

**1(a).** Plants respond to their environments in different ways.

i. Describe the meaning of the term **tropism**.

\_\_\_\_\_

----- [1]

ii. State **one** named example of a tropism.

----- [1]

iii. Give **one** example of an abiotic stress and the corresponding plant response.

Example \_\_\_\_\_

Plant response \_\_\_\_\_

----- [2]

**(b).** Mycorrhizae are associations between some types of fungi and the roots of plants, including trees. The fungal hyphae grow into the roots and help the trees take up water and minerals.

Trees respond to insect attack by producing chemicals that defend against insects.

Trees also release pheromones into the air that stimulate nearby trees to produce defensive chemicals in preparation for possible insect attack.

It is now known that communication between trees of the same or different species can also be carried out via the mycorrhizae.

Some scientists investigate this phenomenon using young fir and pine plants.

This is the method that they use:

- grow a 'donor' fir plant together with a 'recipient' pine plant in the same large pot
- repeat to create 40 pairs of plants
- divide the plants into four groups, with ten pairs of plants in each group
- enclose the roots of the 'recipient' plants of each pair in a mesh bag
- simulate insect herbivory by removing the leaves of 'donor' plants in half of the groups.

The treatment groups are summarised in the table.

Group	Leaves of 'donor' removed	Mesh bag around 'recipient' roots
1	No	0.5 $\mu\text{m}$ mesh bag that allowed passage of solutes but blocked passage of roots and hyphae.
2	Yes	
3	No	35 $\mu\text{m}$ mesh bag that allowed passage of solutes and hyphae but blocked passage of roots.
4	Yes	

The scientists measure the concentration of the enzyme polyphenol oxidase (PPO) in the recipient seedlings at the start of the experiment and after 72 hours. PPO is involved in the production of defence chemicals.

- i. Suggest how the scientists could ensure that airborne pheromones did **not** contribute to communication between plants in this investigation.

---

[1]

- ii. The results are shown in the table.

Group	Mean PPO Activity $\pm$ Standard Deviation (Arbitrary Units)	
	At start	After 72 h
1	18 $\pm$ 2	20 $\pm$ 2
2	16 $\pm$ 2	50 $\pm$ 4
3	12 $\pm$ 2	22 $\pm$ 4
4	18 $\pm$ 2	116 $\pm$ 14

The scientists conclude:

- Removing the leaves of the donor plants leads to a chemical defence response in the recipients.
- This is due to signals carried by the mycorrhizal hyphae.

Evaluate the support given by the results to the scientists' conclusions.

You should comment on the quality of the scientists' data in your answer.

---



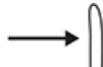
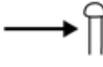
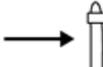
---



---



3. In a phototropism investigation oat seedlings were illuminated from one side as shown by the arrow in the table. The table shows the results of four different experiments.

Experiment	Method	Result
1		
2	 Shoot tip covered with lightproof cap	
3	 Impermeable sheet inserted on shaded side	
4	 Shoot tip removed and replaced on top of a permeable agar block	

Which option correctly explains the experimental results?

- A Experiment 1 shows that auxin increases cell division on the shaded side.
- B Experiments 1 and 2 show that photoreceptors are in the tip of the seedlings.
- C Experiments 1, 3 and 4 show that electrical signals control stem elongation.
- D Experiments 1, 3 and 4 show that soluble inhibitors of elongation move down the illuminated side.

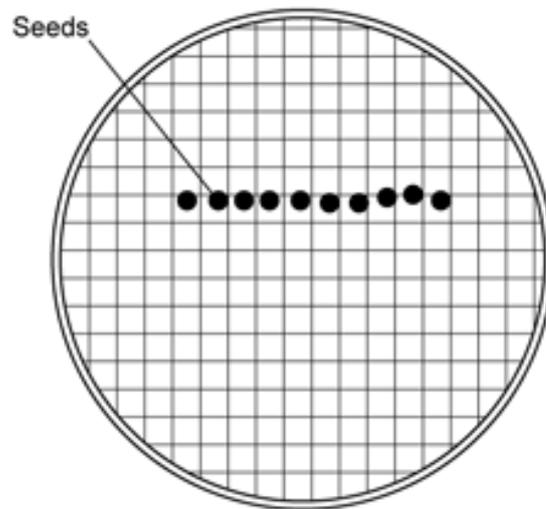
Your answer

[1]

**4(a).** Some students investigate the effect of IAA (auxin) concentration on the growth of roots and shoots in mustard seedlings.

