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 23 October 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 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 People can be infected by a number of different pathogens.

(a) Which of the following statements are correct for pathogens?

(1)

1. They cause disease.
2. They are bacteria only.
3. They are found in the blood only.

☒ **A** 1 only

☒ **B** 1 and 2 only

☒ **C** 2 and 3 only

☒ **D** 1, 2 and 3

(b) Pathogens can enter the digestive system in contaminated food or water.

(i) Name **two** routes of infection by pathogens, other than through the digestive system.

(1)

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(ii) Name **two** barriers that help to protect the body from infection by pathogens.

(1)

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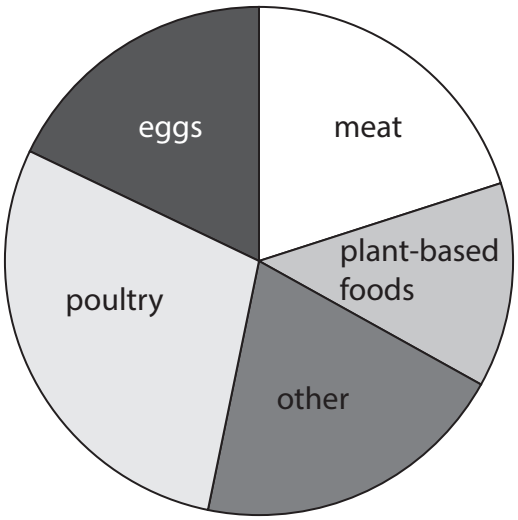
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(iii) *Salmonella* are bacteria that can cause food poisoning.

The chart shows the proportions of contaminated foods responsible for food poisoning caused by *Salmonella* in the European Union.



The inside angle of the section representing poultry is 104°.

Which percentage, to **three** significant figures, is caused by contaminated poultry?

(1)

☒ **A** 28.0%

☒ **B** 28.8%

☒ **C** 28.9%

☒ **D** 29%

(iv) A group of people ate some food contaminated with *Salmonella*.

The table gives the time after eating the meal that people showed the first signs of food poisoning.

Time after eating the meal / hours	Number of people showing first signs of food poisoning
0 to 6	4
7 to 12	28
13 to 24	37
25 to 36	29
37 to 48	37
49 to 72	49

The total number of people showing signs of food poisoning was 184.

Calculate the percentage showing signs of food poisoning in the first 24 hours.

(1)

Answer ..... %

(c) Macrophages are involved in the recovery of a person who has a bacterial infection.

Describe how macrophages destroy bacteria.

(2)

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(Total for Question 1 = 7 marks)

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2 The light-dependent reactions and the light-independent reactions of photosynthesis both take place in the chloroplasts of plants.

(a) Which of the following statements about chloroplasts are correct?

(1)

1. They are found inside every type of cell.
2. There is DNA inside the stroma.
3. They contain ribosomes.

☒ **A** 1 and 2 only

☒ **B** 1 and 3 only

☒ **C** 2 and 3 only

☒ **D** 1, 2 and 3

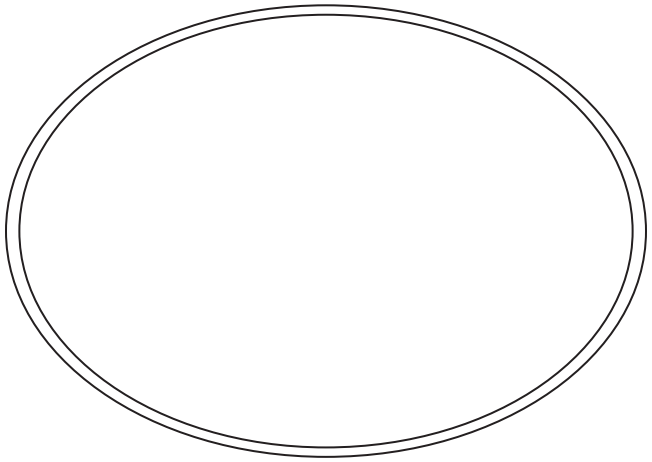
(b) Membranes within chloroplasts play an important role in photosynthesis.

