1. Nov/2023/Paper_9700/41/No.4

The potato plant, *Solanum tuberosum*, is an important food crop. Crop yield is reduced if the leaves of the plant are eaten by the larvae (immature stages) of the Colorado beetle, *Leptinotarsa decemlineata*.

Crop scientists used recombinant DNA technology to create two genetically modified (GM) varieties of potato plant. These plants produce proteins that are poisonous to insects.

- GM potato variety **A** contains two new genes, *SN* and *Bt*.
- GM potato variety **B** contains two new genes, *SN* and *OCII*.

The new varieties were tested by having a constant number of Colorado beetle larvae introduced to the plants at time 0 hours. The number of larvae that were alive after 24, 48 and 72 hours was recorded. The percentage of the larvae that had died in each time interval was calculated. This was repeated for potato plants that had not been genetically modified (non-GM).

Table 4.1 shows the percentage of Colorado beetle larvae that had died on the GM potato plant varieties and on non-GM potato plants.

Table 4.1

type of potato plant	percentage of Colorado beetle larvae that had died		
	24 h	48 h	72 h
GM potato variety **A**	50	93	100
GM potato variety **B**	37	70	93
non-GM potato	0	0	0

(a) (i) Suggest what is meant by recombinant DNA technology.

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(ii) Suggest why the scientists created two different types of GM potato plant.

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(iii) State why the scientists also performed the test on non-GM potato plants.

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(b) Discuss how the results in Table 4.1 provide information that could help to solve the global demand for food.

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[Total: 7]

2. Nov/2023/Paper_9700/41/No.8

Environmental conditions such as light intensity affect plant physiology.

(a) Use the letter **X** to identify a point on the sketch graph in Fig. 8.1 where light intensity is acting as a limiting factor on the rate of photosynthesis. [1]

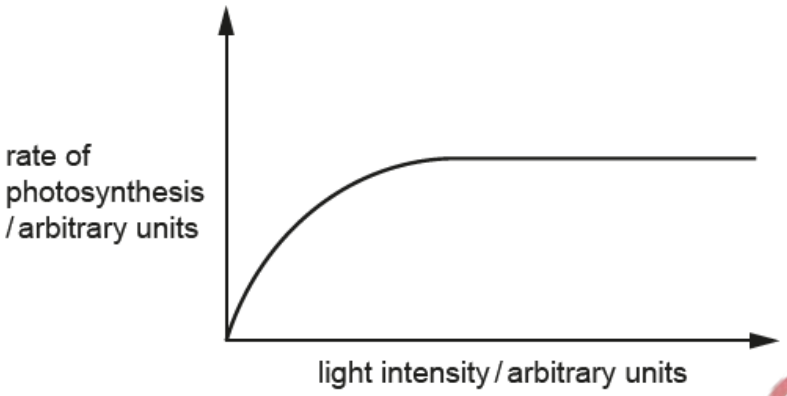

Fig. 8.1

(b) An experiment investigated how light intensity affected gene expression in kale, *Brassica oleracea sabellica*.

- Two groups of kale plants were grown, with one group in high light intensity and one group in low light intensity. All other conditions were standardised.
- After the same period of time, messenger RNA (mRNA) was extracted from each group of kale plants.
- The mRNA was used to produce cDNA.
- The cDNA was hybridised with probes for 89 621 kale genes on a microarray.
- The microarrays showed which genes were switched on (expressed) in each set of conditions.

The results showed that expression of 18% of the genes was affected by light intensity.

- 14% of the genes were switched on only in high light intensity.
- 4% were switched on only in low light intensity.

(i) State the name of the enzyme that produces cDNA from an mRNA template.

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(ii) State the name of the type of proteins that control gene expression in plants.

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(iii) Suggest why **more** genes were switched on only in plants growing in **high** light intensity compared to fewer genes that were switched on only in plants growing in low light intensity.

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[Total: 6]

3. Nov/2023/Paper_9700/41/No.10

Medicine is defined as the diagnosis, treatment and prevention of disease.

Outline the different ways in which genetic technology can be applied to medicine, with reference to named diseases.

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4. Nov/2023/Paper_9700/42/No.4

(a) A marker gene can be used when a gene of interest is introduced into a plant by genetic engineering.

Describe **and** explain how the use of a marker gene coding for a fluorescent product can show that the introduced gene of interest is being expressed in plants.

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(b) Give **two** advantages of genetically engineering herbicide resistance in crop plants such as soybean.

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(c) DNA microarray analysis is a technique used in genetic technology that involves fluorescence. A DNA microarray has single-stranded probes attached to its surface. These probes hybridise to the fluorescently tagged single-stranded DNA that is added.

(i) Explain why DNA hybridisation occurs between the probe DNA and the added DNA.

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..... [1]

(ii) A DNA microarray analysis can be used to identify the level of expression of some genes.

Describe **and** explain how the level of expression of some genes can be identified using the DNA microarray analysis technique.

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[Total: 10]