Paper 5: Data and Statistics: Cambridge (CIE) A Level Biology 9700 Exam Questions

21 questions · 42 marks · about 50 minutes. Answer in the spaces, then check the mark schemes at the end.

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(d) In a further study, the scientists investigated whether gamma radiation **and** a hot water treatment reduce the acrylamide concentration of potato chips.

- Four bags of one variety of potato were each exposed to a different dose of gamma radiation: $0\,J\,kg^{-1}$, $50\,J\,kg^{-1}$, $100\,J\,kg^{-1}$ or $150\,J\,kg^{-1}$.
- After exposure to gamma radiation, the potatoes from each bag were cut into $1\,cm \times 1\,cm \times 5\,cm$ blocks.
- Potato blocks from each bag were given two different treatments.

treatment 1: 100 g of potato blocks were cooked in $1\,dm^3$ of sunflower oil at 170 °C for five minutes.

treatment 2: 100 g of potato blocks were heated in $500\,cm^3$ water at 85 °C for five minutes, removed from the water and then cooked in $1\,dm^3$ of sunflower oil at 170 °C for five minutes.

The scientists measured the acrylamide concentration of the potato chips after these treatments.

This procedure was repeated a further five times to allow statistical tests to be carried out on the results.

The results of the investigation are summarised in Table 1.2.

Table 1.2

gamma radiation dose / $J\,kg^{-1}$	mean acrylamide concentration of potato blocks / $\mu g\,kg^{-1}$	
	treatment 1	treatment 2
0	4551	1768
50	3629	1487
100	3310	1339
150	2073	1010

(i) Using the data in Table 1.2, calculate the percentage decrease in the mean acrylamide concentration of potato blocks given treatment 2 compared to potato blocks given treatment 1, for a gamma radiation dose of $0\,J\,kg^{-1}$.

Show your working.

percentage decrease = ...

[2]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

In some regions of China, marigold plants, *Tagetes erecta*, are grown commercially.

In the investigation into the effect of staghorn sumac root extract on the growth of marigolds, the scientists carried out the procedure described in step 1 to step 5.

step 1 Prepare five containers, each with five marigold plants grown from seed.

step 2 Add 20 cm^3 of distilled water to one of the containers. This is the control.

step 3 Add 20 cm^3 of the root extract concentrations to the other four containers, so that each container has a different concentration of root extract.

step 4 Repeat step 2 and step 3 each day for 60 days.

step 5 After 60 days, remove the marigold plants from the soil and untangle the roots. Measure the length of the longest root for each plant.

The scientists replicated this procedure twice and calculated the mean maximum root length for the control and for the root extract concentrations.

The results are shown in Table 1.2.

Table 1.2

root extract concentration / mg cm^{-3}	mean maximum root length after 60 days / mm
control	163.0
2.5	153.2
5.0	156.4
7.5	152.0
10.0	141.6

(ii) Using the data in Table 1.2, calculate the percentage change in the mean maximum root length between the control and the roots treated with 10 mg cm^{-3} root extract concentration.

Show your working and record your answer to 3 significant figures.

percentage change ..... [3]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(c) The student then plotted a graph of the results, showing the increase in absorbance. Absorbance is measured in absorbance units (au).

Fig. 1.2 shows the results for the increase in absorbance at **pH 5.0**.

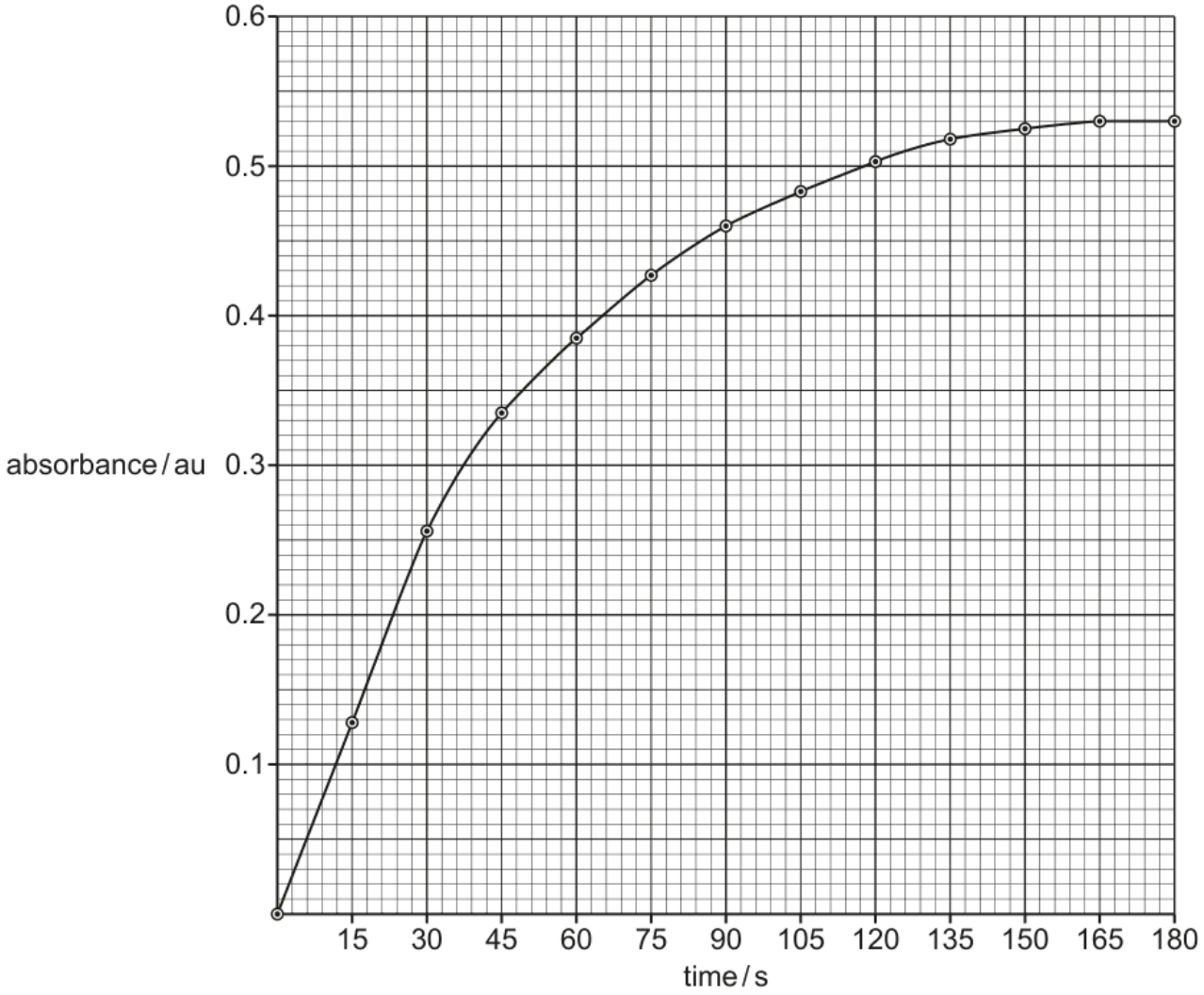


Fig. 1.2

(i) Use Fig. 1.2 to calculate the initial rate of this reaction in absorbance units per second ($au\,s^{-1}$).

Show your working.

initial rate of reaction = ... $au\,s^{-1}$ [2]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(b) Another piece of lower epidermis from a leaf of plantain lily was immersed in a large drop of distilled water on a microscope slide.

Fig. 1.3 shows the lower epidermis viewed using the low-power objective lens.

The student determined the stomatal density on the lower epidermis using Fig. 1.3 only.

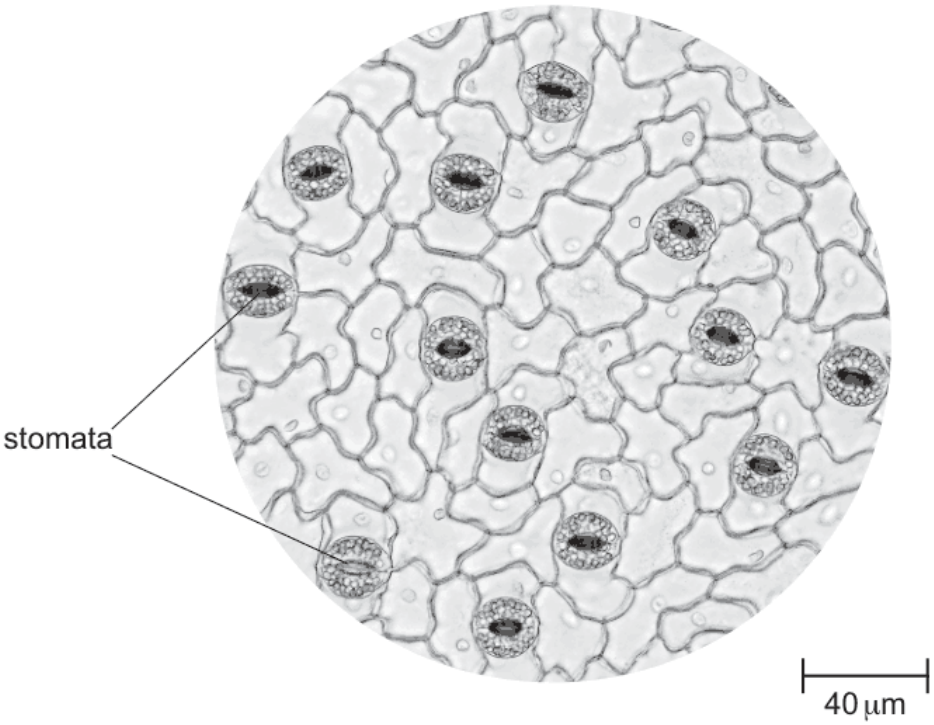


Fig. 1.3

(i) Use Fig. 1.3 to calculate the stomatal density on the lower epidermis.

