

1(a). The Diabetes Specialist Nurse (DSN) is just one healthcare professional who will be involved in the treatment of patients with type 1 and type 2 diabetes.

A DSN must be able to provide and give advice on **injectable** therapies for **hyperglycaemia**. One of the injectable therapies used to treat **type 2** diabetes uses **GLP-1**.

GLP-1 is a small peptide produced naturally by the gut.

GLP-1 has several effects including:

- decreasing glucose release from the liver
- decreasing gastric (stomach) emptying
- increasing insulin release from the pancreas
- decreasing glucagon release from the pancreas.

(i) Suggest why GLP-1 is injected rather than taken orally.

----- [1]

(ii) In what form is glucose normally stored in the liver?

----- [1]

(iii) Suggest how a delay in the emptying of the stomach could improve the management of type 2 diabetes.

----- [1]

(iv) Name the cells in the pancreas where GLP-1 acts.

----- [2]

(b). A DSN also be able to provide and give advice on **oral** therapies for hyperglycaemia and hypoglycaemia.

(i) One of the drugs used in oral therapies for **hyperglycaemia** in **type 2** diabetes targets the enzyme that normally breaks down GLP-1.

Suggest how the action of this drug on the enzyme lowers hyperglycaemia.

----- [1]

(ii) Explain why this drug is **not** used in the treatment of hyperglycaemia in **type 1** diabetes.

----- [1]

(iii) State how **hypoglycaemia** would be treated orally in type 1 diabetes.

----- [1]

(c). In addition to monitoring injectable and oral therapies, and interpreting blood and urine test results, a Diabetes Specialist Nurse (DSN) will also be involved in other aspects of the longterm care of people with diabetes.

Discuss the role of the DSN in the long-term care of people with diabetes **other than** in monitoring different therapies and interpreting blood and urine test results.

----- [3]

2(a).

- (i) Explain what happens to the glucose in the blood sample when it comes into contact with the chemicals on the test strip.

----- [2]

- (ii) Several factors may affect the results when taking a series of readings using a blood glucose meter.

State **two** factors that could affect the results.

----- [2]

- (b). Describe **two** precautions that a person should take when using a blood glucose meter.

----- [2]

3(a). Recent studies, such as those carried out by the World Health Organisation, have noted an increase in the global incidence of **Type 1 diabetes**.

Type 1 diabetes occurs due to changes in pancreatic tissue. Fig. 2.1 shows a photomicrograph taken of a section through pancreatic tissue.

