Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

0929166504

BIOLOGY **9700/51**

Paper 5 Planning, Analysis and Evaluation **October/November 2015**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

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PAPA CAMBRIDGE

1 Protease enzymes catalyse the hydrolysis of protein. There are a number of different types of protease enzyme.

A student was provided with two proteases that hydrolyse the amino acid chains of protein in different ways, producing mixtures of single amino acids and peptides of varying lengths.

1. An endoprotease that hydrolyses peptide bonds between specific amino acids within the protein molecule. The enzyme only functions if there is a minimum of two amino acids on each side of the hydrolysis site.

2. An exoprotease that hydrolyses the terminal peptide bond of a molecule. The enzyme only functions if the substrate molecule has a minimum of three amino acids.

The student used these enzymes to hydrolyse a protein formed by the linking of two polypeptides.

Fig. 1.1 shows the possible hydrolysis sites of these two enzymes on this protein.

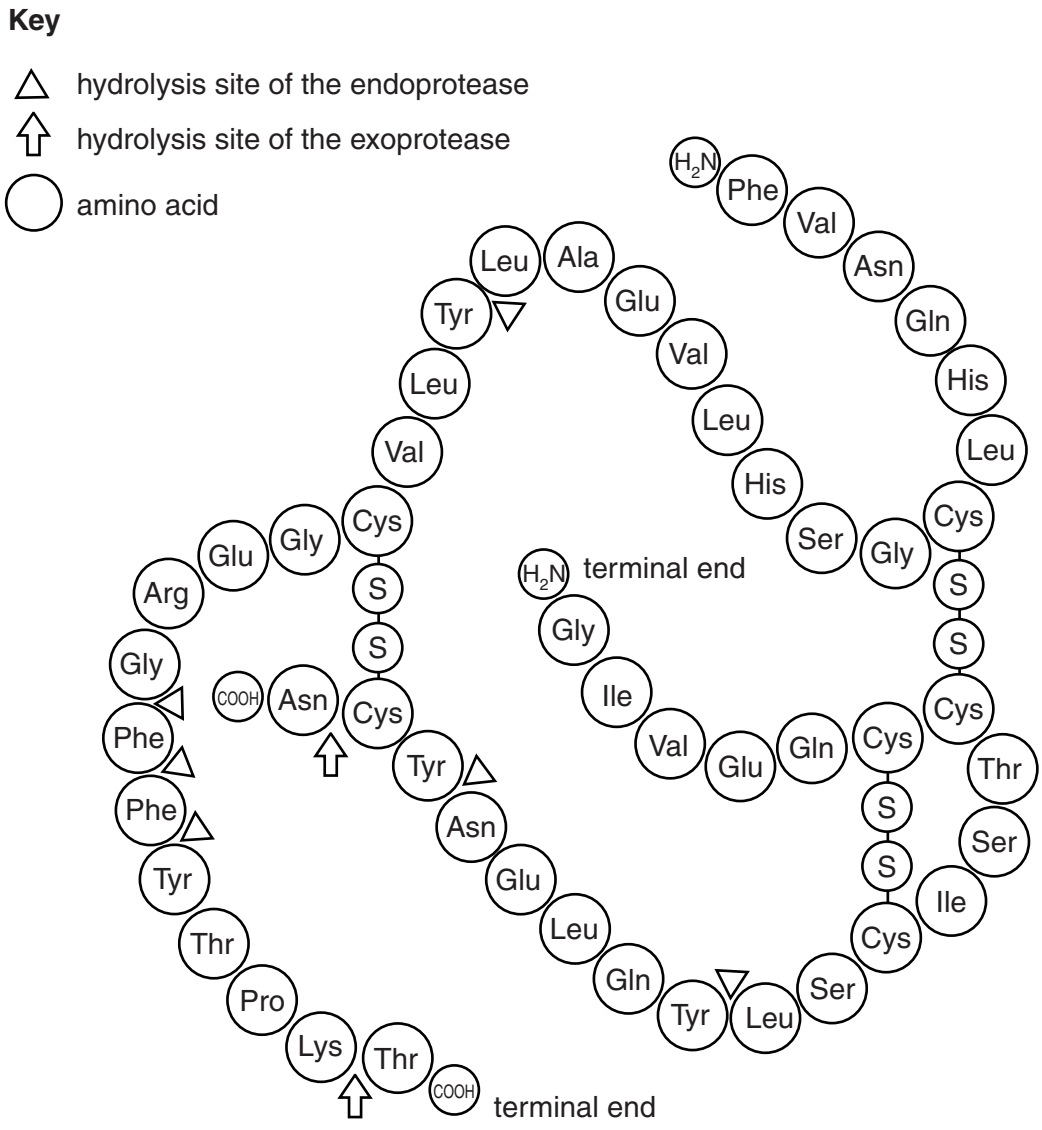


Fig. 1.1

PAPA CAMBRIDGE

(a) The student investigated the effect of these two enzymes on the hydrolysis of this protein by incubating the protein separately with each of the enzymes.

