

BIOLOGY PAPER 1

8:30 am – 11:00 am (2 hours 30 minutes)

This paper must be answered in English

GENERAL INSTRUCTIONS

- (1) There are **TWO** sections, A and B, in this Paper. You are advised to finish Section A in about 35 minutes.
- (2) Section A consists of multiple-choice questions in this question paper. Section B contains conventional questions printed separately in Question-Answer Book B.
- (3) Answers to Section A should be marked on the Multiple-choice Answer Sheet while answers to Section B should be written in the spaces provided in Question-Answer Book B. **The Answer Sheet for Section A and the Question-Answer Book B for Section B will be collected separately at the end of the examination.**

INSTRUCTIONS FOR SECTION A (MULTIPLE-CHOICE QUESTIONS)

- (1) Read carefully the instructions on the Answer Sheet. After the announcement of the start of the examination, you should first stick a barcode label and insert the information required in the spaces provided. No extra time will be given for sticking on the barcode label after the 'Time is up' announcement.
- (2) When told to open this book, you should check that all the questions are there. Look for the words '**END OF SECTION A**' after the last question.
- (3) All questions carry equal marks.
- (4) **ANSWER ALL QUESTIONS.** You are advised to use an HB pencil to mark all the answers on the Answer Sheet, so that wrong marks can be completely erased with a clean rubber. You must mark the answers clearly; otherwise you will lose marks if the answers cannot be captured.
- (5) You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive **NO MARKS** for that question.
- (6) No marks will be deducted for wrong answers.

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

There are 36 questions in this section.

The diagrams in this section are NOT necessarily drawn to scale.

1. Which of the following processes involves enzymes on cell membranes?
- A. excretion of carbon dioxide by the lungs
 - B. transport of water along the xylem vessel
 - C. Calvin cycle in the chloroplasts of plant cells
 - D. digestion of carbohydrates in the small intestine

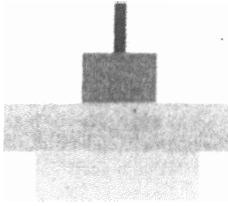
Directions: Questions 2 to 4 refer to an experiment on the enzyme catalase, which speeds up the breakdown of hydrogen peroxide to release oxygen. John added a 1 cm³ cube of pig liver to a boiling tube containing 5 mL hydrogen peroxide solution. Gas bubbles were released and he used a glowing splint to test the gas. He repeated the experiment with beef, potato and apple. The results are shown below:

<i>Tissue</i>	<i>Rate of bubbles released</i>	<i>Glowing splint re-lit</i>
Pig liver	Moderate	Yes
Beef	Moderate	Yes
Potato	Slow	Yes
Apple	Slow	Yes

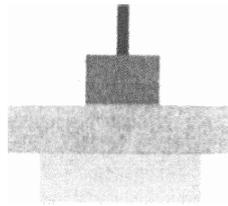
2. Which of the following statements is an observation of the experiment?
- A. These tissues contained catalase.
 - B. Oxygen gas was released in the reaction.
 - C. The gas released re-lit the glowing splint.
 - D. Animal tissues had more catalase than plant tissues.
3. When the release of gas bubbles had stopped, John added more hydrogen peroxide solution to the boiling tubes. Which of the following combinations correctly shows the expected result and the explanation of this additional experiment?
- | | <i>Expected result</i> | <i>Explanation</i> |
|----|------------------------|-------------------------------------|
| A. | Gas bubbles released | Catalase is specific in its action. |
| B. | Gas bubbles released | Catalase is reusable. |
| C. | No gas bubbles | Catalase has been used up. |
| D. | No gas bubbles | Catalase is denatured. |
4. In order to prove that hydrogen peroxide is the substrate of this enzymatic reaction, which of the following steps should be used as a control?
- A. Repeat the experiment using water and the tissues.
 - B. Repeat the experiment using water and boiled tissues.
 - C. Repeat the experiment using hydrogen peroxide but no tissues.
 - D. Repeat the experiment using hydrogen peroxide and boiled tissues.

5. The diagrams below show the pyramids of numbers and biomass of a food chain:

Pyramid of numbers



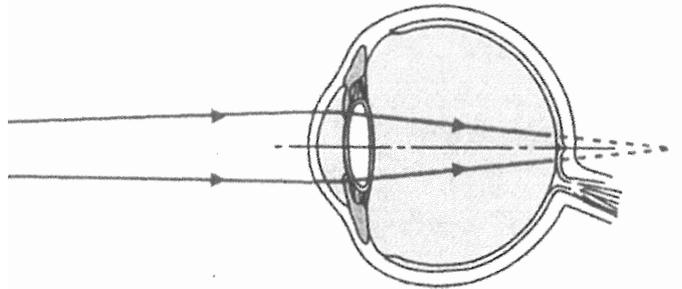
Pyramid of biomass



Which of the following is most likely to be the producer in this food chain?

- A. rice
 - B. trees
 - C. grass
 - D. phytoplankton
6. Protecting sharks in the wild is important for maintaining the ecological balance of the marine ecosystem because
- A. sharks are an endangered species.
 - B. shark fin is a popular dish for banquets.
 - C. the dead bodies of sharks are an important food source for decomposers.
 - D. sharks are top predators that regulate the population sizes of other consumers.

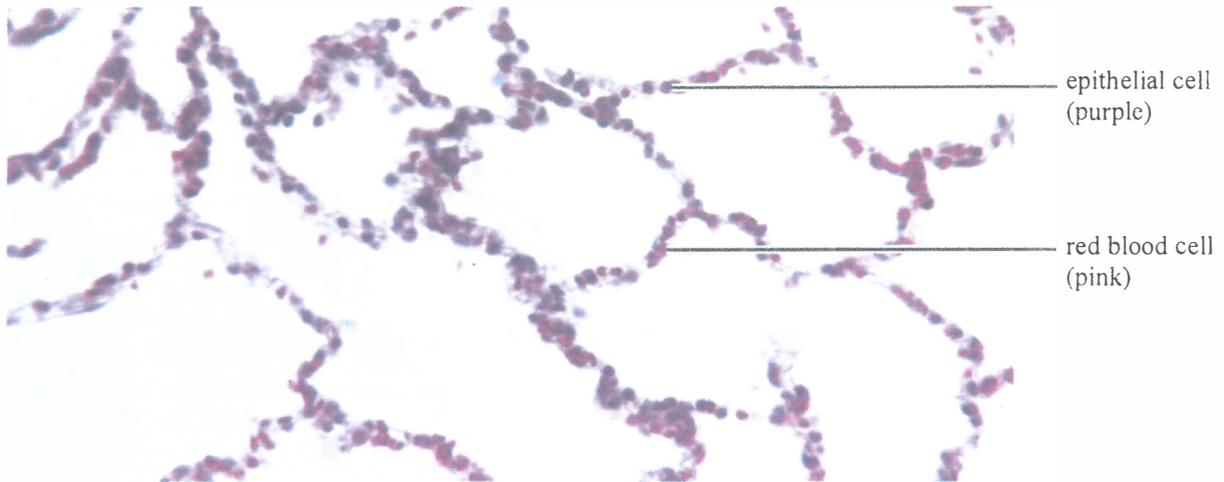
7. Below is a ray diagram of a common eye defect:



Which of the following combinations correctly identifies the eye defect and type of lens to be worn to remedy it?

- | <i>Eye defect</i> | <i>Type of lens</i> |
|----------------------|---------------------|
| A. Long-sightedness | Convex lens |
| B. Long-sightedness | Concave lens |
| C. Short-sightedness | Convex lens |
| D. Short-sightedness | Concave lens |

8. The photomicrograph below shows a section of human lung:

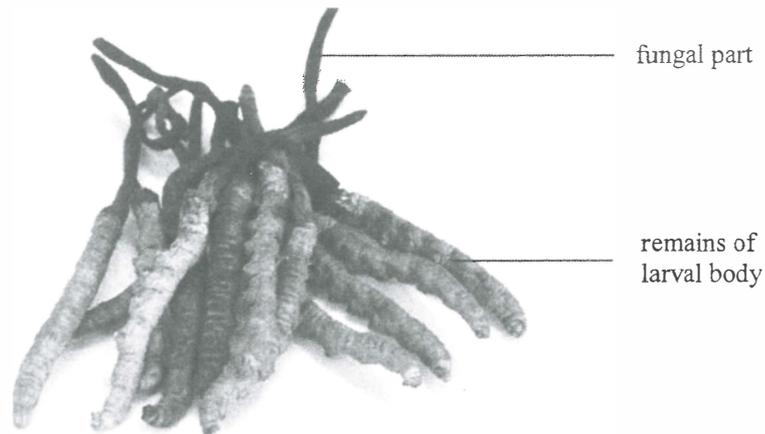


With reference to the structures shown in the photomicrograph, which of the following are adaptive features for gas exchange?

- (1) presence of water film
 - (2) short diffusion distance
 - (3) rich supply of blood capillaries
- A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
9. Which of the following statements provides the best reason for classifying unicellular organisms into domain Bacteria and Archaea?
- A. Archaea are more ancient than bacteria.
 - B. Archaea are smaller than bacteria.
 - C. The DNA sequences of archaea are distinct from those of bacteria.
 - D. The compositions of the cell wall and cell membrane of archaea are different from those of bacteria.
10. Which of the following statements best explains why vaccination against flu is administered annually?
- A. The flu virus is constantly mutating.
 - B. The antibodies against flu virus only last for one year.
 - C. The flu vaccine is not very effective because it is made from a weakened virus.
 - D. When memory cells encounter the flu vaccine again, a secondary response is triggered.
11. Which of the following processes takes place at the inner membrane of mitochondria?
- A. glycolysis
 - B. conversion of pyruvate to acetyl CoA
 - C. Krebs cycle
 - D. oxidative phosphorylation

Directions: Questions 12 and 13 refer to the information below. Kathy had two pure-bred cats, one had long white fur while the other had short black fur. It is known that fur length and fur colour are controlled by two different genes respectively. The two cats gave birth to four kittens which had long black fur.

12. Which of the following conclusions can be drawn based on the above case?
- (1) Long fur is dominant over short fur.
 - (2) The four kittens have the same genotype for fur length and fur colour.
 - (3) The genes controlling fur length and fur colour are located on different chromosomes.
- A. (1) and (2) only
 - B. (1) and (3) only
 - C. (2) and (3) only
 - D. (1), (2) and (3)
13. After the kittens had grown up, they interbred and gave birth to the second filial generation (F_2). Among the F_2 kittens, there was one with short white fur. Which of the following processes mostly likely contributed to the occurrence of this new phenotype?
- (1) Mutation
 - (2) Random fertilisation of gametes
 - (3) Independent assortment of chromosomes
- A. (1) and (2) only
 - B. (1) and (3) only
 - C. (2) and (3) only
 - D. (1), (2) and (3)
14. Caterpillar fungus is a kind of Chinese herbal medicine. When the spores of this fungus land on the larvae of moths, the spores will germinate inside the body of the larvae and grow out of their heads, as shown in the photograph below:



Which of the following best describes the role of this fungus?

