HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2016

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.

Not to be taken away before the end of the examination session

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SECTION A Human Physiology: Regulation and Control

Answer **ALL** parts of the question.

1(a) The table below shows how the relative percentages of energy contribution from anaerobic and aerobic respiration change with different durations of vigorous exercise:

Duration of vigorous exercise	Relative percentage of energy contribution	
	Anaerobic respiration	Aerobic respiration
10 seconds	95	5
30 seconds	85	15
1 minute	70	30
2 minutes	50	50
8 minutes	30	70
12 minutes	15	85
30 minutes	5	95

(i) What is the relationship between the duration of vigorous exercise and the energy contribution from the two respiratory pathways? (1 mark)

(ii) For vigorous exercise of short duration (10-30 seconds), energy mainly comes from the breakdown of the food store in muscles.

(1) Use a flowchart to show the two major steps in converting this food store to a usable form of energy through the anaerobic pathway. (2 marks)
(Note: Details of the intermediates in the pathway are not required.)

(2) Even though energy mainly comes from the anaerobic pathway, athletes who have just performed vigorous exercise for short duration still need to breathe fast for a while. Explain the importance of this phenomenon. (2 marks)

(iii) During exercise, our sympathetic nervous system is stimulated. Explain how this will bring about physiological changes to sustain the exercise. (4 marks)

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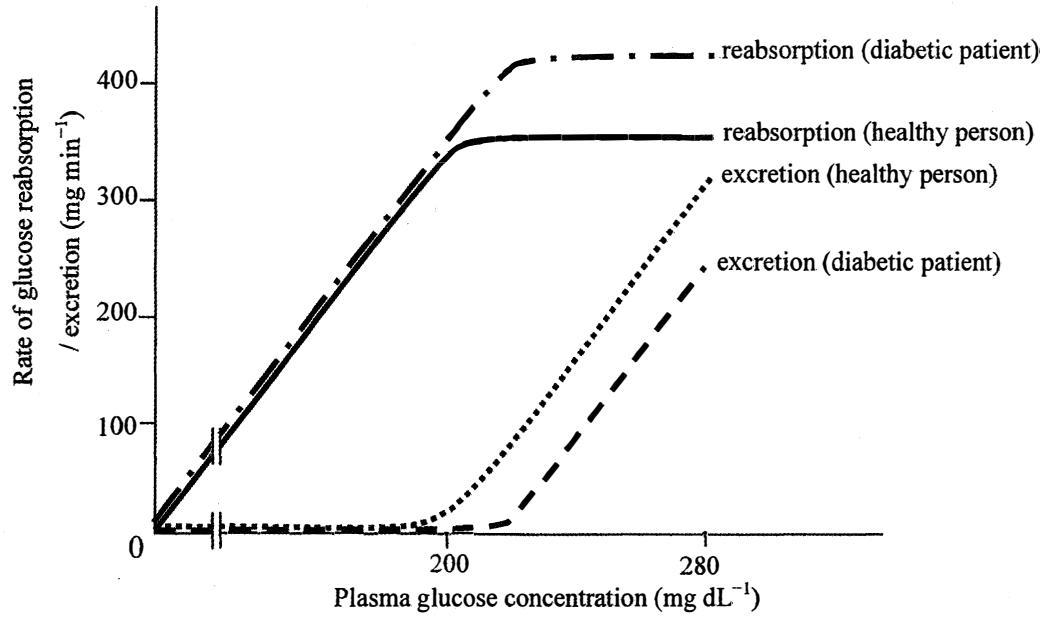
1(b) The graph below shows the renal glucose handling capability (reabsorption and excretion) in a healthy person and in a patient suffering from non-insulin-dependent (type II) diabetes:



(i) Describe the change in the renal handling of glucose in the healthy person if the plasma glucose concentration increases from 0 to 280 mg dL^{-1}. (4 marks)

(ii) It is noted that there is an increased expression of a gene coding for membrane glucose carriers in the kidney tubules of type II diabetic patients.

(1) In which region of the kidney tubules are these membrane glucose carriers located? (1 mark)

(2) Suggest why the type II diabetic patient has a higher glucose reabsorption capability. (2 marks)

(iii) If the diabetic condition of the patient is not properly managed, the plasma glucose concentration can rise to a level beyond 300 mg dL^{-1}. Explain why diabetic patients urinate more frequently than healthy persons. (4 marks)

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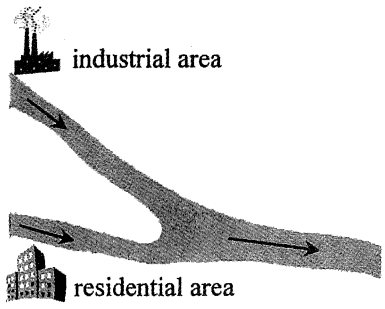
SECTION B Applied Ecology

Answer ALL parts of the question.