- Each mixture of enzyme and protein was incubated at 35 °C and at a pH of 7.6.
- At intervals of 5 minutes, samples of each mixture were removed using a capillary tube.
- The products of hydrolysis of each mixture were separated by chromatography using the same solvent.
- The products of hydrolysis were located by spraying the chromatogram with the same specific dye.
- The student continued sampling every 5 minutes and running chromatograms for each mixture until hydrolysis of the protein was completed by each enzyme.

(i) Identify the **independent** variable in this investigation.

.....[1]

(ii) Identify **three** variables, **other than** the chromatography solvent and the specific dye, that the student has standardised in this investigation.

Describe how the student might have standardised **two** of these variables.

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(iii) Suggest how the student determined when the hydrolysis was complete.

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.....[1]

PAPA CAMBRIDGE

(b) Describe a method that the student could use to prepare and use chromatograms to compare the changes in the products of hydrolysis of the protein by the two different proteases over time.
Your method should be detailed enough for another person to follow.

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(c) Fig. 1.2 shows the appearance of the chromatograms at the times when hydrolysis by the different enzymes was complete.

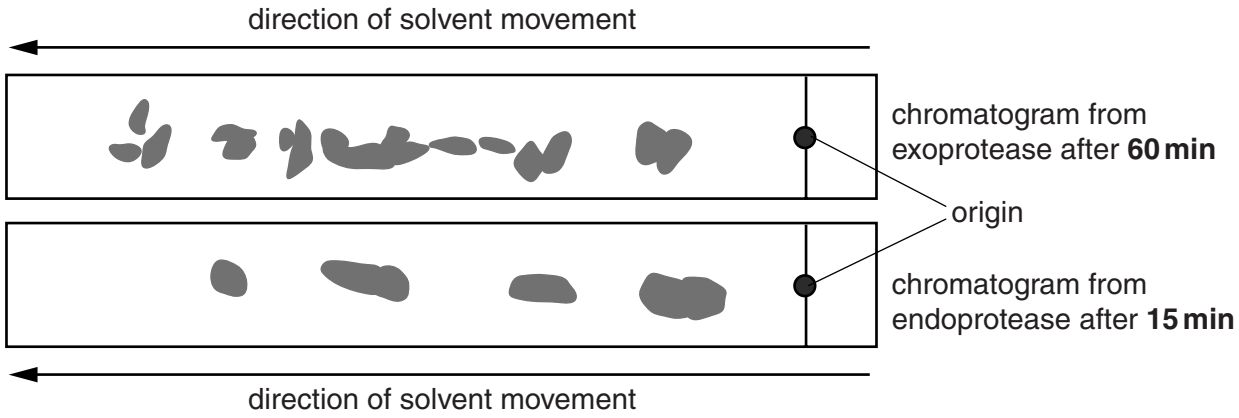


Fig. 1.2

The student concluded that:

1. The endoprotease worked faster than the exoprotease because fewer bonds were hydrolysed.
2. The products of hydrolysis of the exoprotease were all single amino acids giving more spots on the chromatogram.
3. The larger peptides released by the endoprotease have fewer charges and moved more slowly than single amino acids and small peptides.
4. Hydrolysing the protein with a mixture of endoprotease and exoprotease would give the same results as for the exoprotease more quickly.

State **and** explain whether each of these conclusions about the hydrolysis of protein is supported **or** not supported by the evidence in Fig. 1.2 and the information in the question about these two enzymes.

conclusion 1 .....

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conclusion 2 .....

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conclusion 3 .....

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conclusion 4 .....

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PAPA CAMBRIDGE

(d) Using an internet search the student found that:

- electrophoresis can also be used to separate the products of enzyme hydrolysis of proteins
- a combination of electrophoresis and chromatography was used to study haemoglobin from people with sickle cell anaemia (SCA).

In an investigation, the haemoglobin from people with SCA and people without the disease was hydrolysed by an endoprotease. The resulting mixture was placed centrally on one side of chromatography paper and separated by electrophoresis.

Negatively charged peptides moved to the anode (+) and positively charged peptides moved to the cathode (–). The paper was turned through 90° and chromatography used to separate the mixture.

Fig. 1.3 shows the main stages of this experiment.

