

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 9 January 2025

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 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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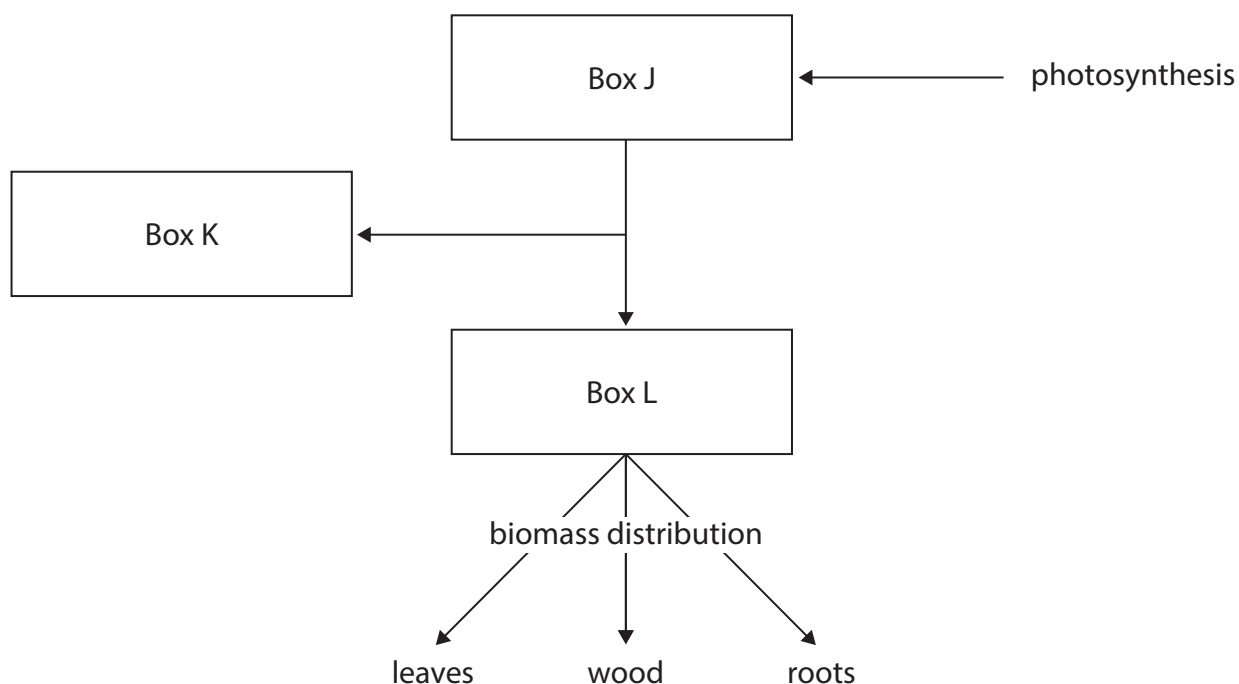



Pearson

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) Which row of the table identifies the box that represents net primary productivity (NPP), the box that represents gross primary productivity (GPP) and the box that represents respiration (R)?

(1)

	Box J	Box K	Box L
☐ A	NPP	R	GPP
☐ B	GPP	NPP	R
☐ C	GPP	R	NPP
☐ D	R	GPP	NPP



(b) Which are suitable units for NPP?

(1)

- ☐ **A** kJ m yr^{-1}
- ☐ **B** $\text{kJ m}^{-1} \text{yr}^{-2}$
- ☐ **C** $\text{kJ m}^{-2} \text{yr}^2$
- ☐ **D** $\text{kJ m}^{-2} \text{yr}^{-1}$

(c) The biomass distributed to the leaves, wood and roots of the trees in this forest was 12 500 a.u.

- (i) The biomass was distributed 34% to the leaves, 37% to the roots and the rest to the wood of the trees.

Calculate how many units of biomass were distributed to the wood of these trees.

(1)

Answer a.u.

- (ii) Which row of the table shows what can be found in the biomass of leaves and roots of trees?

(1)

	Leaves	Roots
☐ A	chlorophyll and starch	chlorophyll and protein
☐ B	chlorophyll and glycogen	lignin and protein
☐ C	chlorophyll and starch	starch and protein
☐ D	glycogen and cellulose	cellulose and protein

(d) Forests are examples of ecosystems.

State what is meant by the term **ecosystem**.

(1)

(Total for Question 1 = 5 marks)



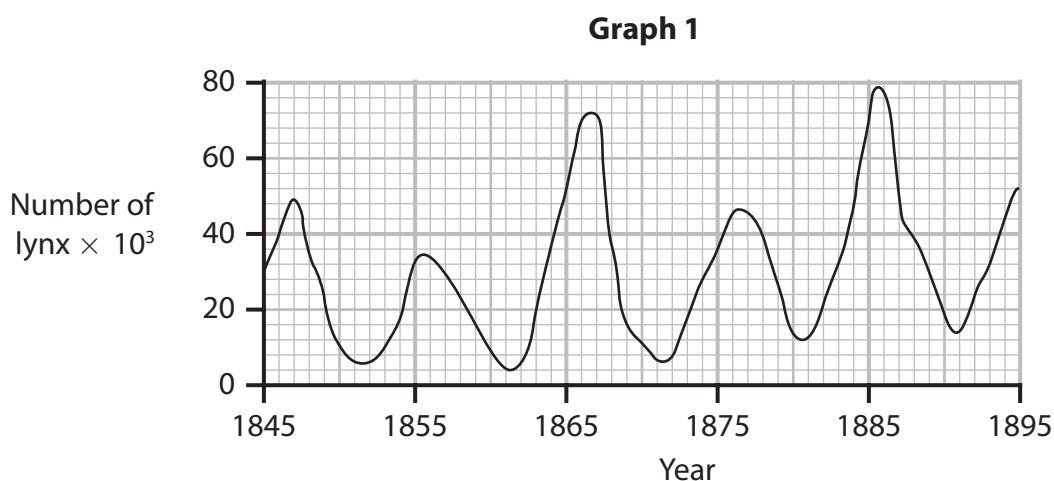
3 The photograph shows a Canadian lynx and a hare.



