AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.6.4.2 CONTROL OF BLOOD GLUCOSE

SCORE	PERCENTAGE
/141	%

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Q1.

(a) (Insulin stimulates release of osteocalcin – no mark)

1. Osteocalcin causes **more** (release of) insulin;

2. (**More**) insulin causes **more** (inactive) osteocalcin (release);

1. and 2. Idea of more required but other words can be used

1. and 2. Ignore ref. to further

1. and 2. Ignore ref. to more B cells / osteoblasts stimulated

2

(b) 1. (Change in pH) changes / breaks ionic / hydrogen bonds;

Ignore ref. to peptide or sulfur-sulfur bonds

Accept polar bonds

2. Changes tertiary structure;

Ignore changes to primary structure

Reject ref. to active site / enzyme

Accept forms binding site

Ignore 3D

Accept 3°

2

(c) 1. (Insulin) leads to more transport proteins / channel (proteins) / carrier (proteins) for glucose;

Ignore references to opening channels

Accept co-transport / GLUT 1 or 4 protein

2. More glucose (for respiration / glycolysis) enters cell;

*Idea of more required **once** to cover both mark points*

Ignore references to glycogen formation / fat metabolism / enzyme activation

2

[6]

Q2.

(a) 1. (Usually)Type II produce insulin;

2. Cells / receptors less sensitive / responsive (to insulin)
OR
Faulty (insulin) receptors;

3. (Treated / controlled by) diet / exercise;

2. Accept: cells / receptors do not respond.

2. Accept: 'fewer receptors'

3. Accept: (Treated / controlled by) weight loss / medication / drugs.

3. Ignore: diabetes is caused by diet / exercise.

2 max

(b) Tick in box 4

1

(c) 1. Attach to gene / DNA / promoter region;
2. Stimulate / inhibit transcription / RNA polymerase;

Note: Genes being expressed / inhibited or switched on / off is not enough on its own.

2

(d) 1. (Effective as) group A / with iPS / treated lower than group B / with diabetes;
2. (Effective as) group A similar to group C / without diabetes;
3. (Investigation) done on mice not humans;
4. Only shows results for 12 weeks / short-time period / long-term effects not known;

Ignore: Only one study / not repeated / sample size.

2. Accept: 'healthy' or 'normal' or control for group C.

4

[9]

Q3.

(a) 1. Treat with insulin (injection/infusion);
2. (Control) diet/control sugar intake;

2. Accept '(regular) exercise'

2

(b) 1. Damage to <u>autonomic</u> (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, so doesn't speed up (enough);
5. (When pressure rises damage to) parasympathetic system, so doesn'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]

Q4.

(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]

Q5.

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

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]

Q6.

(a) (Formation of glycogen)

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]

Q7.

(a) 1. Glucose oxidase and peroxidase;

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]

Q8.

(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

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 (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]

Q9.

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]

Q10.

(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]

Q11.

(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]

Q12.

(a) Enzyme / active site has a (specific) tertiary structure;

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]

Q13.

(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]

Q14.

(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]

Q15.

Quality of Communication

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 / 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 / moleculesmove more slowly;
5. fewer collisions / fewer ES complexes formed'

5

[10]

Q16.

(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]

Q17.

(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]

Q18.

(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]

Q19.

(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]

Q1.

It was hoped that part (a) would be a relatively accessible start to the paper but this did not prove to be the case. However, it discriminated quite well. To address this question, students required understanding that positive feedback is something producing a **greater** deviation from the normal state. They were told that positive feedback was involved and then needed to apply knowledge of the principle to this context. Good answers were seen from a minority (13%) of students who gained both marks by stating that osteocalcin causes **more** insulin and this leads to **more** osteocalcin. About 30% gained one mark by giving half the story; for example, insulin leads to more osteocalcin. Many wrote about insulin or osteocalcin stimulating the production of the other but that re-states what is in the diagram, with no idea of 'more'. Many also wrote about one leading to 'further' production but that could be at the same rate. Others rather over-complicated the situation and wrote about β cells, osteoblasts or osteoclasts being stimulated to divide. A few gave rote-learnt answers consisting of definitions of positive feedback but with no reference to the diagram, or to osteocalcin and insulin. These answers were not credited. In all, 55% of students failed to score.

