark areas show the presence of microorganisms and the light areas show clean areas.

1. before washing

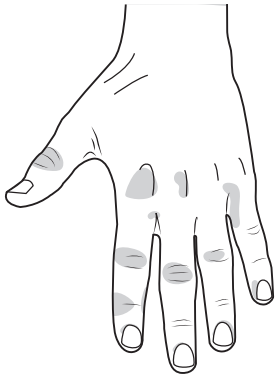


2. "rinse and shake"

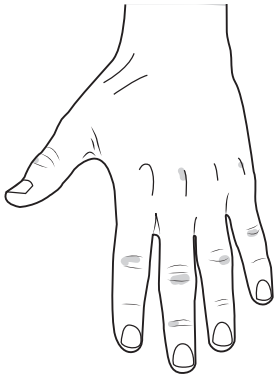
3. six seconds, no soap

4. six seconds with soap

5. fifteen seconds with soap



6. thirty seconds with soap



(i) Describe **two** conclusions that can be made about the different methods of washing hands.

(2)

(ii) Explain the differences in the effects that these methods of washing hands have on the skin flora.

(2)

(Total for Question 1 = 5 marks)

2 The light-independent reactions of photosynthesis use the products of the light-dependent reactions to produce simple sugars.

(a) (i) Which row of the table shows the products of the light-dependent reactions that are used in the light-independent reactions?

(1)

		ATP produced by	NADP
☒	**A**	cyclic photophosphorylation	oxidised
☒	**B**	cyclic photophosphorylation	reduced
☒	**C**	non-cyclic photophosphorylation	oxidised
☒	**D**	non-cyclic photophosphorylation	reduced

(ii) Simple sugars have the formula $C_nH_{2n}O_n$.

Name the inorganic molecule that provides each element in a simple sugar.

(2)

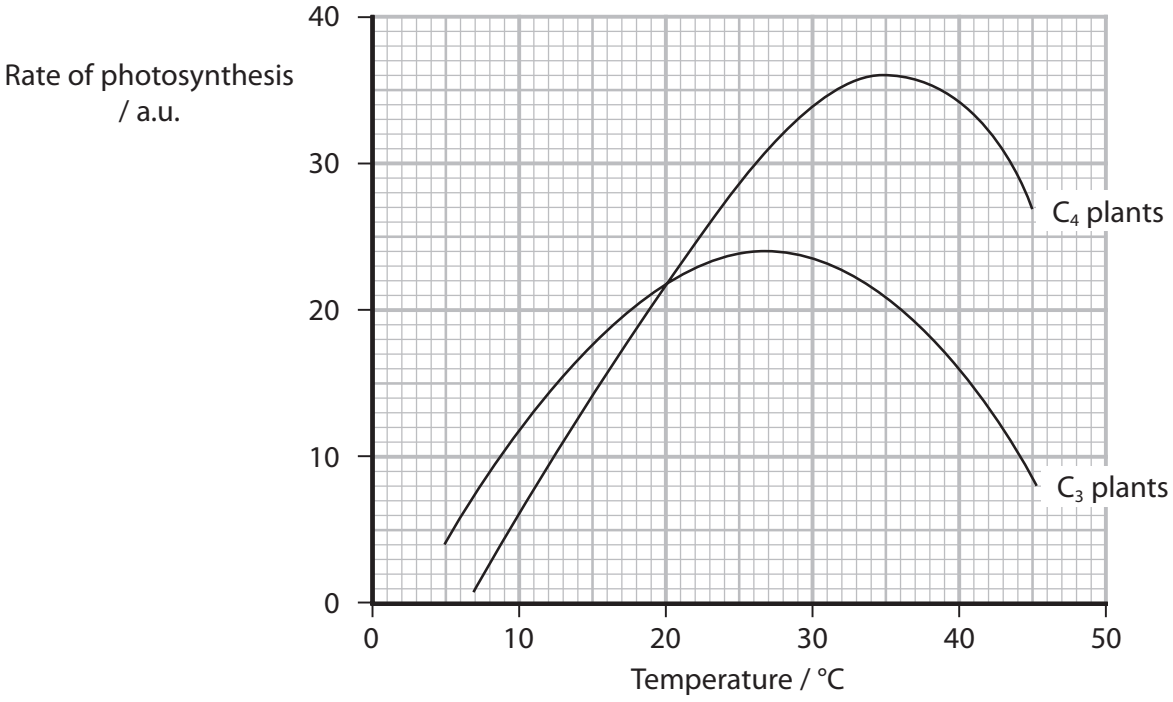
C .....

H .....

O .....

(b) Two types of plant, C_3 and C_4, have slightly different pathways of light-independent reactions.

The graph shows how the rate of photosynthesis is affected by temperature in these two types of plant.



(i) Describe **three** conclusions that can be made about the differences in the effect of temperature on the rate of photosynthesis in these two types of plant.

(3)

(ii) Calculate the Q_{10} for the enzymes in C_4 plants.

Use the formula:

$$Q_{10} = \frac{R_{t+10}}{R_t}$$

where R_t is the initial rate of reaction at 10 °C.

Give your answer as a whole number.

(2)

Answer .....

(Total for Question 2 = 8 marks)

3 Apple maggot flies are thought to have evolved from hawthorn flies by sympatric speciation.

Hawthorn flies are native to North America. They lay their eggs in the berries of the hawthorn bush.

The eggs hatch into maggots and the maggots develop into adult flies.

(a) State the meaning of the term **sympatric speciation**.

(2)

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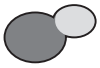
(b) Which row of the table represents sympatric speciation?

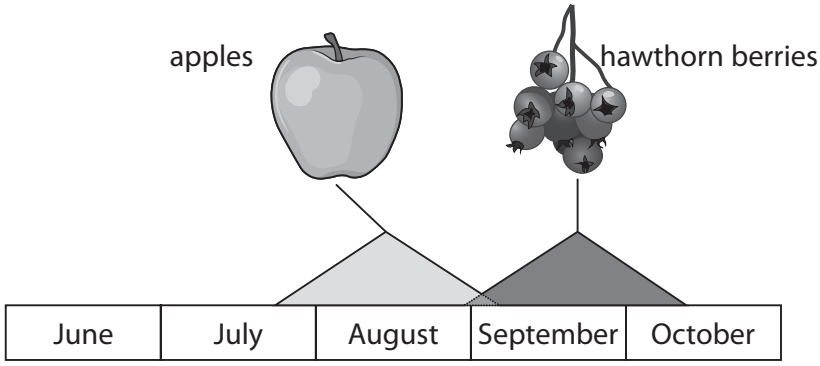
The shapes shaded dark grey represent the original species and the shapes shaded light grey represent the new species.

(1)

		Original species	First step in speciation	Final species
☒	**A**			
☒	**B**			
☒	**C**			
☒	**D**			

(c) Following the introduction of apple trees to North America, a small group of the hawthorn flies started laying their eggs in the apples.

The diagram shows the two types of fruit and the time of year that the fruits are produced.



(i) Suggest **two** adaptations needed for this change in behaviour of the flies.

(2)

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(ii) Explain what had to occur for changes in these flies to be inherited.

(3)

(iii) Explain why it is an advantage for the hawthorn fly and the apple maggot fly to lay their eggs in the fruits of different plants.

(2)

(iv) Suggest how these flies became reproductively isolated.

Use the information in the diagram to support your answer.

(2)

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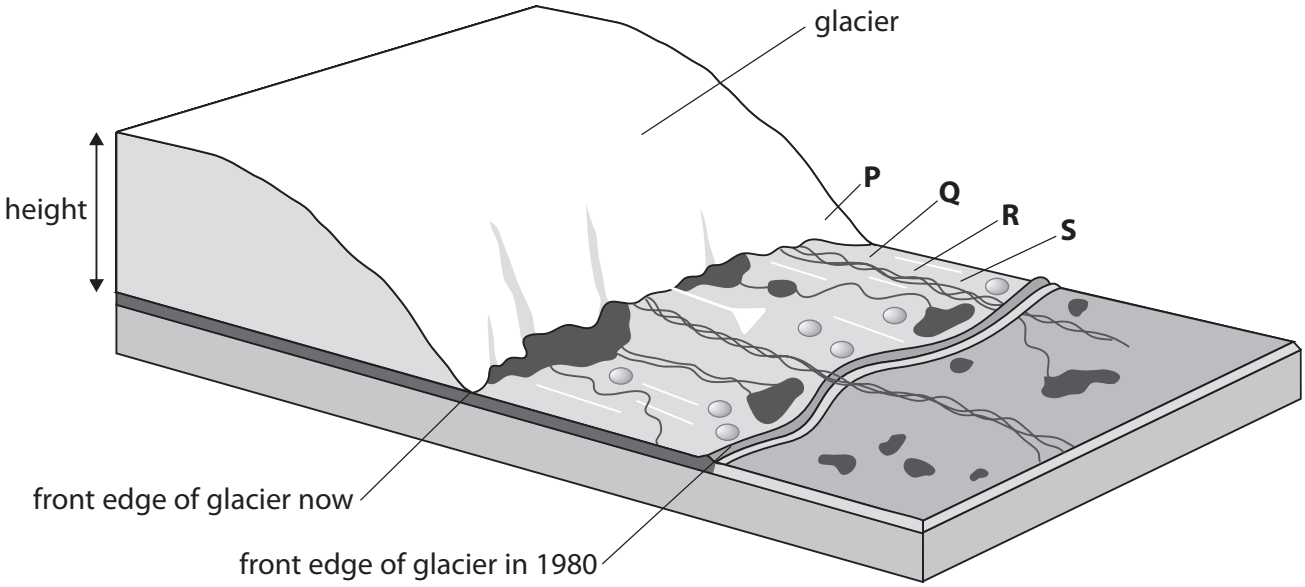
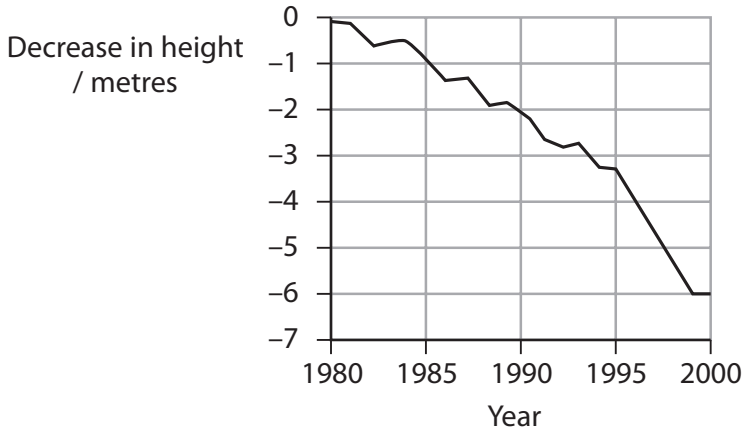
(Total for Question 3 = 12 marks)

4 Glaciers are decreasing in height and retreating due to global warming.

The diagram shows a retreating glacier.



