

Please check the examination details below before entering your candidate information

Candidate surname <i>StemUp Model Solution</i>		Other names
Centre Number	Candidate Number	

Pearson Edexcel Level 3 GCE

Monday 12 May 2025

Morning (Time: 1 hour 30 minutes)

Paper reference **8BI0/01**

Biology B

Advanced Subsidiary

PAPER 1: Core Cellular Biology and Microbiology

You must have:
Scientific calculator, HB pencil, ruler

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 80.
- 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 question(s) 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.

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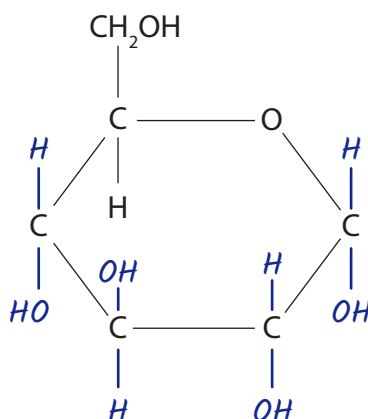
Some questions must be answered with a cross ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

- 1 Some carbohydrates are composed of three monosaccharides. These are called trisaccharides.

Raffinose is a trisaccharide composed of glucose, galactose and fructose.

- (a) Complete the diagram to show the structure of an **alpha** glucose molecule.

(2)



- (b) Name the bond that joins monosaccharides together.

(1)

glycosidic bond

- (c) The three monosaccharides present in raffinose each have a molecular mass of 180.

The relative atomic mass of the element hydrogen is 1 and the relative atomic mass of the element oxygen is 16.

Calculate the molecular mass of raffinose.

(1)

$$3 \times 180 = 540$$

$$\text{two condensation reactions remove 2 water: } 2 \times 18 = 36$$

$$540 - 36 = 504$$

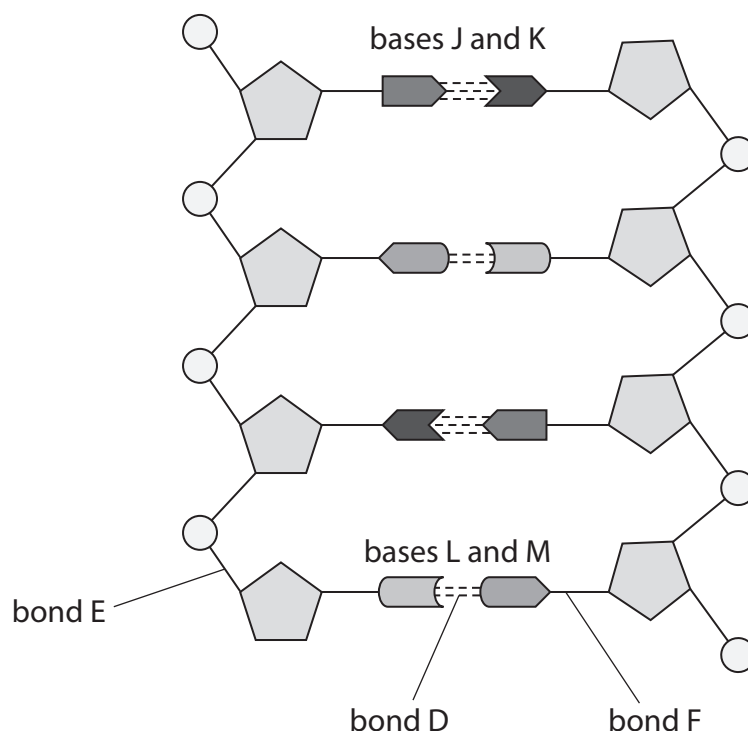
Answer 504

(Total for Question 1 = 4 marks)



- 2 During the S phase of the cell cycle, DNA is synthesised by semi-conservative replication.

The diagram shows part of a DNA molecule.



- (a) (i) Name the base pairs labelled J and K, L and M.

(2)

J and K J = cytosine and K = guanine

L and M L = adenine and M = thymine

- (ii) Name the bonds labelled D, E and F.

(2)

Bond D hydrogen bond

Bond E phosphodiester bond

Bond F covalent bond (N-glycosidic bond)



(iii) Part of a DNA molecule consists of 840 bases. Of these, 136 are base J.

Calculate the percentage of bases that are M in this DNA molecule.

Give your answer to two decimal places.

