DUNMAN SECONDARY SCHOOL

CANDIDATE NAME			
CLASS		**INDEX NUMBER**	

PRELIMINARY EXAMINATION 2026
SECONDARY 4 EXPRESS

BIOLOGY **6093/02**

Paper 2 **27 August 2026**

1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer all the questions, the last question is in the form either/or.
Write your answers in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate.
The number of marks is given in brackets [ ] at the end of each question or part question.

Section A

Answer **all** questions.

1 Fig. 1.1 shows a flatworm which lives in ponds, streams and river. The dimension of the flatworm are 12.5 mm long by 3.0 mm wide. Its volume was estimated to be 12.6 mm^3. Flatworms do not have a transport system for respiratory gases, oxygen and carbon dioxide.

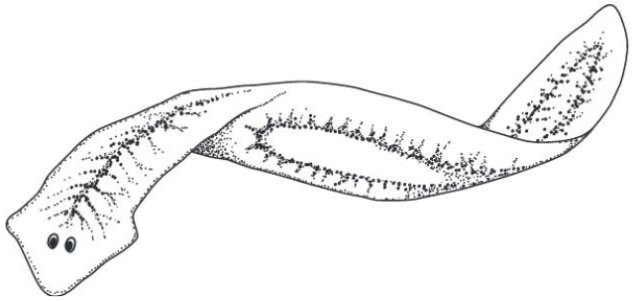

Fig. 1.1

(a) With reference to Fig. 1.1 and the information above, explain how flatworms survive without a transport system for respiratory gases.

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……..... [3]

(b) Flatworms possess a primitive excretory system composed of specialized units called flame cells. These cells actively pump hydrogen ions and other mineral ions into the excretory tubules.

(i) Define the term homeostasis.

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……..……..... [1]

(ii) Explain why the active transport of ions by the flame cells is important for a flatworm living in a low salt, freshwater environment.

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…… [3]

[Total: 7]

2 Fig. 2.1 is a diagram of a longitudinal section of a capillary.

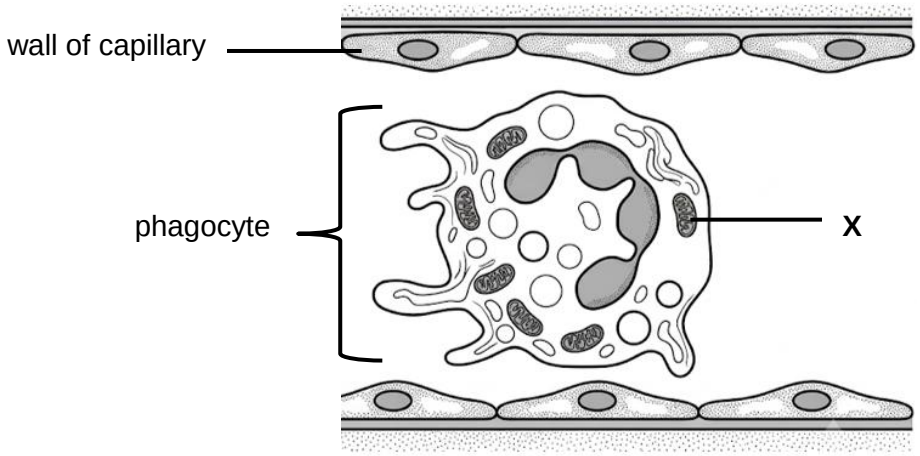

Fig. 2.1

(a) **(i)** Name the organelle **X** and explain how its function enables the phagocyte to carry out its role.

X ……

function ……

…… [2]

(ii) Describe one structural difference between the wall of a capillary and the wall of an artery. Explain how the structural difference relates to the function of that blood vessel.

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…… [4]

(b) Fig. 2.2 shows the blood pressure changes in the left atrium, left ventricle, and aorta of a human during one complete cardiac cycle.