(a) The graph shows the decrease in height of a glacier from 1980 to 2000.



(i) Calculate the mean drop in height from 1980 to 2000.

Give suitable units for your answer.

(1)

Answer .....

(ii) Explain why the decrease in height is greater from 1995 to 2000 than it is from 1980 to 1985.

(3)

(b) Which letter on the diagram indicates the location of pioneer species only?

(1)

- ☒ **A** P
- ☒ **B** Q
- ☒ **C** R
- ☒ **D** S

(c) At different distances from the front edge of the glacier, there will be variations in soil conditions.

These soil conditions include: soil depth, the carbon : nitrogen ratio and the organisms present in the soil.

These differences depend on the length of time the ground has been exposed by the retreating glacier.

(i) Which term describes the changes in soil conditions and organisms with time?

(1)

- ☒ **A** anthropogenic
- ☒ **B** evolution
- ☒ **C** speciation
- ☒ **D** succession

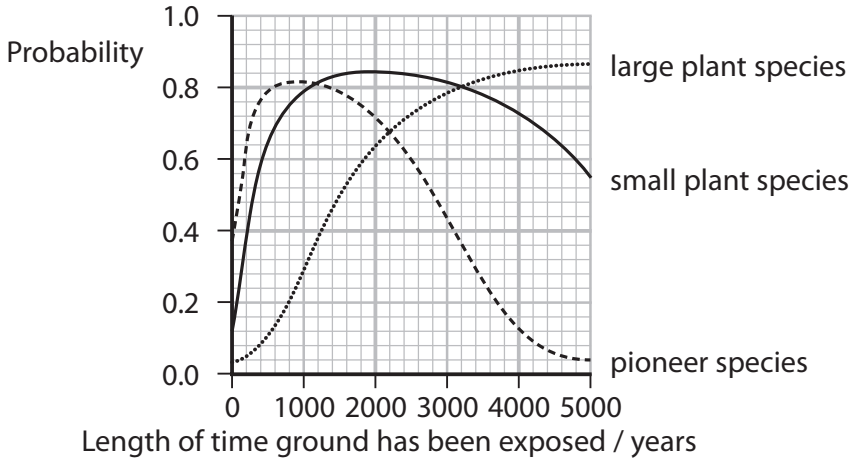
*(ii) The table shows the soil carbon : nitrogen ratio in ground exposed by a retreating glacier.

Length of time that the ground has been exposed / years	Carbon : nitrogen ratio in the soil
< 200	9.8
2 000	11.6
3 500	10.7
7 200	10.3

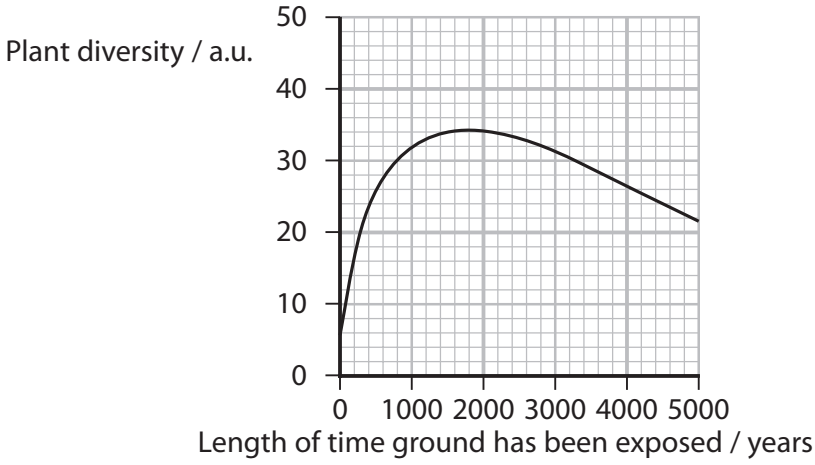
Graph 1 shows the probability that three different types of plant will be found on ground exposed for different lengths of time.

Graph 2 shows a model of plant diversity on ground exposed for different lengths of time.

Graph 1



Graph 2



Explain the variations in soil conditions and the organisms found at different distances from the front edge of the glacier.

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

(6)

(Total for Question 4 = 12 marks)

5 *Mycobacterium tuberculosis* (*Mtb*) and human immunodeficiency virus (HIV) are two pathogens that infect people.

When people infected with either pathogen become infected with the other pathogen the disease is worse.

(a) Explain why HIV infection causes tuberculosis (TB) to be worse.

(4)

(b) In one year, it was estimated that 33.4 million people were infected with HIV. It was estimated that 30 % of these people were also infected with *Mtb*.

(i) Suggest **two** reasons why these figures are only estimates.

(2)

(ii) Calculate the number of people with both infections.

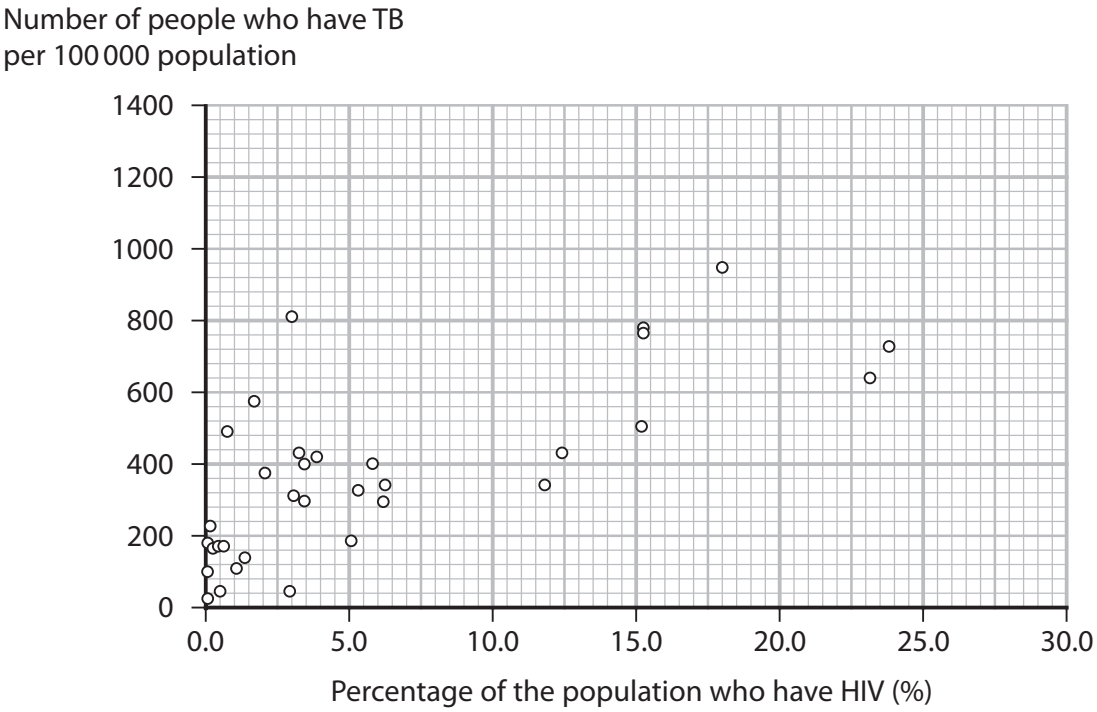
Give your answer in standard form.

(1)

Answer .....

(c) The graph shows the number of people who have TB and the percentage of the population who have HIV.

Each plotted point represents data from a different country.



(i) Comment on the relationship between the number of people who have TB and the percentage of people who have HIV.

(2)

(ii) Describe how the strength of the relationship between the number of people who have TB and the percentage of people who have HIV could be determined.

(3)

(Total for Question 5 = 12 marks)

6 The diagram shows a food chain in a southeast Asian rainforest.

Trophic level 3: Bengal tiger

(Source: © Steve Bloom Images / Alamy Stock Photo)

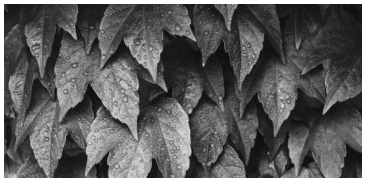
↑

Trophic level 2: Slender loris

(Source: © ephotocorp / Alamy Stock Photo)

↑

Trophic level 1: Young leaves of trees



(Source: © Ivan Kmit / Alamy Stock Photo)

(a) Give the meaning of each of the following terms.

Give an example from this food chain in each of your answers.

(i) Habitat

(2)

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(ii) Population

(2)

(iii) Community

(2)

(b) Explain how the niche of the slender loris affects the distribution and abundance of the Bengal tigers.

(3)

(c) Southeast Asian forests are the oldest rainforests on Earth.

Explain how the age of a tree in a rainforest can be determined, without cutting it down.

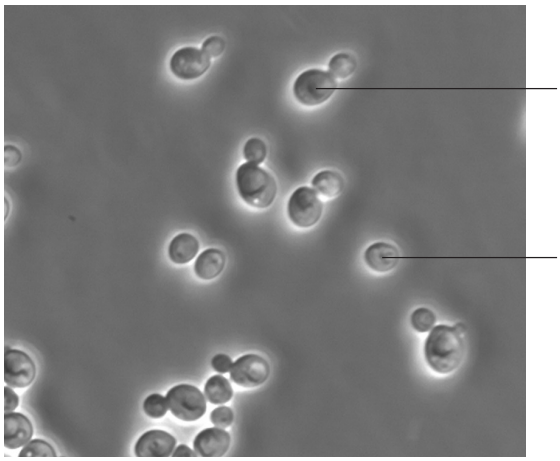
(3)

(Total for Question 6 = 12 marks)

7 Yeast are single-celled eukaryotic microorganisms.

They reproduce asexually by budding. The new yeast cell (bud) grows out of the cell of an adult yeast cell following mitosis.

