Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Biology B

Advanced
Paper 1: Advanced Biochemistry, Microbiology and Genetics

Thursday 7 June 2018 – Morning
Time: 1 hour 45 minutes

Paper Reference
9BI0/01

You must have:
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.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You may use a scientific calculator.
- 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.

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.*

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 venom from some species of snake contains enzymes that affect the blood clotting process.

(a) (i) Which is a correct statement about enzymes?

(1)

☒ **A** enzymes decrease the activation energy of metabolic reactions and decrease reaction time

☒ **B** enzymes decrease the activation energy of metabolic reactions and increase reaction time

☒ **C** enzymes increase the activation energy of metabolic reactions and decrease reaction time

☒ **D** enzymes increase the activation energy of metabolic reactions and increase reaction time

(ii) Which components of the blood clotting process are active enzymes?

(1)

☒ **A** fibrin and thrombin

☒ **B** fibrinogen and thrombin

☒ **C** fibrinogen and thromboplastin

☒ **D** thrombin and thromboplastin

(b) Factor Xa is a clotting factor present in human blood.

The table shows the effect of different masses of Factor Xa and snake venom on the time taken for blood to clot.

Mass added / μg	Time taken for blood to clot / s	
	Factor Xa added	Snake venom added
0.002	150	104
0.004	44	50
0.020	40	38
0.040	39	37

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Describe the effect of snake venom on the time taken for the blood to clot.

(2)

(c) State the role of platelets in the blood clotting process.

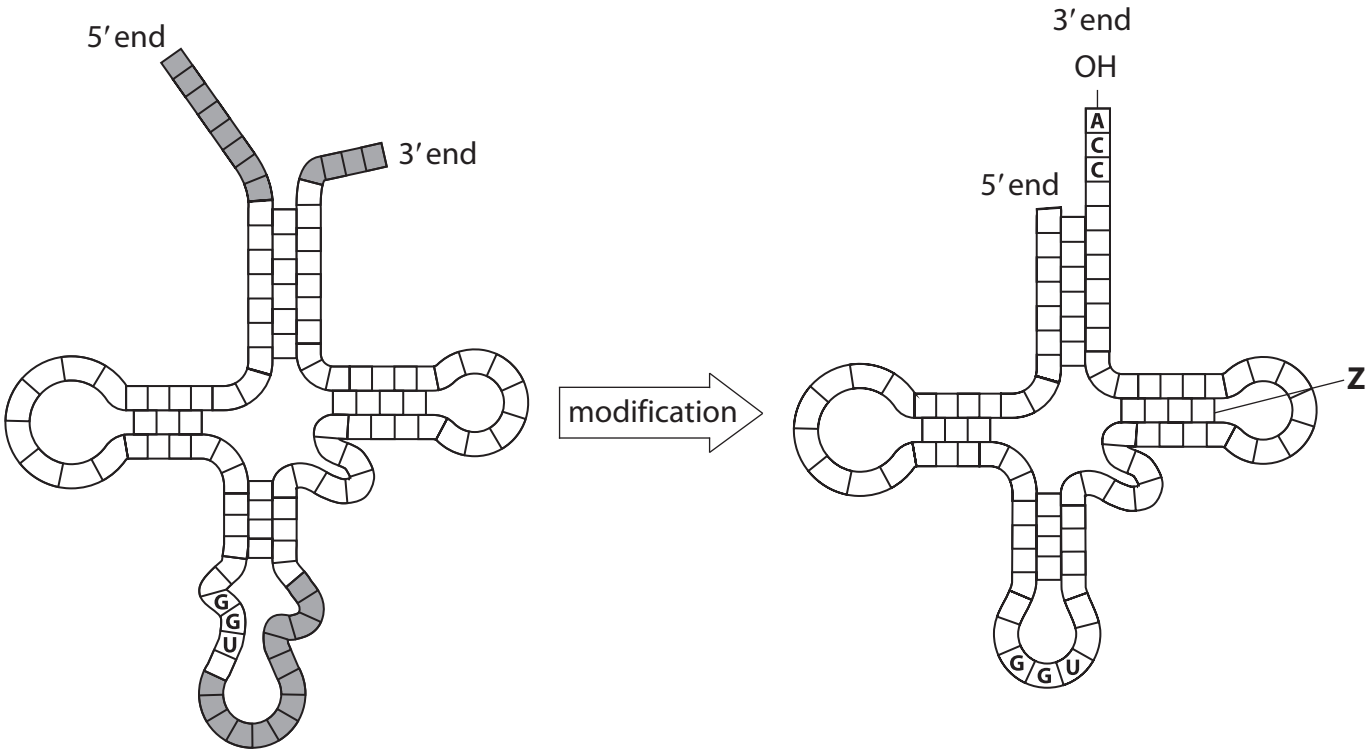
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(Total for Question 1 = 5 marks)

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2 A molecule of tRNA is made from a precursor molecule that is modified. Modification includes splicing, trimming and attachment of new nucleotides.