(Source: © FLPA / Alamy Stock Photo)

The lynx is a type of cat and is a predator of the hare.

Graph 1 shows the changes in the number of lynx from 1845 to 1895.



(a) (i) In 1863, there were 150 000 hares.

Calculate how many times more hares there were than lynx.

(1)

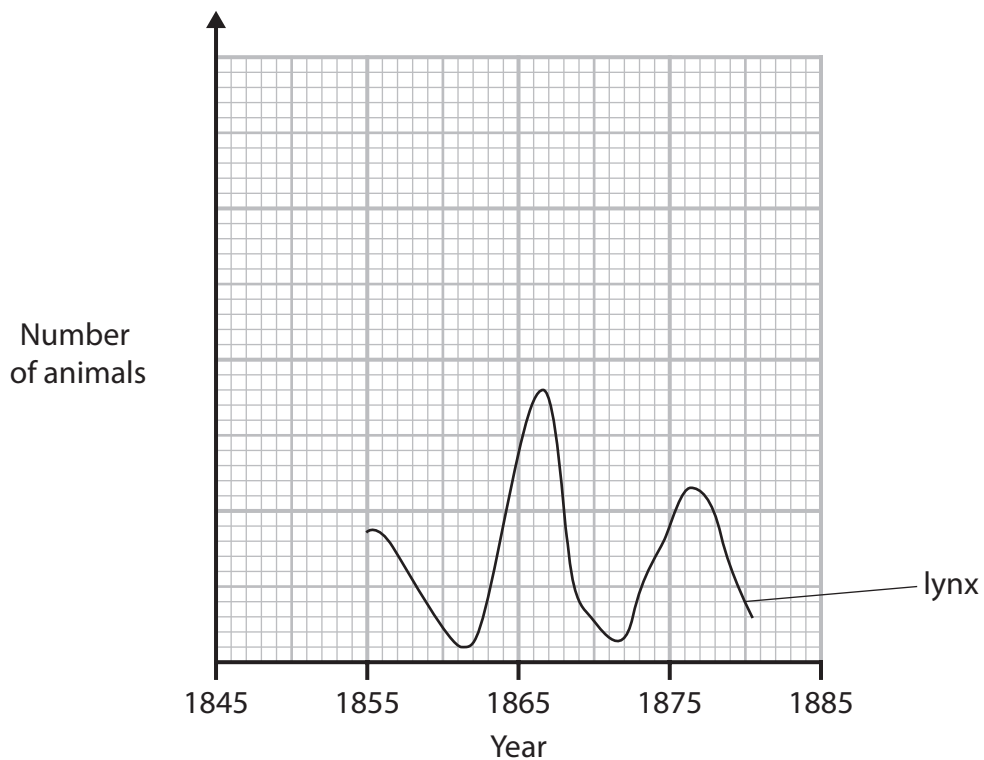
Answer



(ii) Graph 2 shows part of graph 1.

Sketch a line on graph 2 to show the likely changes in the numbers of hares from 1855 to 1880.

Graph 2



(2)

(iii) Explain the changes in the numbers of lynx and hares.

(3)

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- (b) In many ecosystems, the relationship between one predator species and one prey species is less predictable.

Suggest **two** reasons why this relationship is not always predictable.

(2)

(Total for Question 3 = 8 marks)



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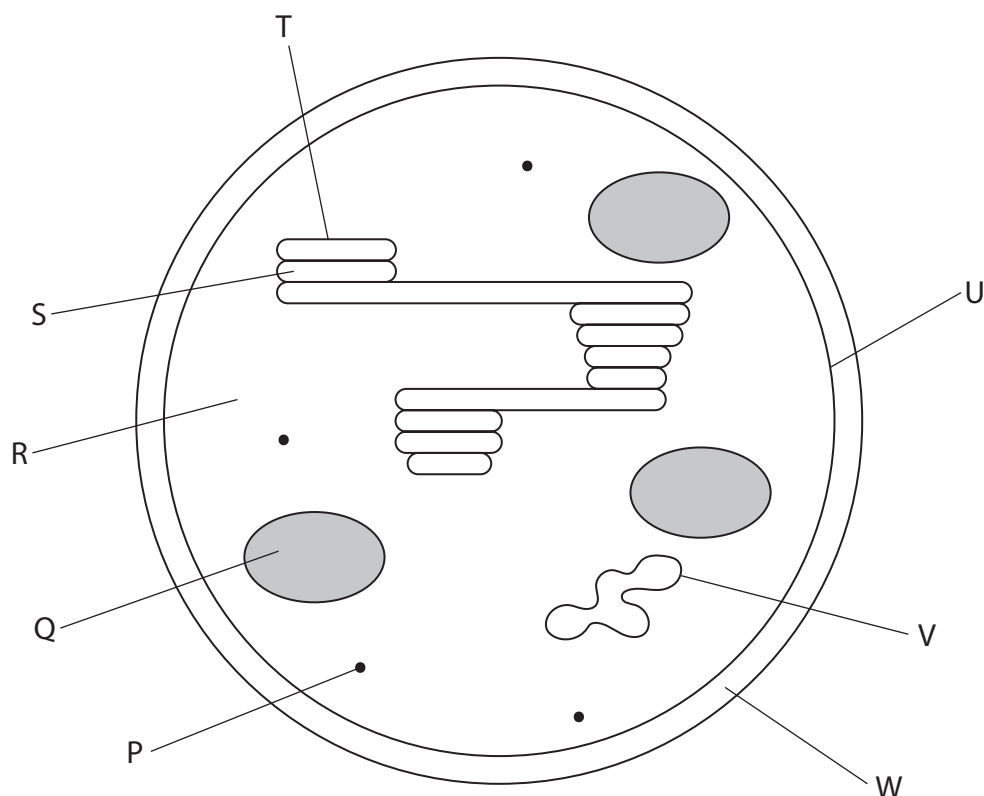
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4 The structure of a chloroplast is related to its role in photosynthesis.