Use the equation:

area = πr^2 and π = 3.14

Give your answer to the nearest whole number and show your working.

stomatal density = ... mm^{-2}

[4]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 5 · information from earlier in the question

1 Fig. 1.1 **A** shows the root vegetable beetroot, *Beta vulgaris*.

Fig. 1.1 **B** shows a single cell from the beetroot tissue. The vacuole contains the red pigment, betalain.

The pigment molecules are too large to diffuse out of the vacuole.

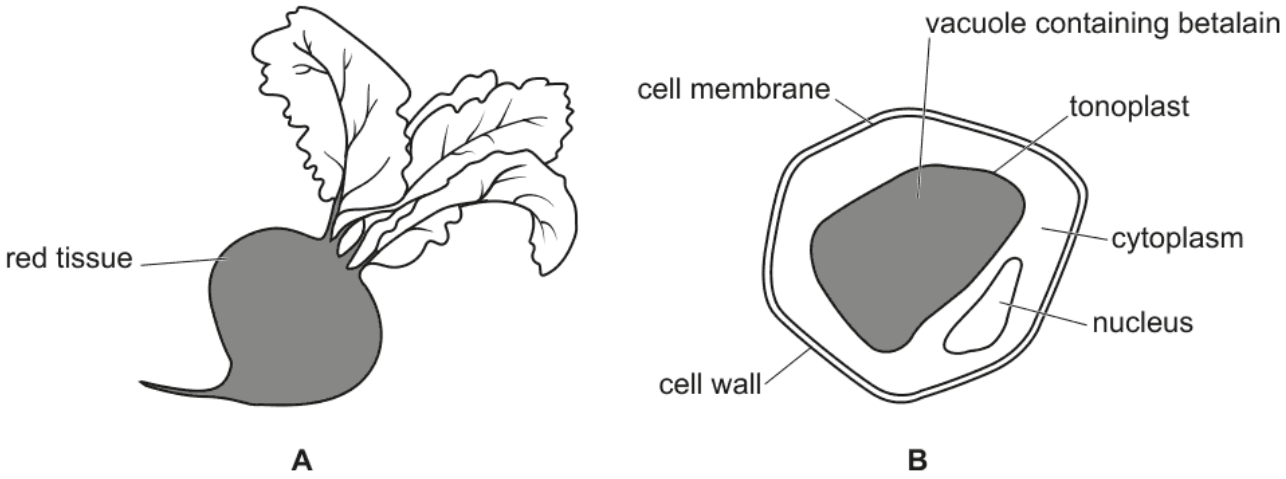


Fig. 1.1

When pieces of beetroot are soaked in a solution of calcium hypochlorite, $Ca(ClO)_2$, the beetroot tissue changes from red to white. This is caused by the calcium hypochlorite diffusing into the beetroot cell vacuoles and decolourising the betalain pigment.

Fig. 1.2 shows a cube of beetroot before soaking in the solution of calcium hypochlorite and the halved cube of beetroot after soaking in the solution of calcium hypochlorite.

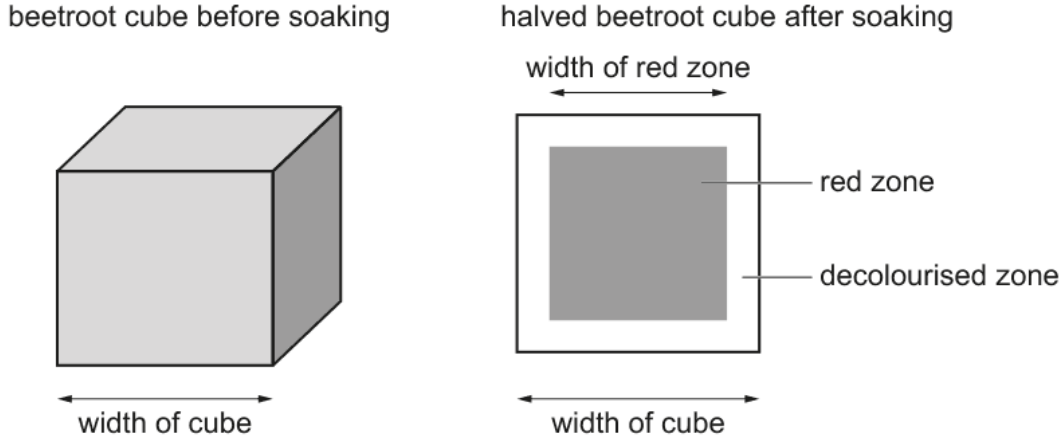


Fig. 1.2

In a class experiment:

- Cubes of beetroot of different dimensions were placed in a beaker containing a 10% solution of calcium hypochlorite.

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 5 · Paper 5 · May/June 2022 (52) · Q1(b)(ii) · 2 marks

(ii) The students decided to calculate the **percentage change in volume** of the red tissue in each cube.

State how the students could calculate the percentage change in volume of the red tissue in each cube.

.....

.....

.....

.....

Question 6 · information from earlier in the question

2 The European badger, *Meles meles*, pictured in Fig. 2.1, is a mammal found in England.

Badgers can contract bovine tuberculosis (bTB) caused by the pathogen, *Mycobacterium bovis*.

- Researchers estimated that 5% of the badger population in England are infected with bTB.
- bTB can be spread between badger populations and other populations of wild animals and farmed animals.
- Herds of dairy cows produce milk for human consumption. If a dairy herd becomes infected with bTB, the pathogen can be transmitted to human populations in milk.
- A variety of measures have been introduced in an attempt to reduce the bTB rate in badgers and so prevent infection of dairy cows.
- These measures include vaccination and the removal of badger populations (culling).



Fig. 2.1

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(b) It is possible that wild badgers infect dairy cows with bTB.

A group of scientists investigated the correlation between bTB infections in badgers and bTB infections in dairy cows.

- 30 study areas in England were identified.
- Each of the areas was approximately 100 km^2.
- 10 of the 30 study areas were randomly selected and given the codes **A**–**J**.
- The number of infected cows **and** the number of infected badgers were counted in each area.
- The number of infected badgers was determined by testing for the presence of *Mycobacterium bovis* in tissue samples taken from the badgers.
- The number of infected cows was determined by testing for a response (inflammation) to the introduction of antigenic material into the skin.

Data was collected as shown in Table 2.1.

Table 2.1

data set	areas where counts were made	year when counts were made
1	**A**, **B**, **C**, **E**, **F**, **G**, **H**	1999
2	**D**, **I**, **J**	2001

The scientists expressed their data on the numbers of infected cows and infected badgers as the population **density** of infected cows and infected badgers.

(i) Explain what is meant by the term population density **and** suggest why the data was expressed in this way.

.....

.....

.....

.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 7 · information from earlier in the question

2 The eye has sensory receptors that convert light energy into nerve impulses. The ability of the human eye to detect separate stimuli one after another has been studied.

- The eye is able to distinguish separate stimuli from a flickering light up to a threshold frequency of about 16 flickers per second. This is referred to as a frequency of 16 hertz (Hz). 1 Hz = 1 flicker per second.
- Once the threshold frequency is reached, the eye can no longer distinguish the separate stimuli so they are detected as one continuous stimulus.
- The frequency at which this happens is called the critical flicker fusion threshold (CFFT).

To find a person's CFFT, a test is carried out.

- The person looks into a binocular eyepiece at two white lights that flicker simultaneously.
- The flickering frequency is started at 4 Hz and is gradually increased at a constant rate.
- When the person first notices that the flickering stimulus appears to have become constant they press a button, which gives their CFFT.
- This is repeated to give ten values for each person.

An investigation was carried out into the effect of alcohol on the CFFT of thirteen females aged from 18 to 35 years old. Before starting the investigation, the women were given time to become familiar with the equipment. The investigation was then carried out over two days.

Day 1 – the women were allowed 5 minutes to drink 250 cm^3 of pure orange juice. The CFFT was tested 40 minutes later.

Day 2 – the women were allowed 5 minutes to drink 250 cm^3 of orange juice containing 16 mg of alcohol. The CFFT was tested 40 minutes later.

The reason for carrying out the test 40 minutes after drinking alcohol is to allow time for the alcohol to reach its peak concentration in the blood.

Fig. 2.1 shows the results of this investigation.

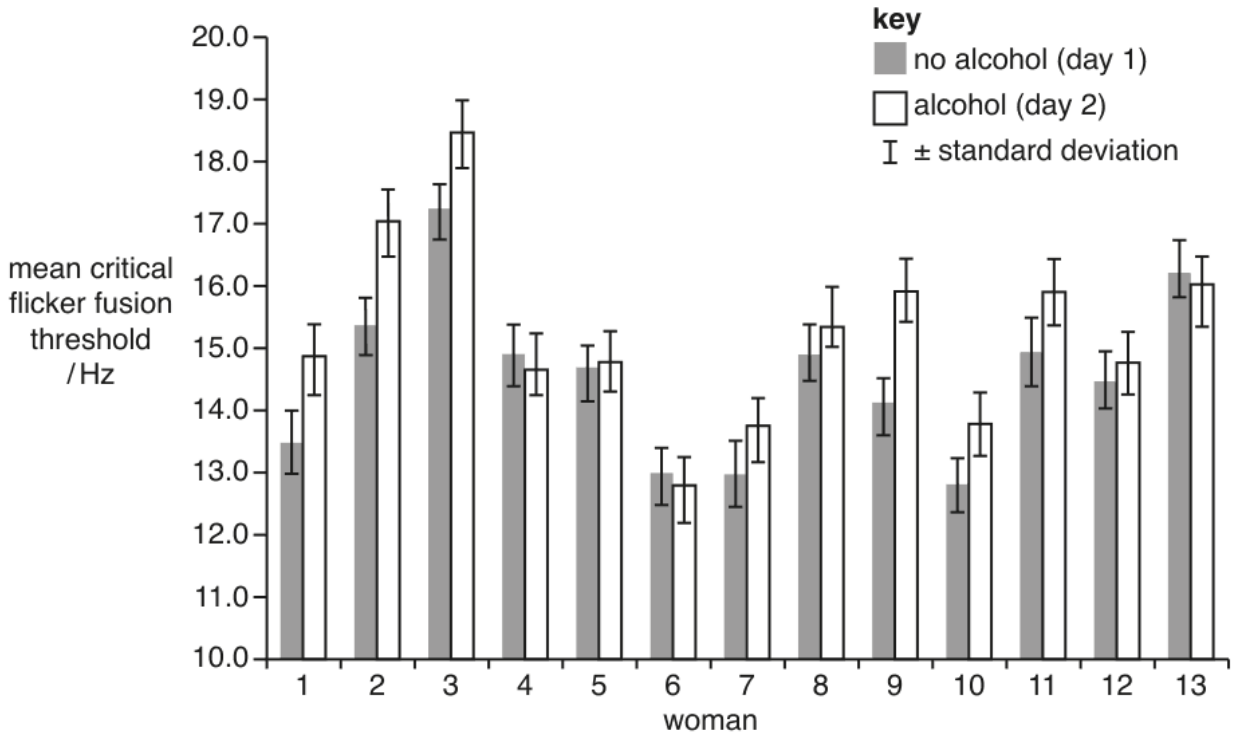


Fig. 2.1

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 7 · Paper 5 · February/March 2018 (52) · Q2(b) · 2 marks

