Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4

A

BIOLOGY

6093/02

Paper 2

Thursday 24 August 2023

1 hour 45 minutes

Additional Materials: -

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE ON THE MARGINS.

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

Section B
Answer **all** questions.
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Electronic calculators may be used.

You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B.
The number of marks is given in brackets [ ] at the end of each question or part question.

For examiner's use only:

Section A	/ 50
Section B	/ 30

Section A

Answer **all** questions.
Write your answer in the spaces provided.

1 Some young grass plants were grown with their roots in a mineral solution that contained nitrate ions. The plants were divided into two batches, **N** and **P**.
Cyanide, which inhibits aerobic respiration, was added to the solution given to the plants in batch **P**.

The quantity of nitrate ions in the plants was determined at regular intervals for 70 hours. After 60 hours, the mineral solution was replaced by distilled water. The results are shown in Fig. 1.1.

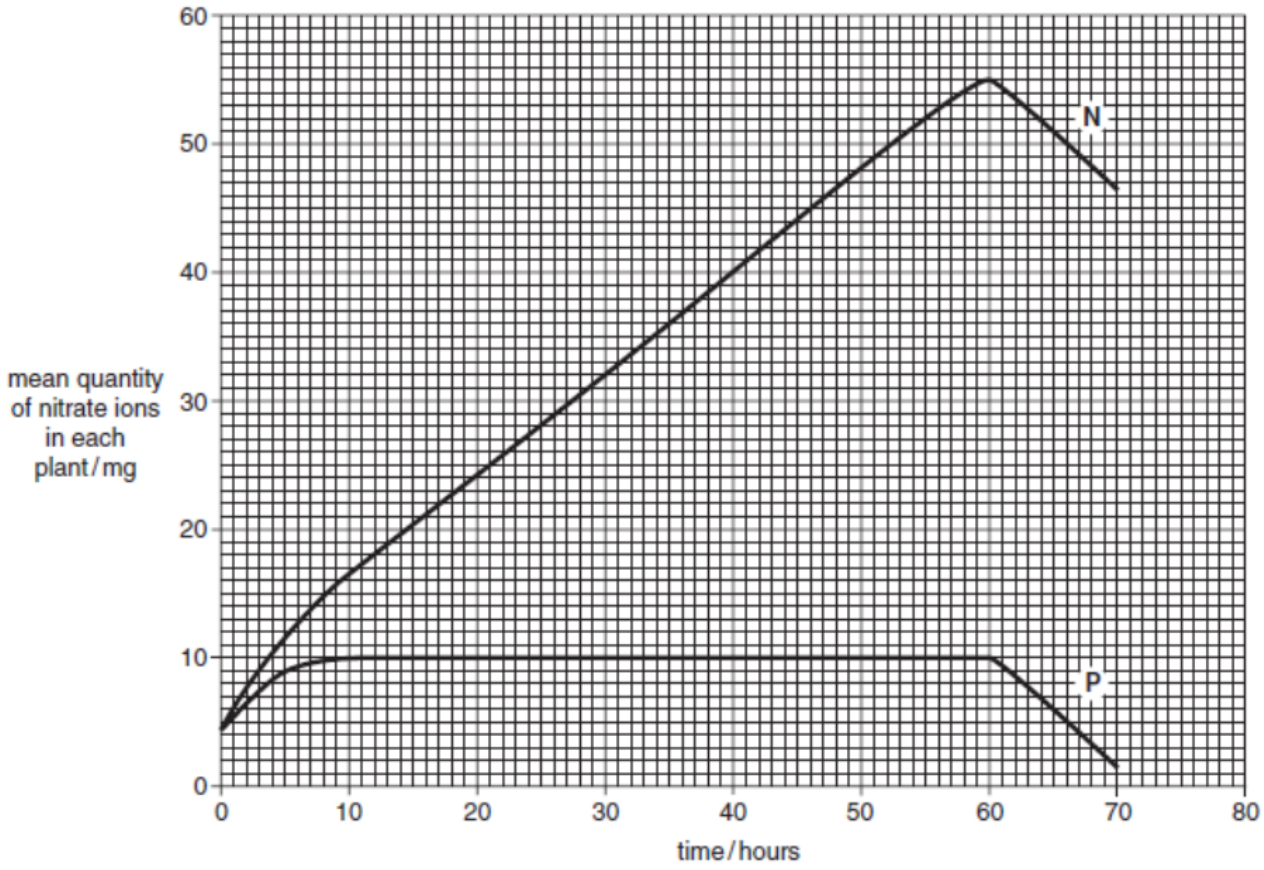

Fig. 1.1

Use the data in Fig. 1.1 to answer parts **(a)** to **(c)**.

