Q1.(a) Give **one** similarity and **one** difference between a taxis and a tropism.

Similarity.....

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Difference .....

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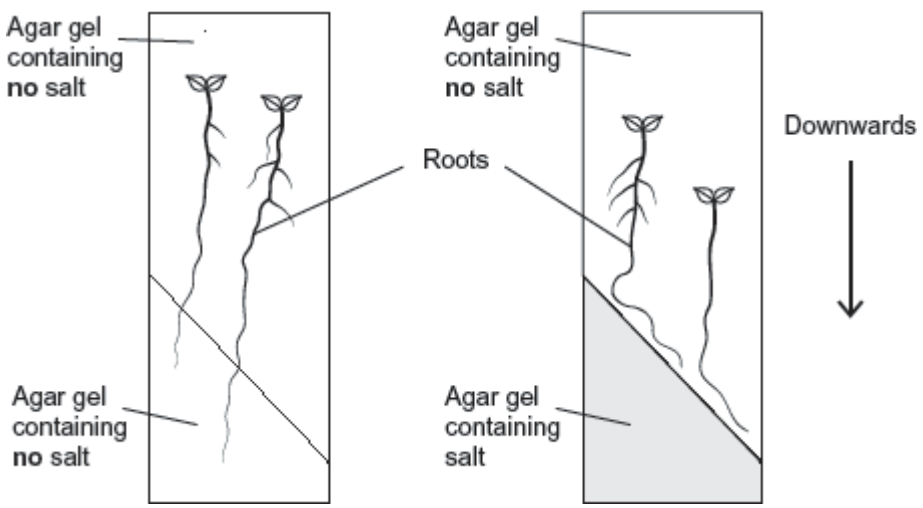
(2)

Scientists investigated tropisms in the roots of tomato plants. They grew tomato plants from seeds on vertical agar plates, as shown in **Figure 1**. The top of each plate was made of agar gel containing **no** salt. The bottom of each plate was made of one of the following:

- agar gel containing **no** salt
- agar gel containing salt.

Typical results for growth of the roots are shown in **Figure 1**.

Figure 1



(b) What do these results show about the responses of the roots of tomato plants to gravity and salt?

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[Extra space] .....

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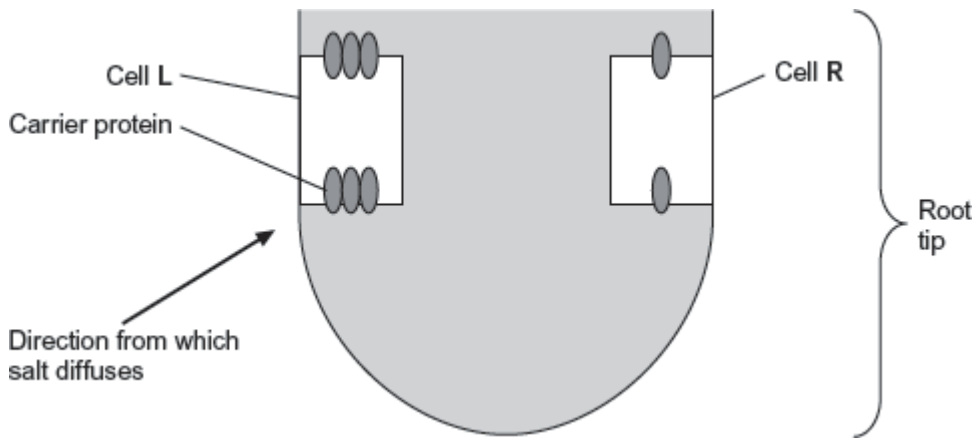
(3)

(c) In root tips of tomatoes, IAA is transported **out** of the cells by a carrier protein. In roots of tomatoes, high concentrations of IAA inhibit cell elongation.

The scientists' hypothesis was that salt causes a change in the number of IAA carrier proteins in cells in different parts of the root tip.

Figure 2 shows two cells, **L** and **R**, in the root tip of a tomato plant.

Figure 2



Explain why this root tip would grow away from salt.

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[Extra space] .....

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(3)
(Total 8 marks)

Q2. A biologist investigated the behaviour of a species of worm that lives in soil.

