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.
- 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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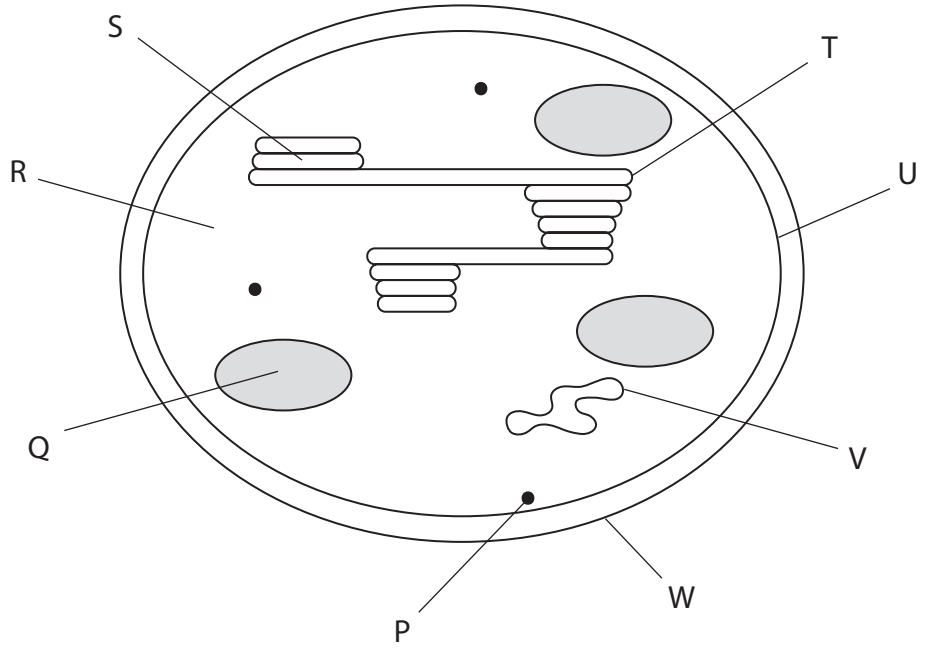
Answer ALL questions. Write your answers in the spaces provided.

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

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(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)

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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)

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

(2)

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

(2)

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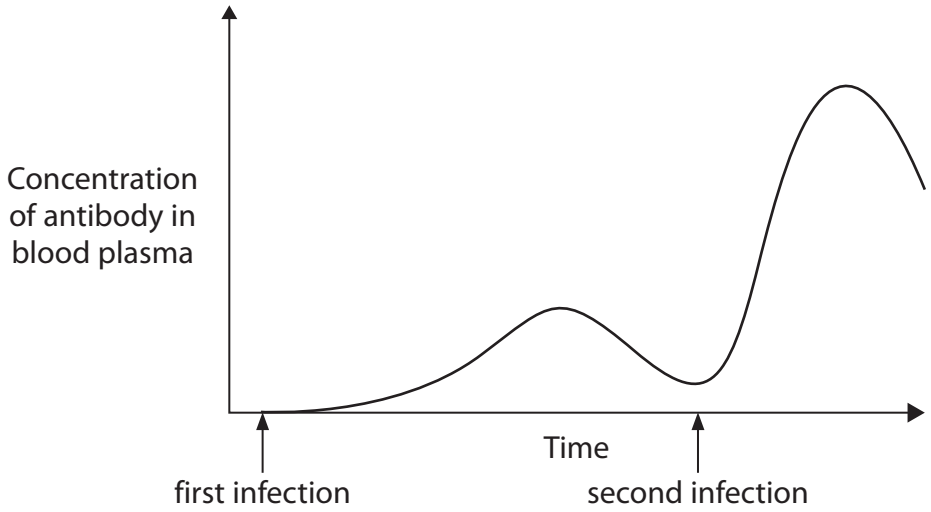
(c) The immune response results in the production of antibodies following the first infection with a pathogen and on further infections with the same pathogen.

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.

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(Total for Question 2 = 8 marks)