2(a) Water samples A and B are collected from an industrial area and residential area along a river respectively. Their locations are shown in the map and the analysis of water samples is shown in the table below:



	Water sample A (industrial area)	Water sample B (residential area)
Biochemical oxygen demand, (BOD, 5 days 20°C) (mg L^{-1})	20	100
Heavy metal (ppm)	30	0.01
Antibiotic residues (μg L^{-1})	0.1	50

(i) Give the particular type of pollutant in water sample B that can contribute to the difference in BOD between water samples A and B. Explain your answer. (4 marks)

(ii) Some people like to go fishing in the river next to the industrial area and consume the fish. Explain the health risks of consuming the fish. (4 marks)

(iii) (1) Suggest why antibiotic residues are present in water sample B. (1 mark)

(2) Suggest ***one*** possible effect of antibiotic residues on the ecosystem. (1 mark)

2(b) Arsenic is poisonous to humans. Contamination of soil with arsenic can occur as a result of using arsenical pesticides and herbicides, mining activity and waste disposal. An experiment was conducted to study the effect of phosphate addition on the growth of wheat and the accumulation of arsenic in different parts of the wheat. 100 pots with uncontaminated soil and 100 pots with arsenic-contaminated soil were prepared for growing wheat. Phosphate was added to 50 pots from each group. The dry masses of grain and plant body (shoot and root), and the distribution of arsenic in different parts of the wheat after seven months are shown in the table below:

	Dry mass of wheat (g pot^{-1})		Distribution of arsenic in the wheat
	Uncontaminated soil	Arsenic-contaminated soil	grown in arsenic-contaminated soil (%)
No phosphate added			
• grain	8	2	10
• plant body	14	5	90
Phosphate added			
• grain	20	12	2
• plant body	15	14	98

(i) Compare the effects of arsenic on the growth of grain and plant body when no phosphate was added. (2 marks)

(ii) With regard to the growth of wheat in the two types of soils, what can you conclude about the effect of phosphate addition on the growth of grain and plant body? (4 marks)
(Note: You should refer to the growth of wheat in uncontaminated soil as the control.)

(iii) Comment on the effect of phosphate addition on the distribution of arsenic in different parts of the wheat. (2 marks)

(iv) With reference to the above results, what is the significance of phosphate addition to the agricultural production of wheat in arsenic-contaminated land? (2 marks)

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SECTION C Microorganisms and Humans

Answer **ALL** parts of the question.

3(a) Sushi is a high risk food item with regard to food poisoning. One of the causative agents for food poisoning due to consumption of sushi is *Bacillus cereus*. The table below shows the growth conditions for this pathogen:

	Range	Optimum
pH	5 - 8	6 - 7
Temperature	10°C - 49°C	30°C

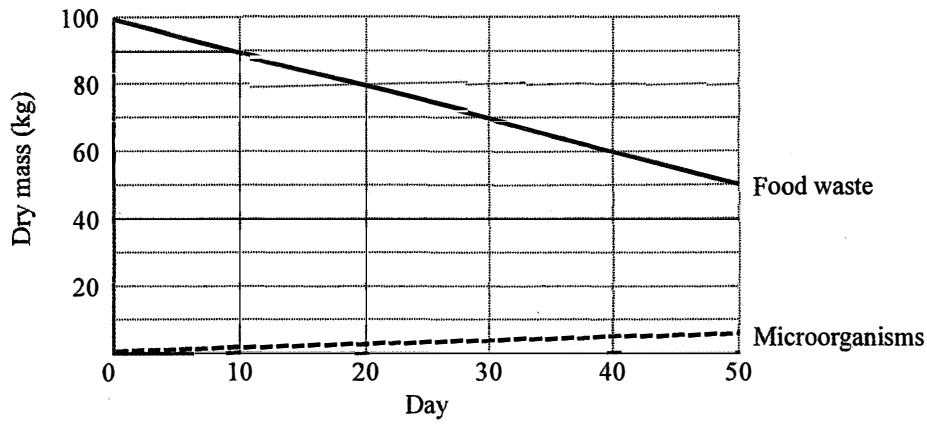
(i) Give ***two*** reasons why sushi itself is a high risk food item. (2 marks)