(i) The diagram shows the outer and inner membranes (envelope) of a chloroplast.

Complete the diagram to show an example of **each** of the other membrane structures found inside a chloroplast.

Label the structures you have drawn.

(3)

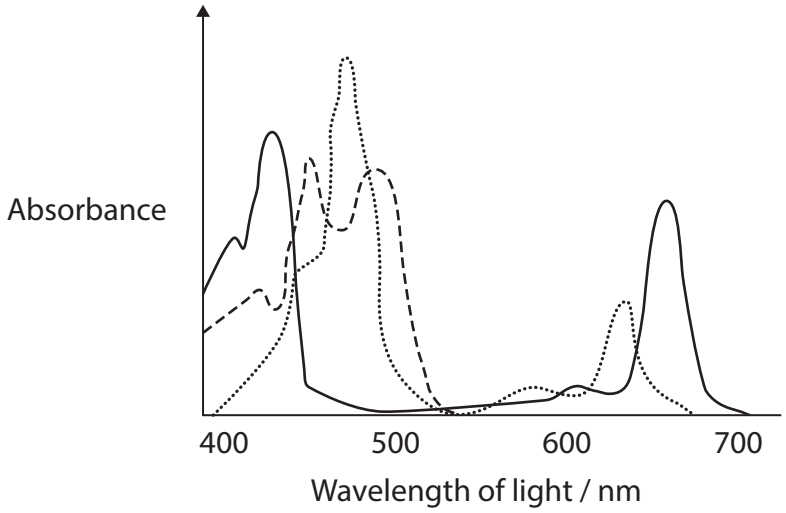


(ii) Which of the following are found in chloroplast membranes?

(1)

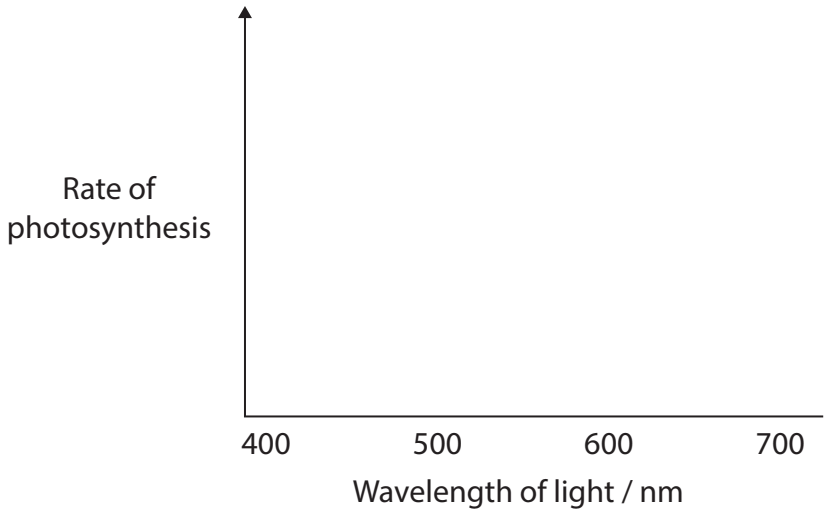
- ☒ **A** ATP synthase and chlorophyll
- ☒ **B** ATP synthase and RUBISCO
- ☒ **C** ATP synthase, chlorophyll and RUBISCO
- ☒ **D** chlorophyll and RUBISCO

(c) The graph shows the absorption spectrum of light by the pigments in a chloroplast.



Complete the graph below to show the **action spectrum** of this chloroplast.

(2)



(Total for Question 2 = 7 marks)

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3 Coral reefs are one of the Earth's most diverse biological environments.

They are thought to cover 348 000 km^2 of the planet.

It is estimated that by 2030, 90% of coral reefs will have been damaged by anthropogenic activities.

The photographs show an undamaged coral reef in the Maldives and a damaged coral reef elsewhere.

Undamaged reef



(Source: © WaterFrame / Alamy Stock Photo)

Damaged reef



(Source: © Sirachai Arunrugstichai/Getty Images)

(a) Calculate the area of undamaged reef likely to remain in 2030.