In question (b), 28% of students gained both marks by stating that the acidic pH would change ionic or hydrogen bonds in osteocalcin and this would change its tertiary structure. Nearly 40% obtained one mark for noting only the change to the tertiary structure. Many of the 32% who failed to score used terminology below A-level standard and only made vague statements about the acid changing the shape of the protein. Many wrote about changes to the 'active site' of the protein and did not score. Many students appear to think that all proteins are enzymes and all have active sites. They were told in the stem of the question that osteocalcin is a hormone. As such, it acts as a chemical messenger that binds specifically onto receptors of target cells; in this case β cells. Osteocalcin has a **binding** site (or even sites), not an active site, it is not a catalyst and it doesn't have a substrate. The same misconception was evident in some later questions. The question discriminated well.

Question (c) was based upon the specification content that requires understanding of "The action of insulin by controlling the uptake of glucose by regulating the inclusion of channel proteins in the surface membranes of target cells". The specification does not give specific examples of target cells. In Fig. 1, students were shown that osteoblasts are target cells for insulin. In the event, 19% of students obtained both marks by stating that more glucose (for respiration) enters osteoblasts because more channel proteins join the surface membrane. About 20% obtained one mark, for suggesting there would be an increase in the uptake of glucose. These students did not mention more channel proteins joining the membrane. Many thought that insulin opens (existing) channels and others made no reference to channels at all. The nearly 60% who failed to score often gave accounts of control of blood glucose concentration. Others wrote about the conversion of glucose into glycogen, which would reduce glucose for respiration. The question discriminated well.

Q2.

(a) This was generally well answered, with over 40% of students obtaining both marks and over 80% gaining one mark. Most students stated that type II diabetics produce insulin, although a number of them simply stated that the pancreas is not damaged. The lack of responsiveness to insulin was not always linked to cells or receptors, or was described as a 'resistance' or 'immunity' to insulin. Although students often understood that diet and lack of exercise may be involved in causing type II diabetes, they did not always suggest that exercise and diet may be used in treating type II diabetes.

(b) 85% of students understood that insulin does not activate enzymes involved in the conversion of glycerol to glucose.

(c) The idea of a transcription factor binding to a gene / DNA / promoter region, which then stimulates transcription by allowing RNA polymerase to bind, was clearly understood and described in the best responses. The inhibition of transcription by transcription factors was referred to less often. Over 50% of students gained at least one mark, often related to the binding process. Many students who did not gain credit limited their explanations to genes being switched on or expressed. Translation to form the proteins linked with pluripotency was often included in these answers. However, a number of students confused transcription and translation.

(d) This question produced a good spread of marks and proved to be an effective discriminator. Over 90% of students gained at least one mark, and almost a third of students gained three out of the four marks available. Most students correctly compared the results of group A with group C. Fewer compared group A with group B. A significant minority of students mistakenly took group B results to be those of group A due to not carefully looking at the key provided for the graph; this restricted their maximum mark to two. Mice often became rats during the explanations but this was not penalised! Most students appreciated that the results could be different for humans, and stated that 12 weeks was not long enough to determine long-term effects. Some students referred to the lack of a statistical test, but this was not credited in this question. Similarly, for this investigation, thirty mice was not considered to be a small sample size.

Q3.

(a) Control of type 1 diabetes was well known by students and 78% obtained both marks.

(b) This part discriminated quite well but 40% scored 0. Many students ignored the results and simply wrote an account of the control of heart rate. Some started in this way and then ‘saved’ themselves by saying that ‘this doesn’t happen in diabetic rats’. Even amongst those who did try to explain the results, answers were often riddled with errors and incorrect terminology. Instead of writing about changes in frequency of nerve impulses, many wrote about faster or slower signals or messages. Some wrote about single impulses, rather than higher or lower frequencies of impulses. Others referred to the sympathetic and parasympathetic systems but not what they each do in regard to heart rate; some got them the wrong way round. Quite a number wrote about chemoreceptors, rather than pressure receptors and the hypothalamus, rather than the medulla. Only 4% managed to obtain all four marks.