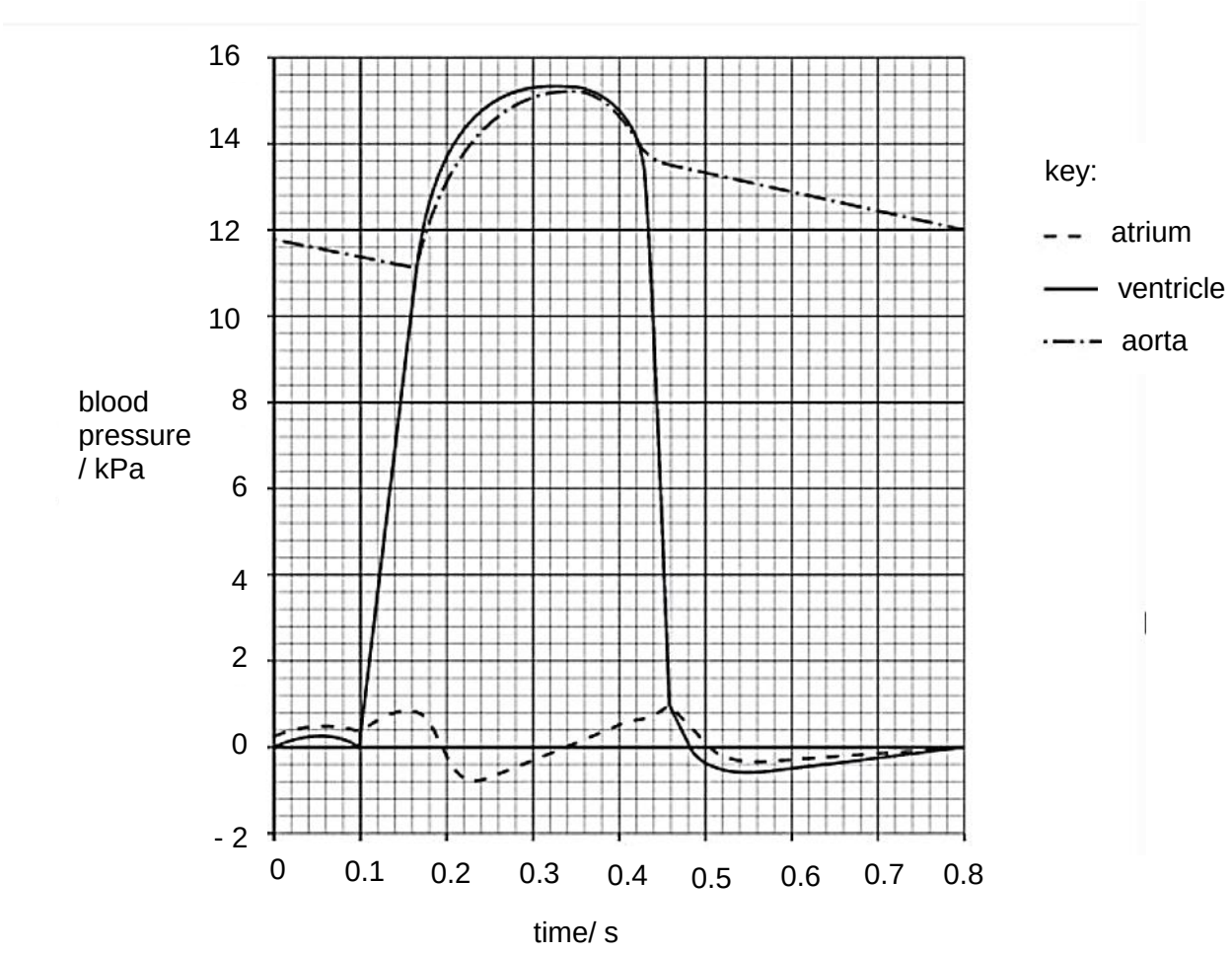

Fig. 2.2

(i) Using Fig. 2.2, identify the specific time interval (in seconds) during which the heart is undergoing ventricular systole.

…….……..…….... [1]

(ii) Describe and explain the flow of blood through the heart during the time interval identified in **(b)(i)**.

