

Please check the examination details below before entering your candidate information

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

Some questions must be answered with a cross . If you change your mind about an answer, put a line through the box  and then mark your new answer with a cross .

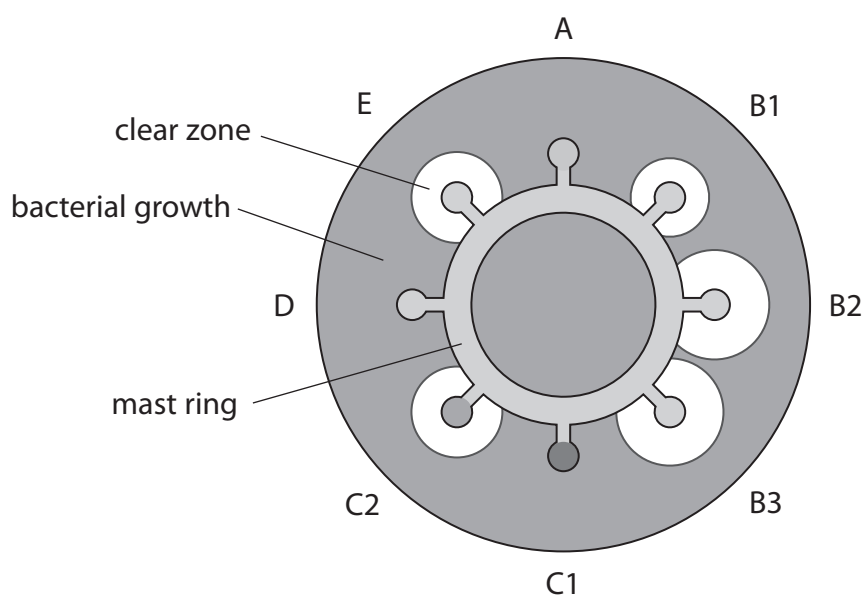
- 1 The resistance of bacteria to antibiotics can be studied using a mast ring.

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 $\mu\text{g}$ antibiotic A
B1	1 $\mu\text{g}$ antibiotic B
B2	10 $\mu\text{g}$ antibiotic B
B3	0.5 mg antibiotic B
C1	20 $\mu\text{g}$ antibiotic C
C2	200 $\mu\text{g}$ antibiotic C
D	100 $\mu\text{g}$ antibiotic D
E	100 $\mu\text{g}$ 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)

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(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.

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**(Total for Question 1 = 6 marks)**



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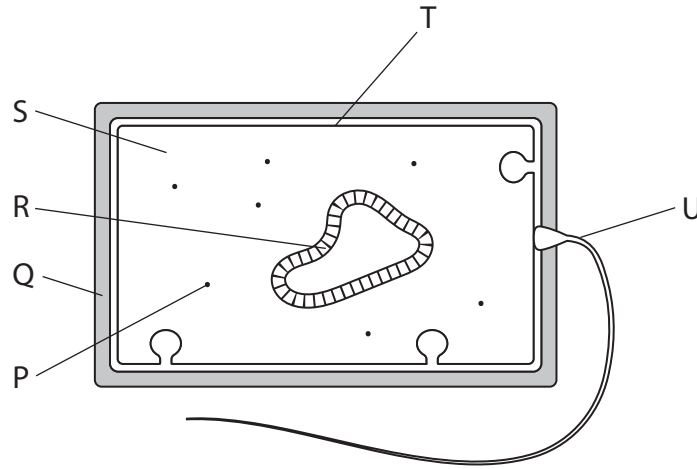
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2 Some bacteria are photosynthetic.

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)