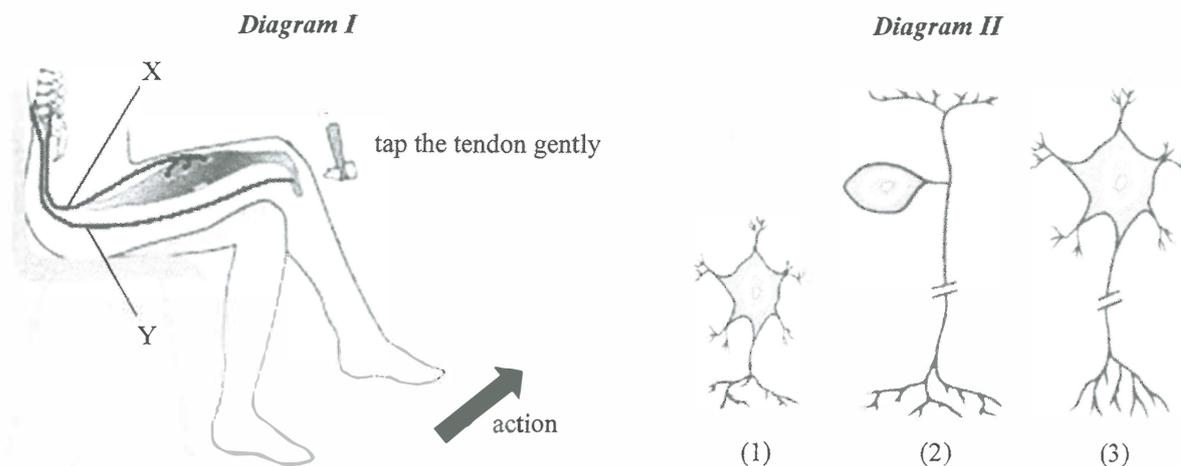
- A. parasite
- B. predator
- C. producer
- D. consumer

Directions: Questions 15 to 17 refer to the following diagram, which shows the structures of a potato plant:



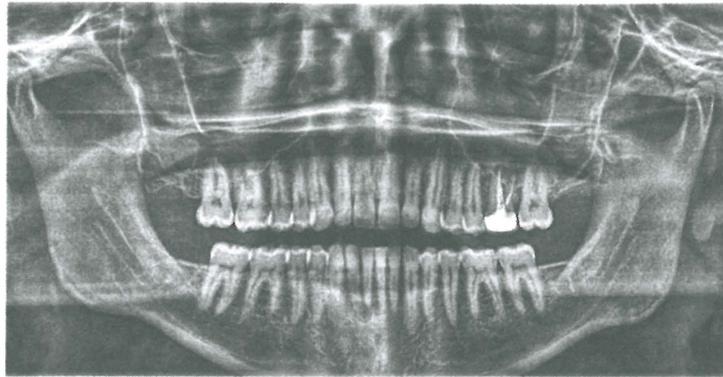
15. Which of the following labelled structure(s) is / are involved in the reproduction of this potato plant?
- A. Q only
 - B. S only
 - C. R and S only
 - D. Q, R and S only
16. Which of the following labelled structures contain cells with different genotypes?
- A. P and Q
 - B. P and S
 - C. Q and R
 - D. R and S
17. Farmers usually grow potato plants by vegetative propagation. This is probably because vegetative propagation
- A. produces tubers for harvesting.
 - B. does not involve seed dispersal.
 - C. takes a shorter time to reproduce.
 - D. allows rapid colonisation of an area.
18. Some people claim that we should chew food for a longer time before swallowing. Which of the following statements about this claim is *incorrect*?
- A. This stimulates the secretion of saliva.
 - B. This moistens the food for easier swallowing.
 - C. This provides enough time for digestion of starch into glucose.
 - D. This increases the surface area of the food for chemical digestion.

Directions: Questions 19 to 21 refer to the diagrams below. Diagram I shows the reflex arc of the knee jerk reflex while diagram II shows three types of neurones:



19. The effector in the reflex arc in Diagram I is
- a flexor because its response bends the limb.
 - an extensor because its response straightens the limb.
 - a flexor because it shortens to bring about the movement.
 - an extensor because it lengthens to bring about the movement.
20. Which of the following combinations correctly identifies the types of neurones to which X and Y belong?
- | | X | Y |
|----|----------|----------|
| A. | (1) | (3) |
| B. | (2) | (1) |
| C. | (2) | (3) |
| D. | (3) | (2) |
21. Another neural pathway allows the man to feel the tapping action. Which of the following parts should this pathway connect to?
- cerebellum
 - spinal cord
 - cerebral cortex
 - medulla oblongata
22. Which of the following combinations correctly identifies the distribution of grey matter and white matter in the cerebrum and spinal cord?
- | | Inner part of the cerebrum | Inner part of the spinal cord |
|----|-----------------------------------|--------------------------------------|
| A. | white matter | grey matter |
| B. | white matter | white matter |
| C. | grey matter | grey matter |
| D. | grey matter | white matter |

23. The following picture shows an X-ray photograph of the dentition of a person:



Which of the following dental formulae correctly describes the dentition in the above photograph?

- | | | | |
|----|---------------------|----|---------------------|
| A. | $\frac{2212}{2212}$ | B. | $\frac{2122}{2122}$ |
| C. | $\frac{2131}{2131}$ | D. | $\frac{2113}{2113}$ |

24. The following photograph shows a tree with roots covered by concrete:



Four students have expressed their views about this:



John

Don't worry! Oxygen produced in the leaves can be transported to the root for respiration!



Tom

How come? Water absorbed cannot be transported to the leaves because the concrete will block the xylem.



Mary

Oh, no! The concrete blocks gas exchange in roots, leading to poor absorption of minerals in roots.



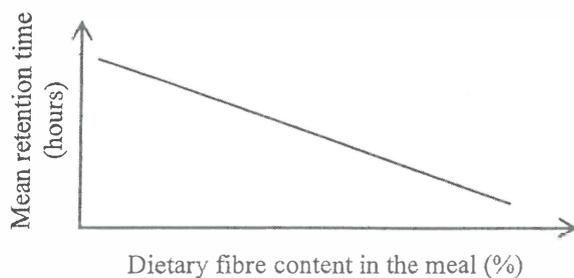
Susan

Good! The concrete can provide mechanical support and keep the tree upright.

Whose view is correct?

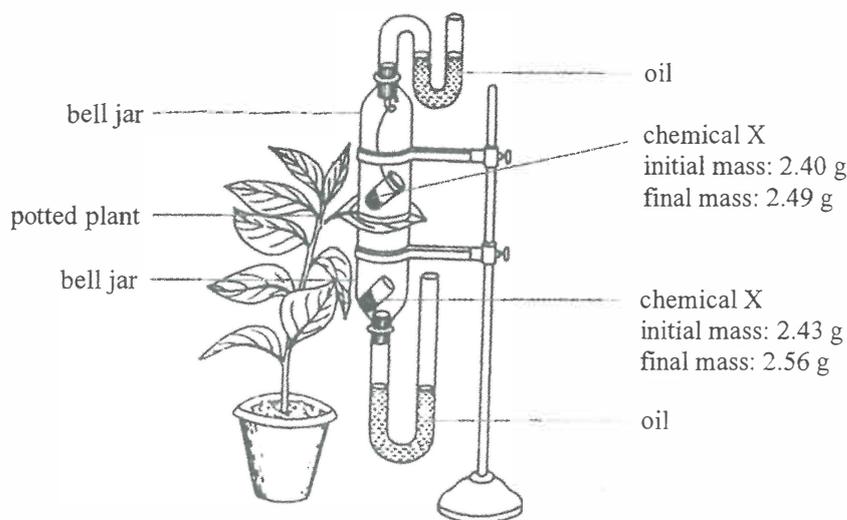
- A. John's view
- B. Mary's view
- C. Tom's view
- D. Susan's view

25. The graph below shows the relationship between the dietary fibre content of a meal and the mean retention time (i.e. the duration for which the undigested materials stay in the large intestine) in the human body:



- Which of the following can be deduced from the graph?
- A. Meals with more dietary fibre can increase the bulk of the faeces.
 - B. Meals with more dietary fibre can hold more water, and so soften faeces better.
 - C. Meals with less dietary fibre have more nutrients and a longer time is required for complete absorption.
 - D. Meals with less dietary fibre result in harder faeces due to an increased time for water absorption.
26. After vigorous exercise, the blood lactic acid concentration of an athlete increases. Which of the following word equations correctly shows the process that leads to the formation of lactic acid?
- A. glucose \rightarrow lactic acid
 - B. glucose \rightarrow lactic acid + water
 - C. glucose \rightarrow lactic acid + carbon dioxide
 - D. glucose + oxygen \rightarrow lactic acid + carbon dioxide
27. 'Lock and Key' is a scientific model which is a selective representation used to explain that enzymes
- A. are biological catalysts.
 - B. are specific in action.
 - C. are protein in nature.
 - D. are required in small amounts.
28. The DNA model proposed by Watson and Crick leads to the understanding of how
- A. organisms store genetic codes.
 - B. organisms share a common ancestor.
 - C. cells produce instructions for protein synthesis.
 - D. cells can pass genetic information to the next generation.
29. Which of the following substances contribute(s) most to the increase in biomass of a plant?
- A. water
 - B. oxygen
 - C. minerals
 - D. carbon dioxide

Directions: Questions 30 and 31 refer to the set-up below. The set-up consists of two bell jars placed one above the other with the leaf of a potted plant in between. Chemical X was placed into the jars to absorb water vapour. The whole set-up was made air-tight. The masses of chemical X in the two jars were measured at the beginning and after five hours.



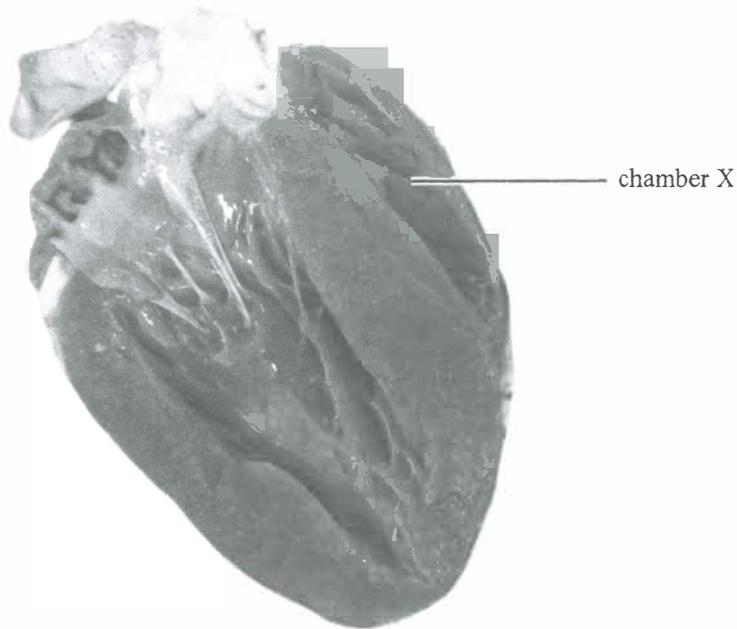
30. The change in mass of chemical X was mainly caused by
- water uptake by the plant.
 - water loss in transpiration.
 - water produced in respiration.
 - water consumed by photosynthesis.
31. Which of the following conclusions can be drawn from the results?
- Water absorption by the root is mainly driven by the lower epidermis of the leaf.
 - There are more stomata at the lower epidermis than the upper epidermis of the leaf.
 - The respiration rate is higher than the photosynthetic rate during the experiment.
 - The photosynthetic rate of the upper layer of the leaf is higher than that of the lower layer.
32. Organisms P and Q are found in the same local habitat. Their population sizes have continued to grow in the last few years. Which of the following statements best describes organisms P and Q?
- They are heterotrophs.
 - They are top predators.
 - They have different niches.
 - They have different predators.
33. Which of the following statements about primary succession and secondary succession is correct?
- Primary succession is always followed by secondary succession.
 - Primary succession always starts with a barren area while secondary succession does not.
 - Secondary succession always ends with a climax community while primary succession does not.
 - Secondary succession always ends with a climax community while primary succession ends with a pioneer community.

34. Which of the following contribute to the continuous blood flow in the aorta?

- (1) pumping action of the heart
- (2) elastic nature of the wall of the aorta
- (3) contraction and relaxation of muscle wall of the aorta

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

35. The following photograph shows a dissected pig heart:



Which of the following descriptions about chamber X is correct?

- A. It receives blood from the pulmonary vein.
- B. It pumps out blood to the aorta.
- C. It receives blood from the vena cava.
- D. It pumps out blood to the pulmonary artery.

36. Which of the following processes mainly involves osmosis?

- A. movement of water along the xylem in plants
- B. movement of water vapour out of stomata in plants
- C. movement of water from tissue fluid to capillaries in humans
- D. movement of water from tissue fluid to lymph capillaries in humans

END OF SECTION A

Go on to Question-Answer Book B for questions on Section B

BIOLOGY PAPER 1

SECTION B : Question-Answer Book B

This paper must be answered in English

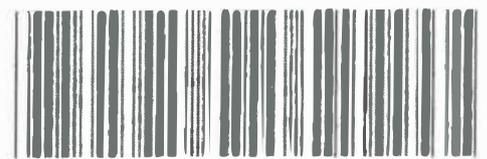
INSTRUCTIONS FOR SECTION B

- (1) After the announcement of the start of the examination, you should first write your Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5, 7 and 9.
- (2) Refer to the general instructions on the cover of the Question Paper for Section A.
- (3) Answer **ALL** questions.
- (4) Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.
- (5) Supplementary answer sheets will be supplied on request. Write your candidate number, mark the question number box and stick a barcode label on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.
- (6) Present your answers in paragraphs wherever appropriate.
- (7) The diagrams in this section are **NOT** necessarily drawn to scale.
- (8) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

Please stick the barcode label here.