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…… [2]

[Total: 9]

3 Fig. 3.1 shows the liver and its associated blood vessels **P**, **Q** and **R**.

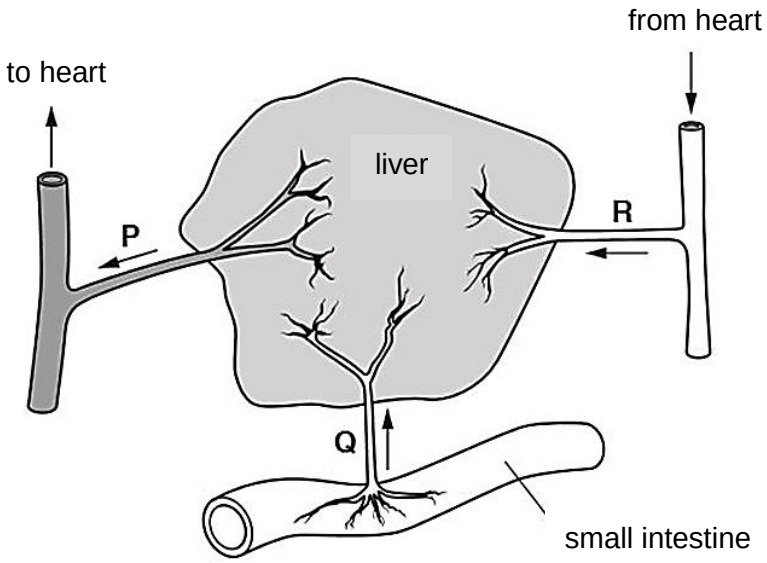

Fig. 3.1

(a) Identify blood vessels:

P ……

Q ……

R …… [3]

(b) Describe and explain how a named nutrient transported in **Q** is stored in the liver.

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…… [3]

(c) The enzyme catalase protects liver cells from oxidative damage by rapidly breaking down hydrogen peroxide into completely harmless substances.

Explain the structural basis for the specificity of catalase toward hydrogen peroxide molecules.

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…….…..... [3]

[Total: 9]

4 In long-duration space flight, astronauts can suffer acute kidney injury due to deep-space radiation, causing their kidneys to suddenly stop filtering metabolic waste. The spacecraft is equipped with a compact Micro-Dialysis Unit to clear toxic waste from the astronaut's blood until they return to Earth.

Fig. 4.1 shows a simplified cross-section of the dialysis cartridge used on the spacecraft.

