HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

HONG KONG DIPLOMA OF SECONDARY EDUCATION EXAMINATION 2015

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) A young couple, John and Judy, wanted to have a baby. After a year of trying, Judy had still not become pregnant. They consulted their family doctor on this issue. The doctor suggested that both of them should undergo some tests to check their fertility.

(i) The doctor requested a semen sample from John for microscopic examination. Suggest *two* items in the sample that should be checked. (2 marks)

(ii) After collecting information about Judy's menstrual cycle, the doctor requested blood samples from Judy to monitor her levels of LH and FSH.

(1) Why should the levels of LH and FSH be checked? (3 marks)

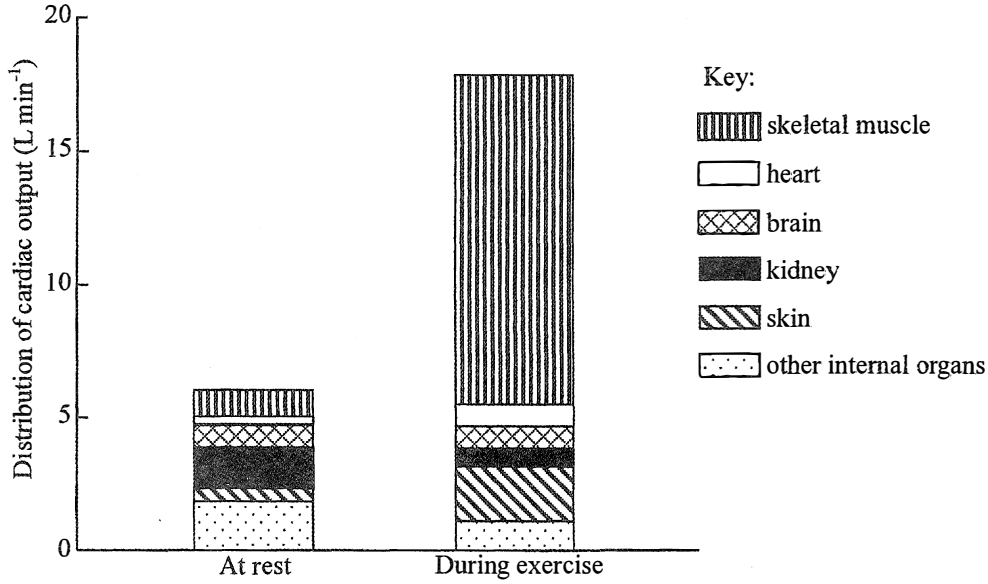
(2) The doctor also checked the condition of Judy's oviducts. What is the importance of this examination? (2 marks)

(iii) All the test results were normal. Three months later, Judy did not experience menstruation on the expected day.

(1) Explain why the absence of menstruation can be a sign of pregnancy. (2 marks)

(2) A hormone named HCG was detected in Judy's blood and urine. HCG prevents the degeneration of the yellow body. Based on the action of HCG, explain why Judy did not experience menstruation. (2 marks)

1(b) The diagram below shows the distribution of cardiac output to various parts of the human body at rest and during exercise:



(i) With reference to the control of heart beat, briefly describe *two* regulatory ways in which the cardiac output can be increased during exercise. (2 marks)

(ii) Explain the importance of skeletal muscles having the greatest increase in blood supply during exercise. (3 marks)

(iii) Explain why there is an increase in blood flow to the skin during exercise. (4 marks)