Candidate Number

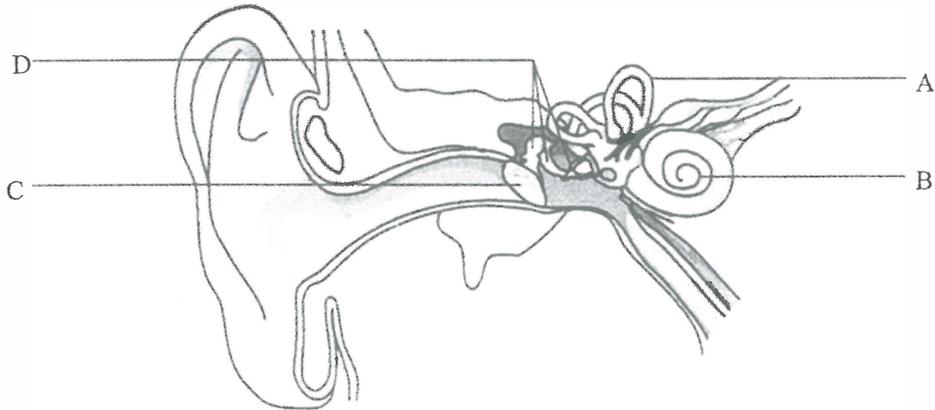
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--



SECTION B

Answer ALL questions. Write your answers in the spaces provided.

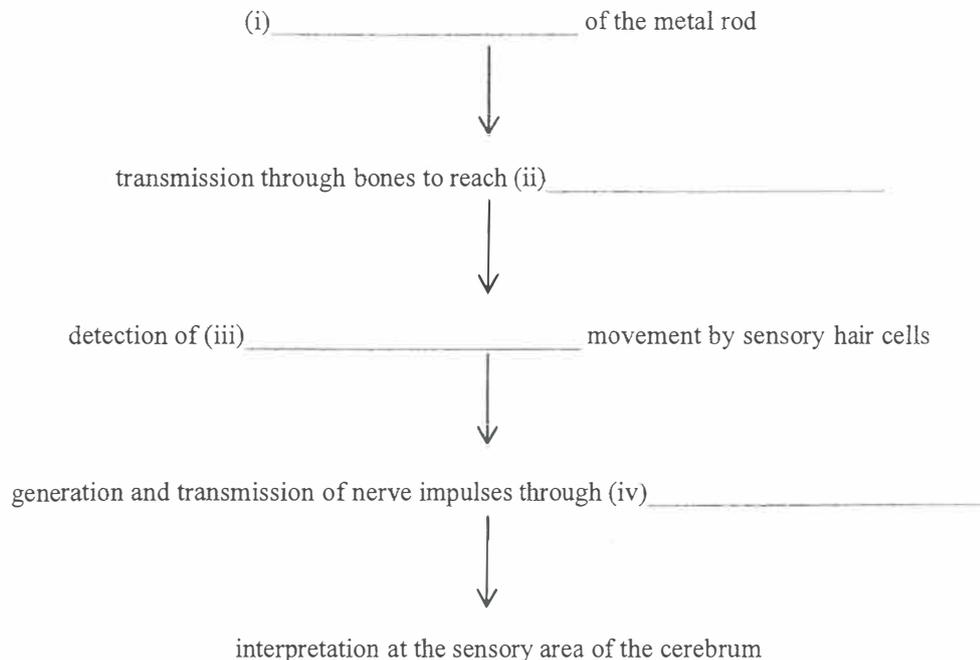
1. The diagram below shows the human ear and its associated structures:



(a) The table below lists two types of hearing loss. Using the label(s) in the above diagram, indicate which structure(s) is / are most likely to be defective in each case. (2 marks)

	Type of hearing loss	Structure
X	Damage to sensory hair cells	
Y	Failure of sound conduction	

(b) Ludwig van Beethoven, a famous 18th century composer, suffered from type Y hearing loss in his 20s and became deaf in his 40s. Some records say that he could hear music through his jawbone and skull by biting on a metal rod attached to his piano. Based on the structures and functions of human ears, complete the following flow chart to show the major steps involved in his method of hearing music. (4 marks)



Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

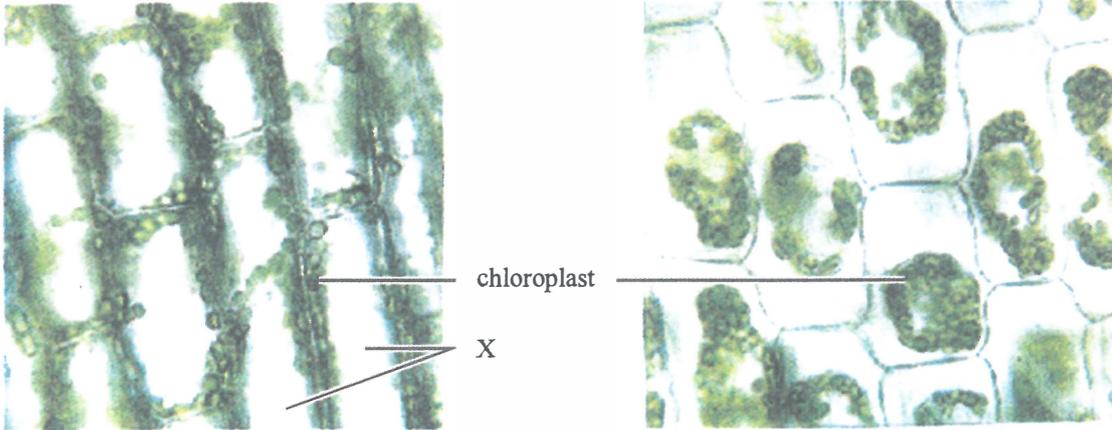
Answers written in the margins will not be marked.

Please stick the barcode label here.

2. The leaf of an aquatic plant was placed in a concentrated sucrose solution and observed under a light microscope. Photomicrographs A and B show the appearance of the cells at the beginning of the experiment and after five minutes respectively:

Photomicrograph A – at the beginning

Photomicrograph B – after five minutes



- (a) X is an organelle which is invisible without staining. Name this organelle. (1 mark)

- (b) Comparing the two photomicrographs, state *two* observable changes in the appearance of the cells after five minutes. (2 marks)

- (c) Explain how the observable changes stated in (b) are brought about. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

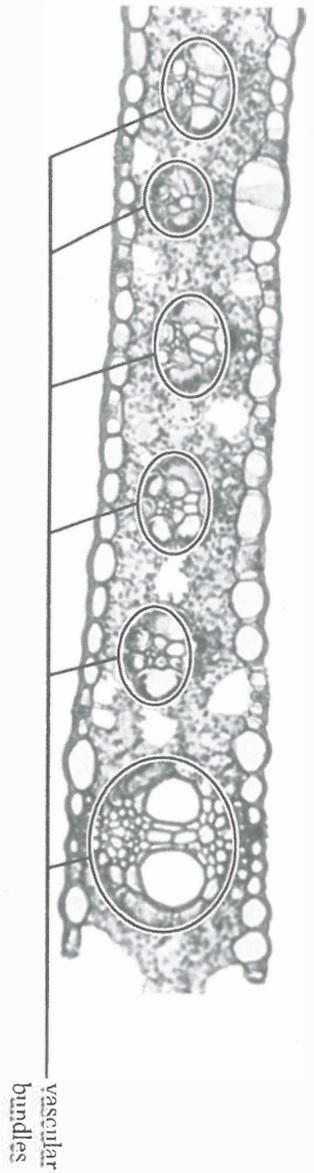
Answers written in the margins will not be marked.

Photomicrograph X



vascular bundle

Photomicrograph Y



vascular bundles

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Please stick the barcode label here.

3. Photomicrographs X and Y on the opposite page (page 4) show the cross sections of two leaves taken from different plant species.

(a) (i) Comparing the cell shapes of both leaves, which labelled tissue (P, Q or R) in Photomicrograph X is absent from Photomicrograph Y? (1 mark)

(ii) With reference to Photomicrograph X, what is the observable adaptive feature of the tissue identified in (i)? What is the significance of this adaptive feature? (2 marks)

(b) The leaf in Photomicrograph Y was taken from a plant species with leaves oriented vertically, as shown in the following photograph:



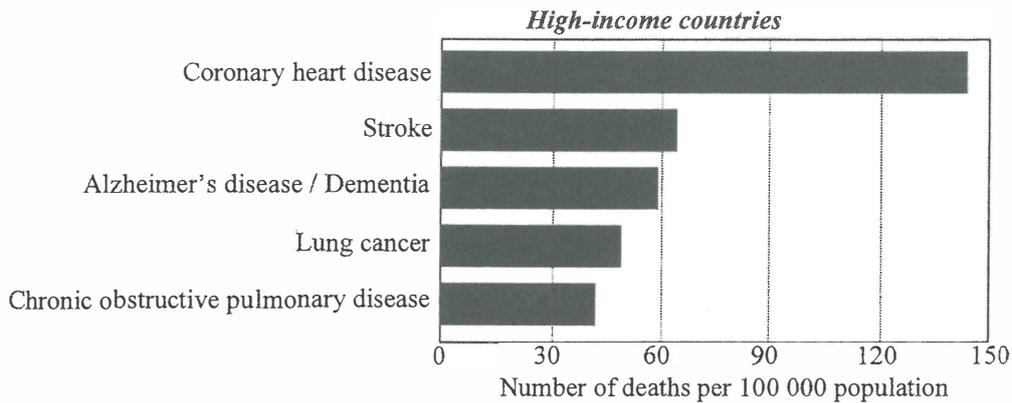
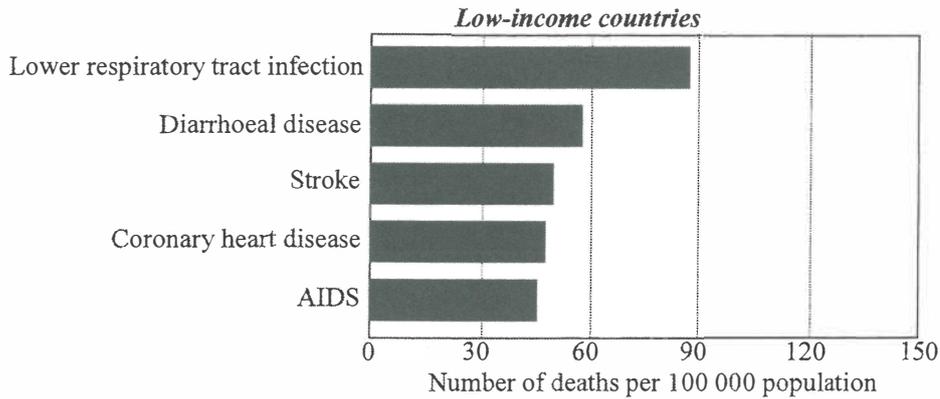
Explain how the distribution of the photosynthetic tissue in these leaves is related to the vertical orientation of the leaves. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

4. The bar charts below show the top five diseases that caused death in low-income countries and high-income countries respectively in the year 2015:



- (a) With reference to the bar charts, which countries (low-income or high-income) have more infectious diseases as the top five diseases that caused death? (1 mark)

- (b) Suggest *two* reasons to account for the phenomenon stated in (a). (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Please stick the barcode label here.

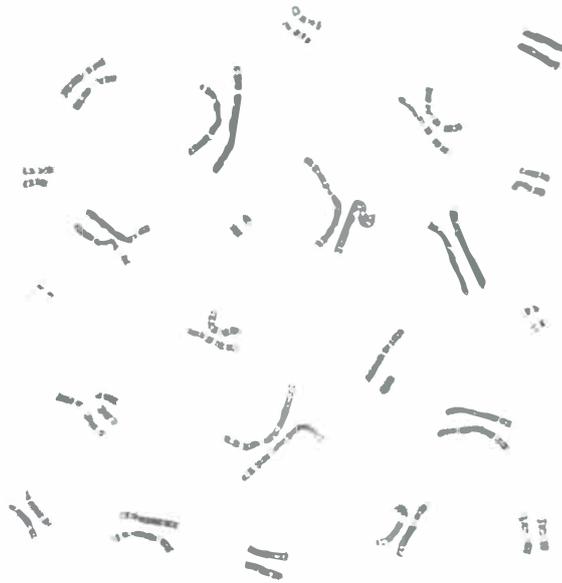
- (c) Coronary heart disease is the top cause of death in high-income countries. Explain how *one* of the lifestyle habits in high-income countries is related to coronary heart disease. (4 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

5. The photomicrograph below shows the paired homologous chromosomes of a normal boy for karyotyping:



- (a) Circle the sex chromosomes on the above photomicrograph. (1 mark)
- (b) State the type of cells, somatic cells or gametes, from which the karyotype was obtained. Explain your answer. (2 marks)

- (c) It is commonly thought that the sex of offspring is mainly determined by the mother. Explain why this is *not* true. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Please stick the barcode label here.