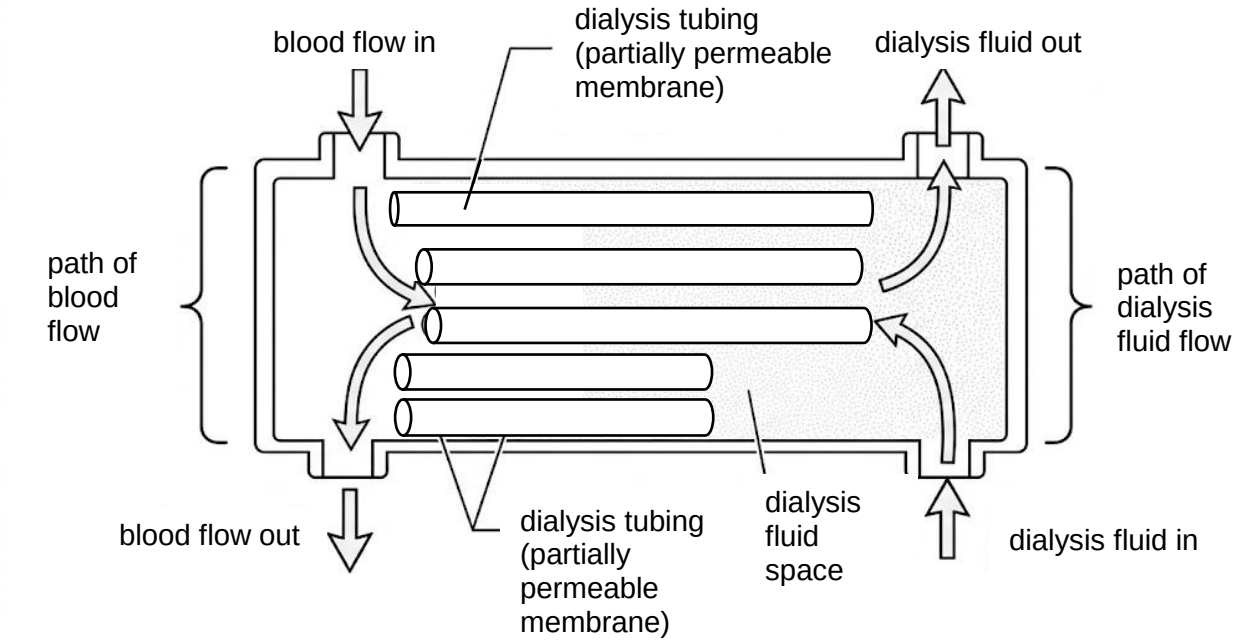

Fig. 4.1

(a) **(i)** State the two waste products that will accumulate rapidly in the astronaut's blood if the Micro-Dialysis Unit is not deployed.

1 ……..……..

2 ……..……..……..... [2]

(ii) Using the structural features shown in Fig, 4.1, explain how the design of the Micro-Dialysis Unit ensures the rapid and continuous removal of metabolic waste from the blood.

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…….…….... [4]

(b) During daily exercise on the space station, an astronaut's body temperature rises during the exercise. Explain how the body detects this change and coordinates a homeostatic response to lower body temperature.

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[Total: 10]

5 The diagram below shows the simplified structure of a typical bacterium.

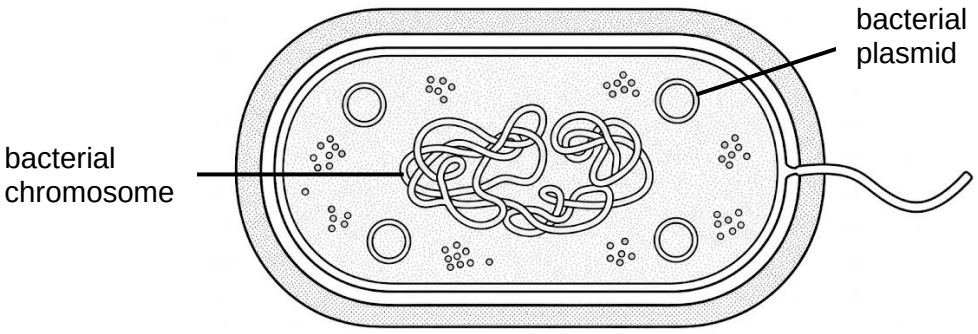

Fig. 5.1

(a) With reference to Fig. 5.1, state one way in which the genetic material in this bacterial cell differs from the genetic material found in a human cheek cell.

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……. [1]

(b) A person diagnosed with pneumococcal disease will test positive for the presence of specific antibodies against the bacterium Streptococcus pneumoniae.

Outline the events that occur in a newly infected person that led to the production of antibodies against this bacterium.

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……. [3]

(c) While many people associate bacteria only with infectious diseases, these microorganisms play a vital role in modern medicine. Today, scientists routinely utilize genetically engineered bacteria as living factories to mass-produce life-saving therapeutic proteins, such as human insulin.

Fig. 5.2 below outlines the major steps involved in creating these insulin-producing bacteria.

