Control of Blood Glucose Concentration

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

Level: AQA A LEVEL 7402

Subject: Biology

Exam Board: AQA A Level 7402

Topic: Control of Blood Glucose Concentration

1 concentration.

1. _____

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2. _____

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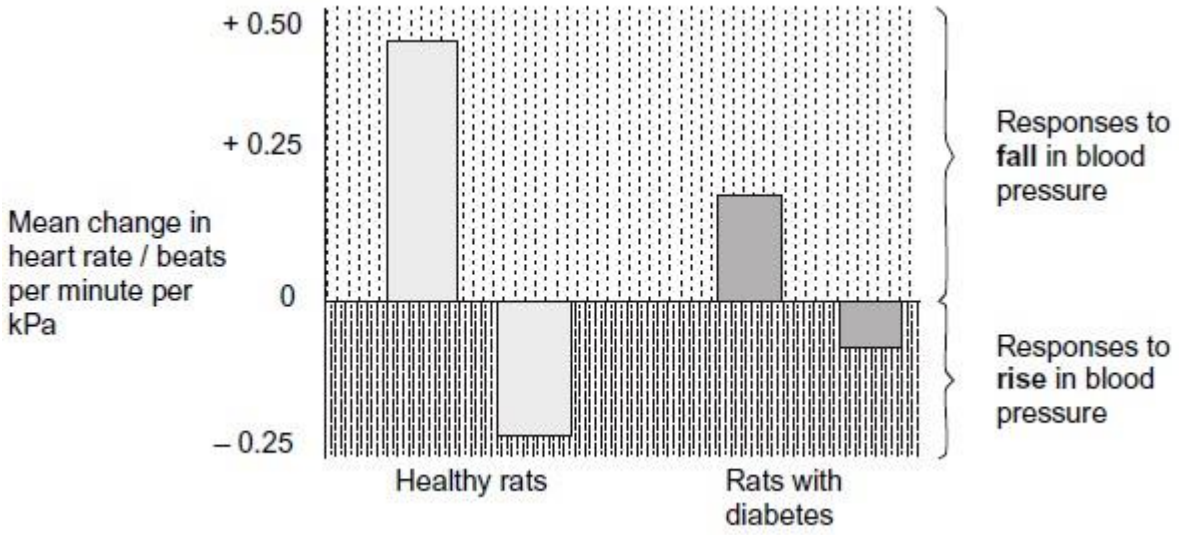
(2)

(b) Scientists investigated the effect of diabetes on the control of heart rate in response to changes in blood pressure in rats.

The scientists found the mean changes in heart rates of healthy rats and rats with diabetes in response to rises or falls in blood pressure.

The diagram shows their results in the form they were presented.



Diabetes can damage the nervous system. The response of the rats with diabetes is different from the response of the healthy rats. Use your knowledge of the control of heart rate by the nervous system to suggest an explanation for these results.

(4)

(Total 6 marks)

Scientists investigated the control of blood glucose concentration in mice. They kept a group of

2

normal mice without food for 48 hours. After 48 hours, the blood glucose concentrations of the mice were the same as at the start of the experiment.

(a) Explain how the normal mice prevented their blood glucose concentration falling when they had **not** eaten for 48 hours.

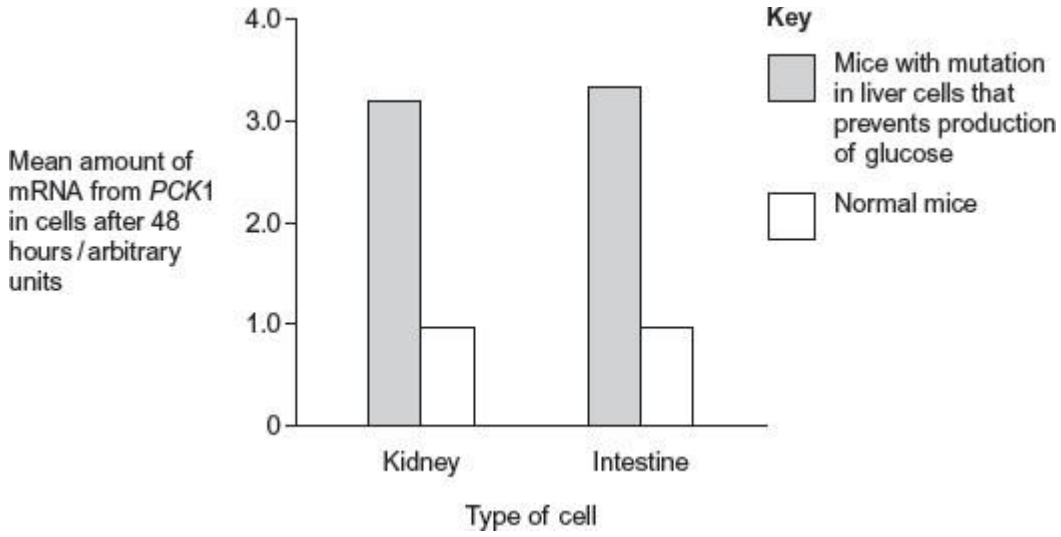
[Extra space]

(3)

The scientists then investigated mice with a mutation that prevents their liver cells making glucose. They kept a group of these mice without food for 48 hours. After 48 hours, the mean blood glucose concentrations of the mutant mice and the normal mice were the same.

The scientists investigated how blood glucose concentration is controlled in these mutant mice. An enzyme required for synthesis of glucose is coded for by a gene called *PCK*1. The scientists measured the mean amount of mRNA produced from this gene in cells from the kidneys and intestines of normal mice and mutant mice. They did this with mice that had previously been without food for 48 hours.

The scientists' results are shown in the graph.



(b) Use information from the graph to suggest how blood glucose concentration is controlled inthe mutant mice, compared with the normal mice.

[Extra space]

(3)

(c) The scientists performed statistical tests on the data shown in the graph, to see whetherthe differences in the amount of mRNA in cells from normal and mutant mice were significant. Both the probability values they obtained were $p<0.01$.

Explain what this means about the differences in the amounts of mRNA produced.

[Extra space]

(2)

(Total 8 marks)

Some mice have diabetes. The diabetes causes the blood glucose concentration to become very

3

high after a meal. Scientists investigated the use of an inhibitor of amylase to treat diabetes.

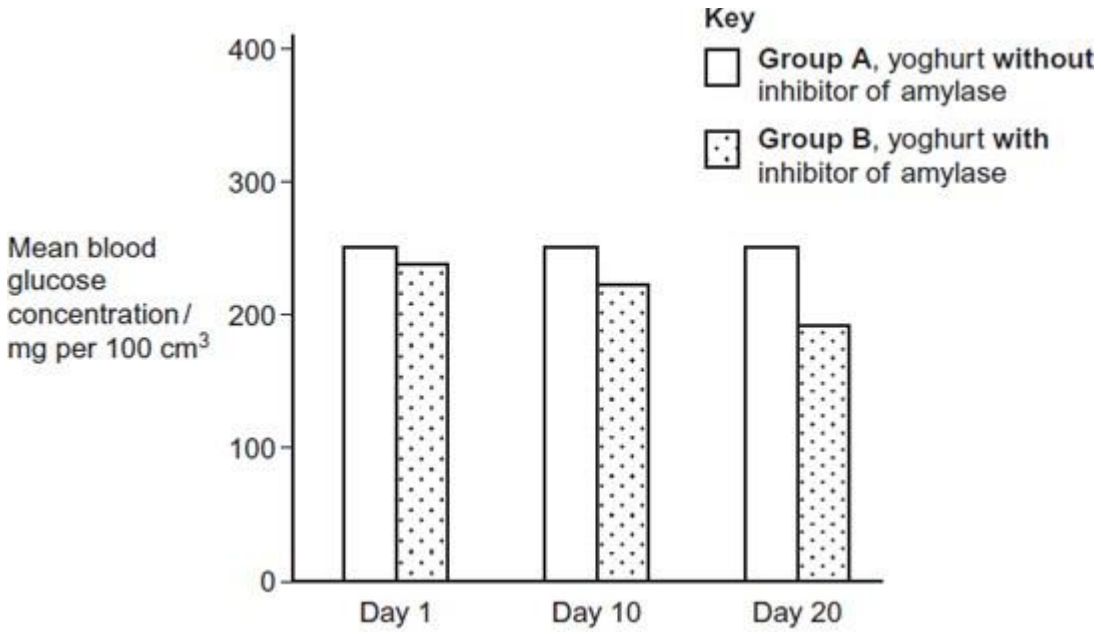
The scientists took 30 mice with diabetes and divided them into two groups, **A** and **B**.

