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 ▶

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

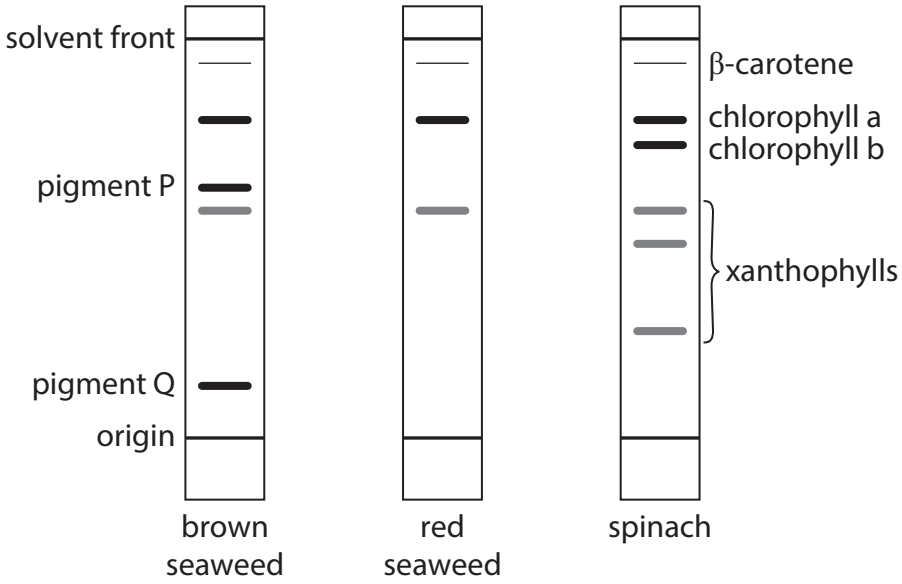
☒ **B** dendrochronology

☒ **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.

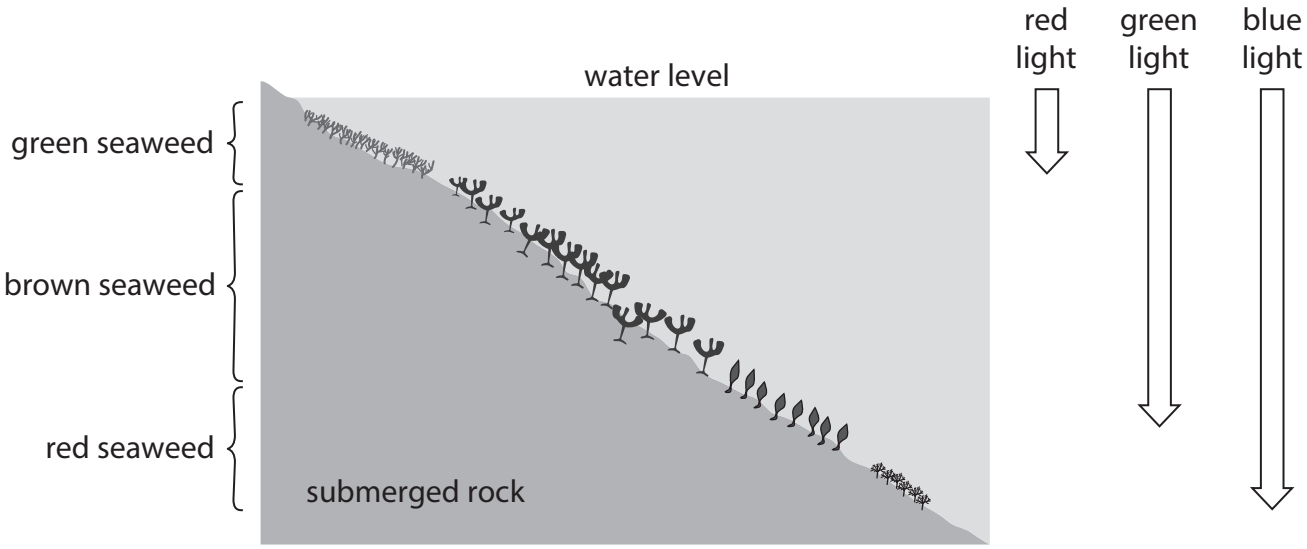
(3)