(1)

$$J = \text{cytosine} = 136, \text{ so guanine} = 136; C + G = 272$$

$$A + T = 840 - 272 = 568, \text{ so M (thymine)} = 568 \div 2 = 284$$

$$284 \div 840 \times 100 = 33.809...$$

Answer 33.81 %

(b) State what is meant by the term **semi-conservative replication**.

(1)

Two DNA molecules are made, each consisting of one original (parent) strand and one newly synthesised strand.

(Total for Question 2 = 6 marks)



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3 Mitochondria are organelles surrounded by a double membrane.

The photograph shows a dividing mitochondrion, as seen using an electron microscope.



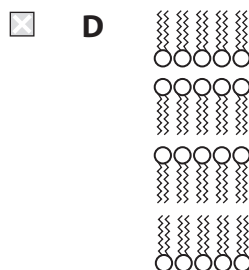
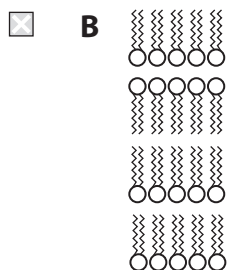
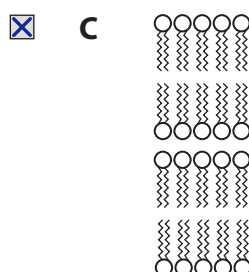
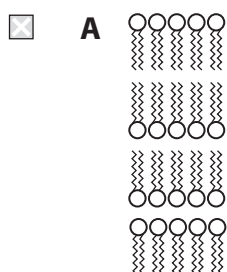
(Source: © DON W. FAWCETT / SCIENCE PHOTO LIBRARY)

- (a) The inner and outer membrane of a mitochondrion each consist of a phospholipid bilayer.

A phospholipid can be represented as

- (i) Which of the following shows the arrangement of phospholipids in these two membranes?

(1)



(ii) The gap between these two membranes is called the intermembrane space.

The intermembrane space is 200 angstroms wide.

One angstrom = 0.1 nm

Which of the following is the width of the intermembrane space in μm ?

(1)

☐ A 0.002

☒ B 0.020

☐ C 0.200

☐ D 2.000

(iii) Explain why the intermembrane space can be seen in this photograph.

(2)

An electron microscope uses electrons instead of light, and electrons have a much shorter wavelength than light.

So the resolution is higher, high enough to distinguish the two membranes and see the space between them.

(iv) Name **one** other organelle with a double membrane.

(1)

chloroplast

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(b) (i) Explain why it is necessary for mitochondria to divide during the cell cycle.

(2)

During the cell cycle one cell divides into two daughter cells, so the mitochondria are shared between the two cells.

Without division, each new cell would only have half the number of mitochondria, so it would not be able to produce enough ATP (provide sufficient energy).

(ii) Describe how mitochondria divide.

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

(3)

First the mitochondrial DNA replicates, so each new mitochondrion gets a copy, and other components such as ribosomes and matrix are synthesised.

As shown in the photograph, the inner membrane extends across the matrix and pinches together in the middle of the mitochondrion, dividing it into two halves.

A second (outer) membrane then forms around each half, enclosing each new mitochondrion, and the two separate.

(Total for Question 3 = 10 marks)



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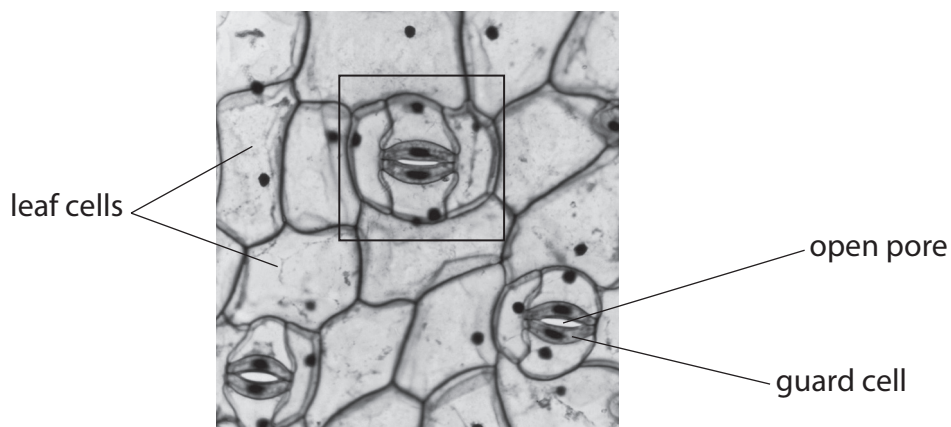
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- 4 Stomata are pores found on the under-surfaces of leaves. They are surrounded by a pair of guard cells.