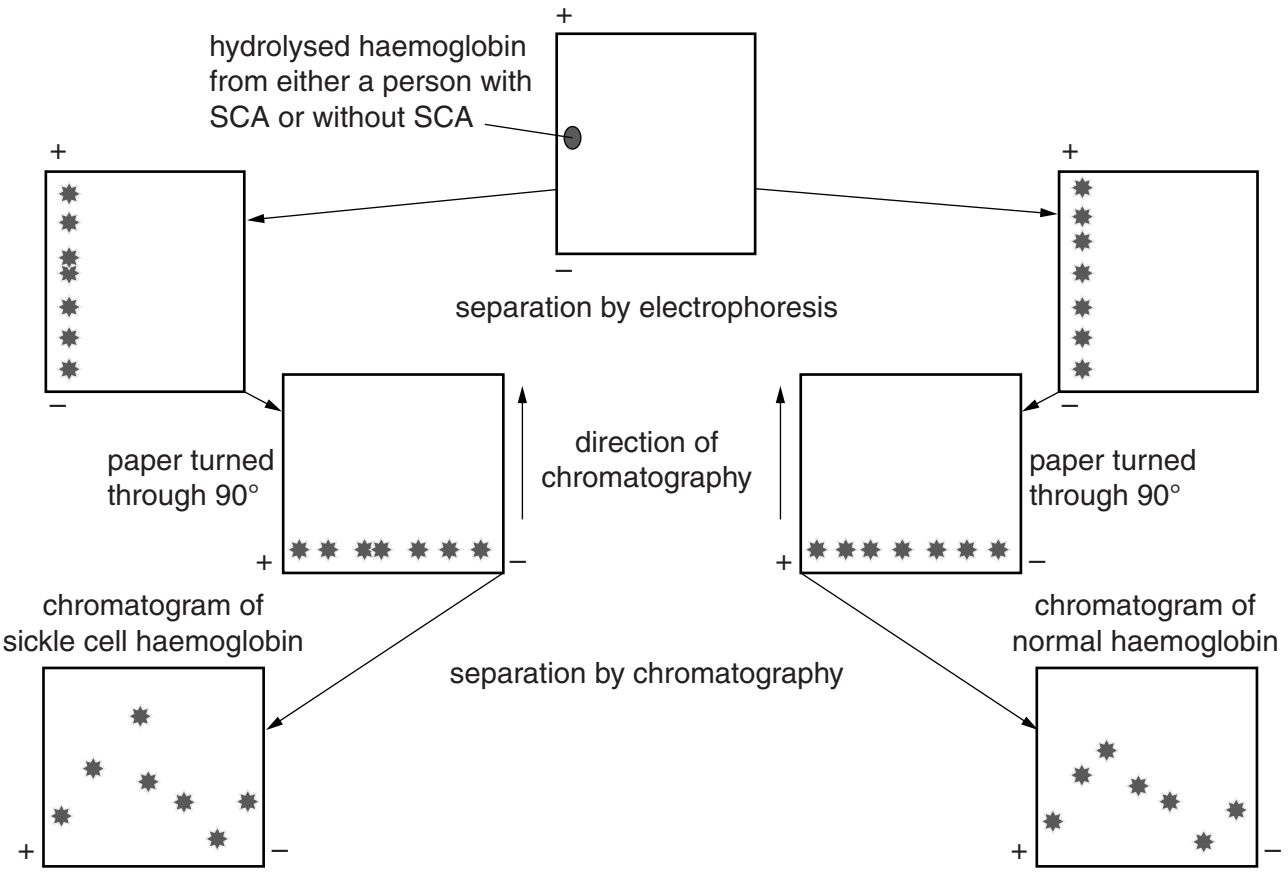


Fig. 1.3

(i) Sickle cell haemoglobin and normal haemoglobin have a difference in amino acid sequence.

On Fig. 1.3, draw a circle around the spot in each chromatogram that shows that the two types of haemoglobin have different amino acid sequences. [1]

(ii) Explain your answer to **(i)**.

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[Total: 19]

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PAPA CAMBRIDGE

2 Aphids are serious pests of many crop plants, causing wilting and spreading virus infections. A newly developed hybrid of a crop plant was found to be very susceptible to aphid infestation. Aphid infestations are usually controlled by spraying with insecticide.

An investigation into the effect of an insecticide was carried out by counting the number of aphids on leaves of the hybrid crop plant before and after treatment.

The insecticide was dissolved in an oily liquid.

- Ten hybrid plants were divided into two groups of five, **A** and **B**.
- Five leaves on each plant were used for the investigation.
- The total number of aphids on **both** surfaces of the five test leaves of each sample plant was counted before treatment.
- The upper surfaces of 5 leaves on the plants in group **A** were sprayed with insecticide.
- The lower surfaces of 5 leaves on the plants in group **B** were sprayed with the same insecticide.
- The same procedure was used to spray the leaves of control plants with a liquid.
- The total number of aphids on **both** surfaces of the treated leaves of all the plants was counted 24 hours, 48 hours and 72 hours after treatment.