(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)

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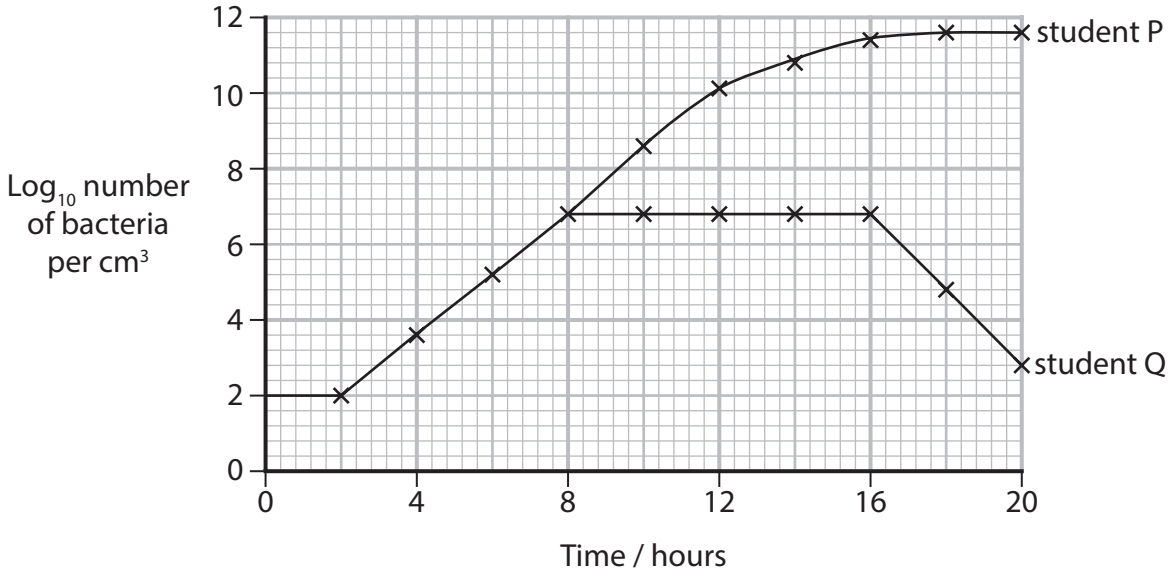
2 Two students, student P and student Q, each cultured bacteria in a liquid medium for 20 hours.

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)

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(ii) Explain **one** aseptic technique that should be used when culturing bacteria.

(2)

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(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

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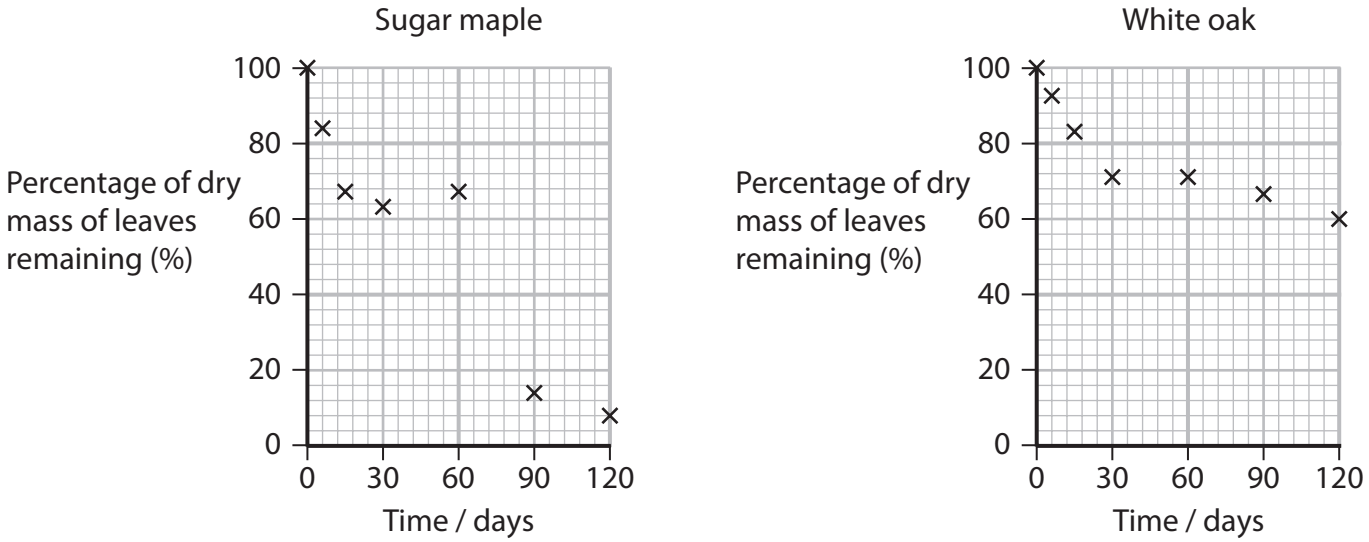
(b) The graphs show the extent to which two types of leaf decomposed in 120 days.