(a) Calculate the rate of absorption of nitrate ions in batch **N** between 40 and 60 hours. Show your working.

..... mg per hour [2]

(b) Explain why the absorption of nitrate ions by the plants in batch **N** differs from that in batch **P**;

[4]

(c) Explain why the mean quantity of nitrate ions in **both** batches of plants decreased after 60 hours.

[2]

[Total: 8 marks]

2 **(a)** Cartilage is present in some parts of the gas exchange system to prevent collapse due to pressure changes during inhalation.

State two parts of the gas exchange system in which cartilage is located.

..... and ..... [1]

(b) Fig. 2.1 shows the changes that occur in atmospheric pressure and oxygen concentration as altitude changes. The highest altitude at which people live permanently is 5100 m.

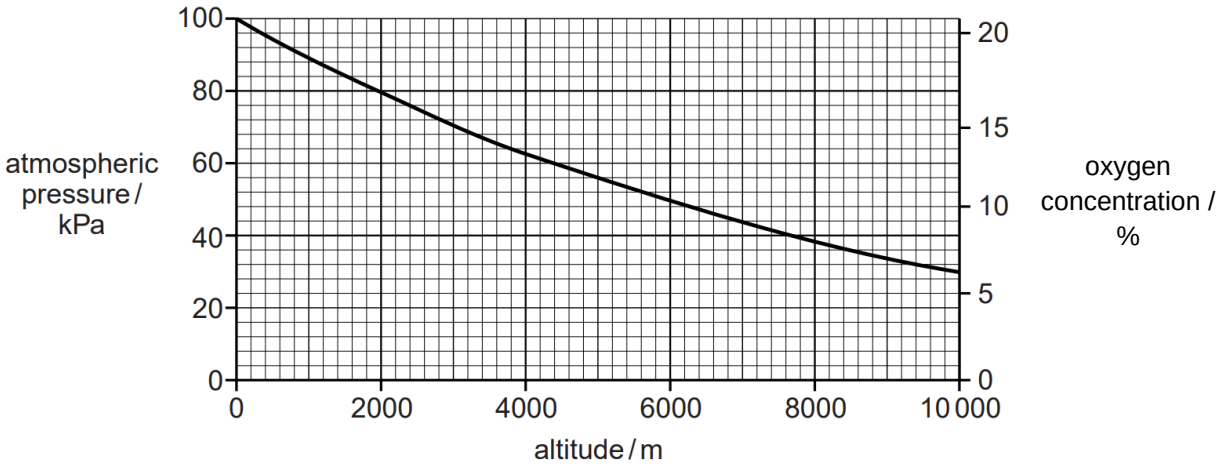

Fig. 2.1

With reference to Fig. 2.1:

(i) describe the effect of increasing altitude on both atmospheric pressure and the oxygen concentration

.....

.....

.....

..... [2]

(ii) calculate the change in the atmospheric pressure when a person travels from sea level to an altitude of 3500 m.

Show your working.

answer ..... [2]

(c) When a person travels from 0 m (sea level) to a high altitude, gas exchange in the lungs is affected. A condition known as hypoxia results, where the body tissues do not receive an adequate oxygen supply.

Explain how hypoxia occurs when a person ascends from sea level to a high altitude.

[4]

(d) At high altitudes, short-term responses by the body to hypoxia include:

- a decrease in the volume of plasma in the blood
- a decrease in the volume of blood pumped out of the heart per heart beat
- an increase in the heart rate
- an increase in the breathing rate.

(i) Suggest why a decrease in the volume of plasma in the blood may reduce the effects of hypoxia

[1]

(ii) Explain why an increase in the heart rate occurs in response to hypoxia.

[2]

[Total: 12 marks]

3 **(a)** Fig. 3.1 shows a flower that reproduces using insect-pollination.