The photograph shows some yeast cells.



(Source: © Andre Nantel/Shutterstock)

(a) One species of yeast, *S. cerevisiae*, has a diameter from 5 µm to 10 µm.

One type of bacteria, *S. aureus*, has a diameter from 500 nm to 1500 nm.

(i) Calculate the smallest difference between the diameters of *S. cerevisiae* and *S. aureus*.

Give suitable units with your answer.

(1)

Answer .....

(ii) The table gives some statements about cells.

For each statement, put **one** cross ☒ in the appropriate box, in each row, to show whether these statements are true for the types of microorganisms shown.

(2)

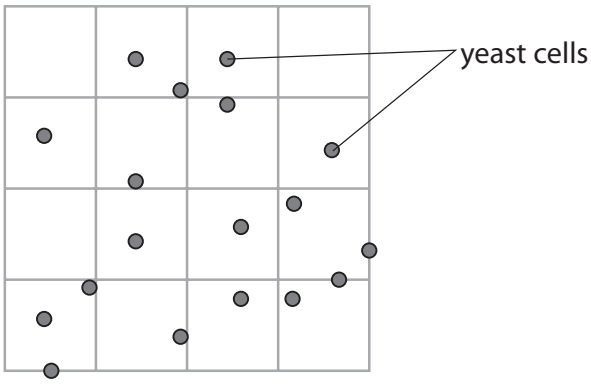
Statement about cells	**Type of microorganism**			
	both *S. cerevisiae* and *S. aureus*	*S. cerevisiae* only	*S. aureus* only	neither *S. cerevisiae* nor *S. aureus*
Contain both DNA and RNA	☒	☒	☒	☒
Have membranes around the cytoplasm and around the nucleus	☒	☒	☒	☒

(b) Yeast cells can be cultured and the rate of growth determined using a haemocytometer (counting chamber / Neubauer chamber).

(i) A student had a suspension of yeast cells in a liquid culture and wanted to determine the concentration of yeast cells in this culture.

A sample of this culture was added to the haemocytometer and observed under a light microscope.

The diagram shows yeast cells in part of the haemocytometer.



The volume of the sample covering this part of the haemocytometer is 0.00625 µl.

$1\ \mu l = 10^{-6}\ dm^3$

Explain how to calculate the concentration of yeast cells, in cells per cm^3, in the culture. Include in your answer an explanation of how the number of cells was determined from the diagram of a haemocytometer.

(3)

Explanation .....

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Answer ..... cells per cm^3

(ii) The growth curve for yeast grown in culture has four phases, similar to bacteria grown in culture.

Sketch a growth curve on the axes drawn below.

Label the axes and the four phases of the growth curve.

(4)

(iii) Describe how the student could use a growth curve to determine the exponential growth rate constant for the yeast.

(4)

(Total for Question 7 = 14 marks)

8 Individuals develop artificial immunity either actively or passively.

(a) The table gives some statements about immunity.

For each statement, put **one** cross ☒ in the appropriate box, in each row, to show whether these statements are true for these types of immunity.

(2)

Statement	Type of artificial immunity			
	both active and passive	active only	passive only	neither active nor passive
Antigens are injected into the person	☒	☒	☒	☒
Immunity is long term	☒	☒	☒	☒

(b) Vaccination against a virus results in the production of antibodies.

Describe how antibodies are produced following activation of T cells.

(2)

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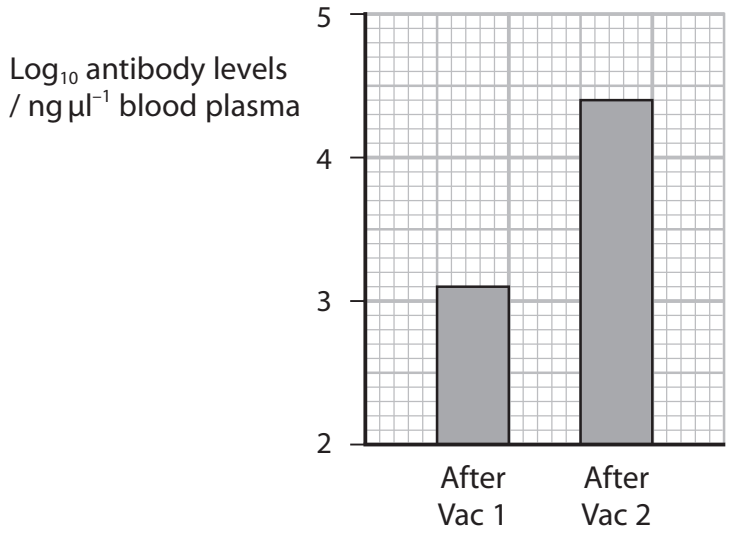
(c) The levels of antibodies following vaccinations were investigated.

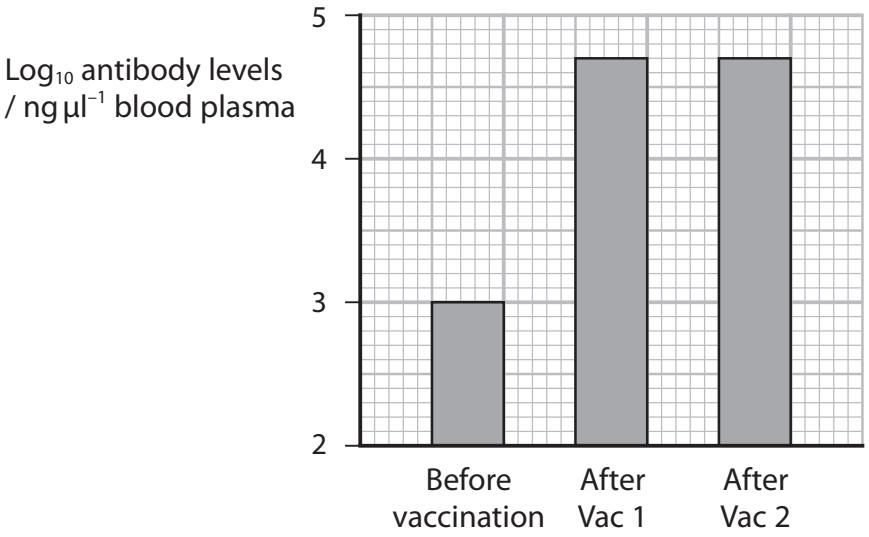
There were two groups of people. Group 1 **had not** been infected with the virus, before the vaccine was given. Group 2 **had** been infected with the virus before the vaccine was given.

Both groups of people received two vaccinations, Vac 1 and Vac 2.

The graphs show the results of this investigation.



Group 1:
People who had not been infected before the vaccine was given



Group 2:
People who had been infected with the virus before the vaccine was given

(i) Explain **two** ways in which this investigation would have to be controlled to provide valid data.

(2)

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(ii) In group 1, Vac 2 increased the levels of antibody more than Vac 1.

Calculate how many times greater this increase was.

(2)

Answer .....

(iii) Suggest why there is no data on the graph for group 1 before vaccination.

(1)

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*(iv) Explain the results of this investigation.

(6)

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(Total for Question 8 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Tuesday 28 May 2024

Morning (Time: 1 hour 45 minutes)

Paper reference **WBI14/01**

Biology

International Advanced Level
UNIT 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or 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.*

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.

Turn over ▶

P75774A

P 7 5 7 7 4 A 0 1 3 2

Pearson

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 Seaweeds are photosynthetic organisms. They contain chloroplast pigments, some of which are similar to land plants and some of which are different.

(a) Which process can be used to separate chloroplast pigments according to their solubility?

(1)

☒ **A** chromatography

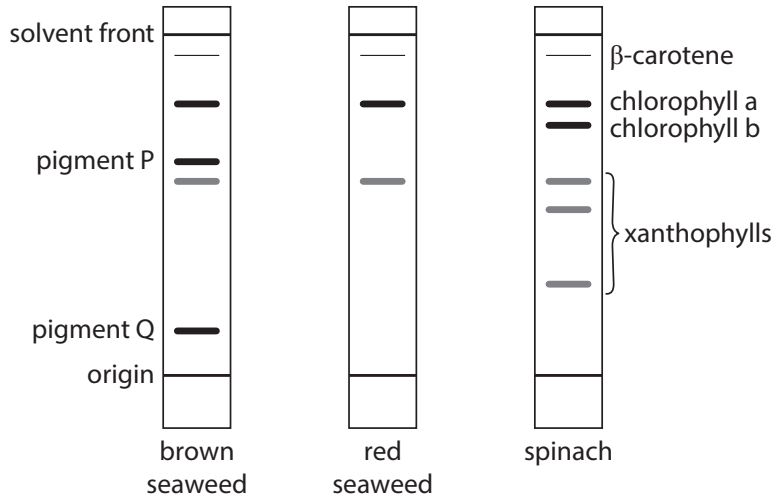
☒ **B** dendrochronology

☒ **C** gel electrophoresis

☒ **D** polymerase chain reaction

(b) A student separated the chloroplast pigments found in brown seaweed, red seaweed and spinach using this method.

The diagram shows the results.



(i) Compare and contrast the types of chloroplast pigment found in the seaweeds with those found in the spinach.

Use the information in the diagram to support your answer.