This is the method that they use with 8 different concentrations of IAA:

- Place a filter paper on a bed of cotton wool in the Petri dish and soak it with IAA solution.
- Place 10 seeds in a horizontal line on the damp filter paper.
- Cover with a lid that has a grid marked on it, as shown in the diagram.
- Repeat this process with each different concentration of IAA.
- Add distilled water to one Petri dish in place of IAA solution.
- Place the Petri dishes vertically in a warm dark place for 2 to 3 days until the seeds have germinated and the roots and shoots have started to grow.
- Measure the length of the shoots and roots by counting the number of grid squares the shoot or root covers.



- i. Explain why the Petri dishes were placed vertically and in the dark.

---

---

---

[2]

- ii. Explain the purpose of the Petri dish containing distilled water instead of IAA solution.

---

---

---

[2]

(b). One of the students recorded the result shown in the table.

Mean root length in test solution (number of grid squares)	Mean root length in water (number of grid squares)
16.5	13.9

Calculate the percentage change in mean root length in test solution compared with water.

Give your answer to **2** significant figures.

Change = ..... % **[2]**

(c). One student's results are shown in the second table below.

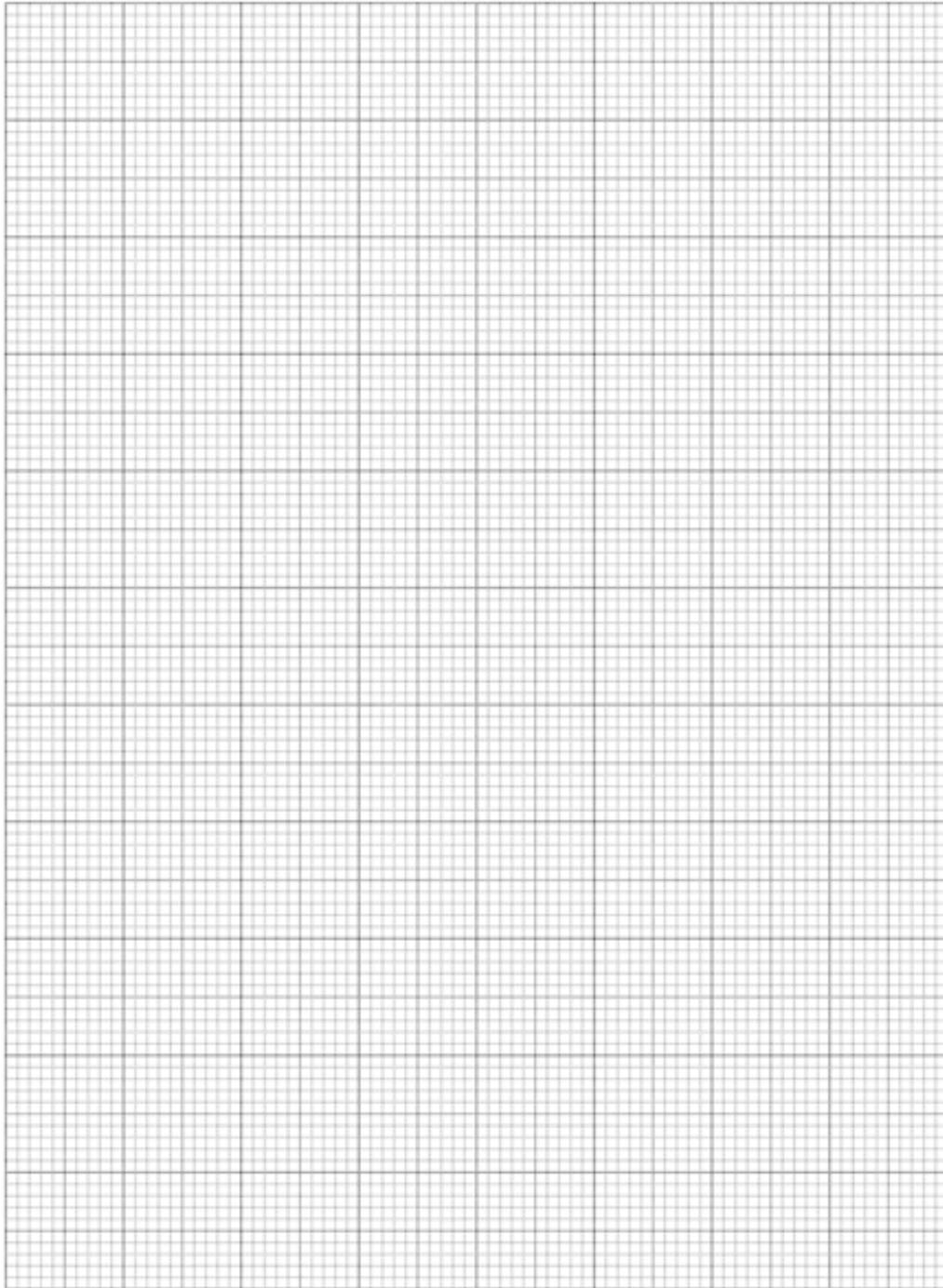
The results have been rounded to the nearest 5%.