- **Group A** was given yoghurt **without** the inhibitor of amylase each day.
- **Group B** was given yoghurt **with** the inhibitor of amylase each day.

Apart from the yoghurt, all of the mice were given the same food each day.

The scientists measured the blood glucose concentration of each mouse, 1 hour after it had eaten. This was done on days 1, 10 and 20 after the investigation started.

The following figure shows the scientists' results.



(a) **Group A** acted as a control in this investigation.

Explain the purpose of this group.

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(2)

(b) Apart from the yoghurt, it was important that all of the mice were given the same food eachday.

Give **two** reasons why it was important that all of the mice were given the same food each day.

1. _____

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2. _____

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(2)

(c) The scientists' hypothesis was that adding the inhibitor of amylase to the food would lead toa lower blood glucose concentration.

Use your knowledge of digestion to suggest how the addition of the inhibitor could lead to a lower blood glucose concentration.

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(2)

(d) Give **one** reason why these results may **not** support the use of the inhibitor of amylase to treat diabetes in mice.

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(2)

(Total 8 marks)

(a) When insulin binds to receptors on liver cells, it leads to the formation of glycogen from

4 glucose. This lowers the concentration of glucose in liver cells.

Explain how the formation of glycogen in liver cells leads to a lowering of blood glucose concentration.

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(2)

People with type II diabetes have cells with low sensitivity to insulin. About 80% of people with type II diabetes are overweight or obese. Some people who are obese have gastric bypass surgery (GBS) to help them to lose weight.

Doctors investigated whether GBS affected sensitivity to insulin. They measured patients' sensitivity to insulin before and after GBS. About half of the patients had type II diabetes. The other half did not but were considered at high risk of developing the condition.

The table below shows the doctors' results. The higher the number, the greater the sensitivity to insulin.

Patients	**Mean sensitivity to insulin / arbitrary units (± SD)**	
	Before gastric bypass surgery	**1 month after gastric bypass surgery**
Did not have diabetes	0.55 (± 0.32)	1.30 (± 0.88)
Had type II diabetes	0.40 (± 0.24)	1.10 (± 0.87)

(b) The doctors concluded that many of the patients who did not have type II diabetes were athigh risk of developing the condition.

Use the data in the table to suggest why they reached this conclusion.

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(2)

(c) The doctors also concluded that GBS cured many patients' diabetes but that some werenot helped very much.

Do these data support this conclusion? Give reasons for your answer.

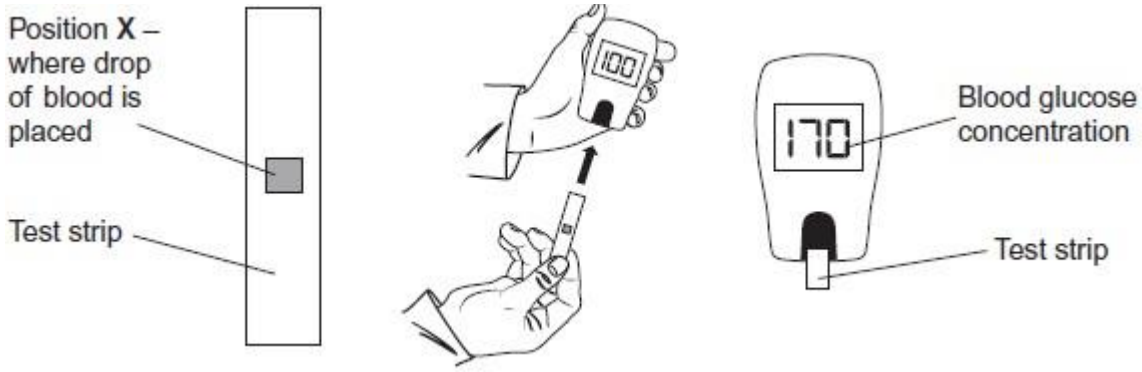
(Extra space)

(3)

(Total 7 marks)

5 A glucometer is a device used to measure blood glucose concentration. A person uses a test strip that goes into the glucometer. They put a drop of blood onto the test strip. There are substances on the test strip that produce a colour change with glucose. The higher the concentration of glucose, the deeper the colour produced. The glucometer measures the depth of colour produced and converts this into a glucose concentration. A new test strip is used for each blood test.

Figure – glucometer and test strip



The following equations show how the substances on the test strip produce a colour change.

$$\text{Glucose + oxygen} \xrightarrow{\text{Glucose oxidase}} \text{gluconic acid + hydrogen peroxide}$$

$$\text{Hydrogen peroxide + dye with colour A} \xrightarrow{\text{Peroxidase}} \text{dye with colour B + water}$$

Non-diabetics have no glucose in their urine. Diabetics have glucose in their urine if their blood glucose concentration rises above about 170 mg 100 cm^{-3}.

Before the glucometer was available, diabetics used test strips to measure the concentration of glucose in their urine as a means of measuring their blood glucose concentration. When testing urine, the colour of the test strip is compared against a colour chart which gives a glucose concentration range for the colour produced.

(a) Identify all the substances located at position **X** on the test strip before a drop of blood is added.

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_____

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(2)

(b) Before the glucometer was available, diabetics used test strips to measure theconcentration of glucose in their urine as a means of measuring their blood glucose concentration.

Give **two** reasons why this method of testing urine would **not** give an accurate measurement of blood glucose concentration.

1. _____

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2. _____

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(2)

(Total 4 marks)

6 There are two types of diabetes: type 1 and type 2.

- People with type 1 diabetes do not produce enough insulin.
- People with type 2 diabetes do produce insulin but have cells which do not respond toinsulin.

Doctors use a glucose tolerance test to help diagnose people with diabetes. They start each test after a person has not eaten overnight. They measure a person's blood glucose concentration. The person then drinks a solution containing 75 g of glucose. The doctors measure the person's blood glucose concentration 2 hours later. During the test, the person remains at rest.

Figure 1 shows three diagnoses that can be made from the results of the test.

Figure 1 – glucose tolerance test results and diagnoses

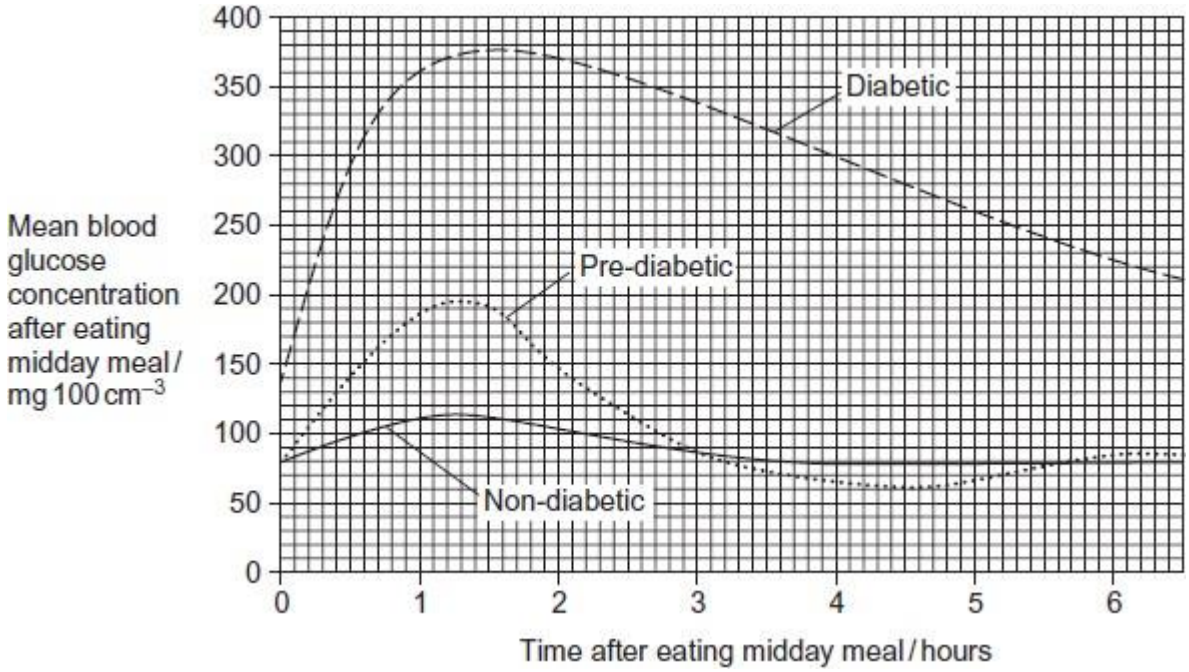
Blood glucose concentration after 2 hours / mg 100 cm^{-3}	**Diagnosis**	**Comments**
≤ 110	Non-diabetic	Low risk for future diabetes

Between 140 and 200	Pre-diabetic	High risk for future diabetes. Some doctors recommend that the upper value should be lowered to 180 mg 100 cm^{-3}
≥ 200	Diabetic	Confirm by doing a second test

A researcher monitored the mean blood glucose concentration of a non-diabetic, a pre-diabetic and a diabetic after they had each eaten a midday meal.