(a) The diagram shows a chloroplast.



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

(1)

	Light-dependent reactions	Light-independent reactions
☐ A	R	S
☐ B	S	T
☐ C	T	R
☐ D	T	S

(ii) Where do hydrogen ions (protons) accumulate?

(1)

- ☐ **A** Q
- ☐ **B** R
- ☐ **C** S
- ☐ **D** W

(iii) The diagram is 16 000 times larger than an actual chloroplast.

Calculate the surface area of the actual chloroplast.

Use the formula:

$$\text{Surface area} = 4 \pi r^2$$

Give your answer as a whole number in μm^2 .

(3)

Answer μm^2

(iv) Explain the advantages of thylakoids in a chloroplast having a large surface area.

(2)

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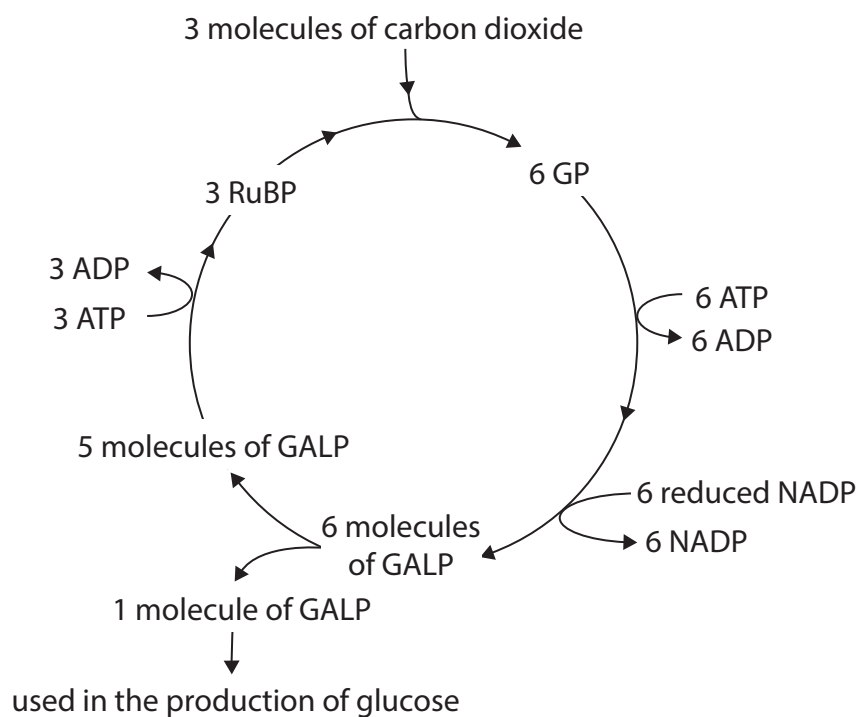
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(b) In the light-dependent reactions, ATP and reduced NADP are generated.

These products are used in the light-independent reactions.

The diagram shows some of the light-independent reactions.



(i) Which describes how ATP is generated in the light-dependent reactions?

(1)

- ☐ **A** by hydrolysis of ADP releasing energy
- ☐ **B** by hydrolysis of ADP requiring energy
- ☐ **C** by phosphorylation of ADP releasing energy
- ☐ **D** by phosphorylation of ADP requiring energy

- (ii) When one molecule of glucose is made in the light-independent reactions, the ratio of ATP used to reduced NADP used is 1.5 : 1.

Show how this ratio can be calculated, using the information in the diagram.

(2)

- (iii) Explain why only a small proportion of the GALP produced is used to make the glucose.

(2)

(Total for Question 4 = 12 marks)



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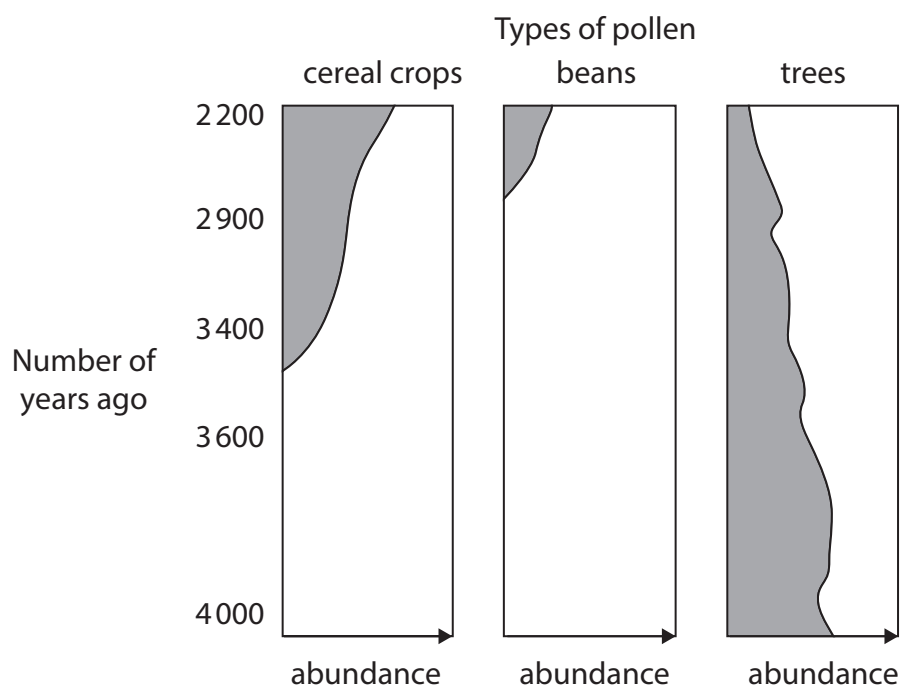