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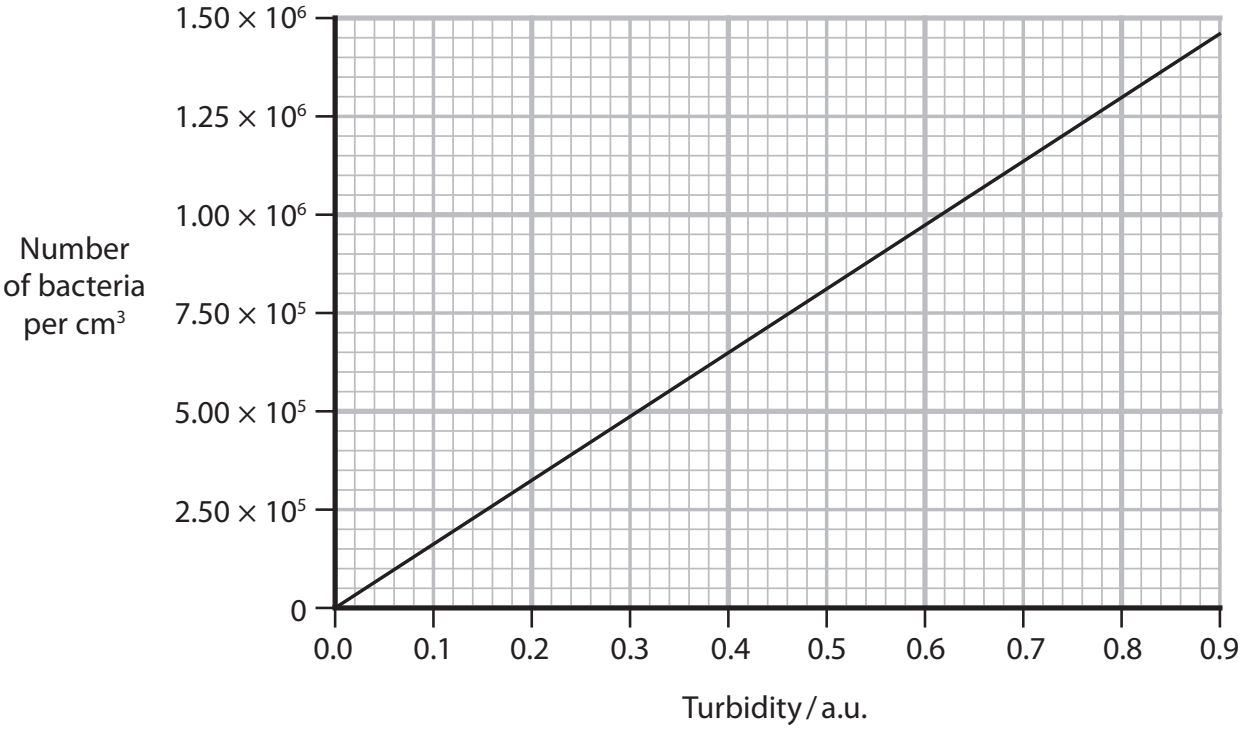
3 The growth of bacteria in a liquid culture was investigated over a 14 hour period, using an optical method (turbidity).

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)

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

(2)

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(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)

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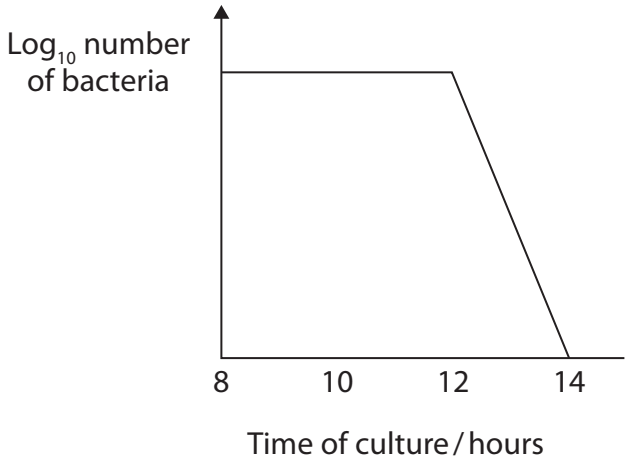
(ii) The sketch shows the shape of the growth curve produced using dilution plating and colony counts between 8 and 14 hours of this culture.



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.

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(Total for Question 3 = 8 marks)

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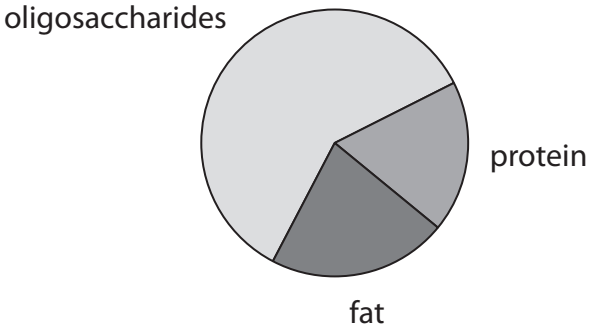
4 Human breast milk supports the growth and development of a baby.

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

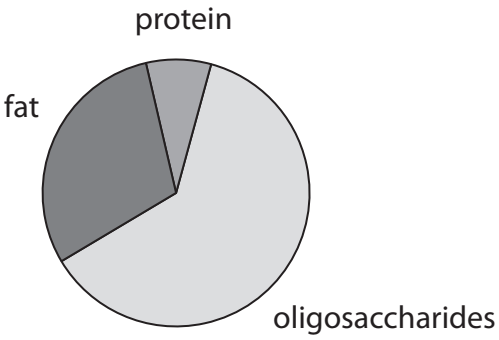
(a) During the first few days after birth, the milk produced is called colostrum. By two weeks, the composition of the milk has changed and it is called mature breast milk.