Q4.

(a) About a third of students correctly explained how glucagon would be involved in regulation of blood glucose concentrations in the mice and obtained 3 marks. Some students failed to mention what glucagon does, or where it acts. There were some students who got very confused between glucagon and glycogen and others who wrote about glucagon either acting on glycogen to break it down, or had glucagon broken down into glucose. This question showed weaknesses in use of language and terminology by many students.

(b) This was marked by a very large number of students who wrote about large amounts of mRNA but did not link this to large amounts of the enzyme PCK1. These answers were simply describing the results shown in the graph, not giving a suggestion about how the process is controlled. The examiners required students to

show understanding that large amounts of mRNA would (probably) mean large amounts of the enzyme. It should be noted that quite a large number of students wrote about mRNA breaking down glycogen (as an enzyme), or being broken down into glucose. Many students did write about the role of the enzyme in kidney and intestinal cells in producing glucose. However, many of these did not compare this with what happens in the normal mice referred to in the question. Some weak answers simply involved attempts to use rote-learned material about control of blood glucose concentration with no reference to the information in the question.

(c) This again had students writing about the results / data being significant, rather than the difference in the amounts of mRNA, as given in the stem. Quite a few ignored the 'less than' symbol, or read it as 'more than'. Others ignored the 0.01 and wrote entirely about less than 5%, which did not gain credit.

Q5.

The examiners noted that many students appeared not to have read the main stem of the question carefully.

(a) Quite a large number wrote about amylase in yoghurt, rather than an inhibitor of amylase. About two thirds identified that **Group A** allowed the effect of the inhibitor to be seen. Very few noted that it also allowed the effect of yoghurt on its own to be seen. Quite a large number simply stated that the group 'allowed for comparison'.

(b) 60% identified that different foods might affect glucose intake. Very few went on to identify that they could also contain different amounts of starch, the substrate of amylase. Quite a few simply wrote about 'removing a variable'.

(c) A third of students obtained both marks. These students displayed a clear understanding of the digestion of starch, including the enzymes involved, the products produced and the impact of the inhibitor. About 40% failed to score, with the commonest error being a statement that starch is 'broken down' directly into glucose.

(d) The examiners had identified six different reasons why the results might not support the use of the inhibitor, based on the context of this question. Many students resorted to rote How Science Works answers about correlation not causing causation, or bias. Nearly half of students failed to score.

Q6.

(a) 80% of students failed to score. Most repeated the stem of the question and wrote that formation of glycogen leads to a lowering of blood glucose. Others drifted into explanations of the mode of action of insulin and the role of the pancreas. The examiners were looking for the idea that formation of glycogen lowers the concentration of glucose in liver cells below that in the blood. As a result, there is a diffusion / concentration gradient for the entry of glucose into liver cells (from the blood).

(b) Students scored much better on this part. Most noted that the insulin sensitivity was similar in both groups of patients. Some backed this up with observations about overlap of standard deviations. Again, the examiners accepted standard errors here but it should not be assumed that this applies in all cases. About 40% of students got both marks and a similar percentage got one mark.

(c) It was heartening in this part to see many students using knowledge of standard deviations to answer this question correctly. Nearly 40% obtained all three marks

and these students all included statements about the large standard deviations of the means after surgery and how these showed that some patients' sensitivity to insulin did not increase after surgery. In this context, the examiners ignored references to standard errors, since it was the spread of data about the mean(s) that was important.

Q7.

(a) Most students were able to identify the correct substances but it was an error of assessment not to cancel a mark when an additional substance, such as hydrogen peroxide, was also included in the list.

(b) This question proved to be demanding for many students despite the possible reasons exceeding the maximum mark possible.

Q8.

(a) Almost all students appreciated what was meant by 'insulin-dependent'.

(b) Although the wording used by many students did not entirely match that of the Marking Guidelines, there was often a good understanding of the scientific principles demonstrated to support the assessments made.

(c) It was appropriate to consider exercise as equivalent to movement. The majority of students appreciated that such was based on respiration and that respiration uses glucose.

