1 An investigation was carried out into the effects of different plant extracts on 13 species of bacteria. This investigation was carried out in a university laboratory, using species of bacteria that cause disease in humans.

The bacteria were grown on agar in Petri dishes. Plant extracts were added to 0.5 cm^2 filter paper discs and the discs were placed on the surface of the agar.

The Petri dishes were then incubated at 37 °C for 24 hours.

After incubation, the zones of inhibition were measured. If the zone of inhibition was greater than 7 mm, the bacteria were described as sensitive to the plant extract.

The results are shown in the table below.

Plant extract	Part of the plant used to prepare extract	Number of species of bacteria showing sensitivity
Basil	Leaves and stem	1
Clove	Flower bud	8
Lemon balm	Leaves and stem	3
Rosemary	Leaves and stem	1
Sage	Leaves and stem	0
Thyme	Leaves and stem	3

(a) (i) Explain what is meant by **zone of inhibition**.

(1)

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(ii) Suggest why the size of the zone of inhibition was used to indicate how sensitive the bacteria were to the plant extracts.

(1)

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(b) Using the information from the table, suggest what conclusions can be drawn from these data.

(3)

(c) Suggest **one** way in which this investigation could be improved. Give an explanation for your answer.

(2)

(d) Suggest a change that would have to be made if this investigation were to be carried out **safely** in a school laboratory. Give a reason for your suggestion.

(2)

(Total for Question 1 = 9 marks)

2 Almond trees can be grown from shoot tips using a tissue culture technique.

This involves removing explants (small pieces of plant tissue) from the shoot tips of adult plants. The explants are placed on a growth medium, such as agar. The explants develop roots and shoots as they grow into new plants.

Tissue culture techniques have to be carried out under conditions that prevent contamination of the explants.

(a) (i) Describe how contamination of a tissue culture is avoided.

(2)

(ii) Explain why contamination of tissue cultures has to be avoided.

(2)

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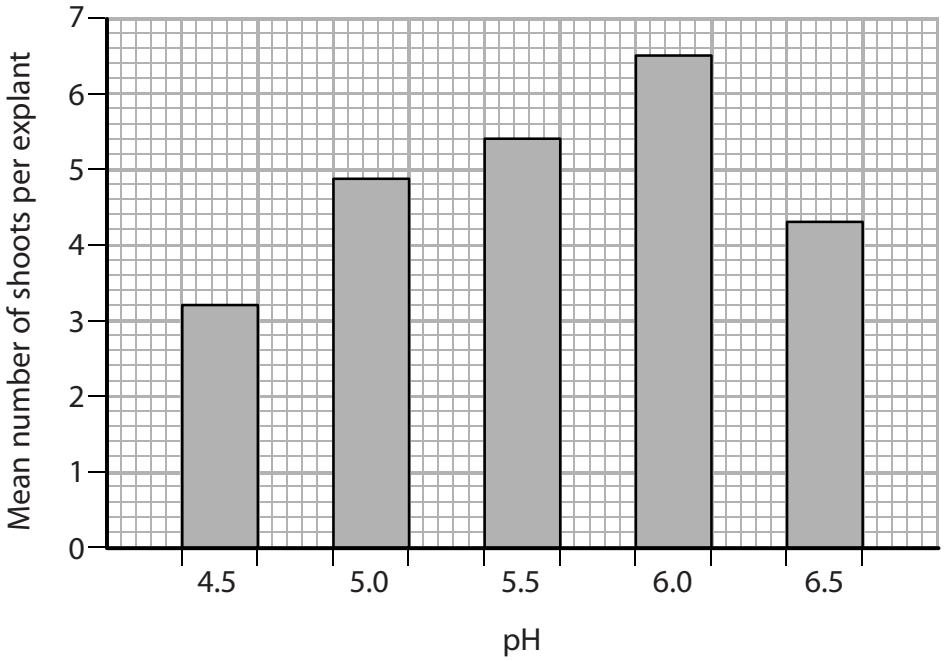
(b) Explants of almond plant shoot tips were grown using tissue culture techniques.

The effect of pH on the development of shoots from the explants was investigated.

The graph below shows the effects of pH on the number of shoots that developed from each explant.



(i) Give **two** environmental factors that would have to be controlled when investigating the effect of pH on the development of shoots from the explants.

(2)

1 .....

2 .....

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(ii) Using the information in the graph, explain the effect of pH on the development of shoots from explants of almond trees.

(3)

(Total for Question 2 = 9 marks)

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3 The time of death of a person can be estimated in a number of ways. One method is to use a Henssge nomogram.

The Henssge nomogram relates the time of death to the ambient (surrounding) temperature, the core temperature and the mass of the body.

