Cambridge Pre-U

Cambridge Assessment International Education
Cambridge Pre-U Certificate

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

5700864584

BIOLOGY (PRINCIPAL) **9790/03**

Paper 3 Case Study and Synoptic Essay **May/June 2019**

1 hour 45 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.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer **one** question.
Write your answer on the Question Paper.

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.

For Examiner's Use	
Section A	
Section B	
Total	

This syllabus is regulated for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document consists of **13** printed pages and **3** blank pages.

Cambridge Assessment International Education

Section A – Case study

Read the passages carefully and answer **all** of the questions.

You are advised to spend no more than 50 minutes on this section.

1 Innate® potatoes

The Innate® potato is a genetically modified potato plant, grown for its nutritional and economic benefits.

Fig. 1.1 shows the tubers, stems and leaves of a potato plant. The tubers are the parts that are eaten.

Fig. 1.1

The Innate® potato plant was produced by a process known as RNA interference. A DNA sequence is inserted that codes for a short RNA strand which is complementary to the mRNA for a specific protein. As a result, the gene for that protein is no longer expressed (silenced).

(a) Use your knowledge of protein synthesis to suggest how RNA interference results in gene silencing.

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The DNA sequence that is added comes from a wild variety of potato.

The genetic modification of potato plants can involve the following stages.

- The desired DNA sequence is located and isolated from a suitable plant.
- The DNA sequence is amplified using PCR.
- The DNA sequence, a promoter sequence and an antibiotic resistance marker gene are inserted into a Ti plasmid.
- This Ti plasmid is inserted into *Agrobacterium tumefaciens*.
- The host potato plants are infected with *A. tumefaciens*.

(b) (i) Explain how PCR can be used to amplify the DNA sequence.

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(ii) Explain why a promoter and a marker gene are added to the DNA sequence.

promoter .....

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marker gene .....

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[2]

(iii) Describe how *A. tumefaciens* is used to genetically modify potato plants.

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(c) Discuss possible concerns that people may have about the introduction of potatoes that have been engineered by gene silencing.

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[Total: 16]

2 Benefits

Asparagine synthetase and polyphenol oxidase are two enzymes found in potato tubers.

Asparagine synthetase

Asparagine synthetase converts the amino acid glutamine into asparagine.

$$\text{glutamine} \xrightarrow{\text{asparagine synthetase}} \text{asparagine}$$

When heated to very high temperatures, asparagine combines with sugars and is converted to acrylamide. Acrylamide is a neurotoxin and possible carcinogen.

Polyphenol oxidase

Polyphenol oxidase is released from damaged plant cells. This causes the polymerisation of chemicals that results in the browning of the plant tissues, as shown in Fig. 2.1.

$$\text{quinones} \xrightarrow{\text{polyphenol oxidase}} \text{polyphenols}$$

Fig. 2.1

Potato tubers can be damaged, resulting in browning, when being transported or during storage. This results in them being unable to be sold.

The Innate® potato plant has two gene silencing modifications.

- The gene for asparagine synthetase, *StAst1*, has been silenced.
- The gene for polyphenol oxidase has been silenced.

[Turn over

(a) Explain why the silencing of these two genes has economic and nutritional benefits.

economic .....

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nutritional .....

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[4]

In field trials, potatoes with just the *StAst1* gene silenced were grown in three trial plots and harvested. The mean concentrations of glutamine and asparagine were measured in the tubers. The results are shown in Fig. 2.2. The error bars represent one standard deviation.