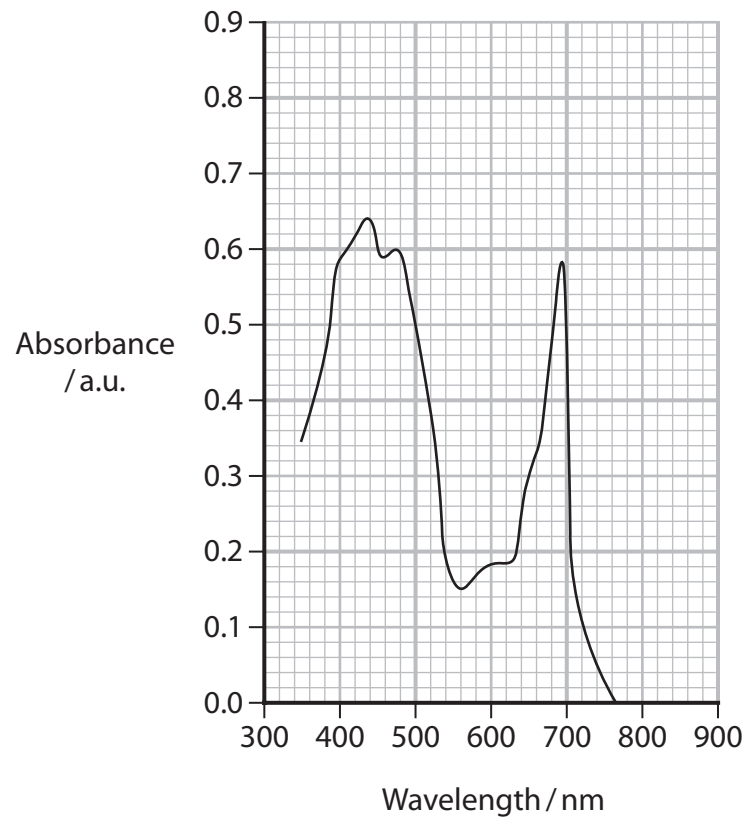
- A Q
- B S
- C T
- D U



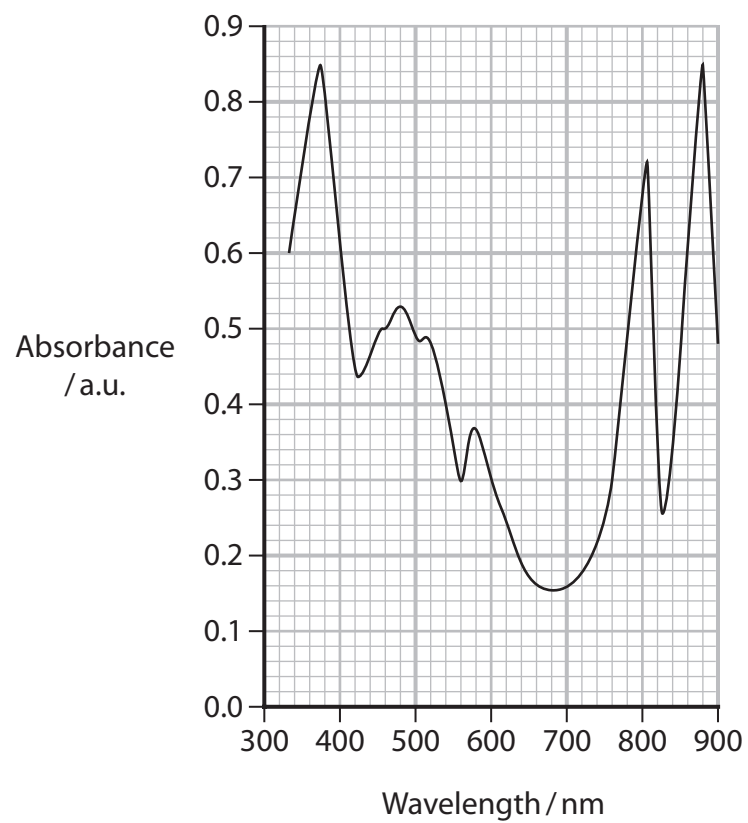
P 7 1 8 8 3 R A 0 5 3 2

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

### Plant



### Bacterium



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

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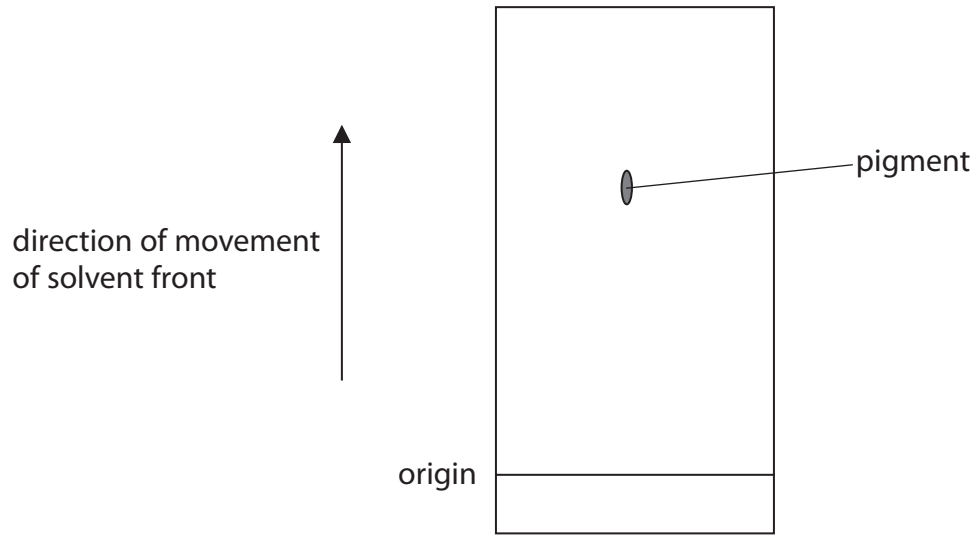
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(c) Photosynthetic pigments can be identified using chromatography.