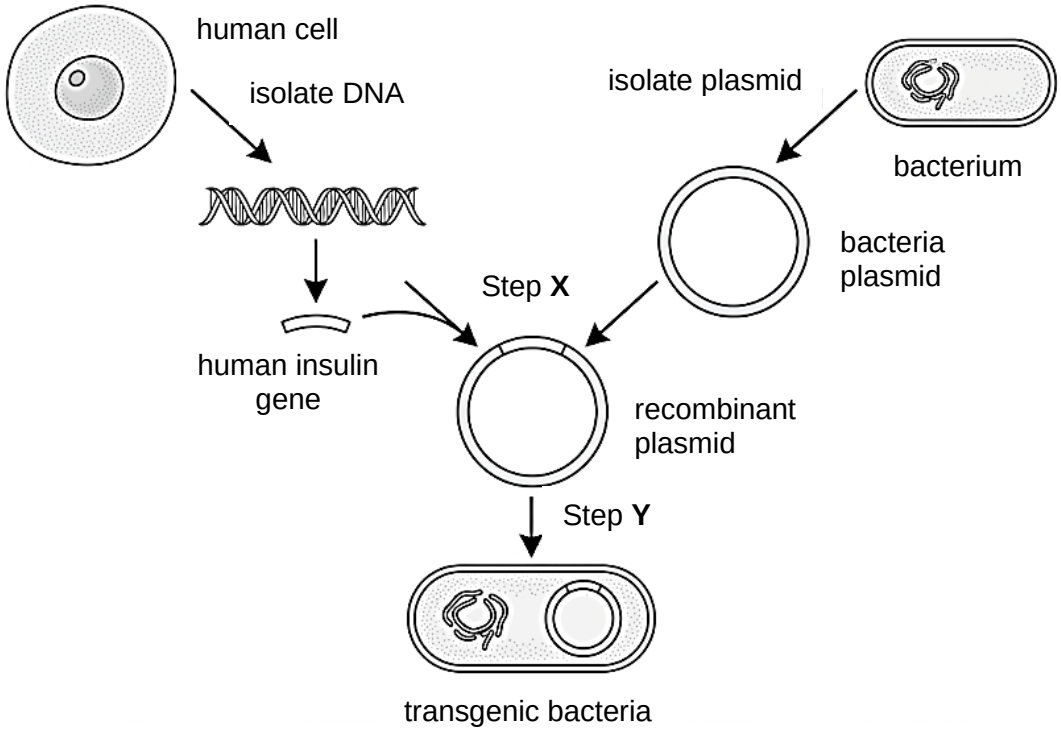

Fig. 5.2

Step **X** involves cutting both the human DNA and the bacterial plasmid before joining them together.

(i) Name the type of enzyme used to cut the DNA fragments and explain its function.

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……..... [2]

(iii) Name the enzyme used to join the human insulin gene to the cut plasmid vector.

……..…….... [1]

(iii) Describe step **Y** and explain how transgenic bacteria are subsequently used to produce large quantities of human insulin for medical use.

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[Total: 10]

6 Four girls, Aisha, Brenda, Chloe and Divya, were adopted as infants by different families in Singapore and grew up attending different schools. Years later, the girls discovered that they were sisters with the same biological parents.

Before undergoing formal DNA testing, the school health coordinator compiled their health booklet data. The following physical characteristics were recorded:

- Aisha and Chloe are both exactly 1.62 meters tall, while Brenda is 1.55 meters and Divya is 1.68 meters.
- Aisha and Divya have blood group O, while Brenda has blood group A and Chloe has blood group B.
- Their weights fluctuated significantly over the track season, ranging from 48 kilograms to 55 kilograms depending on their training routines and diets.

(a) Complete the table below by classifying the physical characteristics into their correct categories of biological variation.

continuous variation	discontinuous

[2]

The girls narrowed their search for their biological parents to four couples across Singapore. The blood groups of these couples are shown in the table below:

Table 6.1

couple	father's blood group	mother's blood group
1	AB	O
2	A	O
3	A	B
4	O	O

(b) Which couple are the biological parents of the four girls?

Explain your answer.

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…….. [3]

(c) All four couples shown in Table 6.1 have brown eyes.

Brenda and Divya have brown eyes. Chloe has blue eyes. The allele for brown eyes is dominant over the allele for blue eyes.

Calculate the probability that Aisha has blue eyes.

probability: …….. [1]

[Total: 6]

7 An agricultural scientist investigated the physiological responses of a dicotyledonous crop plant under three distinct environmental setups. The light intensity was kept constant across all three setups. The results are recorded in Table 7.1 below.

Table 7.1

setup	room temperature	relative humidity	rate of photosynthesis (arbitrary units)	rate of transpiration (g/ m^2/ hour)	average stomatal aperture / width (μm)
1	25°C	low (40%)	85	150	6.5
2	25°C	high (85%)	85	45	6.5
3	42°C	low (40%)	25	185	1.8

(a) With reference to table 7.1, describe the trends shown and explain the difference in the rate of transpiration between set-up 1 and set-up 2.