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..... %

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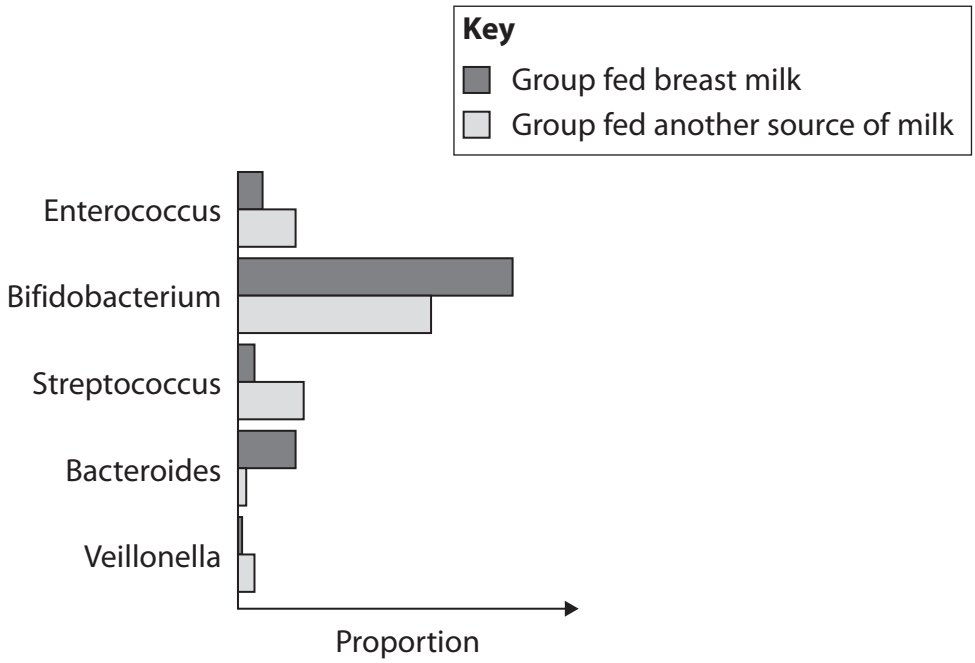
(b) Oligosaccharides in breast milk have been shown to be important in establishing a healthy gut flora in the developing baby.

(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)

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(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.

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(Total for Question 4 = 8 marks)

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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)

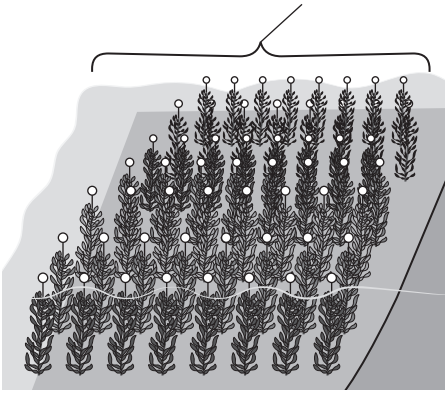
		Hydrogen is combined with carbon dioxide	Oxygen is released into the atmosphere
☒	**A**	light-dependent reactions	light-dependent reactions
☒	**B**	light-dependent reactions	light-independent reactions
☒	**C**	light-independent reactions	light-dependent reactions
☒	**D**	light-independent reactions	light-independent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

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

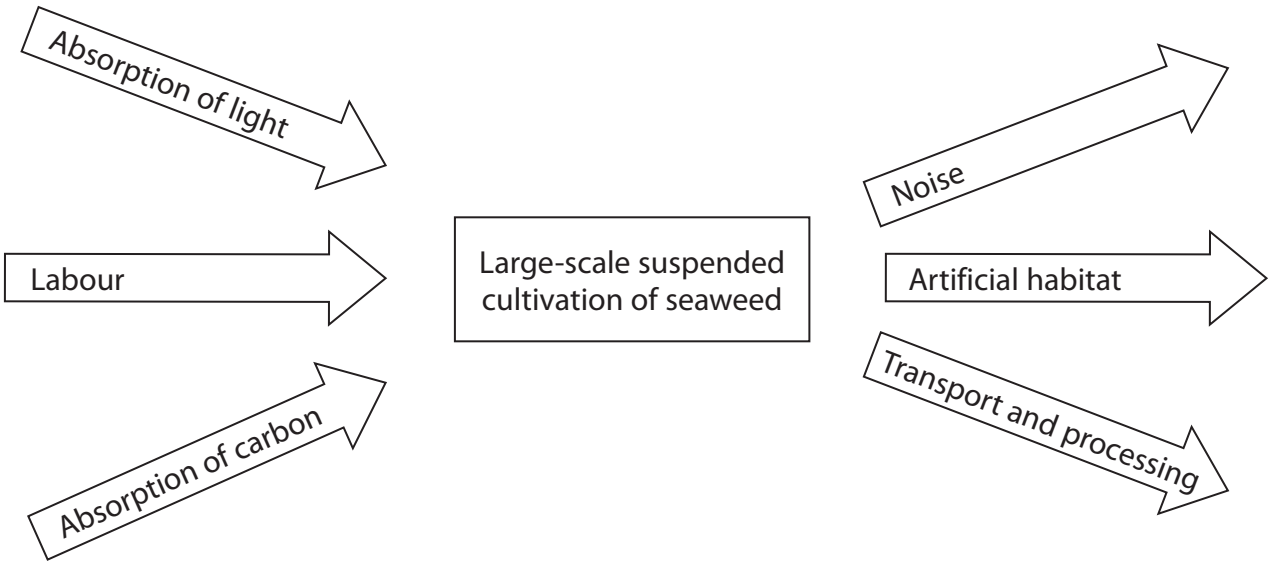
Effective management of the conflict between human needs and conservation is necessary before large-scale cultivation can be used.