(a) Explain why the ambient temperature and the core temperature of the body are used to determine the time of death of a person.

(3)

(b) The chart shows a Henssge nomogram.

The steps below need to be followed to estimate the time of death using the Henssge nomogram:

Step 1

Draw a straight line between the core temperature of the body and the ambient temperature (= line 1)

Step 2

Draw a straight line that extends from the centre of the circle through the diagonal line, at the point where it crosses line 1 (= line 2)

Step 3

Read the time of death from the nomogram at the point line 2 crosses the appropriate semicircle for the mass of the body.

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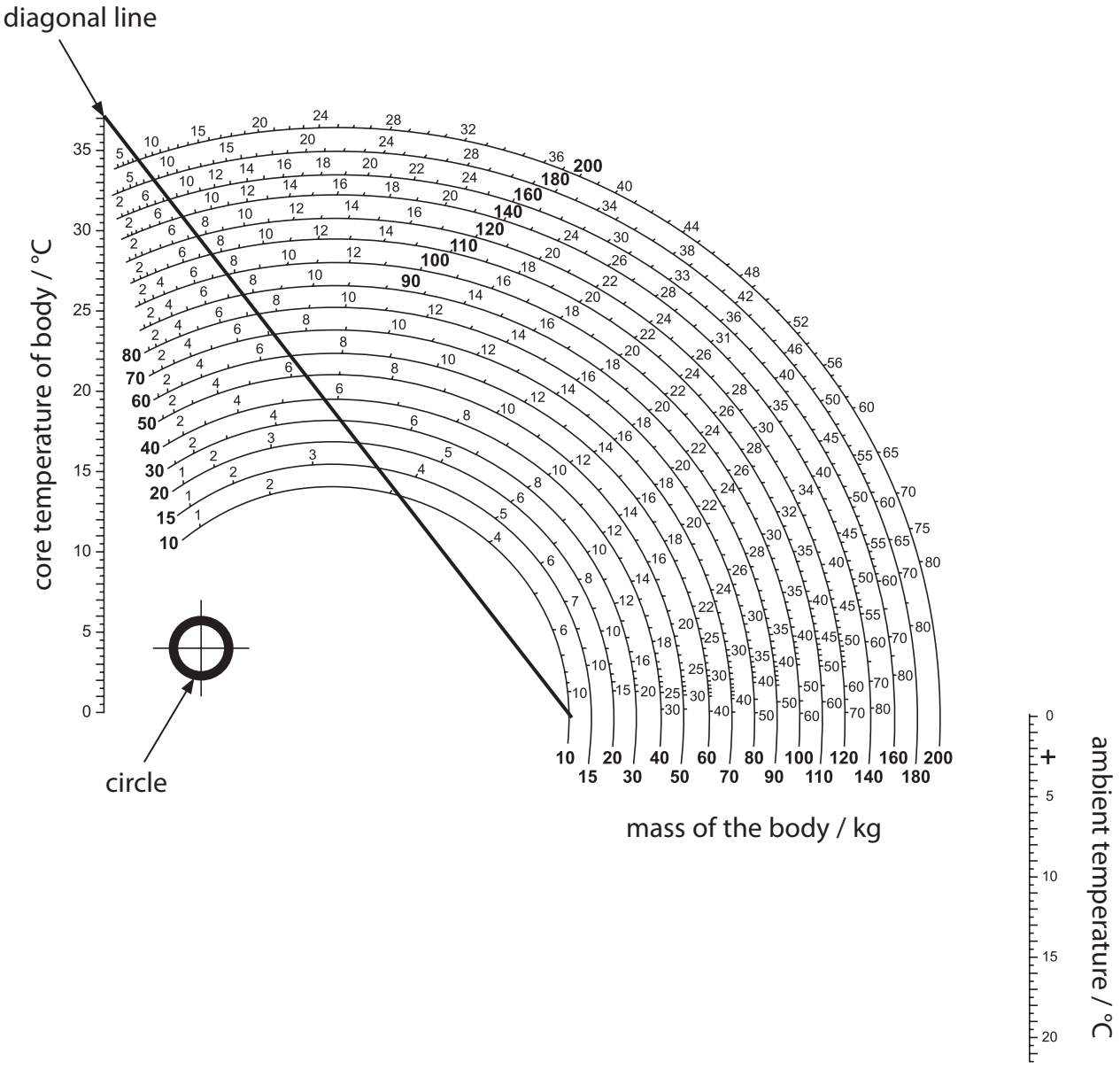
Henssge nomogram



(i) A body was found. The mass of the body was 100 kg and the core temperature of the body was 25 °C. The ambient temperature was 15 °C.

Use the Henssge nomogram to estimate the time of death.

(3)

time of death = ... hours ago

*(ii) The Henssge nomogram is used to estimate the time of death of a naked body, lying stretched out and in still air.