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…….. [2]

(b) In setup 3, the rate of photosynthesis drops drastically compared to setup 1.

Describe and explain this drastic decrease, referencing the structural state of the stomata.

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(c) With reference to the internal structure of a leaf, explain the difference between evaporation and transpiration.

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[Total: 9]

8 **(a)** Compare the biological advantages of self-pollination versus cross-pollination in flowering plants.

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…… [4]

(b) Describe the events that take place from the moment a pollen grain lands on a compatible stigma, up to the point of fertilization in the ovule.

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…… [3]

(c) Describe the structural adaptations of the human placenta that allow the efficient exchange of materials between the mother and the fetus.

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…… [3]

[Total: 10]

Candidate Name:	Class:	Index No:

Section B

Answer **one** question from this section.

9 People who have smoked cigarettes for many years are at risk of developing lung cancer.

(a) State the chemical responsible for the development of lung cancer in cigarette smoke.

…… [1]

(b) Exposure to this chemical can result in a genetic mutation within the DNA of lung cells. Explain how a mutation in a gene sequence can ultimately lead to a change in lung function.

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…… [3]

(c) Fig. 9.1 shows the changes in mortality rates for lung cancer in five countries between 1950 and 2006 for males.

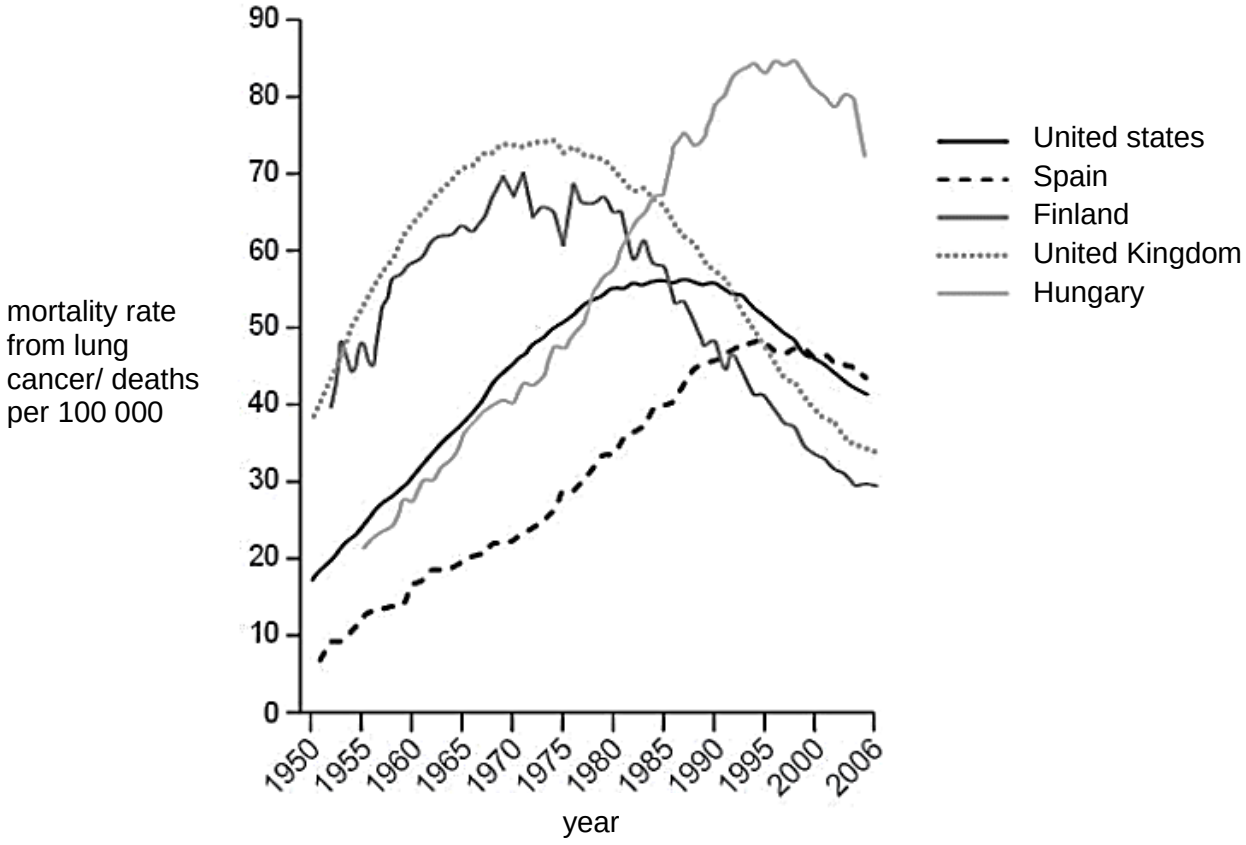

Fig. 9.1

With reference to Fig. 9.1, compare the trends in mortality rates in the countries shown. Your answer should include both similarities and differences and support your answer with data from the graph.

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[Total: 10]

10 (a) Animals do not have the ability to produce enzymes to digest cellulose. Most herbivores have bacteria in their digestive systems that can digest cellulose.

Fig. 10.1 shows the results of a study on 24 different herbivores. The percentage of cell wall material that was digested by each animal was determined. The time taken for the plant material to pass through the digestive system, the retention time, was also recorded.

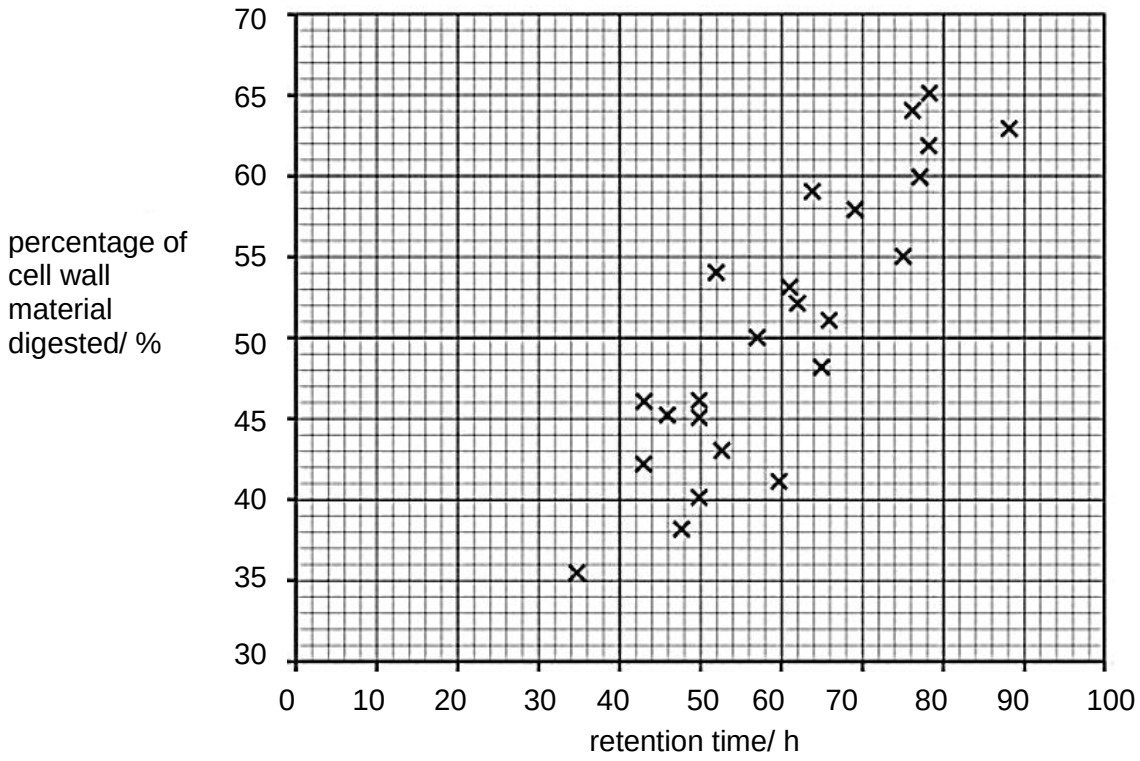

Fig.10.1

(a) Explain why plants are considered producers in a food chain?

