

BIOLOGY PAPER 2

11:45 am – 12:45 pm (1 hour)
This paper must be answered in English

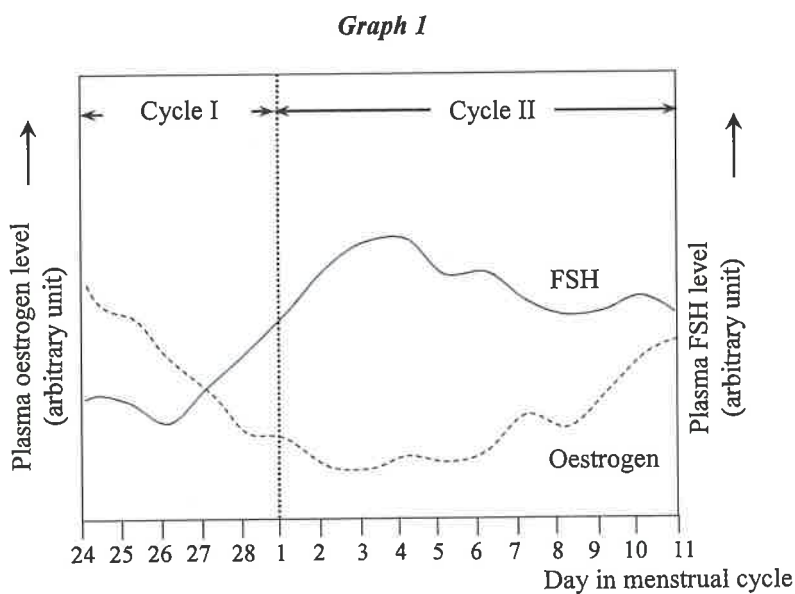
INSTRUCTIONS

- (1) There are **FOUR** sections, A, B, C and D in this Paper. Attempt **ALL** questions in any **TWO** sections.
- (2) Write your answers in the Answer Book DSE (C) provided. Start each question (not part of a question) on a new page.
- (3) Present your answers in paragraphs wherever appropriate.
- (4) Illustrate your answers with diagrams wherever appropriate.
- (5) The diagrams in this paper are **NOT** necessarily drawn to scale.

SECTION A Human Physiology: Regulation and Control

Answer **ALL** parts of the question.

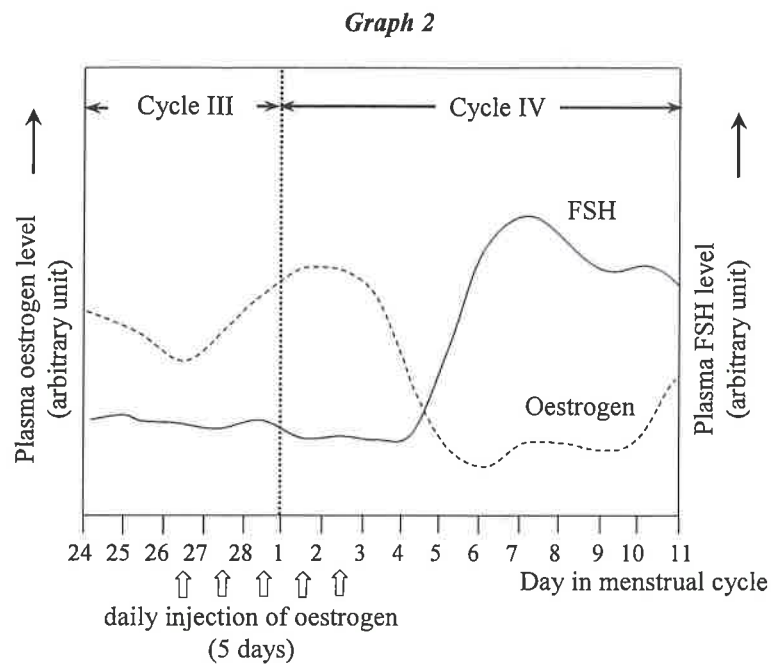
1(a) To investigate the interaction between oestrogen and follicle stimulating hormone (FSH), the plasma levels of the two hormones in a group of females were measured over a period of time. Graph 1 below shows the change in the plasma levels of the two hormones throughout the course of the study:



(i) With reference to the events occurring in the ovaries, explain the changes in plasma oestrogen level during the following periods of time:

- (1) from day 24 of cycle I to day 3 of cycle II (2 marks)
- (2) from day 5 to day 11 of cycle II (2 marks)

- (ii) The same group of females received an additional daily oestrogen injection from day 26 of cycle III for 5 consecutive days. Graph 2 below shows the changes in the plasma levels of the two hormones over the same period of time:



- (1) The pattern of the change in plasma FSH level in Graph 2 was modified by the injection of additional oestrogen. With reference to graphs 1 and 2, deduce the effect of oestrogen on FSH. Explain your answer. (4 marks)
- (2) Contraceptive pills usually contain oestrogen and progesterone. With reference to your answer in (1), explain the function of oestrogen in these contraceptive pills. (2 marks)

- 1(b) To investigate the effects of dehydration on cardiovascular functions, professional cyclists were divided into two groups (dehydrated group and hydrated group) and asked to ride a cycling machine set at the same resistance for 120 minutes. The dehydrated group did not drink any fluid throughout the course of the experiment, while the hydrated group drank an isotonic fluid to compensate for the water loss during cycling. The table below shows the changes in their cardiovascular functions:

Duration of exercise (min)	Heart rate (beat min ⁻¹)		Stroke volume (L)		Cardiac output (L min ⁻¹)	
	Dehydrated group	Hydrated group	Dehydrated group	Hydrated group	Dehydrated group	Hydrated group
10	138	139	0.138	0.136	19.0	18.9
60	155	148	0.120	0.129	18.6	19.1
110	168	150	0.093	0.128	15.7	19.2

- (i) Over the course of the experiment, the cycling speed of the hydrated group was constant while that of the dehydrated group dropped slowly. With reference to the data on cardiac output, explain the performance of the two groups of cyclists in terms of the cycling speed. (5 marks)
- (ii) (1) With reference to the data on heart rate and stroke volume in the dehydrated group, which parameter led to the change in their cardiac output? (1 mark)
- (2) With reference to water balance in the dehydrated group, explain the change in the parameter stated in (1) during the course of the experiment. (2 marks)
- (iii) Suggest why there was a greater increase in heart rate in the dehydrated group as compared to the hydrated group. (2 marks)

SECTION B Applied Ecology

Answer ALL parts of the question.

2(a) An artificial wetland was introduced to treat sewage in some small villages in Africa and the effluent collected was used for irrigating farms. This helped to alleviate the problems of water shortage and sewage treatment. In a study, domestic sewage after primary treatment was conveyed to either a sewage treatment plant or an artificial wetland, and the effluents were collected and compared.

- (i) Briefly describe the processes involved in the primary treatment of sewage. (2 marks)
- (ii) The table below shows some parameters in the influent and effluents collected from the sewage treatment plant and the artificial wetland:

	Influent (sewage after primary treatment)	Effluent from different systems	
		Sewage treatment plant	Artificial wetland
Oxygen content (mg L ⁻¹)	5.0	5.3	3.5
Organic nitrogen content (mg L ⁻¹)	35	3	12
Phosphate content (mg L ⁻¹)	29	28	27
Magnesium content (mg L ⁻¹)	42	40	41

- (1) With regard to the handling of organic nitrogen in the two systems, explain the difference in the organic nitrogen content in the effluents from the sewage treatment plant and the artificial wetland. (4 marks)
- (2) Using the effluent of this study to irrigate the farms is advantageous to the growth of crops. Apart from the presence of nitrates, briefly explain another advantage in terms of the synthesis of biomolecules. (2 marks)
- (iii) State *two* advantages of adopting an artificial wetland over a sewage treatment plant for small villages. (2 marks)

2(b) Mining activities often produce large quantities of heavy metal wastes, which cause contamination of the ecosystem. The photographs below show an abandoned mining site and the ecological restoration of this mining site after 10 years:

Photograph I – Abandoned mining site

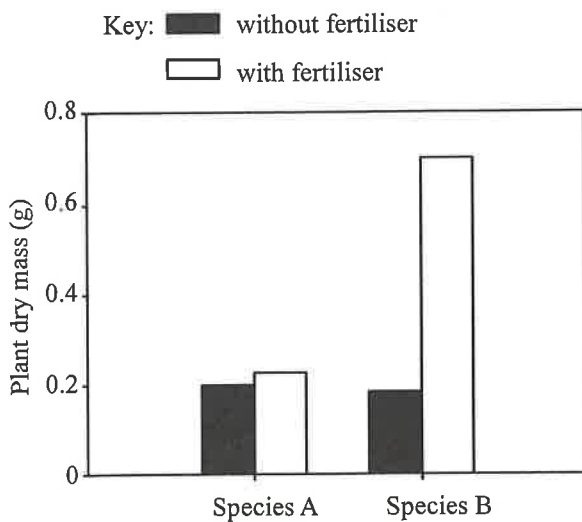


Photograph II – the mining site after ecological restoration

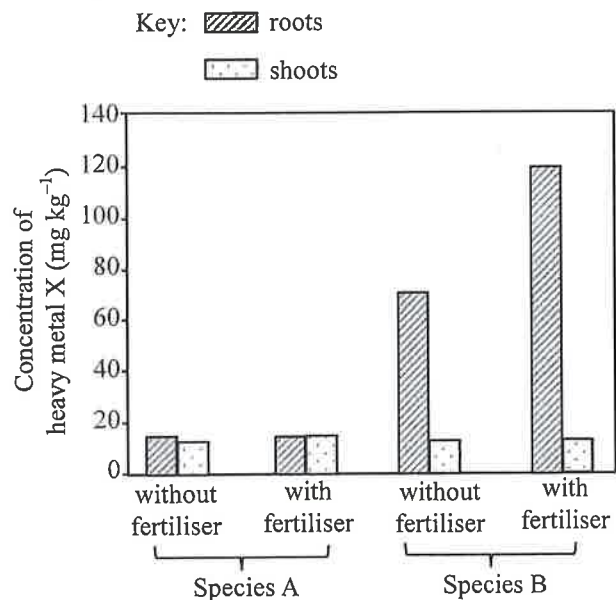


- (i) Besides heavy metal pollution, state *two* other ecological problems of the abandoned mining site. (2 marks)
- (ii) In a study, two native plant species, A and B, were tested for their suitability to restore an abandoned mining site. Their seedlings were planted in pots containing soil from the mining site with a high concentration of heavy metal X. Half of the pots of each plant species were supplied with fertiliser but not the other half. Graph 1 shows the dry masses of plants in the eighth week of the experiment and Graph 2 shows the concentrations of heavy metal X in the roots and shoots:

Graph 1



Graph 2



- (1) Species B is more suitable for the restoration of the mining site in terms of the removal of heavy metal X from the soil. With reference to the above two graphs, give evidence to support this choice. (4 marks)
- (2) There is another plant species C which accumulates a much higher concentration of heavy metal X in the shoots than in the roots. Which species, B or C, would you choose for the restoration of the abandoned mining site? Why? (2 marks)
- (3) Give *two* reasons why native plant species were used in this experiment. (2 marks)

SECTION C Microorganisms and Humans

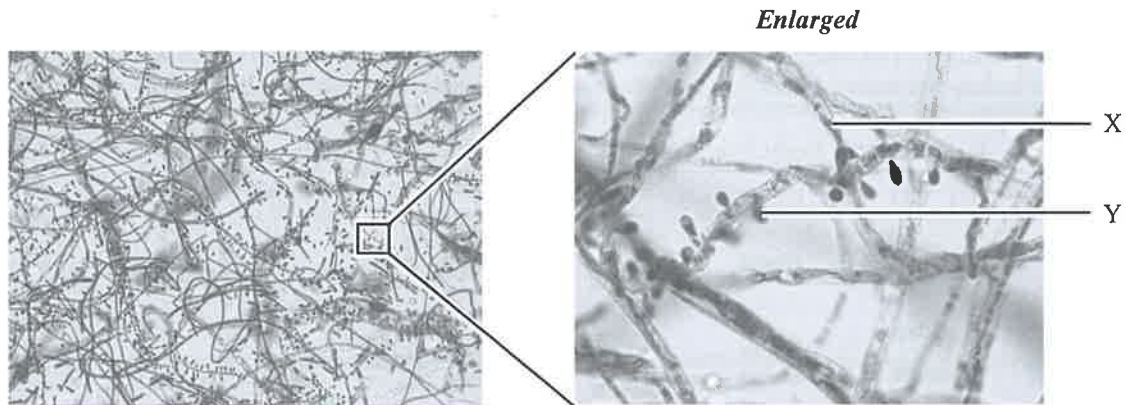
Answer **ALL** parts of the question.