6. Hong Kong Red Cross Blood Transfusion Service keeps stocks of different blood groups to ensure that there is enough blood supply for transfusion in hospitals.

(a) Of all the blood groups, blood group O is in greatest demand in the Accident and Emergency Departments of hospitals. Suggest why the demand for blood group O is the greatest. (3 marks)

(b) The table below shows some recommendations for adult female and male donors:

	Female donors	Male donors
Maximum number of donations in a year	4	5
Interval between donations	No less than 105 days	No less than 75 days

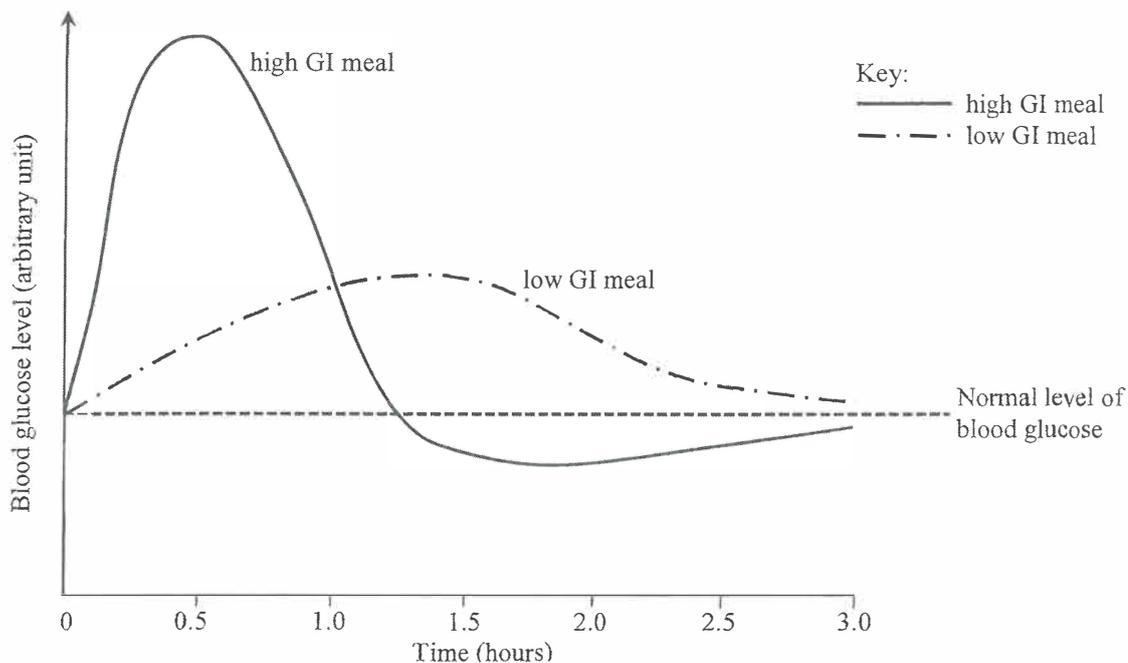
Suggest why there are different recommendations for female and male donors. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

7. The glycemic Index (GI) is an indication of the effect of food on the blood glucose level. The higher the GI value of a food, the quicker is the rise in blood glucose level. The graph below shows the changes in the blood glucose level of a healthy individual after consuming the same quantity of a low GI or high GI meal over a period of three hours:



- (a) Describe how the consumption of a meal leads to an increase in the blood glucose level. (2 marks)

- (b) (i) Name the key hormone which lowers the blood glucose level. (1 mark)

(ii) Describe how this hormone lowers the blood glucose level. (3 marks)

Answers written in the margins will not be marked.

(iii) On the graph on the opposite page (page 10), sketch a curve to show the change in the level of this key hormone in response to the consumption of a high GI meal by the healthy person. (2 marks)

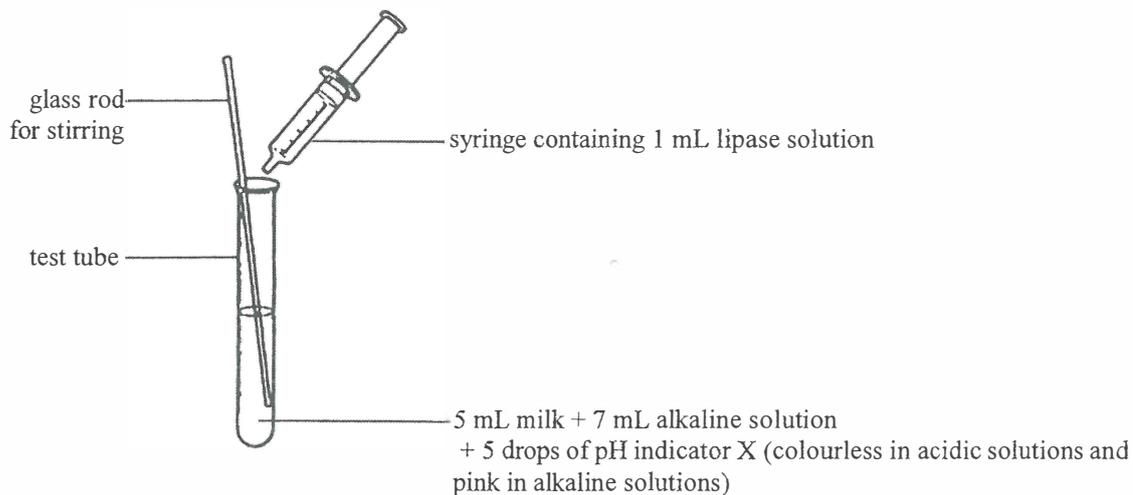
(c) Explain why diabetic patients should consume low GI meals. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

8. A student used the following set-up to compare the fat digestion of full fat fresh milk and half fat fresh milk:



- (a) Write a simple word equation of fat digestion. (2 marks)

- (b) Two test tubes, each with a different type of milk, were prepared. The colour of each mixture was recorded immediately after the addition of lipase solution, and then monitored until there was no more change in colour. The colours of the mixtures at the beginning and the end are shown in Diagram I and Diagram II respectively:

Diagram I (at the beginning)

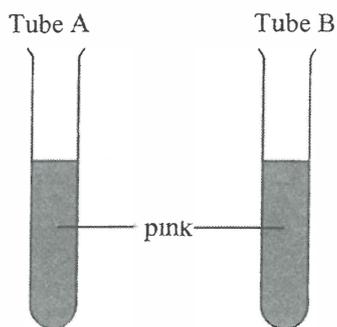
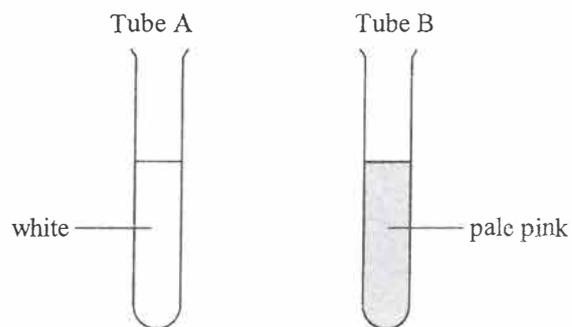


Diagram II (at the end)



- (i) What is the independent variable in this investigation? (1 mark)

- (ii) Describe the results of this investigation. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(iii) Which test tube (A or B) was the one with full fat fresh milk? Explain your answer.

(4 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

9. Although most DNA is stored in the nucleus, mitochondria also have a small amount of their own DNA. The mitochondrial DNA contains some genes coding for enzymes which are essential for oxidative phosphorylation. Mutations of these mitochondrial genes cause Leigh syndrome, which is a rare and fatal metabolic disease.

(a) Explain why gene mutations in the mitochondrial DNA can affect oxidative phosphorylation.

(4 marks)

(b) What are the major products of oxidative phosphorylation? State their significance.

(4 marks)

Answers written in the margins will not be marked.

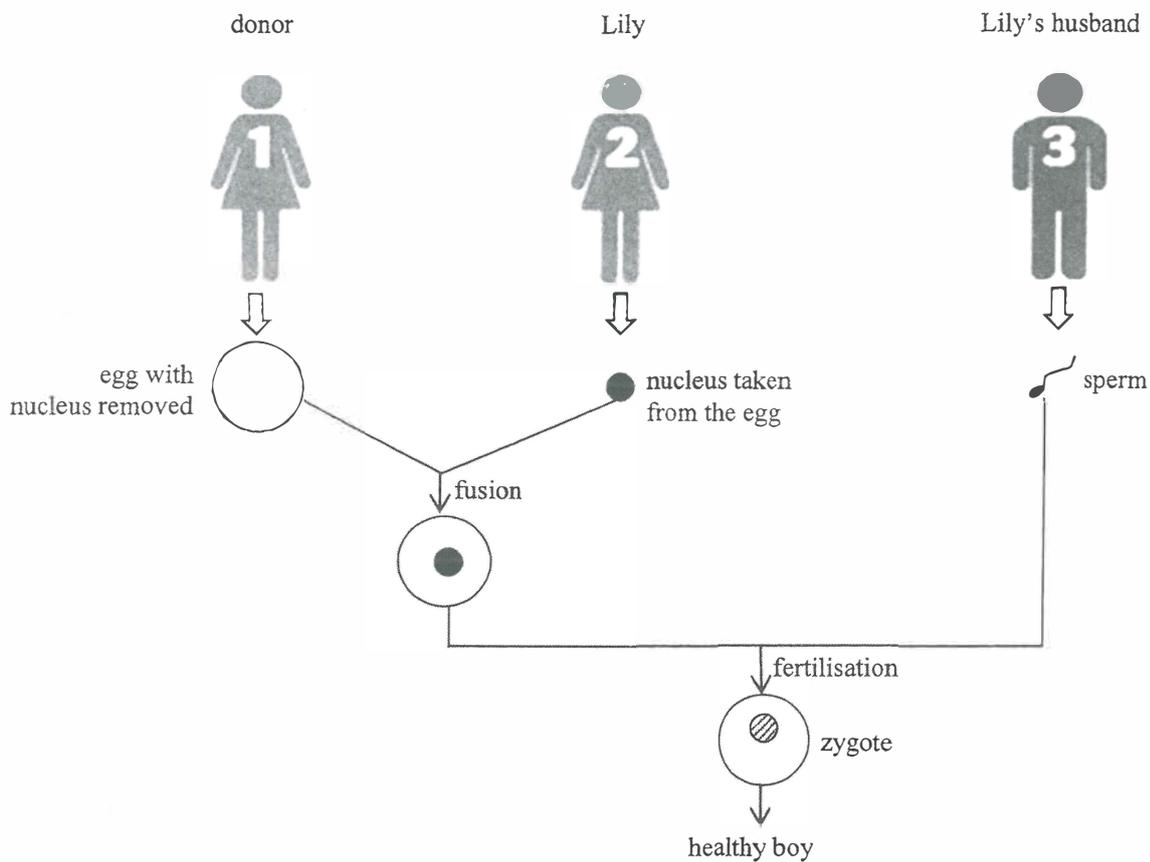
Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(c) Lily had two children who died from Leigh syndrome. It was found that her eggs contained mutated mitochondrial genes. Her children suffered from the disease because normally mitochondria in zygotes come from the eggs while sperms do not contribute any.