(b) Explain why the investigators calculated the standard deviation of the results for each person.

.....

.....

.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 8 · information from earlier in the question

2 Abscisic acid (ABA) is a plant hormone that influences the growth and development of plants.

Salicylic acid (SA) is a plant hormone that interacts with other plant hormones, such as ABA, to influence growth and development in plants.

Scientists investigated the effects of ABA and SA on shoot growth in seedlings of rice, *Oryza sativa*.

The scientists germinated some rice grains and divided the young seedlings into four batches, **A** to **D**, each containing 9 seedlings of the same length. The seedlings were put into trays containing a seedling growth medium. The shoots in each batch of seedlings were sprayed once with a different solution:

batch **A** – water
batch **B** – 2 μmol dm^{-3} ABA
batch **C** – 2 μmol dm^{-3} ABA + 1.0 mmol dm^{-3} SA
batch **D** – 1.0 mmol dm^{-3} SA

The seedlings were then put into a growth chamber with constant conditions of light, temperature and humidity. The length of the shoot on each seedling was measured one day after spraying and five days after spraying.

Fig. 2.1 shows two seedlings taken at random from each batch five days after being sprayed.

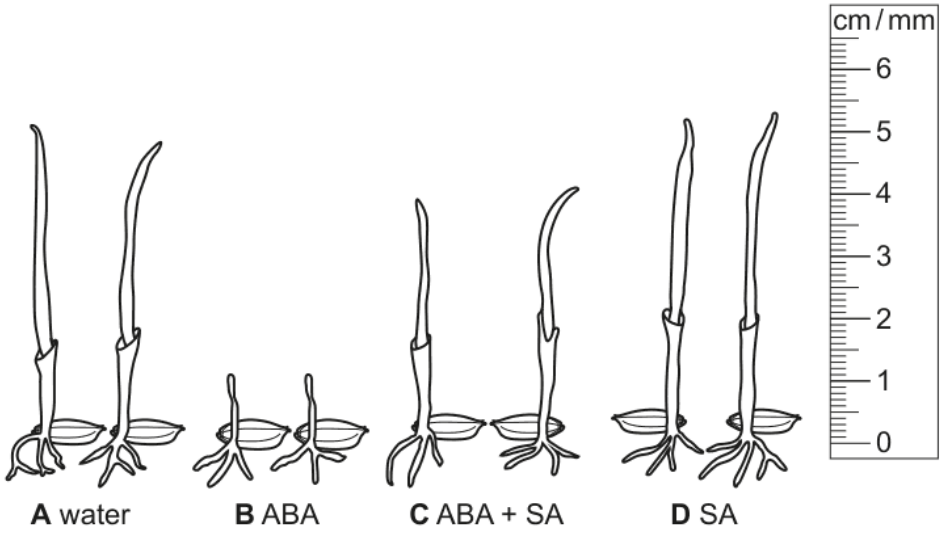
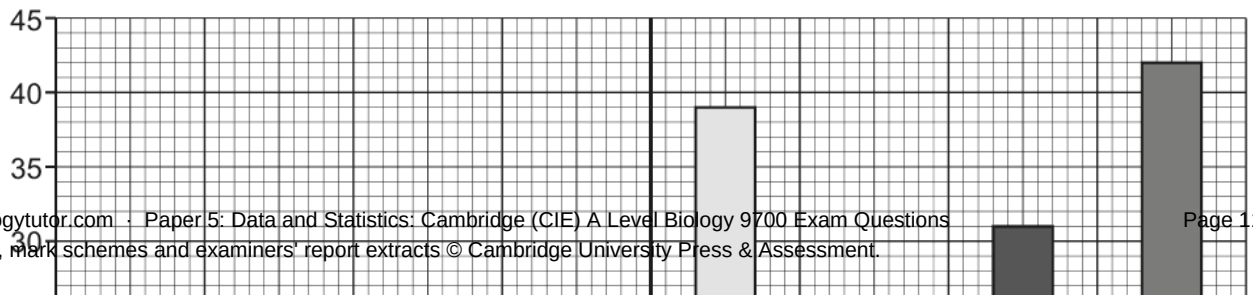


Fig. 2.1

The mean results of the investigation are shown in Fig. 2.2.



Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 8 · Paper 5 · October/November 2023 (52) · Q2(b)(i) · 1 mark

(b) There were nine seedlings in each batch.

The standard deviation for the length of seedlings in batch **D** (sprayed with SA only) at day 5 is 5 mm.

The formula for calculating standard error (SE) is:

$$SE = \frac{s}{\sqrt{n}}$$

s = sample standard deviation
n = sample size (number of observations)

The formula for calculating the 95% confidence interval (95% CI) is:

$$95\%\ CI = \bar{x} \pm (2 \times SE)$$

$\bar{x}$ = mean

(i) Calculate the 95% CI for batch **D** (treated with SA only) at day 5.

95% CI = ... mm [1]

Question 9 · Paper 5 · May/June 2025 (54) · Q1(d)(i) · 2 marks

(d) In another investigation the student tested the effect of gibberellin (GA) on the elongation of shoots. Five groups of 20 wheat grains were soaked in GA solution. Each group was treated with a different concentration of GA and then left to germinate and grow for 10 days. The length of each shoot was measured and a mean shoot length was calculated for each GA concentration.

Table 1.1 shows the results of this investigation.

Table 1.1

concentration of GA / mol dm^{-3}				
0	1×10^{-7}	1×10^{-6}	1×10^{-5}	1×10^{-4}
mean shoot length / mm ± SE				
120 ± 10	150 ± 5	175 ± 15	210 ± 12	180 ± 8

(i) Explain what standard error (SE) shows about the reliability of the results in Table 1.1.

.....

.....

.....

.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 10 · information from earlier in the question

1 Blood vessels must be able to withstand and maintain varying blood pressures.

There are several methods that could be used to determine the strength of a blood vessel. One method is called the circumferential tensile strength (CTS) test, as shown in Fig. 1.1.

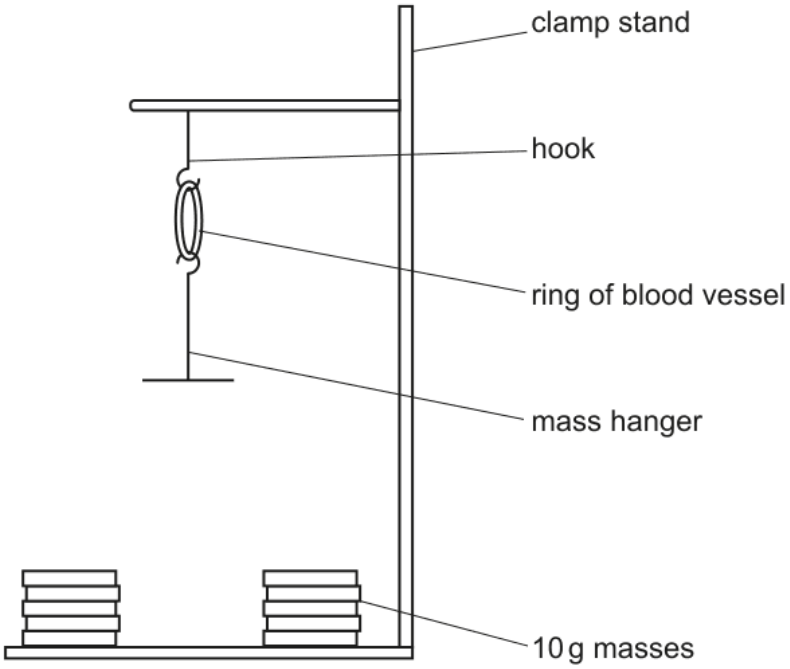


Fig. 1.1

The ring of blood vessel, shown in Fig. 1.1, was cut from a length of artery or vein that was prepared by removing surrounding tissues.

A student wanted to use the apparatus in Fig. 1.1 to determine the mass needed to break an artery and the mass needed to break a vein.

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Another student investigated how the length of a ring of vein and the length of a ring of artery increases as more mass is added.

The student used the apparatus shown in Fig. 1.2 with the ring of vein.