Give your answer in standard form.

(1)

Answer ..... km^2

(b) Explain how **one** anthropogenic activity could result in damage to a coral reef.

(2)

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(c) One method used to restore coral is 'coral gardening'.

This method involves two stages:

- Stage 1: growing corals in underwater nurseries
- Stage 2: transplanting the individual corals into damaged reefs.

(i) The corals grown in the underwater nurseries increase in number by sexual and asexual reproduction.

Explain the advantages of having corals that have been produced by both sexual and asexual reproduction.

(2)

(ii) Suggest **one** difficulty of transplanting individual corals into damaged reefs.

Give a reason for your answer.

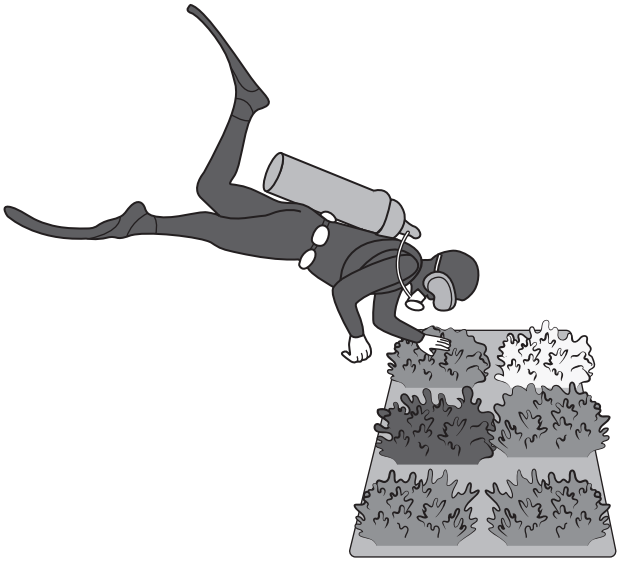
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(d) Another method being developed to restore damaged coral reefs uses 'reef carpets' (RC).

The diagram shows coral RCs.

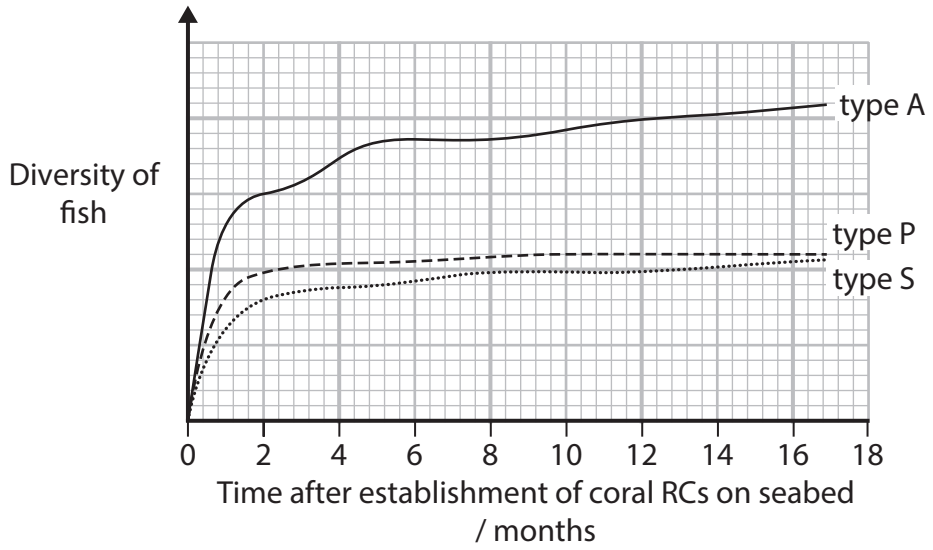


Three types of coral were each grown on a RC.

The coral RCs were left on the seabed and monitored for 17 months.

The scientist developing this method monitored the health of the coral and the diversity of fish that were present on three types of coral, A, P and S.

The graph shows the diversity of fish present with these types of coral RCs.



State **two** conclusions that can be made about the diversity of fish on these three types of coral.

(2)

(e) Describe how the **biodiversity** of a coral reef could be determined.