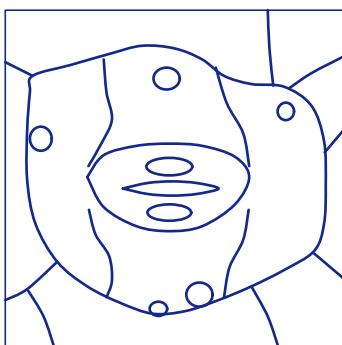
The photograph shows three stomata, as seen using a light microscope.



(Source: © Science History Images/Alamy Stock Photo)

- (a) Draw the cells in the box on the photograph, at a magnification $\times 2$ of the photograph.

(3)



*(b) The pores are closed in the dark and open in the light.

When the pores are open, the width of the pores increases.

Potassium ions are involved in the opening of the pores.

Devise an investigation to determine the effect of potassium ion concentration on the width of the pores of stomata.

(6)

Take epidermal strips from the lower surface of leaves (e.g. Tradescantia), all from the same plant (same species), and keep them in the dark first so that all the stomata are closed.

Soak the strips in potassium ion solutions (e.g. potassium chloride) of at least five different concentrations, plus distilled water as a control, for the same period of time; use several strips (repeats) at each concentration.

Control variables: keep all strips in the dark (same light intensity), at the same temperature, for the same time, with no other ions present.

Mount each strip on a slide, thin enough for light to penetrate, add a stain and view under a light microscope (or use a nail varnish peel).

Measure the width of the pore of several stomata on each strip using an eyepiece graticule, calibrated with a stage micrometer.

Calculate the mean width and standard deviation at each concentration, plot a graph of mean pore width against potassium ion concentration, and use a correlation coefficient test (statistical analysis).

(Total for Question 4 = 9 marks)

5 Water has a high surface tension.

(a) Explain how the properties of water molecules result in a high surface tension.

(3)

Water molecules are dipolar; there is an uneven distribution of charge, with the oxygen slightly negative (δ^-) and the hydrogens slightly positive (δ^+).

Therefore hydrogen bonds form between the δ^- oxygen of one water molecule and the δ^+ hydrogen of another, giving strong cohesive forces (cohesion) between water molecules.

At the surface, hydrogen bonds only form with molecules to the side and below, not with the air, resulting in an inward (downward) force that pulls the surface molecules closer together.

(b) Mosquitoes are insects. They lay their eggs on the surface of water.

The photograph shows a mosquito and eggs on the surface of water.



(Source: © doug4537/Shutterstock)

(i) Analyse the information in the photograph to explain why the mosquito does not sink.

(2)

The mosquito has long legs with hairs, so its weight is spread out over a large area, exerting less downward pressure (force) on the water.

So the force of the mosquito is less than the cohesive forces of the water; it is insufficient to break the hydrogen bonds at the surface.

- (ii) Kerosene is a mixture of non-polar organic molecules made of carbon and hydrogen.

When kerosene is sprayed on the water, the floating mosquito eggs sink.

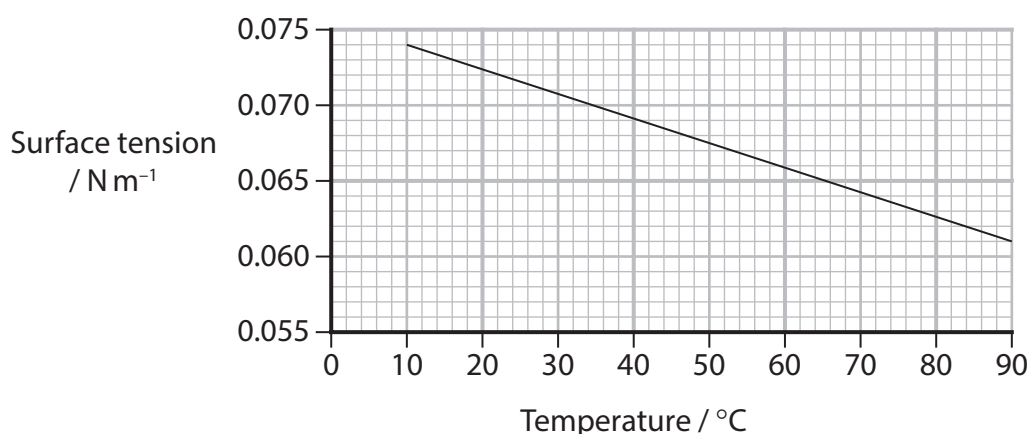
Explain why the eggs sink when kerosene is sprayed on the water.