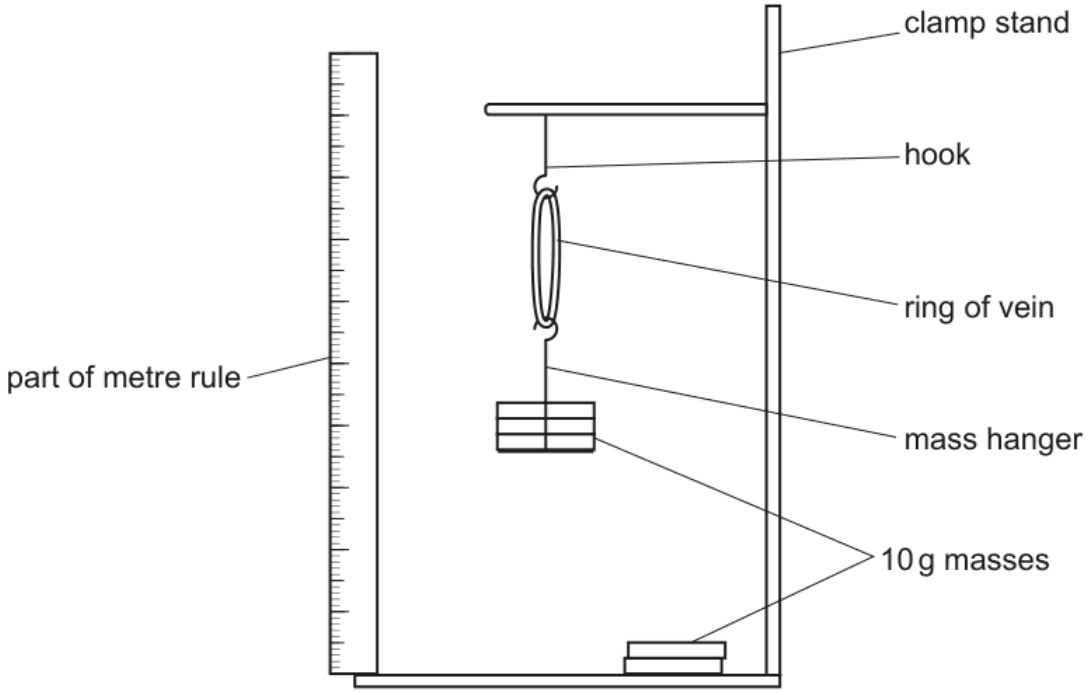


Fig. 1.2

The results for the ring of vein are shown in Table 1.1.

Table 1.1

mass added / g	length of ring of vein / mm	percentage increase in length of ring of vein
0	21	0
10	36	.....
20	38	81
30	40	90
40	41	.....
50	41	.....

(b) (i) Complete Table 1.1 by calculating the percentage increase in length of the ring of vein for 10 g, 40 g and 50 g. [2]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 11 · Paper 5 · May/June 2024 (53) · Q1(b)(ii) · 1 mark

(ii) Explain why the student calculated the percentage increase in length of the ring of vein.

.....

.....

Question 12 · Paper 5 · May/June 2024 (53) · Q1(b)(iii) · 3 marks

(iii) On the grid in Fig. 1.3, plot a graph of the data shown in Table 1.1.

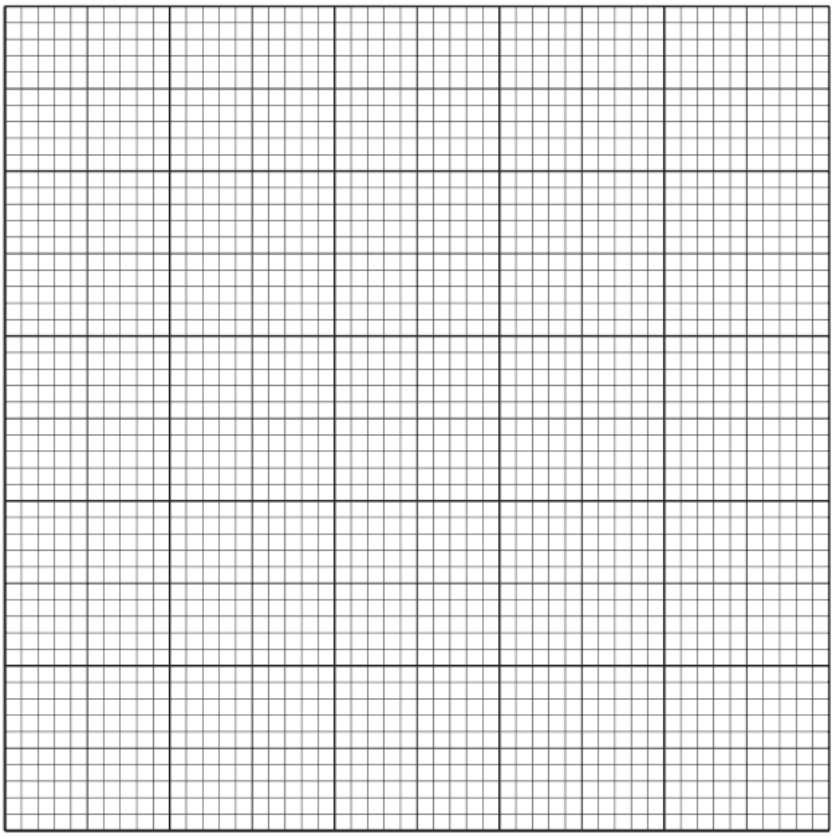


Fig. 1.3

[3]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

2 Abscisic acid (ABA) is a plant hormone that influences the growth and development of plants.

Salicylic acid (SA) is a plant hormone that interacts with other plant hormones, such as ABA, to influence growth and development in plants.

Scientists investigated the effects of ABA and SA on shoot growth in seedlings of rice, *Oryza sativa*.

The scientists germinated some rice grains and divided the young seedlings into four batches, **A** to **D**, each containing 9 seedlings of the same length. The seedlings were put into trays containing a seedling growth medium. The shoots in each batch of seedlings were sprayed once with a different solution:

batch **A** – water
batch **B** – 2 μmol dm^{-3} ABA
batch **C** – 2 μmol dm^{-3} ABA + 1.0 mmol dm^{-3} SA
batch **D** – 1.0 mmol dm^{-3} SA

The seedlings were then put into a growth chamber with constant conditions of light, temperature and humidity. The length of the shoot on each seedling was measured one day after spraying and five days after spraying.

Fig. 2.1 shows two seedlings taken at random from each batch five days after being sprayed.

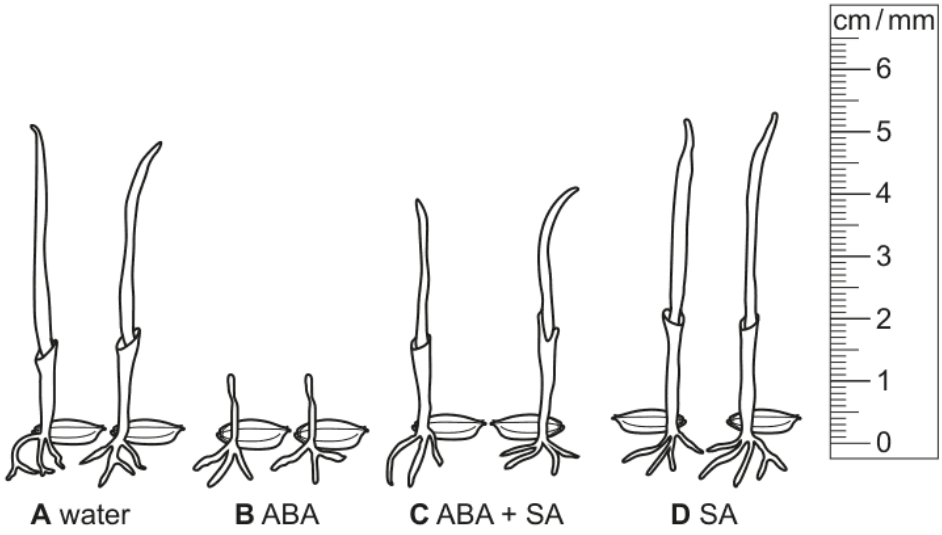
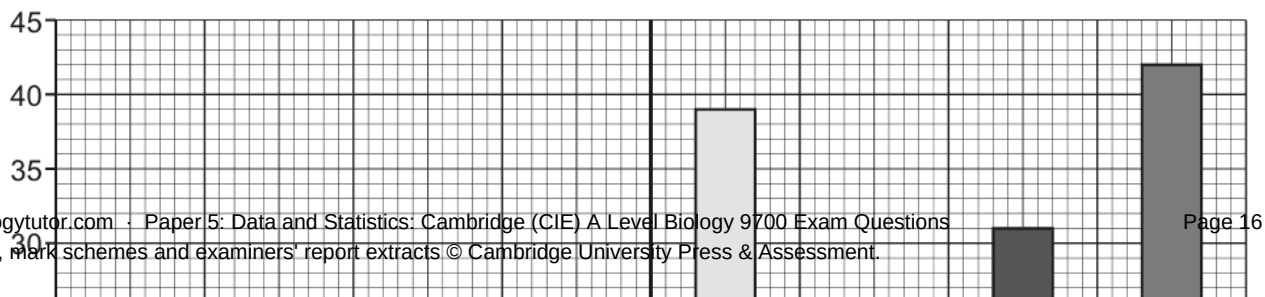