His results are shown in **Figure 2**.

Figure 2



(a) People with type 1 diabetes are described as being insulin-dependent.Suggest why they are described as insulin-dependent.

_____

_____

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(1)

(b) Some people with type 2 diabetes have cells which do **not** respond to insulin. Explain how this leads to a reduced ability to regulate blood glucose concentration.

(Extra space)

(3)

(c) During a glucose tolerance test the person remains at rest.Why is it important that the person remains at rest?

(2)

(d) Use **Figure 2** to calculate how many times the maximum mean blood glucose concentration of the pre-diabetic is greater than the maximum of the non-diabetic person. Show your working.

Answer =

(2)

(e) Give **three** differences between the method used by the researcher to obtain the results in **Figure 2** and the method doctors use to carry out a glucose tolerance test.

1. _____

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2. _____

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3. _____

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(3)

(f) Some doctors have recommended that the upper value used in the glucose tolerance testshould be lowered to 180 mg 100 cm^{-3}.
Using information from **Figure 1** and **Figure 2**, suggest why.

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(Extra space)_____

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(3)

(Total 14 marks)

Resource A

7

A glucometer is a device used to measure blood glucose concentration. A person uses a test strip that goes into the glucometer. They put a drop of blood onto the test strip. There are substances on the test strip that produce a colour change with glucose. The higher the concentration of glucose, the deeper the colour produced. The glucometer measures the depth

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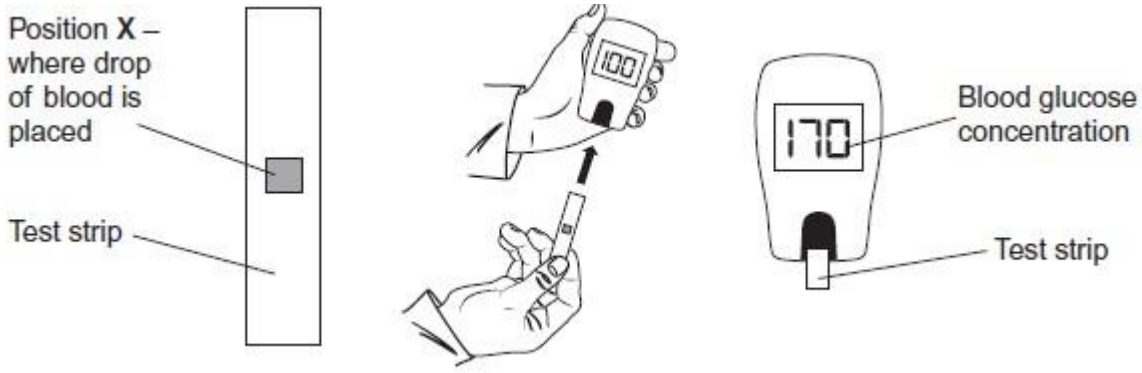

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Resource B

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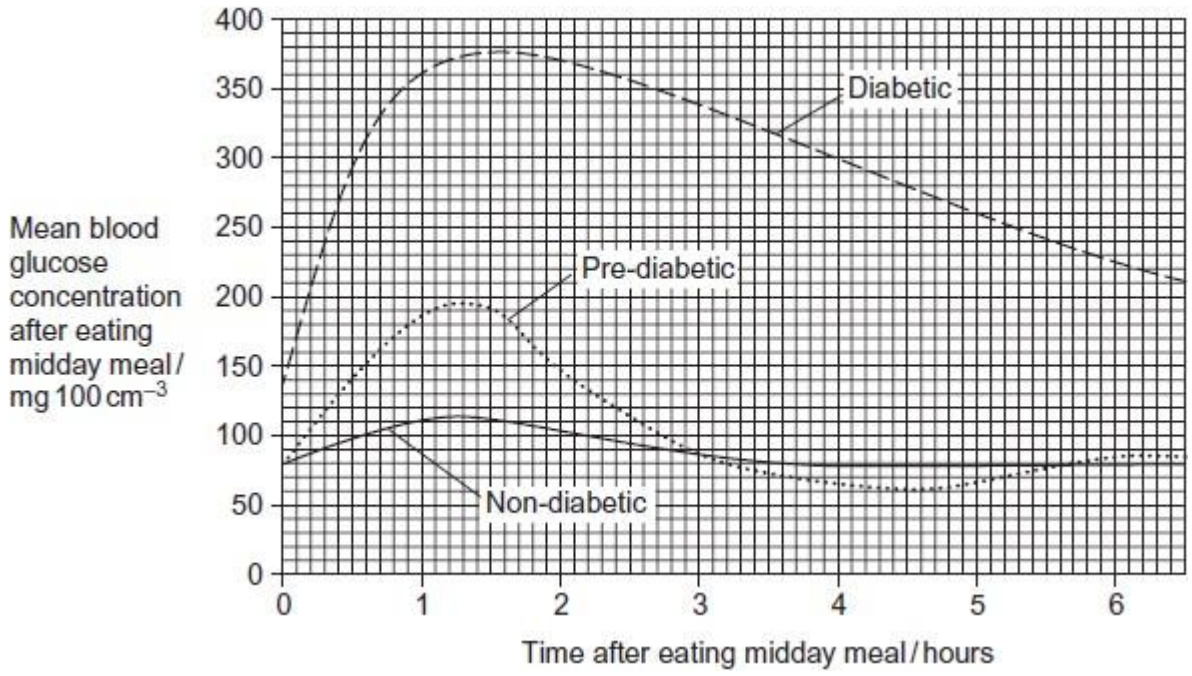
His results are shown in **Figure 3**.

Figure 3



A laboratory worker suspected she had type 2 diabetes but did not have a glucometer. Instead she added a drop of her blood to a test strip and used a colour chart to estimate her blood glucose concentration as 140 mg 100 cm^{-3}.

Is it valid to conclude that she did have type 2 diabetes?

Use this information, and **Resource A** and **Resource B**, to explain your answer.

(Extra space)

(Total 3 marks)

8 (a) Adrenaline binds to receptors in the plasma membranes of liver cells. Explain how this causes the blood glucose concentration to increase.

(Extra space)

(2)

(b) Scientists made an artificial gene which codes for insulin. They put the gene into a virus which was then injected into rats with type I diabetes. The virus was harmless to the rats but carried the gene into the cells of the rats.

The treated rats produced insulin for up to 8 months and showed no side-effects. The scientists measured the blood glucose concentrations of the rats at regular intervals. While the rats were producing the insulin, their blood glucose concentrations were normal.

(i) The rats were not fed for at least 6 hours before their blood glucose concentrationwas measured. Explain why.

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(1)

(ii) The rats used in the investigation had type I diabetes. This form of gene therapy maybe less effective in treating rats that have type II diabetes. Explain why.

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(1)

(iii) Research workers have suggested that treating diabetes in humans by this method ofgene therapy would be better than injecting insulin. Evaluate this suggestion.