(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 .....

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(iii) Describe **two** conclusions that can be made about the decomposition of sugar maple leaves compared with the white oak leaves.

(2)

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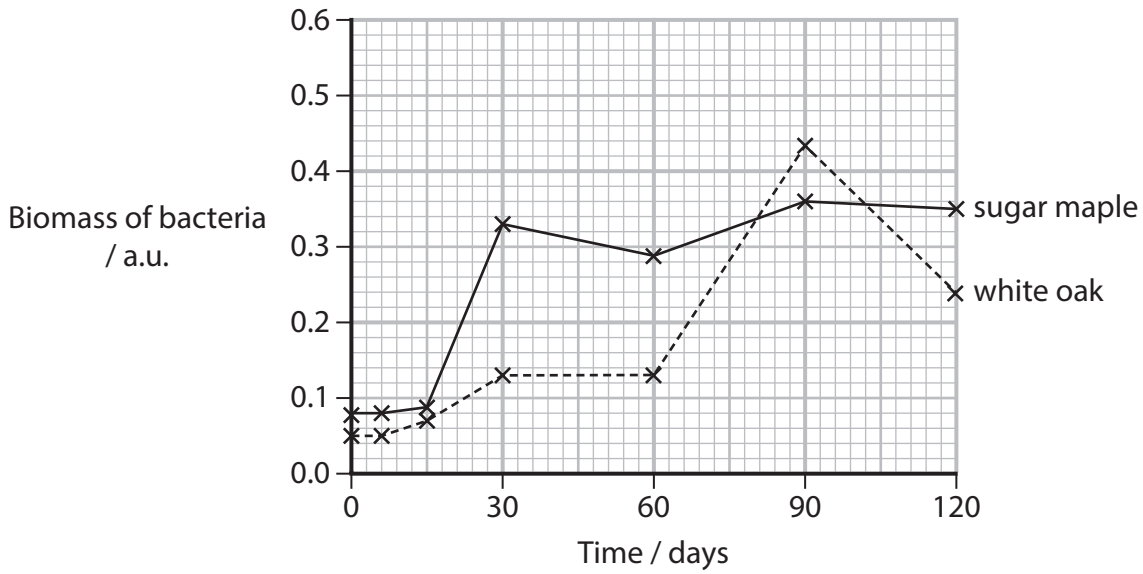
(c) The biomass of bacteria on the two types of leaf during the 120-day period was determined.

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)

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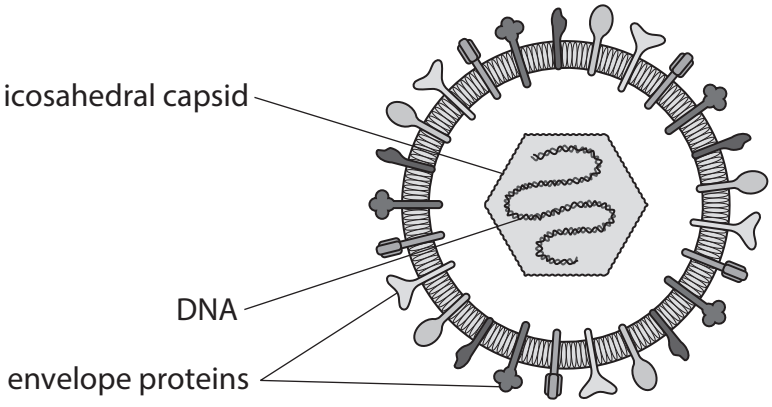
5 Herpes simplex is a virus that causes sores around the nose and mouth.