(a) (i) State the **dependent** variable in this investigation.

.....[1]

(ii) Suggest what liquid should be used as the control.

.....

.....[1]

Table 2.1 shows the results of the investigation.

Table 2.1

time/h	mean total number of aphids on **both** surfaces of leaves ± standard error (S_M)			
	Group **A** upper surfaces of leaves sprayed		Group **B** lower surfaces of leaves sprayed	
	control	treated	control	treated
0	75 ± 5	75 ± 8	80 ± 20	85 ± 15
24	80 ± 6	85 ± 15	85 ± 25	3 ± 1
48	85 ± 5	90 ± 10	98 ± 20	2 ± 1
72	110 ± 4	110 ± 8	115 ± 25	2 ± 1

(b) (i) State what is meant by standard error.

.....

.....[1]

PAPA CAMBRIDGE

(ii) Identify the results from Table 2.1 which suggest that the difference in the numbers of aphids as a result of the insecticide treatment may be significant.

Give a reason for your answer.

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.....[2]

(c) Identify **three other** features of the results shown in Table 2.1.

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(d) A *t*-test was used to find out if the number of aphids in Group **A** and in Group **B**, 72 hours after treatment with insecticide, differed significantly.

(i) State **one** reason why a *t*-test was used.

.....

.....[1]

(ii) State a null hypothesis for this test.

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.....[1]

(iii) The number of degrees of freedom for this statistical test is 48.

Describe how this is calculated.

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[Total: 11]

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PAPA CAMBRIDGE

Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5726098057

BIOLOGY **9700/52**

Paper 5 Planning, Analysis and Evaluation **October/November 2015**

1 hour 15 minutes

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[Turn over

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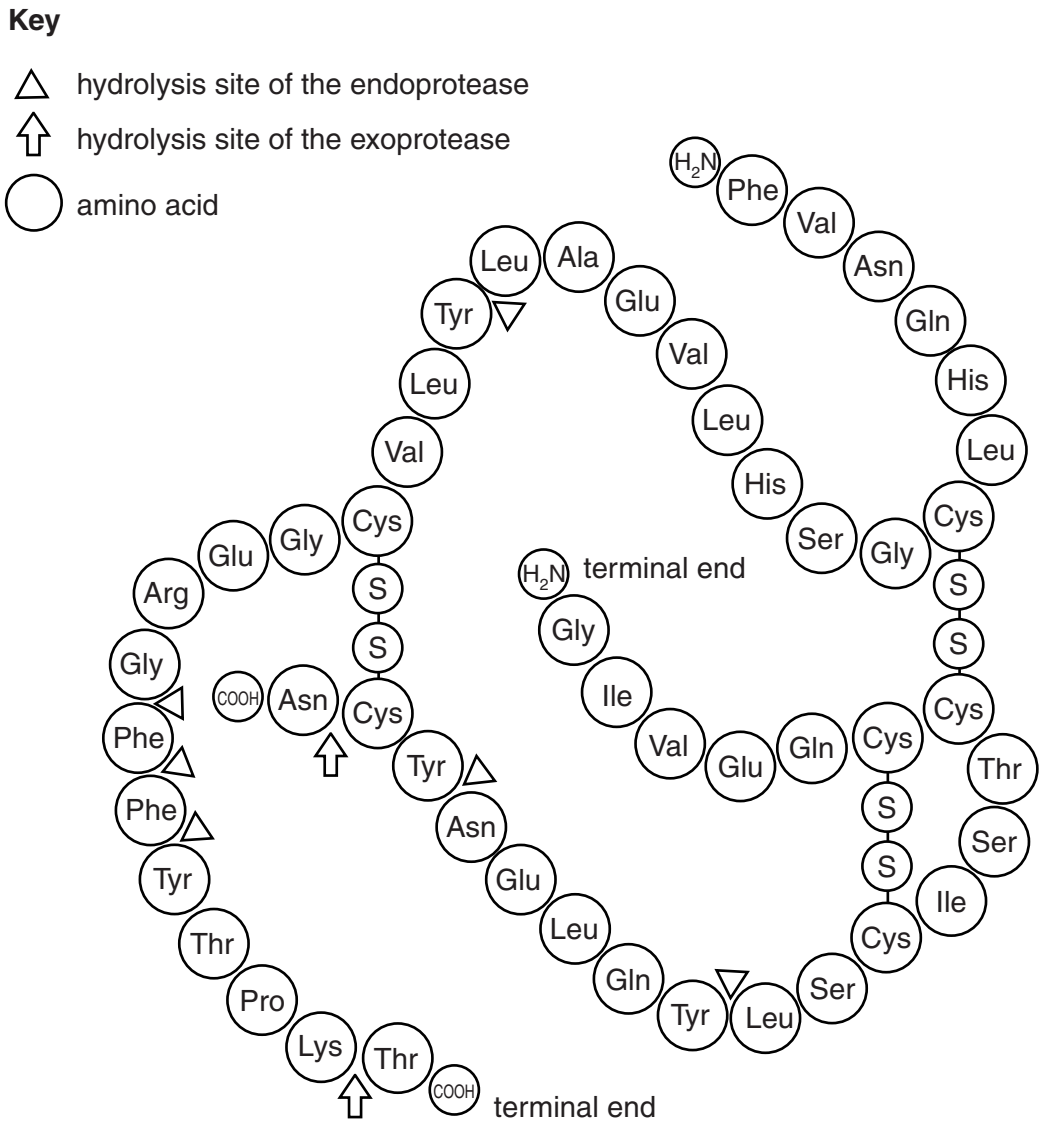