5 Peat bogs are waterlogged areas with low pH.

- (a) Pollen grains in peat bogs can be used to determine the types of plants that grew in a particular area in the past.

The diagram shows the types of pollen (shaded areas) found in a site in New Mexico.

Cereal crops and beans are sources of food for humans and their animals.



Explain why the abundance of these types of pollen changes, as shown in this diagram.

(3)

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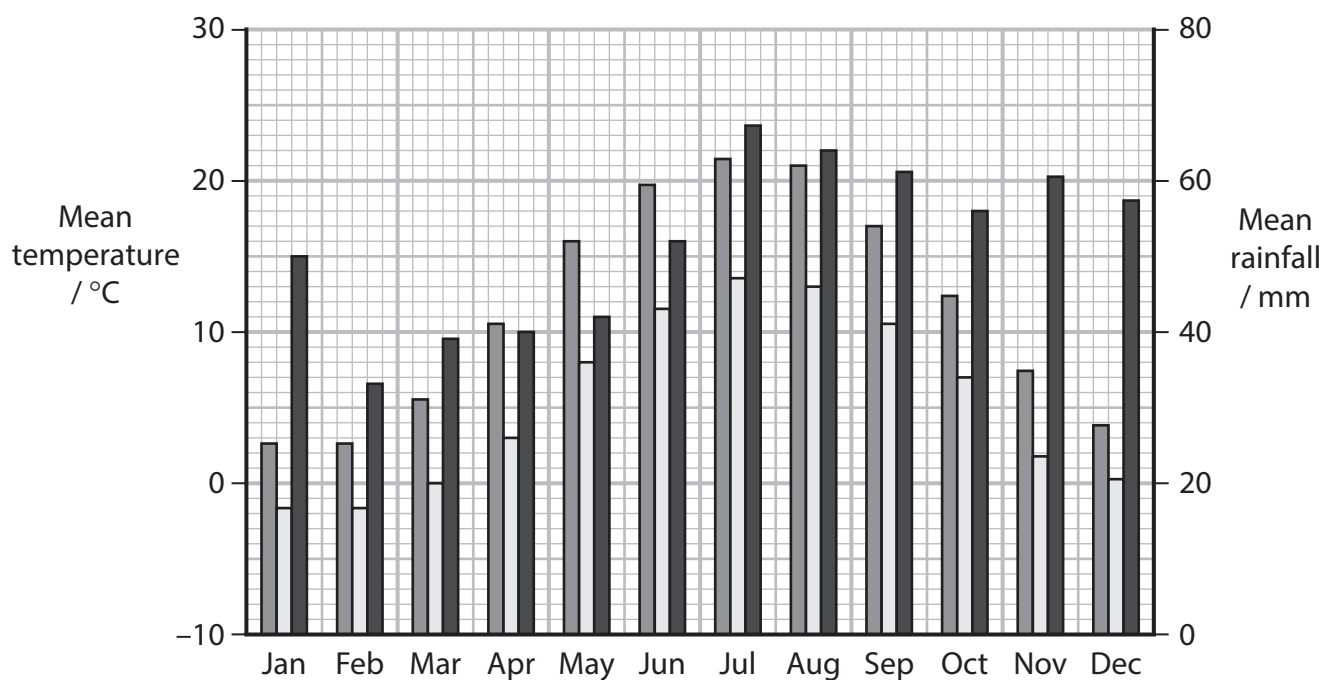
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- (b) In 1950, the preserved body of a man was found in a peat bog in Denmark. The man died over 2 000 years ago.

The graph shows the maximum and minimum mean temperature and the mean rainfall in Denmark.

Key:

- max temperature
- min temperature
- rainfall



- (i) Which is the difference between the maximum and minimum temperatures in May?

(1)

- ☐ **A** 5°C
- ☐ **B** 8°C
- ☐ **C** 10°C
- ☐ **D** 16°C

(ii) Explain how the conditions in the peat bog preserved the body of this man.

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

(5)

(Total for Question 5 = 9 marks)

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- 6 The development of antibiotic resistance in bacteria is a global concern.

A new type of drug is being developed against bacteria.

This drug has a number of effects on bacteria including making the bacteria more susceptible to antibiotics.

This drug is not an antibiotic.

- (a) State the meaning of the term **antibiotic**.

(1)

- (b) In 2019, 1.27 million deaths were due to antibiotic resistance.

It is estimated that this will rise to 10 million per year in 2050.

Which is the percentage increase in the number of deaths due to antibiotic resistance?

(1)

- ☐ **A** 13%
- ☐ **B** 87%
- ☐ **C** 687%
- ☐ **D** 787%

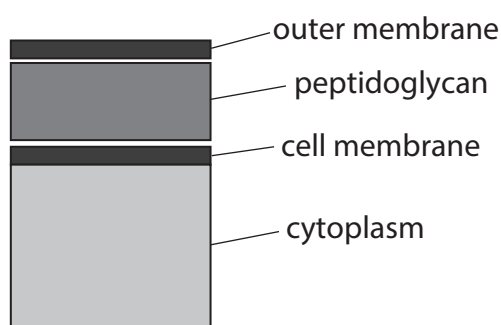
- (c) Explain why it is important that these new types of drugs are developed.