(2)

(Total for Question 3 = 11 marks)

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4 The table shows the energy content in the three trophic levels of a food chain of organisms living in a salt marsh in California.

Trophic level	Organism	Energy content
3	Sea otter 	745
2	Shore crab  (Source: © Dave Hansche/ Shutterstock	6 590
1	Pickleweed  (Source: © Redjina Ph /Getty Images)	69 565

(a) (i) Which are suitable units for the energy content of organisms in trophic level 1?

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

(1)

- ☒ **A** GPP = NPP + R
- ☒ **B** GPP = NPP – R
- ☒ **C** GPP = R – NPP
- ☒ **D** GPP = R × NPP

(iii) Which is the percentage of energy lost between trophic level 1 and trophic level 2?

(1)

- ☒ **A** 9.5%
- ☒ **B** 10.6%
- ☒ **C** 90.5%
- ☒ **D** 95.6%

*(b) The Elkhorn Slough estuary in California is a salt marsh whose edges have been worn away by erosion.

The erosion could have been caused by:

- rising sea levels
- increased levels of nitrogen in the water
- shore crabs digging into the roots to feed on the pickleweed.

A decline in top predators has had damaging effects on many ecosystems and their conservation is important in protecting these ecosystems.

This is called top-predator recovery.

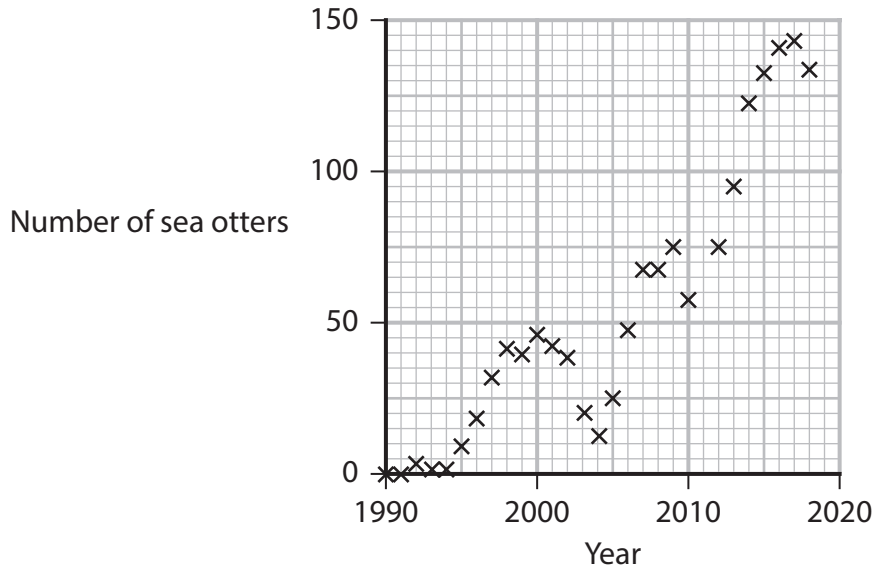
Scientists investigated the effect of the sea otters on this salt marsh ecosystem in California.

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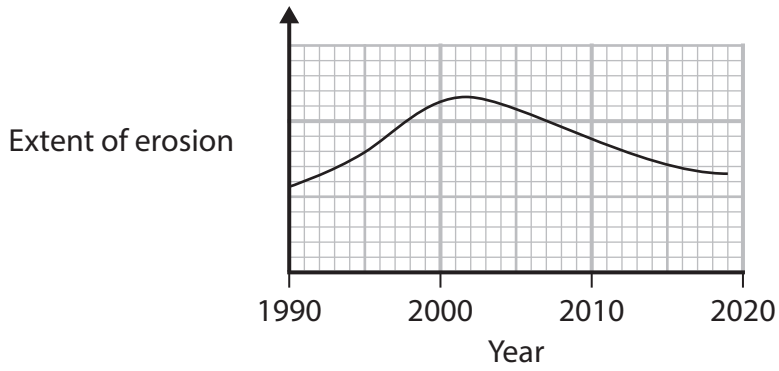
The graphs and table show some of the results of this investigation.