Positive values represent increased growth and negative values represent decreased growth.

The concentration of IAA was measured in parts per million (ppm).

Concentration of IAA (ppm)	% change in length	
	Root	Shoot
$1 \times 10^2$	-100	0
$1 \times 10^1$	-100	+200
$1 \times 10^0$	-75	+140
$1 \times 10^{-1}$	-45	+70
$1 \times 10^{-2}$	+25	+30
$1 \times 10^{-3}$	+65	+10
$1 \times 10^{-4}$	+70	0
$1 \times 10^{-5}$	+55	0

i. Plot a graph of the data in the table showing the % change in length with different concentrations of IAA.

**[4]**

- ii. The students were given an IAA solution of concentration 100 ppm.

Outline a procedure the students could use to prepare the 8 test solutions required for the experiment.

---

---

---

---

-----  
**[2]**

- iii. Describe **two** precautions the students should take to make sure the concentrations of the solutions they prepare are accurate.

1

2

----- [2]

- iv. Suggest why the range of IAA concentrations could be described as logarithmic.

----- [1]

**5.** Gene therapy is a possible future treatment for heart disease.

The *AC6* gene codes for one form of the enzyme adenylyl cyclase.

Clinical trials have tested the effect of increasing levels of the *AC6* gene in heart cells.

- i. Suggest how using gene therapy to increase levels of the *AC6* gene in heart cells may improve heart function.

----- [2]

- ii. State **one** method for inserting the *AC6* gene into the heart cells during gene therapy.

----- [1]

- iii. The results from gene therapy trials are published in peer-reviewed journals.

State why the results from gene therapy trials are published in journals.

----- [1]

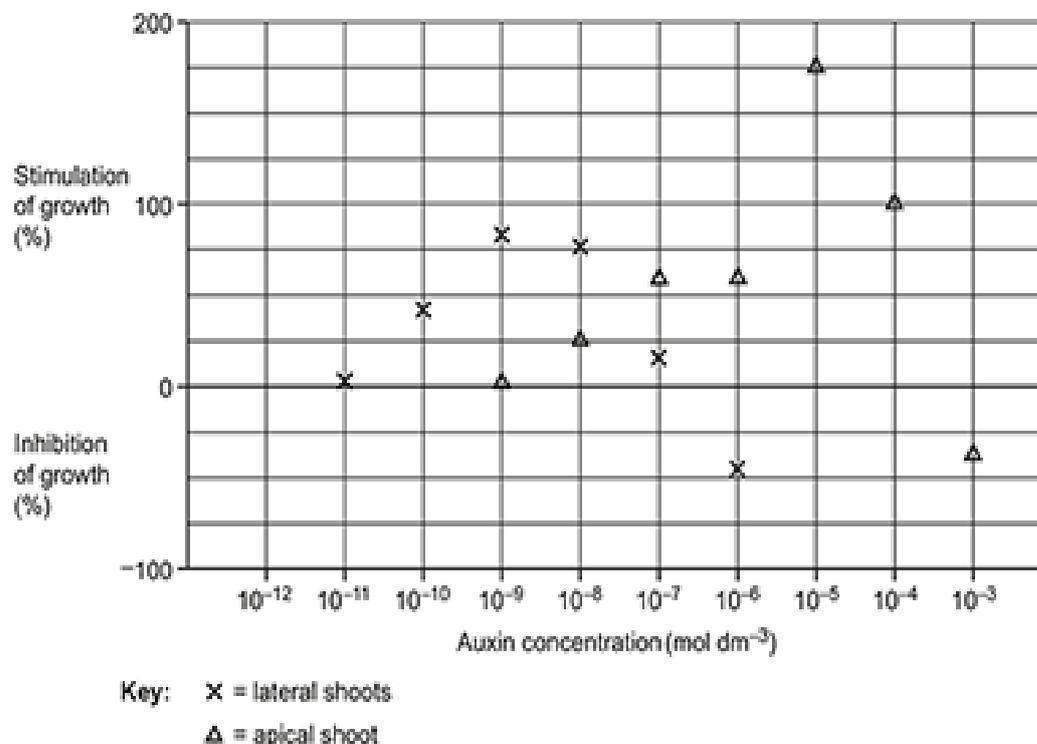
**6(a).** The student investigated the effect of auxin concentration on the growth of shoots.