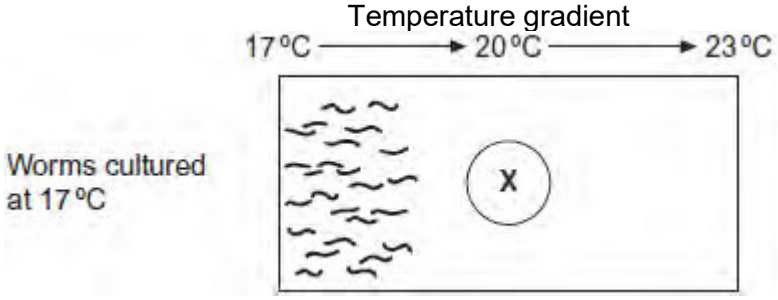
He cultured three samples of worms in three separate trays of soil for many days. Each culture:

- contained a food supply
- was kept at a different temperature.

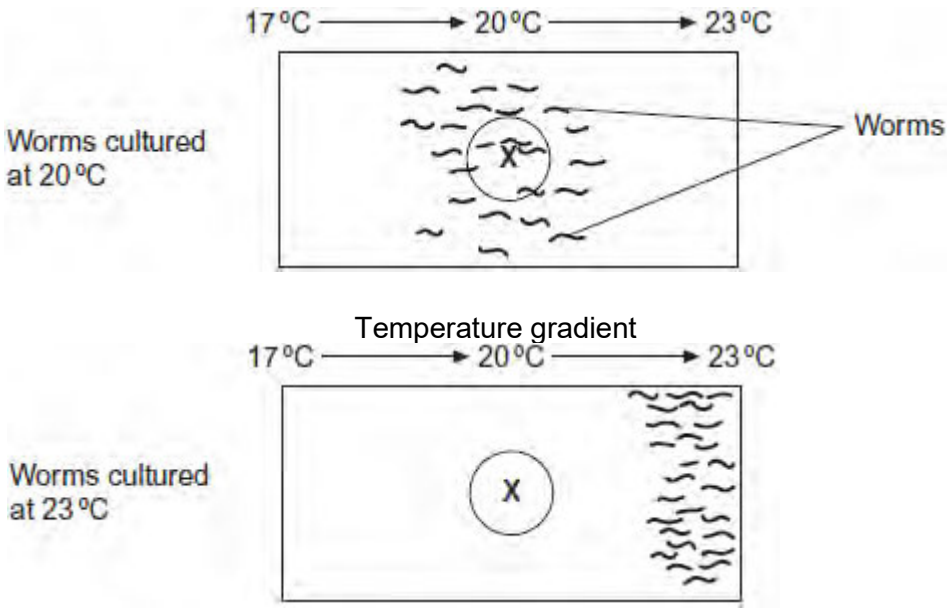
The temperatures of the cultures were 17 °C, 20 °C and 23 °C.

The biologist then removed food from the trays for several hours. Then he transferred each sample of worms onto a glass surface where there was **no food**. Each surface had a temperature gradient across it. After 1 hour, the biologist recorded the position of each worm.

The figure below shows his results. On each diagram, X marks where he released the worms onto the glass surface.



Temperature gradient



(a) The biologist concluded that the worms' behaviour demonstrated taxis. How do these results support this conclusion?

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(2)

(b) Using the information provided, suggest an explanation for the worms' behaviour on the glass surfaces in the absence of food.

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(Extra space) .....

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(3)

(c) In each experiment, the biologist exposed the surfaces to light that was dim and even, so he could see where the worms went.

Apart from seeing where the worms went, suggest **two** reasons why it was important that the light was dim and even.

1 .....

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2 .....

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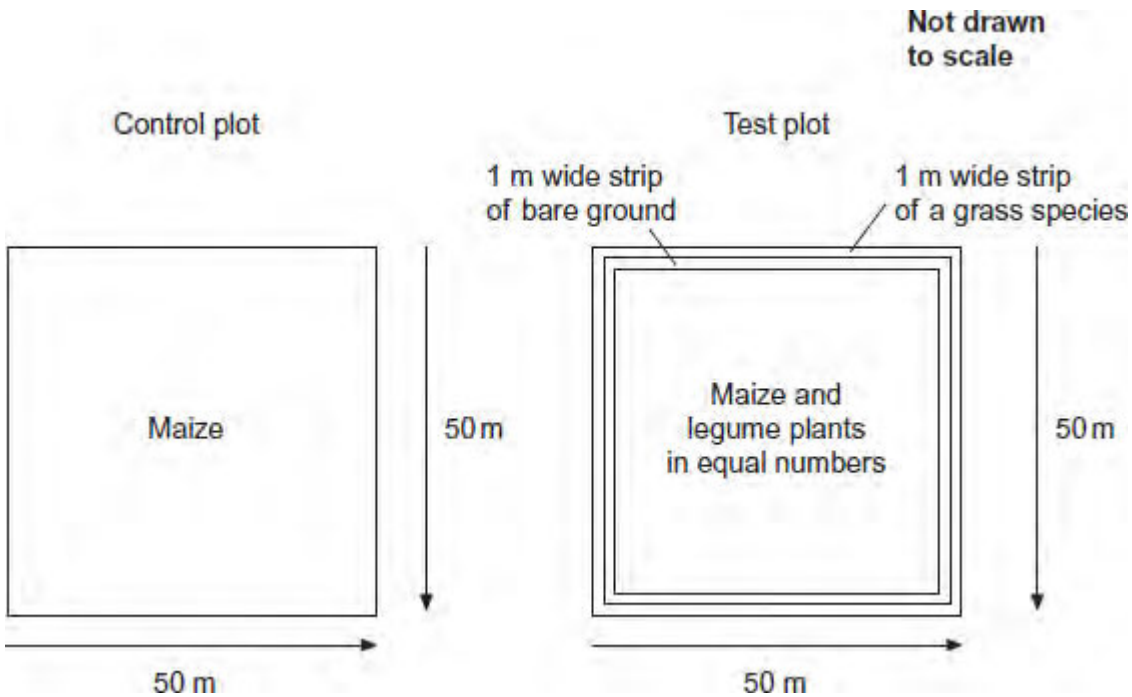
(2)
(Total 7 marks)