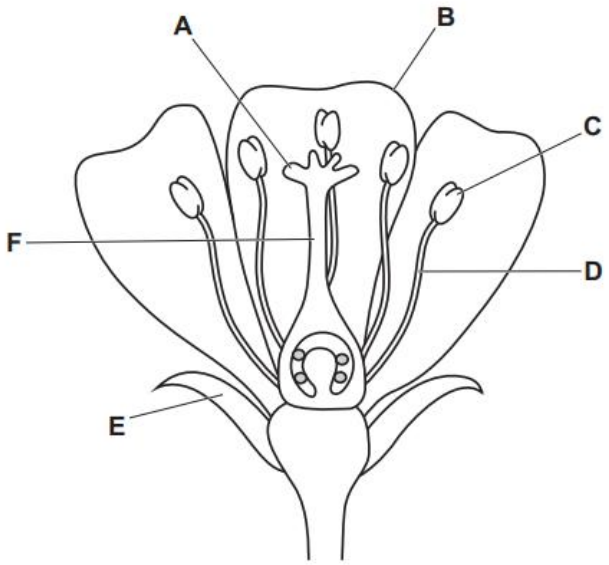

Fig. 3.1

With reference to Fig. 3.1, describe two ways which the labeled parts differ in a wind-pollinated flower.

1 .....

.....

2 .....

..... [2]

(b) *Mimulus* is a plant genus containing a diverse range of species that have colourful flowers to attract pollinators, such as bees and hummingbirds. Pollinators transfer pollen between flowers for plant sexual reproduction.

Table 3.1 compares some features of two closely-related species of *Mimulus* that both grow in the same region of North America.

The features in which they differ are:

- the altitude at which the two species grow
- their flower characteristics, including petal colour and the distance from the opening of the flower to the nectar on which the pollinators feed
- the percentages of pollinator visits that they receive from bees or from hummingbirds.

Table 3.1

species of *Mimulus*	altitude/ m	petal colour	distance to nectar/mm	percentage of visits from pollinator type	
				bee	hummingbird
M. lewisii	1600 – 3000	pink	14	100	0
M. cardinalis	0 – 2000	red	27	3	97

With reference to the data in Table 3.1, explain how the exchange of genetic materials between *M. lewisii* and *M. cardinalis* populations is prevented.

[3]

(c) Breeding experiments in the laboratory show that *M. lewisii* and *M. cardinalis* can breed together and produce offspring. The F1 hybrid offspring are fertile.

Suggest, with reasons, what prediction can be made about the chromosome numbers of *M. lewisii* and *M. cardinalis.*

[2]

(d) The inheritance of the petal colour was investigated.

Draw a genetic diagram to show a cross between two heterozygous parents with pink petals.

Use the symbols **R** and **r** for the alleles representing red and white petals respectively.

parental genotypes

gametes

offspring genotypes

offspring phenotypes

[3]

[Total: 10 marks]

4 **(a)** Maize is an important food crop that has been improved both by selective breeding and by genetic engineering.

(i) Outline how selective breeding has been used to improve maize.

.....

.....

.....

.....

..... [2]

(ii) Suggest two advantages of genetic engineering over selective breeding.

1 .....

.....

.....

2 .....

.....

..... [2]

(b) Fig. 4.1 shows part of a maize cob. The cob is made up of many individual seeds called kernels. Each kernel results from a separate fertilisation of a male and a female gamete. Some kernels are yellow and some are purple.

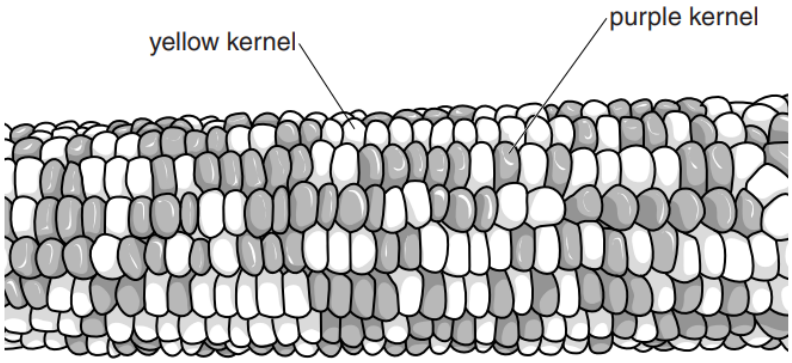

Fig. 4.1

Name the type of variation shown in Fig. 4.1. Suggest a genetic explanation for this pattern of variation in colour.

type of variation .....

explanation .....