(2)

Kerosene is non-polar, so its molecules come between the water molecules, reducing the number of hydrogen bonds that can form and reducing the cohesive forces.

So kerosene reduces the surface tension, the surface can no longer support the eggs, and the eggs sink.

- (c) The graph shows the effect of temperature on the surface tension of water.



- (i) Calculate the decrease in surface tension per 1 °C rise in temperature.

Give your answer in standard form, to one decimal place.

(2)

at 10 °C = 0.074 N m⁻¹; at 90 °C = 0.061 N m⁻¹

decrease = 0.074 - 0.061 = 0.013 N m⁻¹ over 80 °C

0.013 ÷ 80 = 0.0001625

Answer *1.6 × 10⁻⁴* N m⁻¹ per °C

(ii) Explain why a rise in temperature causes a decrease in surface tension.

(2)

A rise in temperature gives the water molecules more kinetic energy, so they move faster and vibrate more.

This breaks (reduces) the hydrogen bonds between water molecules, so the cohesive forces are weaker and the surface tension decreases.

(Total for Question 5 = 11 marks)

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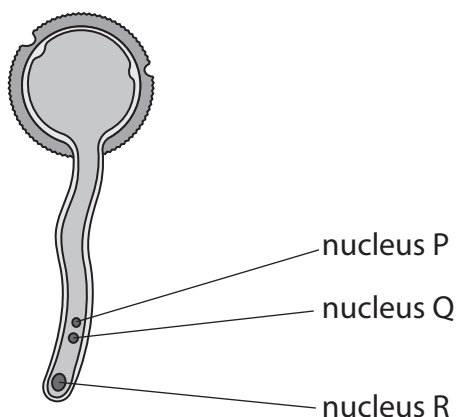
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- 6 In sexual reproduction in plants, a pollen grain lands on the stigma of a flower. The pollen grain germinates and a pollen tube grows.

(a) The diagram shows a germinated pollen grain.



- (i) Which row of the table shows the role of each of these nuclei?

(1)

Role of nucleus			
	P	Q	R
☐ A	control pollen tube growth	fertilise the female nucleus	fertilise the endosperm nucleus
☐ B	control pollen tube growth	fertilise the endosperm nucleus	fertilise the female nucleus
☐ C	fertilise the endosperm nucleus	control pollen tube growth	fertilise the female nucleus
☒ D	fertilise the endosperm nucleus	fertilise the female nucleus	control pollen tube growth

- (ii) Which row of the table shows the number of sets of chromosomes each nucleus contains?

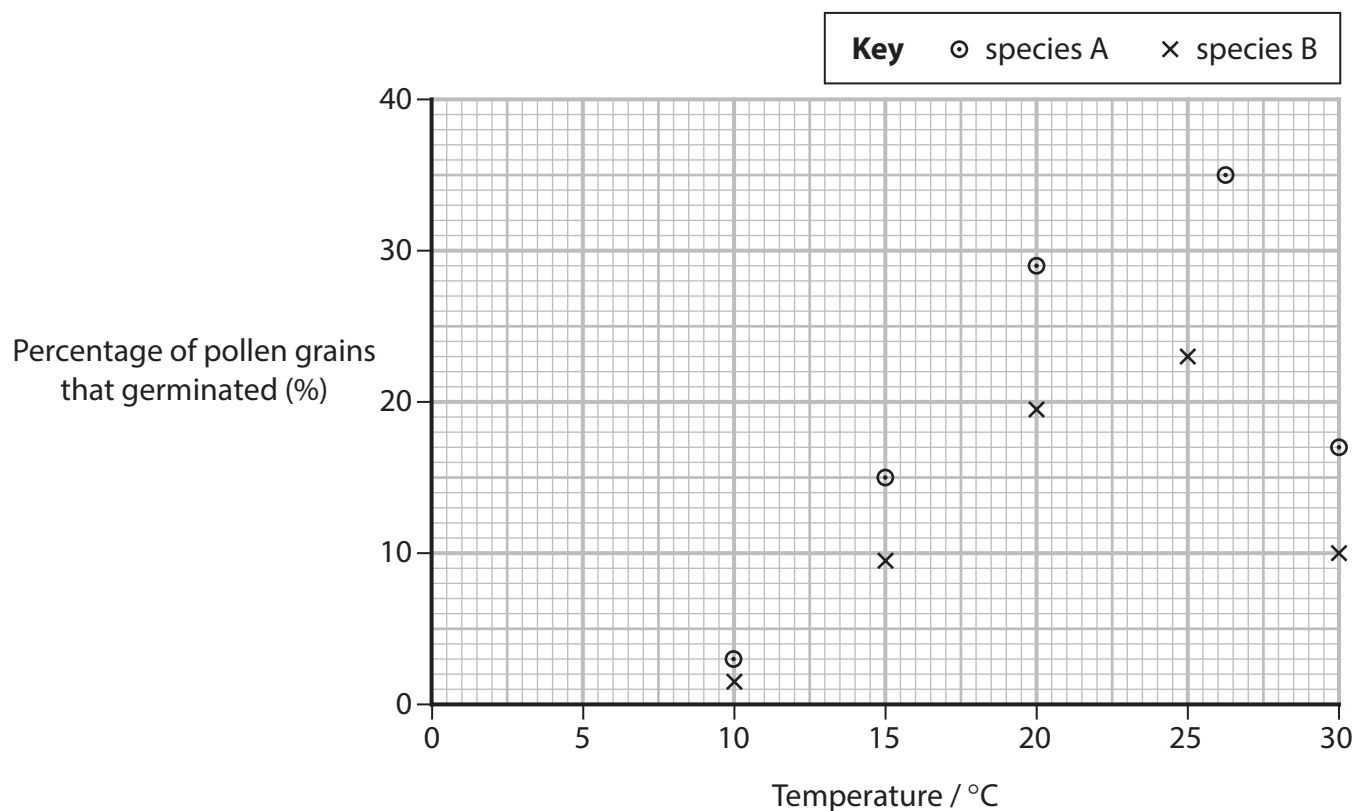
(1)