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*(Extra space)*_____

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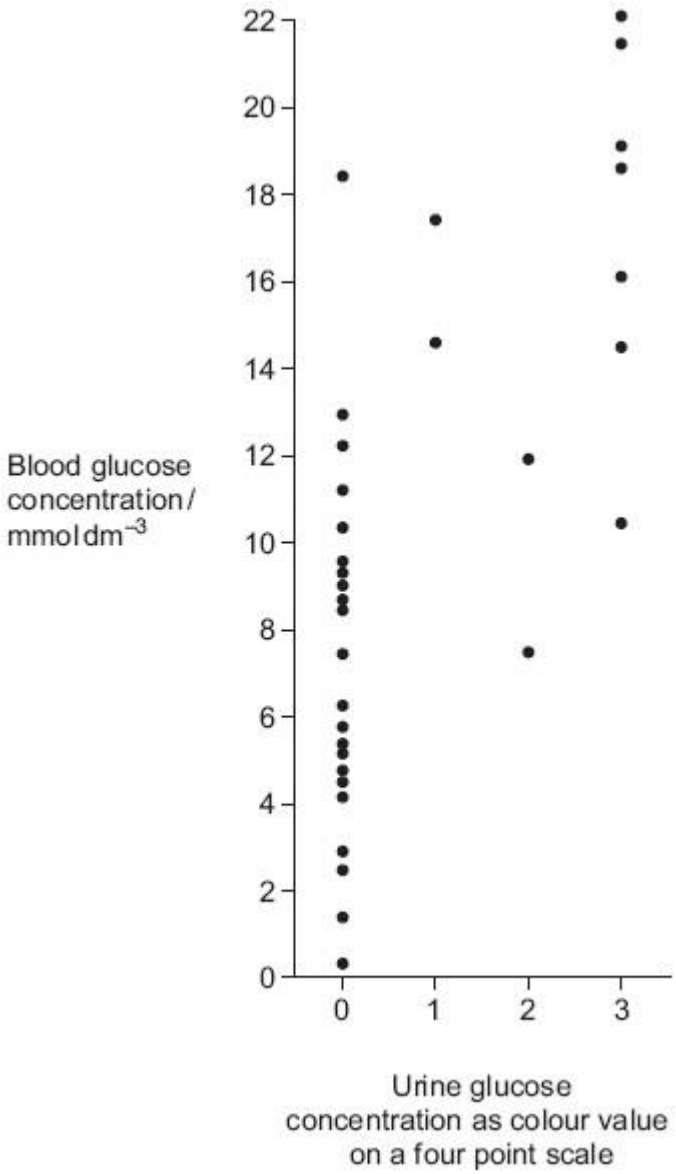
(4)

(Total 8 marks)

9 (a) Technicians in a hospital laboratory tested urine and blood samples from a girl with diabetes at intervals over a one-year period. Each time the technicians tested her urine, they also measured her blood glucose concentration. Their results are shown in the graph.



(i) The girl who took part in this investigation was being successfully treated with insulin.The graph shows that on some occasions, the concentration of glucose in her blood was very high. Suggest why.

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(2)

(ii) Use the graph to evaluate the use of the urine test as a measure of blood glucoseconcentration.

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(3)

(b) Diabetic people who do not control their blood glucose concentration may become unconscious and go into a coma. A doctor may inject a diabetic person who is in a coma with glucagon. Explain how the glucagon would affect the person's blood glucose concentration.

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(2)

(Total 7 marks)

A glucose biosensor is an instrument used to measure glucose concentration. It contains an

10

enzyme called glucose oxidase.

(a) A glucose biosensor detects only glucose. Use your knowledge of the way in whichenzymes work to explain why.

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(3)

(b) It is better to use a biosensor than the Benedict's test to measure the concentration ofglucose in a sample of blood. Suggest **two** reasons why.

1. _____

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2. _____

_____

(2)

(c) (i) Diabetes mellitus is a disease that can lead to an increase in blood glucoseconcentration. Some diabetics need insulin injections. Insulin is a protein so it cannot be taken orally. Suggest why insulin cannot be taken orally.

_____

_____

_____

(1)

(ii) A drug company produced a new type of insulin. Scientists from the company carried out a trial in which they gave this new type of insulin to rats. They reported that the results of this trial on rats were positive. A newspaper stated that diabetics would

benefit from this new drug. Suggest **two** reasons why this statement should be viewed with caution.

1. _____

_____

2. _____

_____

(2)

(Total 8 marks)

11

(a) Sucrose, maltose and lactose are disaccharides.

(i) Sucrase is an enzyme. It hydrolyses sucrose during digestion. Name the products ofthis reaction.

_____ and _____

(2)

(ii) Sucrase does **not** hydrolyse lactose. Use your knowledge of the way in which enzymes work to explain why.

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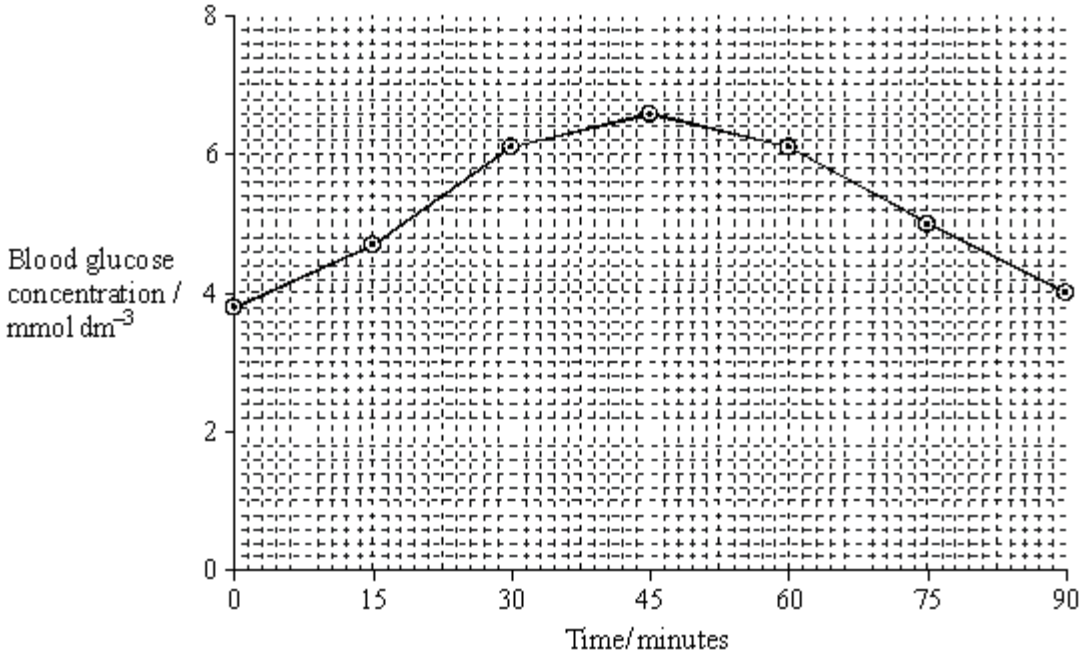
(2)

(b) A woman was given a solution of sucrose to drink. Her blood glucose concentration was measured over the next 90 minutes. The results are shown on the graph.



(i) Describe how the woman's blood glucose concentration changed in the period shownin the graph.

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(2)

(ii) Explain the results shown on the graph.

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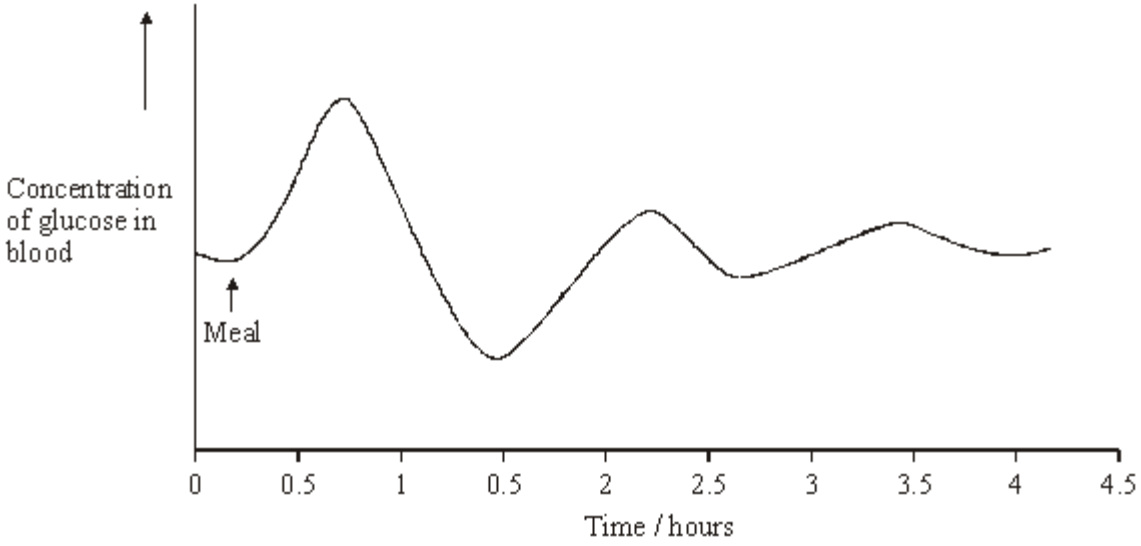
(2)

(Total 8 marks)

12 (a) The graph shows changes in the concentration of glucose in a person's blood following a meal.