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.



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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.

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(Total for Question 5 = 10 marks)

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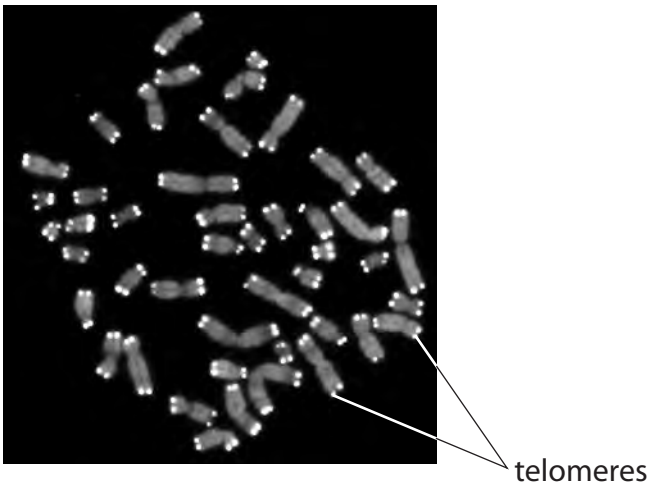
6 A telomere is a repetitive nucleotide sequence at the end of a chromosome.

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.

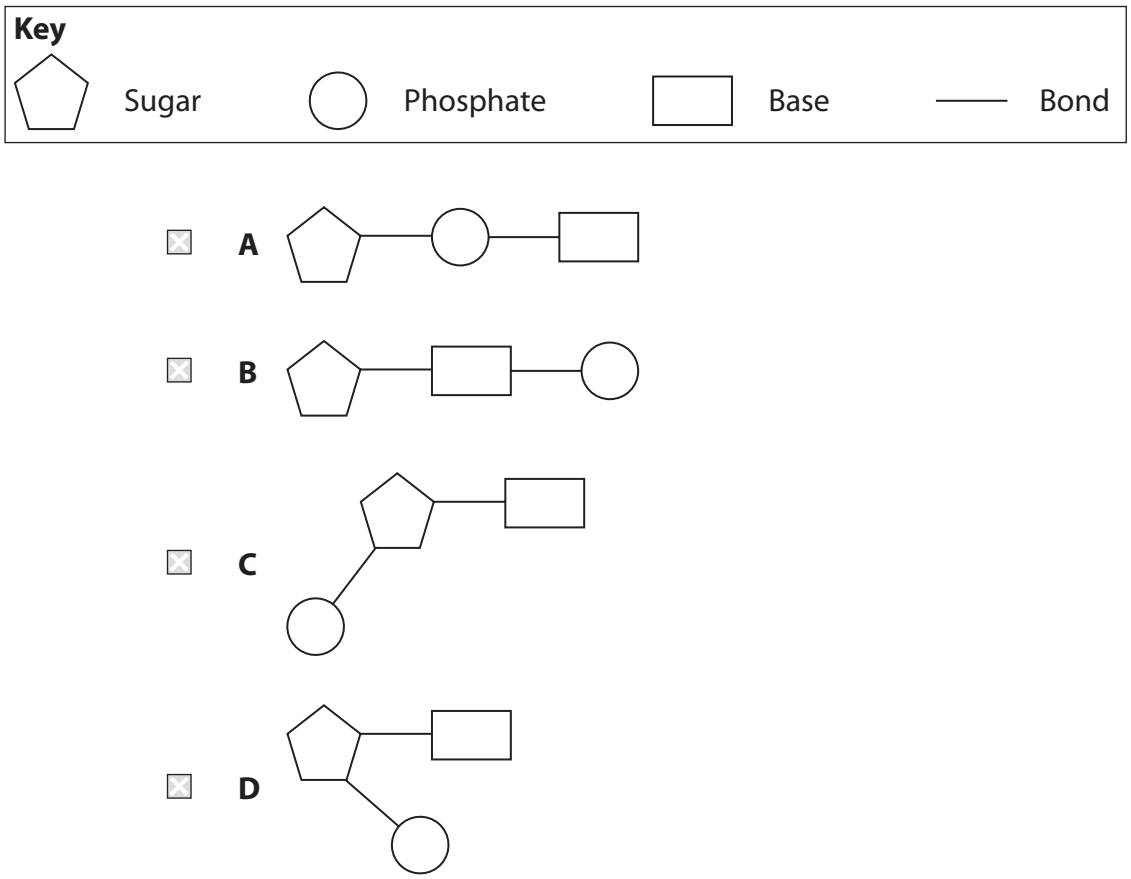
The photograph shows telomeres on the ends of chromosomes.



(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)



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

(1)

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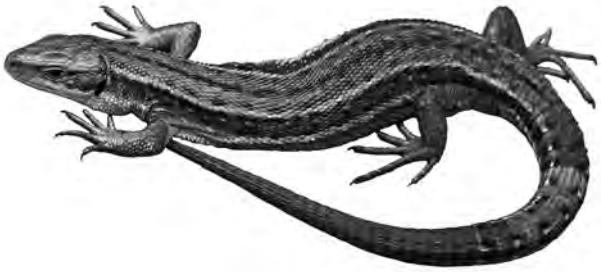
(b) The photograph shows a common lizard.