Q3. Stemborers are insect pests that feed on maize plants. Scientists investigated the effect of **push-pull** stimuli on the control of these pests.

For this investigation, the scientists divided a large field into plots measuring 50 m × 50 m. They then designated each plot as a control plot or a test plot. The following figure shows what they planted in each type of plot.



The legumes planted with the maize drive stemborers away.
The grass species attracts stemborers.

The table below shows the scientists' results.

Plots	Mean percentage damage to maize plants	Mean maize grain yield / tonnes per hectare (± standard deviation)	Mean production costs per farmer / $ per hectare (± standard deviation)	Mean total income for farmer / $ per hectare (± standard deviation)
Control	29.6	1.5 (±0.2)	250 (±0.7)	329 (±5.9)
Test	6.7	3.7 (±0.3)	278 (±1.1)	679 (±10.2)

(a) In the test plot of land, identify the push stimulus and the pull stimulus.

Push stimulus .....

Pull stimulus .....

(1)

(b) When measuring the mean percentage damage to maize plants, 60 plants from each test plot were selected at random and examined.
Describe how the maize plants could be selected at random.

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(Extra space) .....

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(3)

(c) In the test plot, bare ground was left between the maize and the grass species.
Suggest an explanation why.

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(2)

(d) The legume plants have nodules containing nitrogen-fixing bacteria on their roots.
Explain how nitrogen-fixing bacteria could increase the growth of the maize.

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(2)

(e) A year after this investigation, the government of one country decided that their farmers should use these **push-pull** stimuli.
How do these data support this decision?

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(Extra space) .....