.....

..... [2]

(c) Mammoths are extinct mammals related to elephants. About three million years ago, the ancestors of mammoths migrated from Africa into Europe and Asia. There, about 1.7 million years ago, the steppe mammoth evolved and became adapted to the cooler conditions. Then, about 700 000 years ago, as the climate changed and the Arctic became much colder, the woolly mammoth evolved.

Woolly mammoths showed a number of obvious adaptations to reduce heat loss, including thick fur, small ears and small tails.

Fig. 4.2 shows the steppe mammoth (top) and the Woolly mammoth (bottom).

Fig. 4.2 (not to scale)

Adapted from https://prehistoric-fauna.com/Mammuthus-sungari (Steppe mammoth) and https://www.theboxplymouth.com/blog/press-release/mammoth-moment (Woolly mammoth)

Explain how variation and natural selection may have brought about the evolution of the woolly mammoth from the steppe mammoth.

[4]

[Total: 10 marks]

5 Some pollutants are not broken down easily and remain in the environment for a long time. These are described as persistent pollutants.

PCBs are a waste material from the manufacturing of electrical insulation. PCBs are one of the most persistent pollutants in the environment.

Between 1947 and 1976, factories dumped large quantities of PCBs into the Hudson River in the USA. Studies measured the concentrations of PCBs in the tissues of organisms in a food chain in the sea near the Hudson River, as shown in Fig. 5.1.