(i) With regard to the fertilisation process and the structure of sperms, suggest why sperms do not contribute any mitochondria to zygotes. (1 mark)

(ii) By using a new method called the 'three-parent baby' technique, Lily gave birth to a healthy boy in 2016. Below are the main steps in the technique:



Identify the source(s) of DNA of the nucleus and mitochondria in the boy's cells. (2 marks)

Nucleus:

Mitochondria:

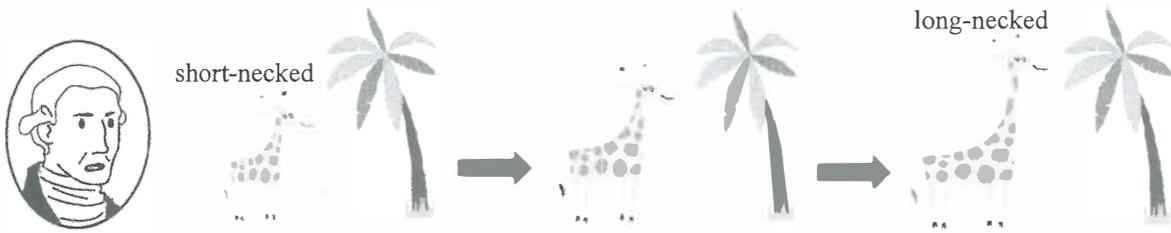
Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

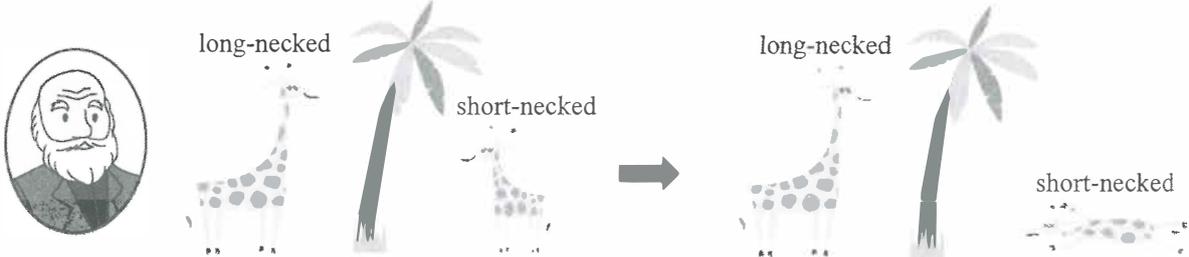
10. Both Lamarck and Darwin contributed greatly to the understanding of evolution. They proposed different explanations for the evolution of long necks in giraffes, as shown below:

Lamarck's idea about evolution



Long necks evolved as generations of giraffes stretched their necks to feed on leaves at high level above the ground

Darwin's idea about evolution



Giraffes with long necks were born by chance and had more offspring due to their competitive advantage over those with short necks

- (a) Put a '✓' in the appropriate box to indicate whether the ideas listed were proposed by the scientists. You may put more than one '✓' for each idea. (2 marks)

	Lamarck	Darwin
Characters acquired during life time can be passed on to the next generation		
Organisms become more adaptive to the environment over the generations		

- (b) Based on the current understanding of evolution, elaborate on the view of Darwin on the evolution of the giraffe's long neck. (4 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

- (c) In Darwin's era, his idea caused intense debates. The concept of humans evolving from common ancestors along with other species was unacceptable to many people due to their religious belief. What does this tell us about the nature of science? (1 mark)

written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

A large rectangular box containing 25 horizontal lines for writing answers. The lines are evenly spaced and extend across the width of the box. The box is empty, with no text or markings inside.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

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.

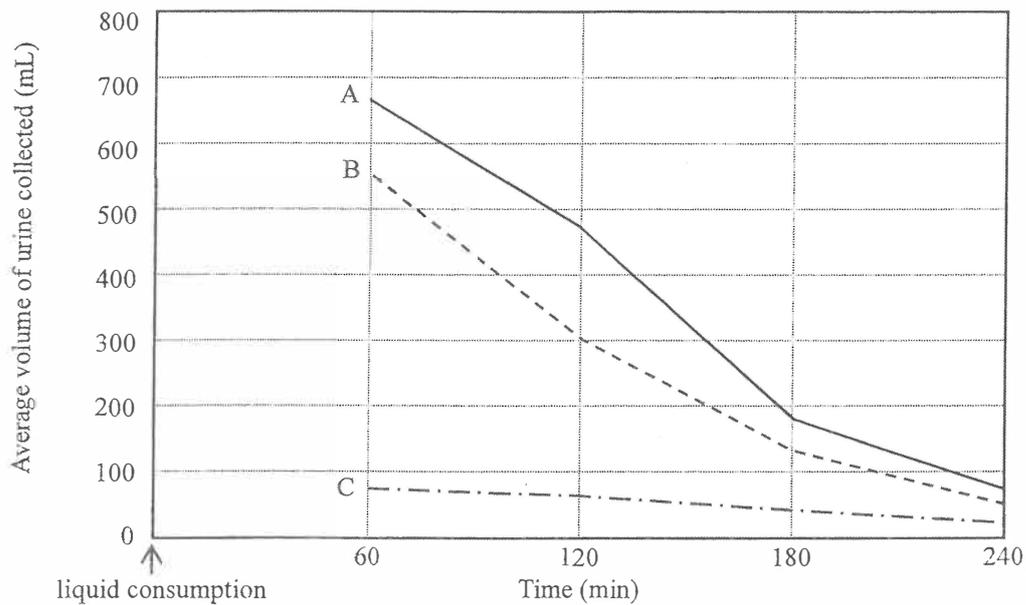
Not to be taken away before the
end of the examination session

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):

		Air temperature (°C)			
		24	28	32	36
Relative humidity (%)	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)

SECTION B Applied Ecology

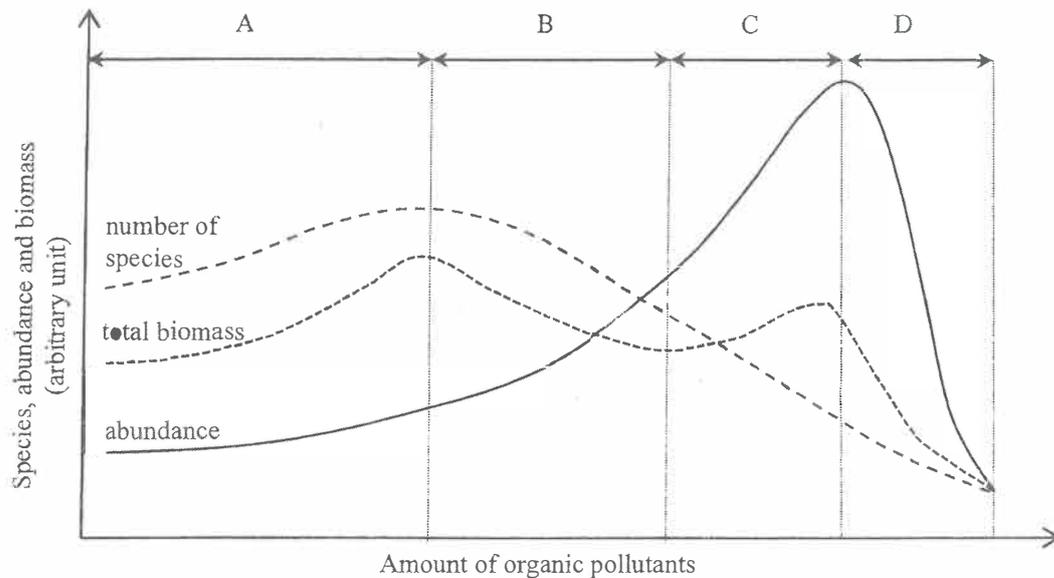
Answer **ALL** parts of the question.

- 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 (<i>arbitrary unit</i>)	Cadmium (<i>arbitrary unit</i>)
Concentration in phytoplankton (C_p)	20	0.6
Concentration in bivalve (C_b)	16	1.2
C_b/C_p Ratio	0.8	?

- (1) Calculate the C_b/C_p ratio for cadmium. (1 mark)
 - (2) What is the implication of a C_b/C_p ratio greater than 1? (1 mark)
 - (3) Compare the C_b/C_p 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:



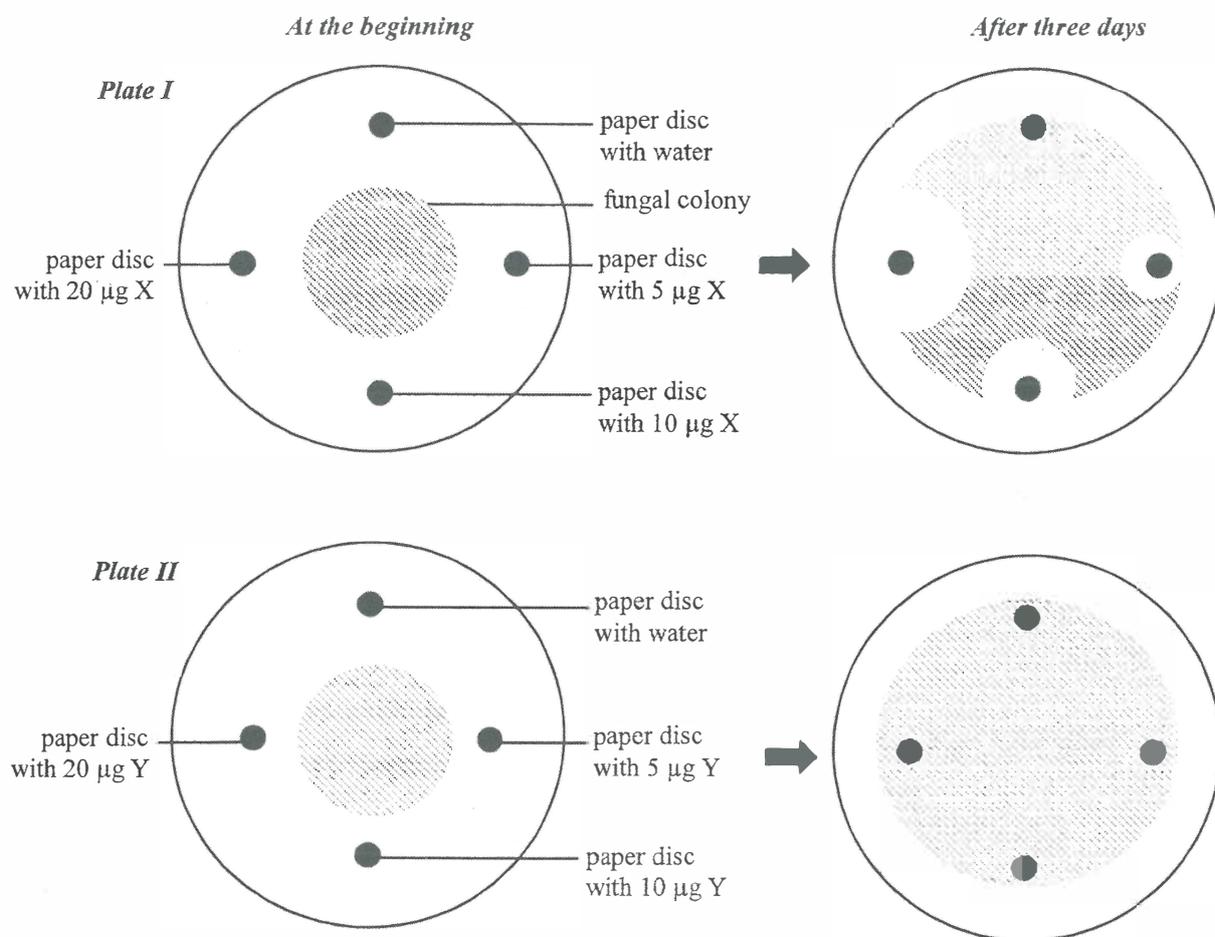
- (i) Explain why the invertebrate community expands when the amount of organic pollutants increases at Stage A. (2 marks)
- (ii) It is found that the proportion of larger invertebrates in the community declines in Stage B as the amount of organic pollutants continues to increase.
 - (1) With reference 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)

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:



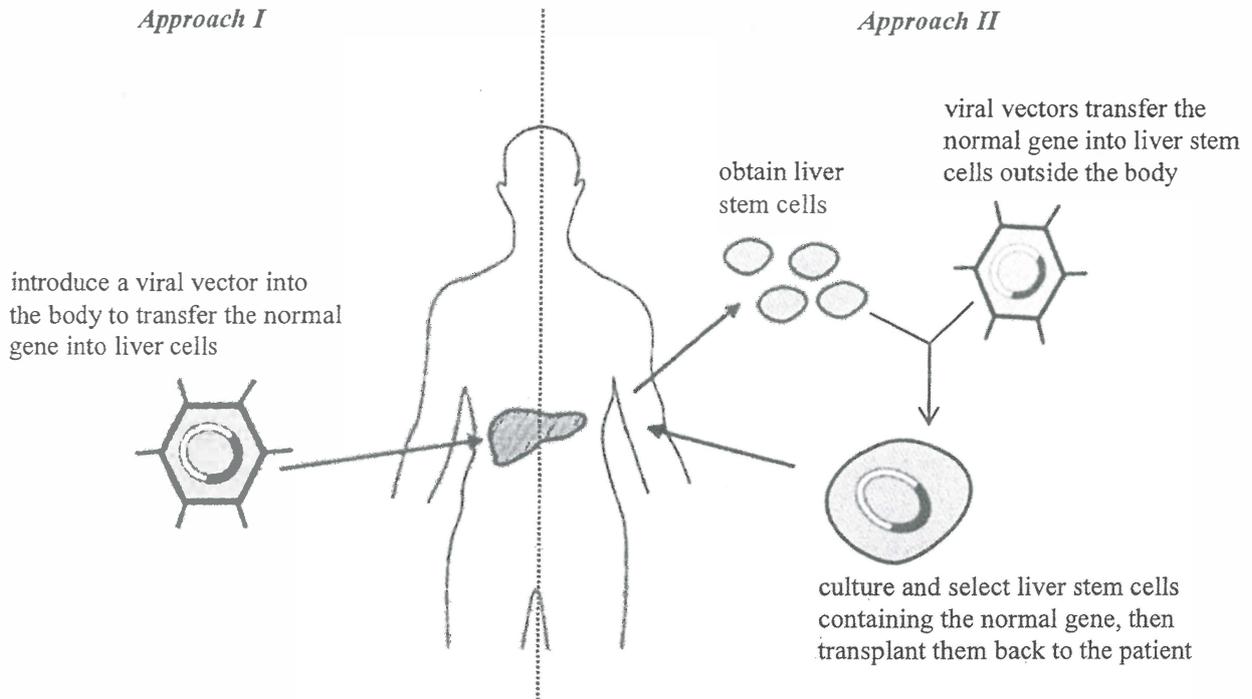
- (i) Describe the effects of compounds X and Y on the growth of this fungus. (3 marks)
- (ii) In another experiment, the fungus was incubated for 1 hour with compound X or Y. After that, a green fluorescent dye which cannot pass through cell membranes was added. Green fluorescence stained the nuclei 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)

This page is blank.