- 3(a) There is a diversity of foodborne pathogens which have different abilities in causing illness in humans. Investigations of their growth rate under different conditions can provide important information about the disease-causing risks of the pathogens. Below are the results of a series of experiments testing the doubling time of bacterial pathogens A, B and C under different conditions:

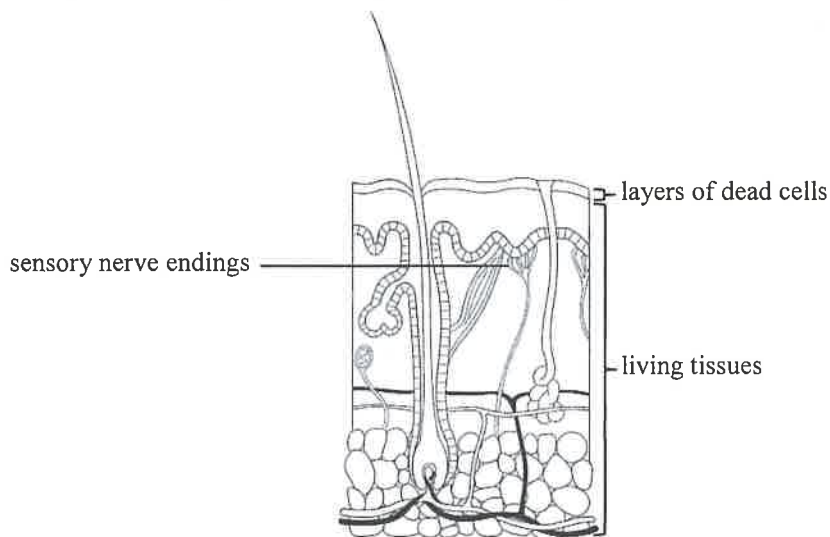
pH	Temperature (°C)	Doubling time (hour)		
		Pathogen A	Pathogen B	Pathogen C
4	4	100	5	10
	37	20	20	1
8	4	50	1	30
	37	1	10	10

- (i) The doubling time indicates the time that a bacterial population requires to double its population size once under a particular growth condition. Using the data in the table, calculate the amount of time required by bacterial pathogens A and B respectively to increase their population size by 4 times at 37°C and pH 8. (2 marks)
- (ii) Gastric juice in the human stomach has a pH value of around 2. However, when there is food inside the stomach, the pH value can be raised to 4–5. With reference to the above table, deduce which bacterial pathogen is most likely to cause stomach infection. (4 marks)
- (iii) Bacterial pathogen B would lead to food safety concerns to the food stored in the chilling compartment of a refrigerator which is kept at around 4°C. Even though the food has been cooked thoroughly, people may still contract a foodborne illness after consuming food contaminated by bacterial pathogen B. With reference to the above table, explain if the illness is more likely to be food poisoning or a foodborne infection. (3 marks)

- 3(b) Athlete's foot is a common skin infection caused by a fungus. The disease can be spread by contact with infected skin or the fungus in the environment. The photomicrograph below shows the appearance of the fungus on an agar plate:



- (i) Identify structures X and Y. (2 marks)
- (ii) One of the common symptoms of athlete's foot is itching. The itchy feeling comes from the sensory nerve endings located in the skin. The diagram below shows a section of the skin:



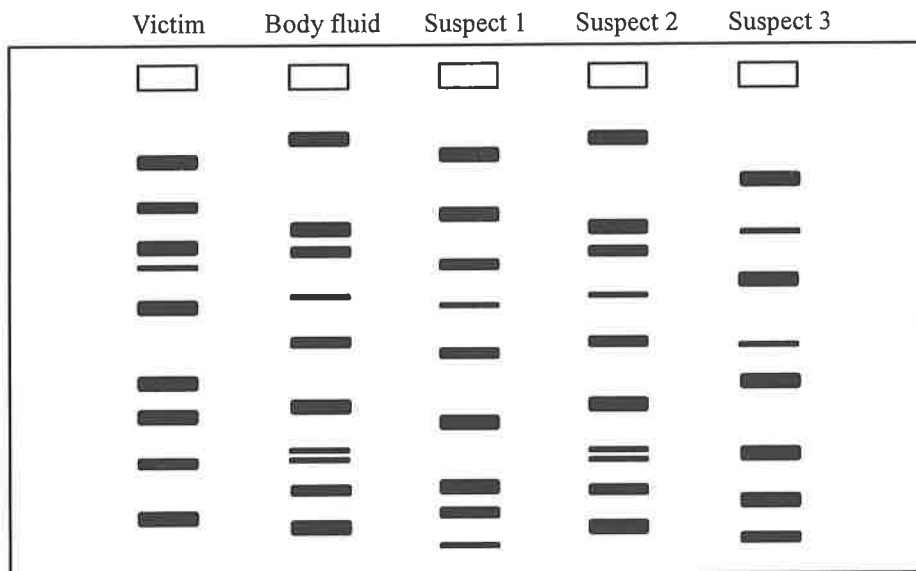
With reference to the mode of nutrition of fungi, describe how structure X of the fungus can pass through layers of dead cells to reach and stimulate the sensory nerve endings. (4 marks)