The diagram shows a precursor molecule for a tRNA specific for the amino acid proline, and a tRNA molecule specific for the amino acid proline. Some of the bases are shown in each diagram.



precursor molecule

tRNA molecule specific for the amino acid proline

(a) Which bond is labelled **Z**?

(1)

☒ **A** glycosidic

☒ **B** hydrogen

☒ **C** peptide

☒ **D** phosphodiester

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(b) Describe how this precursor molecule is modified to produce a tRNA molecule specific for the amino acid proline.

(3)

(c) (i) Which of the following base sequences is the mRNA code for proline?

(1)

☒ **A** A A T

☒ **B** C C A

☒ **C** C C T

☒ **D** C C U

(ii) Which of the following base sequences is the DNA code for proline?

(1)

☒ **A** A C C

☒ **B** C C A

☒ **C** G G T

☒ **D** U G G

(Total for Question 2 = 6 marks)

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3 The photograph shows an adult mayfly.



(a) *Rhithrogena germanica* is commonly known as the March brown mayfly.

The classification hierarchy for this mayfly is: Animalia
Arthropoda
Insecta
Ephemeropteroidea
Heptageniidae
Rhithrogena germanica

(i) State the genus of this mayfly.

(1)

.....

(ii) This mayfly belongs to the phylum Arthropoda.

Which is the order for this mayfly?

(1)

☒ **A** Animalia

☒ **B** Ephemeropteroidea

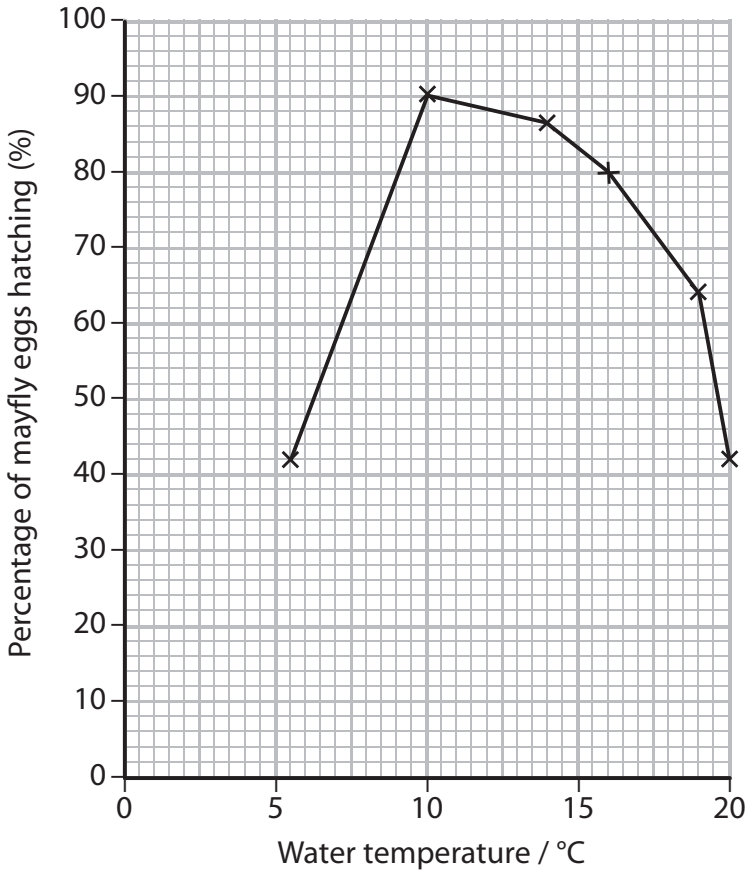
☒ **C** Heptageniidae

☒ **D** Insecta

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(b) Mayflies lay their eggs in water.