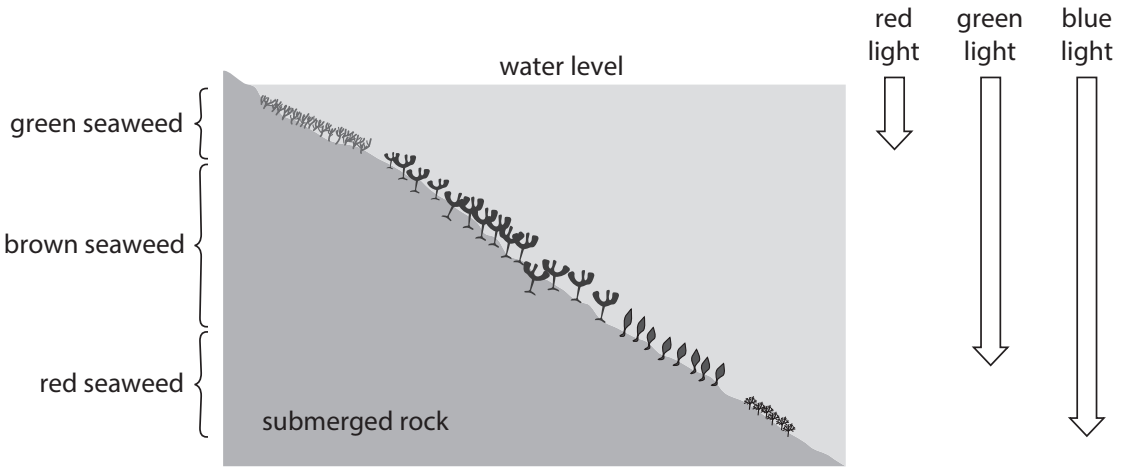
(3)

(ii) Describe how the student could identify pigment P using this method.

(3)

(c) The diagram shows the position of three different types of seaweed on rock covered in water.

The diagram also shows the depth to which red light, green light and blue light penetrate into the water.



(i) Which row of the table shows the light that green seaweed can absorb?

(1)

		Green light	Red light
☒	**A**	can absorb	can absorb
☒	**B**	can absorb	cannot absorb
☒	**C**	cannot absorb	can absorb
☒	**D**	cannot absorb	cannot absorb

(ii) Explain the positions of the brown and red seaweeds on the submerged rock.

(2)

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(Total for Question 1 = 10 marks)

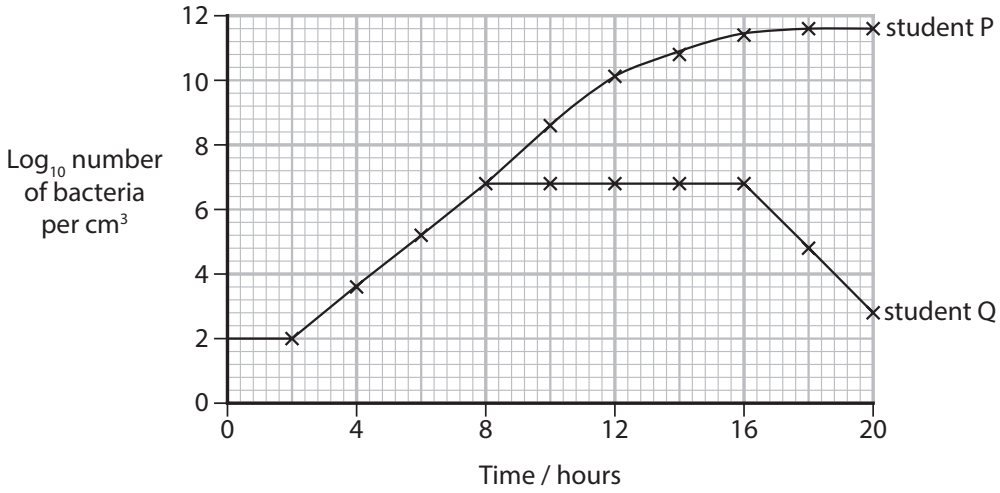
2 Two students, student P and student Q, each cultured bacteria in a liquid medium for 20 hours.

The culture conditions used by both students were identical.

Every two hours, each student removed a sample of the culture to count the number of bacteria.

Each student used a different method to count the number of bacteria in the samples.

The graph shows the bacterial growth curve that each student drew using their results.



(a) Both students used aseptic techniques to culture the bacteria.

(i) Explain the importance of using aseptic techniques to culture bacteria.

(2)

(ii) Explain **one** aseptic technique that should be used when culturing bacteria.

(2)

(b) Calculate the growth rate constant (*k*) of these bacteria between 2 hours and 6 hours of culture.

(2)

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

where:

$\log_{10}N_t$ = $\log_{10}$ number of cells at 6 hours

$\log_{10}N_0$ = $\log_{10}$ number of cells at 2 hours.

Answer .....

(c) The number of bacteria in the samples taken after 10 hours were:

398 107 171 in the culture of student P

6 309 573 in the culture of student Q.

(i) Calculate the ratio of the number of bacteria in these two cultures.

(1)

Answer ..... : 1

(ii) Student P and student Q used different methods for determining the number of bacteria.

State which method each student used.

Give a reason for your answer.

(2)

Student P .....

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.....

.....

Student Q .....

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(Total for Question 2 = 9 marks)

3 Textiles used in clothing can be made from:

- plants, for example cotton
- animals, for example wool and leather
- crude oil, for example nylon and polyester.

The photographs show cotton being grown and harvested.

(Source: © Design Pics Inc/Alamy Stock Photo)

(Source: © Jim Parkin/Alamy Stock Photo)

In 2022, it was estimated that 92 million tonnes of textile waste was produced in the world.

Textile waste is either burned or buried underground in landfill sites.

(a) It is estimated that by 2030, there will be 134 million tonnes of textile waste produced each year.

Calculate this increase in textile waste.

Give your answer in standard form.

(1)

Answer ..... tonnes

(b) The production of textiles and the removal of textile waste is an example of human activity affecting the environment.

Which term is used to describe the effect of **human** activity on the environment?

(1)

- ☒ **A** antigenic
- ☒ **B** anthropogenic
- ☒ **C** epigenetic
- ☒ **D** polygenic

(c) There are companies in Scandinavia that are producing sustainable textiles for clothing.

One company is recycling textile waste. It is removing dyes and making new fibres that can be woven.

Another company is using waste from the wood industry, wheat straw and leather scraps to make fibres.

(i) Give the meaning of the term **sustainable**, as used in this context.

(1)

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.....

*(ii) Discuss the extent to which these companies are reducing the conflict between human needs, climate change and conservation.

Use the information in the question, the photographs and your own knowledge to support your answer.

(6)

(Total for Question 3 = 9 marks)

4 Leaves that have fallen from trees are an important source of nutrients for many organisms living in streams.

Bacteria and fungi can break down molecules such as cellulose and lignin, releasing nutrients for small animals that live in the water.

Decomposition of two types of leaf in the Mahoning River, Ohio, was investigated.

(a) (i) Which row of the table describes the structure of cellulose?

(1)

		Type of glucose molecule	Type of glycosidic bond
☒	**A**	alpha (α)	1–4
☒	**B**	alpha (α)	1–6
☒	**C**	beta (β)	1–4
☒	**D**	beta (β)	1–6

(ii) Cellulose and lignin are broken down by enzymes released from the bacteria and fungi.

Fungi belong to the domain Eukarya.

Which of the following statements are correct for **both** bacteria and fungi?

1 The enzymes are synthesised on ribosomes

2 The genes coding for these enzymes are found in the nucleus

3 Enzymes are released by endocytosis

(1)

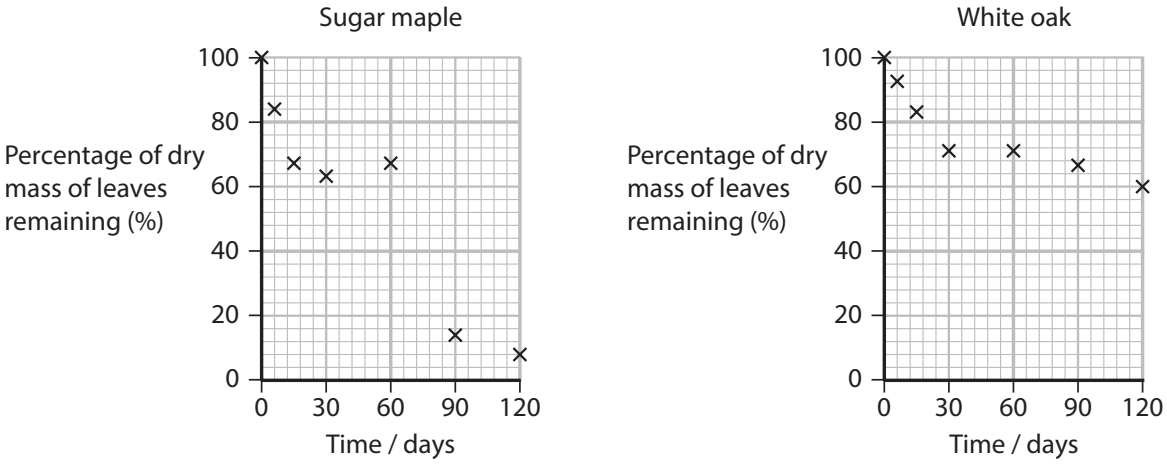
☒ **A** 1 only

☒ **B** 1 and 2 only

☒ **C** 2 only

☒ **D** 2 and 3 only

(b) The graphs show the extent to which two types of leaf decomposed in 120 days.



(i) Decomposition was measured as a decrease in dry mass of the leaves.

Suggest why dry mass was measured and not wet mass.

(1)

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(ii) Calculate the rate of decrease in percentage dry mass between 30 days and 120 days for the sugar maple leaves.

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

(2)

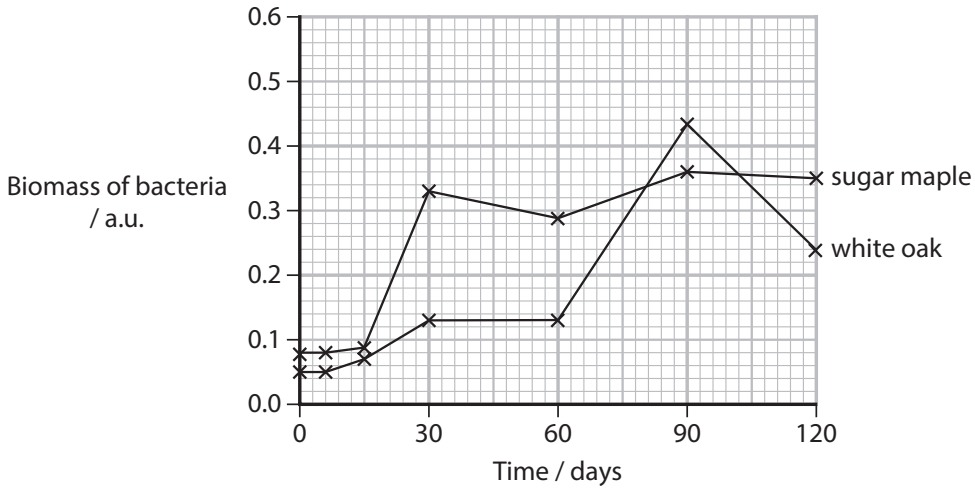
Answer .....