(2)



- (d) The diagram shows the structure of the cell wall of a bacterial cell. It also shows the cell membrane.

The molecules in the outer membrane vary in different types of bacteria.



When bacteria were treated with the new drug, together with antibiotics, the antibiotics were effective at lower doses.

The new drug attached to the outer membrane.

Suggest why the new drug resulted in the antibiotics being effective at lower doses.

(2)

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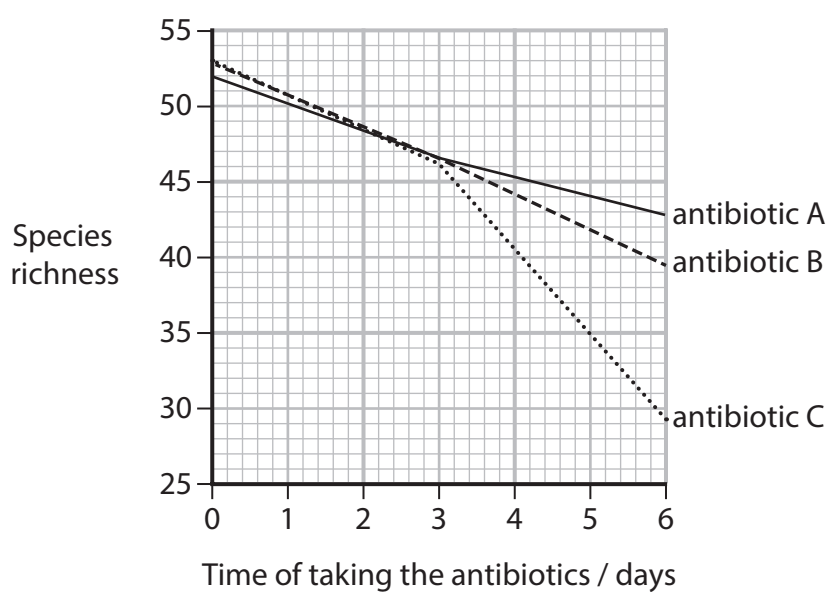
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- (e) The graph shows the effects of three antibiotics on the species richness of gut flora.



- (i) Describe **two** conclusions that can be made about the effects of these three antibiotics on the species richness of gut flora.

(2)

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- (ii) Explain the advantages of adding this new drug when treating a bacterial infection with antibiotic C.

(3)

(Total for Question 6 = 11 marks)

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7 Carbon dioxide, methane and nitrous oxide are greenhouse gases.

Nitrous oxide is produced by bacteria in the soil.

- (a) State **one** anthropogenic source of carbon dioxide and **one** different anthropogenic source of methane.

(1)

Carbon dioxide

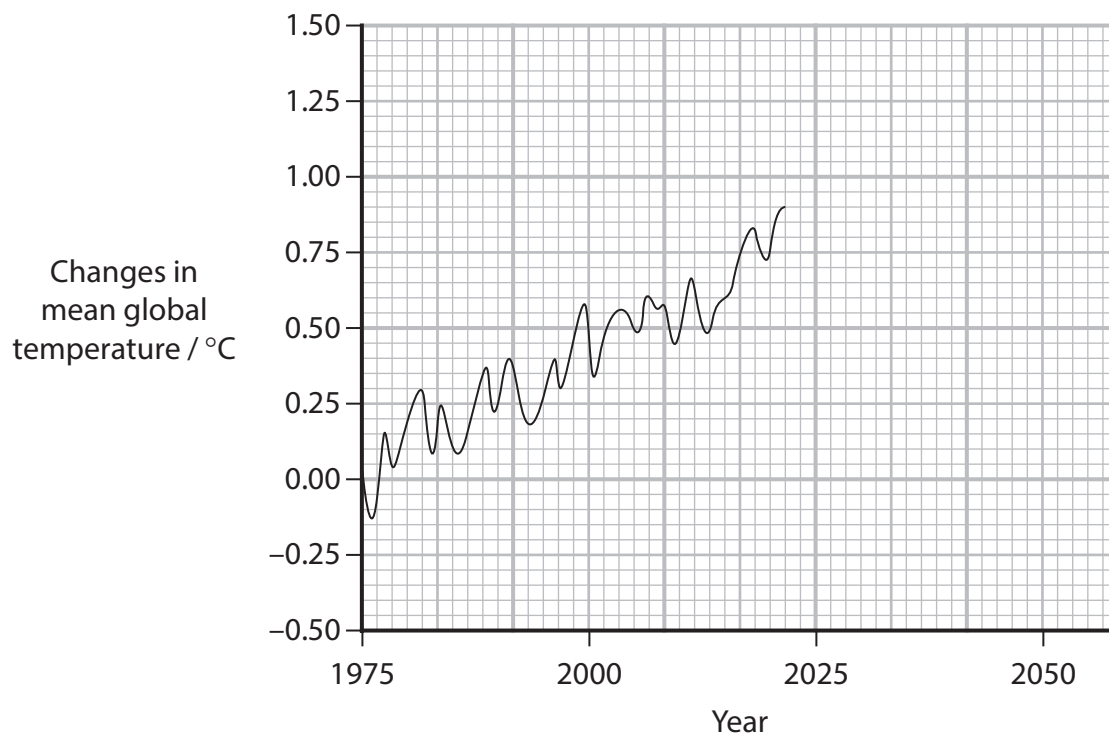
Methane

- (b) Describe how greenhouse gases cause global warming.