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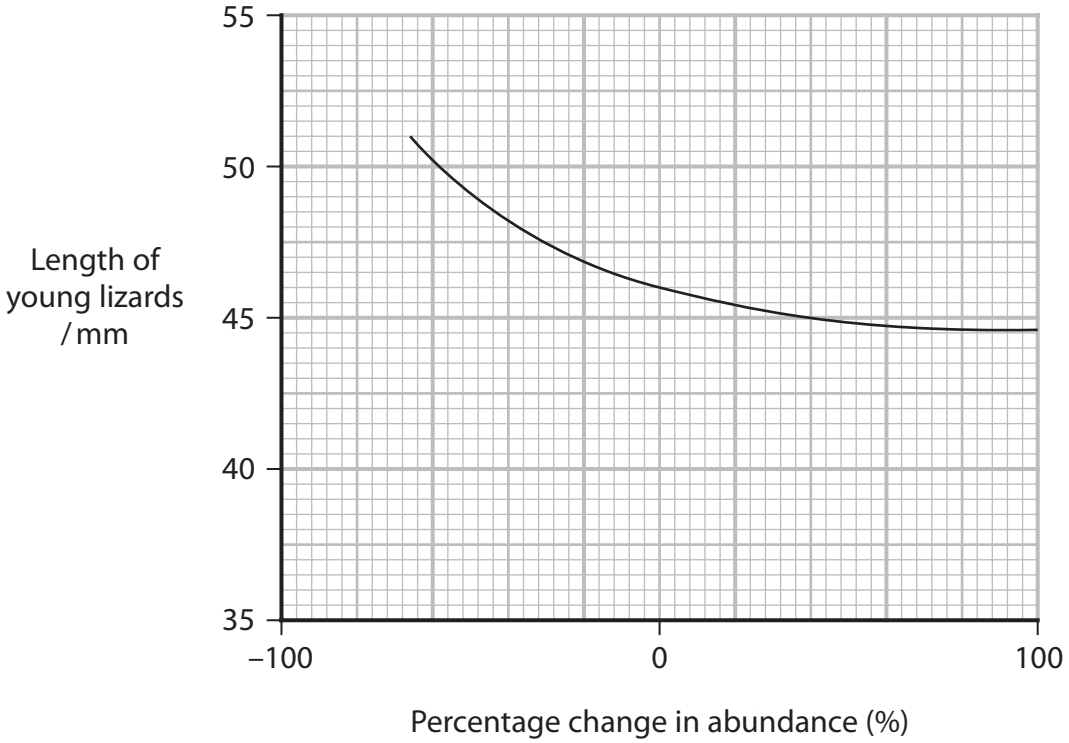
(ii) The scientists used the data to predict a relationship between the length of the young lizards and the percentage change in abundance of lizards over the 12 year period.

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)

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(Total for Question 6 = 10 marks)

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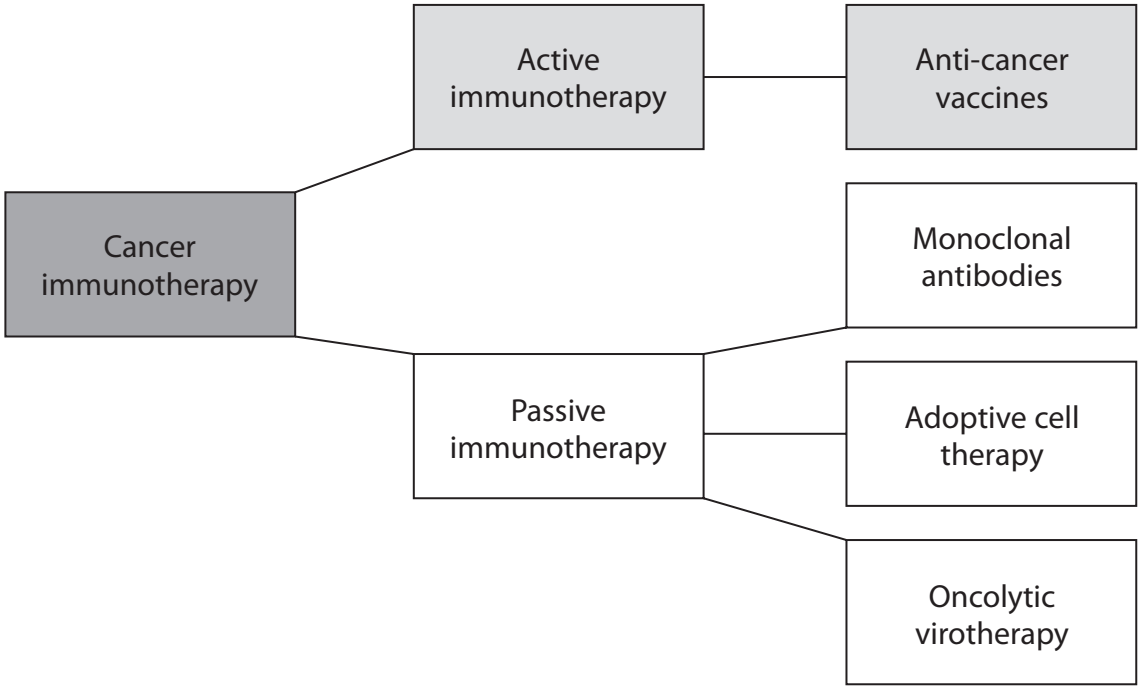
7 Cancer immunotherapy stimulates and strengthens an individual's active and passive immune systems to destroy cancer cells.