Changes in the concentration of glucose are controlled by the hormones glucagon and insulin. Write the letters **X** and **Y** on the graph to show

X a time when glucagon secretion would be high;

Y a time when insulin secretion would be high.

(1)

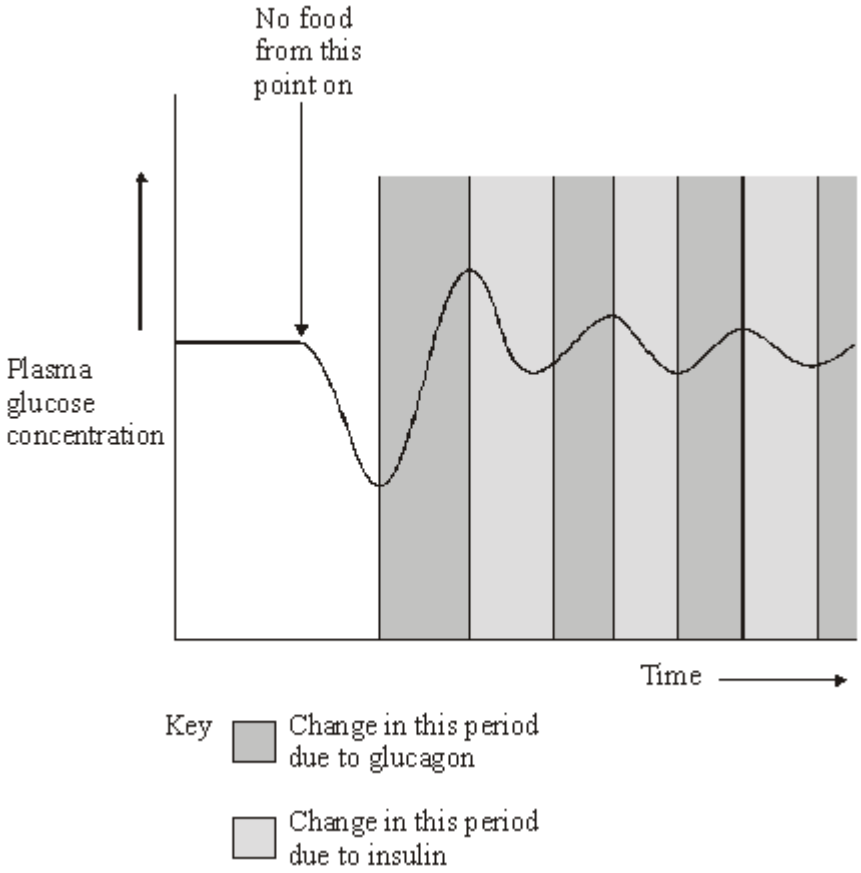
S (b) Many diabetics require regular injections of insulin. Describe how bacteria can be genetically modified to produce human insulin.

(4)

(Total 5 marks)

13 Homeostatic mechanisms maintain a constant environment in the body.

(a) The graph shows changes in plasma glucose concentration that occurred in a person who went without food for some time.



Use evidence from the graph to explain the role of negative feedback in the control of plasma glucose concentration.

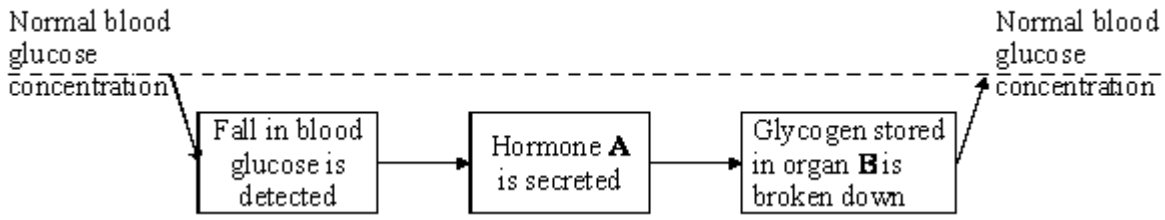
(5)

(b) How does maintaining a constant body temperature allow metabolic reactions in cells to proceed with maximum efficiency?

(5)

(Total 10 marks)

14 The diagram shows some of the events which maintain blood glucose concentration in a mammal.



(a) Name

(i) hormone **A**; _____

(ii) organ **B**. _____

(2)

(b) Explain why the events shown in the diagram can be described as an example of negativefeedback.

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(1)

(Total 3 marks)

15 (a) Describe how insulin reduces the concentration of glucose in the blood.

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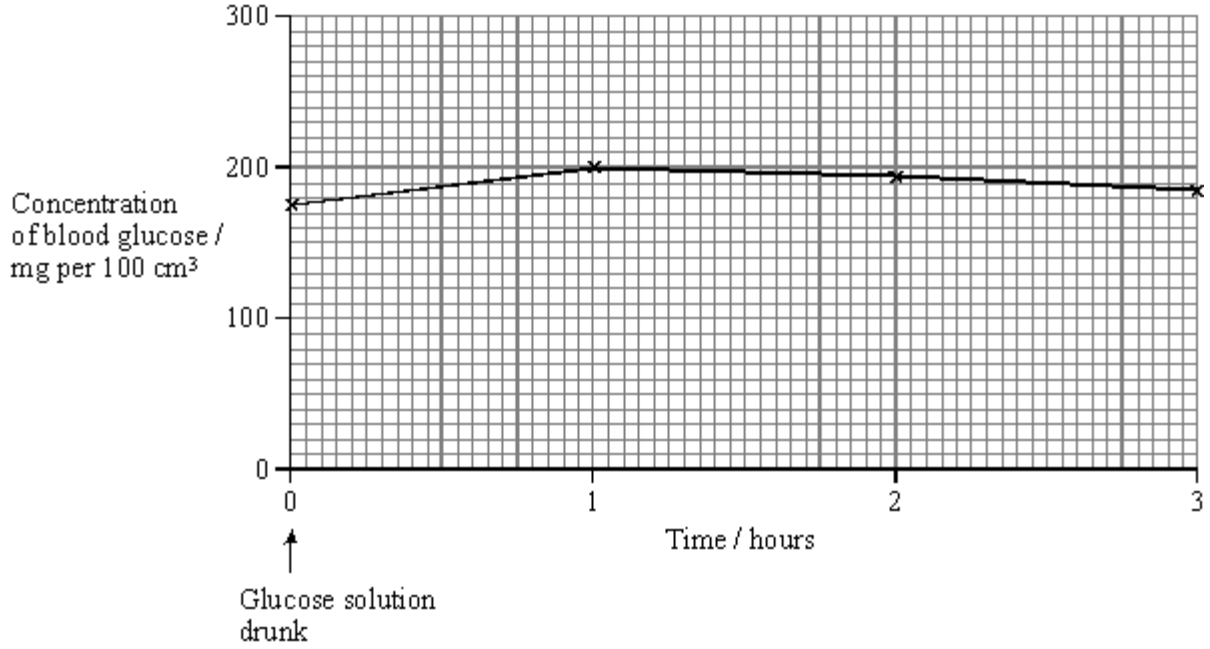
(3)

Some people produce no insulin. As a result they have a condition called diabetes. In an investigation, a man with diabetes drank a glucose solution. The concentration of glucose in his blood was measured at regular intervals. The results are shown in the graph.



(b) Suggest **two** reasons why the concentration of glucose decreased after 1 hour even though this man's blood contained no insulin.

1. _____

_____

2. _____

_____

(2)

(c) The investigation was repeated on a man who did not have diabetes. The concentration ofglucose in his blood before drinking the glucose solution was 80 mg per 100 cm^3. Sketch a curve on the graph to show the results you would expect.

(1)

(d) The diabetic man adopted a daily routine to stabilise his blood glucose concentration withinnarrow limits. He ate three meals a day: breakfast, a midday meal and an evening meal. He injected insulin once before breakfast and once before the evening meal.