Graph 1 shows the number of sea otters from 1990 to 2018.



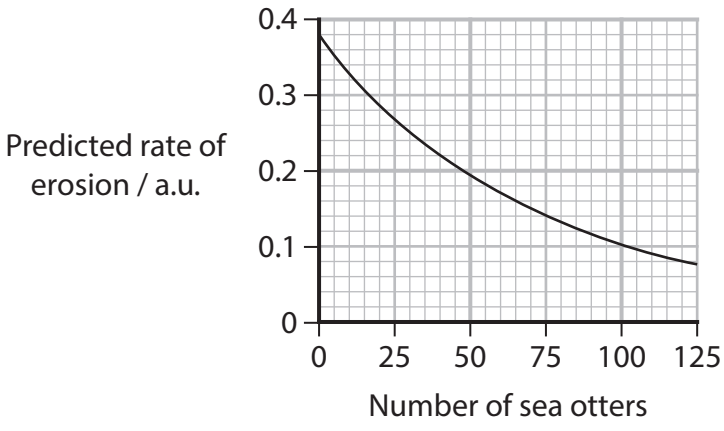
Graph 1

Graph 2 shows the extent of erosion during this period.



Graph 2

Graph 3 shows the relationship between the predicted rate of erosion and the number of sea otters.



Graph 3

The table shows the results of a predator exclusion experiment.

Some areas of the salt marsh were covered in cages for three years to prevent sea otters entering the area.

Other areas were left uncovered so that sea otters could enter the area.

The effects of sea otters on shore crabs were investigated.

The mean increase in the number of burrows dug by shore crabs over the time period was recorded.

The mass of pickleweed roots at the end of the time period was recorded.

Data recorded	Areas without sea otters present	Areas with sea otters present
Mean increase in the number of burrows per m^2	6	0
Mass of pickleweed roots / kg dry mass m^{-2}	3.2	3.7

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Assess whether or not top-predator recovery could protect this salt marsh from erosion.

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

(6)

(Total for Question 4 = 9 marks)

5 Cyanobacteria are photosynthetic prokaryotic organisms that live in water.

Cyanobacteria living in water with high salt concentrations synthesise sucrose.

Scientists think that this sucrose can be used to produce food for cattle and biofuels, reducing the need to use fossil fuels.

(a) Which of the following statements are correct for sucrose?

(1)

1. The elements in sucrose are carbon, hydrogen and oxygen only.

2. Sucrose is made from the monosaccharides glucose and galactose.

3. The monosaccharides are joined by hydrolysis reactions.

- ☒ **A** 1 only
- ☒ **B** 2 only
- ☒ **C** 1 and 3 only
- ☒ **D** 2 and 3 only

(b) Suggest why cyanobacteria can survive in water with high salt concentrations by increasing the levels of sucrose inside their cells.

(2)

(c) Explain **one** advantage of reducing the use of fossil fuels.

(2)

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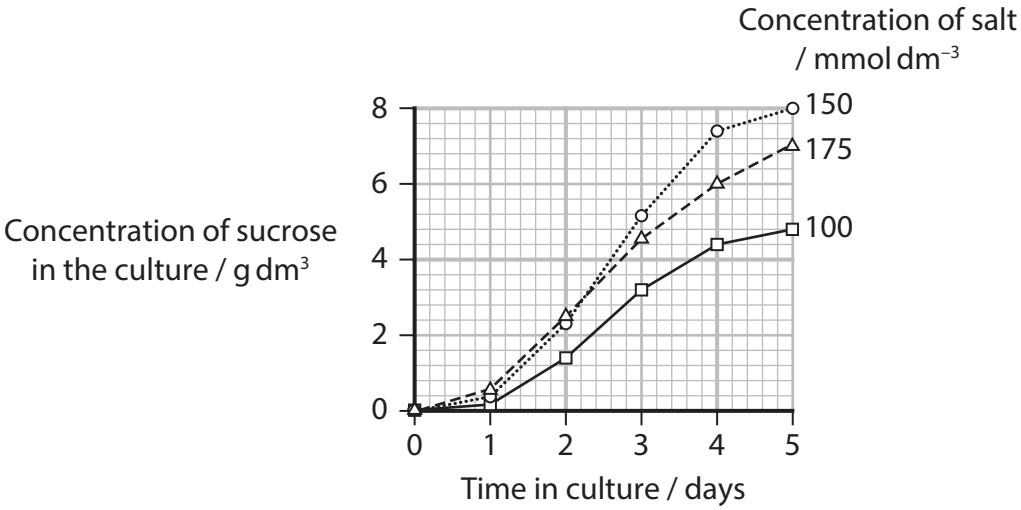
(d) Cyanobacteria use the products of photosynthesis to produce cell biomass.