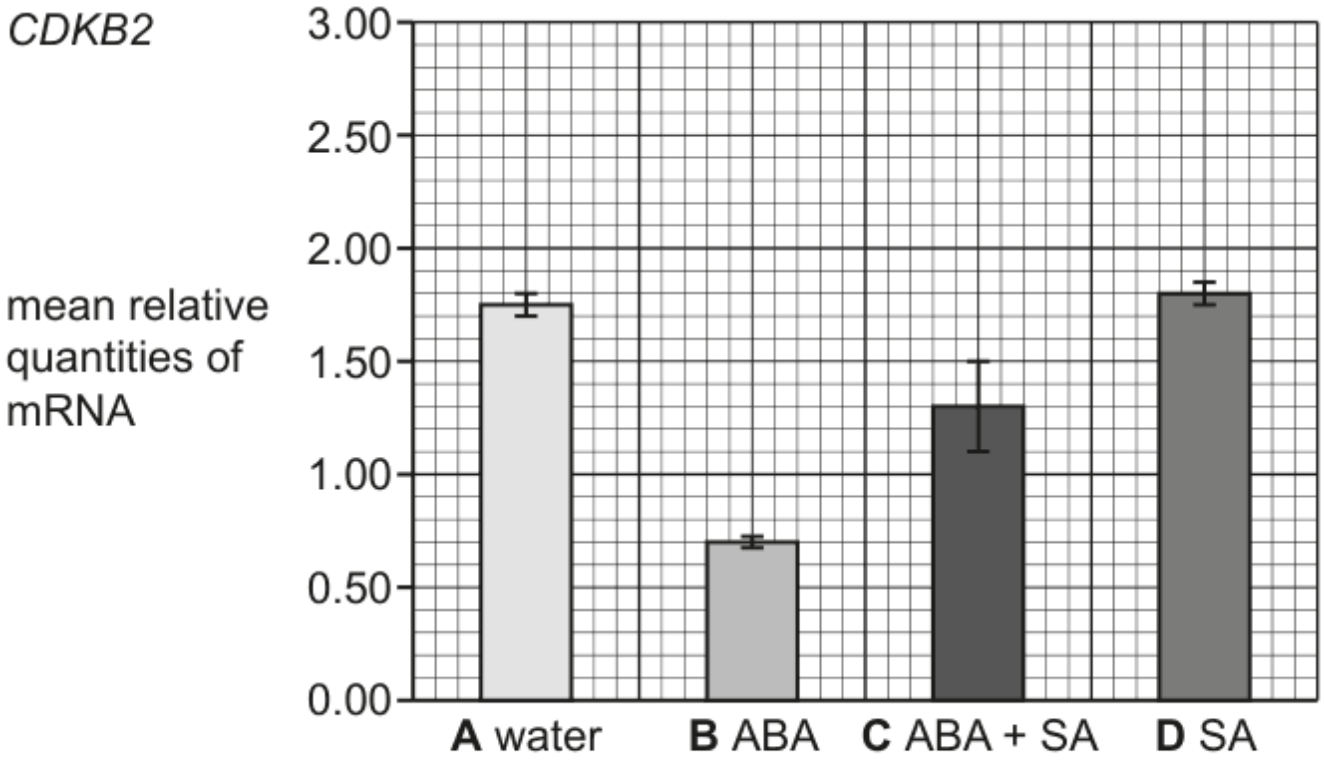
Fig. 2.1

The mean results of the investigation are shown in Fig. 2.2.

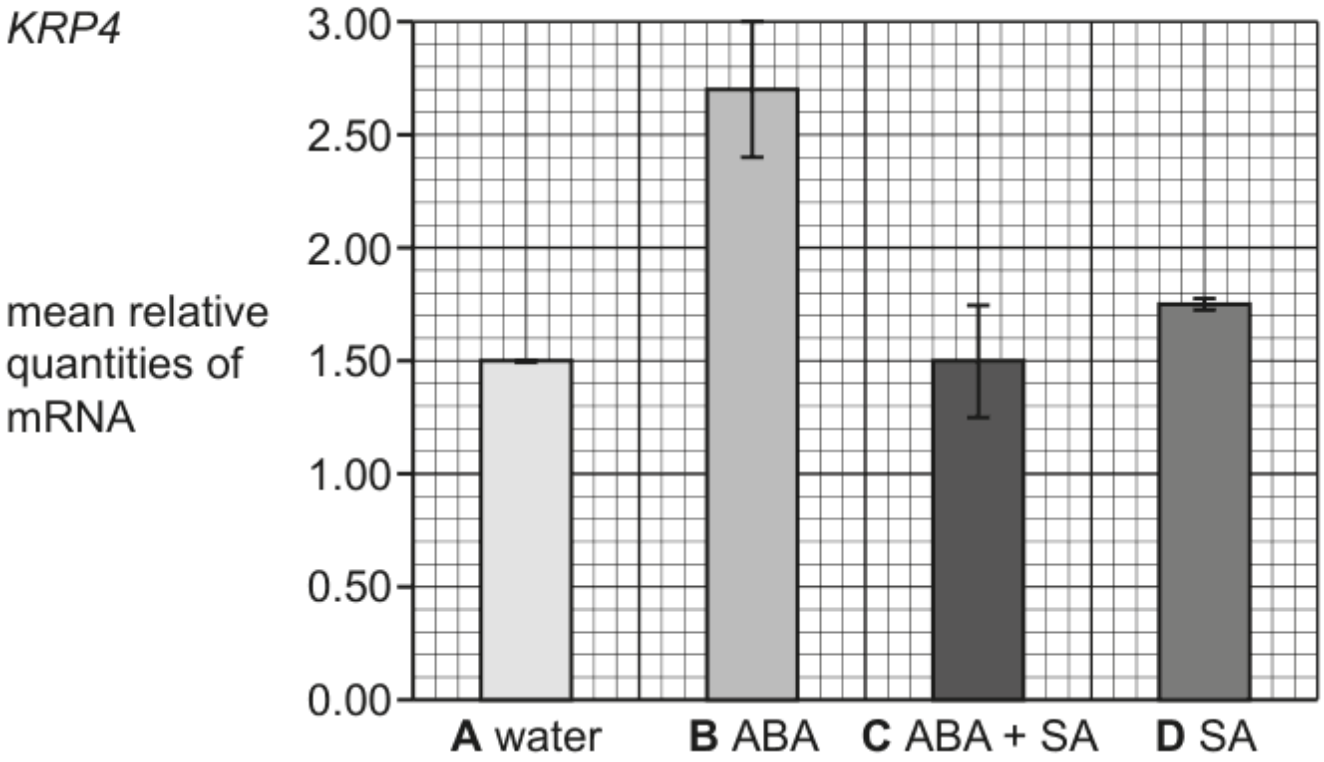


Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

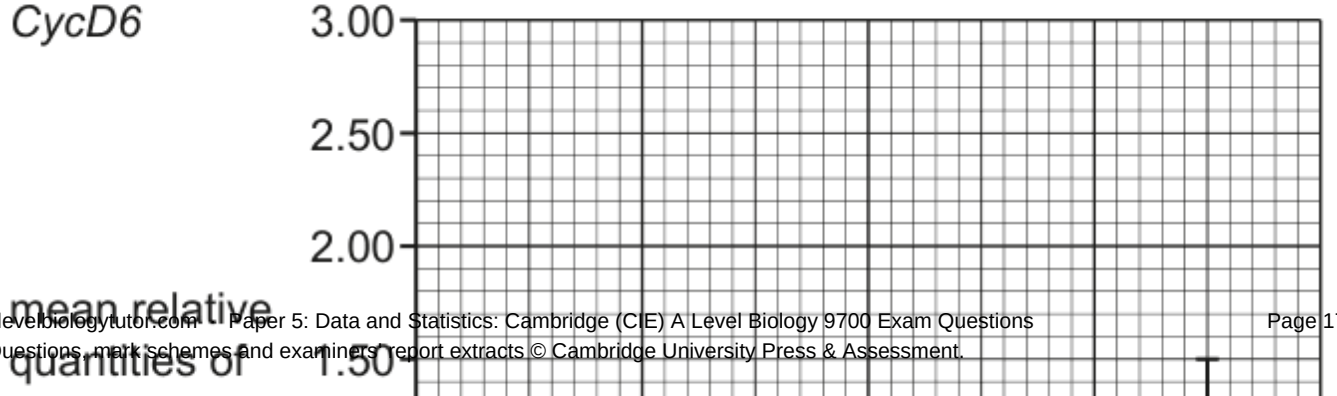
CDKB2



KRP4



CycD6



Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 2 continues on page 12

(e) ABA and SA are reported in the scientific literature to be involved in the control of the mitotic cell cycle.

Cyclin-dependent kinases (CDKs) are enzymes involved in the control of the mitotic cycle. The gene *CDKB2* codes for one of these kinase enzymes.

Genes *KRP4* and *CycD6* code for proteins that regulate the activity of CDKs.

The scientists investigated the effect of ABA and SA on gene expression.

Microarrays were used to measure the relative quantities of mRNA produced by transcription of the three genes, *CDKB2*, *KRP4* and *CycD6*, in the cells of the seedlings that were sprayed by ABA and SA.

The relative quantity of mRNA produced is a measure of the level of gene expression.

Fig. 2.3 shows the effects of ABA alone, SA alone and ABA and SA combined on the expression of the three genes.

Error bars show **standard deviation** (n = 3).

(i) Complete Table 2.1 to show how the expression of the three genes is affected by the presence of ABA alone and SA alone, shown in Fig. 2.3.

Use **only** these descriptions to complete the table:

large increase **small increase** **large decrease** **small decrease** **no change**

Table 2.1

gene	**effect on gene expression**	
	ABA only	SA only
CDKB2		
KRP4		
CycD6		

[3]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 14 · information from earlier in the question

2 Compounds containing nitrite ions (NO_2^-) are present in many foods eaten by humans.

Scientists tested the effect of different concentrations of nitrite ions on the population growth of 5 species of bacterium. All 5 species are pathogenic and can infect the human digestive system.

For each species of bacterium, the scientists placed suspensions of the bacteria in a microwell plate. A microwell plate is a plastic plate containing 96 wells, which are similar to small test-tubes.

In each well, the scientists added:

- a suspension of the bacterial species
- a solution containing nitrite ions
- nutrient broth.

The scientists incubated the microwell plate at 37 °C for 24 hours. After 24 hours, the scientists estimated the number of bacteria in each well by measuring optical density, using a microwell plate reader.

For each species of bacterium, the scientists repeated the experiment with several different concentrations of solution containing nitrite ions.

The scientists determined the lowest nitrite concentration at which no bacterial population growth had occurred after 24 hours.