The injection he used before breakfast was a mixture of two types of insulin. The mixture contained slow-acting insulin and fast-acting insulin.

(i) Explain the advantage of injecting both types of insulin before breakfast.

_____

_____

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_____

(2)

(ii) One day, the man did not eat a midday meal. Suggest **one** reason why his blood glucose concentration did not fall dangerously low even though he had injected himself with the mixture of insulin before breakfast.

_____

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(1)

(Total 9 marks)

16

(a) What is homeostasis?

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(1)

(b) Describe the role of the hormone glucagon in the control of blood sugar concentration.

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(4)

(c) The kidney removes various substances from the blood plasma. The clearance value for asubstance is the volume of blood cleared of that substance by the kidney in one minute. This clearance value can be calculated using the equation.

$$C = \frac{U \times V}{P}$$

where the concentration of a substance in the blood is P g cm^{-3}

the concentration of a substance in the urine is U g cm^{-3}

the volume of urine produced is V cm^3 per minute

(i) Use the equation to work out the clearance value of glucose.

_____

_____

(1)

(ii) Explain how the activity of the kidney results in this clearance value for glucose.

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(3)

(Total 9 marks)

17 Diabetes is a disorder affecting the ability to control blood glucose concentration. One type of diabetes can be due to an abnormality of the insulin receptors in the cell surface membranes of cells in the liver and muscles. A high blood glucose concentration and the presence of glucose in the urine are signs of this type of diabetes.

(a) (i) Suggest **one** way in which the insulin receptors might be abnormal.

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_____

(1)

(ii) Explain how the presence of abnormal insulin receptors results in a high bloodglucose concentration.

(2)

(iii) Explain how the kidneys normally prevent glucose appearing in the urine of anon-diabetic person.

(3)

(b) Twin studies have been used to determine the relative effects of genetic and environmentalfactors on the development of this type of diabetes. The table shows the concordance (where both twins have the condition) in genetically identical and genetically non-identical twins.

Concordance in genetically identical twins / %	Concordance in genetically non-identical twins /%
85	35

(i) What do the data show about the relative effects of environmental and genetic factorson the development of diabetes?

(1)

(ii) Suggest **two** factors which should be taken into account when collecting the data in order to draw valid conclusions.

1. _____

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2. _____

_____

(2)

(Total 9 marks)

18 Exenatide is a drug used for treating Type 2 diabetics. Scientists investigated the effects of exenatide on insulin production.

The scientists used three groups of volunteers who were treated in the following ways.

Group 1: healthy, non-diabetics who were injected with exenatide in salt solution
Group 2: Type 2 diabetics who were injected with exenatide in salt solution
Group 3: Type 2 diabetics who were injected with salt solution.

Three hours after these injections, the scientists injected the same amount of glucose into the blood of each volunteer.
The scientists measured the rate of insulin production by each person before and after injecting the glucose.

(a) (i) **Group 1** and **Group 3** were control groups in this investigation.

Explain why each group was used.

Group 1 _____

_____

Group 3 _____

_____

(2)

(ii) The scientists measured the rates of insulin production per unit body mass.

Explain why.

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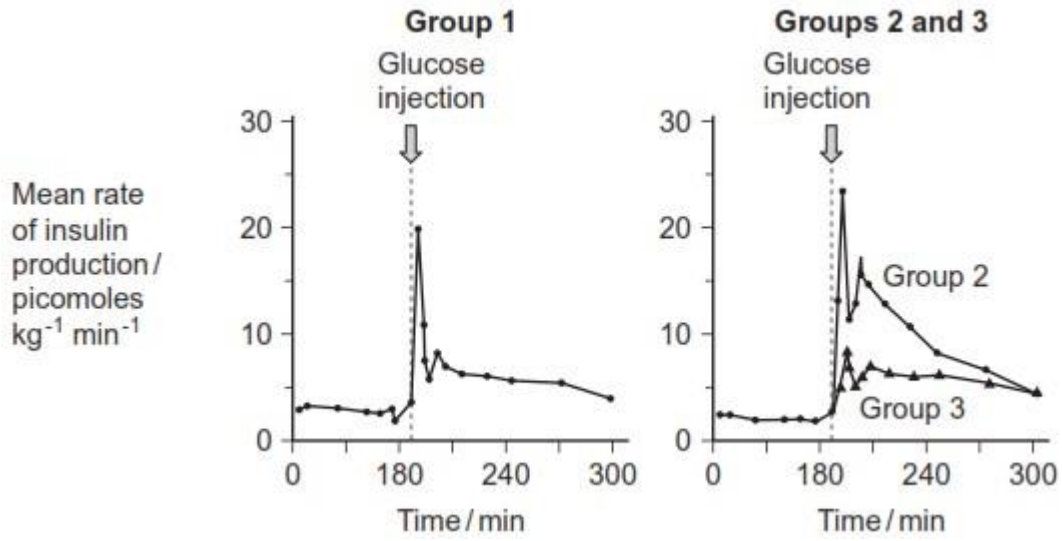
(1)

(b) The graphs show the mean rates of insulin production for each group.



Suggest how exenatide could help people with Type 2 diabetes.

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(Extra space) _____

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(3)

(Total 6 marks)

19 (a) Explain how insulin lowers the concentration of blood glucose.

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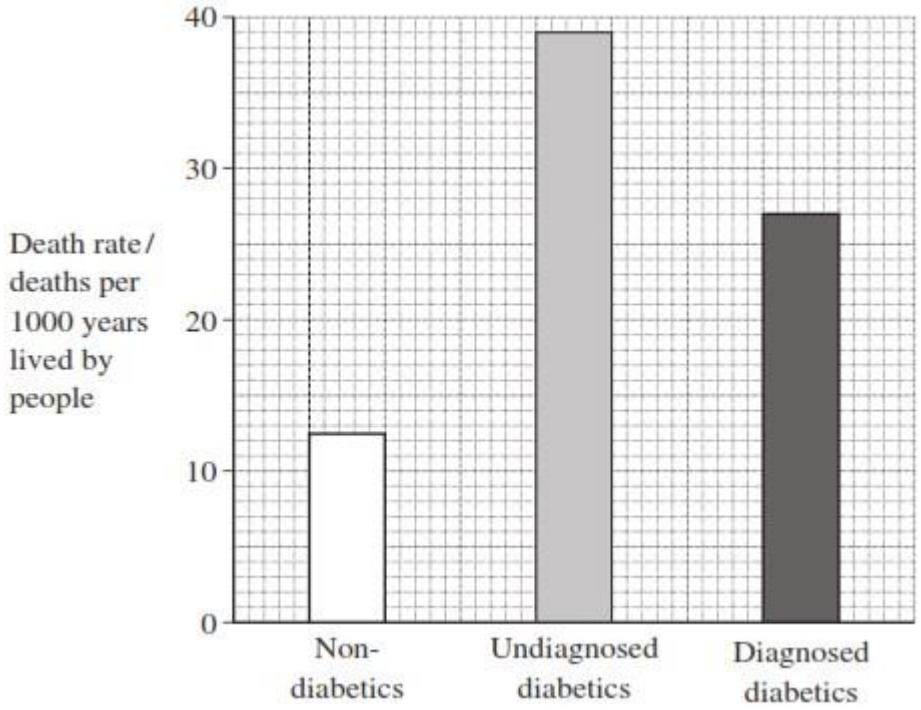
(Extra space)

(3)

(b) Doctors studied a large group of people. They recorded the death rates for non-diabetic people, undiagnosed diabetics and diagnosed diabetics.

They gave the death rates as deaths per 1000 years lived by people.

The graph shows these death rates.



(i) Calculate the ratio of the death rate of diagnosed diabetics to undiagnosed diabetics.

Ratio _____

(2)

(ii) People with undiagnosed diabetes were not receiving treatments, such as insulininjections. Suggest **one** reason for the difference in death rates for undiagnosed and diagnosed diabetics.

