2018-DSE
BIO
PAPER 2

HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY
HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2018

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.

©香港考試及評核局 保留版權
Hong Kong Examinations and Assessment Authority
All Rights Reserved 2018

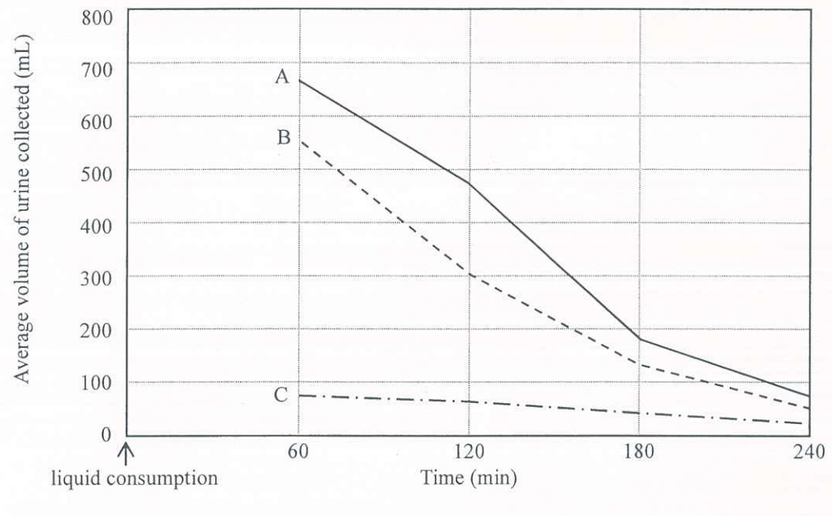
Not to be taken away before the end of the examination session

SECTION A Human Physiology: Regulation and Control

Answer **ALL** parts of the question.

1(a) In a study of the effect of consuming different liquids on urine production, three groups of healthy persons were asked to follow the same pattern of physical activity and dietary intake. After that, Group A consumed a 1500 mL alcoholic beverage, Group B consumed 1500 mL water and Group C did not consume any liquid. Their urine was collected and its volume measured at 60-minute intervals over a period of 240 minutes. The results are shown in the graph below:

Key: ——— Group A: each person consumed a 1500 mL alcoholic beverage
- - - - - - Group B: each person consumed 1500 mL water
—·—·— Group C: did not consume any liquid



(i) With reference to the hormonal control of osmoregulation, explain why Group C had a much lower average volume of urine produced than Group A and Group B. (5 marks)

(ii) (1) With reference to the results of Group A and Group B, what is the overall effect of consuming alcoholic beverages on urine production? (1 mark)

(2) Based on (ii) (1), deduce ***one*** possible effect of alcohol on the hormonal control of osmoregulation. (1 mark)

(iii) Explain why the participants should avoid doing vigorous physical activity during the study. (2 marks)

1(b) Nowadays, many weather forecast apps list 'real feel' temperature in addition to air temperature. The real feel temperature is the temperature which takes into account multiple factors influencing the effectiveness of heat loss from the human body. The higher the effectiveness, the lower is the real feel temperature. The table below shows the real feel temperatures at different air temperatures and relative humidities (other environmental conditions remain the same):

Relative humidity (%)	*Air temperature (°C)*			
	24	*28*	*32*	*36*
40	24	29	34	39
50	24	29	35	41
60	25	30	36	41
70	26	31	37	42
80	26	32	37	44
90	27	32	38	45
100	27	33	39	46

Note: Real feel temperatures are highlighted in grey.

(i) Describe the effect of relative humidity on the real feel temperature. Explain this phenomenon with reference to the effectiveness of heat loss from the body. (3 marks)

(ii) How does the effect described in (i) change at higher air temperatures? Explain this phenomenon with reference to the effectiveness of heat loss from the body. (3 marks)

(iii) Other than relative humidity and air temperature, suggest ***two*** environmental factors that may affect the real feel temperature. Explain your answer. (4 marks)

(iv) People who are engaged in outdoor work or activities are advised to drink plenty of water when the Hong Kong Observatory issues the Very Hot Weather Warning. Based on your biological knowledge, suggest an explanation for this advice. (1 mark)

Go on to the next page

SECTION B Applied Ecology

Answer **ALL** parts of the question.