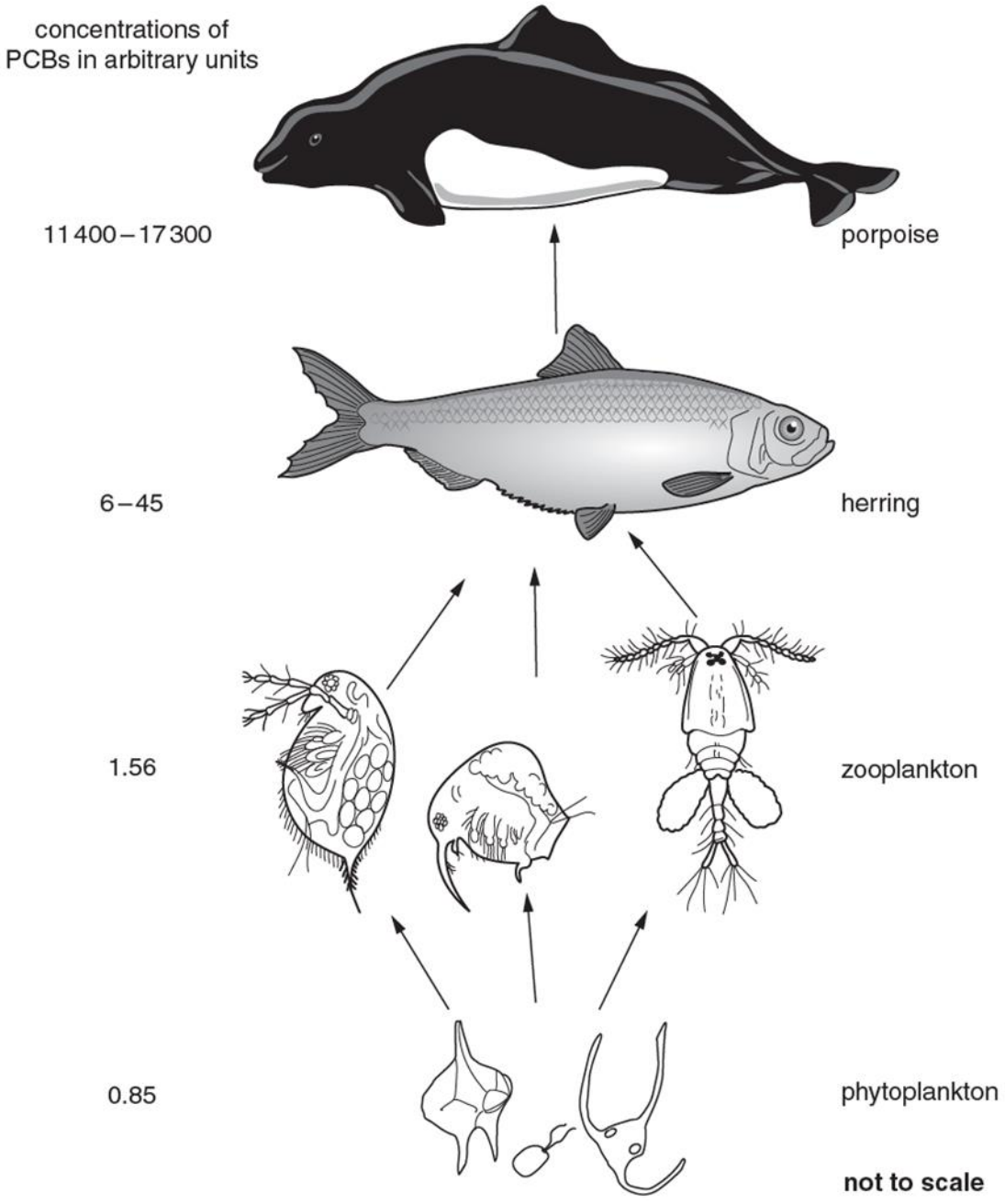

Fig. 5.1

(a) **(i)** Describe the results shown in Fig. 5.1.

[3]

(ii) Suggest an explanation for the different concentrations of PCBs in the organisms of the food chain.

[3]

(b) Explain why there are no more than four trophic levels in the ecosystem shown in Fig. 5.1

[3]

(c) Humans play a significant role in ecosystems.

Suggest how conservation programmes have helped to prevent the extinction of endangered species.

[1]

[Total: 10 marks]

- End of Section **A** -

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This paper consists of **19** printed pages.

[Turn over

Section B

Answer **three** questions.

Question 8 is in the form of an **Either**/**Or** question. Only one part should be answered.

6 Fig. 6.1 shows a diagram of an aphid feeding by pushing their stylet on a stem of a plant.

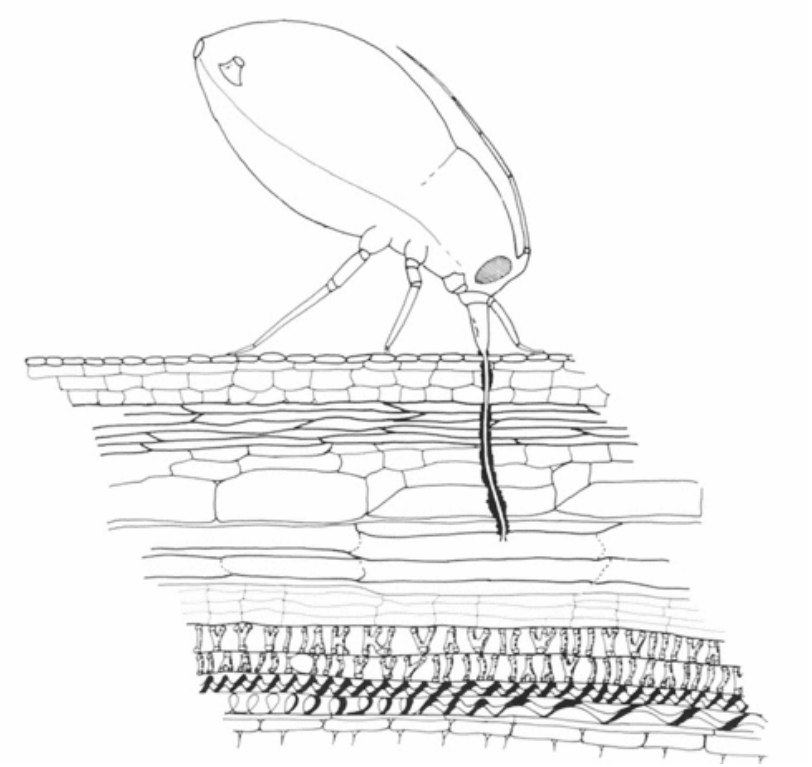


Fig. 6.1

(a) On Fig. 6.1, label clearly the xylem and phloem tissues. [1]

By using stylets, it is possible for scientists to collect the sap from a stem.

Scientists have investigated the different rates of flow of sap in the stylets of aphids of different ages from hatching, **H**, up to the adult, **M**.