(3)



(c) The graph shows the changes in mean global temperature from 1975 to 2023.



Predict the change in the mean global temperature in 2050 from the data in this graph.

(1)

Answer °C

(d) The greenhouse gases have different warming potentials (WP).

Over a 100-year timescale:

- one tonne of methane would generate 28 times the WP of one tonne of carbon dioxide
- one tonne of nitrous oxide would generate 265 times the WP of one tonne of carbon dioxide.

(i) Calculate the ratio of the WP of nitrous oxide to the WP of methane.

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

(1)

Answer : 1



- (ii) Carbon dioxide can last in the atmosphere for thousands of years. Methane lasts for about 12 years and nitrous oxide for about 121 years.

Discuss the implications of this data and the WPs when scientists are deciding how to tackle climate change.

(3)

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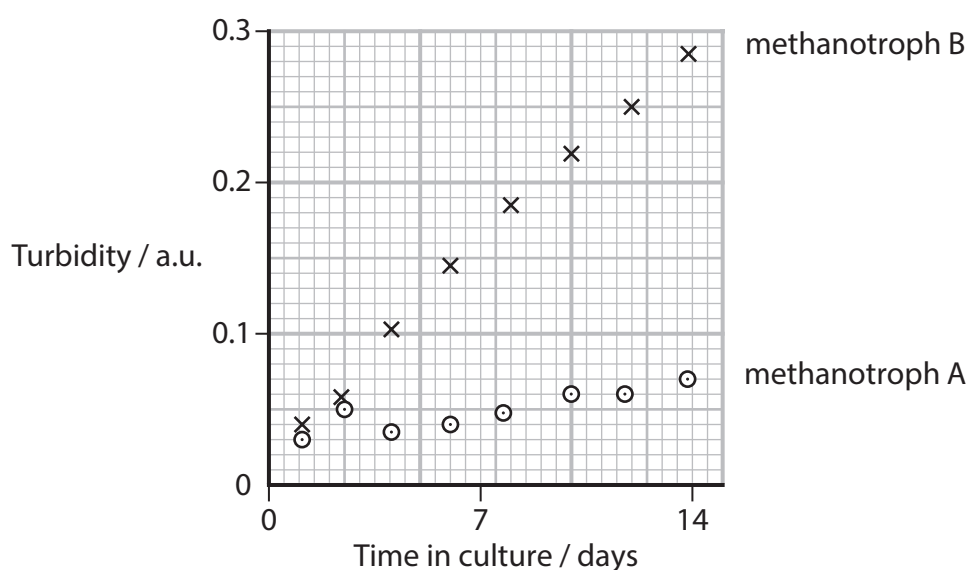
- (e) Methanotrophs are a group of bacteria that can absorb methane and use it as a source of energy and as a material to convert into biomass.

Most methanotrophs grow best in methane concentrations of 5 000 a.u. to 10 000 a.u. This is greater than the methane concentration in the atmosphere.

Scientists wanted to identify the methanotrophs that could grow at lower methane concentrations, as these could help reduce the levels of methane in the atmosphere.

- (i) The graph shows the growth curve for two types of methanotrophs grown in a methane concentration of 500 a.u.

The increase in turbidity of the culture was used to assess the growth of the methanotrophs.



Explain how this graph can be used to compare the growth rate of these two types of methanotrophs.

(2)

- (ii) Suggest why low methane concentrations are not able to support the growth of some methanotrophs, such as methanotroph A.

(1)

- (iii) Suggest why the scientists analysed the cultures of methanotroph B for the production of nitrous oxide and carbon dioxide.

(2)

(Total for Question 7 = 14 marks)

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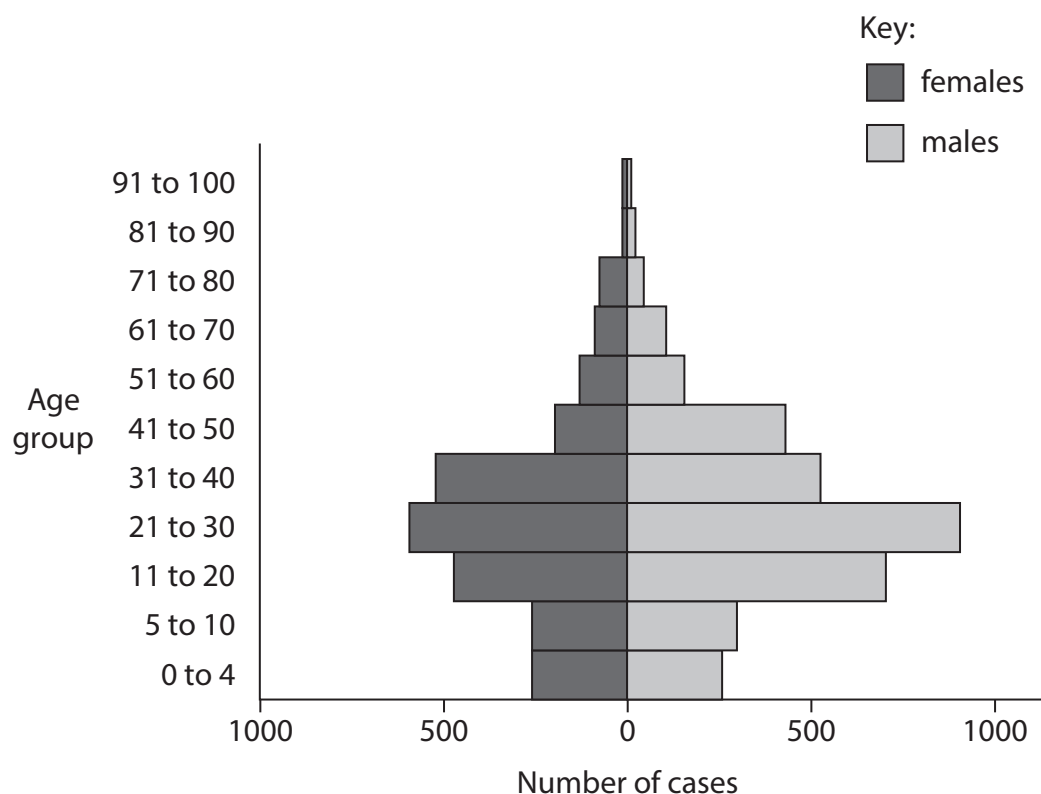
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- 8 Since the early 2020s, the number of cholera cases and deaths due to this disease are high as the world is facing its seventh pandemic of cholera.