_____

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_____

_____

(2)

(Total 7 marks)

Mark schemes

1

(a) 1. Treat with insulin (injection/infusion);

2. (Control) diet/control sugar intake;

2. Accept '(regular) exercise'

2

(b) 1. Damage to autonomic (nervous) system in diabetic rats;

2. (Could be) pressure receptors/baroreceptors (in arteries/aorta /carotid body) don't work as well;

3. Damage to medulla

OR

Change in (number of) impulses to/from medulla;

4. (When pressure drops damage to) sympathetic system, sodoesn't speed up (enough);

5. (When pressure rises damage to) parasympathetic system, sodoesn't slow down (enough);

*Accept answers in terms of what happens in healthy rats **only** if then qualified by statement these things don't happen/happen less in rats with diabetes*

1. Accept damage to ANS

2. Ignore reference to chemoreceptors

4 and 5. Appropriate system and effect on heart rate both needed

4 max

[6]

2

(a) 1. Release of glucagon;

2. Leads to formation of glucose in liver (cells);

Reject: glucagon breaks down glycogen, or any other biological molecule

3. From non-carbohydrates / amino acids / fatty acids.

Accept: gluconeogenesis / references to glycogen as source of glucose

3

(b) 1. Mutant mice (mRNA suggests) make a lot of (the) enzyme;*Accept: PCK1 made (for enzyme made)*

2. Mutant mice use kidney / intestine (cells) to make glucose;*Accept: use other organ (than liver)*

3. Normal mice do this much less / normal mice use liver cells.

3

(c) 1. Differences significant;

Reject: references to results being significant once

2. Probability of difference being due to chance less than 0.01 / 1% / 1 in 100 / probability of difference not being due to chance more than 0.99 / 99% / 99 in 100.

Ignore: references to 0.05 / 5% / 5 in 100

2

[8] (a) 1. To show the effect of the inhibitor / drug;

3

2. To show the effect of yoghurt (on its own does not affect blood glucose);

2

(b) 1. Food is a factor affecting blood glucose / different foods containdifferent amounts of starch / glucose / sugar / carbohydrate; *Accept converse*

2. To keep starch / fibre intake the same / similar;

Accept something in food which affects the inhibitor

2

(c) 1. Fewer E-S complexes formed;

2. (With inhibitor) less / no starch digested to maltose ;

Require knowledge that maltose comes from starch

3. (So) less / no glucose from maltose;

Require knowledge that glucose comes from maltose

Accept no glucose

4. (So) less absorption of glucose (from gut);

2 max

(d) **Suitable reason; with explanation;**

Paired responses – do not mix and match

Ignore references to correlation does not prove causation, it could be due to other factors

Examples,

1. Need larger sample / only 30 mice / only 15 mice in each group;*Accept small sample size*

2. Might not be representative / anomalies might have a bigger or smaller effect;*Accept mean not reliable*

OR

3. Investigation only lasted 20 days;
   Experiment was not long enough

4. Can't see what longer term effects are;

OR

5. Fall in blood glucose is small / numbers from graph;

6. Mice with inhibitor still have a large rise in blood glucose / so don't know ifdifferences significant;
   Accept differences are due to chance

OR

7. No stats / SDs / SEs;

8. So don't know if differences significant;

OR

9. Blood glucose could continue to fall;

10. which could be harmful;

OR

11. No group without yoghurt;

12. So cannot compare to other groups;

2 max

[8]

4

(a) (Formation of glycogen)

1. Glucose concentration in cell / liver falls below that in blood (plasma) whichcreates / maintains glucose concentration / diffusion gradient;

2. Glucose enters cell / leaves blood by facilitated diffusion / via carrier(protein) /channel (protein);

Not just diffusion

2

(b) 1. Insulin sensitivity similar to / not (significantly) different from those withdiabetes;

No values for non-obese, so comparisons with 'normal' not possible

2. Overlap of SDs;*Accept SE*

3. Their sensitivity (to insulin also) improved by GBS;

2 max

(c) 1. Sensitivity (to insulin) does increase;

This part of the question concerns spread of data, not overlap of SDs

2. But large SD / large variation (after GBS);

Accept use of figures / use of SD values to make this point.

Ignore ref to SE

3. (So) some showing no / little change / get worse;

4. Do not know what sensitivity to insulin is of non-diabetics (who are not obese);*Accept 'normal' as non-diabetic*

3 max

[7] (a) 1. Glucose oxidase and peroxidase;

5

Both enzymes required

2. Dye (with colour A);

Reject 'dye with colour B'. Ignore named dyes

2

(b) 1. Concentration is given as a range (for each colour) / measurement is not precise;

2. Only measures glucose concentration above normal / above 170 (mg 100 cm^{-3}) (in blood);

3. 170 (mg 100 cm^{-3}) is an average figure / concentration for loss to urine varies (between people);

4. Difficult to match colour against chart / colour match is subjective;

2 max

[4]

6 (a) Treatment requires person receiving insulin (in some way);

Accept descriptions e.g. insulin injection

Reward idea that insulin must be received, not that it isn't being produced

1

(b) 1. No / fewer / abnormal receptors on (cell) membrane;

2. (So) fewer (glucose) transport proteins;

3. (So) less glucose can enter (cells);

4. (So) less glucose converted to glycogen;

Accept no / fewer enzymes (for this conversion) are activated

5. (So, without treatment) blood glucose concentration not lowered when high /above normal;

Accept converse

3 max

(c) 1. Movement uses muscles;

2. Movement increases (rate of) respiration;

3. Respiration uses glucose / respiration reduces blood glucose concentration;

2 max

(d) 1. Identification of 195 ± 2 and 113 ± 2;

2. Answer within range of 1.67 to 1.77 (times greater);

Ignore numbers after two decimal places

Correct answer = 2 marks

(e) 1. Meal / uncontrolled intake v 75 g glucose / controlled intake;

Must have both sides of the story for each point. Marking guidance shows researcher's method first

Idea of could eat anything in meal as against just glucose

2. (Concentration) measured over 6 hours / 6+ hours / longer v measured at 2 hours;

3. (After intake) regular monitoring / several measurements v only measured once/ at 2 hours only;

4. No fasting v fasting before test;

Credit other descriptions of fasting e.g. went without food as opposed to didn't have to

5. Not (necessarily) at rest v remained at rest;

6. Tested during afternoon v tested in morning;

Accept idea of tested at different times of the day

3 max

(f) 1. Pre-diabetics are at risk of developing diabetes / some pre-diabetics reach aconcentration of 180 (mg 100 cm^{-3}) after a meal;

2. Some pre-diabetics will now be classed as diabetic;

3. Detection leads to treatment (sooner);

4. Diabetes damages the body / is life-threatening;

Accept examples of damage e.g. blindness, heart disease

3 max

[14]

7 1. Diabetics have (blood glucose) concentration greater than 140 mg cm^{-3} / than her estimate

/ estimate suggests she is pre-diabetic;

2. Colour change is subjective / blood on test strip masks colour change;

3. Concentration given as a range / estimation is not reliable;

4. May not have fasted;

5. May not have had a drink with 75 g glucose;

6. Only one test carried out;

No mark for valid or not valid

[3]

8

(a) 1. Adenylate cyclase activated / cAMP produced / second messenger produced;

2. Activates enzyme(s) (in cell so) glycogenolysis / gluconeogenesis occurs / glycogenesis inhibited;

2. Neutral: 'glucose produced' as given in the question stem

Accept: correct descriptions of these terms

2

(b) (i) 1. Glucose / sugar in food would affect the results;

1. Accept references to starch / carbohydrateOr

2. Food / eating would affect blood glucose (level);

Or

3. (Allows time for) blood glucose (level) to return to normal;

3. Neutral: allows time for insulin to act

1 max

(ii) Type 2 diabetes is a failure to respond to insulin / still produces insulin / is notinsulin-dependent;

1

(iii) (For) – 3 max

A maximum of three marks can be awarded for each side of the argument

1. Avoids injections / pain of injections;

2. Long(er) lasting / permanent / (new) cells will contain / express gene;*Ignore references to methodology e.g. sample size not known*

3. Less need to measure blood sugar / avoids the highs and lows in bloodsugar;

4. Less restriction on diet;

(Against) – 3 max

5. Rats are different to humans;

6. May have side effects on humans;

6. *Accept: virus may be harmful / disrupt genes / cause cancer*

7. Long(er) term effects (of treatment) not known / may have caused effectsafter 8 months;

8. (Substitute) insulin may be rejected by the body;

4 max

[8]

9

(a) (i) Eaten;

Containing carbohydrate / sugar;

Glucose absorbed from intestine / into blood;

Long time after insulin injection / needs more insulin / has not taken insulin;

Does not convert glucose to glycogen / glucose not taken up from blood;

2 max

(ii) Shows positive correlation / directly proportional;

A range of results for a particular value / values (for different colours) overlap;

Urine test only an arbitrary scale / not directly related to concentration / colour is subjective / few colour values;

Accept description

3

(b) Glycogen to glucose / glycogenolysis by activating enzymes;*If name incorrect this disqualifies.*

Gluconeogenesis;

Allow explanation in terms of glucose from a non-carbohydrate / named non-carbohydrate source.