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PAPA CAMBRIDGE

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PAPA CAMBRIDGE

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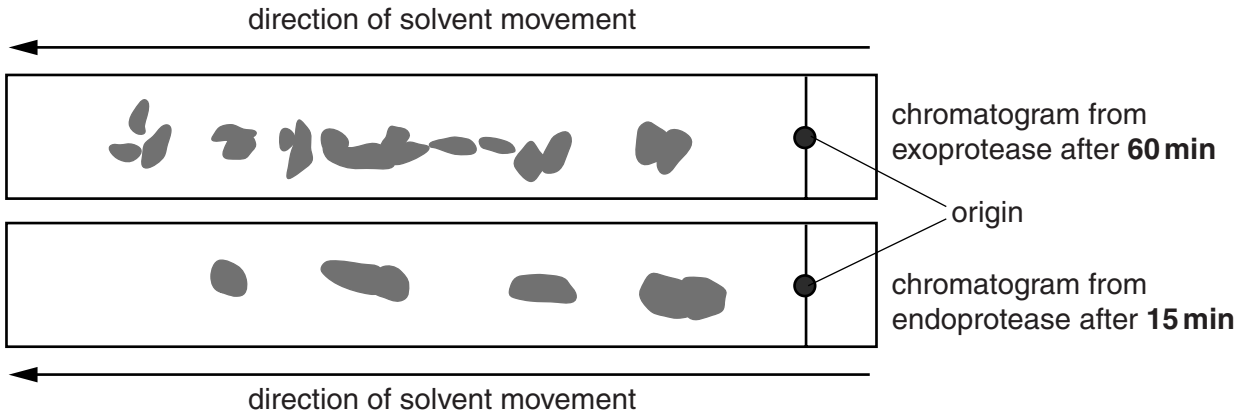


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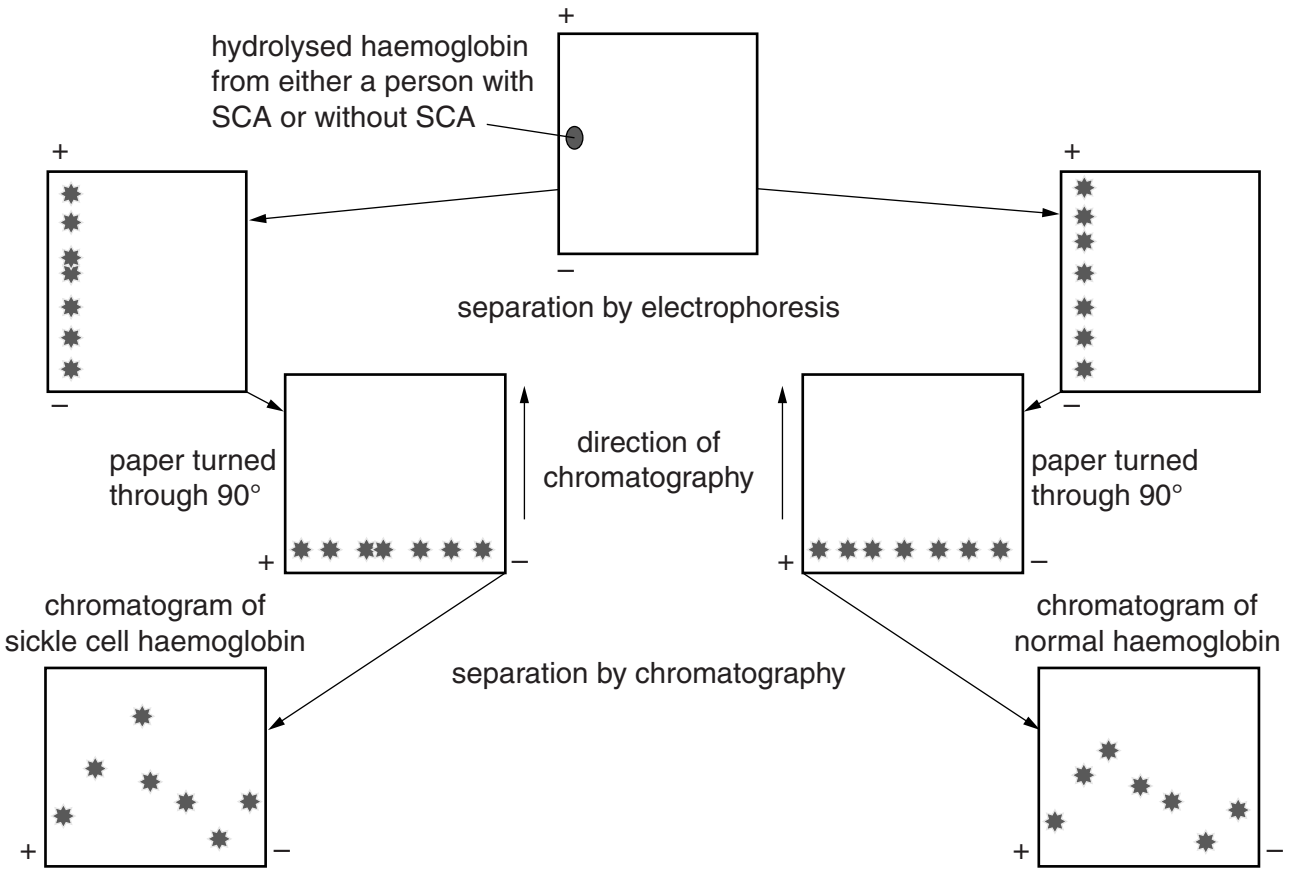