Cholera is caused by ingestion of food or water contaminated with the bacterium *Vibrio cholerae*.

- (a) The diagram shows the distribution of cholera cases by age group and sex at birth in Malawi, in the first nine months of 2022.



Describe **two** conclusions that can be made about the distribution of cholera cases by age group and sex.

(2)

(b) *Vibrio cholerae* produce a toxin made up of several subunits.

Genetically modified rice plants are grown that produce rice grains that contain one of these subunits. This subunit acts as a vaccine.

The rice grains were harvested and ground into a powder that can be eaten.

In a clinical trial, three groups of people were given one of three doses of this rice powder vaccine.

Another group of people were given a placebo.

The change in the levels of antibody against the subunit in their blood was measured over an eight-week period.

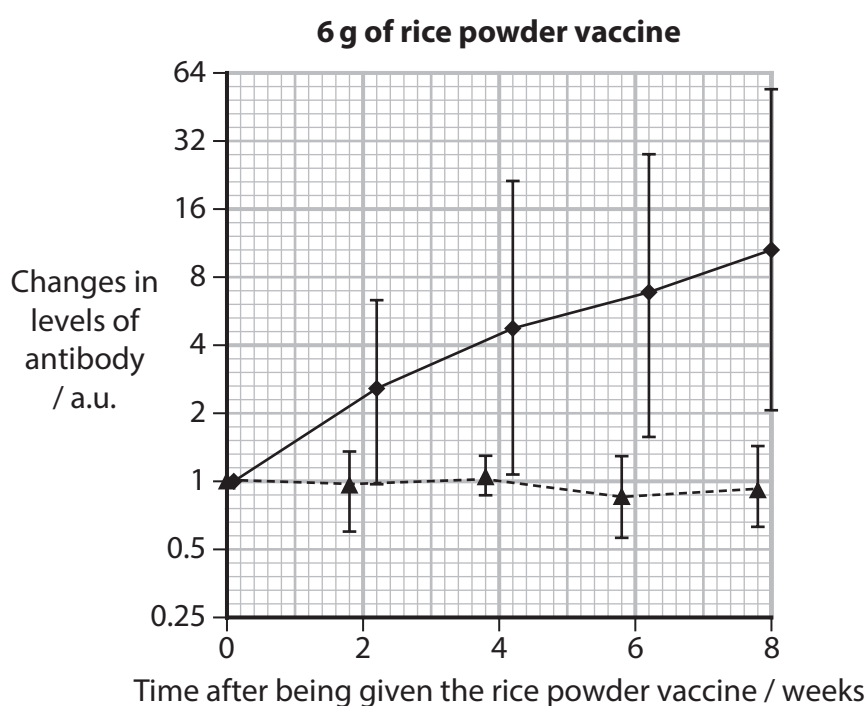
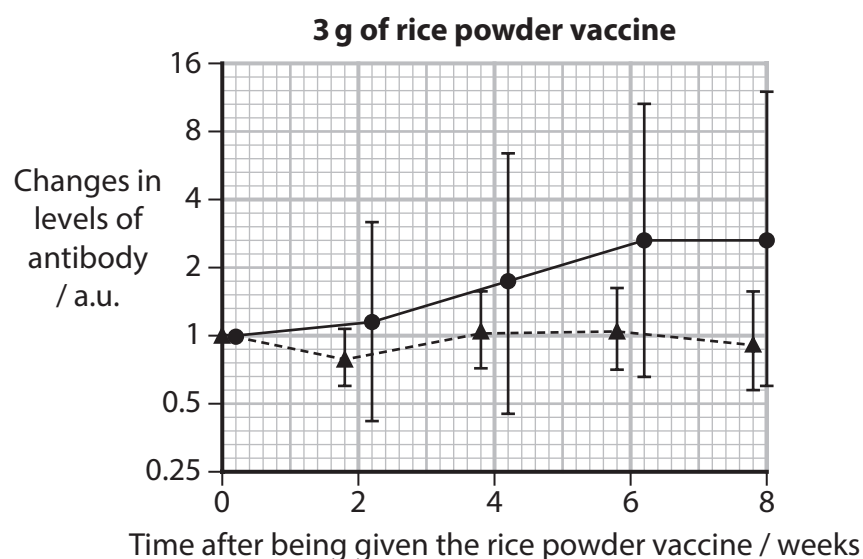
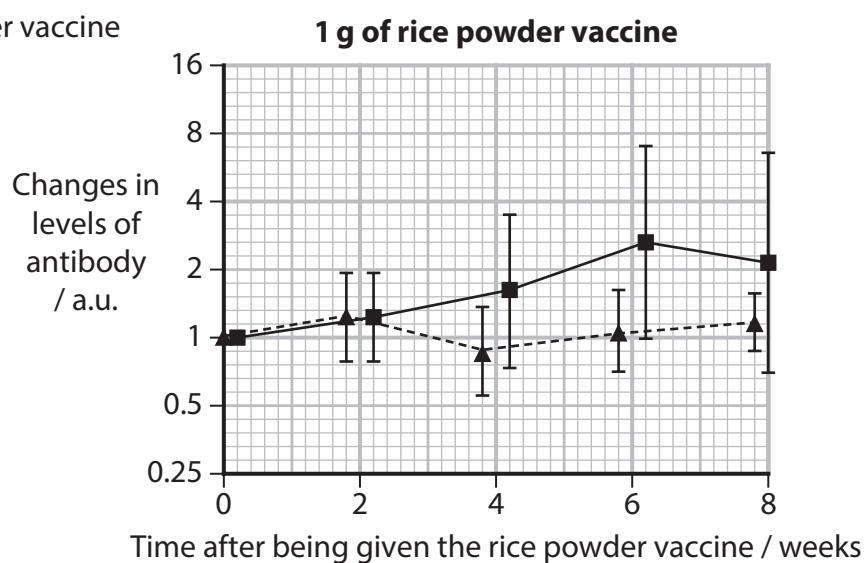
The graphs show the data obtained.