SECTION D Biotechnology

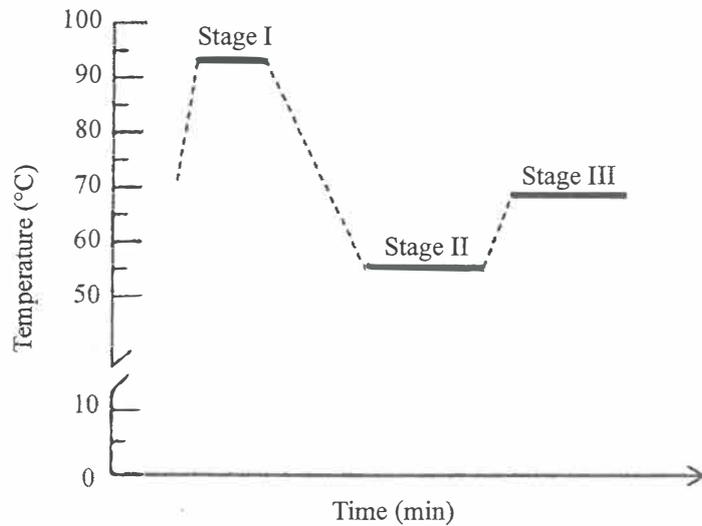
Answer **ALL** parts of the question.

- 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:

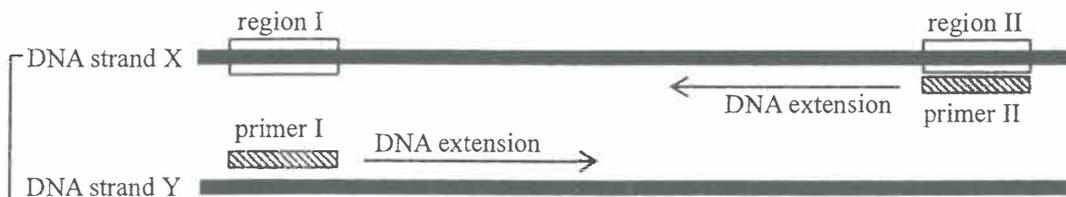


- (1) Explain why stem cells should be used for the gene therapy in Approach II. (2 marks)
- (2) With reference to the information in the diagram, explain why Approach II is a better option in terms of the potential hazards of gene therapy to John. (4 marks)

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:

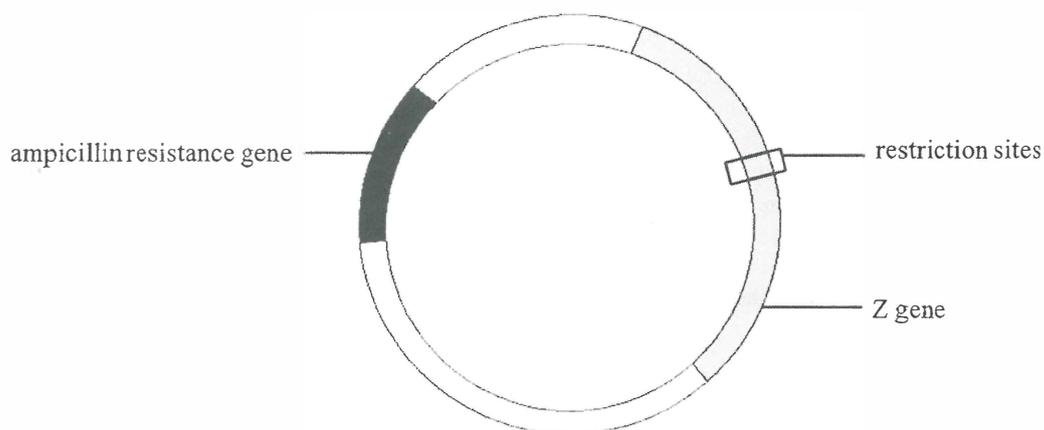
					no. of bases
→ TGGCGCTGGG	CGCAATGCGC	GCCATTACCG	AGTCCGGGCT	GCGCGTTGGT	50
	region I				
GCGGATATCT	CGGTAGTGGG	ATACGACGAT	ACCGAAGACA	GCTCATGTTA	100
TATCCCGCCG	TTAACCACCA	TCAAACAGGA	TTTTCGCCTG	CTGGGGCAAA	150
CCAGCGTGGA	CCGCTTGCTG	CAACTCTCTC	AGGGCCAGGC	GGTGAAGGGC	200
AATCAGCTGT	TGCCCGTCTC	ACTGGTGAAA	AGAAAACCA	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	ATTCACACA	450

Mary designed the following primers for the PCR:

Primer I: CGGUAGUGGG AUACGACGAU $\xrightarrow{\text{DNA extension}}$

Primer II: CCTTAACACT CGCCTATTGT $\xrightarrow{\text{DNA extension}}$

- (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.

BIOLOGY PAPER 1

SECTION B: Question-Answer Book B

This paper must be answered in English

INSTRUCTIONS FOR SECTION B

- (1) After the announcement of the start of the examination, you should first write your Candidate Number in the space provided on Page 1 and stick barcode labels in the spaces provided on Pages 1, 3, 5, 7 and 9.
- (2) Refer to the general instructions on the cover of the Question Paper for Section A.
- (3) Answer **ALL** questions.
- (4) Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked.
- (5) Supplementary answer sheets will be supplied on request. Write your candidate number, mark the question number box and stick a barcode label on each sheet, and fasten them with string **INSIDE** this Question-Answer Book.
- (6) Present your answers in paragraphs wherever appropriate.
- (7) The diagrams in this section are **NOT** necessarily drawn to scale.
- (8) No extra time will be given to candidates for sticking on the barcode labels or filling in the question number boxes after the 'Time is up' announcement.

Please stick the barcode label here.

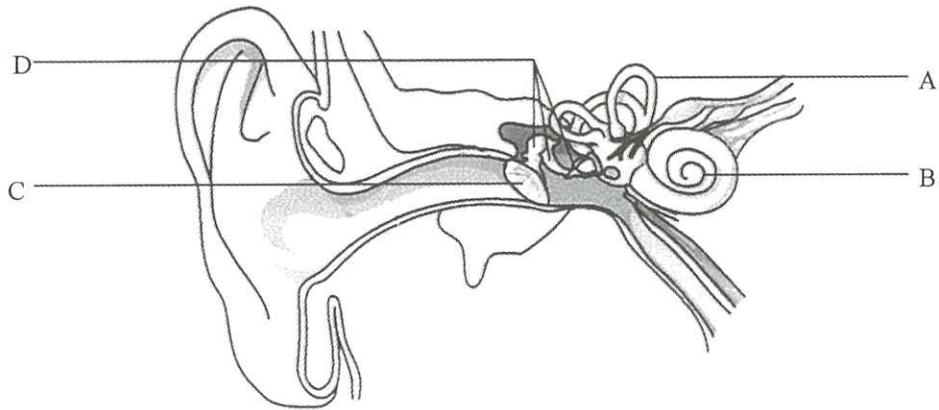
Candidate Number



SECTION B

Answer ALL questions. Write your answers in the spaces provided.

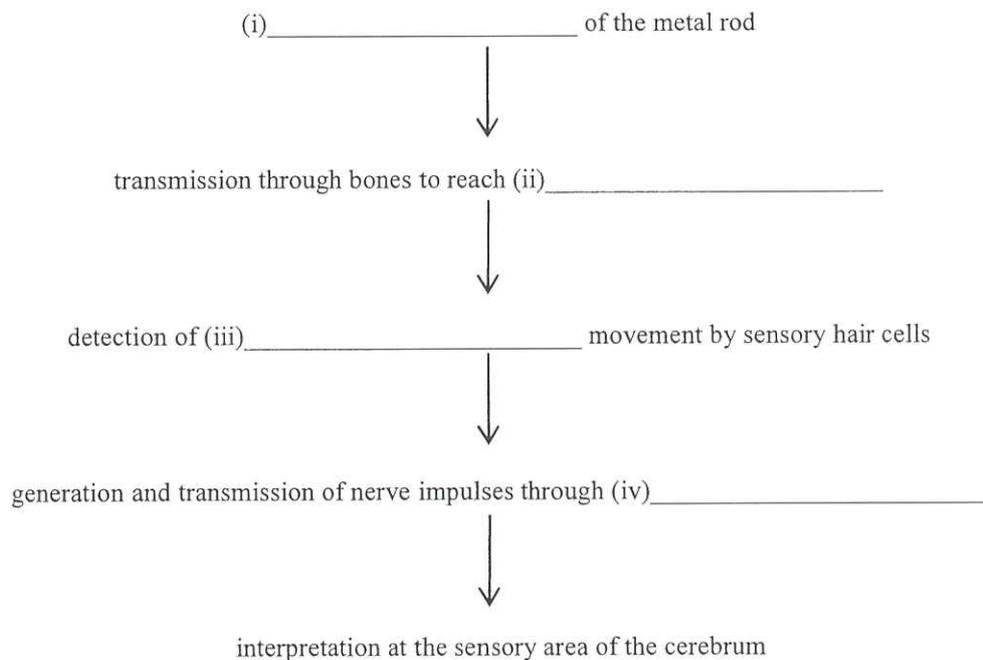
1. The diagram below shows the human ear and its associated structures:



(a) The table below lists two types of hearing loss. Using the label(s) in the above diagram, indicate which structure(s) is / are most likely to be defective in each case. (2 marks)

	Type of hearing loss	Structure
X	Damage to sensory hair cells	
Y	Failure of sound conduction	

(b) Ludwig van Beethoven, a famous 18th century composer, suffered from type Y hearing loss in his 20s and became deaf in his 40s. Some records say that he could hear music through his jawbone and skull by biting on a metal rod attached to his piano. Based on the structures and functions of human ears, complete the following flow chart to show the major steps involved in his method of hearing music. (4 marks)



Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

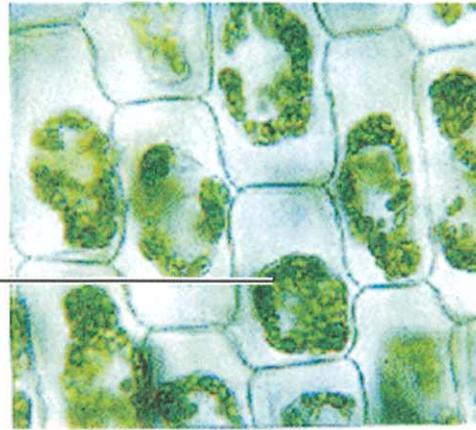
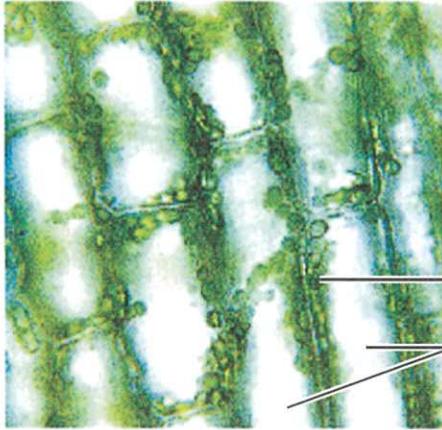
Answers written in the margins will not be marked.