(iii) Describe **two** conclusions that can be made about the decomposition of sugar maple leaves compared with the white oak leaves.

(2)

(c) The biomass of bacteria on the two types of leaf during the 120-day period was determined.

The graph shows the changes in biomass of bacteria on these leaves.



(i) Calculate how many times greater the biomass of bacteria on the sugar maple leaves is after 30 days compared with the biomass of bacteria at 0 days.

(1)

Answer .....

(ii) Suggest why the increase in biomass of bacteria after 30 days is greater on the sugar maple leaves than it is on the white oak leaves.

Give a reason for your answer.

(2)

(iii) Suggest why the biomass of bacteria on the white oak leaves decreased after 90 days.

Give a reason for your answer.

(2)

(Total for Question 4 = 12 marks)

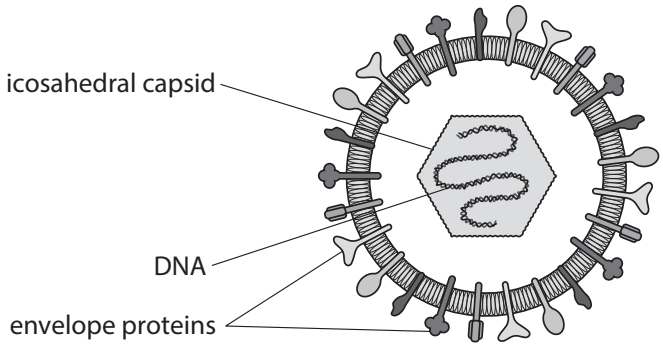
5 Herpes simplex is a virus that causes sores around the nose and mouth.

A modified form of this virus has been developed to infect and kill cancer cells in humans.

(a) Explain how a cell can become a cancer cell.

(2)

(b) The diagram shows a herpes simplex virus.



(i) Which of the following statements are true?

(1)

1 Ebola virus has the same type of genetic material as herpes simplex virus

2 Both Ebola virus and human immunodeficiency virus (HIV) have envelope proteins

3 HIV has an icosahedral capsid

☒ **A** Statements 1 and 2 only

☒ **B** Statements 1 and 3 only

☒ **C** Statements 2 and 3 only

☒ **D** Statements 1, 2 and 3

(ii) State the function of the envelope proteins.

(1)

(iii) Explain why the herpes simplex virus has to be modified before it can be used to infect cancer cells.

(2)

(iv) Explain how the infection of a cancer cell with herpes simplex virus can result in the death of this cell.

(2)

(c) Using a modified herpes simplex virus activates the immune system.

Explain why activation of the immune system would result in destruction of the cancer cells.

(4)

(Total for Question 5 = 12 marks)

6 Aquaculture is the controlled cultivation of aquatic organisms such as fish, shellfish and plants. It is an important source of food in many countries of the world.

The photograph shows freshwater aquaculture ponds in Africa.

(Source: © E.Westmacott/Alamy Stock Photo)

Vibrio are bacteria that are common in aquatic habitats. They cause diarrhoea and cholera and are also pathogenic to shellfish.

The resistance of *Vibrio* to antibiotics and to heavy metals in aquaculture ponds in Nigeria was investigated.

(a) Samples of water were taken from 120 ponds. Of these, 74 of the ponds had been treated previously with antibiotics.

Which of the following is the percentage of **untreated** ponds?

(1)

☒ **A** 38

☒ **B** 61

☒ **C** 62

☒ **D** 163

(b) *Vibrio* were grown on agar containing different heavy metals at a range of concentrations.

The highest concentration of heavy metal tested was 3.2 mg cm^{-3} and the lowest concentration was 6.25 μg cm^{-3}.

(i) How many times does the highest concentration need to be diluted to make the lowest concentration?

(1)

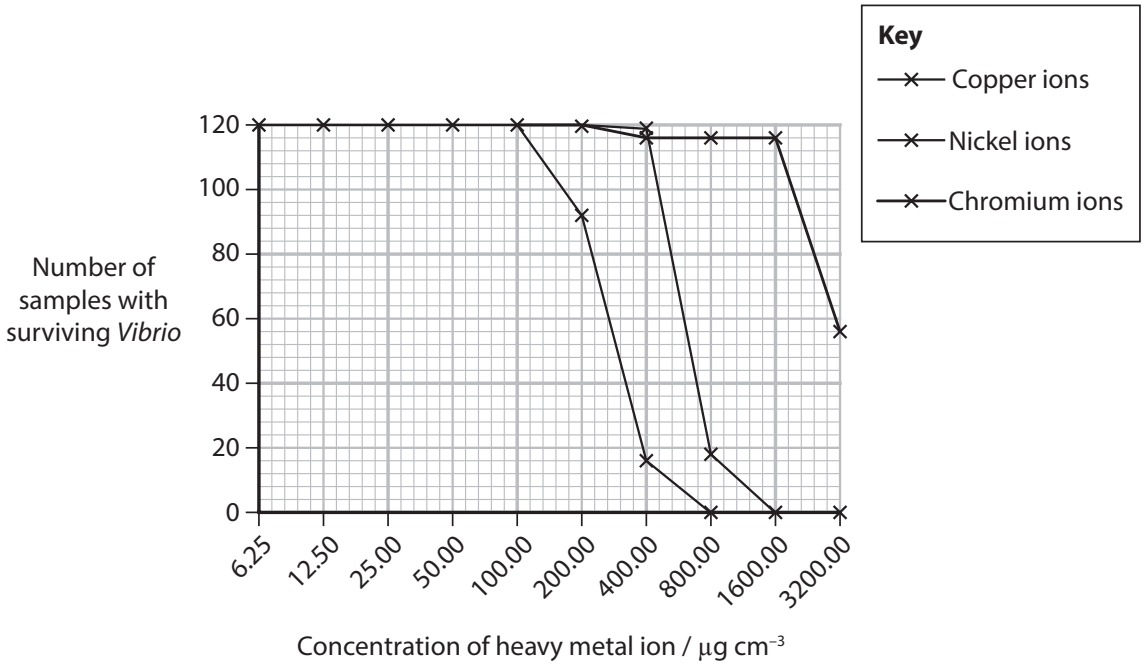
☒ **A** 5.12

☒ **B** 51.2

☒ **C** 512

☒ **D** 5120

(ii) The graph shows the effect of different concentrations of heavy metals on the survival of the *Vibrio* collected from each of the 121 ponds.



Describe the conclusions that can be made about the effects of heavy metal ions on the survival of *Vibrio*.

(3)

(c) The samples of *Vibrio* taken from each pond were spread on agar containing different antibiotics.

(i) The scientists expected the percentage of resistant bacteria to be higher in the samples of *Vibrio* taken from the ponds previously treated with antibiotics.

Explain why the scientists expected this difference.

(3)

(ii) Some of the antibiotics used were bacteriostatic and some were bactericidal.

State the difference between a bacteriostatic antibiotic and a bactericidal antibiotic.

(1)

(iii) The method did not distinguish between bacteriostatic and bactericidal antibiotics because no colonies grew.

Suggest how the method would need to be modified to show which antibiotics were bacteriostatic and which were bactericidal.

Give a reason for your answer.

(2)

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(Total for Question 6 = 11 marks)

7 Increased levels of atmospheric carbon dioxide can lead to an increased rate of photosynthesis. This is called the CO_2 fertilisation effect.

This effect varies depending on air and soil temperature, the availability of water, the availability of nutrients and the species of plant.

Plants that can take advantage of higher carbon dioxide levels will have a greater increase in biomass.

(a) Describe how carbon becomes incorporated into plant biomass.

(3)

(b) (i) Explain why air temperature affects the CO_2 fertilisation effect.

(2)

(ii) Suggest why soil temperature affects the CO_2 fertilisation effect.

(2)

(c) Explain why a lack of water availability in the leaves would decrease the CO_2 fertilisation effect.

(3)

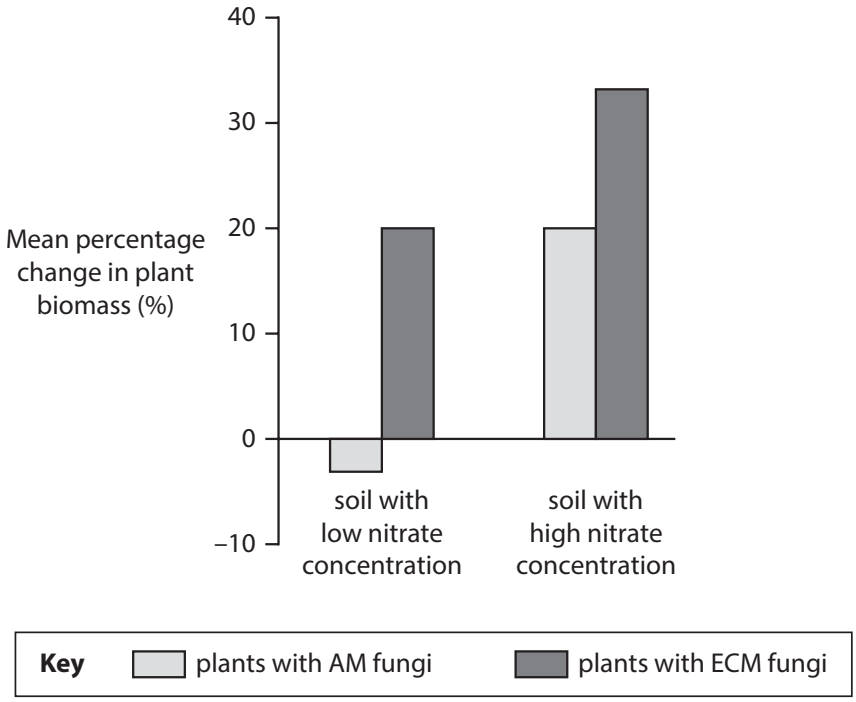
(d) The roots of most land plants are associated with microscopic fungi called mycorrhizal fungi.