The diagram shows part of a chromatogram.



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

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

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- 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



P 7 1 8 8 3 R A 0 9 3 2



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

(i) In 2018,  $8.3 \times 10^{12}$  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.

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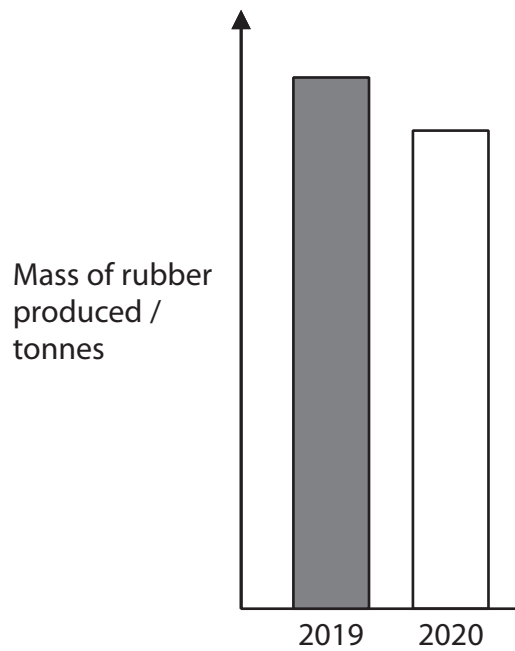
4 Natural rubber is harvested from rubber trees.

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

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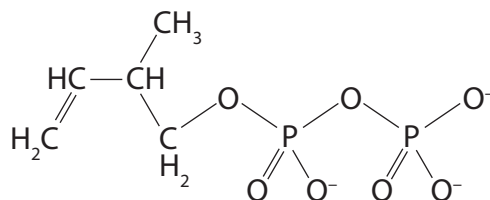
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(b) Rubber is synthesised by specialised cells in the trunks of rubber trees.

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



GALP is produced in the light-independent 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.

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(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.

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**(Total for Question 4 = 8 marks)**

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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 .....%



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\*(b) It has been estimated that because humans have planted more trees and crops, the leaf area increased by 0.5 million km<sup>2</sup> 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)

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(Total for Question 5 = 9 marks)