2

[7] (a) Enzyme / active site has a (specific) <u>tertiary</u> structure;

10

Only glucose has correct shape / is complementary / will bind / fit to active site;

(Forming) enzyme-substrate <u>complex</u>;

Q *Allow second mark if candidate refers to correct shape or complementary in terms of the enzyme. Do not allow 'same' shape*

Q *Do not allow third mark if active site is described as being on substrate.*

3

(b) (Only detects glucose whereas) Benedict's detects (all) reducing sugars / namedexamples;

Provides a reading / is quantitative / Benedict's only provides a colour / doesn't measure concentration / is qualitative / semiquantitative;

Is more sensitive / detects low concentration;

Red colour / colour of blood masks result;

Can monitor blood glucose concentration continuously;

Q *Do not credit quicker / more accurate unless qualified.*

Q *Allow Benedict's detects monosaccharides for first mark point.*

2 max

(c) (i) Broken down by enzymes / digested / denatured (by pH) too large to beabsorbed;

1

(ii) Study not carried out on humans / only carried out on rats;
Long-term / side effects not known;
Scientists have vested interest;
Study should be repeated / further studies / sample size not known;

2 max

[8]

11 (a) (i) Glucose;

Fructose;

Any order.

2

(ii) Lactose has a different shape / structure;

Does not fit / bind to active site of enzyme / sucrase;

Only allow a second mark if reference is made to the active site.
Max 1 mark if active site is described as being on the substrate.

OR

Active site of enzyme / sucrase has a specific shape / structure; Does not fit / bind to lactose;

Do not accept same shape.

2

(b) (i) Rose and fell;

Peak at 45 (minutes) / concentration of 6.6 (mmol dm^{-3});

2

(ii) Glucose (produced by digestion) is absorbed / enters blood;

Decrease as used up / stored;

2

[8]

12 (a) On graph: **X** where glucose level is below norm

AND **Y** where glucose level is above norm;

1

(b) EITHER
1. Use m-RNA + reverse transcriptase to produce gene / (c)-DNA;
2. Restriction enzyme to cut open plasmid;
3. Add sticky ends (to insulin gene and to plasmid);OR Allow:
1. Cut out insulin gene / cut open plasmid with restriction enzyme;
2. Use same restriction enzyme on second DNA;
3. Reference to (complementary) sticky ends;
4. Use ligase to join 2 DNA molecules;5. Modified plasmid taken up by bacteria;

max 4

[5]

Quality of Communication

13 The answers to all sections of this question require the use of continuous prose.
Quality of language should be considered in crediting points in the scheme. In order to gain credit, answers should be expressed logically and unambiguously, using scientific terminology where appropriate.

(a) 1. Deviation of a value from norm initiates corrective mechanisms;
2. fluctuations in plasma glucose concentration detected by hypothalmus / isletcells in pancreas;
3. initial decrease, no food given (in plasma glucose) stimulates (increased) secretion of glucagon;
4. increases (in plasma glucose) stimulate (increased) secretion of insulin from βcells as secretors;
5. correct ref. to interconversion of glycogen / glucose / increased / decreaseduptake of glucose by cells (as appropriate) / correct ref to change in membrane permeability;

5

(b) 1. Body temp. / 37 °C is optimum temp for enzymes;
2. excess heat denatures enzymes / alters tertiary structure / alters shape ofactive site / enzyme so substrate cannot bind / eq;
3. reactions cease / slowed;
4. too little reduces kinetic energy of molecules / moleculesmove more slowly;
5. fewer collisions / fewer ES complexes formed'

5

[10]

14 (a) (i) glucagon;

Insist on spelling

1

(ii) liver;

1

(b) A change to the normal level initiates a response which reduces the effect / reverses / acts against the change;

1

[3]

15 (a) insulin binds to specific receptors (on membranes);

insulin activates carrier proteins / opens channels / causes more channels to form; insulin increases the permeability of liver / muscle cells / tissues to glucose; insulin action results in glucose conversion to glycogen / glycogenesis;

3 max

(b) glucose is used in cell respiration / as energy source / in metabolism;

(must qualify how glucose is used)

glucose enters cells / converted to glycogen in cells;
glucose is excreted / in urine;

(do not credit no reabsorption of glucose in kidneys)

2 max

(c) line from 80 mg, increasing but keeping below line for diabetic,dropping to 80 mg;

(line must stablise at, or fluctuate around 80 mg)

1

(d) (i) fast acting insulin reduces blood glucose from breakfast;slow acting insulin reduces blood glucose from other meals before the evening meal / eliminates the need to inject at lunch;

(must be a reference to the meals)
(one mark if neither of the above but a clear reference is made to glucose conversion to glycogen);

2

(ii) glucagon is still active; glycogen converted to glucose / glycogenolysis; insulin injected at breakfast causes cells to take up glucose too slowly for levels to become dangerously low; person is not active so little glucose used in respiration;

(do not credit statements about consuming large breakfasts)

1 max

[9]

16 (a) Maintaining a constant internal environment;

1

(b) Binds to (specific) receptor;
On muscle / liver cell;
Activation of enzymes (in liver);
Hydrolysis of glycogen;
(Facilitated) diffusion of glucose out of (liver cells) cells;
Increases blood glucose levels;

4

(c) (i) 0 / zero;

1

(ii) 1. Filtration, out of blood (plasma) / into renal capsule;
2. (Hydrostatic) pressure ;
3. PCT;
4. All reabsorbed;
5. Active transport;

3 max

[9]

17 (a) (i) different shape / different tertiary structure / different sequence of amino acids;

1

(ii) insulin unable to attach to receptors;reduced / no uptake of glucose into cells / no carrier proteins / channels for glucose transport;

2

(iii) glucose reabsorbed / absorbed into blood;from proximal tubule;
by active transport / involving membrane carriers;

3

(b) (i) larger genetic component;
(must be comparative)

1

(ii) number of cases studied;
matched samples; age of twins; named environmental factor;;
(allow 2 marks for 2 different factors if no overlap in effect)

family history of diabetes;
method of diagnosis; same sex in non-identical twins;

2 max

[9]

18

(a) (i) Group 1: To see 'normal' response / non-diabetic response / as comparison with diabetic response;

Group 3: To ensure any difference was due to exenatide / not due to salt / as comparison to show effect of exenatide on diabetes / to ensure effect was not psychosomatic / to see placebo effect;

2

(ii) Different mass of person → different amount insulin secreted / larger person secretes more insulin / (valid) basis for comparisons between people;
Ignore refs to accuracy

1

(b) Any **three** from:
Increases sensitivity of pancreas cells to glucose;
Increases insulin secretion (by pancreas) / similar insulin production as healthy / non-diabetic / Group 1;
So more stimulation of cells / of liver / of muscles;
Causes more glucose uptake (from blood) / blood glucose level lowered / kept at normal level / can control blood glucose conc.;
Person can consume more carbohydrate / glucose / doesn't need special diet / will not develop symptoms of diabetes;

3 max

[6] (a) Binds to receptor on target/liver/muscle cell;

19

Reject reference to insulin as an enzyme

Causes more transport/carrier proteins to become active/
move to (plasma) membrane;

Glucose (diffuses) into cells (and lowers blood glucose);

(Enzymes in cells) convert glucose to glycogen;

Stimulates fatty acids/lipid/fat formation (from glucose);

Raises rate of respiration (in cells), using more glucose;

3 max

(b) (i) 27 : 39;
1 : 1.44;
2 *marks for 1 : 1.44*
Accept 0.69 : 1
Accept 9 : 13

2

(ii) One suitable reason; with explanation;

e.g. undiagnosed
Diabetic coma/brain cells not enough respiration;
Due to low blood glucose/acidosis/dehydration;

Heart attacks/coronary heart disease;
Due to faster atheroma formation/damage to arteries;

Kidney failure;
Due to damage to blood vessels;

2 max

[7]