These fungi provide the plants with nitrate ions.

The effect of two types of mycorrhizal fungi, ECM and AM, on the change in plant biomass was investigated.

Plants were grown in soil containing either low or high concentrations of nitrate.

The graph shows the results of this investigation.



Explain the results of this investigation.

(4)

(Total for Question 7 = 14 marks)

8 The Bajau people are nomadic people who free-dive in the waters around the Philippines, Malaysia and Indonesia.

They have been travelling around these waters on house boats for over 1 000 years.

They can free-dive to depths of 70 m for as long as 13 minutes, spending 60% of their working time underwater.

The photograph shows a Bajau free-diving, without breathing equipment.

(Source: © Marko Reimann/Alamy Stock Photo)

Scientists measured the size of the spleens of the Bajau people and a related group of people called Saluan.

The Saluan people live on the mainland of Indonesia and do not free-dive.

The genomes of the two groups of people were analysed.

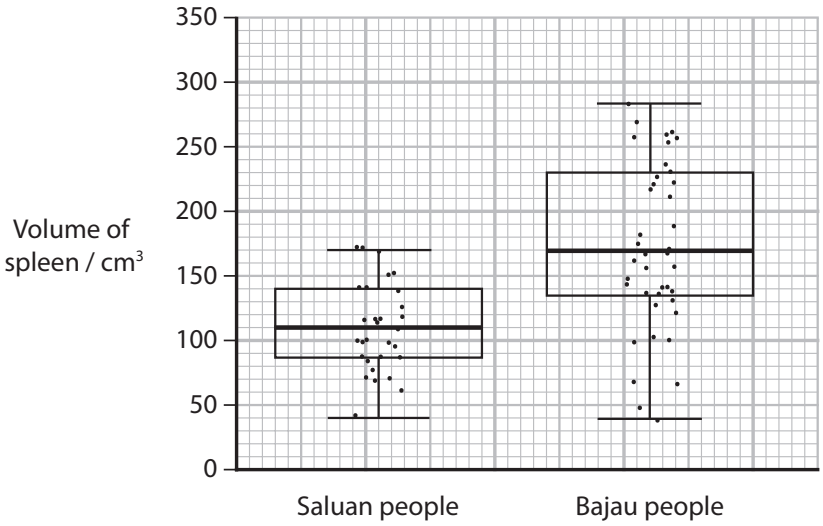
(a) Animals, such as seals, that spend much of their time underwater have very large spleens.

Spleens store oxygenated red blood cells which are released into the bloodstream during a dive.

Explain why a large spleen would help the seal during its dive.

(4)

(b) The graph shows the volumes of the spleens of individuals from the Saluan people and the Bajau people.



(i) The two horizontal lines **in bold** show the middle values for each set of the volumes of spleen.

Which of the following is the term that describes the middle value of a set of data?

(1)

- ☒ **A** mean
- ☒ **B** median
- ☒ **C** mode
- ☒ **D** standard deviation

(ii) Describe **two** conclusions that can be made from this data.

(2)

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*(c) The study analysed the genomes of the Saluan people and the Bajau people to identify any genetic relationships that correlated with spleen volume.

The scientists concluded that the Bajau had become genetically-adapted to diving.

Explain how the Bajau could have become genetically-adapted to diving.

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

(6)

(Total for Question 8 = 13 marks)

TOTAL FOR PAPER = 90 MARKS

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Monday 21 October 2024

Afternoon (Time: 1 hour 45 minutes)

Paper reference **WBI14/01**

Biology

International Advanced Level
UNIT 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or 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.*

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.

Turn over ▶

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Pearson

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 Very little of the light energy falling on a field of plants is absorbed by the plants and transferred to higher trophic levels.

(a) Suggest **two** reasons why very little of the light energy is absorbed by plants.

(2)

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(b) In an American study, the light energy falling on one square metre of a field in one year was recorded as 1 700 000 kilocalories.

(i) Only one fifteenth of this light energy was converted into plant biomass.

Calculate the number of kilocalories of light energy converted into plant biomass.

Give your answer in standard form.

(1)

Answer ..... kilocalories

(ii) Only 6 kilocalories became animal biomass.

Calculate the number of kilojoules (kJ) of energy that became biomass.

1 kilocalorie = 4.2 kJ.

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

(1)

Answer ..... kJ

(iii) In another field 154 000 kilocalories of energy was converted into plant biomass.

Only 25 kilocalories of this energy was passed onto the highest trophic level in a food chain.

Calculate the percentage of energy that was passed onto the highest trophic level.

(1)

Answer ..... %

(Total for Question 1 = 5 marks)

2 Broccoli is a vegetable plant that is grown as a crop in many parts of the world.

Broccoli is susceptible to a disease called clubroot.

Genetic engineering can be used to produce clubroot-resistant varieties of broccoli.

Genetic engineering involves inserting resistance genes into the cells of the broccoli plants.

The resistance genes were obtained from linseed plants.

Scientists can use DNA profiling to identify the broccoli plants that have been successfully genetically engineered.

(a) Samples of DNA were extracted from the plants and subjected to a polymerase chain reaction (PCR) before analysis.

(i) Explain why PCR was used on the DNA samples.

(2)

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(ii) Taq (DNA) polymerase is used in PCR.

Describe the role of Taq (DNA) polymerase.

(2)

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(b) After PCR, gel electrophoresis was used to separate the DNA fragments.

(i) Which type of enzyme is used to produce DNA fragments?

(1)

- ☒ **A** integrase
- ☒ **B** restriction enzyme
- ☒ **C** reverse transcriptase
- ☒ **D** RUBISCO

(ii) The results of the gel electrophoresis were used to identify the plants that contained the resistance genes.

Deduce the types of plants that would have supplied the DNA samples for this analysis.

Give reasons for your answer.

Use the information in the question to support your answer.

(3)

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(Total for Question 2 = 8 marks)

3 A person's immune response to viral infections involves T killer cells.

Cells infected with viruses present viral antigens to the T killer cells.

(a) Peptide fragments bind to MHC molecules to form an antigen-MHC complex. This takes place in the rough endoplasmic reticulum (rER).

The complex is then transported to the surface of the infected cell.

Describe how the antigen-MHC complex is transported from the rER onto the outside of the surface membrane of the infected cell.

(2)

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(b) An electron microscope with a resolution of 3.7 Å can be used to study antigen-MHC complexes.

1 µm = 1×10^4 Å

(i) Calculate the resolution of this electron microscope in nanometres.

(1)

Answer ..... nm

(ii) State what is meant by a resolution of 3.7 Å

(1)

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(c) Explain why antigens need to be presented to T killer cells in a person's immune response to viral infections.

(2)

(d) Explain how the action of T killer cells results in a person recovering from a viral infection.

(3)

(Total for Question 3 = 9 marks)

4 The time of death of a mammal can be determined by a number of different methods.

(a) Insects can be used to determine the time of death of a mammal.

(i) Which is the term used to describe the use of insects in determining the time and place of death of a mammal?

(1)

- ☒ **A** chromatography
- ☒ **B** dendrochronology
- ☒ **C** forensic entomology
- ☒ **D** heterozygosity

(ii) Which of the following factors provides information about the time of death of a mammal?

1. species of insect
2. size of larvae, e.g. maggots
3. stages in development of insects

(1)

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

(b) The body temperature of a human corpse can be used to determine the time of death.

(i) Which is the most accurate method of measuring the body temperature of a human corpse to determine time of death?

(1)

- ☒ **A** placing a temperature-sensitive strip on the forehead
- ☒ **B** pushing a temperature probe into the liver
- ☒ **C** putting a thermometer under the tongue
- ☒ **D** putting a temperature probe under the armpit

(ii) Time of death can be estimated by determining the fall in body temperature.

Which row of the table shows how more clothing and higher ambient temperature would affect the estimated time of death?

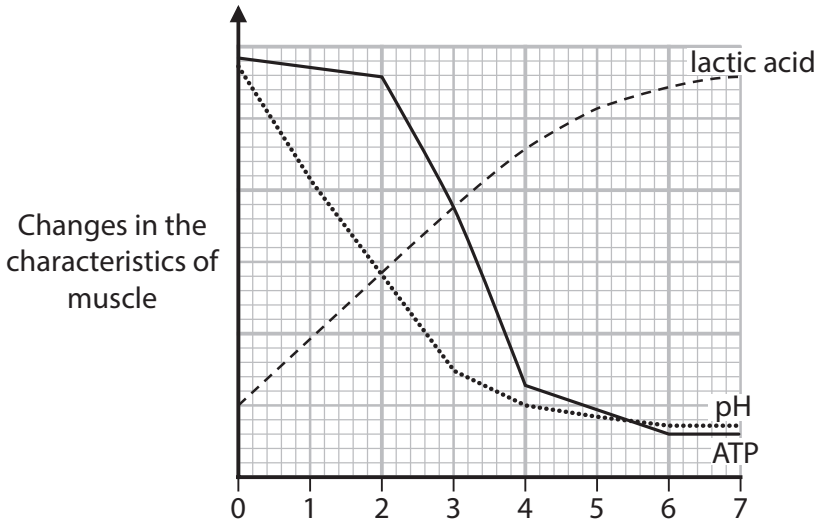
(1)

		Effect on estimated time since death of:	
		more clothing	**higher ambient temperature**
☒	**A**	increase	increase
☒	**B**	increase	decrease
☒	**C**	decrease	increase
☒	**D**	decrease	decrease

(c) The extent of muscle contraction (*rigor mortis*) can be used to estimate the time of death.