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



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

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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)

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(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.

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(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)

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(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)

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(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)

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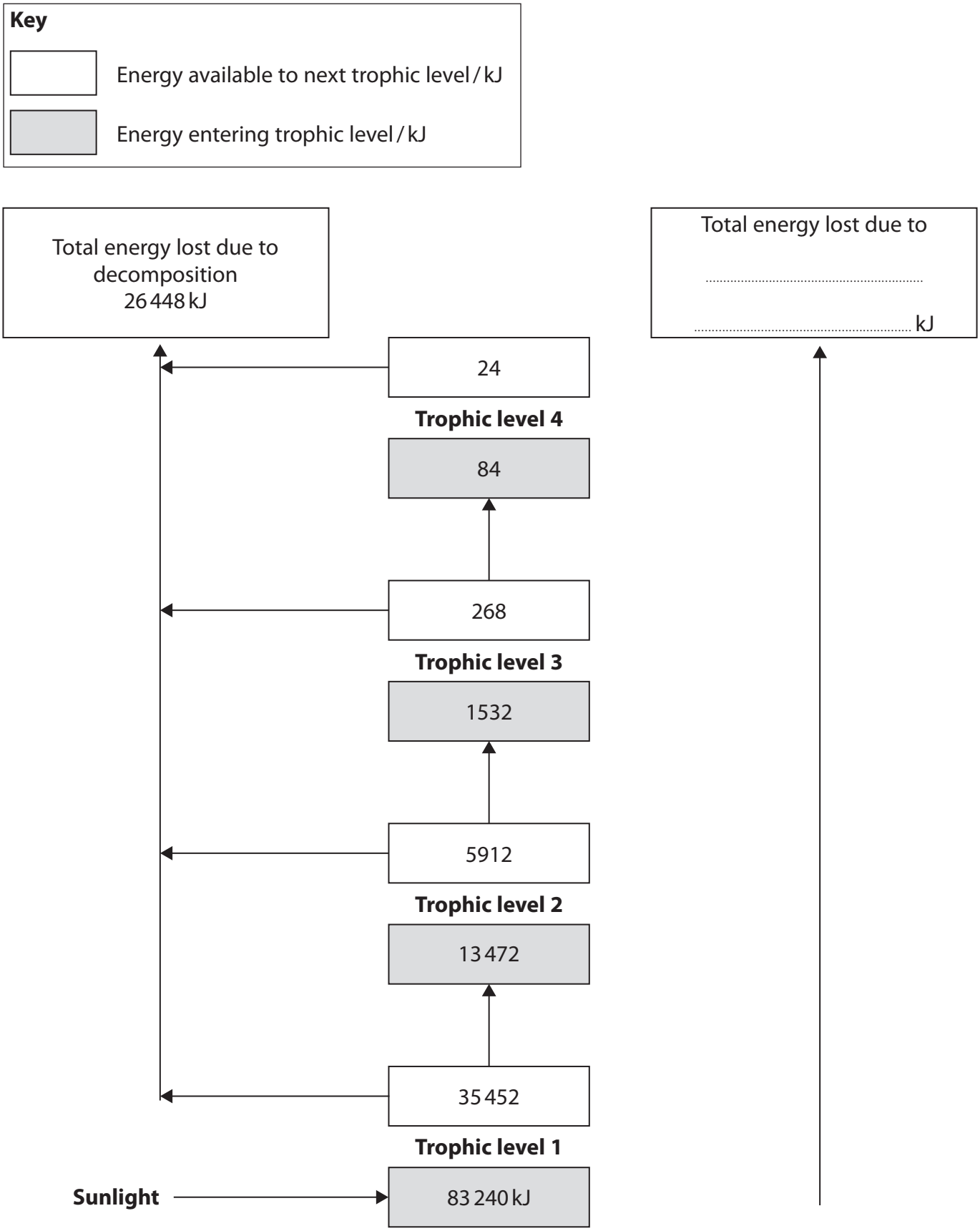
8 The trophic level of an organism is the position it occupies in a food chain.