- (iii) Ken suffered from athlete's foot. He was infected while he was walking barefoot in the shower room of a fitness centre.
- (1) Suggest *one* environmental condition that enables the shower room to be a breeding ground for the fungus. (1 mark)
- (2) Ken's doctor instructed him to apply an antifungal cream to the infected area for two weeks. After several days, Ken did not feel itchy any more and stopped the treatment. However, he felt itchy again two days later. With reference to the life cycle of fungi, explain the changes in symptoms mentioned above. (4 marks)

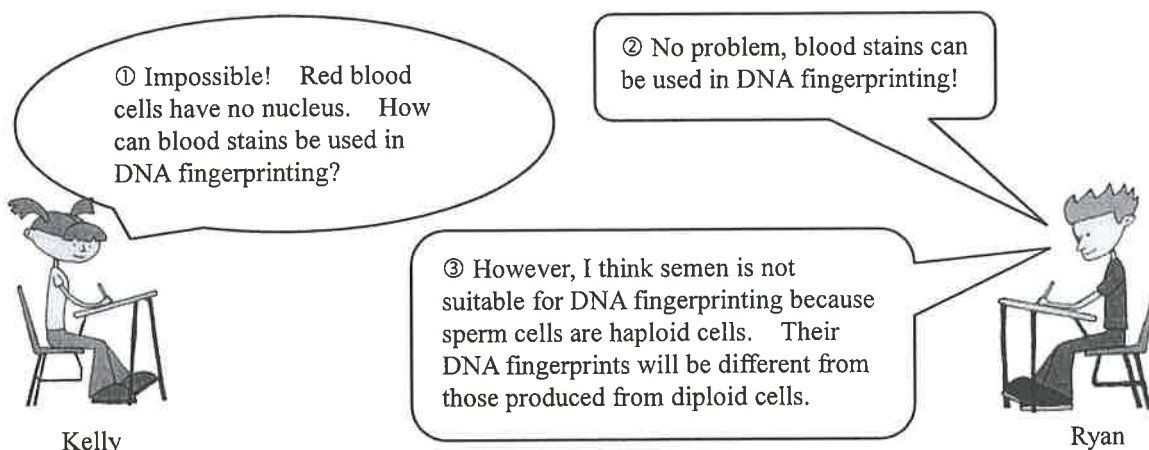
SECTION D Biotechnology

Answer **ALL** parts of the question.

4(a) Samples of body fluids or cells collected from crime scenes can be examined with VNTR-based DNA fingerprinting. The diagram below shows the DNA fingerprints of body fluid samples collected from a crime scene, and those of the victim and three suspects:

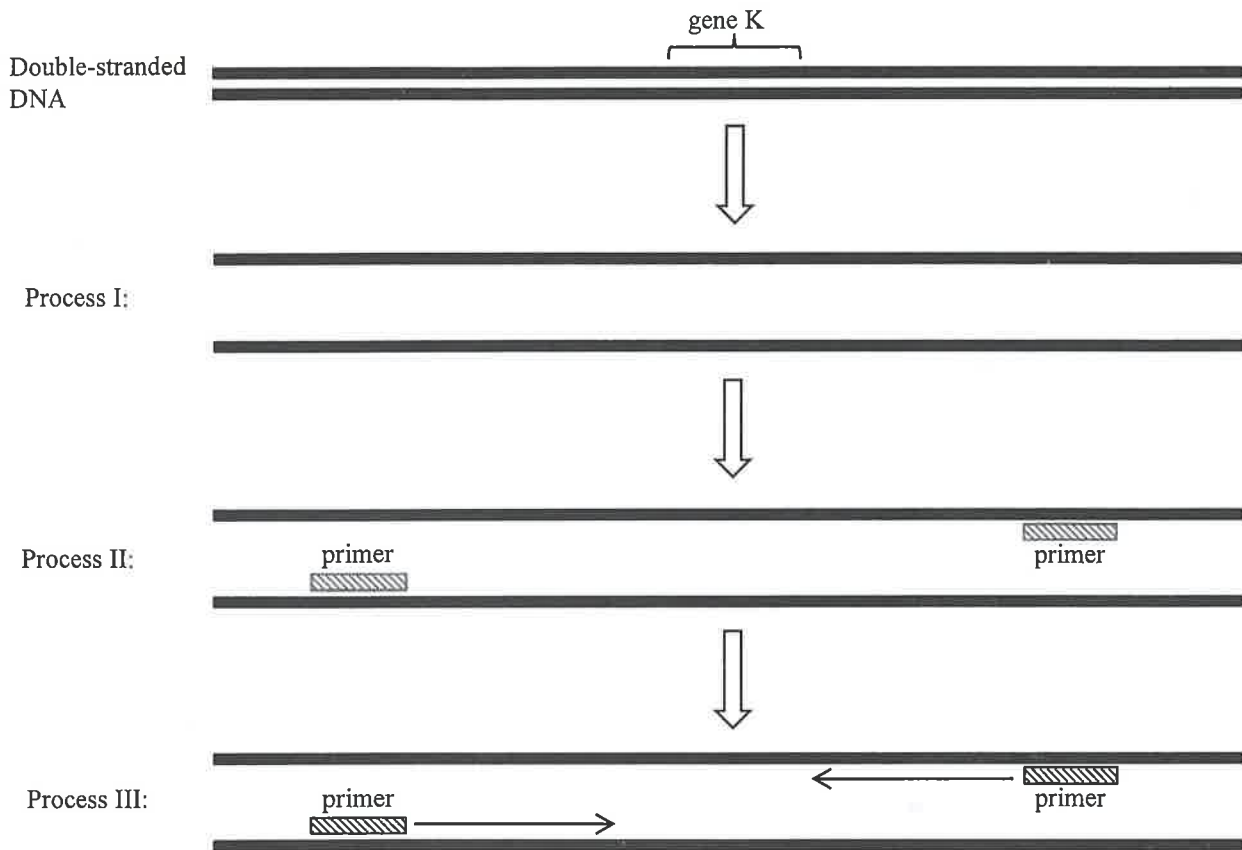


- (i) Based on the above results, deduce who is most likely the criminal among the three suspects. (1 mark)
- (ii) Explain why the DNA fingerprints of these suspects showed different patterns. (3 marks)
- (iii) Semen and blood stains are body fluid samples which can be collected from crime scenes. Kelly and Ryan disagree about the suitability of using these body fluid samples for DNA fingerprinting. Below is their conversation:



- (1) Is Kelly or Ryan right about whether blood stains can be used for DNA fingerprinting? Explain your answer. (2 marks)
- (2) Do you agree with Ryan’s comment about the suitability of using semen for DNA fingerprinting? Explain your answer. (4 marks)

- 4(b) A scientist discovered a bacterial species capable of secreting a protein. This protein is toxic to insects that damage the roots of a certain crop. The protein is encoded by gene K. The scientist used polymerase chain reaction (PCR) to amplify gene K. The diagram below shows some PCR processes:



- What is Process II? (1 mark)
- Draw a simple labelled diagram to show the expected PCR product. (2 marks)
- Primers often contain about 18–22 bases. If primers with fewer bases are used, PCR products of different sizes are obtained. Explain this phenomenon. (2 marks)
- The scientist wanted to transfer gene K into the crop by using *Agrobacterium* (a soil bacterium). Explain why *Agrobacterium* is suitable for transferring the target gene into the crop. (2 marks)
- The cultivation of this transgenic crop was found to produce higher yields than its non-transgenic counterpart. Suggest an explanation for this. (3 marks)

END OF PAPER

Sources of materials used in this paper will be acknowledged in the *HKDSE Question Papers* booklet published by the Hong Kong Examinations and Assessment Authority at a later stage.