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)

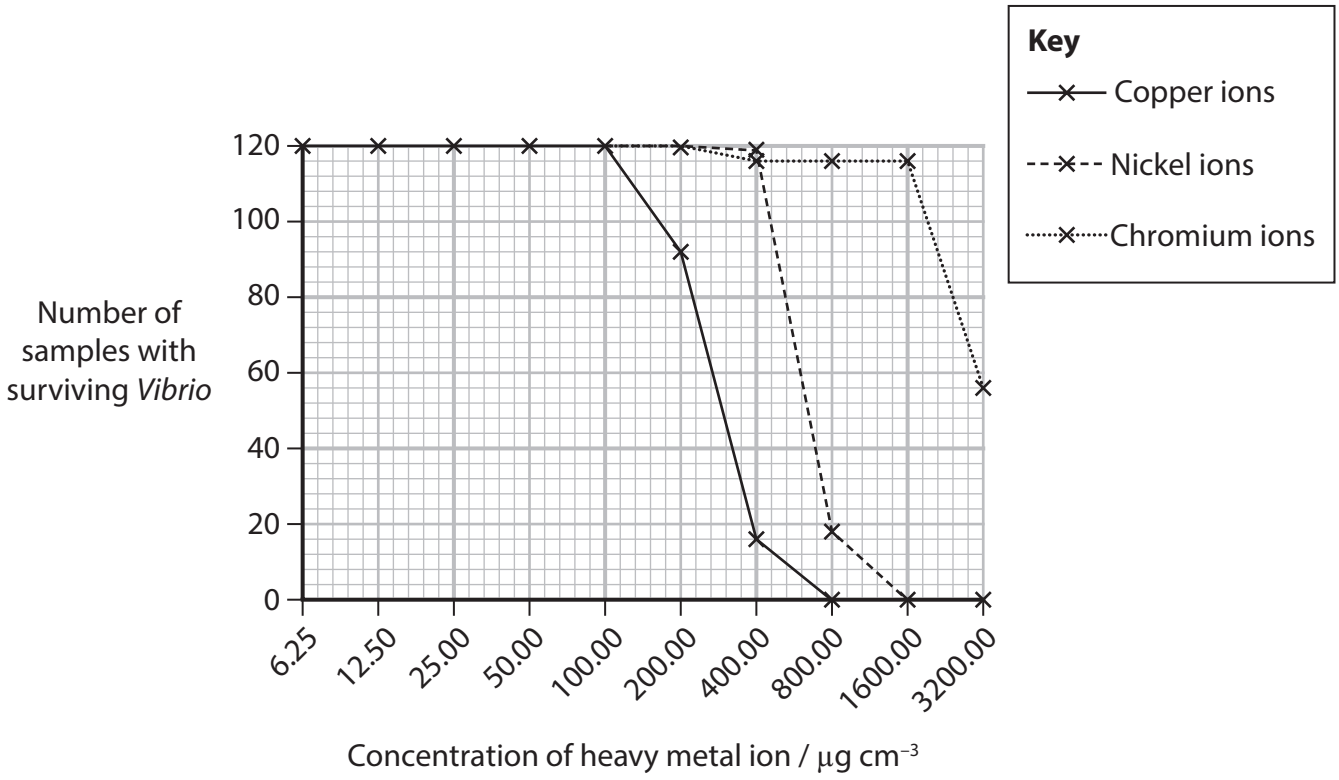
☒ **A** 5.12

☒ **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)

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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)