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PAPA CAMBRIDGE

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(ii) State a null hypothesis for this test.

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Describe how this is calculated.

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PAPA CAMBRIDGE

Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1438374994

BIOLOGY **9700/53**

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[Turn over

PAPA CAMBRIDGE

1 Amylases are enzymes that hydrolyse starch. There are three types of amylase:

- **α–amylase** hydrolyses 1,4 glycosidic bonds randomly within amylose and amylopectin chains. It has an optimum pH of 6.7.
  Hydrolysis releases saccharides made of varying numbers of glucose molecules, for example the disaccharide maltose, the trisaccharide maltotriose and short chain polymers made of eight to ten glucose units.
- **β-amylase** hydrolyses 1,4 glycosidic bonds of both amylose and amylopectin releasing maltose. It has an optimum pH of 4.5.
- **γ-amylase** hydrolyses 1,6 glycosidic bonds in amylopectin. It has an optimum pH of 3.0.

Fig. 1.1 shows some of the possible hydrolysis points of these enzymes in molecules of amylopectin and amylose.

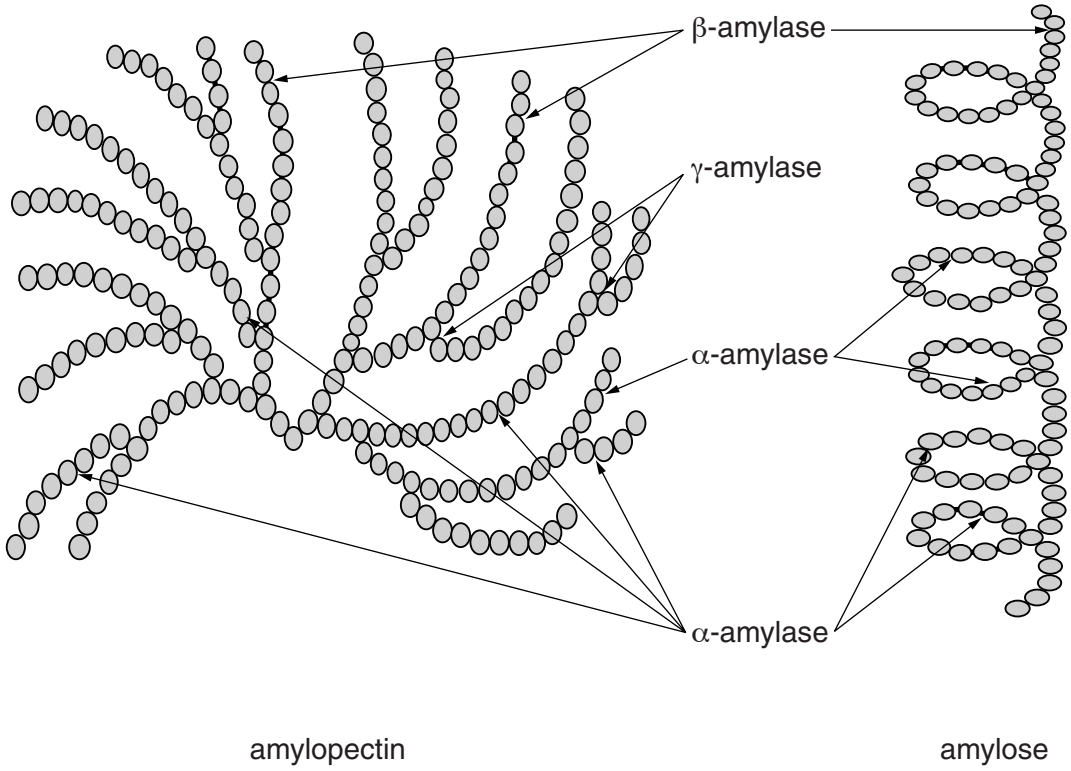


Fig. 1.1

PAPA CAMBRIDGE

(a) A student investigated the effect of these enzymes on the hydrolysis of starch by incubating a 2% starch suspension separately with each of the enzymes.

The mixtures were incubated for 60 minutes to allow all the reactions to be completed.

