

2 Metachromatic leukodystrophy (MLD) is an inherited disorder. This disorder, due to brain damage during the first two years of life, can prevent a child learning how to walk and talk.

In one of the first gene therapy treatments approved in Europe, one child from each of three families with a history of MLD, was treated.

As a result of this treatment the children were able to talk at an age when some of their untreated brothers and sisters were unable to talk.

MLD is associated with a recessive allele.

(a) Two parents, who are physically unaffected by the disorder, have already had one child with the disorder.

Using a suitable genetic diagram, calculate the probability that the next child of these parents will also be affected by this disorder.

(4)

probability

(ii) Suggest why the development of the treated children was compared with the development of their untreated brothers and sisters.

(2)

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(d) There are some risks associated with somatic gene therapy.

Suggest why the parents of these children gave consent for their children to be involved in the gene therapy treatment for MLD.

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(Total for Question 2 = 13 marks)

3 The root tip squash procedure can be used to observe cells undergoing mitosis.

(a) Explain the role of mitosis in the development of roots.

(2)

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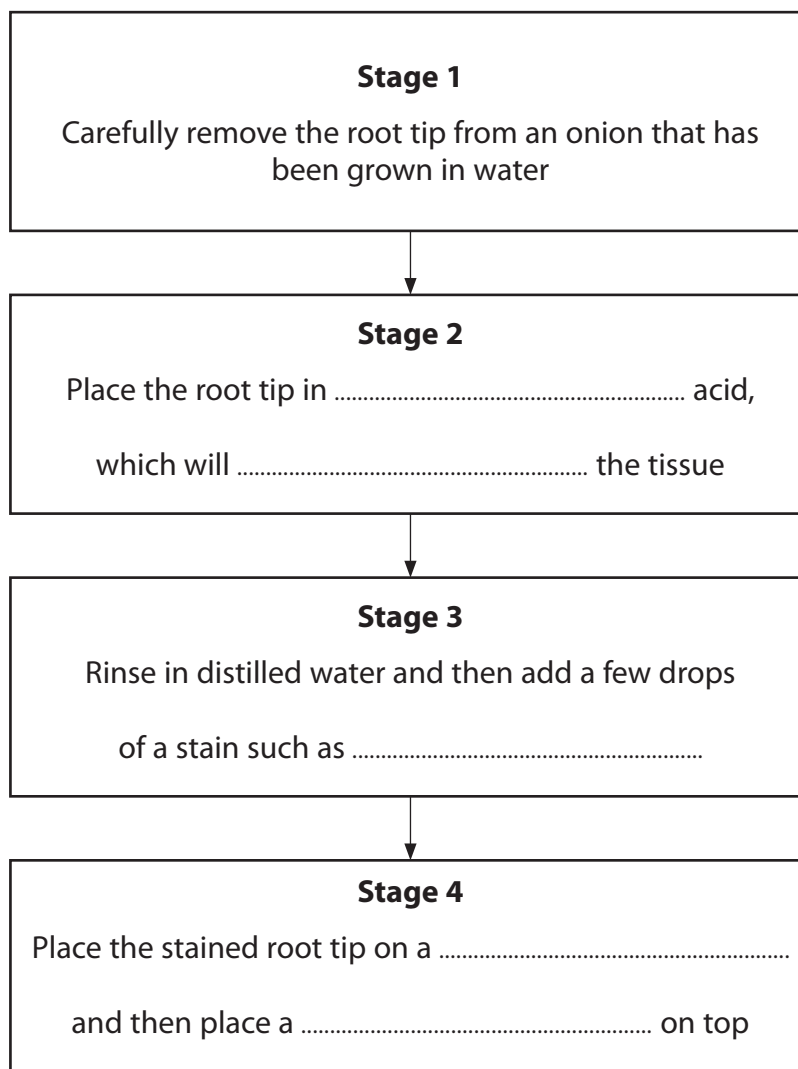
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(b) (i) The flow chart below describes the stages involved in staining a root tip squash to show mitosis.

Complete the flow chart by writing the most appropriate word or words on the dotted lines.

(3)



(ii) Describe **one** safety precaution that should be taken when carrying out this procedure.

(1)

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*(c) Following mitosis, some cells undergo differentiation to become specialised tissues, such as xylem.

Explain how cells differentiate to become specialised tissues.

(4)

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(d) Similar staining techniques can be used to observe cells undergoing meiosis.

(i) Name a process that may be observed in cells undergoing meiosis but **not** mitosis.

(1)

(ii) Explain how meiosis can give rise to genetic variation in the gametes produced.

(2)

(Total for Question 3 = 13 marks)

- (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)

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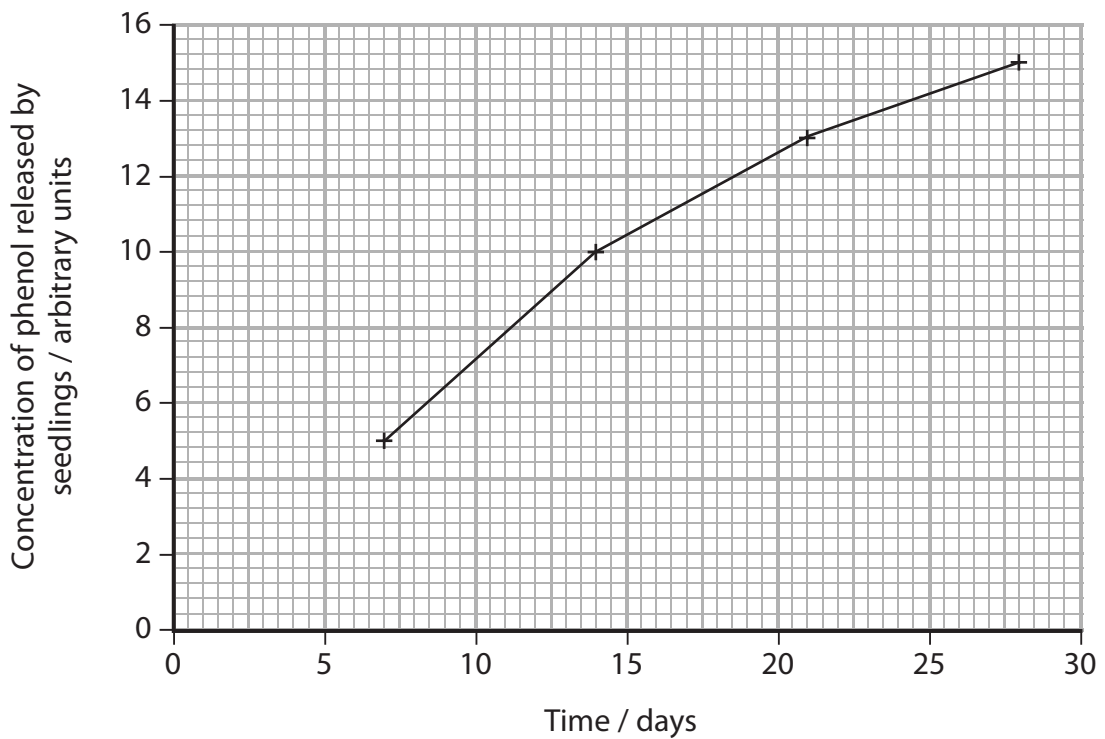
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(c) As cotton plants grow, they release a substance called phenol.

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)