Key:

— rice powder vaccine

----- placebo



- (i) Describe suitable placebos for use in this clinical trial.

Use the information in the question to support your answer.

(2)

- (ii) The scientists running the trial concluded that a dose of 6 g of rice powder vaccine was needed to stimulate an immune response.

State why they came to this conclusion.

(1)

- (iii) The scientists found that these antibodies also bind to different toxins produced by another type of bacteria.

Explain why these antibodies, produced as a result of the rice powder vaccine, could bind to different toxins.

(2)

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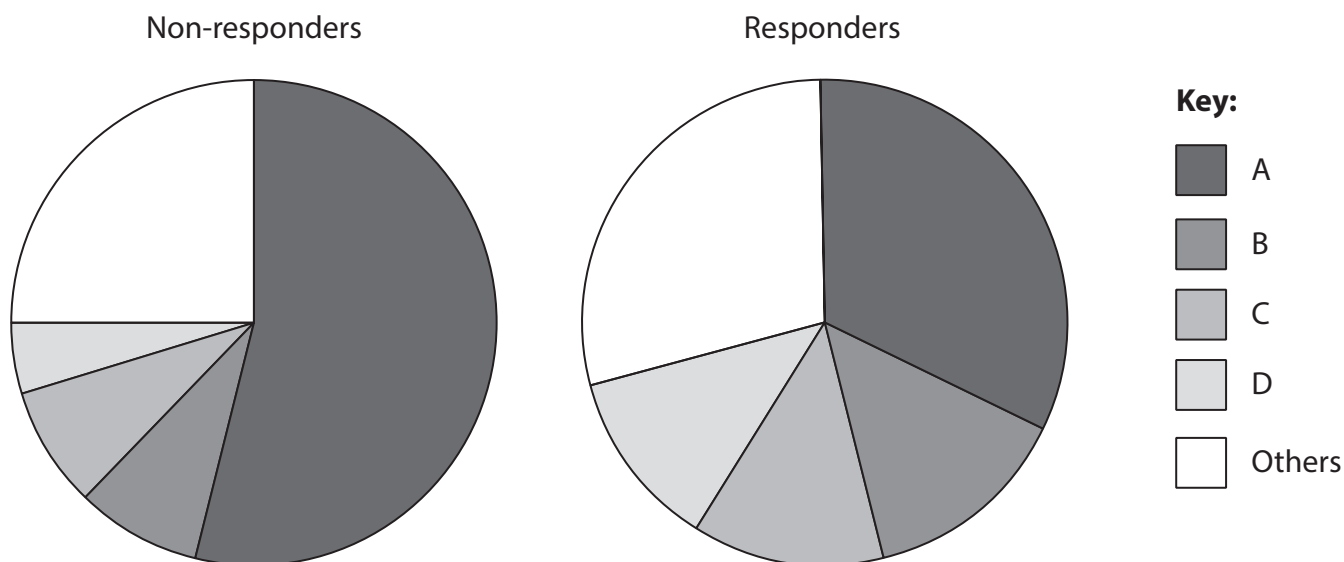
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- (iv) Some people in the clinical trial did not respond to the rice powder vaccine.

The scientists determined the proportions of different types of bacteria (A, B, C, D and others) in the gut flora of these non-responders with those of the responders.

The charts show the results.



Compare and contrast the results for the non-responders and the responders.

(3)

- (v) Give **two** limitations when using this data to determine if the type of gut flora could cause a person to be a non-responder to the vaccine.

(2)

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(Total for Question 8 = 12 marks)

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- 9** The human genome contains sequences of DNA called endogenous retroviruses (ERVs).

These ERVs result from infection with retroviruses.

Retroviruses are a group of RNA viruses that have a replication cycle similar to that of human immunodeficiency virus (HIV).

This replication cycle results in latency.

Some of the ERVs in the human genome have been present for millions of years, because the ERVs are passed down through many generations.

- *(a) Explain how retroviruses introduce ERVs into human cells and how the ancient ERVs can be transmitted to offspring in families.

(6)

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(b) One group of ERVs code for viral envelope proteins.

In normal cells, these proteins are not synthesised due to epigenetic regulation.

Explain how epigenetic regulation prevents the synthesis of these viral envelope proteins.

(3)



- (c) In cancer cells, the viral envelope proteins are synthesised and incorporated into the cancer cell membrane.

Explain why these viral envelope proteins could be used in a vaccine against cancer cells.

Use the information in the question to support your answer.

(5)

(Total for Question 9 = 14 marks)

TOTAL FOR PAPER = 90 MARKS