The graph shows the effect of water temperature on the percentage of mayfly eggs that hatch.



Explain the effect of temperature on the percentage of mayfly eggs that hatch.

(4)

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(c) Mayfly eggs hatch into immature insects called nymphs. The nymphs live in the water and develop to form adult mayflies.

The photograph shows a mayfly nymph.



Compare and contrast the structure of the gas exchange system of the mayfly nymph with the adult mayfly.

(3)

(Total for Question 3 = 9 marks)

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4 Mitochondria can be extracted from liver cells.

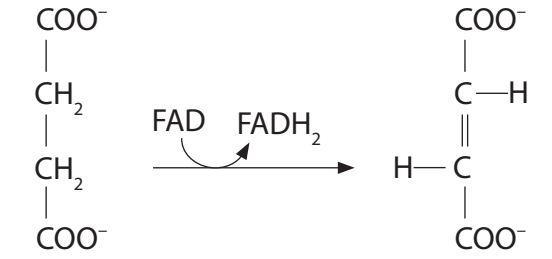
In order to monitor the purification of a sample of mitochondria, a protein concentration : enzyme activity ratio can be determined.

(a) Describe the structure of a globular protein.

(2)

(b) The enzyme used to monitor the purification of mitochondria is succinate dehydrogenase.

This enzyme is involved in the Krebs cycle and converts succinate into fumarate in this reaction.



Succinate Fumarate

(i) When succinate is converted into fumarate, succinate is

(1)

☒ **A** hydrolysed

☒ **B** oxidised

☒ **C** phosphorylated

☒ **D** reduced

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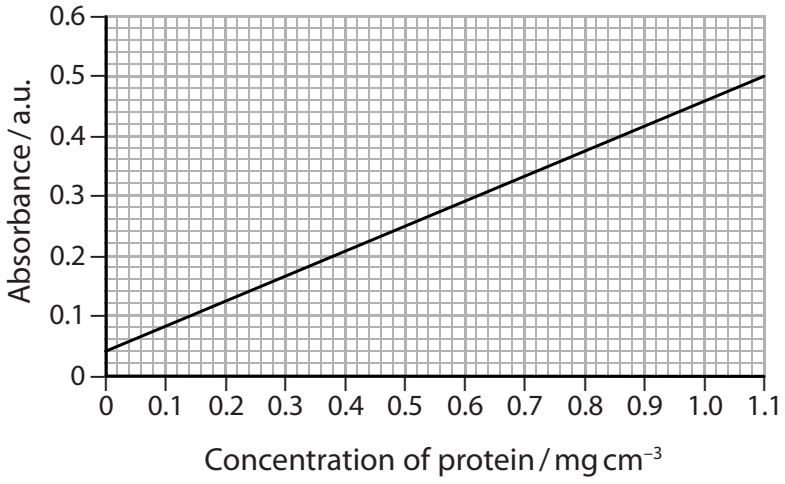
(ii) Explain the role of the Krebs cycle.

(4)

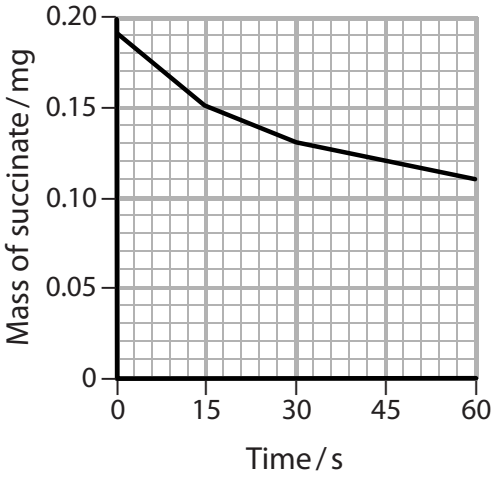
(c) Protein concentrations can be determined by using a calibration curve, shown in graph 1.

The initial rate of activity of succinate dehydrogenase, from a sample of mitochondria, can be determined using graph 2.

Graph 1



Graph 2



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(i) This sample of mitochondria had an absorbance of 0.28 when the protein concentration was measured.

Determine the protein concentration of this sample of mitochondria.

(1)

Answer .....

(ii) Determine the initial rate of enzyme activity to obtain the protein : enzyme activity ratio for this sample of mitochondria.

(2)

Ratio .....