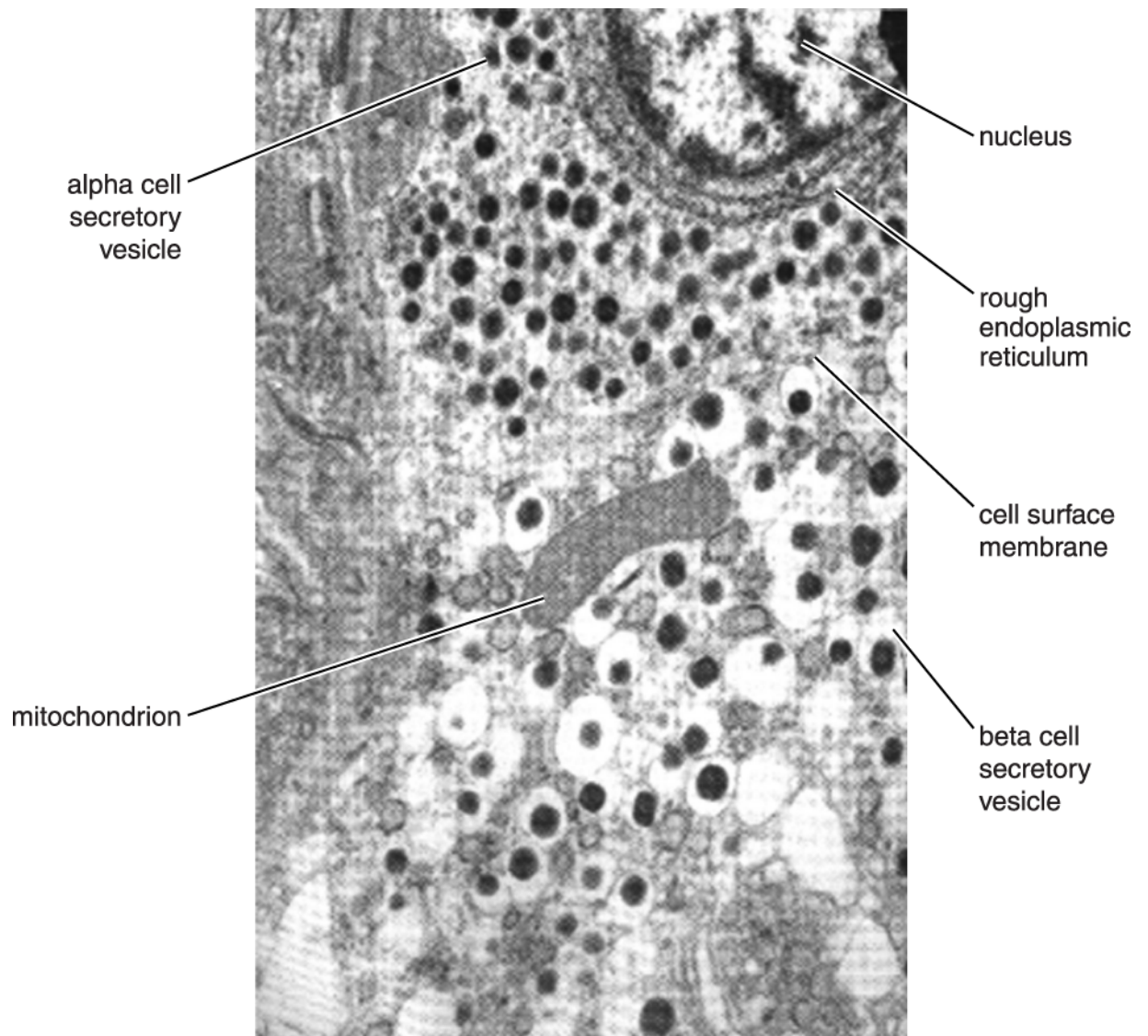


Fig. 2.1

(i) State the region of the pancreas from which this tissue section has been taken.

----- [1]

(ii) Which of the secretory vesicles contains the hormone that lowers blood glucose?

----- [1]

[8]

4(a). The control of blood glucose is essential because changes in blood glucose concentration will change the water potential of blood.

Water potential changes are detected by the osmoregulatory centre and adjustments are then made to the secretion of ADH.

(i) State **one** reason, other than the effect that it has on water potential, why blood glucose concentrations must be controlled.

----- [1]

(ii) State the location in the brain of the osmoregulatory centre and the source of ADH secretion.

osmoregulatory centre

source of ADH secretion

[1]

(b). If people with type 1 diabetes do not administer the appropriate medication, the concentration of glucose in the blood can remain higher than the normal range for relatively long periods of time.

(i) Name the medication that is required to treat type 1 diabetes.

Describe how and when this medication is administered and how it acts to reduce the blood glucose concentration.

[5]

(ii) **Predict** the effect of high blood glucose concentration on ADH release and urine volume. You should assume that no glucose is lost from the blood and that glucose levels remain high. Justify your prediction.

effect on ADH release

effont on urine volume

justification

[3]

5(a). This question is about the hormonal control of blood glucose concentration in health and disease.

Complete the missing words in the paragraph below to explain the role of insulin in blood glucose homeostasis.

When the concentration of blood glucose rises above a set point, _____ cells in the _____ of the pancreas are stimulated to release insulin. Effector cells respond to insulin by increasing the expression of _____ proteins in the cell surface membrane. This increases the uptake of glucose. Liver cells store some excess glucose in a process known as _____. The concentration of blood glucose then falls.