2(a) (i) The concentrations of copper and cadmium per unit biomass in marine phytoplankton and its consumer, filter-feeding bivalves, were determined in a study. Their concentrations are shown in the table below:

	Copper (arbitrary unit)	*Cadmium (arbitrary unit)*
Concentration in phytoplankton (Cp)	20	0.6
Concentration in bivalve (Cb)	16	1.2
Cb/Cp Ratio	0.8	?

(1) Calculate the *Cb/Cp* ratio for cadmium. (1 mark)

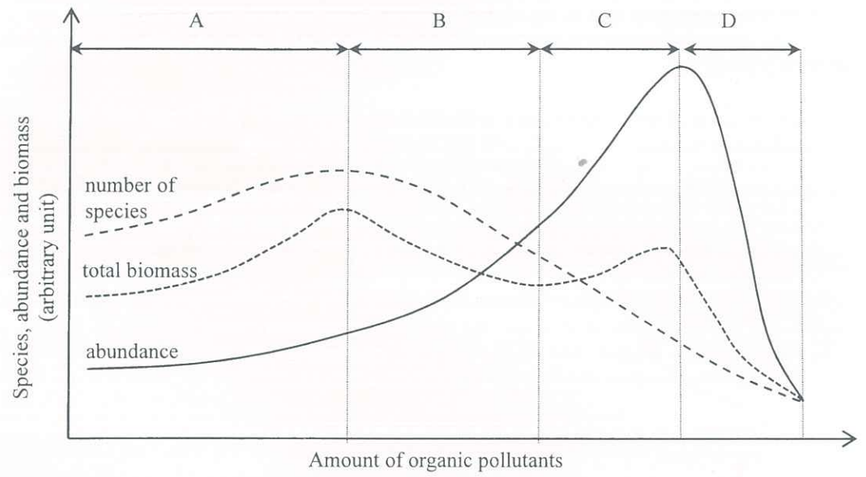
(2) What is the implication of a *Cb/Cp* ratio greater than 1? (1 mark)

(3) Compare the *Cb/Cp* ratios for copper and cadmium. List ***two*** possible reasons for the difference. (3 marks)

(ii) Briefly describe an experiment to study the effect of different concentrations of cadmium on the mortality of bivalves. (3 marks)

(iii) Cadmium in rechargeable batteries is one of the sources of cadmium pollution in the environment. Suggest ***two*** possible ways to reduce such pollution. (2 marks)

2(b) Invertebrates that live on, in and near the seabed are important components of the coastal ecosystem. These invertebrates feed on organic matter. The diagram below shows the effects of increasing amounts of organic pollutants from household sewage on the invertebrate community in a harbour in terms of the number of species, abundance (total number of organisms) and total biomass:



(i) Explain why the invertebrate community expands when the amount of organic pollutants increases at Stage A. (2 marks)

(ii) It is found that the proportion of larger invertebrates in the community declines in Stage B as the amount of organic pollutants continues to increase.

(1) With reference to the graph, give evidence to support the above statement. (3 marks)

(2) Suggest why the increase in the amount of organic pollutants will lead to a decline in the proportion of larger invertebrates in the community at Stage B. (3 marks)

(iii) Although the abundance and biomass of invertebrates continues to increase at Stage C, the community is deteriorating. State a piece of evidence from the graph to support this statement. (1 mark)

(iv) Suggest ***one*** property of the dominant species in the invertebrate community at Stage C. (1 mark)

Go on to the next page

SECTION C Microorganisms and Humans

Answer **ALL** parts of the question.

3(a) Trillions of microorganisms live in the human intestine. Most of them are non-pathogenic and play an important role in many functions in the human body, including food digestion, defence against pathogens and vitamin production.

