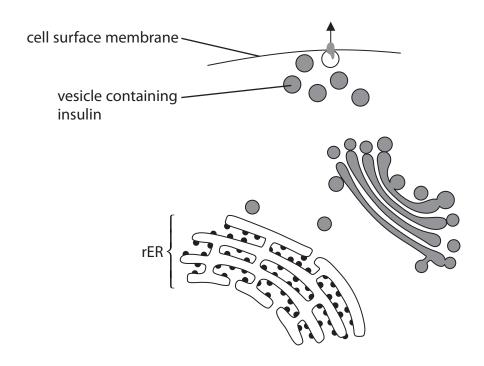
1 Insulin is a protein produced by beta cells in the pancreas. Insulin is synthesised on ribosomes, then modified and packaged in vesicles. It is stored in these vesicles until it is secreted.

The diagram below shows the organelles involved in this process of modifying and packaging the insulin in vesicles.



and secreted by the cell.

(4)

*(a) Using the information in the diagram, describe how insulin is modified, packaged

(b)	Тур	oe 1	diabetes occurs when beta cells in the pancreas do not produce insulin.	
			ells produced from skin cells can be used to replace these beta cells in The skin cells can be stimulated to become pluripotent stem cells.	
	(i)		ce a cross \boxtimes in the box next to the correct definition to complete the owing statement.	
		Plu	ripotent stem cells are	(4)
				(1)
	×	Α	specialised cells that can differentiate to give rise to almost any type of cell in the body, including totipotent cells	
	X	В	specialised cells that can differentiate to give rise to any type of cell in the body, excluding totipotent cells	
	×	C	unspecialised cells that can differentiate to give rise to almost any type of cell in the body, excluding totipotent cells	
	×	D	unspecialised cells that can differentiate to give rise to any type of cell in the body, including totipotent cells	
	(ii)		e pluripotent stem cells were injected into the mice. After eight weeks, ese cells had developed into insulin-secreting beta cells.	
		Des	scribe how these pluripotent stem cells became specialised beta cells.	
				(4)
			(Total for Question 1 = 9 mai	rks)

- 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.

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	ű	-0	

(b) Suggest how a newborn baby could be tested for MLD before brain damage deve	elops. (2)
 (c) The gene therapy involved taking bone marrow stem cells from the child to be treated. A virus was then used to transfer DNA with the dominant allele into the stem cells. These modified stem cells were then injected into this child.	
(i) Suggest how these modified stem cells can result in the prevention of MLD.	(3)

(ii) Suggest why the development of the treated children was compared with the development of their untreated brothers and sisters.	
	(2)
(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.	
	(2)
(Total for Question 2 = 13 ma	arks)

3			sh procedure can be used to lead to le	observe cells undergoing mitosis.	
			·		(2)
	(b) (i)		chart below describes the stag show mitosis.	ges involved in staining a root tip	
		Complete the dotted		most appropriate word or words on	
					(3)
			Sta	ogo 1	
				t tip from an onion that has	
				wn in water	
			Sta	ige 2	
			Place the root tip in	acid,	
			which will	the tissue	
				T	
			Sta	ige 3	
			Rinse in distilled water a	and then add a few drops	
			of a stain such as		
				T	
				ige 4	
			Place the stained root tip or	1 a	
			and then place a	on ton	

	(ii) Describe one safety precaution that should be taken when carrying out this procedure.	
	processine.	(1)
*(c)	Following mitosis, some cells undergo differentiation to become specialised tissue such as xylem.	s,
	Explain how cells differentiate to become specialised tissues.	(5)
		(4)

(d) Sir	milar 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 may	·ks)

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)
•••••		

 (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

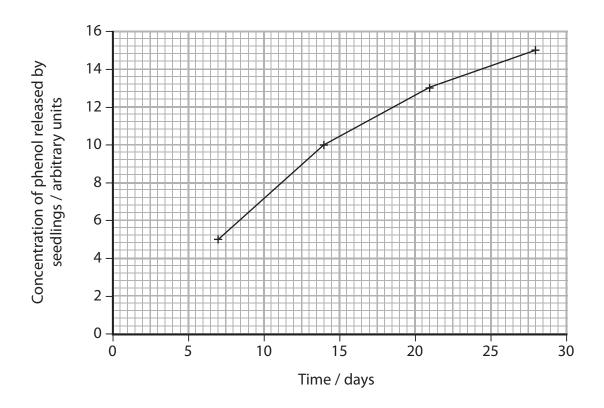
(i)	Describe the effect of age on the percentage of seedlings showing totipotency.
	(2)

(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)

(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)
(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)