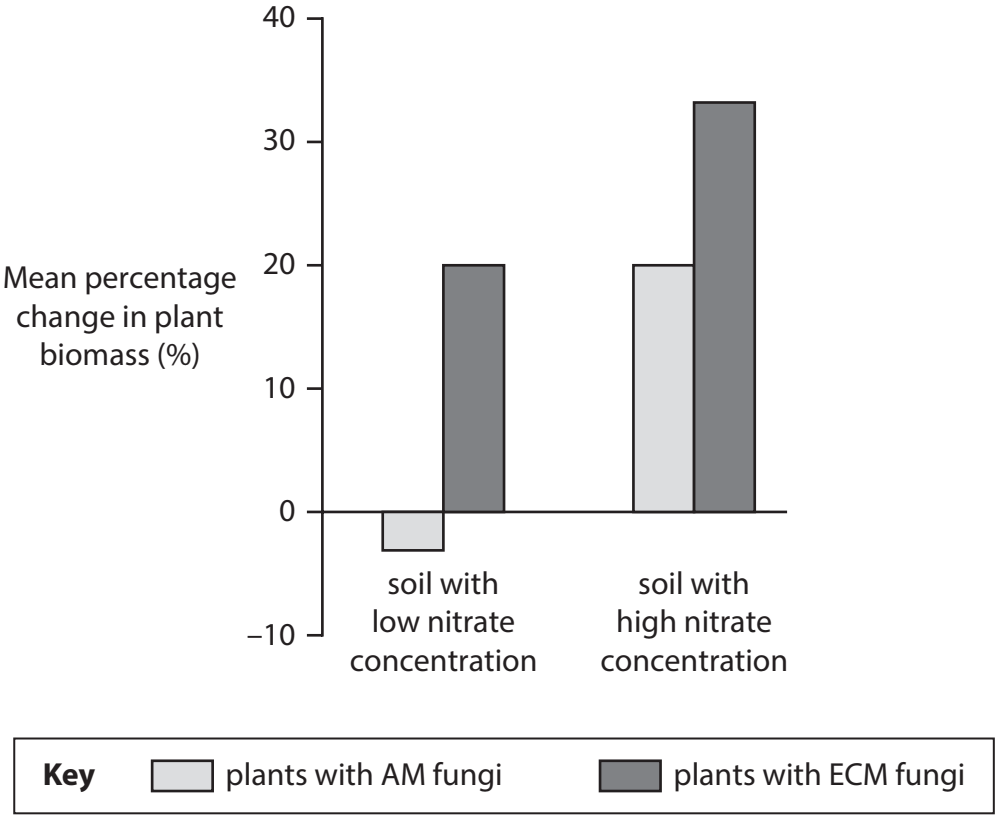
(d) The roots of most land plants are associated with microscopic fungi called mycorrhizal fungi.

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.

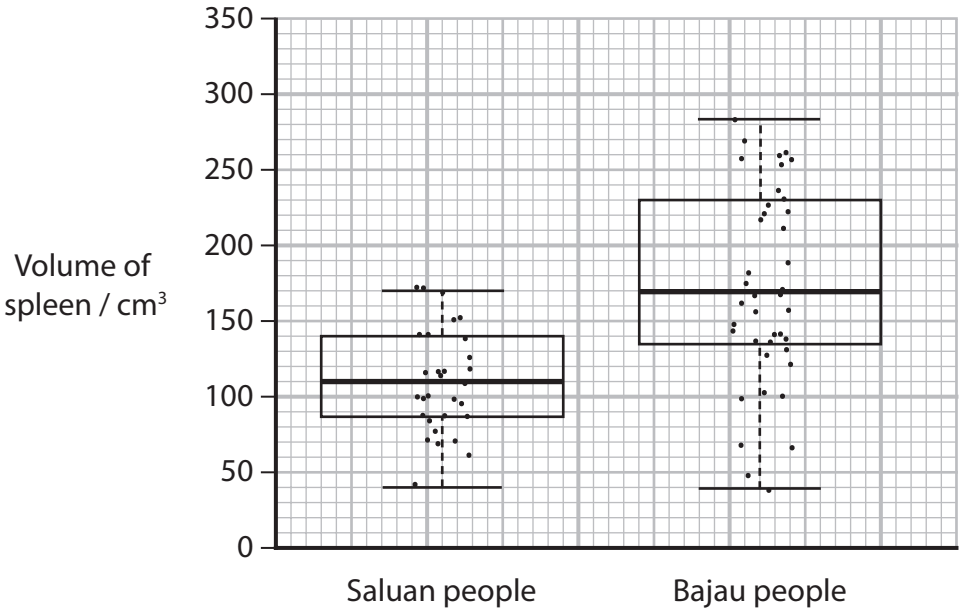
(a) Animals, such as seals, that spend much of their time underwater have very large spleens.

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

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