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…… [2]

(b) Describe how energy is lost from one trophic level to another.

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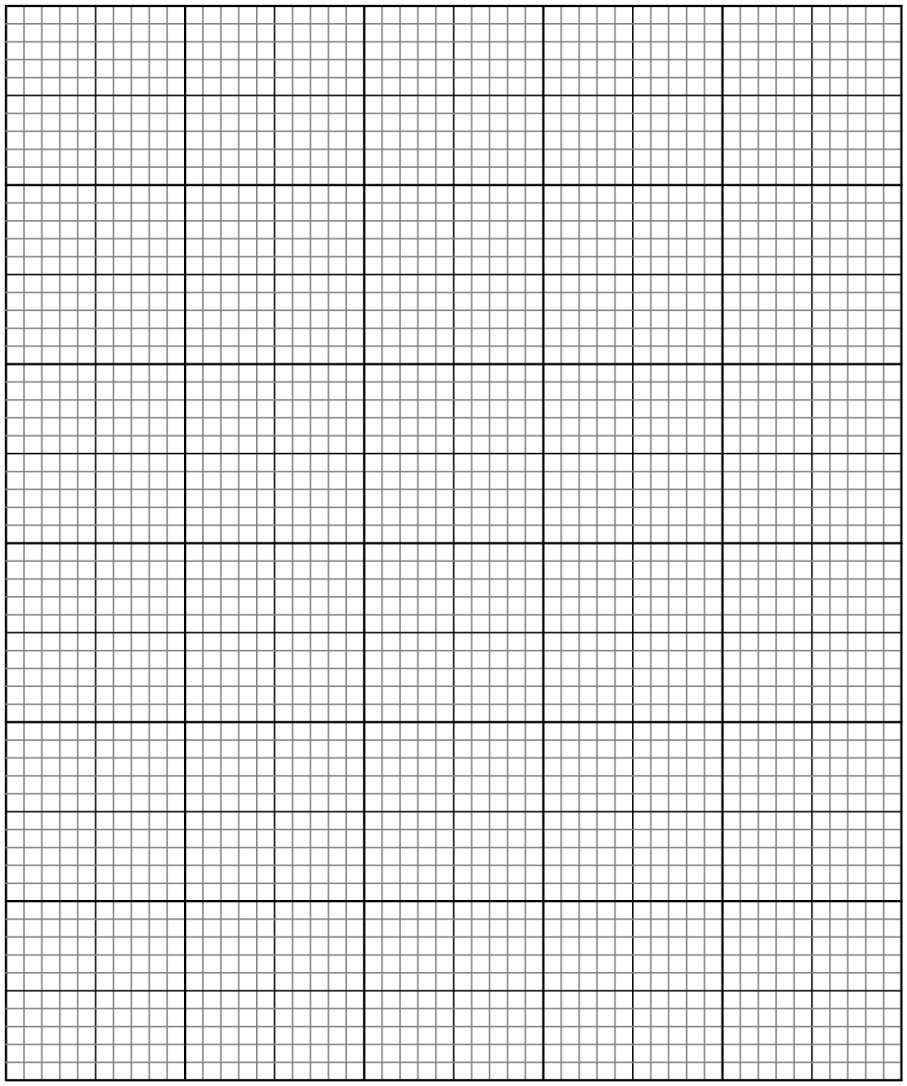
…… [2]

(c) Complete the frequency tally table below by counting the number of data points from Fig. 10.1 that fall into each range of percentage of cell wall material digested.

percentage of cell wall material digested (%)	tally	frequency (number of species)
31 – 40		
41 – 50		
51 – 60		
61 – 70		

[2]

(d) Using the data from your frequency table in part **(c)**, draw a histogram on the grid below to show the distribution of cell wall digestion efficiency among the sampled herbivores.



[4]

[Total: 10]

End of paper