Number of sets of chromosomes			
	P	Q	R
☒ A	n	n	n
☐ B	n	2n	2n
☐ C	2n	n	2n
☐ D	2n	2n	n



- (b) The effect of temperature on the germination of pollen grains from two species of plant was investigated.

The graph shows the results of this investigation.



A student made two conclusions from these results.

- (i) Conclusion 1: species A has a wider range of temperatures for pollen grain germination.

Comment on this conclusion.

(3)

The conclusion is not justified: from the data both species have the same range of temperatures, both germinating from 10 °C to 30 °C.

There is no data below 10 °C or above 30 °C, so the full range is not known; species A is always higher so could germinate at lower and higher temperatures, but its germination drops more steeply above its peak so its range could be narrower.

Large gaps between temperatures, no idea of sample size and no standard deviations calculated.

- (ii) Conclusion 2: species A has a higher optimum temperature for germination than species B.

Devise an investigation to confirm conclusion 2.

(4)

Use pollen grains from the same two species, A and B.

Investigate more temperatures between 20 °C and 30 °C, at smaller increments of 1 °C, using water baths or incubators.

Put the pollen grains on slides in the same volume and concentration of sucrose solution (and mineral salts), and place the slides in a Petri dish with a humid atmosphere (damp filter paper) for the same time period.

Using a microscope, count the number of pollen grains and the number that have germinated, to calculate the percentage germination.

Repeat at least three times at each temperature, calculate the mean and standard deviation, and find the temperature with the highest mean germination for each species.

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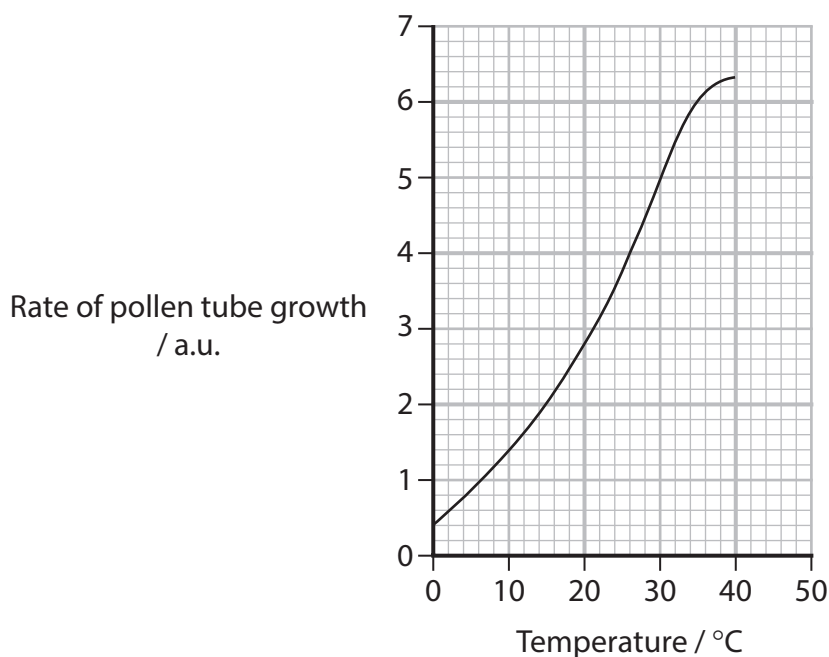
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- (c) In another investigation, the rate of pollen tube growth at different temperatures was determined.