Please stick the barcode label here.

2. The leaf of an aquatic plant was placed in a concentrated sucrose solution and observed under a light microscope. Photomicrographs A and B show the appearance of the cells at the beginning of the experiment and after five minutes respectively:

Photomicrograph A – at the beginning

Photomicrograph B – after five minutes



chloroplast

X

- (a) X is an organelle which is invisible without staining. Name this organelle. (1 mark)

- (b) Comparing the two photomicrographs, state *two* observable changes in the appearance of the cells after five minutes. (2 marks)

- (c) Explain how the observable changes stated in (b) are brought about. (2 marks)

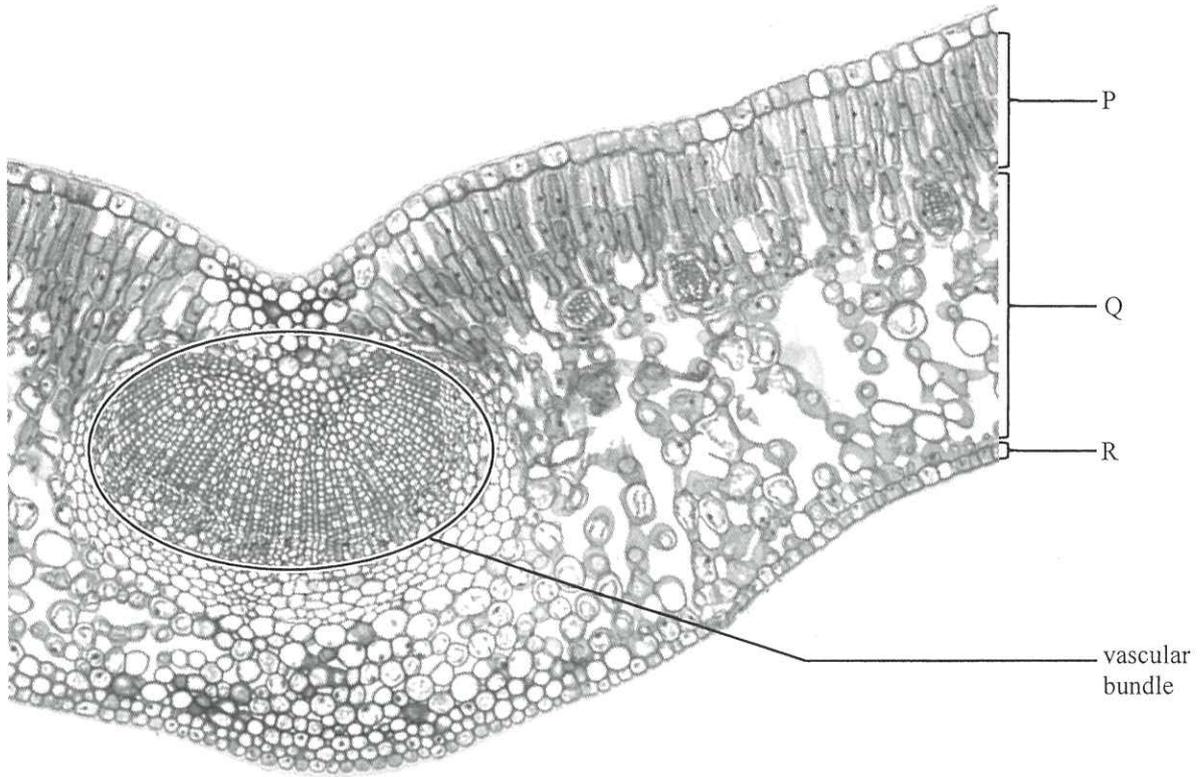
Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

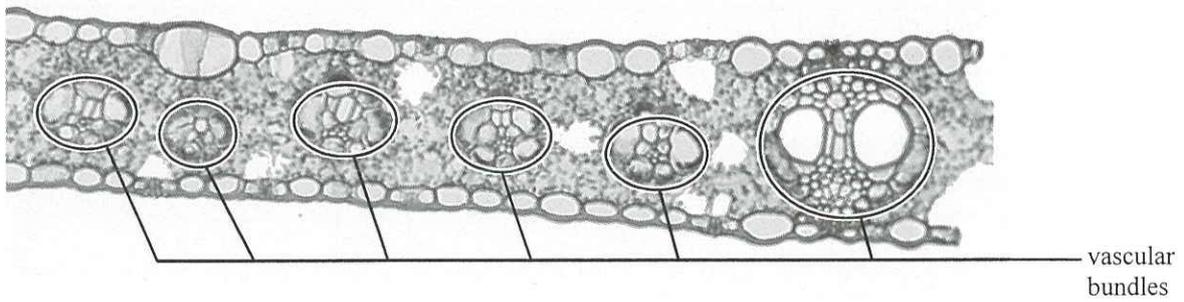
Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Photomicrograph X



Photomicrograph Y



Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

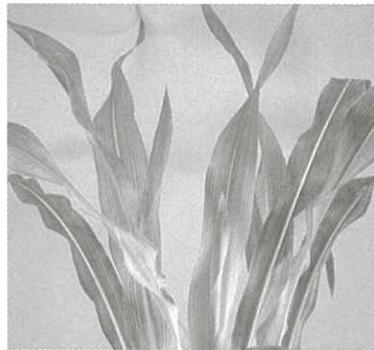
Please stick the barcode label here.

3. Photomicrographs X and Y on the opposite page (page 4) show the cross sections of two leaves taken from different plant species.

(a) (i) Comparing the cell shapes of both leaves, which labelled tissue (P, Q or R) in Photomicrograph X is absent from Photomicrograph Y? (1 mark)

(ii) With reference to Photomicrograph X, what is the observable adaptive feature of the tissue identified in (i)? What is the significance of this adaptive feature? (2 marks)

(b) The leaf in Photomicrograph Y was taken from a plant species with leaves oriented vertically, as shown in the following photograph:



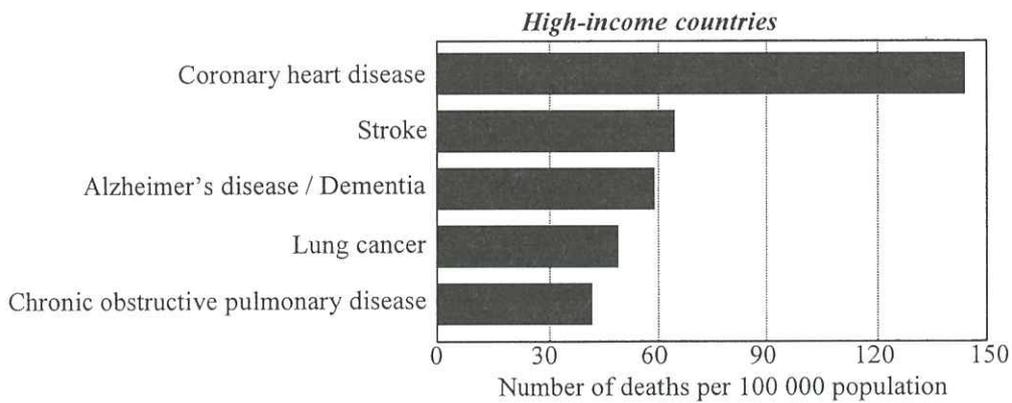
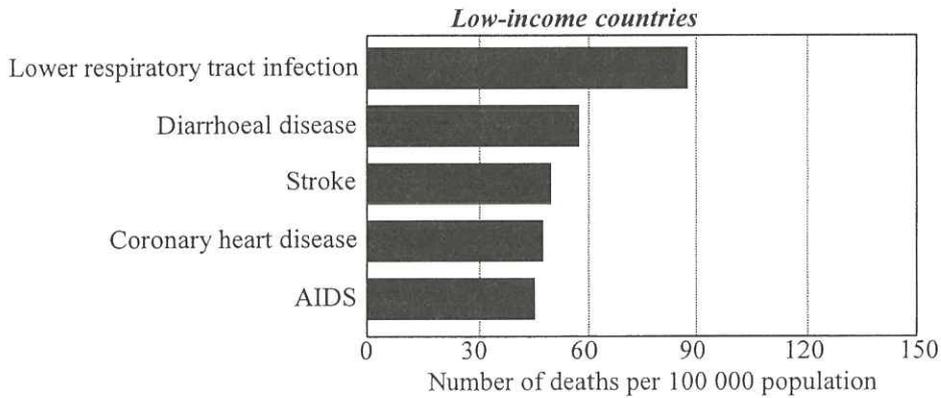
Explain how the distribution of the photosynthetic tissue in these leaves is related to the vertical orientation of the leaves. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

4. The bar charts below show the top five diseases that caused death in low-income countries and high-income countries respectively in the year 2015:



- (a) With reference to the bar charts, which countries (low-income or high-income) have more infectious diseases as the top five diseases that caused death? (1 mark)

- (b) Suggest *two* reasons to account for the phenomenon stated in (a). (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Please stick the barcode label here.

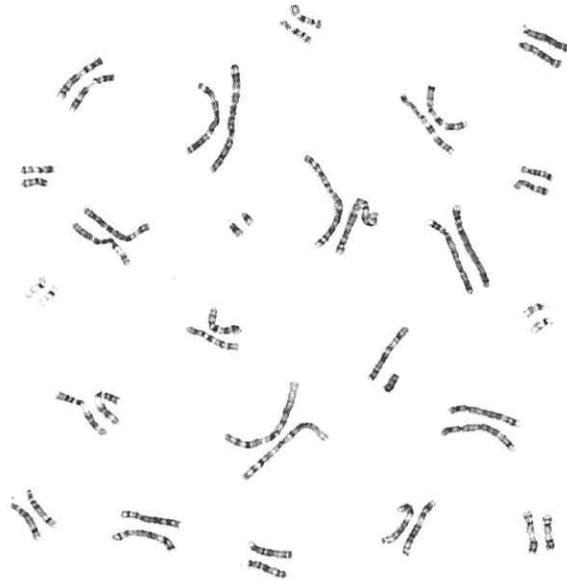
- (c) Coronary heart disease is the top cause of death in high-income countries. Explain how *one* of the lifestyle habits in high-income countries is related to coronary heart disease. (4 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

5. The photomicrograph below shows the paired homologous chromosomes of a normal boy for karyotyping:



- (a) Circle the sex chromosomes on the above photomicrograph. (1 mark)
- (b) State the type of cells, somatic cells or gametes, from which the karyotype was obtained. Explain your answer. (2 marks)

- (c) It is commonly thought that the sex of offspring is mainly determined by the mother. Explain why this is *not* true. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Please stick the barcode label here.

6. Hong Kong Red Cross Blood Transfusion Service keeps stocks of different blood groups to ensure that there is enough blood supply for transfusion in hospitals.