[4]

(b). The oral glucose tolerance test (OGTT) is used to diagnose diabetes.

A result from an OGTT measuring blood glucose and insulin concentrations is shown in Fig. 32.

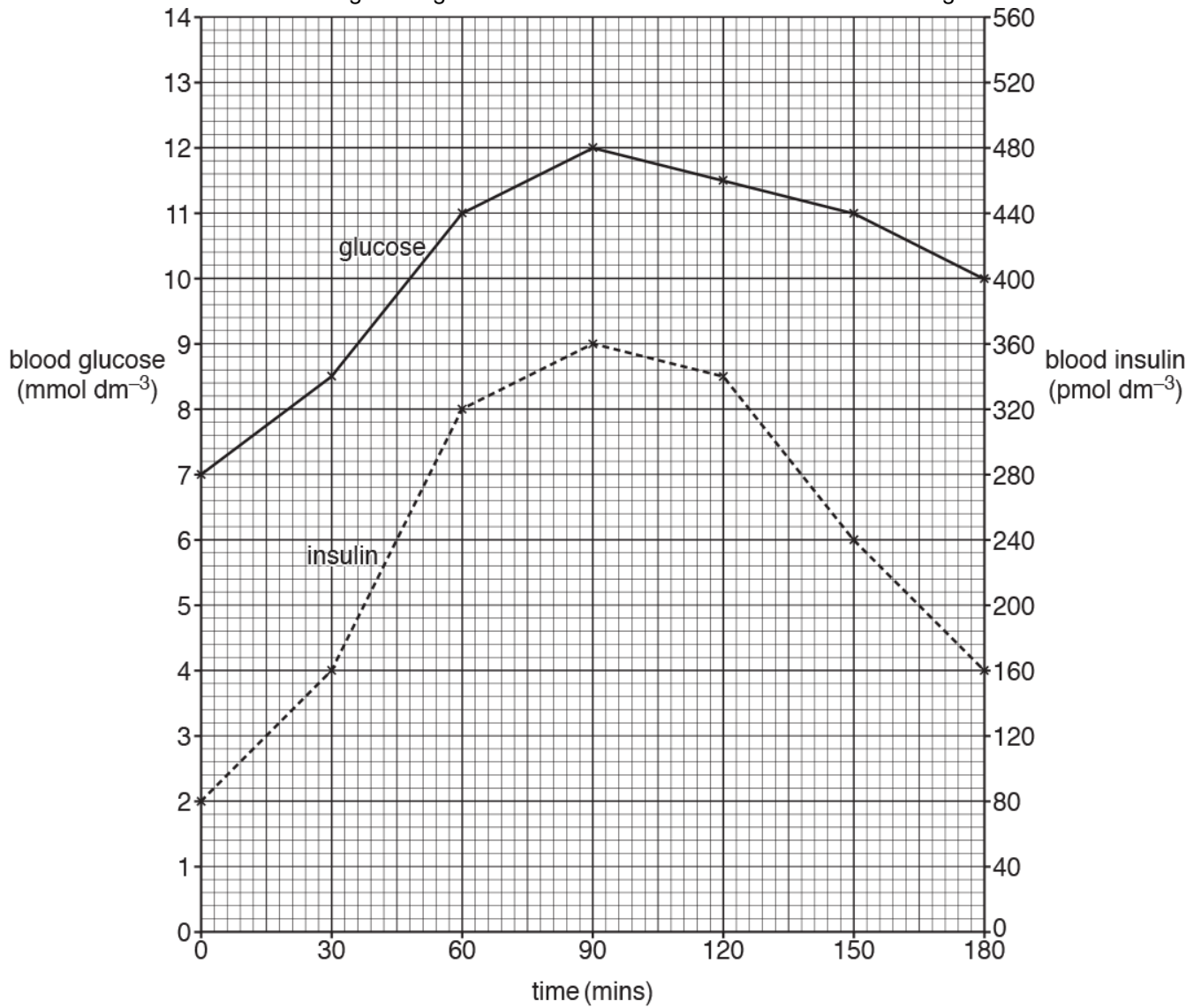


Fig. 32

(i) The OGTT result in Fig. 32 shows evidence of diabetes. State which type of diabetes the patient has and explain how this can be concluded.

type -----

explanation -----

----- [1]

- (ii) Calculate the percentage increase in blood glucose concentration after 90 minutes compared to time 0.
Give your answer to **two** significant figures.