(d) In written papers, students often struggle with calculations. However, in this case, the majority produced an answer that fell within the stipulated range.

(e) It was pleasing to see that most students gave both sides of the story to give differences between the two methods. It was not appropriate to give credit where this was not the case. Many students were able to make full use of the resource material and obtain full marks for this question.

(f) This part proved to be more challenging for many students although some excellent accounts were seen. A synthesis of ideas from the resource material was the key in this question as opposed to lifting relevant aspects for comparison with the previous part, a skill that was more demanding and reflected by the mark range seen.

Q9.

Many students produced sound responses to the final question using information from the resources appropriately.

Q10.

(a) This proved to be an excellent discriminator and just less than half of students gained full credit. This was usually for describing the production of cAMP and its effect on glycogenolysis or gluconeogenesis. Very few students were able to name the enzyme within the plasma membrane as adenylate cyclase. Similarly, there was sometimes confusion between the activation of this enzyme and intracellular enzymes. Some students thought that adenylate cyclase directly affects glycogenolysis or gluconeogenesis. This said, the correct use of scientific terms beginning with 'g' was generally good and only a minority of weaker students confused 'glycogen' and 'glucagon'. The terms 'glyconeogeneis' and 'glucogenolysis' also appeared in weaker answers.

(b) (i) Most students were aware that glucose in food would affect the results or that eating would affect the blood glucose concentration. Very few students referred to the importance of allowing the blood glucose concentration to return to normal.

(ii) Students who failed to score typically stated that type 2 diabetes is not a genetic disease.

(iii) The most common advantages given for gene therapy were the avoidance of injections and the longer-lasting effect. The most common disadvantages given were the possible side effects, which were usually linked to the virus, and that the long- term effects are not known. Surprisingly, relatively few students made reference to the fact that rats are different from humans. Weaker students seemed to rely on 'stock' *How Science Works* answers to gain credit for the 'against' side of the evaluation. They typically referred to unknown sample sizes and the influence of unnamed 'other factors'. These were not credited.

Q11.

(a) In part (i), the simple statement that the girl may have eaten a meal rich in carbohydrate gained marks for many; others were able to relate high blood glucose concentration to insulin concentration. Given the scatter of points on the graph, it was perhaps unsurprising that relatively few candidates, in answering part (ii), commented on the positive correlation between the results of the two tests. Many, however, referred to the wide range of glucose concentrations corresponding to individual urine measurements. Candidates should be aware that when required to evaluate it is only fair that the information provided genuinely allows candidates to judge the worth of a particular data set or conclusion. As such, they should consider both how the argument is supported and how it fails to be supported.

(b) Quality of Written Communication proved a challenge in the final part of this question. The more able candidates gained credit with succinct answers referring to glycogenolysis and gluconeogenesis. Others used the terms but were clearly confused by their meanings, or suggested rather predictably that glucagon could be converted into glucose.

Q12.

(a) This question proved to be an effective discriminator with only a third of candidates obtaining maximum marks. Most candidates gained at least one mark often for stating that glucose has a complementary shape to the enzyme in the biosensor. Although many candidates did gain a second mark for referring to the active site a significant number did not and often suggested that an active site is present on the substrate.
There were, however, some excellent explanations of the way in which enzymes work including references to their tertiary structure and the formation of enzyme substrate complexes.

(b) The majority of candidates gained at least one mark often by stating that the Benedict's test only provides a colour or does not measure the concentration of blood glucose. Another common correct response was that the Benedict's test detects not only glucose but all reducing sugars. However, a number of candidates incorrectly stated that the Benedict's test detects all sugars. A few candidates indicated that the red colour produced during a positive Benedict's test would be masked by the colour of the blood. Responses which simply referred to the biosensor being more accurate or quicker without any further details were not

credited.

(c) (i) Most candidates obtained this mark by suggesting that insulin would be digested or broken down by enzymes. A few candidates did suggest that it may be too large to be absorbed or that it could be denatured by acid in the stomach.
Candidates who failed to gain the mark often suggested that it would be broken down by amylase.