(i) What is the ecological relationship between humans and these microorganisms in the intestine? Explain your answer. (2 marks)

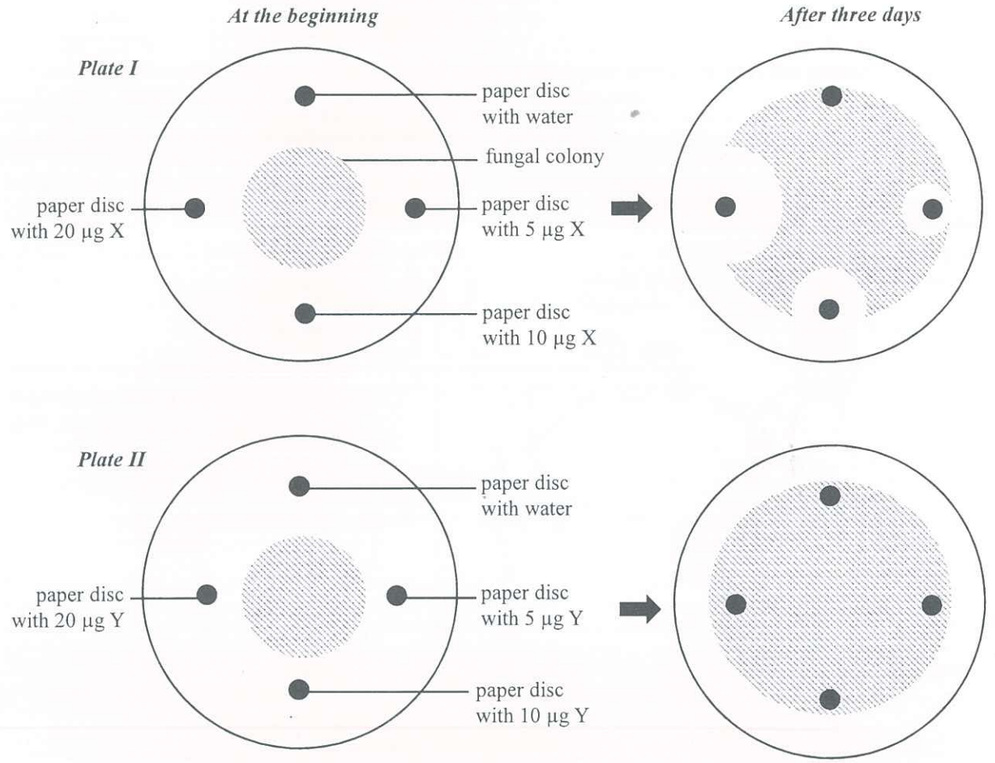
(ii) According to the World Health Organization, probiotics are microorganisms that confer health benefits on humans. However, a large amount of probiotics has to be ingested so that a sufficient number can survive gastric digestion and reach the intestine.

(1) You are given a flask of cultured probiotic bacteria and a 37°C incubator. In order to design an investigation to estimate the number of probiotic bacteria that can survive gastric digestion, suggest ***two*** other pieces of information that are required to simulate, in a laboratory setting, the physiological conditions in the stomach. (2 marks)

(2) Describe how you can estimate the number of living probiotic bacteria at the end of the experiment. (4 marks)

(3) It is believed that patients who have completed a course of antibiotic treatment should consume food that contains probiotics. Suggest why this may protect patients from infection. (3 marks)

3(b) An experiment was conducted to study the effects of compounds X and Y on the growth of a fungal colony. Paper discs with different dosages of compound X or Y were placed on nutrient agar plates previously inoculated with a fungal colony. The appearance of the fungal colony at the beginning of the experiment and after three days are shown in the diagrams below:



(i) Describe the effects of compounds X and Y on the growth of this fungus. (3 marks)

(ii) In another experiment, the fungus was incubated for 1 hour with compound X or Y. After that, a green fluorescent dye which cannot pass through cell membranes was added. Green fluorescence stained the nuclei of the fungal cells exposed to compound X while no fluorescence was detected in fungal cells exposed to compound Y.