(i) The graph shows the changes in three characteristics of muscle with time after the death of a mammal:

- ATP
- lactic acid
- pH

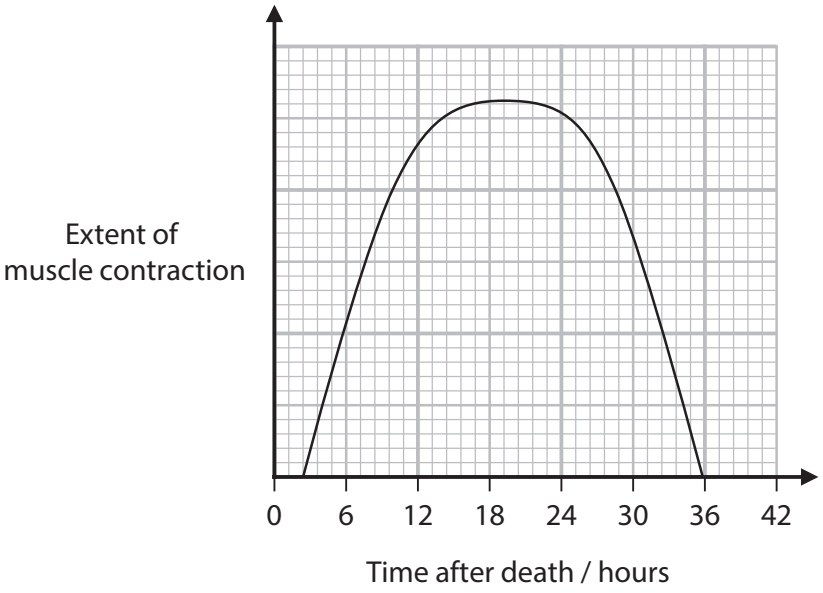


Explain the changes in each of the **three** characteristics shown in this graph.

Use your own knowledge to support your answer.

(3)

(ii) The graph shows the changes in the extent of muscle contraction with time after death.



Explain why using the extent of muscle contraction by itself may give an incorrect time of death.

Use the information in the graph to support your answer.

(3)

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(Total for Question 4 = 10 marks)

5 Succession can result in the formation of different types of habitat.

(a) State the meaning of the term **succession**.

(1)

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(b) Which of the following describes a habitat?

(1)

☒ **A** a group of interacting organisms

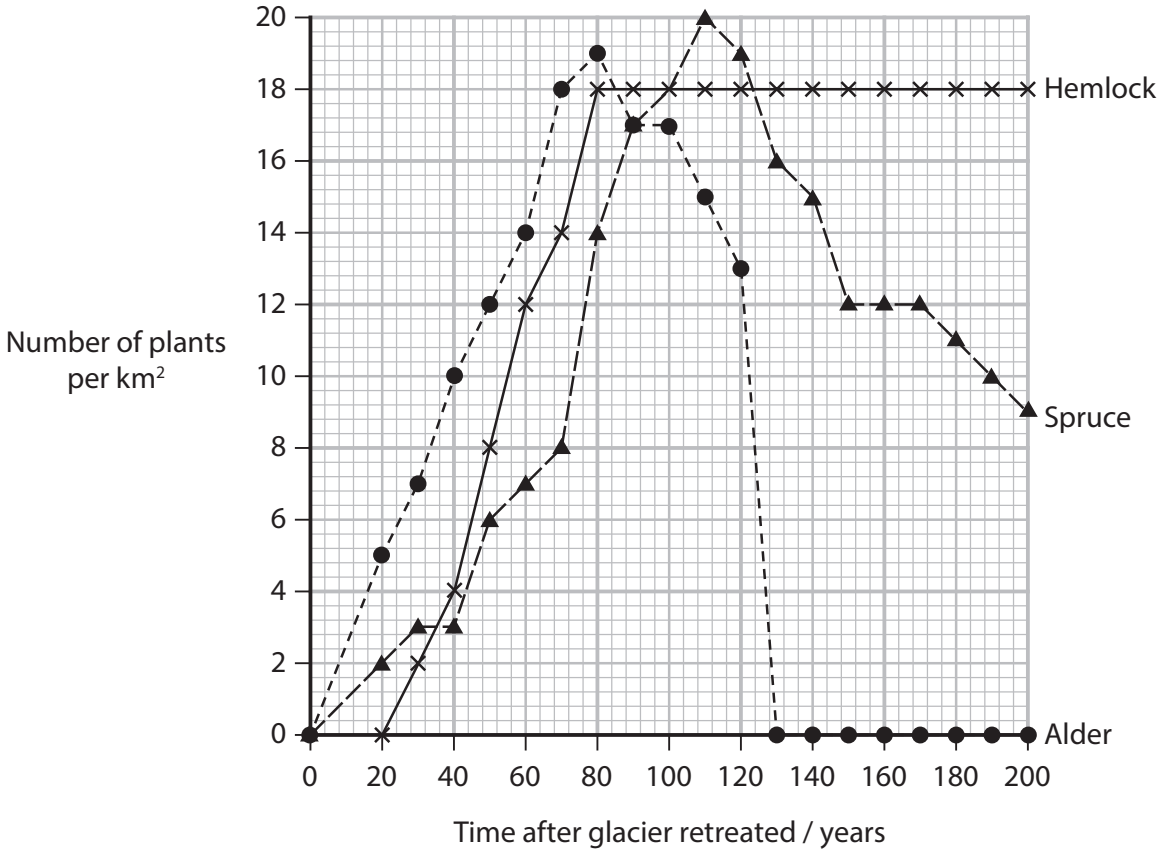
☒ **B** a place that meets the environmental conditions an organism needs to survive

☒ **C** the number of one species found in a particular place

☒ **D** the niche of an organism

*(c) Succession takes place as a glacier retreats. As the ice melts, bare rock is exposed.

The graph shows the changes in the numbers of three different types of plant, alder, spruce and hemlock, with time after a glacier has retreated.



Explain the changes in the numbers of the three types of plant with time after the glacier has retreated.

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

(6)

(Total for Question 5 = 8 marks)

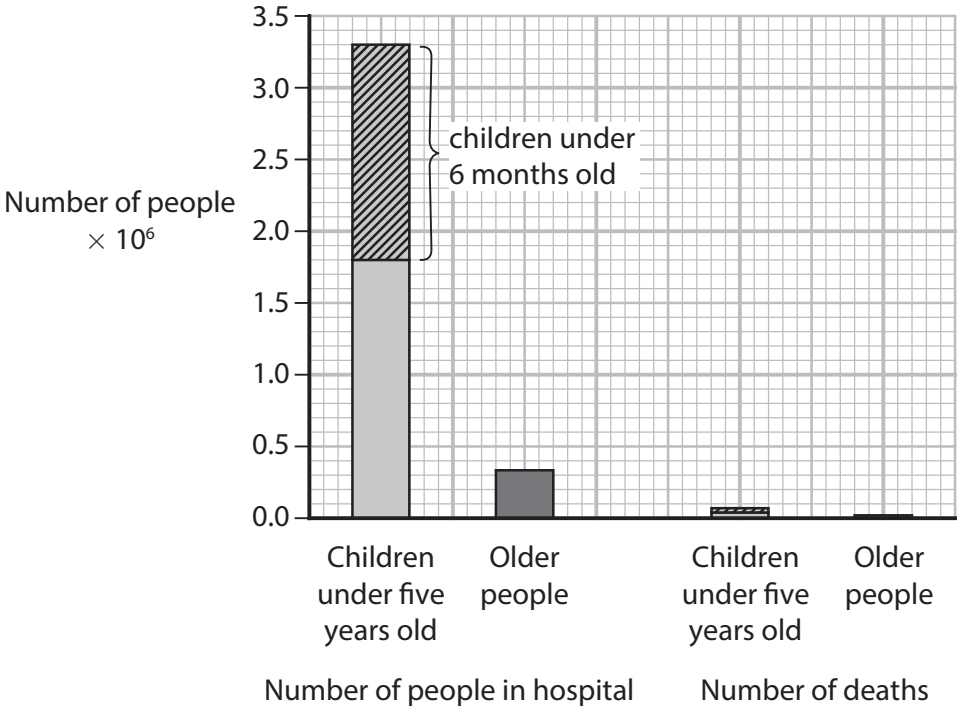
6 Respiratory syncytial virus (RSV) usually causes mild, cold-like symptoms from which most people recover.

Infection with RSV can be serious in young children and older people.

Currently, there are no approved vaccines against RSV, although there are some in clinical trials.

(a) The graph shows the number of people who had to go to hospital in one country in one year.

The graph also shows the number of deaths in children under five years old and in older people in the same country in that year.



(i) Which is the proportion of the children under five in hospital who are under 6 months old?

(1)

☒ **A** $\frac{5}{11}$

☒ **B** $\frac{6}{11}$

☒ **C** $\frac{5}{6}$

☒ **D** $\frac{6}{5}$

(ii) Which would be a more appropriate scale to use on the y-axis so that the range of values for the number of deaths can be seen clearly?

(1)

- ☒ **A** linear
- ☒ **B** logarithmic
- ☒ **C** standard deviation
- ☒ **D** standard form

(b) In one trial, people received a new vaccine against RSV.

The results showed that this vaccine protected against two subtypes of RSV.

Give **two** reasons why one vaccine can protect against two subtypes of RSV.

(2)

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(c) In another trial, pregnant women were given a vaccine against RSV.

This vaccine did not cross from the mother into the developing fetus.

(i) As a result of passive immunity, the babies of these pregnant women were born with high levels of antibodies against RSV.

Explain how passive immunity developed in these babies before they were born.

(5)

(ii) The scientists running this trial claimed that the vaccine was 85 % successful at protecting babies against RSV infections that required medical attention.

Describe how the data could have been collected to support this claim.

(3)

(Total for Question 6 = 12 marks)

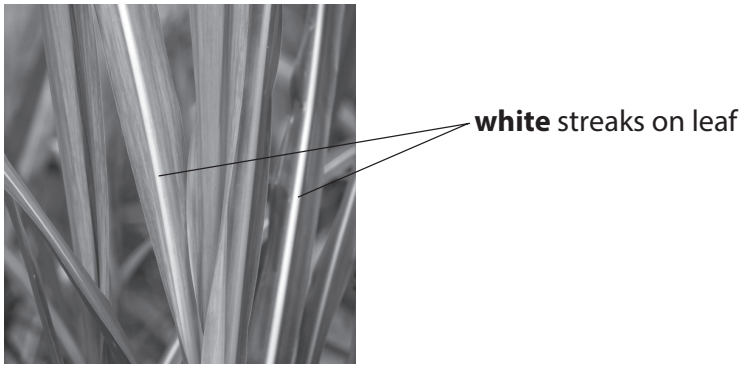
7 Leaf scald is a disease of sugarcane caused by bacteria.

These bacteria are found in the **xylem** and release chemicals, one of which is called albicidin.

Some of these chemicals stimulate the xylem vessels to produce a sticky gum.