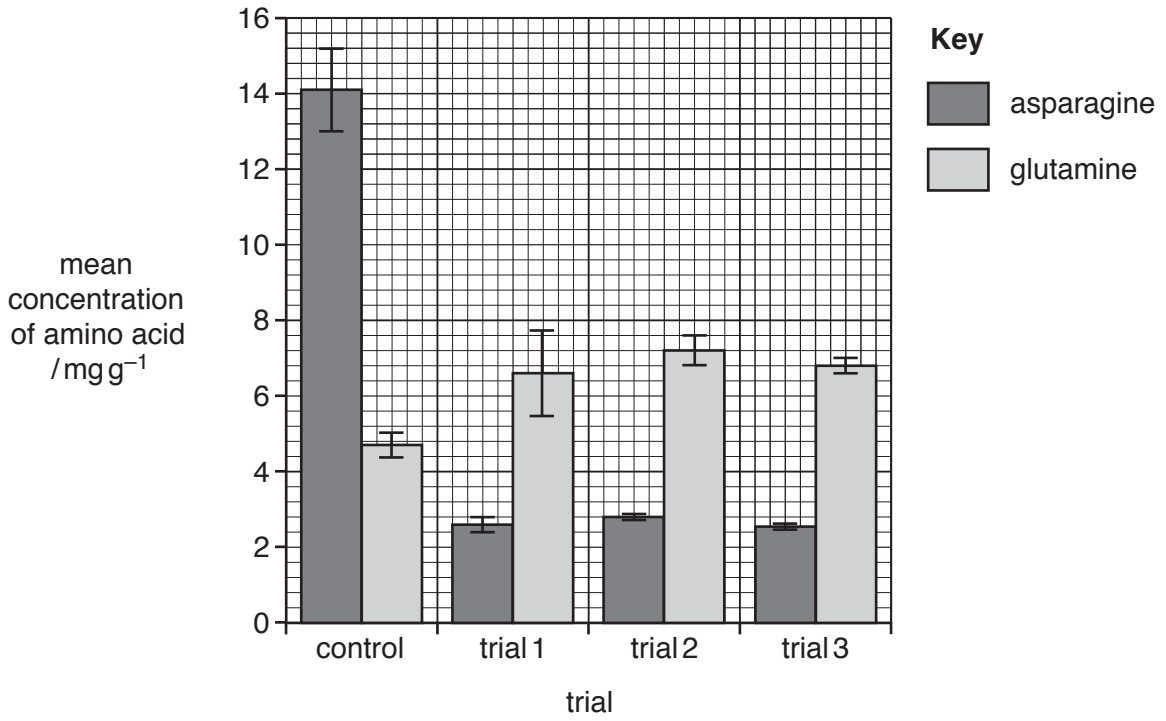

Fig. 2.2

The yield of potato tubers (as mean dry mass of potato tubers) from each plot was also measured. The results are shown in Fig. 2.3. The error bars represent one standard deviation.

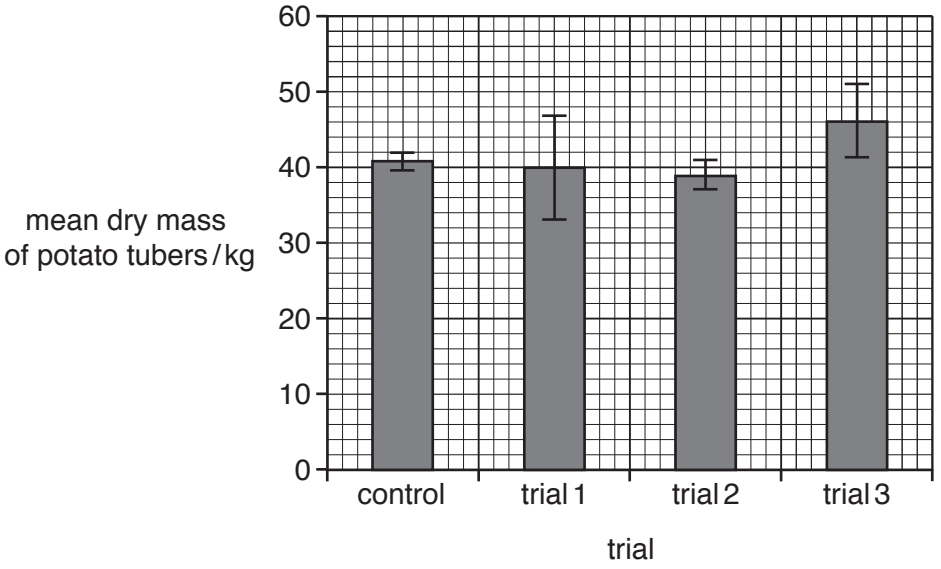

Fig. 2.3

(b) Describe the effect of *StAst1* gene silencing on asparagine concentration and yield of potato tubers.

In your answer, include reference to the standard deviations.

asparagine concentration .....

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yield of potato tubers .....

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[4]

(c) Explain why glutamine concentrations are higher in the *StAst1* gene-silenced tubers compared to the control.

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(d) In the leaves, a second gene (*StAst2*) produces another enzyme that converts glutamine to asparagine. The asparagine produced in the leaves does not appear to be transported to the tubers. Other amino acids produced in the leaves are transported to the tubers.

(i) Outline how amino acids are transported from the leaves to the tubers.

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(ii) Suggest why asparagine is not transported.

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[Total: 14]

Section B – Synoptic Essay

Answer **one** question on the lined paper that follows.

You are advised to spend no more than 50 minutes on this section.

Choose **one** question from Question **3**, Question **4** or Question **5**.

3 All living organisms rely on the Sun to survive.

Discuss the extent to which this is true. [30]

4 Describe applications of stem cell research and discuss the implications of this area of research. [30]

5 *'Biologically the species is the accumulation of the experiments of all its successful individuals since the beginning.'* HG Wells, A Modern Utopia, 1905

Discuss this statement. [30]

Your answer should draw from a wide range of syllabus material and also demonstrate evidence of reading around the subject.

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