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SECTION B Applied Ecology

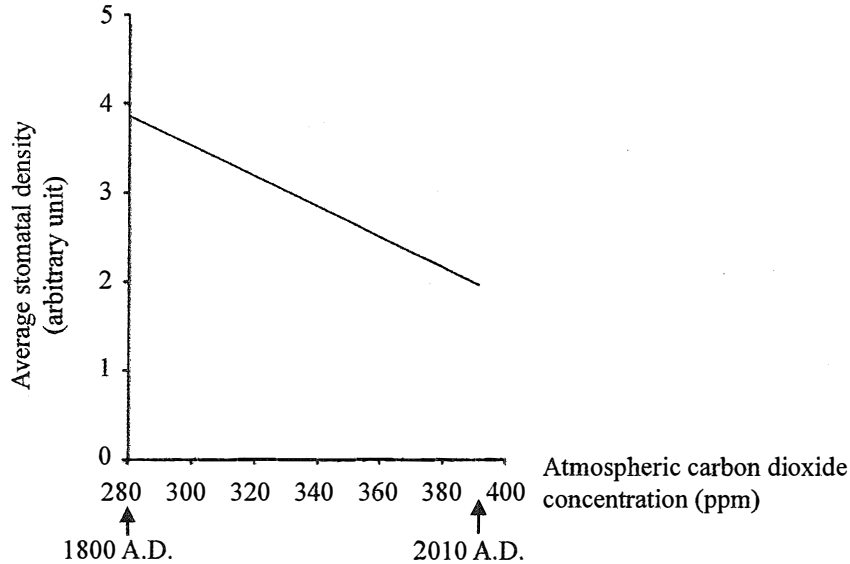
Answer **ALL** parts of the question.

2(a) The atmospheric concentration of carbon dioxide has been increasing in the last 210 years. The increase is believed to be the major cause of global climate change.

(i) Explain why the increase in carbon dioxide concentration leads to a change in the atmospheric temperature. (2 marks)

(ii) It has been suggested that the rate of increase in carbon dioxide concentration can be slowed down by photosynthesis. What is the biological principle behind this suggestion? (3 marks)

(iii) The graph below shows the changes in the average stomatal density of some plant species and the atmospheric carbon dioxide concentration over the past 210 years:



(1) How may the observation contradict the suggestion given in (ii)? (3 marks)

(2) It has been hypothesized that the decrease in the average stomatal density of plant species may further affect the regional climate. With reference to the water cycle, explain the rationale behind this hypothesis. (2 marks)

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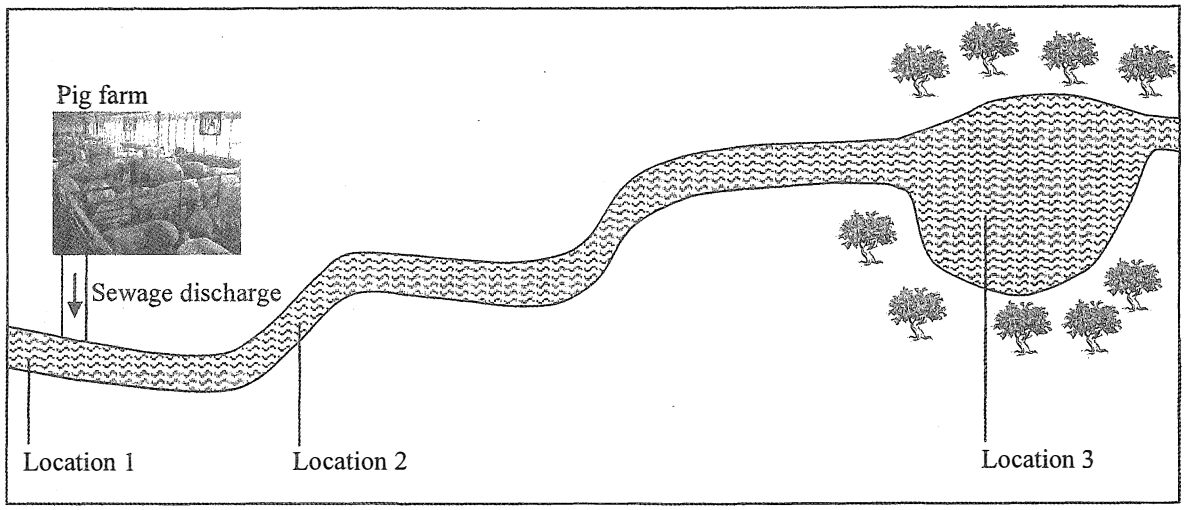
2(b) A pig farm is located in the upper course of a freshwater stream. Sewage is discharged illegally into the stream. To investigate the impact of the sewage discharge, water samples and aquatic animals were collected from upstream near to the sewage discharge (Location 1) and 50 m downstream (Location 2). The diagram below shows the position of the pig farm and the stream:



The table below shows the data obtained at locations 1 and 2:

	Location 1	Location 2
Dissolved oxygen (% saturation)	95	22
Animal community	Fish species A	Fish species C
	Fish species B	Larvae of insect species A
	Snail species A	
	Crab species A	

(i) (1) Explain the change in the level of dissolved oxygen as water flows from Location 1 to Location 2. (4 marks)

(2) With reference to the change in the level of dissolved oxygen, explain the differences in the animal species at Location 2 as compared to Location 1. (2 marks)

(ii) It was found that the level of dissolved oxygen 1 km downstream (Location 3) from the sewage discharge had been restored to 95%.