(ii) This was very well answered. Almost every candidate obtained at least one mark often by indicating that the study had not been carried out on humans. Many candidates then linked this to unknown long term or side effects to gain a second marking point. It was also pleasing to note the number of responses which displayed an understanding of 'How Science works' including references to the vested interests of scientists, unknown sample size and the need for further or repeat studies.

Q13.

(a) Most candidates were able to identify glucose as one of the monomers from which a molecule of sucrose was formed, but there was less certainty about the other. Part (ii) was designed to be accessible to grade E candidates and, in view of this, it was disappointing to see so few gaining full credit. There were a number of predictable errors such as in describing the active site as being on the substrate, and in maintaining that active site and substrate were the same shape. Credit was generally lost however because of a lack of precision in the answers. There were many general references to specificity that were simply worded in terms of sucrose and lactose not being 'specific to each other' or enzymes being specific to a particular substrate. Good answers amplified the concepts of shape and fit with appropriate reference to complementarity and the active site of the enzyme.

(b) It is encouraging to note that most candidates were able to describe the data in the graph with appropriate precision and gained full credit for their answers to part (i). There were, however, candidates who failed to distinguish between the terms 'describe' and 'explain' and offered inappropriate responses both here and in part (ii). In part (ii), better candidates generally identified the role of absorption in raising the glucose concentration and respiration or storage resulting in the fall after 45 minutes. Difficulties arose where candidates referred imprecisely to sugar, and there were many answers where the examiners were left unclear as to whether glucose or sucrose was being discussed. It was also apparent that many candidates considered the graph to be showing some aspect of enzyme activity and responded in terms of the effect of a particular parameter on substrate or product concentration.

Q14.

(a) This question was well answered by a majority of the candidature. The labelling of the graph was clear and candidates produced distinct X and Y marks.

(b) Good responses to this question told the story well using technical language throughout and obtained the four marks easily. Some candidates used the term 'restriction enzyme' but did not state what it was used for (i.e removing the gene for insulin or cutting the bacterial plasmid) so failed to obtain either of the first two marking points. Responses given showed that some candidates had not understood what was taking place and gave lengthy responses which were factually incorrect at every stage.

Q15.

BYA6

(a) Many candidates understood the control of plasma glucose concentration in great detail and were able to reproduce this. However, the question did not simply ask 'how is plasma glucose concentration maintained?', but required an explanation of the role of negative feedback in this control. Better candidates realised the distinction and began their answers by explaining the concept of negative feedback and then related this concept to the events shown in the graph. Naturally, they included the method of action of the hormones, but their responses showed a better balance between supplying detail and explaining principles than those who simply answered, once again, the question they assumed had been asked on the basis of one or two key words. Candidates failed to gain marks through confusion between glucagon and glycogen, despite the former being clearly named on the graph. There was also some confusion between what detected the changes in plasma glucose concentration and what subsequently secreted the hormones. Only better candidates were aware of the effect of insulin in stimulating the absorption of glucose from the plasma.

(b) In this question nearly all candidates knew that enzymes have an optimum temperature, but too many failed to relate this specifically to core body temperature. They were also frequently careless in their description of the effect of temperature on enzymes. The phrase 'enzymes are denatured by extremes of temperature' was all too common. Clearly an extreme temperature of –10°C does not denature enzymes. Candidates also need to be more precise in their descriptions of how and why reactions take place. Reactions, in this context, take place because *molecules* of the enzyme and substrate have sufficient kinetic energy to collide frequently and with sufficient energy. Finally, some candidates re-used the term 'maximum efficiency' used in the question, without explaining what this meant in terms of rate of reaction.

BYA7

(a) Most candidates were able to state that the release of insulin was triggered by increased plasma glucose concentrations and glucagon was triggered by a decrease. The more able then correctly identified the sites of secretion and their effects on the interconversions between glucose and glycogen. It was disappointing to see few candidates using the graph as instructed by the question and many candidates scored one less mark than perhaps they would have if they had used the graph more. As is often the case, frequent instances of imaginative intermediate spelling of glycogen and glucagon were observed and these were usually too ambiguous to be credited by the examiners.