The graph shows the results of this investigation.



Pollen tube growth is controlled by enzymes.

The temperature coefficient (Q_{10}) describes the increase in rate of reaction as a result of increasing the temperature by 10°C.

Calculate the Q_{10} for a temperature rise from 10°C to 20°C.

Use the formula:

$$Q_{10} = \frac{R_{(t+10)}}{R_t}$$

where R_t is the rate of reaction at 10°C.

Give your answer to one decimal place.

(2)

$$\text{rate at } 10^\circ\text{C } (R_t) = 1.4 \text{ a.u.}$$

$$\text{rate at } 20^\circ\text{C } (R_{t+10}) = 2.8 \text{ a.u.}$$

$$Q_{10} = 2.8 \div 1.4 = 2$$

Answer 2.0

(Total for Question 6 = 11 marks)

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7 Diseases caused by viruses, such as Ebola, can be difficult to treat.

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

1. It contains DNA
2. It has an envelope
3. It is a retrovirus

(1)

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

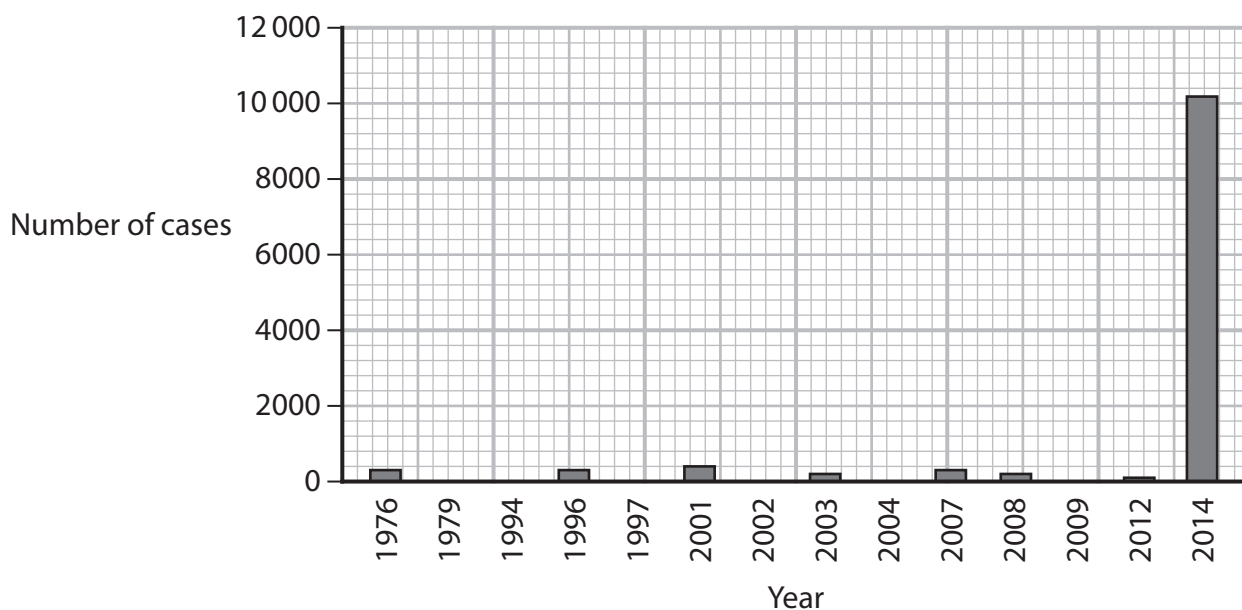
(b) Explain why diseases caused by viruses are difficult to treat.

(2)

Viruses are non-living and have a protein coat, so antibiotics have no target sites to act on.

Viruses reproduce (and can hide in latency) inside host cells, so drugs cannot access them without damaging the host cells.

- (c) The graph shows the number of cases of Ebola in each outbreak from 1976 to 2014.



- (i) State **two** conclusions that can be made about the outbreaks of Ebola in this time period.