(Total for Question 4 = 10 marks)

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5 Leigh syndrome is a genetic disorder inherited from the mother. The mother carries genes for the disorder in her mitochondrial DNA.

(a) Draw and label a mitochondrion.

(4)

(b) Scientists have developed a technique for producing 'three-parent' babies.

This ensures that a mother with Leigh syndrome will not pass on the genes for this disorder to her baby.

The technique involves:

- removing the nucleus from the ovum of the mother
- removing the nucleus from the ovum of a donor female to produce an enucleated ovum
- inserting the nucleus from the ovum of the mother into the enucleated donor ovum
- fertilising this ovum with the sperm of the father to produce a zygote
- implanting the resulting embryo into the uterus of the mother.

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(i) The 'three-parent' baby produced by this technique will inherit mitochondrial DNA from the

(1)

☒ **A** donor female

☒ **B** donor female and father

☒ **C** mother

☒ **D** mother and father

(ii) Explain the importance of DNA replication during the development of this zygote into a blastocyst.

(3)

(Total for Question 5 = 8 marks)

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6 During the development of active immunity, macrophages present antigens to T helper cells.

(a) Describe how macrophages present antigens to T helper cells.

(2)

(b) In an investigation into clonal selection, macrophages and T cells were isolated from two strains of guinea pig, strain 2 and strain 13.

The macrophages from each strain of guinea pig were exposed to an antigen and treated with mitomycin.

Mitomycin forms cross links between complementary strands of DNA.

These macrophages were then cultured with T cells from each of the strains of guinea pig for 72 hours.

Radioactive thymidine was included in the culture. This molecule will become incorporated into DNA during DNA replication instead of thymine.

The table shows the results of this investigation.

Source of macrophages	Level of radioactive thymidine incorporated into T cells / a.u.	
	T cells from strain 2 guinea pigs	T cells from strain 13 guinea pigs
strain 2	180	13
strain 13	17	59

(i) Explain why the macrophages were treated with mitomycin.

(3)

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(ii) Explain how radioactive thymidine becomes incorporated into the DNA.

(2)

(iii) Analyse the data to explain the results of this investigation.

(4)

(Total for Question 6 = 11 marks)

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7 Xylem and phloem are involved in transport in plants.

(a) (i) Which row of the table shows some of the substances transported in xylem and phloem?

(1)

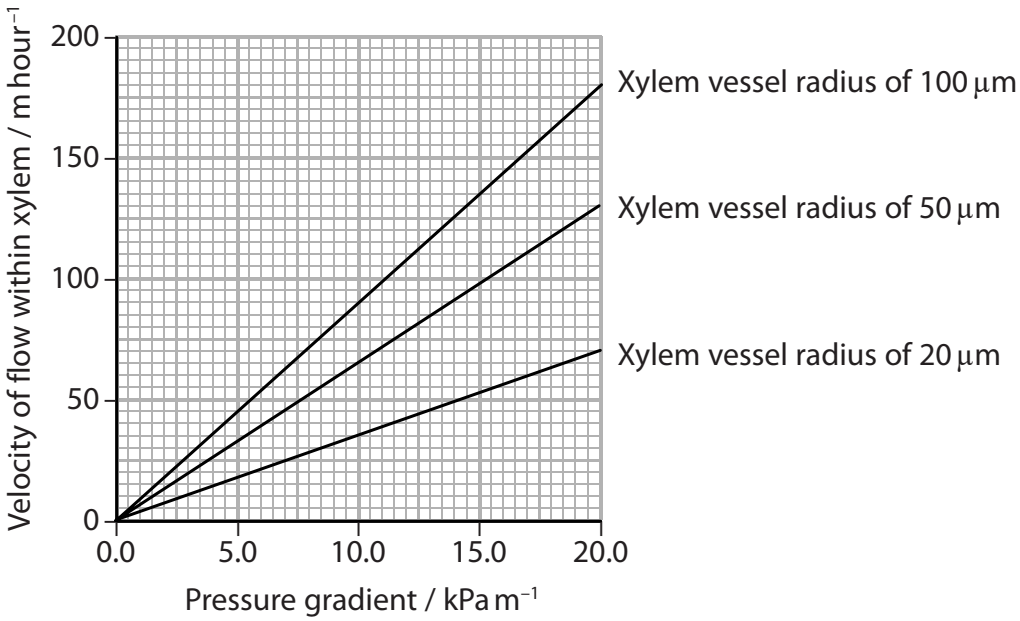
		Xylem	Phloem
☒	**A**	water only	sucrose only
☒	**B**	water only	water and sucrose
☒	**C**	water and mineral ions	sucrose only
☒	**D**	water and mineral ions	water and sucrose

(ii) Describe the differences between the structure of xylem and that of phloem.