(ii) During the preparation of sushi, vinegar is added for its palatability. In fact, this also helps improve the safety of the food if enough vinegar is added. Explain why. (2 marks)

(iii) Briefly describe how the growth of *B. cereus* under various pH conditions can be measured experimentally. (4 marks)

(iv) Some sushi restaurants serve plates with sushi on a rotating conveyor belt that moves past every table. Explain why this way of serving sushi increases the risk of food poisoning. (2 marks)

3(b) In natural ecosystems, bacteria and fungi decompose dead bodies and release minerals into the environment for other organisms to use. Composting utilizes such biological activity to treat food waste. The diagram below shows the change in the dry mass of food waste over time and the change in dry mass of the microorganisms that grow on the food waste during the same period of time:



(i) Explain the overall changes in the dry mass of the food waste and the changes in the dry mass of the microorganisms growing on the food waste. (4 marks)

(ii) (1) Determine the total dry mass of food waste and microorganisms on day 0 and day 50. (1 mark)

(2) Explain the change in the total dry mass of food waste and microorganisms as determined in (1). (4 marks)

(iii) State ***one*** way that treated food waste can be utilised in daily life. (1 mark)

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SECTION D Biotechnology

Answer **ALL** parts of the question.

4(a) Parkinson's disease is a disorder of the central nervous system resulting from the degeneration of neurones and deficiency of a certain type of neurotransmitter in a particular area of the brain. Symptoms of this disease include tremor and muscular rigidity.

(i) With reference to the roles of neurones and neurotransmitters, suggest why patients with Parkinson's disease demonstrate the above symptoms. (2 marks)

(ii) In 1906, a drug was developed to relieve the symptoms of Parkinson's disease. This drug has a similar molecular structure to the neurotransmitter. Suggest how this drug works. (2 marks)

(iii) The benefits of this drug diminish after prolonged medication. In 2001, scientists attempted to use stem cell therapy to treat these patients by transplanting stem cells derived from aborted foetal tissues into their brains. Explain the principle behind this treatment. (2 marks)

(iv) A conceptual breakthrough came in 2007, when a team of biologists in Japan created stem cells from an adult's own tissue. They have 'reprogrammed' skin cells to a state like that of stem cells. Explain why this breakthrough will help overcome the problems associated with the use of stem cells from aborted foetuses for transplants. (3 marks)

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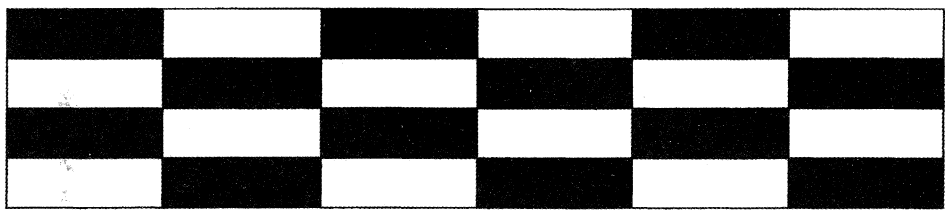
4(b) *Bt* crops were one of the early transgenic plants produced to fight against pests. They contain a *Bt* gene that produces a chemical (*Bt* toxin) which is toxic to the larvae (caterpillars) of the pest.

(i) In the production of *Bt* crops, soil bacteria are used to infect and transform the original crops. Outline the steps that should be taken to modify the soil bacterium in preparation for the infection. (4 marks)

(ii) Many scientists are concerned that the overuse of *Bt* crops will produce pests resistant to the *Bt* toxin. *Bt* resistance is a result of a mutation in the pests. The mutated allele (b) is recessive to the wild type allele (B). After feeding on *Bt* crops, only the homozygous recessive (bb) caterpillars can survive. To minimise the emergence of *Bt* resistance, scientists divided farmland into small areas, some growing *Bt* crops and others growing normal crops, as shown in the diagram below:



Key: *Bt* areas growing *Bt* crops
Non- *Bt* areas growing normal crops

(1) It was found that the mutated allele is very rare in the pest population.

(I) Compare the population size of the adult pests found in the *Bt* areas and non-*Bt* areas. (1 mark)

(II) State the genotype(s) of the adult pests found in the *Bt* areas. (1 mark)

(III) State the genotype(s) of the adult pests that make up the largest proportion in the non-*Bt* areas. (1 mark)

(2) (I) Explain how this strategy (growing crops in the above pattern) works in minimising the emergence of *Bt* resistance in the offspring of adult pests. (3 marks)

(II) What is the assumption behind this strategy? (1 mark)

END OF PAPER

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

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