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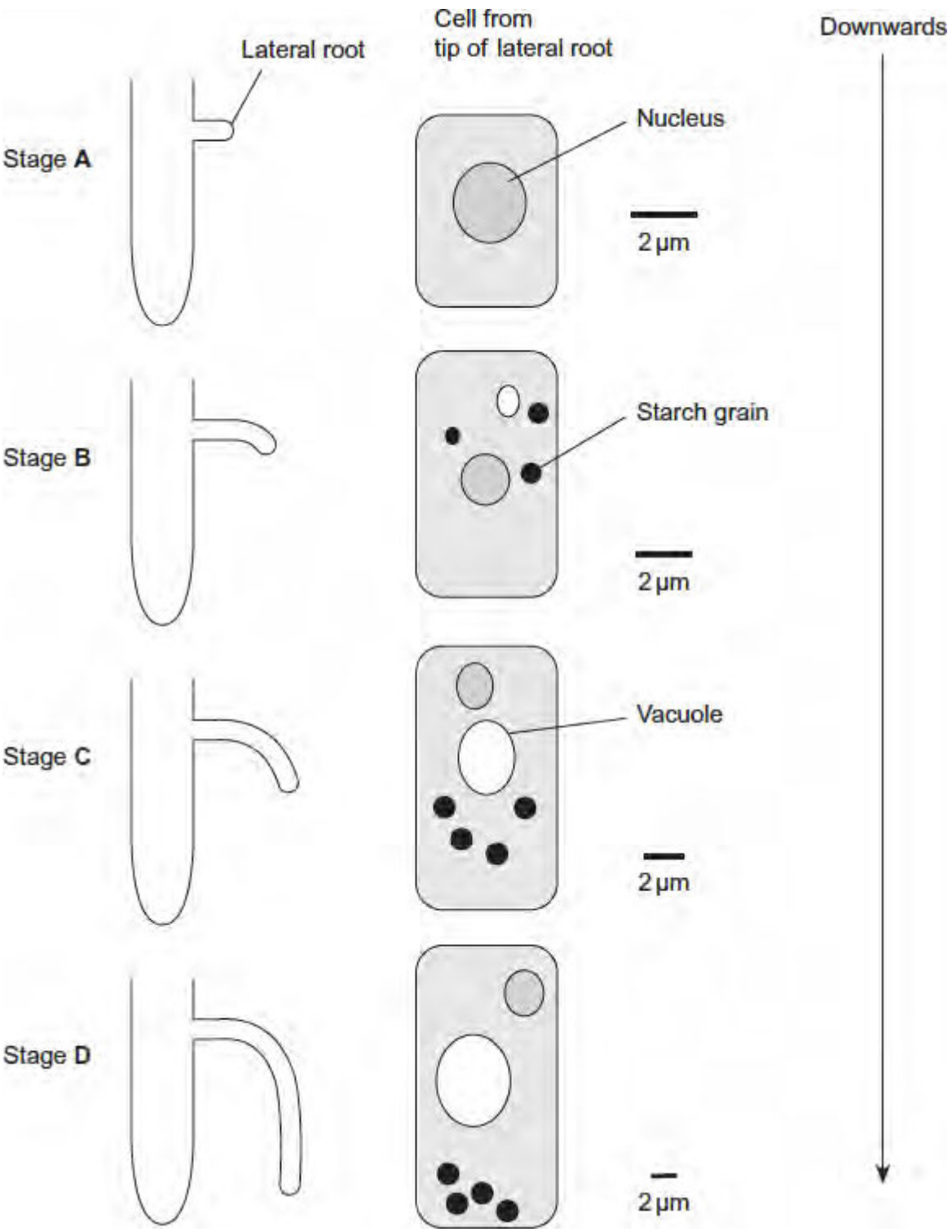
(3)
(Total 11 marks)

Q4. Scientists investigated the response of lateral roots to gravity. Lateral roots grow from the side of main roots.

The diagrams show four stages, **A** to **D**, in the growth of a lateral root and typical cells from the tip of the lateral root in each stage. All of the cells are drawn with the bottom of the cell towards the bottom of the page.



(a) Describe **three** changes in the root tip cells between stages **A** and **D.**

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2.....

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3.....

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(3)

(b) The scientists' hypothesis was that there was a relationship between the starch grains in the root tip cells and the bending and direction of growth of lateral roots.

Does the information in the diagram support this hypothesis? Give reasons for your answer.

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(Extra space).....

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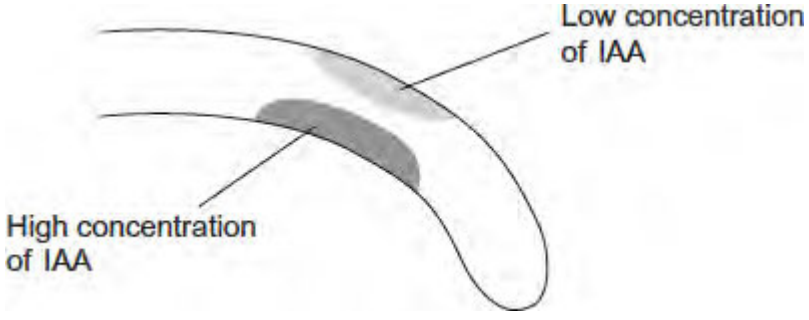
(3)

(c) The diagram shows the distribution of indoleacetic acid (IAA) in the lateral root at Stage **B.**



Explain how this distribution of IAA causes the root to bend.

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(2)
(Total 8 marks)

Q5. Scientists investigated the response of the roots of pea seedlings to gravity.

They took three samples of seedlings, **A**, **B**, and **C**, and placed them so that their roots were growing horizontally. The root tips of each sample had been given different treatments. After a set time, the scientists recorded whether the roots of the seedlings had grown upwards or downwards and the amount of curvature. The table shows the treatment they gave to each sample and their results.

Treatment	**Results**	
	Direction of growth	**Mean amount of curvature / degrees**
A None	Downwards	60
B Root tip removed	Continues to grow horizontally	0
C Upper half of root tip removed	Downwards	30

(a) The pea seedlings were kept in the dark after each treatment. Explain why this was necessary.

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(1)

(b) What conclusion can be made from the results for treatment **B**?

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(1)

(c) Suggest how indoleacetic acid (IAA) could have caused the results for

(i) treatment **A**

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(2)

(ii) treatment **C**.

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(2)
(Total 6 marks)