

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] (a) 1. Release of glucagon;

2

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 contain different 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 if differences 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]

- (a) (Formation of glycogen)

4

1. Glucose concentration in cell / liver falls below that in blood (plasma) which creates / 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 with diabetes;

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

6

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 **2**
- (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 a concentration of $180 \text{ (mg } 100 \text{ cm}^{-3}\text{)}$ 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**

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 / carbohydrate Or*
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 not insulin-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 blood sugar;
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 effects after 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) tertiary structure;

10

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

(Forming) enzyme-substrate complex;

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 / named examples;

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 be absorbed;

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] (a) (i) Glucose;

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

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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

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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 hypothalamus / islet cells 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 β cells as secretors;
 5. correct ref. to interconversion of glycogen / glucose / increased / decreased uptake 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 of active site / enzyme so substrate cannot bind / eq;
 3. reactions cease / slowed;
 4. too little reduces kinetic energy of molecules / molecules move more slowly;
 5. fewer collisions / fewer ES complexes formed'

5

[10] (a) (i) glucagon;

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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]

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

15

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 stabilise 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] (a) Maintaining a constant internal environment;

- (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] (a) (i) different shape / different tertiary structure /

17 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] (a) (i) Group 1: To see 'normal' response / non-diabetic response /

18

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;

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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]