Cambridge International A Level

Cambridge International Examinations
Cambridge International Advanced Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1438374994

BIOLOGY **9700/53**

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

Write your Centre number, candidate number and name on all the work you hand in.
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.

DC (KN/KN) 90320/3

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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.

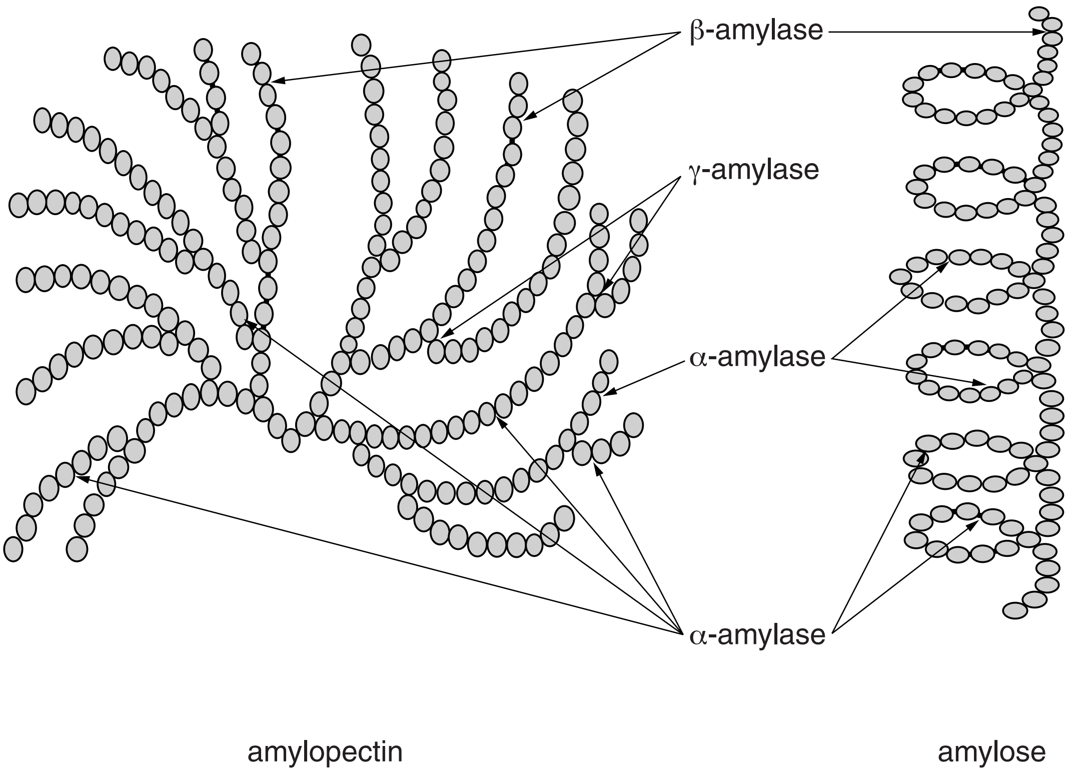

Fig. 1.1

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

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....[1]

(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.

....[8]

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

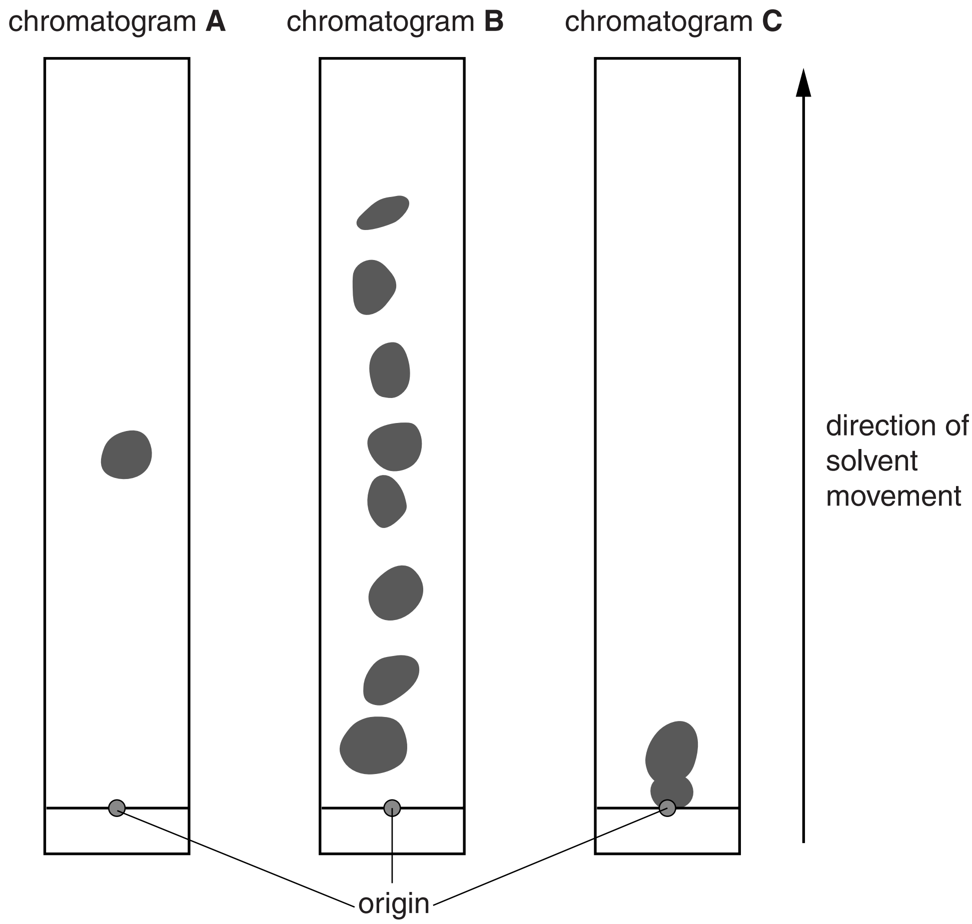

Fig. 1.2

(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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....[2]

[Total: 16]

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.

NBt + In	NBt	Bt	NBt + In	Bt	NBt	Bt	NBt + In	NBt	NBt + In	Bt	NBt

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

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....[1]

(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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(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.

....

....[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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....[2]

[Total:14]