Answer =% [2]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
1	a	i	<i>Idea that</i> peptide / GLP-1 would be denatured (by stomach acid);	1	CREDIT peptide / GLP-1, would be, digested / hydrolysed / broken down
		ii	glycogen;	1	
		iii	<i>idea that</i> person feels full for longer; <i>idea that</i> prevents rapid, digestion (of carbohydrate) / absorption (of glucose); <i>idea that</i> person will eat less / less risk of obesity / AW;	1	Mp2 CREDIT ref to preventing a sudden increase in blood glucose DO NOT CREDIT less breakdown of glucose
		iv	alpha (cells); beta (cells);	1	Examiner's Comments This was answered well although in (iv) a failure to read the stem of the question led to candidates answering in terms of a tissue rather than the cells.
	b	i	<i>idea that</i> GLP-1 circulates for longer / half life prolonged / stays active in the blood for longer;	1	CREDIT <i>idea that</i> drug is an enzyme inhibitor; ACCEPT idea that GLP-1 isn't broken down
		ii	<i>idea that</i> Type 1 due to, lack of / AW, insulin (secretion);	1	CREDIT (type 1 diabetes) treated with insulin injections
		iii	using / AW, glucose, tablets / drink / gel;	1	ACCEPT reference to a named sweet foodstuff Examiner's Comments Good candidates were able to apply their knowledge of enzyme action. It was disappointing to see that some candidates were unaware of how to treat hypoglycaemia. Reference to insulin injections suggests that some of them had misread the term.