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



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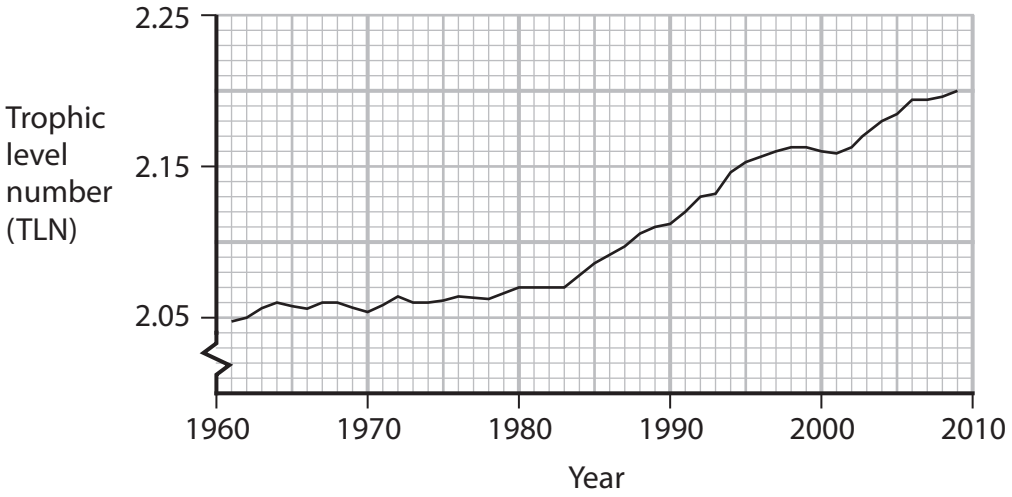
(b) Some animals eat a diet of meat and plant material.

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.

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(Total for Question 8 = 11 marks)

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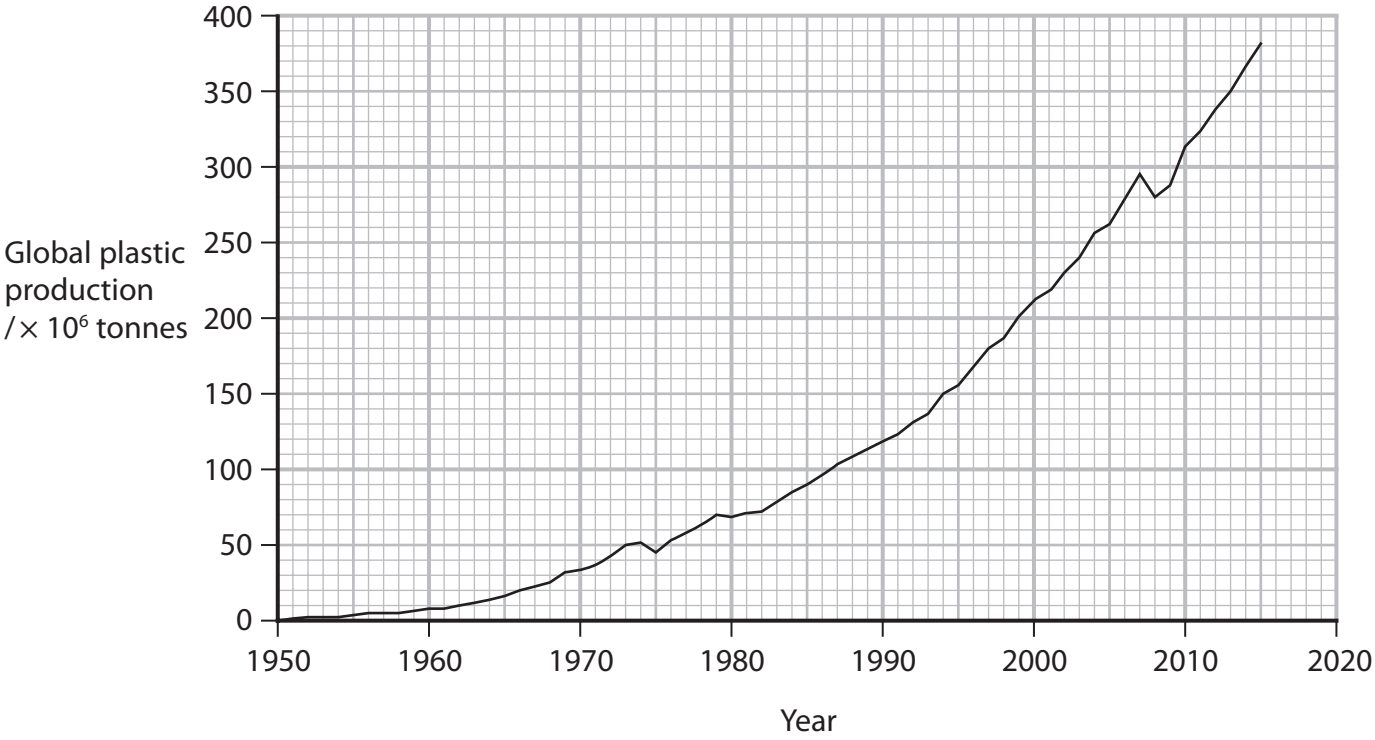
9 The photograph shows a sea turtle.

(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.