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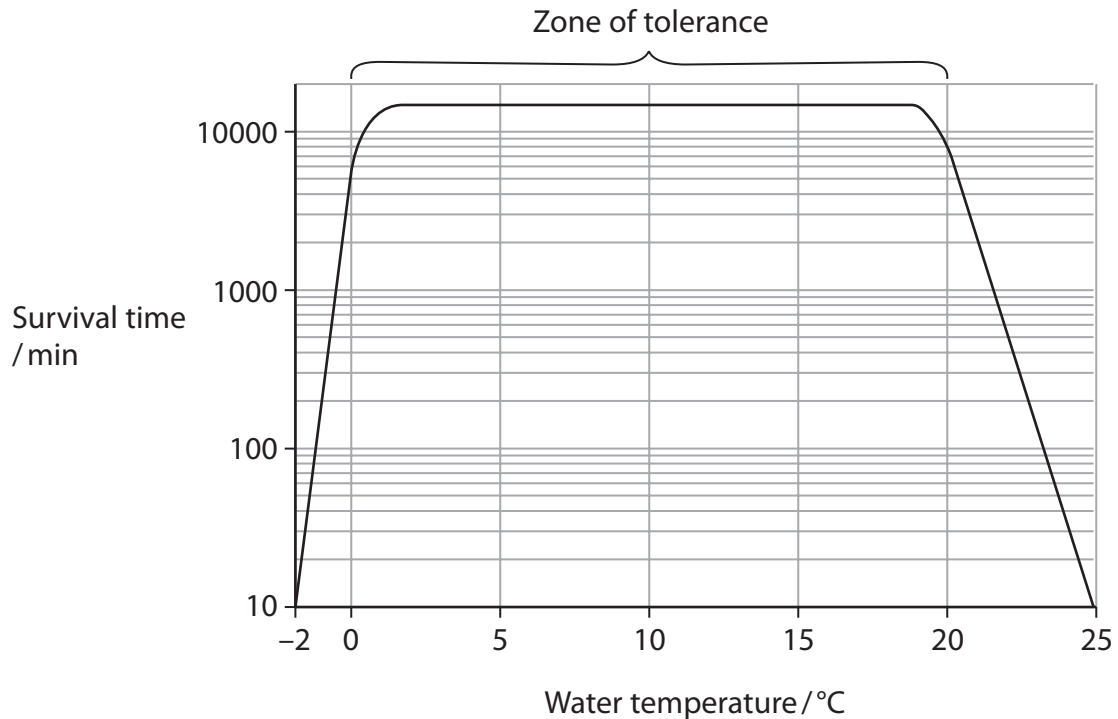
6 Changes in temperature affect the rate of enzyme activity and the survival of living organisms.

(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)



(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.

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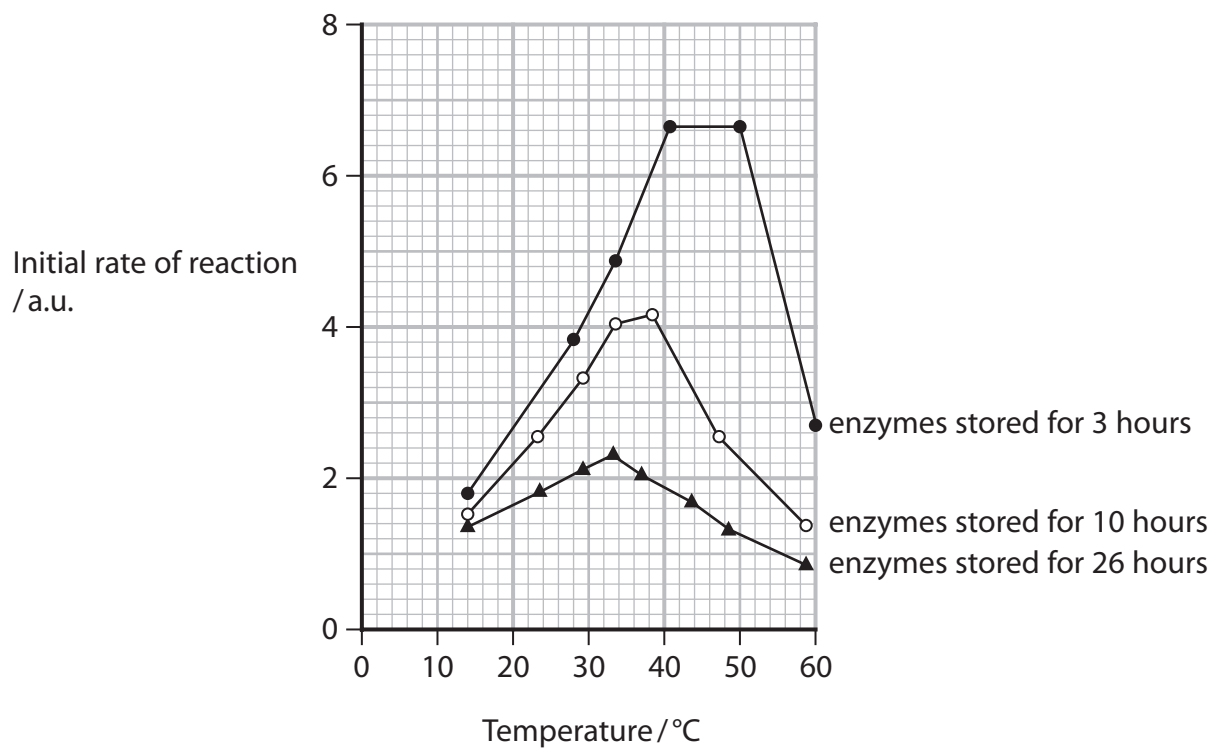
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- (c) Enzymes were stored for different lengths of time.  
The effect on the initial rate of reaction was investigated.