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 14 · Paper 5 · October/November 2025 (51) · Q2(b)(i) · 2 marks

(b) The results of the investigation are shown in Fig. 2.1.

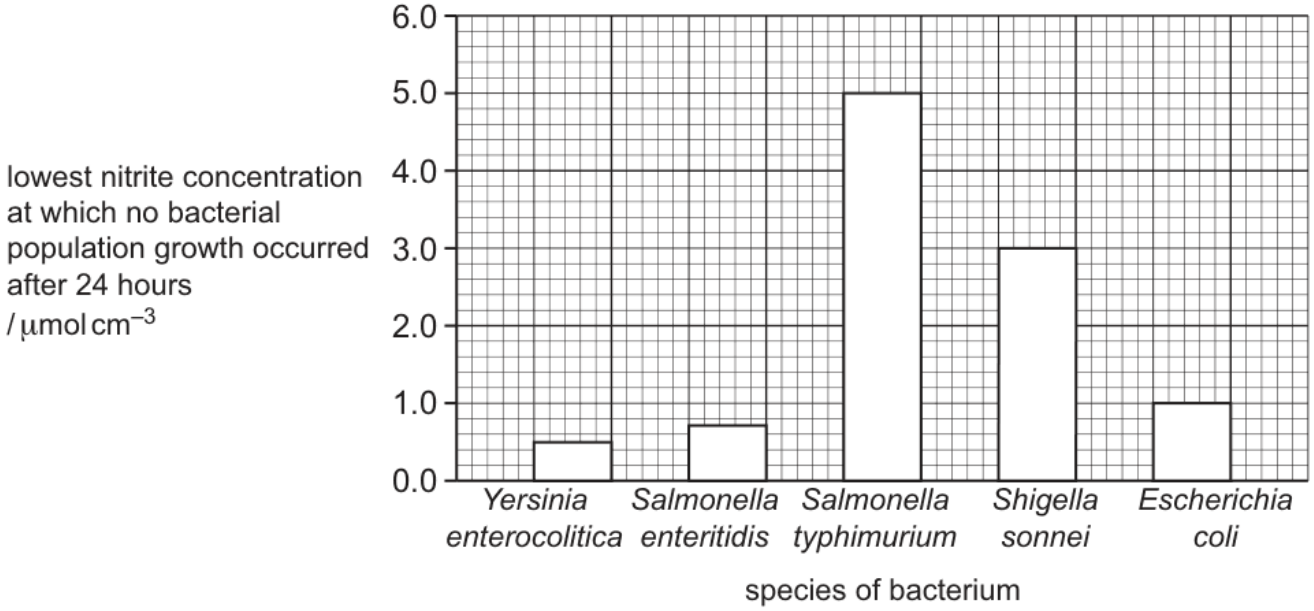


Fig. 2.1

(i) State the type of **data** represented by the species of bacterium and the lowest nitrite concentration in Fig. 2.1.

species of bacterium .....

lowest nitrite concentration .....

[2]

Question 15 · information from earlier in the question

2 A main feature of Huntington's disease (HD) is a loss of neurones from a region of the brain known as the striatum. A study of brain tissue taken from people with HD showed higher than normal (increased) urea concentrations in the anterior striatum and cerebellum regions of the brain.

Urea is a toxic waste product of amino acid and protein metabolism. It is produced from ammonia, which is also toxic, in an enzyme-controlled cycle known as the urea cycle.

Scientists carried out a study using transgenic (genetically modified) sheep, known as *OVT73*, to investigate the increased urea concentrations. *OVT73* have the mutant allele of the *Huntingtin* (*HTT*) gene. At the time of the study, *OVT73* were 5 years old and had no detectable loss of striatal neurones or disease symptoms.

Samples of tissue were taken from the same region of the anterior striatum in:
- six *OVT73* (three females and three males)
- a control group of non-transgenic sheep.

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(c) A second sample of tissue was taken from the same region of the anterior striatum of each of the same individuals. A different commercial diagnostic testing kit was used to obtain a comparison of gene expression for the 24 genes of interest.

Analysis of the results identified ten genes with differential gene expression at a statistically significant level of $p \leq 0.05$.

Table 2.1 shows the results for these ten genes and how much greater the value for *OVT73* is, calculated as a ratio.

Mean count is a standardised value based on the quantity of mRNA transcripts obtained from the diagnostic testing.

Table 2.1

SE = standard error

gene name	*OVT73* / mean count ± SE	control / mean count ± SE	ratio (*OVT73* count ÷ control count)
SLC14A1	1061.5 ± 149.9	483.6 ± 82.1	2.20
OXTR	110.3 ± 14.6	50.5 ± 13.5	2.18
SMOC2	113.4 ± 14.8	62.2 ± 13.3	1.82
SLC5A7	458.5 ± 37.9	300.4 ± 29.7	1.53
ETV5	2651.7 ± 252.6	1780.4 ± 192.6	1.49
RHCG	118.6 ± 12.3	80.7 ± 11.4	1.47
SIAH3	230.5 ± 9.3	167.2 ± 10.6	1.38
CBS	546.0 ± 24.7	456.0 ± 18.5	1.20
ITGB4	60.2 ± 8.1	94.2 ± 8.3	0.64
CPAMD8	22.0 ± 4.0	42.4 ± 8.1	0.52

(i) State which statistical test would have been used to establish the statistical significance between the control and *OVT73* data sets.

Explain why the test chosen was suitable.

statistical test .....

explanation .....

.....

.....

.....

[2]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

2 The two-spot ladybird, *Adalia bipunctata*, is a species of small, flying beetle that is found in northern Europe and other parts of the world. The wings of these beetles are covered by two tough structures known as elytra, as shown in Fig. 2.1.

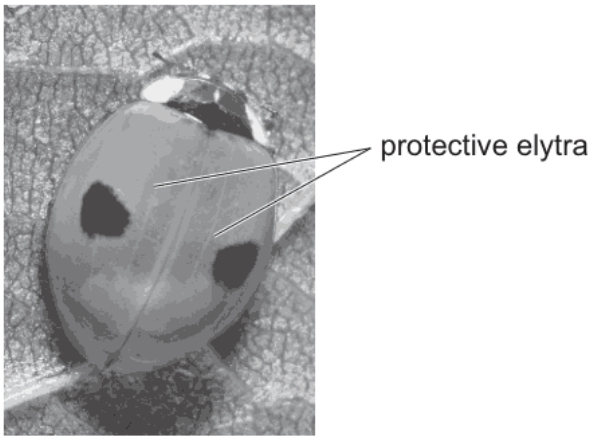


Fig. 2.1

A. bipunctata is an important predator of insect pests such as aphids. These insect pests feed on plants, including many crop species. Population numbers of *A. bipunctata* fluctuate in response to changes in the population numbers of their prey.

The elytra of *A. bipunctata* show phenotypic variation. The three most common morphs (forms) found in northern Europe are known as typica (**T**), quadrimaculata (**Q**) and sexpustulata (**S**).

- The typica morph, shown in Fig. 2.1, is mostly red with two black spots and is described as **non-melanic**.
- The other two morphs are described as **melanic** as they are mainly black with some red.
- The distribution of the colours in these three morphs is shown in Fig. 2.2.

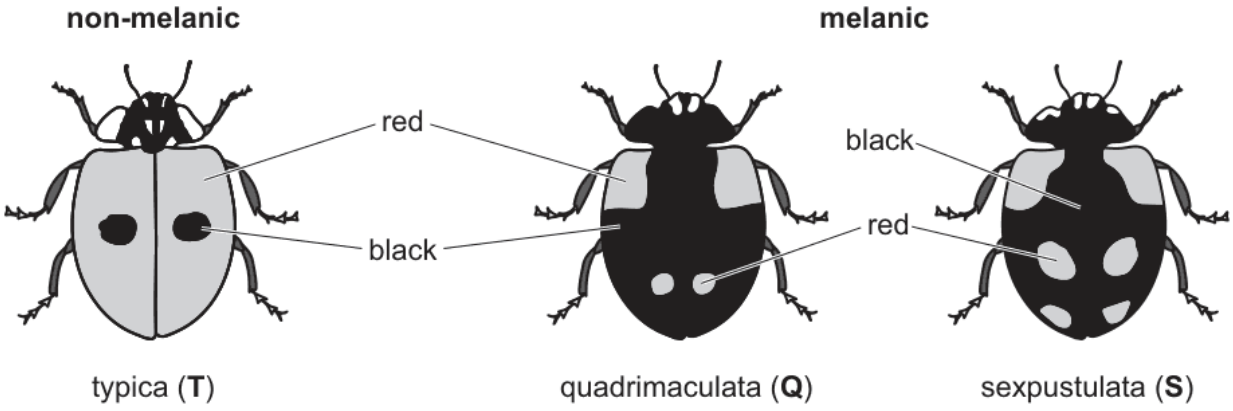


Fig. 2.2

In northern Europe, the populations of *A. bipunctata* hibernate (are inactive) during the winter. As the temperature increases in early spring, the populations become active. The populations remain active and produce three generations before the next winter begins.