Cyanobacteria do not produce sufficient sucrose for commercial use.

Scientists have genetically modified (GM) cyanobacteria to increase the production of sucrose.

(i) In an investigation, scientists first cultured GM cyanobacteria in different concentrations of salt and measured the production of sucrose in the culture each day.

The graph shows the results of this part of the investigation.



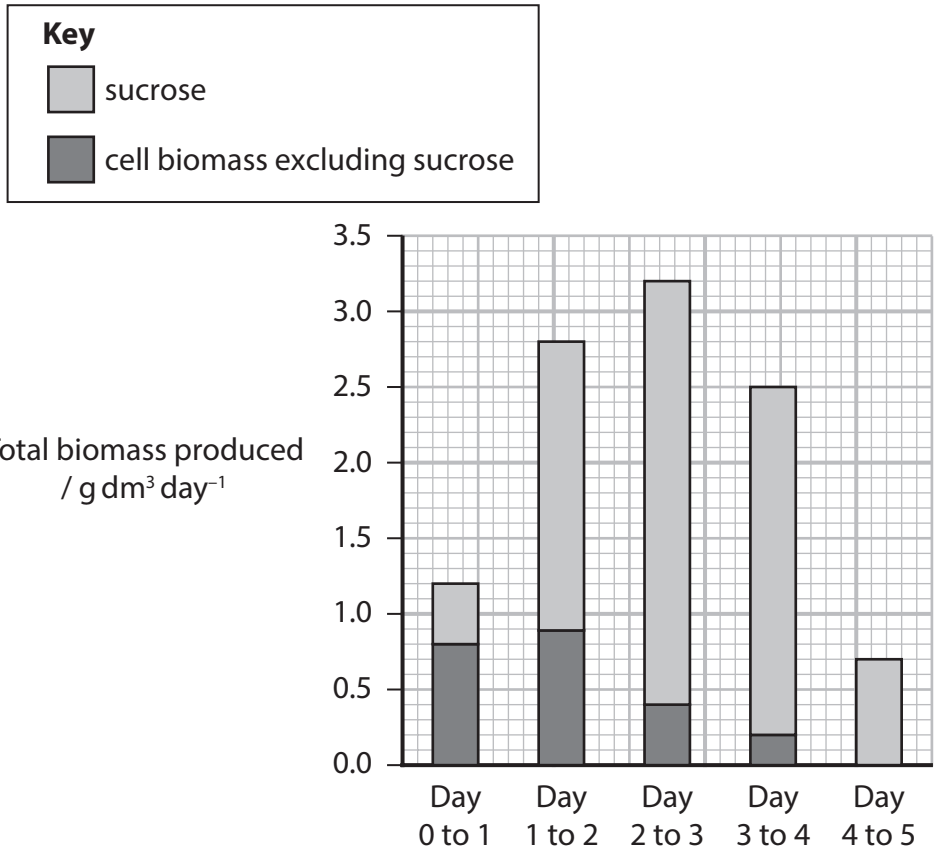
Comment on the relationship between the concentration of salt and the concentration of sucrose in the culture.

(3)

(ii) The scientists then grew GM cyanobacteria in a culture containing 150 mmol dm^{-3} of salt.

The rate of production of sucrose and cell biomass excluding sucrose was recorded.

The graph shows the results of this part of the investigation.



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Describe the conclusions that can be made about the changes in the proportion of sucrose and cell biomass excluding sucrose produced during this time period.

Use the data in the graph to support your answer.