(1) With reference to the results, suggest the possible action of compound X on the fungus. (2 marks)

(2) Based on your answer in (1), suggest why clear zones were present in plate I after three days as shown in the diagram above. (2 marks)

(iii) Aseptic technique should be used during the inoculation of the fungus on the agar plate. Explain the importance of this. (1 mark)

(iv) This fungus occurs commonly in air and grows on our household goods. Suggest ***one*** possible daily use of compound X in our household products. (1 mark)

Go on to the next page

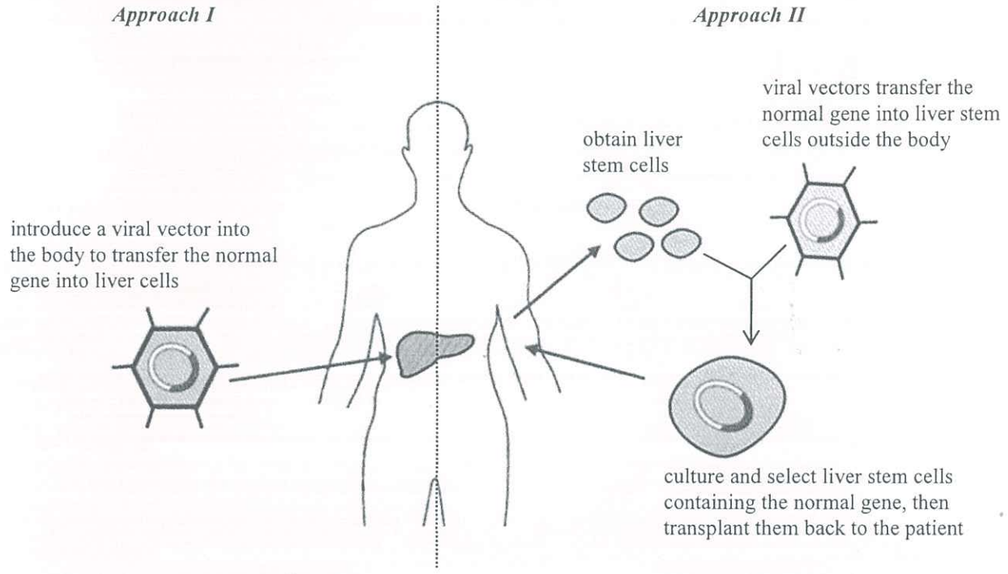
This page is blank.

SECTION D Biotechnology

Answer **ALL** parts of the question.

4(a) (i) John suffers from a genetic disorder that leads to difficulty in blood clotting. One way to treat John is infusing blood. Give ***two*** disadvantages of this treatment. (2 marks)

(ii) It was found that John's problem is caused by a defective gene that fails to produce a certain liver protein for blood clotting. Scientists have proposed gene therapy to treat this genetic disorder. The diagram below shows two possible gene therapy approaches:

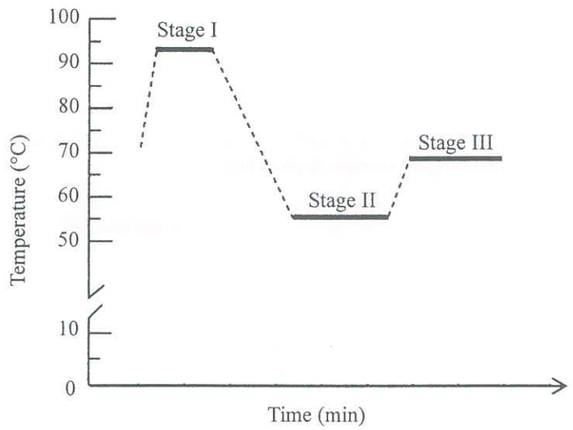


(1) Explain why stem cells should be used for the gene therapy in Approach II. (2 marks)

(2) With reference to the information in the diagram, explain why Approach II is a better option in terms of the potential hazards of gene therapy to John. (4 marks)