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.

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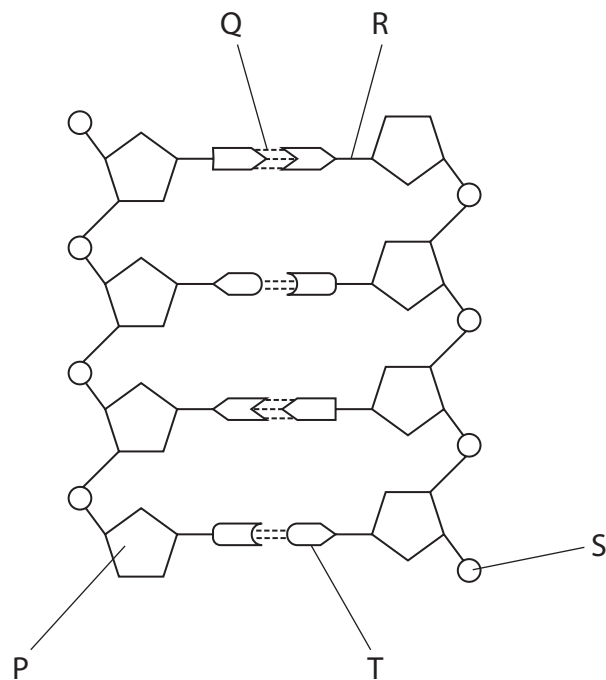
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7 Analysis of DNA samples taken from endangered species can be used in the conservation and management of these species.

(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
<input type="checkbox"/> <b>A</b>	covalent	hydrogen
<input type="checkbox"/> <b>B</b>	hydrogen	covalent
<input type="checkbox"/> <b>C</b>	hydrogen	phosphodiester
<input type="checkbox"/> <b>D</b>	phosphodiester	covalent

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

(1)

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



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

(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)

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(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.

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(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.

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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.

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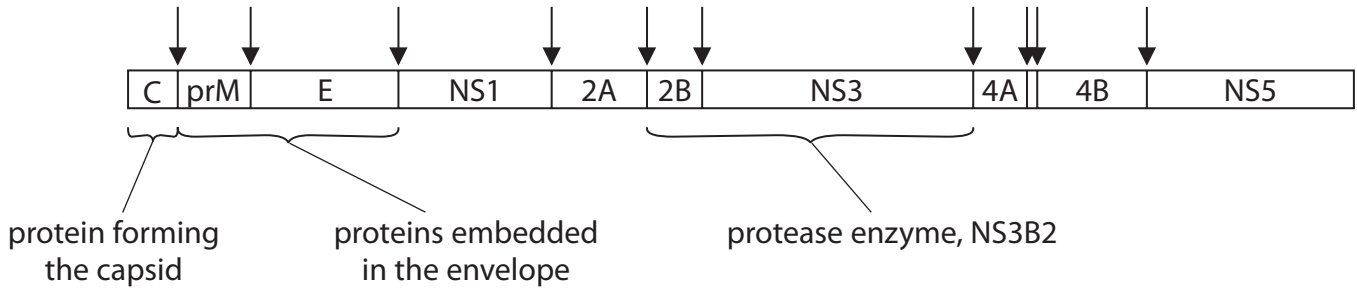
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(ii) The diagram shows this polyprotein and the function of some of the individual proteins it contains.

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.

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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)

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(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.

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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.