(4)

(Total for Question 5 = 12 marks)

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6 The increasing resistance of bacteria to antibiotics is a global concern.

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

(1)

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(b) In 2019, there were an estimated 1.27 million deaths resulting from antibiotic-resistant bacterial infections.

Of these deaths, 121 000 were caused by methicillin-resistant *S. aureus* bacteria (MRSA).

(i) Calculate the proportion of deaths due to MRSA.

(1)

Answer .....

(ii) It is predicted that the number of deaths each year resulting from antibiotic-resistant bacterial infections could rise to 10 million by 2050.

Calculate the percentage increase in the number of deaths resulting from antibiotic-resistant bacterial infections from 2019 to 2050.

(1)

Answer ..... %

(iii) Explain **one** way that codes of practice regarding antibiotic prescriptions could help to reduce the increase in antibiotic-resistant bacteria.

(2)

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(c) Artificial intelligence (AI) has been used to screen millions of compounds for antibiotic activities.

This is done by identifying molecules with chemical structures linked to antibiotic activity.

Scientists have used AI to identify a group of compounds that could be effective against MRSA.

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*(i) Before any of these compounds can be tested on animals or humans, their effectiveness on MRSA has to be confirmed.

Devise an investigation to determine whether these compounds are effective against MRSA.

Give reasons for your choice of method.

(6)

(ii) Explain why AI could help humans in the 'evolutionary race' against MRSA and other bacterial pathogens.

(3)

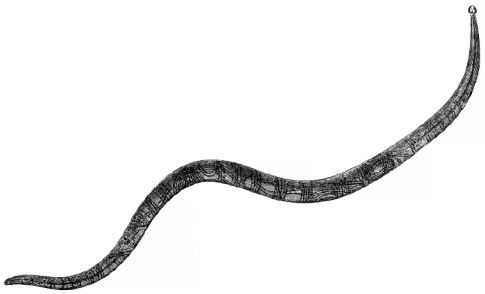
(Total for Question 6 = 14 marks)

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7 Nematodes are a type of worm that live in a wide range of environments.

The photograph shows a nematode.



(Source: © mikroman6/Getty Images)

In 1986, there was a nuclear power plant disaster resulting in high levels of radiation in the surrounding area.

Scientists have been studying nematodes in the area affected by radiation (the exclusion zone).

(a) The exclusion zone is an area with a radius of 18.6 miles from the nuclear power plant.

Calculate the area of the exclusion zone in km^2.

1 mile = 1.6 km.

Give your answer to a suitable number of decimal places.

(2)

Answer ..... km^2

(b) Radiation can cause mutations.

Mutations can affect the evolution of an organism.

Nematodes reproduce very quickly.

One female can lay many eggs.

The life cycle can take from three to six weeks depending on the temperature of the environment.

(i) Explain how temperature affects the life cycle time of these nematodes.

(3)

(ii) Explain why nematodes are suitable organisms for investigating the effects of radiation on evolution.

(3)

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(c) The scientists sequenced small sections of the genomes of nematodes from the exclusion zone and of nematodes not exposed to radiation.

They found that all the changes in the genomes of nematodes collected from the exclusion zone were also present in the genomes of nematodes not exposed to radiation.

(i) Describe a method that would enable scientists to look for possible changes in the genomes.

(4)

(ii) The scientists concluded that the radiation had not damaged the DNA in the population of nematodes now living in the exclusion zone.

Explain why these nematodes possess undamaged DNA even though radiation is known to cause mutations.

(3)

(Total for Question 7 = 15 marks)

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8 In 2022, approximately 650 000 people in the world died from human immunodeficiency virus (HIV)-related causes.

There is currently no cure for people infected with HIV and no effective vaccine available.

Diagram 1 shows a human immunodeficiency virus (HIV).