(2)

1 *Outbreaks of Ebola do not occur every year, so Ebola is rare.*

2 *The number of cases is relatively low in every outbreak except in 2014, when most cases occurred.*



(ii) Give **two** reasons why the figures presented in this graph are likely to be an underestimate.

(2)

1 *Not all infections are documented, as some infections are asymptomatic, so they are never reported.*

2 *Some people died without a diagnosis because they were never seen by a healthcare professional.*

(iii) In October 2014, 10 141 cases and 4 922 deaths were reported.

Calculate the ratio of cases to deaths.

Give your answer in whole numbers.

(1)

10 141 : 4 922

10 141 ÷ 4 922 = 2.06, so 2.06 : 1

Answer *2 : 1*



*(d) The Ebola virus can spread between animals and humans and between humans.

The virus is present in bodily fluids of both infected animals and humans.

It can be passed on by contact with contaminated fluids, through open wounds, or by eating contaminated meat and fruits.

The spread of the disease is also affected by:

- changes in climate
- changes in land-use
- the economy of the country
- the health of the people.

A model has been developed to predict when and where outbreaks of Ebola could occur.

This model has shown that some countries in Africa are at risk of an outbreak of Ebola even though there have not been any known cases of Ebola there before.



Analyse the information to discuss the measures that could be used to reduce the risk of an Ebola outbreak in these countries.

(6)

Between people: isolate (quarantine) infected people, health workers wear protective clothing, cover wounds and never share needles; increase testing facilities and train healthcare workers to recognise early symptoms; limit movement into and out of infected areas.

From animals: the virus is in the fluids and meat of infected animals, so do not eat meat of carrier animals, cook meat thoroughly, cover uncooked meat and wash fruits and vegetables.

Climate and land use: monitor conditions and regulate land use, educate about sustainable agricultural practices, and monitor wildlife for signs of disease, as the model predicts outbreaks from these changes.

Economy and health: put more money into the health service, develop rapid response teams, stockpile medical supplies and PPE, run public awareness campaigns on health and hygiene, and develop and use vaccines.

However, these measures are costly, so lack of money, dependence on foreign aid and trade-offs with other programmes are problems; there may be public resistance, mistrust of authorities, misinformation, poor access to remote areas, a limited healthcare workforce and an impact on food supply.

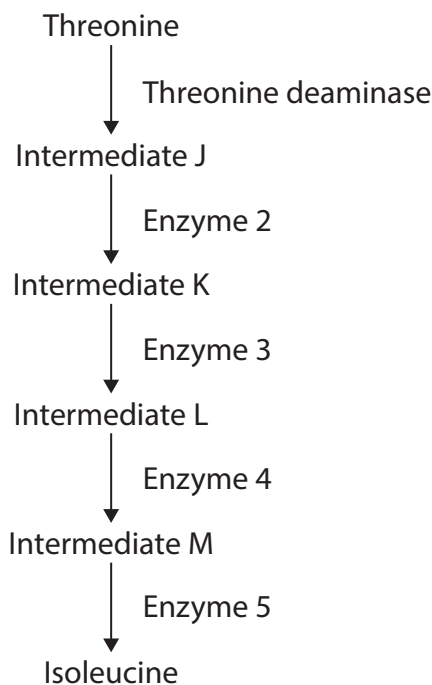
(Total for Question 7 = 14 marks)

8 Threonine is an amino acid that can be converted into another amino acid, isoleucine.

This conversion takes five steps.

The first step is catalysed by the enzyme threonine deaminase.

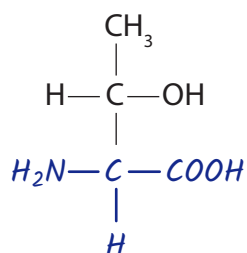
The diagram shows this conversion.



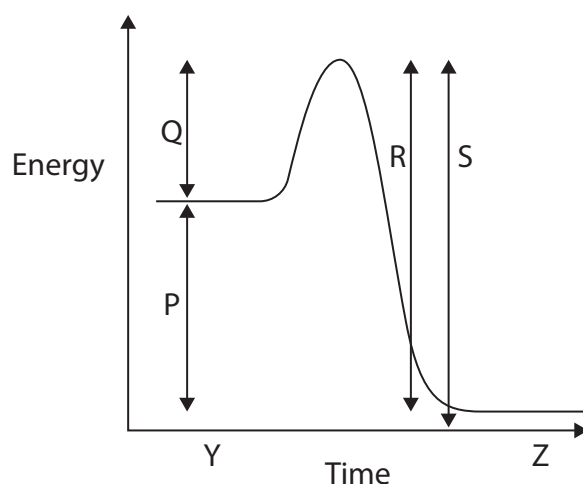
(a) The diagram shows the R group of threonine.