(3)

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(b) The graph shows the effect of pressure gradient on the velocity of flow within three xylem vessels.



(i) Describe the effect of pressure gradient and radius on the velocity of flow within the xylem vessels.

(2)

(ii) Calculate the percentage increase in the velocity of water flowing through a xylem vessel of radius 20 μm and a xylem vessel of radius 100 μm, at a pressure gradient of 17.5 kPa m^{-1}.

(2)

Answer .....

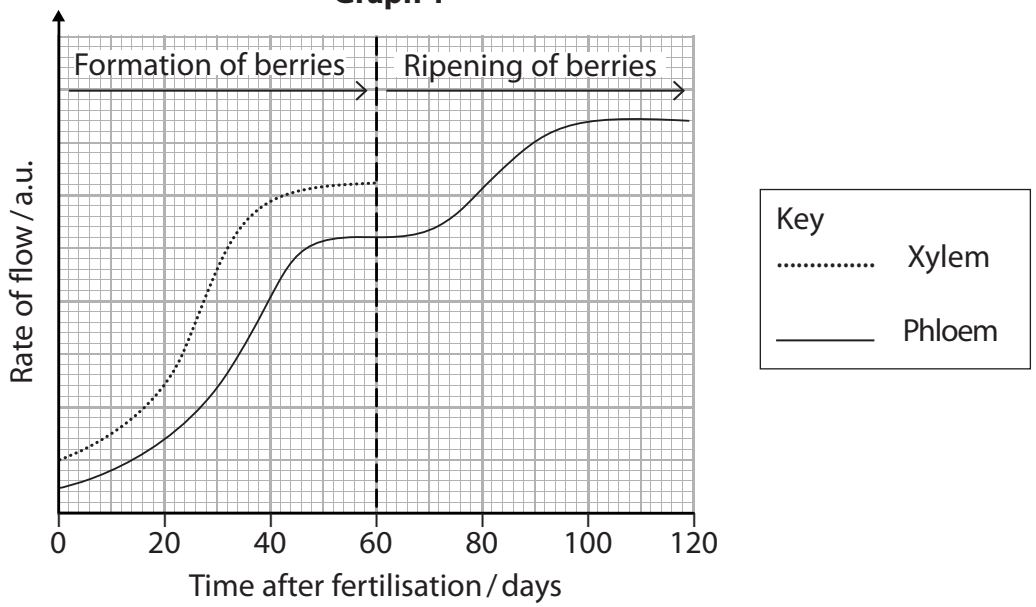
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*(c) Double fertilisation in some plants leads to the development of fruits, such as berries.

In an investigation, the rate of flow in xylem during the formation of berries was measured. The rate of flow in the phloem during the formation and ripening of the berries was also measured.

The results are shown in graph 1.

Graph 1



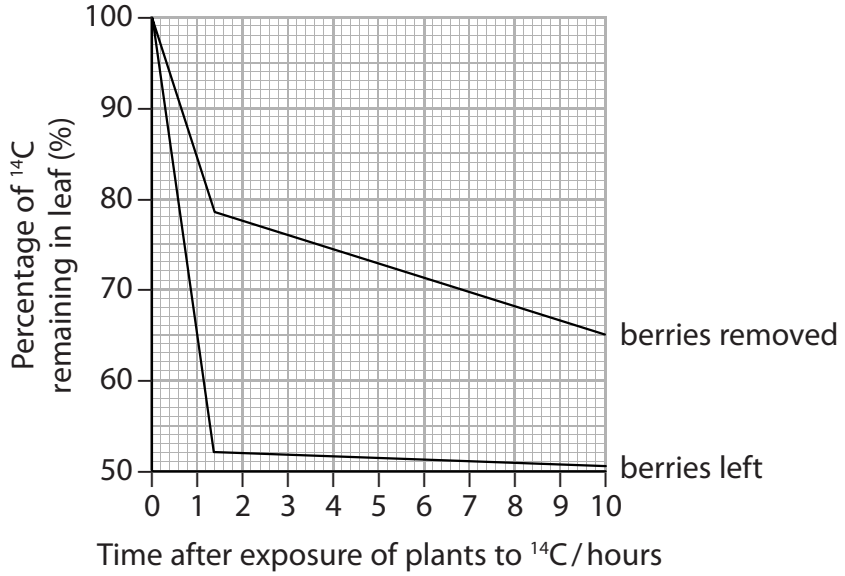
In a second investigation, two plants with berries were exposed to radioactive carbon dioxide (^{14}C).