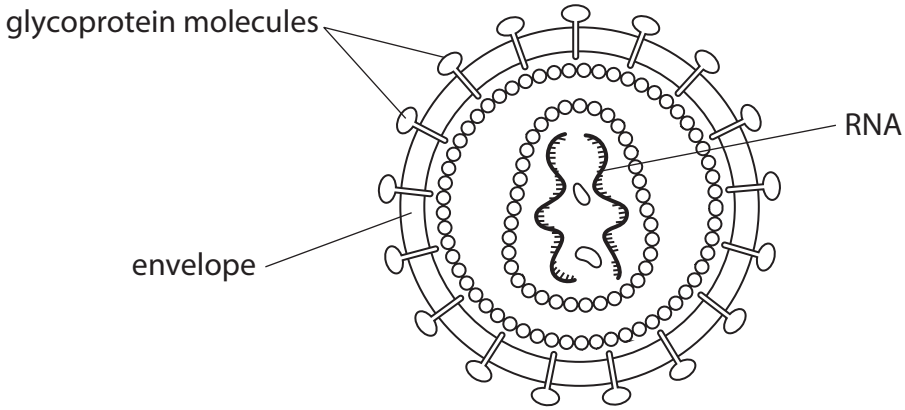


Diagram 1

Diagram 2 shows a glycoprotein molecule in the envelope of HIV.

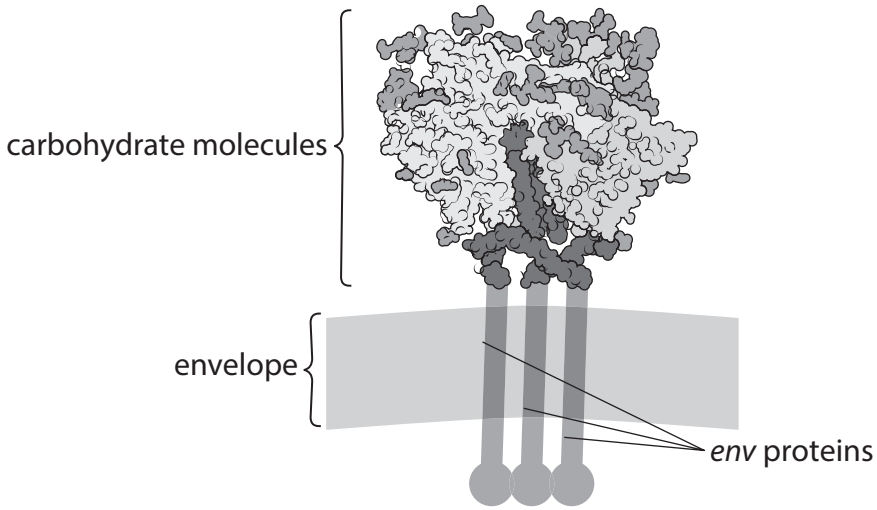


Diagram 2

(a) The glycoproteins attach to the host cell of the virus.

(i) Which is the host cell of HIV?

(1)

☒ **A** B cells

☒ **B** macrophages

☒ **C** T helper cells

☒ **D** T killer cells

(ii) Once the HIV is attached to the host cell, its envelope fuses with the cell membrane.

Explain why the envelope of HIV can fuse with the cell membrane.

(2)

(b) The *env* gene codes for the *env* protein components of the glycoprotein.

Post-transcriptional modification of the *env* mRNA has to occur before the mRNA can be translated.

Explain why post-transcriptional modification of the *env* mRNA has to take place before translation.

(2)

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(c) The glycoproteins are thought to protect HIV from the immune system in three ways:

- the *env* protein is a weak antigen
- antibodies cannot bind strongly to the carbohydrate
- the RNA that codes for the parts of the *env* protein not covered by carbohydrate has a high mutation rate.

Explain why each of these protective mechanisms make vaccines containing *env* proteins ineffective.

(i) The *env* protein is a weak antigen.

(3)

(ii) Antibodies cannot bind strongly to the carbohydrate.

(2)

(iii) The RNA that codes for the parts of the *env* protein not covered by carbohydrate has a high mutation rate.

(3)

(iv) A vaccine has been developed using glycoproteins that have had some of the carbohydrate molecules removed.

This vaccine is more effective than vaccines that use the whole glycoprotein.

Suggest why removing some of the carbohydrate molecules could make an effective HIV vaccine.

(2)

(Total for Question 8 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

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