Albicidin inhibits chloroplast development.

The photograph shows the appearance of part of a sugarcane leaf infected with these bacteria.



(Source: © Nigel Cattlin / Alamy Stock Photo)

(a) Explain how infection with these bacteria results in the death of the leaf cells and eventually the whole plant.

(4)

(b) Albicidin is an inhibitor of the enzyme DNA gyrase.

This enzyme is present in prokaryotic cells.

It binds to DNA and causes the DNA to supercoil, a process needed for cells to function properly.

(i) Describe **two** differences in the structure of DNA found in prokaryotic cells and the structure of DNA found in human cells.

(2)

(ii) Albicidin is being developed as an antibiotic to human pathogens.

Suggest why albicidin can be used as an antibiotic.

Use the information in the question to support your answer.

(3)

(iii) Explain the importance of developing new antibiotics, such as albicidin.

(2)

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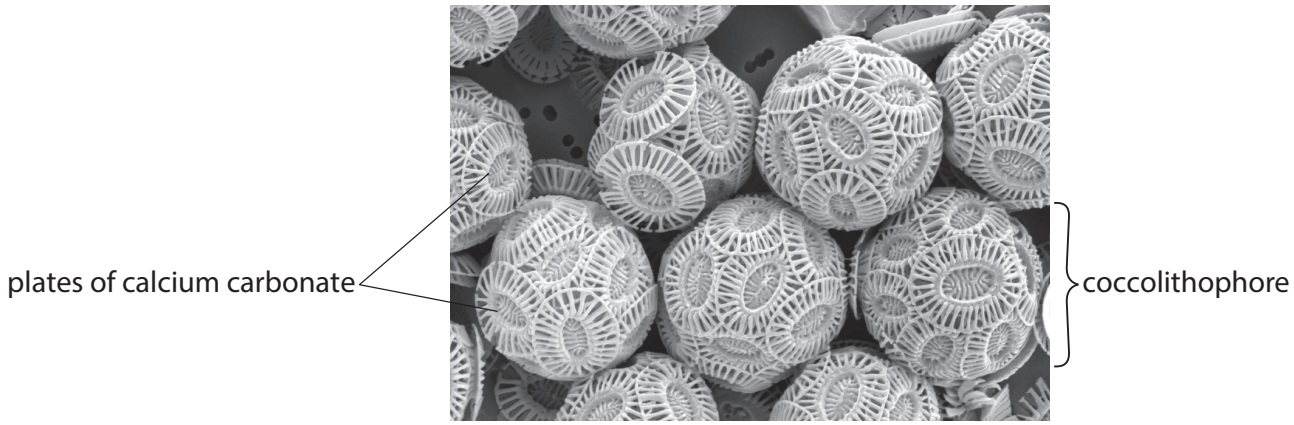
(Total for Question 7 = 11 marks)

8 Phytoplankton are single-celled eukaryotic organisms that can photosynthesise. They live in the oceans.

A coccolithophore is a phytoplankton enclosed by plates of calcium carbonate.

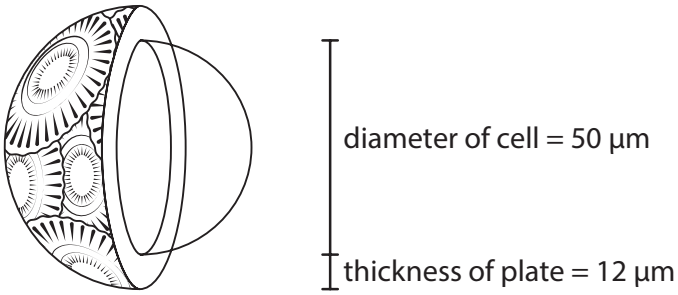
The photograph shows one species of coccolithophore, *E. huxleyi*.



(Source: © The Natural History Museum / Alamy Stock Photo)

(a) In one drop of seawater there are between 1 000 and 10 000 *E. huxleyi*.

The diagram shows the dimensions of one *E. huxleyi*.



Calculate the **total** volume of this *E. huxleyi*.

Give your answer in mm^3.

Use the formula:

$$V = \frac{4}{3}\pi r^3$$

(3)

Answer ..... mm^3

(b) Scientists think that *E. huxleyi* may have an impact on global warming and climate change.

E. huxleyi are continually producing the plates of calcium carbonate using the carbon dioxide they have taken in from the water.

(i) One *E. huxleyi* can contain 12 plates.

It takes 75 minutes to produce one plate.

Calculate the number of **hours** it takes one *E. huxleyi* to produce 12 plates.

Assume only one plate at a time is made.

(1)

Answer ..... hours

(ii) Some of the plates produced by *E. huxleyi* are shed into the ocean water.

Scientists have discovered that plates shed into the water can attach to other *E. huxleyi*.

Describe how scientists could show that plates shed into the water can attach to **other** *E. huxleyi* cells.

(3)

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*(iii) The plates can carry viruses that infect the *E. huxleyi*.

Infected *E. huxleyi* produce a glue that sticks many cells and plates together to form a 'marine snow'.

The marine snow is very dense and sinks to the bottom of the oceans.

Explain the possible impact that infected *E. huxleyi* could have on global warming and the effects of climate change.

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

(6)

(Total for Question 8 = 13 marks)

9 Light is essential for photosynthesis.

(a) Explain the role of light in the light-dependent reactions in photosynthesis.

(3)

(b) The photograph shows thale cress, a small flowering plant found in Europe, Asia and Africa.

(Source: © blickwinkel / Alamy Stock Photo)

The effect of wavelength of light on thale cress was investigated.

Three groups of plants were treated with a different wavelength of light.

One group of plants was treated with blue light, one group with amber light and one group with red light.

The following were measured:

- rate of photosynthesis
- leaf biomass
- pigment content of the leaves
- changes in transcription of genes in the leaves.

Another group of these plants had a control light shone on them.

(i) Which would have been the most appropriate light to use as a positive control?

(1)

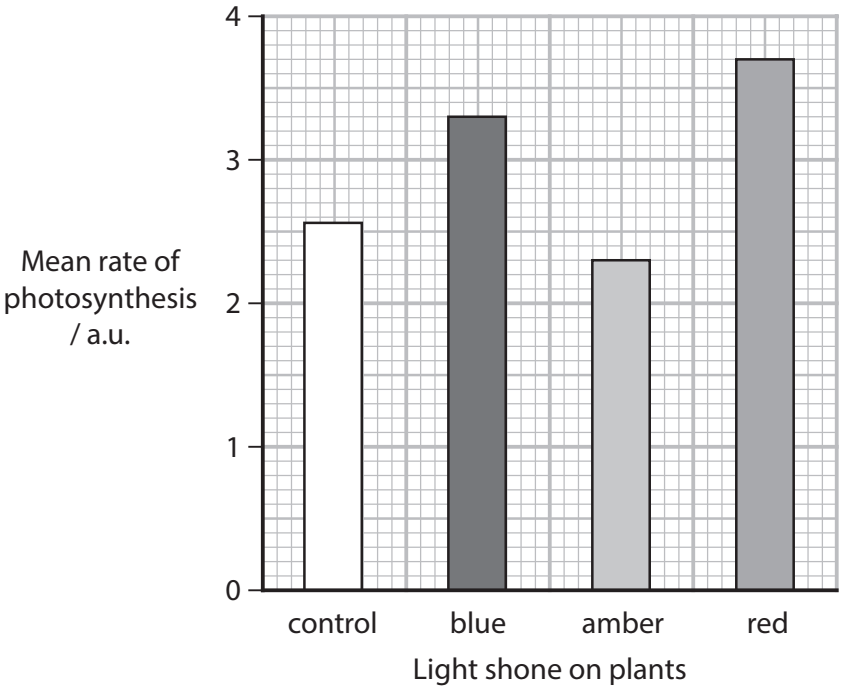
☒ **A** green

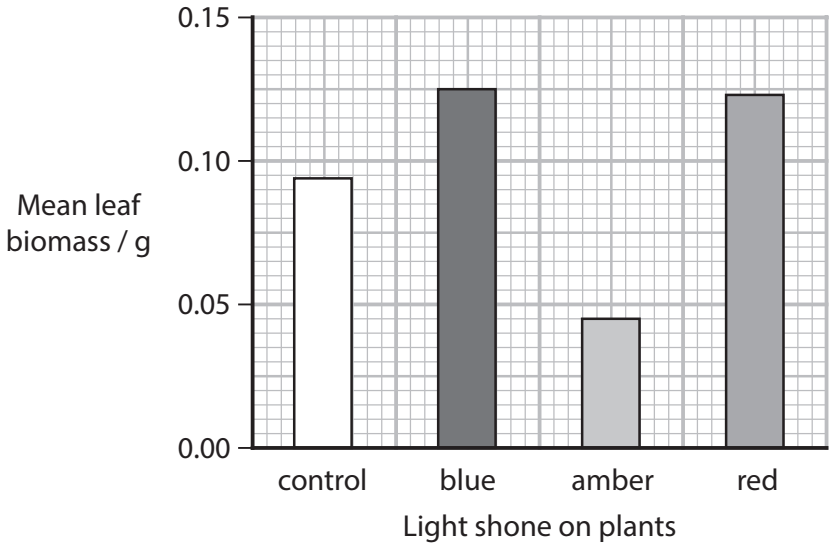
☒ **B** mixture of green, blue and red light

☒ **C** ultraviolet

☒ **D** sunlight

(ii) The graphs show the results for the mean rate of photosynthesis and mean leaf biomass.





Explain the results shown in these graphs.

(4)

(iii) The table shows the results for the pigment content of the leaves.

Pigment	Mass of pigment / µg per g of leaf biomass			
	Control light	Blue light	Amber light	Red light
Chlorophyll a	382	412	315	441
Chlorophyll b	148	148	125	133
Anthocyanins	78	79	71	72

Describe **three** conclusions that can be made from these results.

(3)

(iv) Plants treated with blue light had an increase in photosynthesis caused by an increase in the transcription of some genes in the leaves.

Suggest **two** genes whose transcription could be increased in the presence of blue light.

Give a reason for suggesting each of these genes.

(3)

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(Total for Question 9 = 14 marks)

TOTAL FOR PAPER = 90 MARKS