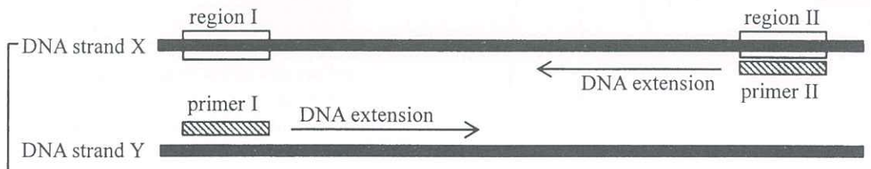
Go on to the next page

4(b) The diagram below shows the change in temperature during a polymerase chain reaction (PCR) cycle:



(i) Which stage corresponds to DNA denaturation? Explain your answer. (3 marks)

(ii) Mary planned to amplify a fragment of DNA using PCR. The following diagram shows the annealing of primers during PCR. The sequence of DNA strand X is shown below and the corresponding sequences of regions I and II are highlighted:



Sequence of DNA strand X:

					no. of bases
TGGCGCTGGG	CGCAATGCGC	GCCATTACCG	AGTCCGGGCT	GCGCGTTGGT	50
		region I			
GCGGATATCT	CGGTAGTGGG	ATACGACGAT	ACCGAAGACA	GCTCATGTTA	100
TATCCCGCCG	TTAACCACCA	TCAAACAGGA	TTTTCGCCTG	CTGGGGCAAA	150
CCAGCGTGGA	CCGCTTGCTG	CAACTCTCTC	AGGGCCAGGC	GGTGAAGGGC	200
AATCAGCTGT	TGCCCGTCTC	ACTGGTGAAA	AGAAAACCA	CCCTGGCGCC	250
CAATACGCAA	ACCGCCTCTC	CCCGCGCGTT	GGCCGATTCA	TTAATGCAGC	300
TGGCACGACA	GGTTTCCCGA	CTGGAAAGCG	GGCAGTGAGC	GCAACGCAAT	350
TAATGTGAGT	TAGCTCACTC	ATTAGGCACC	CCAGGCTTTA	CACTTTATGC	400
			region II		
TTCGGCTCG	TATGTTGTGT	GGAATTGTGA	GCGGATAACA	ATTTCACACA	450

Mary designed the following primers for the PCR:

Primer I: CGGUAGUGGG AUACGACGAU DNA extension →

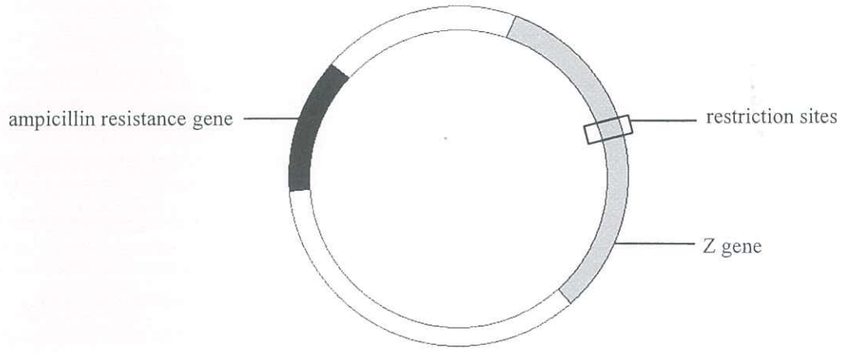
Primer II: CCTTAACACT CGCCTATTGT DNA extension →

(1) There is one type of mistake in each primer. Write the correct primers to be used. (2 marks)

(2) What is the predicted size (in terms of number of base pairs) of the PCR product? (1 mark)

(iii) Mary used the following plasmid as a vector to carry the PCR product to transform bacteria. The plasmid contained:

(I) an ampicillin resistance gene;
(II) a Z gene encoding an enzyme that converts substance X to blue compounds;
(III) some restriction sites within the Z gene.



After the transformation of the bacteria, Mary grew the bacteria on agar plates containing both ampicillin and substance X. Blue and white bacterial colonies were formed.

(1) What is the purpose of adding ampicillin to the agar plates? Explain your answer. (2 marks)

(2) Explain which type of colony (blue or white) contains non-recombinant plasmids, i.e. without DNA insert. (4 marks)

END OF PAPER

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