The student applied different concentrations of auxin to the apical shoot and the lateral shoots.

The student measured the percentage of growth stimulation or inhibition compared to normal.

Normal growth was represented by 0%.

The student's results are shown in the graph.



- i. Use the graph to estimate the auxin concentration at which inhibition of lateral shoots is 100%.

Auxin concentration = ..... mol dm<sup>-3</sup> [1]

- ii. The student identified a possible anomaly in their results: the data point for the apical shoot receiving 10<sup>-6</sup> mol dm<sup>-3</sup> of auxin.

State what the student could do to determine whether this data point was an anomaly.

---

[1]

- iii. Using the graph, describe the conclusions that can be drawn about the role of different auxin concentrations in the control of apical dominance.

---

---

---

---

---

---

---

---

---

---

----- [3]

**(b).** A student plans to investigate the effect of gibberellin concentration on the rate of stem elongation in the pea plant, *Pisum sativum*.

- i. Suggest appropriate units for the dependent variable in this investigation.

----- [1]

- ii. \*The student has access to standard laboratory equipment and planting materials.

Outline a method that the student could use to investigate the effect of gibberellin concentration on stem elongation in *P. sativum*.

In your answer, you should include details of an appropriate statistical test for this investigation.

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

----- [6]

Additional answer space if required.

---

---

---

---

(c). A student asked if there was a way to ripen the fruit on an apple tree more quickly so that it would be ready to eat within a few days.

Another student gave this advice:

'You should spray the tree with ethene.'

Evaluate whether acting on the student's advice would produce fruit that was ready to eat within a few days.

---

---

---

---

---

---

---

---

..... [3]

7. The Society for Endocrinology has produced a booklet about adrenal failure to help patients understand their illness.

The following statements are adapted from this booklet.

- Adrenal failure is caused by inability of the adrenal glands to produce sufficient amounts of cortisol and aldosterone.
- In healthy people, the hormone ACTH is produced by the pituitary gland and causes the adrenal cortex to release more cortisol and aldosterone.
- A pituitary tumour can stop ACTH production by the pituitary. This leads to adrenal failure.
- Symptoms of adrenal failure include severe fatigue and weakness, weight loss, low blood pressure and salt craving.

i. Explain the symptoms of adrenal failure.

---

---

---

---

..... [2]

- ii. Explain why patients with a pituitary tumour have adrenal failure but still respond normally to situations of danger or excitement.

---



---



---



---



---



---



---

[3]

**8(a).** The table lists structural and functional differences between different types of muscle.

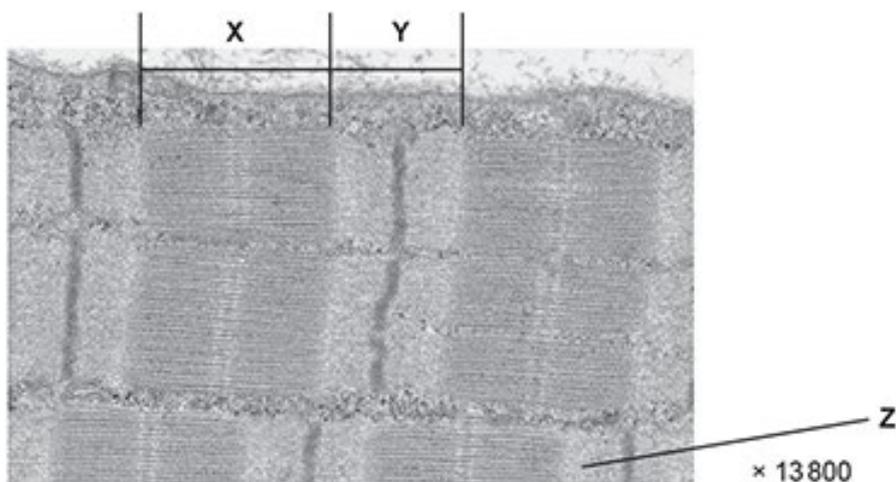
Place a tick (✓) in each box where the structure or function applies to that type of muscle.