- Each mixture of enzyme and starch was incubated at 35 °C and at the optimum pH of each enzyme.
- After 60 minutes, samples of each mixture were removed using a capillary tube.
- The products of hydrolysis of each mixture were separated by chromatography using the same solvent.
- The products of hydrolysis were located by spraying the chromatogram with the same specific dye.

(i) Identify the **independent** variable in this investigation.

.....[1]

(ii) Identify **three** variables, **other than** the chromatography solvent and the specific dye, that the student has standardised in their investigation.

Describe how the student might have standardised **two** of these variables.

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.....[3]

(iii) Suggest a control that the students could use for this investigation.

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.....[1]

PAPA CAMBRIDGE

(b) Describe a method that the student could use to prepare and use chromatograms to compare the changes in the products of hydrolysis of starch by the three different amylases over time. Your method should be detailed enough for another person to follow.

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PAPA CAMBRIDGE

(c) Fig. 1.2 shows the chromatograms produced from each of the starch enzyme mixtures after 60 minutes incubation.

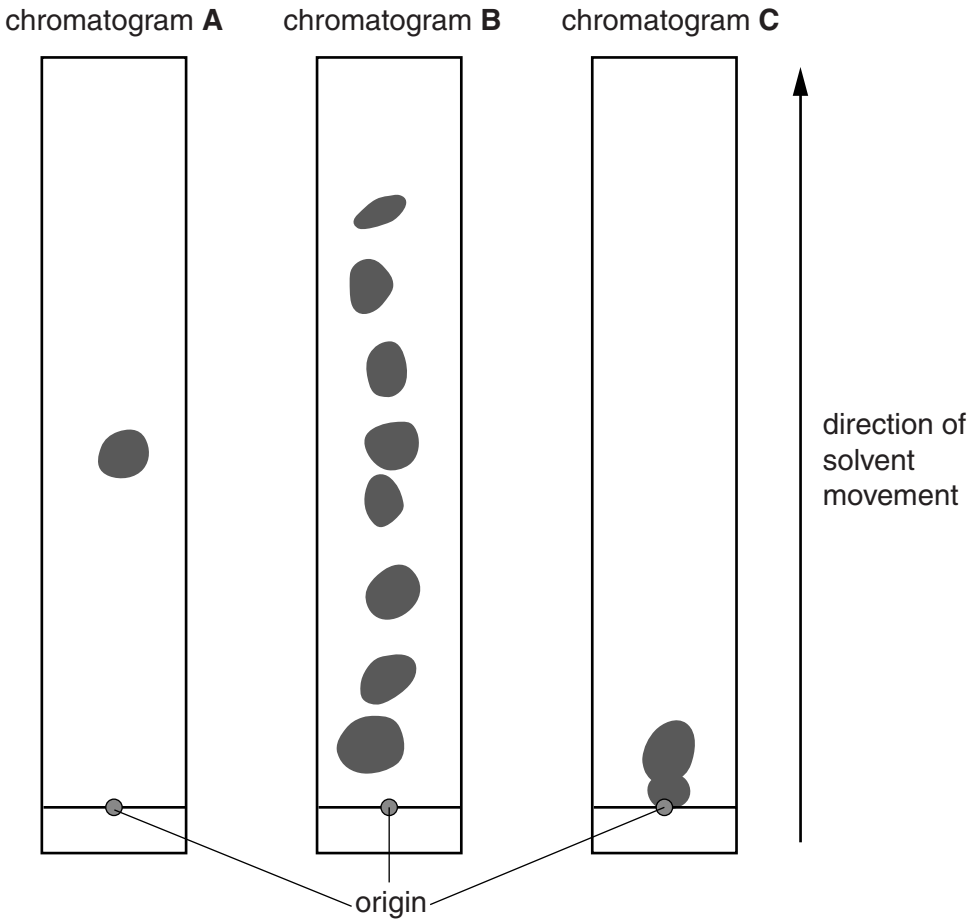


Fig. 1.2

(i) Use the information on page 2 to identify which type of amylase gave each of the results shown in chromatograms, **A**, **B** and **C**. Write your answers in Table 1.1.