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	c	<p>advise / AW, related to retinal examinations;</p> <p>advise / AW, related to foot care;</p> <p>advise / AW, related to diet;</p> <p>advise / AW, related to BMI / weight;</p> <p>advise / AW blood pressure;</p> <p>advise / AW, kidney function tests;</p> <p>AVP;</p>	3	<p>CREDIT ref to retinopathy or eye checks</p> <p>CREDIT ref to neuropathy</p> <p>e.g. advise on exercise, ref to crisis management, information on support groups / involving family members</p> <p>Examiner's Comments</p> <p>The most common answers on the role of the DSN included general support, dietary advice and exercise. References to checking eyes, feet, blood pressure and kidney function were rarely seen.</p>
		Total	11	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
2	a	i	glucose is converted to gluconolactone; by glucose oxidase;	2	CREDIT glucose dehydrogenase
		ii	time of day the blood sample is taken; exercise before testing; food / drink, before testing; insulin has been used before testing;	2 max	<p>IGNORE ref. to glucagon administration</p> <p>Examiner's Comments</p> <p>This part was well-answered across the ability range and in (i) there were some good responses from stronger candidates with both marking points being awarded. However, some candidates referred to a <i>reaction</i> occurring between the enzyme on the test strip and glucose. Candidates at AS level would be expected to understand that enzymes are catalysts in reactions and do not react with their substrates.</p>
	b		reference to sterile conditions; <i>idea that</i> the meter should be calibrated; safe disposal of test strip;	2 max	<p>CREDIT description e.g. swab skin with alcohol use of sterile lancet CREDIT description of meter function ACCEPT safe disposal of e.g. lancet</p> <p>Examiner's Comments</p> <p>This question incorporated a range of assessment objectives (AOs 1, 2 and 3) with a biochemical thread running throughout. Some questions were in the context of the procedure for testing for blood glucose. This part was in the context of testing for blood glucose and many candidates were able to gain credit in this part for referring to sterile conditions as a safety precaution; few candidates referred to precautions relating to the functioning of the blood glucose meter itself.</p>
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
3	a	i	Islet(s) of Langerhans;	1	<p>ACCEPT upper or lower case, phonetic spelling</p> <p>Examiner's Comments</p> <p>This question was almost entirely AO1 but did contain marks which were synoptic with F221 (cell structure) and F224 (protein synthesis).</p> <p>Most candidates correctly identified the Islets of Langerhans in (a)(i) from the photomicrograph. A failure to gain credit usually resulted from either an imprecise answer ('endocrine tissue') or confusion with the glomerulus despite the question clearly being about the pancreas.</p>
		ii	beta / β (cells);	1	<p>Examiner's Comments</p> <p>This question was almost entirely AO1 but did contain marks which were synoptic with F221 (cell structure) and F224 (protein synthesis).</p> <p>In (a)(ii) again most candidates correctly stated beta cells.</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	b	<p>1 (gene(s) for hormones) transcribed / AW, in nucleus;</p> <p>2 hormones / polypeptide / protein / synthesised, on ribosomes</p> <p>;</p> <p>3 (ribosomes / proteins synthesised / translation) on RER;</p> <p>4 hormones / polypeptides / proteins, transfer to Golgi (apparatus);</p> <p>5 (golgi) packages / AW, hormones into vesicles;</p> <p>6 vesicles, fuse with / AW, cell surface membrane / hormones released by exocytosis;</p> <p>7 mitochondria provide, energy / ATP, for (named) process;</p> <p>8 (hormones) soluble in blood / transported in, blood / plasma;</p> <p>9 (targets) muscle / liver;</p> <p>10 ref to (hormone binding to) receptors on cell surface / plasma, membrane (of cells in target tissues);</p>	7	<p>ACCEPT hormone / named hormone / polypeptide for mps 1.2.3. and 4</p> <p>1 ACCEPT a description of transcription such as 'mRNA (for hormones) being synthesised'</p> <p>2. ACCEPT mRNA translated on ribosomes or a description</p> <p>DO NOT CREDIT if exocytosis is given as part of a list</p> <p>7 CREDIT this mark if linked to any process from mp 1,2.,4, 5 DO NOT CREDIT 'produce energy'</p> <p>DO NOT CREDIT as part of a list with other non-target organs</p>

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	QWC;	1	<p>Award if: mp 8 and 9 have been awarded plus any two from mps 1,3,5,6,7</p> <p>Examiner's Comments</p> <p>In part 2(b), several candidates answered the question in terms of homeostasis and wrote excellent answers to a question which had not been asked. In terms of homeostasis, a surprising number of candidates still believe that the alpha and beta cells are regulated by the hypothalamus and the pituitary. For those candidates who did attempt to address the question recurring errors included using the terms 'transcription' and 'translation' as if they were interchangeable, describing exocytosis as the release of vesicles into the blood stream and using the term 'active transport' to describe exocytosis. Examiners were happy to credit the link between mitochondria and use of ATP for exocytosis as ATP would be required, for example, to move vesicles to the cell surface membrane. However, the term 'active transport' is reserved for transmembrane transport which requires a specific ATP- driven protein 'pump' - a different form of transport to exocytosis. As stated in the introduction, too many candidates wrote about the release of glycogen or glucogen from alpha cells.</p>
	Total	10	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
4	a	i	<p><i>idea that</i> glucose is a respiratory substrate OR (plasma) glucose is the only respiratory substrate for neurones OR if blood glucose too low neurones lose function / AW;</p>	1	<p>IGNORE ref to preventing hyper or hypo glycaemia without further qualification</p> <p>CREDIT idea of preventing a coma</p> <p>Examiner's Comments</p> <p>In (i) the question required applying knowledge of the role of blood glucose other than its effect on water potential. High blood pressure and damage to cells are due to the osmotic effect of glucose. A number of candidates also think that high blood glucose causes diabetes rather than being a symptom of it. Many candidates did answer in terms of the role of glucose as a respiratory substrate.</p>
		ii	<p>hypothalamus AND (posterior) pituitary;</p>	1	<p>Mark the first answer on each line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks</p> <p>BOTH answers required for 1 mark</p> <p>DO NOT CREDIT anterior pituitary</p> <p>Examiner's Comments</p> <p>In (ii) many candidates lost marks by stating the anterior pituitary gland as the source of ADH secretion.</p>
	b	i	<p>insulin;</p> <p>injections / pump / insulin pen;</p> <p><i>idea that</i> injected prior to a meal OR blood glucose measured to determine how much insulin is needed;</p> <p>binds to receptors on,(cell surface membrane(s) of,) liver / fat / muscle (cells);</p>	5	<p>IGNORE epipen</p> <p>ACCEPT 3 or 4 times a day</p>