Complete the diagram to show the structure of threonine.

(3)



- (b) The graph shows the energy changes during the conversion of threonine to intermediate J, in the presence of threonine deaminase.



- (i) Which arrow shows the activation energy for this reaction?

(1)

- ☐ A P
☒ B Q
☐ C R
☐ D S

- (ii) Which row of the table identifies the molecule present at time Y and the molecule present at time Z on this graph?

(1)

	Time Y	Time Z
☐ A	the product threonine	the reactant intermediate J
☐ B	the product threonine	the reactant isoleucine
☒ C	the reactant threonine	the product intermediate J
☐ D	the reactant threonine	the product isoleucine

(iii) Which row of the table shows the change in length of the arrows P and Q on this graph in the absence of the enzyme threonine deaminase?

(1)

		Change in length of arrow	
		P	Q
☐	A	increase	increase
☐	B	increase	no change
☒	C	no change	increase
☐	D	no change	no change

(c) Explain why the conversion of threonine to isoleucine involves several different enzymes.

(3)

Threonine is not converted directly to isoleucine: it is a metabolic pathway of five steps, each producing a different intermediate.

Each intermediate (substrate) has a different 3D shape.

Enzymes are specific, so the active site of one enzyme is not complementary to all the substrates; a different enzyme is needed for each step.

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(d) This reaction is affected by end-product inhibition.

(i) Explain how end-product inhibition affects this reaction.

(3)

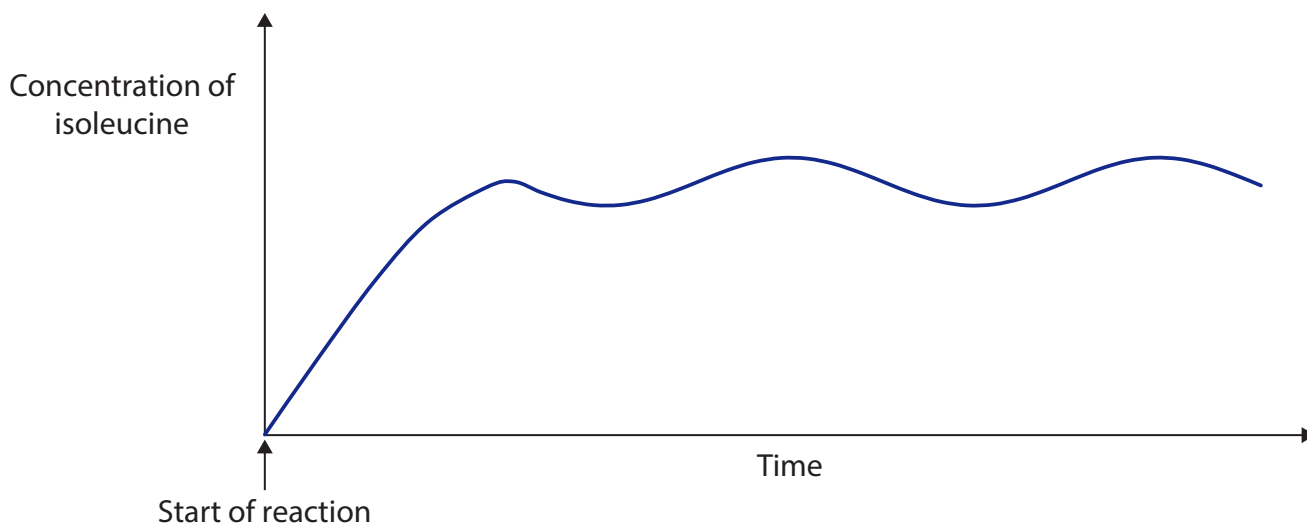
Above a certain concentration, isoleucine (the final product) binds to threonine deaminase, the first enzyme in the pathway.

It binds at an allosteric site, a site other than the active site, causing a conformational change in the enzyme.

The 3D shape of the active site changes, so threonine can no longer bind and no enzyme-substrate complexes form; less isoleucine is made until its concentration falls and it is released.

(ii) Complete the graph to show how the concentration of isoleucine would change as a result of end-product inhibition of threonine deaminase.

(3)



(Total for Question 8 = 15 marks)

TOTAL FOR PAPER = 80 MARKS

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