After exposure to ^{14}C, the berries were removed from one plant and left on the second plant.

The percentage of ^{14}C remaining in the leaves of each plant was determined during the next 10 hours.

The results are shown in graph 2.

Graph 2



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Analyse the data to explain the role of double fertilisation, xylem and phloem in the development of the berries.

(6)

(Total for Question 7 = 14 marks)

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8 *Salmonella* are Gram negative bacteria found in the large intestine of humans.

(a) Which is the correct statement about *Salmonella*?

(1)

☒ **A** *Salmonella* has a thick peptidoglycan cell wall and produces endotoxins

☒ **B** *Salmonella* has a thick peptidoglycan cell wall and produces exotoxins

☒ **C** *Salmonella* has a thin peptidoglycan cell wall and produces endotoxins

☒ **D** *Salmonella* has a thin peptidoglycan cell wall and produces exotoxins

(b) A scientist studied the growth of *Salmonella*.

(i) *Salmonella* was isolated from a mixed culture of bacteria, using streak plating onto selective media.

Explain why this is a suitable method for isolating the *Salmonella*.

(4)

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(ii) The scientist made a broth culture of *Salmonella* at a concentration of 5×10^3 cells per cm^3.

Ten hours later the concentration of *Salmonella* was 4×10^6 per cm^3.

Calculate the exponential growth rate constant (k) for this culture of *Salmonella* using the formula

(3)

$$k = \frac{\log_{10}N_t - \log_{10}N_0}{0.301 \times t}$$

Answer .....

(iii) In this calculation, the scientist did not allow for the time that the *Salmonella* spent in the lag phase.

Explain the effect that this will have on the calculated value for the growth rate constant.

(3)

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(Total for Question 8 = 11 marks)

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9 Soya beans are an important crop for the production of food and oil.

(a) In the 2012 to 2013 growing season, production of soya beans was highest in the United States and second highest in Brazil.

The United States produced 93 million tonnes of soya beans from 31 million hectares.

This was 9.4% more than Brazil produced from 28 million hectares.

Calculate the difference in the yield per hectare of soya beans from these two countries.

(3)

Answer .....

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(b) Soya beans can be genetically modified to form transgenic plants.

A study of the nutritional content of soya beans from non-transgenic soya bean plants and from transgenic soya beans plants was carried out in two regions of Brazil.

The regions were Ponta Grossa and Londrina.

Tables 1 and 2 show the results of this study.

Table 1

Type of plant	Region	Mean mineral content / mg per 100 g dried soya beans		
		Iron	Copper	Manganese
Non-transgenic	Ponta Grossa	3.34	0.76	1.38
Transgenic	Ponta Grossa	3.44	0.86	1.40
Non-transgenic	Londrina	4.59	1.35	2.20
Transgenic	Londrina	4.15	1.25	2.02

Table 2

Type of plant	Region	Mean organic content / mg per 100 g dried soya beans		
		Protein	Lipid	Carbohydrate
Non-transgenic	Ponta Grossa	38.61	21.09	23.88
Transgenic	Ponta Grossa	38.80	21.19	23.41
Non-transgenic	Londrina	41.68	18.56	25.74
Transgenic	Londrina	40.62	19.87	25.26

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*(i) Analyse the data to assess the nutritional content of soya beans from transgenic and from non-transgenic soya bean plants grown in these two regions.

(6)

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(ii) The soil in Londrina is more fertile than the soil in Ponta Grossa. Londrina has higher temperatures and rainfall during the growing season.

Explain the differences in the nutritional content of soya beans grown in these two regions.

(5)

(iii) Explain why this study also analysed the types of fatty acid found in soya beans from transgenic plants and from non-transgenic plants.

(2)

(Total for Question 9 = 16 marks)

TOTAL FOR PAPER = 90 MARKS

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