Suggest how a change in each of these three factors could affect the estimated time of death. Give reasons for your answer.

(6)

(Total for Question 3 = 12 marks)

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4 Recently, scientists have shown an interest in using plant tissue culture techniques to produce large numbers of genetically identical cotton plants. Cotton plants provide fibres used for clothing.

Plant tissue culture techniques depend on the totipotent properties of the cells used.

(a) Describe how you could use a plant tissue culture technique to show totipotency in cotton plant seedlings.

(4)

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(b) Scientists used similar plant tissue culture techniques to investigate the effect of the age of the seedlings on totipotency.
Seedlings were divided into four groups, each consisting of 25 seedlings. One group was grown for 7 days before the plant tissue culture technique was carried out.
The number of seedlings that showed totipotency was recorded as a percentage.

This procedure was repeated for the other three groups of seedlings, which were grown for 14, 21 and 28 days respectively before the plant tissue culture technique was carried out.

The results are shown in the table below.

Age of seedlings before plant tissue culture technique carried out / days	**Percentage of seedlings showing totipotency (%)**
7	76
14	56
21	40
28	60

(i) Describe the effect of age on the percentage of seedlings showing totipotency.

(2)

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(ii) The scientists were concerned about the reliability of the data.

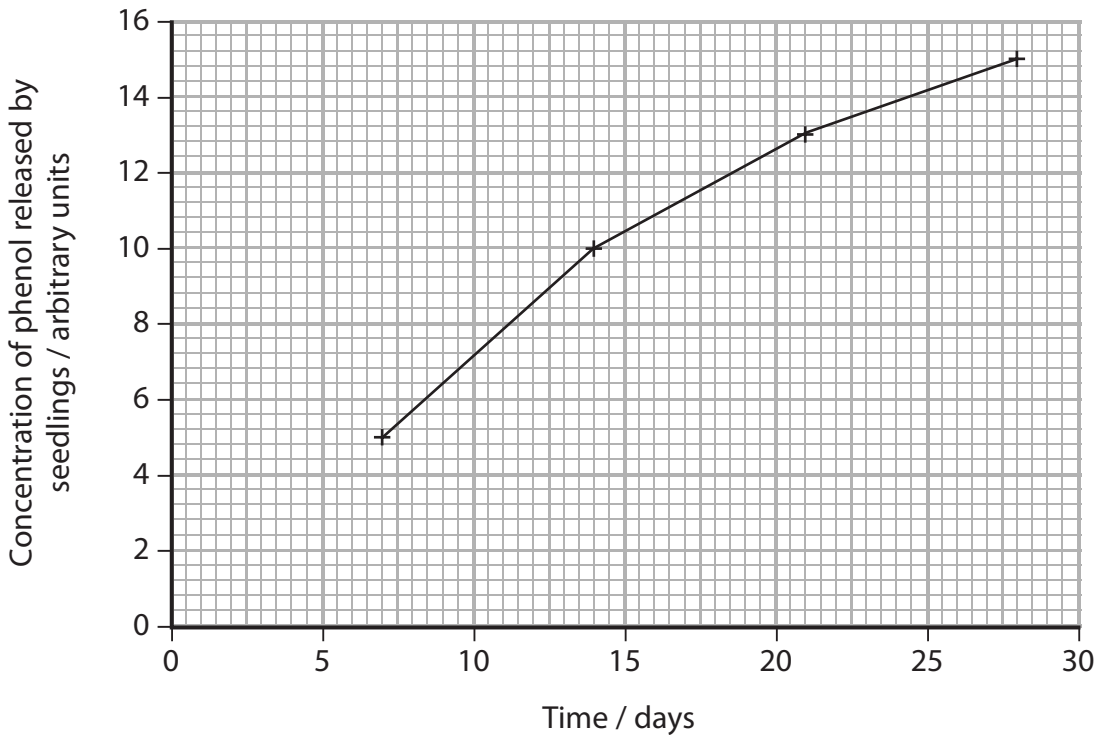
Suggest how the data could have been made more reliable.

(2)

(c) As cotton plants grow, they release a substance called phenol.

In another investigation, the scientists measured the concentration of phenol released by seedlings.

The results are shown in the graph below.



(i) Using the information in the table in part (b) and the graph, give evidence to support the hypothesis that phenol reduces totipotency.

(1)

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(ii) Using the information in the table in part (b) and the graph, give evidence that does **not** support the hypothesis that phenol reduces totipotency.

(1)

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(d) Human stem cell research involves the use of both totipotent and pluripotent stem cells.

Describe the differences between a totipotent stem cell and a pluripotent stem cell.

(2)

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(Total for Question 4 = 12 marks)

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