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

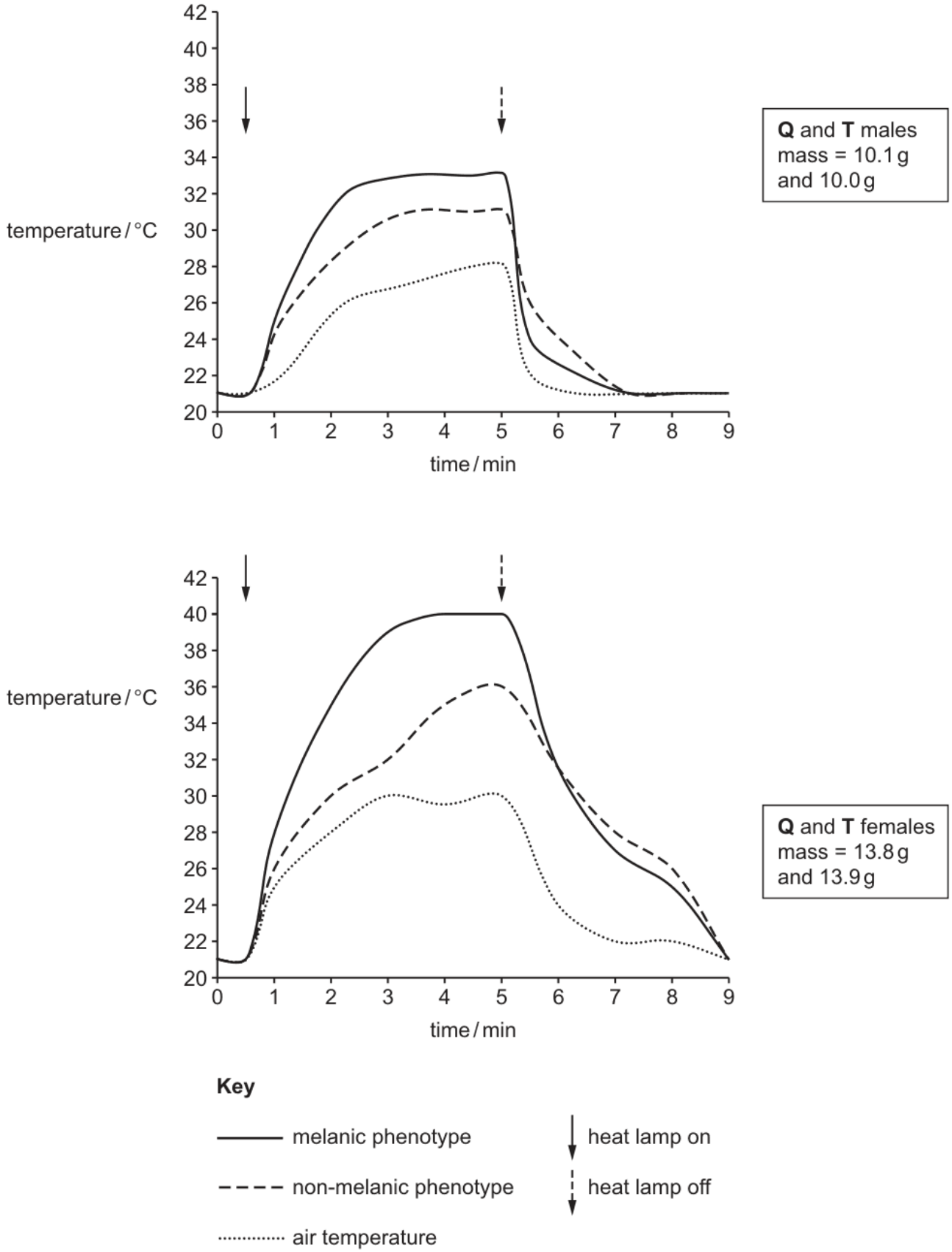


Fig. 2.4

(c) The scientists noticed that there appeared to be a relationship between body mass and the increase in body temperature. The scientists therefore continued to take results from another 17 individuals. They recorded the maximum difference between body temperature and the air

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 17 · information from earlier in the question

2 Nagarahole National Park in southern India is a forest ecosystem that is important for the conservation of large mammals such as the Asian elephant, *Elephas maximus*. Conflicts between people and elephants in the area surrounding the national park can threaten conservation work.

Fig. 2.1 shows a group of Asian elephants.



Fig. 2.1

Several coffee farms (farms where coffee is the crop) are found close to Nagarahole National Park. Asian elephants sometimes leave the national park and enter the coffee farms. Elephants damage crops and trees, and sometimes injure people who work on the farms.

December trees, *Erythrina subumbrans*, are planted on coffee farms to provide shade and are often damaged when elephants enter the farms.

Some scientists wanted to investigate the reasons why elephants enter coffee farms close to Nagarahole National Park.

20 coffee farms in an area to the south of Nagarahole National Park were chosen at random.

In March 2008, the scientists measured four variables at each coffee farm, as shown in Table 2.1.

Table 2.1

variable	how the variable was determined for each coffee farm
water availability	counting the number of ponds, lakes and water holes visible in satellite images
density of December trees	counting the number of December trees in ten circular areas, each with a radius of 10 m
grass biomass	drying and measuring the dry mass of all the grass leaves collected in 50 randomly selected areas of 0.25 m^2

Question 17 · Paper 5 · February/March 2025 (52) · Q2(b) · 1 mark

(b) State a null hypothesis for testing whether there is a correlation between water availability and the number of months that elephants entered each coffee farm per year.

.....

.....

Question 18 · Paper 5 · February/March 2025 (52) · Q2(c)(i) · 1 mark

(c) Table 2.2 shows the results of using Spearman's rank correlation (r_s) to investigate the relationship between each of the four variables in Table 2.1 **and** the number of months that elephants entered each coffee farm per year. The table is **not** complete.

Table 2.2

variable	r_s value	significance
water availability	0.63	
density of December trees	– 0.30	
grass biomass	0.02	
distance to Nagarahole National Park	0.38	

Table 2.3 shows some critical values for the Spearman's rank correlation at different probabilities. When comparing critical values in Table 2.3 with values of Spearman's rank correlation that are negative, the minus sign should be ignored.

Table 2.3

number of paired observations	probability			
	0.50	**0.10**	**0.05**	**0.01**
18	0.170	0.401	0.472	0.600
19	0.165	0.391	0.460	0.584
20	0.161	0.380	0.447	0.570
21	0.156	0.370	0.435	0.556

(i) For each variable in Table 2.2, decide whether the r_s value is **significant** or **not significant**. Record your decision in the third column of Table 2.2, headed **significance**. Write **yes** if the value is significant or **no** if the value is **not** significant. [1]

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

2 Tumours may be described as benign or malignant. Malignant tumours can lead to greater complications for the person with the tumour.

Early identification of tumours, particularly malignant tumours, is important for effective treatment. Benign tumour cells and malignant tumour cells can look similar when viewed using a light microscope.

Some scientists wanted to develop a diagnostic test to identify tumour cells as benign or malignant. The scientists investigated whether the diameter of the cell nucleus could be used to identify the type of tumour cell as benign or malignant.

The scientists used a light microscope with a calibrated eyepiece graticule to measure the diameter of the nuclei of stained tumour cells.

Fig. 2.1 shows a photomicrograph of stained tumour cells viewed using a light microscope.

An eyepiece graticule was placed across the nucleus of one of the tumour cells.

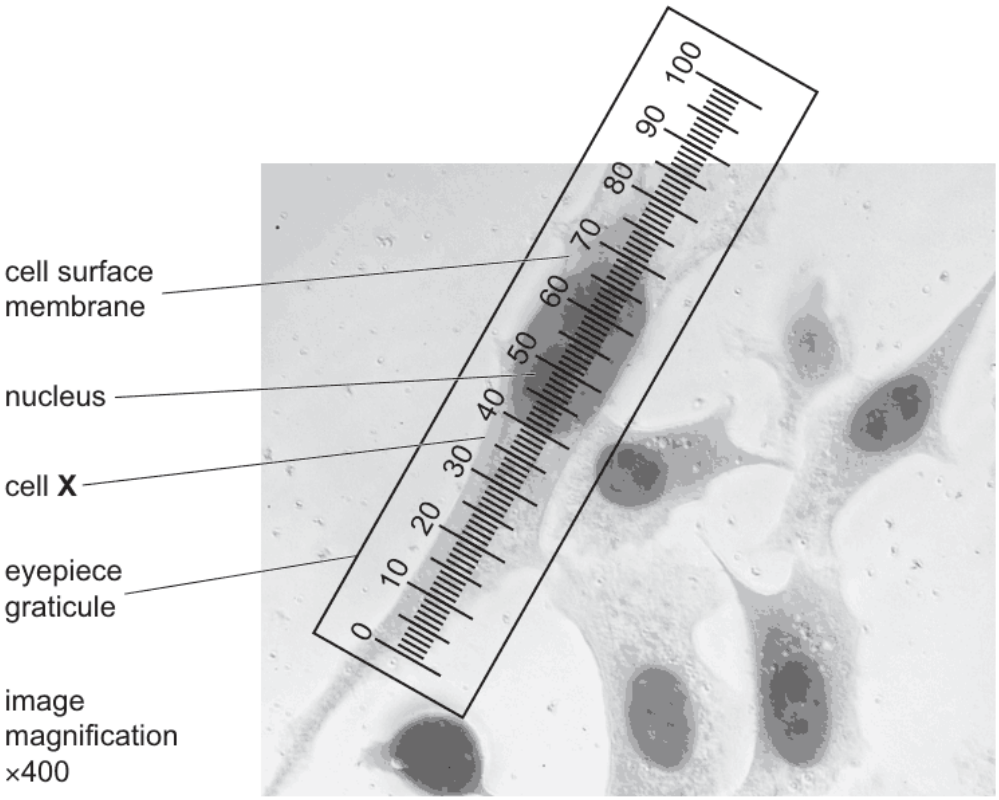


Fig. 2.1

The calibration of the eyepiece graticule scale is:

one eyepiece graticule division = 320 nm

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(b) For the investigation into whether the diameter of the nucleus could be used to identify the type of tumour cell, tumours of the thyroid gland (an endocrine gland) were used.

For the diagnostic test the scientists carried out a procedure using two different stains.

step 1 50 people diagnosed with benign tumours and 24 people diagnosed with malignant tumours were selected.

step 2 A sample of tumour cells was removed from the thyroid gland of each person.

step 3 The cells were stained with either Papanicolaou stain (Pap) or haematoxylin and eosin stain (H&E).

step 4 Samples were viewed using a light microscope with a magnification of ×400.

step 5 In each sample, the diameters of 100 nuclei were measured.

step 6 The measurements were made by one of the scientists who did not know the type of tumour cell they were measuring.