Table 1.1

chromatogram	**A**	**B**	**C**
type of amylase			

[1]

(ii) Explain how you decided which chromatogram showed the results of hydrolysing starch with each type of amylase.

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[Total: 16]

PAPA CAMBRIDGE

2 Rootworms are insect larvae which feed on the roots of plants causing extensive damage. They are a serious pest of maize (corn) resulting in poor yields. The larvae hatch from eggs laid in the soil by female insects. The larvae are attracted to the plant roots by carbon dioxide released by respiration.

A gene, *cry*, from the bacterium *Bacillus thuringiensis* (Bt), gives resistance to insect damage. The gene from Bt can be inserted into maize to give transgenic Bt maize. The protein coded for by the gene *cry* is toxic to some insects.

An investigation was carried out over a two year period using:

- non-Bt maize without any treatment (NBt)
- non-Bt maize with conventional soil insecticide treatment (NBt + In)
- transgenic Bt maize without conventional soil insecticide treatment (Bt).

Experimental sites were divided into equal-sized plots separated by a standard gap. At each site, the plots were randomised. Fig. 2.1 shows one random arrangement of the plots.

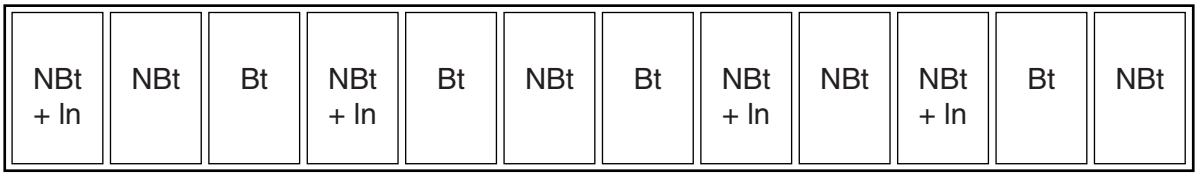


Fig. 2.1

Each plot was planted with 24 evenly spaced rows of maize; each row contained 100 plants. The maize was planted at the same density in each plot. The same plots and treatments were used in each year.

A sample of soil was taken from around five randomly selected plants in each plot at intervals during the growing season. The number of rootworms was counted in each sample.

(a) (i) State the **dependent** variable in this investigation.

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.....[1]

(ii) Describe the features of the experimental design that are intended to ensure reliability.

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PAPA CAMBRIDGE

(b) (i) State the reason for including the plots of non-Bt maize without any treatment (NBt) in this investigation.

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(ii) Explain how the results from the plots of non-Bt maize could be used to analyse the results from the other two plots.

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.....[1]

Table 2.1 shows the results of the investigation.

Table 2.1

treatment	mean number of rootworms per plant in year 1					
	day 1	day 6	day 14	day 19	day 26	day 34
NBt	16.4	20.4	6.0	8.4	5.6	1.3
NBt +In	13.1	14.1	3.6	2.5	4.6	0.6
Bt	18.0	1.8	2.5	0.4	1.4	0.5
	mean number of rootworms per plant in year 2					
	day 1	day 4	day 11	day 19	day 26	no more data collected
NBt	1.3	2.3	0.8	2.3	0.5	
NBt +In	0.5	1.0	0.3	1.3	0.1	
Bt	0.3	0.8	0.2	0.3	0.0	

(c) In this investigation, Bt maize (Bt) or a soil insecticide (NBt + In) were used to control rootworm.

Describe the effectiveness of these two treatments as shown by the data in Table 2.1.

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PAPA CAMBRIDGE

(d) Statistical tests were carried out on the data obtained from each day that samples were taken and tested to find out if the effectiveness of rootworm control by using insecticide was significantly different from growing transgenic Bt maize.
Pairs of soil samples were tested from:

- Bt and non-Bt +In
- Bt and non-Bt
- non-Bt +In and non-Bt.

(i) State a null hypothesis for the test between Bt and non-Bt +In.

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.....[1]

(ii) Show how to calculate the number of degrees of freedom for this test.

answer ..... degrees of freedom [2]

(e) The results of the statistical tests at $p < 0.05$ showed that:

- in both years the results on day 1 were not significant
- In year 1 the results for Bt maize and non-Bt maize +In were significant on day 6, 19 and 26 and in year 2 the results were significant on day 4 and day 19
- In year 1 the results for NBt +In maize and NBt was significant on day 14 and 19 and in year 2 on day 4.

Explain what is meant by *not significant at $p < 0.05$*.

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[Total:14]

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