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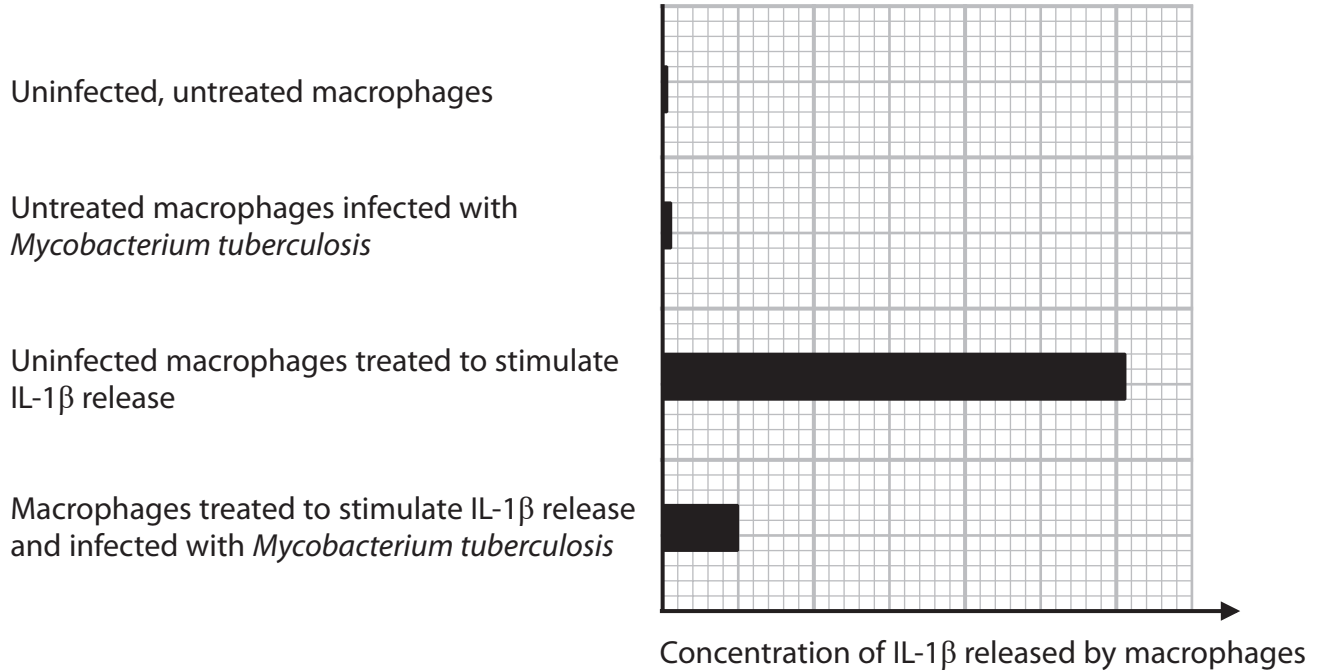
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(c) *Mycobacterium tuberculosis* has evolved to evade host immunity by interfering with macrophage function.

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-1 $\beta$  being released.

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



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

Use the information in the graph to support your answer.

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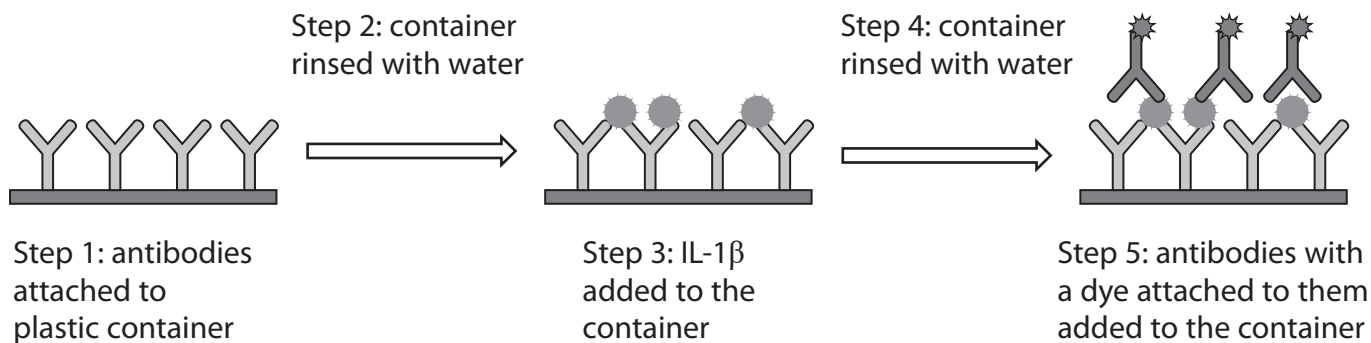
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(ii) An ELISA is used to detect a specific antigen.

The IL-1 $\beta$  was detected using an ELISA.

The diagram shows an ELISA.



**Key**

- first antibody used
- IL-1 $\beta$
- antibody with dye attached

Explain how the steps in the ELISA result in the identification of IL-1 $\beta$ .

Use the information in the diagram to support your answer.

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(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)

Area with horizontal dotted lines for writing the answer to part (iii).

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

(1)

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**(Total for Question 9 = 15 marks)**

**TOTAL FOR PAPER = 90 MARKS**

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