Mark Scheme

Question	Answer/Indicative content	Marks	Guidance
	<p><i>idea that it, <u>promotes</u> / <u>increases</u> uptake of glucose;</i></p> <p><i>idea that it promotes / triggers, the conversion of glucose to glycogen / <u>glycogenesis</u>;</i></p> <p>idea that use of glucose in respiration, is increased</p> <p>OR</p> <p>glucose is respired preferentially to, fats/fatty acids;</p>		<p>CREDIT '<u>more</u> glucose is taken up'</p> <p>DO NOT CREDIT a description if an incorrect term or incorrectly spelled term is then used as this is a contradiction</p> <p>e.g. 'stimulates glycogenolysis which is the conversion of glucose to glycogen' = 0 MARK</p> <p>DO NOT CREDIT 'insulin converts glucose to glycogen'</p> <p>DO NOT CREDIT 'increase in respiration of glucose'</p> <p>Examiner's Comments</p> <p>Part (i) was answered well although one common misconception was that insulin is administered after meals. Some candidates lost marks by describing the conversion of glucose to glycogen but then using an incorrect term. This was treated as a 'contradiction'. Most candidates expressed themselves well but some phrase their answer in terms of insulin converting glucose to glycogen or insulin opening glucose channels in the membrane rather than insulin being the cell signalling molecule which triggers these events.</p>

Mark Scheme

Question		Answer/Indicative content	Marks	Guidance
	ii	<p>more / AW,(ADH) AND decrease (in urine volume);</p> <p><i>justification</i> (high blood glucose) lowers water potential, (stimulating /AW, release of ADH);</p> <p>(ADH triggers) more water reabsorption (so a lower urine volume);</p>	3	<p>Examiner's Comments</p> <p>Many candidates gained full marks on (ii) although some candidates linked the presence of ADH to glucose uptake.</p>
		Total	10	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
5	a		beta / β ✓ islets of Langerhans ✓ (glucose) transport(er) ✓ glycogenesis ✓	4	ALLOW wrong use of upper and lower cases ALLOW GLUT (1-4) OR carrier DO NOT ALLOW receptor / co-transport ALLOW glycogen synthesis Examiner's Comments (a) addressed AO1 criteria, part (b)(i) was focused on AO3, part b(ii) was focused on AO2 and the Level of Response question, part (c), addressed both AO1 and AO2. (a) was done well although candidates need to be careful when writing β cells so not to confuse it with B cells (remembering that B cells are very different to β cells). The most common incorrect responses were channel / receptor proteins and there was still some evidence of candidates confusing glycogenesis with glycogenolysis and occasionally gluconeogenesis.
	b	i	Type: 2 AND Explanation: production / release of insulin ✓	1	ORA ALLOW any reference to graph showing insulin resistance / insulin not having effect on glucose / blood glucose remaining high Examiner's Comments In (b)(i) most candidates correctly identified type 2 diabetes although fewer used evidence from the figure to explain their conclusion and simply stated that type 1 diabetes produced no insulin.
		ii	71% ✓ ✓	2	ALLOW 71.4 or unrounded answer (71.4285...) for 1 mark Examiner's Comments The calculation in (b)(ii) was done well by many candidates although a few did not notice the reference to 2 significant figures.
			Total	7	