(a) Of all the blood groups, blood group O is in greatest demand in the Accident and Emergency Departments of hospitals. Suggest why the demand for blood group O is the greatest. (3 marks)

(b) The table below shows some recommendations for adult female and male donors:

	Female donors	Male donors
Maximum number of donations in a year	4	5
Interval between donations	No less than 105 days	No less than 75 days

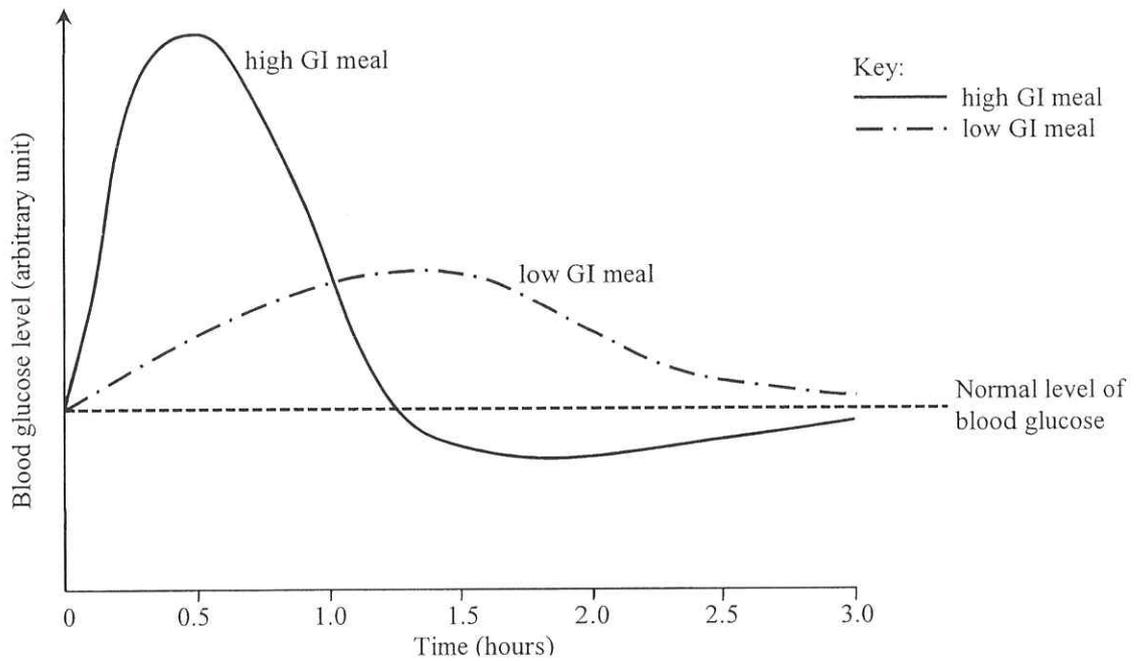
Suggest why there are different recommendations for female and male donors. (3 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

7. The glycemic Index (GI) is an indication of the effect of food on the blood glucose level. The higher the GI value of a food, the quicker is the rise in blood glucose level. The graph below shows the changes in the blood glucose level of a healthy individual after consuming the same quantity of a low GI or high GI meal over a period of three hours:



- (a) Describe how the consumption of a meal leads to an increase in the blood glucose level. (2 marks)

- (b) (i) Name the key hormone which lowers the blood glucose level. (1 mark)

- (ii) Describe how this hormone lowers the blood glucose level. (3 marks)

Answers written in the margins will not be marked.

(iii) On the graph on the opposite page (page 10), sketch a curve to show the change in the level of this key hormone in response to the consumption of a high GI meal by the healthy person. (2 marks)

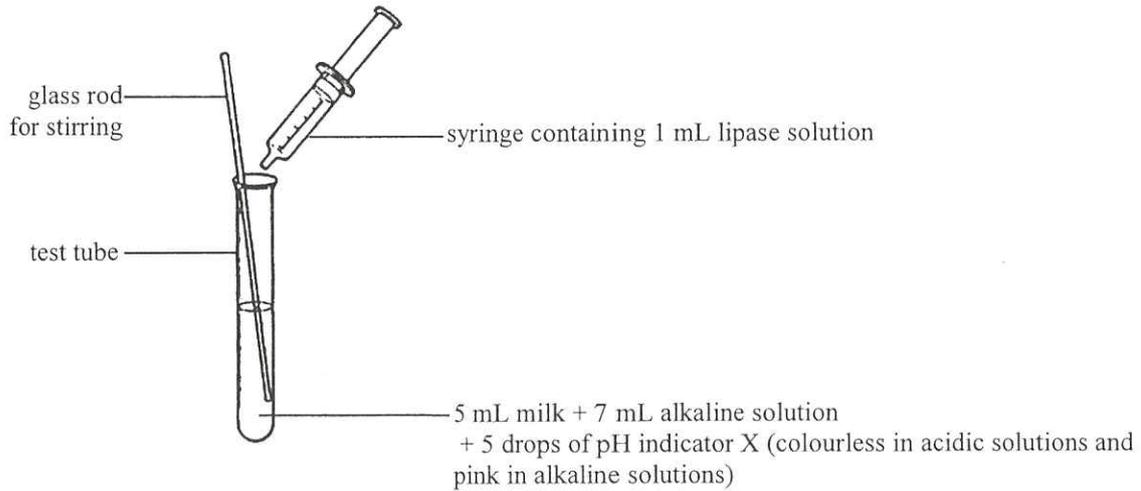
(c) Explain why diabetic patients should consume low GI meals. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

8. A student used the following set-up to compare the fat digestion of full fat fresh milk and half fat fresh milk:



- (a) Write a simple word equation of fat digestion. (2 marks)

- (b) Two test tubes, each with a different type of milk, were prepared. The colour of each mixture was recorded immediately after the addition of lipase solution, and then monitored until there was no more change in colour. The colours of the mixtures at the beginning and the end are shown in Diagram I and Diagram II respectively:

Diagram I (at the beginning)

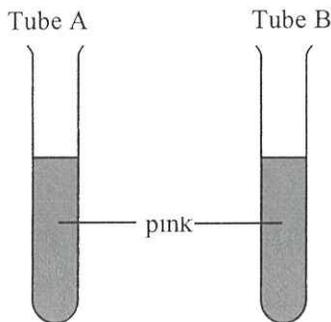
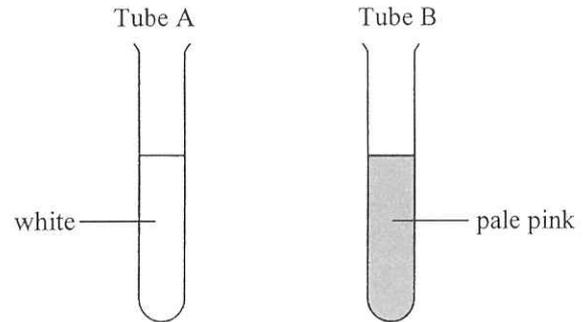


Diagram II (at the end)



- (i) What is the independent variable in this investigation? (1 mark)

- (ii) Describe the results of this investigation. (2 marks)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(iii) Which test tube (A or B) was the one with full fat fresh milk? Explain your answer. (4 marks)

Answers written in the margins will not be marked.

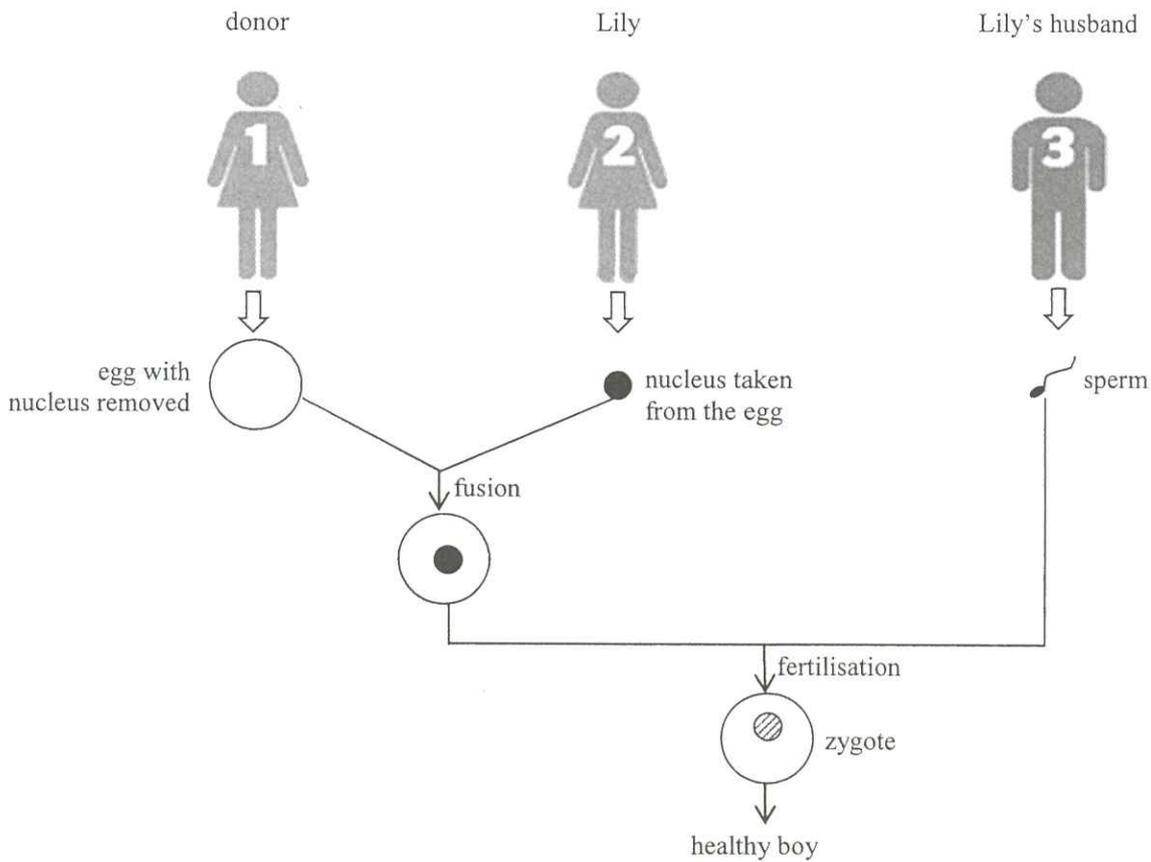
Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

(c) Lily had two children who died from Leigh syndrome. It was found that her eggs contained mutated mitochondrial genes. Her children suffered from the disease because normally mitochondria in zygotes come from the eggs while sperms do not contribute any.

(i) With regard to the fertilisation process and the structure of sperms, suggest why sperms do not contribute any mitochondria to zygotes. (1 mark)

(ii) By using a new method called the ‘three-parent baby’ technique, Lily gave birth to a healthy boy in 2016. Below are the main steps in the technique:



Identify the source(s) of DNA of the nucleus and mitochondria in the boy's cells. (2 marks)

Nucleus:

Mitochondria:

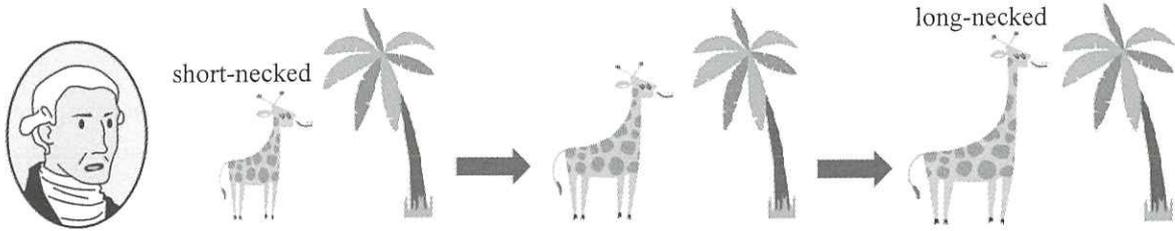
Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

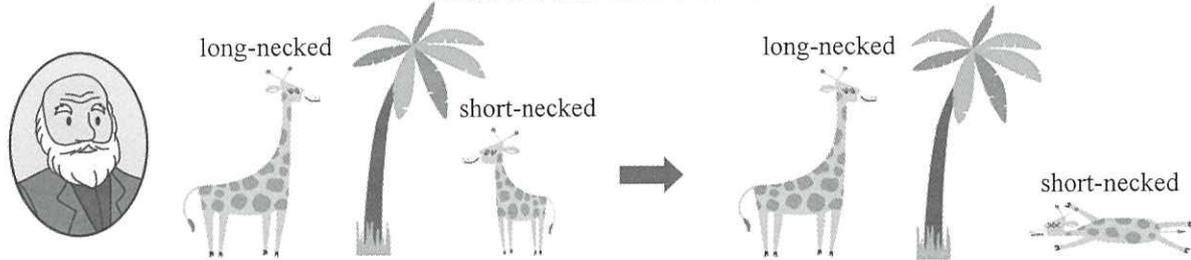
10. Both Lamarck and Darwin contributed greatly to the understanding of evolution. They proposed different explanations for the evolution of long necks in giraffes, as shown below:

Lamarck's idea about evolution



Long necks evolved as generations of giraffes stretched their necks to feed on leaves at high level above the ground

Darwin's idea about evolution



Giraffes with long necks were born by chance and had more offspring due to their competitive advantage over those with short necks

- (a) Put a '✓' in the appropriate box to indicate whether the ideas listed were proposed by the scientists. You may put more than one '✓' for each idea. (2 marks)

	Lamarck	Darwin
Characters acquired during life time can be passed on to the next generation		
Organisms become more adaptive to the environment over the generations		

- (b) Based on the current understanding of evolution, elaborate on the view of Darwin on the evolution of the giraffe's long neck. (4 marks)

.....

.....

.....

.....

.....

.....

.....

.....

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

- (c) In Darwin's era, his idea caused intense debates. The concept of humans evolving from common ancestors along with other species was unacceptable to many people due to their religious belief. What does this tell us about the nature of science? (1 mark)

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

Answers written in the margins will not be marked.