(b) This question produced some very comprehensive answers. Candidates had a good knowledge of thermoregulation. Examiners did not credit the term 'cold centre' and this term tended to be used only by the weaker candidates. The detail of vasoconstriction was explained very clearly by approximately 50% of candidates. The other 50% had muddled thought on this topic, with constriction of capillaries and veins and movement of capillary networks towards the centre of the body appearing in their answers.

Candidates who did not realise that the question was about enzymes struggled to score marks. The majority of candidates gained some credit. One common error was to refer to the effects of temperature on enzyme activity without direction. Better answers gave the effects of low temperatures quite separately from the effects of high temperatures.

Q16.

(a) Candidates generally had no difficulty naming A and B.

(b) Most candidates were able to provide a sufficiently detailed response to be awarded the mark. There were some responses that were too vague to be awarded credit at this level.

Q17.

This topic area seems generally well understood and many candidates were able to apply their knowledge effectively and gained credit. Careless use of terminology and lack of detail marred the answers of weaker candidates.

(a) The definition was well learnt by the majority of candidates although some missed the idea of keeping conditions constant or gave a named example rather than the definition.

(b) Generally this question was well answered but lack of precision in some answers cost candidates marks, for example, by failing to refer to receptors and/or identifying their location. Common misconceptions included the involvement of the pituitary and the hormone directly catalysing the conversion of glycogen to glucose thereby acting as an enzyme.

Weaker candidates confused glucagon with glycogen and usually scored only one mark for the idea of raising blood glucose levels. Diffusion of glucose out of cells into the blood was rarely seen.

(c) A surprisingly high proportion of candidates correctly used the information given in the stem of the question and their own knowledge to work out the clearance value for glucose and go on to obtain full marks. Many of those unsure of the maths did explain the mechanism of reabsorption of glucose in the kidney and gained two or three marks. The most common omission was to the principle of all the glucose being reabsorbed and weaker candidates were also unsure of the precise location in the tubule where this process actually occurs.

Q18.

This question also resulted in the full range of marks.

(a) (i) Although most candidates correctly referred to shape as being important, many of these explained their answer in terms of active sites and so could not be awarded the mark.

(ii) There were many full and accurate answers showing a good understanding of the role of insulin. However, many answers showed considerable confusion. Many candidates stated that glucose was unable to bind to the receptors, that the release of insulin was stopped or that insulin converted glucose to glycogen with no reference to glucose uptake into cells or enzyme activation.

(iii) This was answered well by the majority of candidates. Most realised that the glucose was reabsorbed, but some stated that the molecule was too large to pass through Bowman's capsule. Similarly, most candidates stated correctly the site and method of reabsorption. Candidates tended to lose marks as a result of incomplete rather than incorrect answers.

(b) This was answered well by the majority of candidates. The weaker candidates tended to repeat the data in the table rather than explaining it or did not make a

comparison. Most candidates gave at least one valid factor, with many also scoring a second mark. Some failed to score because of vague references to the environment being the same, rather than giving a named environmental factor.

Q19.

(a) Generally, this question was answered well, although a lack of precision in some answers cost candidates marks, for example, by failing to refer to receptors that are specific to insulin or by not stating the type of cell where the carrier proteins for glucose are located. Common misconceptions were observed when candidates implied that glucose would only enter cells when insulin was present. Even though this is a topic that is generally covered well by candidates at GCSE, a number still believes that insulin catalyses the production of glycogen and others that insulin is responsible for the breakdown of glycogen. The poor spelling of important technical terms also cost some candidates marks; glycogen and glucagon were most often incorrect.

(b) The role of glucose in respiration was a commonly given as a correct response and many candidates obtained both marks, usually by including a description about the excretion of glucose in urine. However, a surprisingly high proportion of candidates referred to glucose being lost in urea.

(c) Most candidates answered this question correctly. A common error was to begin the curve from 175 mg rather than from 80 mg as indicated in the question.

(d) (i) Generally, this was answered well by candidates across a wide range of ability levels, but the idea that insulin breaks down glucose was a common misconception.

(ii) References to the role of glucagon or the process of glycogenolysis were common, although many failed to gain the mark by confusing the spellings of these technical terms.