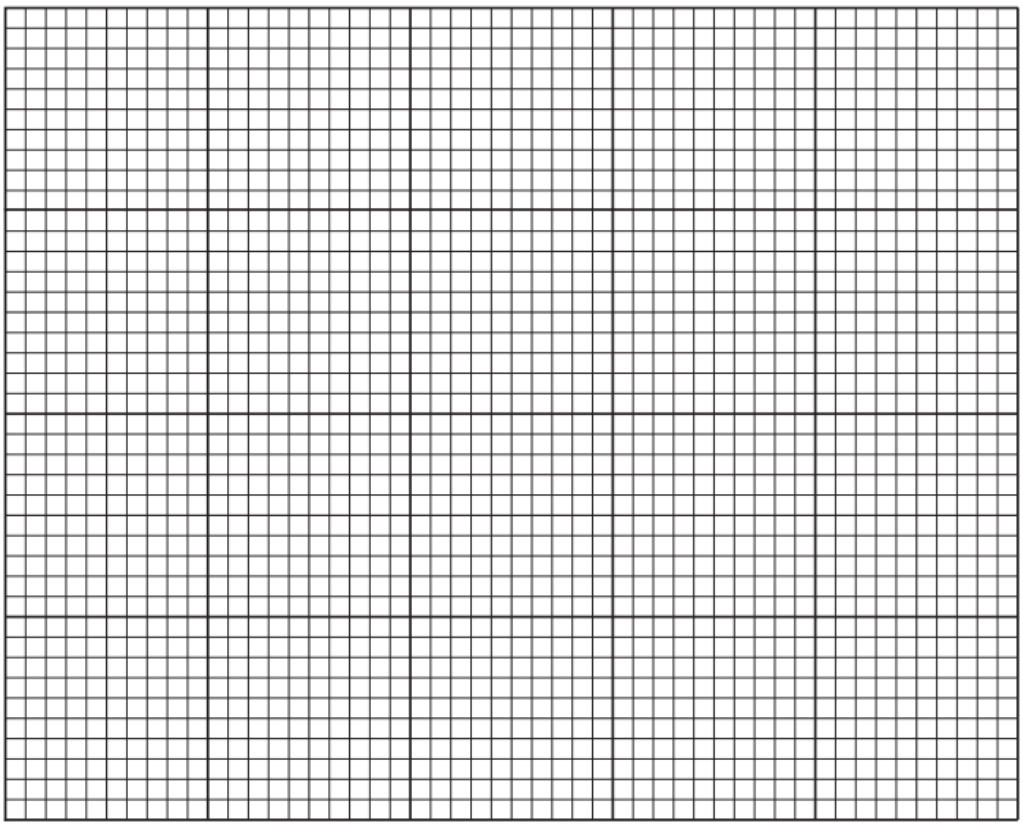
The results are shown in Table 6.1.

Table 6.1

different ages of aphid	rate of flow of sap /µl h^{-1}			
	trial 1	**trial 2**	**trial 3**	**mean**
H	0.452	0.448	0.451	0.450
J	0.726	0.722	0.726	0.725
K	0.977	1.232	0.973	……...
L	1.401	1.601	1.399	1.400
M	1.978	1.975	1.972	1.975

(b) **(i)** Complete the table by calculating the missing mean value. [1]

(ii) Plot a bar chart of the data in Table 6.1.



[4]

(iii) Describe the relationship between the age of the aphid and the rate of flow of sap.

.....

.....

..... [1]

(iv) Suggest a reason which might explain the relationship described in **(iii)**.

.....

.....

..... [1]

(c) Compare the differences between transpiration and translocation.

1 .....

.....

2 .....

..... [2]

[Total: 10 marks]

7 Cells have specialised structures for their specific functions.

(a) Compare and contrast the structure and function of root hairs and villi.

[7]

(b) Primary ciliary dyskinesia (PCD) is a genetic disorder that can cause cilia in various parts of the body to malfunction.

Suggest how PCD may prevent pregnancy.

[3]

[Total: 10 marks]

8 Either

(a) Explain why most foods must be digested.

[3]

(b) Excess amino acids are broken down in liver cells to form molecules of urea.

Describe the pathway taken by a molecule of urea, from the liver of a mammal until it leaves the body.

[7]

[Total: 10 marks]

8 Or

(a) Explain how the nervous system plays a vital role in the maintenance of a constant body temperature.

[6]

(b) Describe the role of the hormone adrenaline and give one example of a situation in which adrenaline may be released.

[4]

[Total: 10 marks]

- End of Section **B** -