(1) Suggest how the level of dissolved oxygen was restored at Location 3. (2 marks)

(2) Although the level of dissolved oxygen had recovered, the animal community found at Location 3 was different from that at Location 1. Suggest why. (2 marks)

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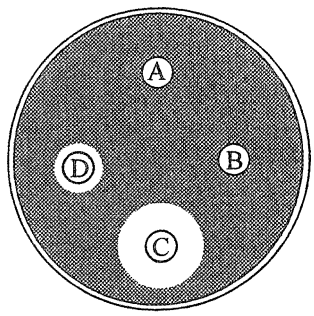
SECTION C Microorganisms and Humans

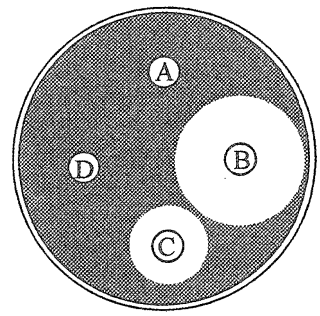
Answer **ALL** parts of the question.

3(a) To investigate the effectiveness of antibiotics on inhibiting the growth of different microorganisms, four agar plates, each with a different microorganism (1, 2, 3 and 4) were prepared. Circular paper discs soaked with the same concentration of antibiotics A, B, C and D respectively were placed onto the plates. Clear zones were formed on the agar plates after incubation as shown in the diagram below:

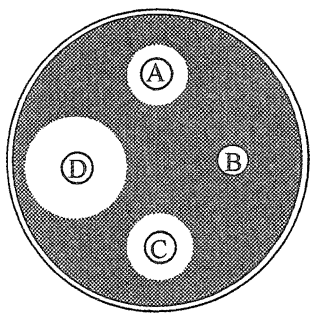
Agar plate with microorganism 1



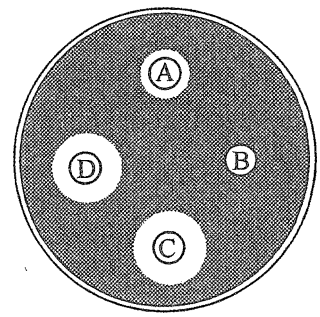
Agar plate with microorganism 2



Agar plate with microorganism 3



Agar plate with microorganism 4



Key:

○ circular paper disc soaked with different antibiotics

▒ region with the growth of microorganisms

▭ clear zones formed around the paper discs

(i) In this investigation, how can you compare the effectiveness of different antibiotics on inhibiting the growth of a microorganism? (1 mark)

(ii) If a doctor has not yet confirmed which microorganism is responsible for an infection, which antibiotics should he use? Explain your answer. (3 marks)

(iii) To find out the type of microorganism responsible for a certain infection, a microbial sample taken from a patient is cultured for identification.

(1) State *two* steps in the aseptic technique that should be used during the inoculation of microorganisms on the agar plate. (2 marks)

(2) What is the advantage of identifying the microorganism responsible for a certain infection? (2 marks)

(iv) Give *two* properties of antibiotics which can be generalized from the above results. (2 marks)