Table 2.1 shows the results of the investigation.

Table 2.1

category	mean nuclear diameter / μm	standard deviation / μm	standard error / μm
total benign cells (50 people) 5000 cells:	7.3	±0.8	±0.011
• Pap-stained cells (41 people) 4100 cells	7.3	±0.7	±0.011
• H&E-stained cells (9 people) 900 cells	7.2	±1.0	±0.033
total malignant cells (24 people) 2400 cells:	9.0	±0.6	±0.122
• Pap-stained cells (18 people) 1800 cells	9.0	±0.7	±0.016
• H&E-stained cells (6 people) 600 cells	8.8	±0.5	±0.020

Question 19 · Paper 5 · May/June 2024 (52) · Q2(b)(iii) · 1 mark

(iii) The scientists used a *t*-test to compare the mean nuclear diameter of the Pap-stained cells and the H&E-stained cells in Table 2.1.

State a null hypothesis for the *t*-test.

.....

.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 20 · information from earlier in the question

2 Cereal crops are often sprayed with selective herbicides which can reduce the population of the local wildlife. One method of helping to conserve wildlife is to leave a 6 m strip, called a headland, around fields where cereal crops are grown. The headland is not sprayed with any herbicides.

An investigation was carried out into the effect on the butterfly populations of leaving headlands unsprayed.

- Two groups of 20 fields growing the same cereal crop were studied.
- The headlands of one group of 20 fields were left unsprayed by herbicide.
- The headlands of the other group of 20 fields were sprayed with herbicide.
- The total number of each species of butterfly was counted in each group of 20 fields.
- A chi-squared (χ^2) test was used to find out if the differences in the butterfly populations were significant.

Question 20 · Paper 5 · October/November 2016 (52) · Q2(b)(ii) · 1 mark

(ii) State a null hypothesis for the chi-squared test for this investigation.

.....

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

(c) All the F1 plants grown from the seeds collected from plant **B** had purple petals and long pollen grains.

The plant breeder then carried out a test cross by crossing the F1 plants with homozygous recessive plants with red petals and round pollen grains.

Table 2.1 shows the results of the test cross.

Table 2.1

offspring phenotypes	frequency
purple petals long pollen grains	102
red petals round pollen grains	112
purple petals round pollen grains	14
red petals long pollen grains	20
total	248

The plant breeder expected the test cross to result in a 1:1:1:1 phenotypic ratio.

(i) Complete Table 2.2 **and** calculate the value of chi-squared (χ^2) for the results of the test cross.

The equation for the calculation of χ^2 is:

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

O = observed result
E = expected result
$\sum$ = sum of

Table 2.2

offspring phenotype	O	E	$\frac{(O-E)^2}{E}$
purple petals long pollen grains	102	62	
red petals round pollen grains	112	62	
purple petals round pollen grains	14	62	

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Mark schemes

Question 1 · Paper 5 · February/March 2023 (52) · Q1(d)(i) · 2 marks

1(d)(i)	(–)61 (%) ; correct working ;	**2**

Question 2 · Paper 5 · May/June 2024 (52) · Q1(d)(ii) · 3 marks

1(d)(ii)	1	correct processes <u>and</u> correct figures ;	**3**
	2	(correct) answer to 3 significant figures ; **ecf** if mp1 is incorrect	
	3	decrease / minus (number) ;	

Question 3 · Paper 5 · May/June 2023 (52) · Q1(c)(i) · 2 marks

1(c)(i)	1	figures from printed line at or below 0.26 au and 30 s **or** figures from correct tangent ;	**2**
	2	correct calculation / 0.0083 to 0.0089 / 8.3×10^{-3} to 8.9×10^{-3} ;	

Question 4 · Paper 5 · October/November 2025 (52) · Q1(b)(i) · 4 marks

1(b)(i)	1	stomatal density = 367 (mm^{-2}) ;	**4**
	*Any **three** of:*		
	2	(number of stomata) = 13 ;	
	3	<u>diameter</u> of picture = 8.5 <u>cm</u> / 85 <u>mm</u> **or** <u>radius</u> of picture = 4.25 <u>cm</u> / 42.5 <u>mm</u> **or** <u>length</u> of scale bar / 40 µm = 1.6 <u>cm</u> / 16 <u>mm</u> ;	
	4	show stomatal density calculation ;	
	5	show magnification (calculation) ;	

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 5 · Paper 5 · May/June 2022 (52) · Q1(b)(ii) · 2 marks

1(b)(ii)	1 $\frac{\text{Initial volume of (red) cube} - \text{volume final red cube}}{\text{Initial volume of (red) cube}}$; 2 $\times 100$;	2

Question 6 · Paper 5 · May/June 2022 (52) · Q2(b)(i) · 2 marks

2(b)(i)	numbers (of infected badgers / cows) per unit area ; allow (valid) comparison (between infected cows and infected badgers) ;	2

Question 7 · Paper 5 · February/March 2018 (52) · Q2(b) · 2 marks

2(b)	*any* ***two*** *from*: *idea of* shows the spread about the mean / AW ; indicates the reliability of the data ; to put error bars on the graph / see if the standard deviations overlap / see if the differences are significant ;	2

Question 8 · Paper 5 · October/November 2023 (52) · Q2(b)(i) · 1 mark

2(b)(i)	38.7 and 45.3 ;	1

Question 9 · Paper 5 · May/June 2025 (54) · Q1(d)(i) · 2 marks

1(d)(i)	*any* ***two*** *from:* 1 *idea of* smaller standard error (SE) shows that (the mean is) more reliable **; ora** 2 *idea of* smaller SE shows that (calculated / sample) mean is closer to the, true / actual, mean **; ora** 3 suitable example from Table 1.1 ; 4 correct *ref. to* overlap of SE from Table 1.1 ; *for example:* *idea of*, SE for 1×10^{-7} ABA concentration **and** 1×10^{-6} ABA concentration do not overlap, (therefore mean shoot length may be) significantly different **or** *idea of*, SE for 1×10^{-6} ABA concentration and 1×10^{-4} ABA concentration overlap, (therefore mean shoot length) is not significantly different	2

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 10 · Paper 5 · May/June 2024 (53) · Q1(b)(i) · 2 marks

1(b)(i) **2**

mass added / g	length of vein / mm	percentage increase in length of ring of vein
0	21	0
10	36	71
20	38	81
30	40	90
40	41	95
50	41	95

three values correct ;;
one or two correct max 1

Question 11 · Paper 5 · May/June 2024 (53) · Q1(b)(ii) · 1 mark

1(b)(ii) 1 to make a valid comparison (with other blood vessels / veins) ; **1**

2 allows comparison as, initial / starting, length (of veins) is, not constant / AW ;

Question 12 · Paper 5 · May/June 2024 (53) · Q1(b)(iii) · 3 marks

1(b)(iii) 1 correct orientation for axes and linear scale ; **3**

2 axes labelled and units;

3 all points plotted correctly and line drawn accurately ;

Question 13 · Paper 5 · October/November 2023 (52) · Q2(e)(i) · 3 marks

2(e)(i) *one mark per row* **3**

gene	effect on gene expression	
	ABA alone	SA alone
CDKB2	large decrease	no change / small increase ;
KRP4	large increase	no change / small increase ;
CycD6	large decrease	no change / small decrease ;

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 14 · Paper 5 · October/November 2025 (51) · Q2(b)(i) · 2 marks

2(b)(i)	(*species of bacterium:*) nominal ; (*lowest nitrite concentration:*) continuous ;	**2**

Question 15 · Paper 5 · October/November 2022 (52) · Q2(c)(i) · 2 marks

2(c)(i)	*t*-test ; comparing means / continuous data / data has a normal distribution / comparing two samples with fewer than 30 values ;	**2**

Question 16 · Paper 5 · October/November 2024 (52) · Q2(c) · 3 marks

2(c)	1 Pearson's (linear correlation) / Spearman's (rank correlation) ; *any **two** from:* *Pearson's* 2 data (for temperature and mass) is, paired / linked ; 3 data is continuous ; 4 scatter diagram, suggests a linear, relationship / correlation / association ; 5 there are at least 5 (paired) observations ; **OR** *Spearman's* 6 data (for temperature and mass) is, paired / linked ; 7 the data is ordinal / interval ; 8 scatter diagram, suggests an increasing, relationship / correlation / association ; 9 there are more than 5 (paired) observations ;	**3**

Question 17 · Paper 5 · February/March 2025 (52) · Q2(b) · 1 mark

2(b)	(there is) no correlation between the water availability and the number of months that elephants entered each (coffee) farm per year ;	**1**

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 18 · Paper 5 · February/March 2025 (52) · Q2(c)(i) · 1 mark

2(c)(i) all correct ; **1**

r_s value	significance
0.63	yes
–0.30	no
0.02	no
0.38	no

Question 19 · Paper 5 · May/June 2024 (52) · Q2(b)(iii) · 1 mark

2(b)(iii)	there is no difference, in / between the (mean) nuclear diameters of, the Pap-stained cells and H&E- stained cells ;	**1**

Question 20 · Paper 5 · October/November 2016 (52) · Q2(b)(ii) · 1 mark

2(b)(ii)	there is no significant difference between number of butterflies of each species when headland sprayed and when not sprayed ;	**1**

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.

Question 21 · Paper 5 · May/June 2021 (52) · Q2(c)(i) · 2 marks

2(c)(i)

offspring phenotype	O	E	$\frac{(O-E)^2}{E}$
purple petals long pollen grains	102	62	25.81
red petals round pollen grains	112	62	40.32
purple petals round pollen grains	14	62	37.16
red petals long pollen grains	20	62	28.45 ;
		χ^2 =	131.74 ;

2

Questions, mark schemes and examiners' report extracts © Cambridge University Press & Assessment.