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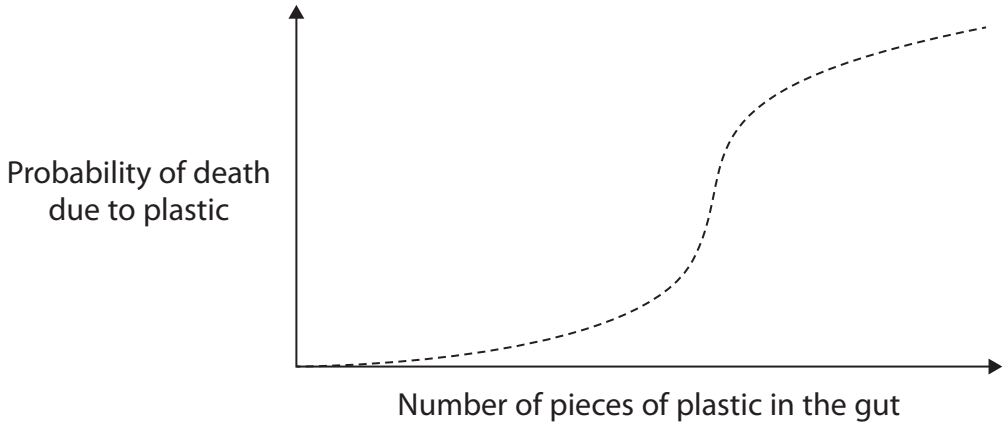
(b) One group of scientists determined the number of pieces of plastic in the guts of individual sea turtles.

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.

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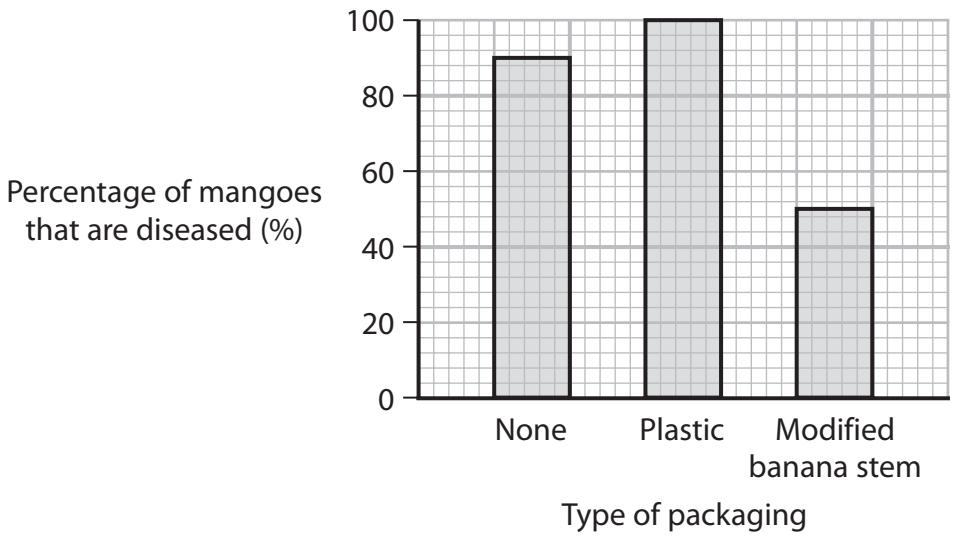
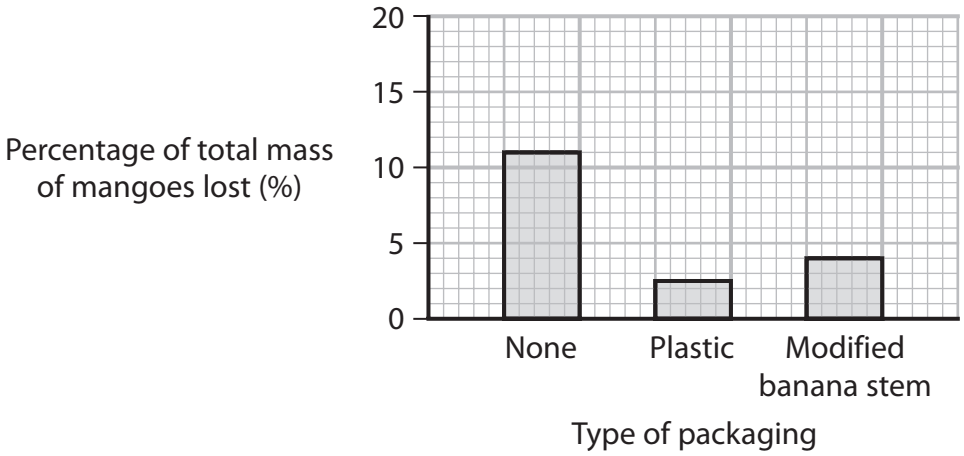
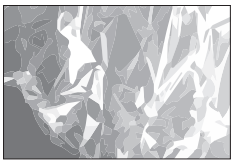
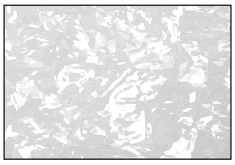
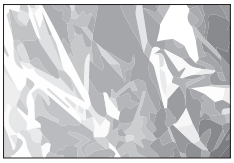
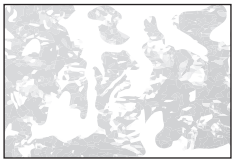
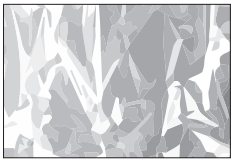




Time of decomposition of packaging / weeks	Appearance of packaging	
	Plastic packaging	**Modified banana packaging**
0		
2		
4		

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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)

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(Total for Question 9 = 14 marks)

TOTAL FOR PAPER = 90 MARKS

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