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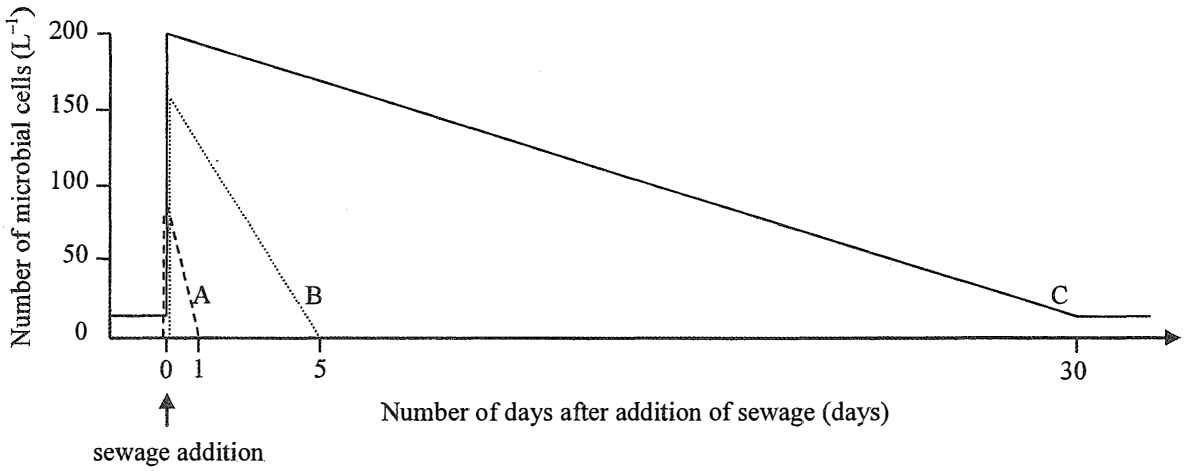
3(b) An experiment was conducted to investigate the change in the population size of sewage microorganisms by adding sewage to a beaker of unpolluted river water. The beaker was then placed outdoors under natural light. The graph below shows the change in population size of three kinds of sewage microorganisms A, B and C in the beaker during the course of the experiment:



(i) State ***two*** environmental factors that would cause the drop in the population of sewage microorganisms observed above. Explain your answer. (4 marks)

(ii) Suggest why the microbial populations dropped at different rates as shown above. (1 mark)

(iii) Some microorganisms can be used as indicating organisms of sewage pollution in river water. Discuss whether the microorganisms shown above are suitable for use as indicating organisms. (3 marks)

(iv) In the above case, both biomass measurement and optical measurement are ***not*** suitable for monitoring the population size of the microorganisms effectively. Explain why not. (2 marks)

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SECTION D Biotechnology

Answer **ALL** parts of the question.

4(a) Read the following passage and answer the questions that follow it.

'Bubble kid' success puts gene therapy back on track

When Nina was a 5-week-old baby, she had a condition called severe combined immunodeficiency (SCID) which is caused by a faulty *ADA* gene. This gene originally encodes the enzyme adenosine deaminase. The absence of this enzyme will lead to the accumulation of toxins in white blood cells and finally kill the cells. Affected kids have to live in a sterile environment and they are often called 'bubble kids'.

Today, Nina is a happy girl with a functioning immune system. She has gene therapy – and its latest improvements – to thank for this. In the therapy, cells were harvested from Nina's bone marrow and given a working version of the *ADA* gene, before being injected back into her bone marrow. After 5 months, her white blood cell count had nearly doubled, and today her immune system is fully functional.

(i) With reference to the roles of white blood cells, explain why children suffering from SCID have to live in a sterile environment. (2 marks)

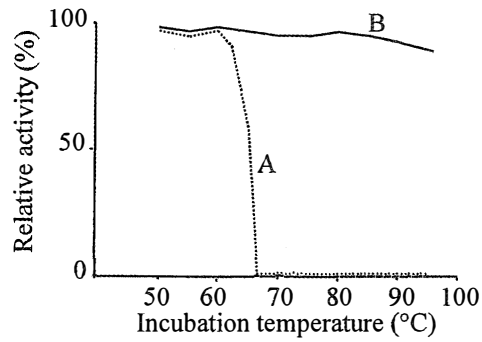
(ii) Why are cells from the bone marrow instead of white blood cells used in the gene therapy for SCID patients? (4 marks)

(iii) With reference to Nina's case, briefly describe how recombinant DNA technology is applied in gene therapy. (3 marks)

(iv) Suggest the potential hazards of gene therapy. (2 marks)

4(b) (i) Briefly describe the three major stages involved in a PCR cycle. (3 marks)

(ii) To test heat resistance of DNA polymerases A and B, the polymerases were incubated at different temperatures for 30 minutes. Their relative enzyme activities as compared to the maximum activity of the enzyme were measured. The results are shown in the graph below:



(1) Of the three stages mentioned in (i), which stage requires the action of DNA polymerase? (1 mark)

(2) Which DNA polymerase is more suitable for use in PCR? Explain your answer. (4 marks)

(iii) State ***one*** application of PCR. (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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