The first row has been completed for you.

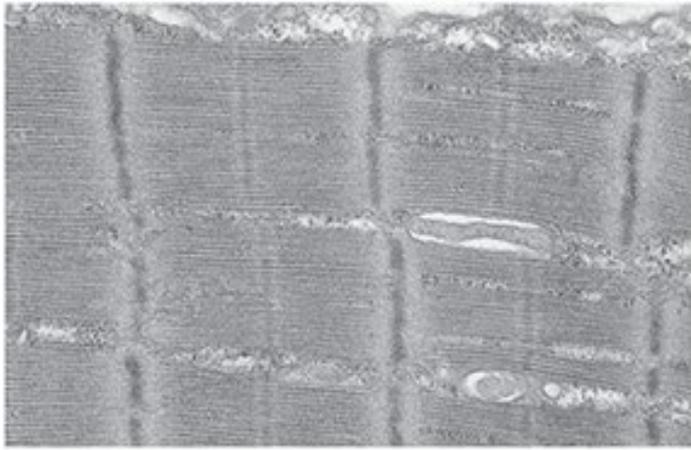
	Skeletal	Cardiac	Involuntary
Contraction speed is slow			✓
Fibres are multinucleate			
Fibres are branched and interconnected			
Under conscious control			

[3]

**(b).** Fig. 19.1 and Fig. 19.2 are transmission electron micrographs (TEMs) of striated muscle.



**Fig. 19.1**



× 13800

**Fig. 19.2**

- i. Identify **three** proteins that make up the filaments labelled **Z** on **Fig. 19.1**.

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

**[3]**

- ii. Labels **X** and **Y** in **Fig. 19.1** indicate two distinct bands.

Explain why the two bands look different.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**[2]**

- iii. Use your knowledge of the sliding filament model of muscle contraction to explain why **Fig. 19.2** represents contracted muscle.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

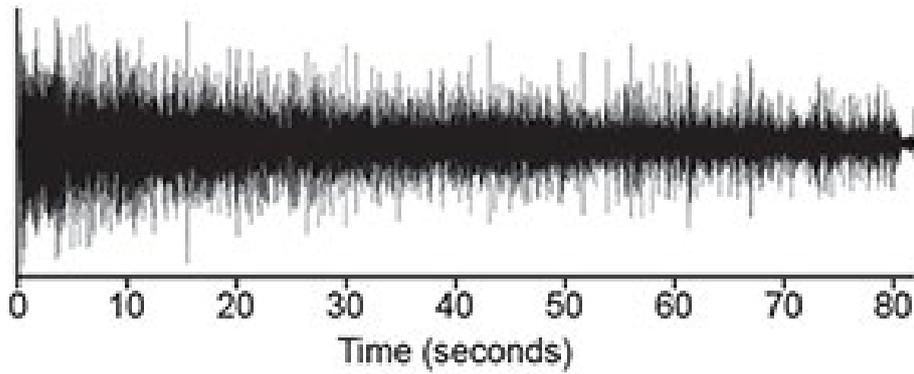
\_\_\_\_\_

**[3]**



9. An electromyogram (EMG) records the electrical activity of a muscle.

The figure shows an EMG trace of a muscle undergoing fatigue.



Which of the statements about muscle fatigue is/are correct?

- 1 Increased acidity in the muscle during long periods of contraction is a cause of muscle fatigue.
- 2 There is a decrease in the frequency of the signal on an EMG trace as the muscle becomes fatigued.
- 3 There is an increase in amplitude of the signal on an EMG trace as the muscle becomes fatigued.

- A** 1, 2 and 3 are correct  
**B** Only 1 and 2 are correct  
**C** Only 2 and 3 are correct  
**D** Only 1 is correct

Your answer

[1]

**END OF QUESTION PAPER**