AQA A-LEVEL · 7402

BIOLOGY



MARK SCHEME

3.6.4.1 PRINCIPLES AND NEGATIVE FEEDBACK

SCORE	PERCENTAGE
/103	%

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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. Binding (of interferon gamma) changes shape/tertiary structure of receptor (protein);
2. This activates/switches on the enzyme;
3. Use of ATP (to phosphorylate STAT1);

1. Accept reference to second messenger mechanism/process

3. Context is important

2 max

(b) 1. Phosphorylated STAT1;
2. IRF (protein);

Accept in either order

1. Must be phosphorylated but accept STAT1P

2. Ignore references to phosphorylated

2

(c) 1. Causes more helper T cells to form;
2. (So) more interferon (gamma) production (by helper T cells);

1. and 2. require idea of more

2

(d) 1. (Tumour suppressor gene) slows cell division/causes death of damaged/tumour/cancer cells;
2. *IRF* gene leads to formation of IRF (protein) that binds to gene B;
3. (Gene B protein) causes death of damaged/mutated cells OR slows division;

2. 'It' means IRF gene

3. Context is important

*3. If clearly stated **and** includes the protein, scores 2 marks because it subsumes point 1*

3

[9]

Q3.

(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 <u>less than</u> 0.01 / 1% / 1 in 100 / probability of difference not being due to chance <u>more than</u> 0.99 / 99% / 99 in 100.

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

2

[8]

Q4.

(a) 1. Positive correlation between sucrose and dopamine concentrations / higher concentration of sucrose, more dopamine;

Q NB question is 'How do these ...', not 'Do these ....

1. Ignore simple statements of numbers from graph without description of trend

2. So (dopamine) makes them want to drink / eat more (sucrose);

3. Positive feedback because drinking / eating leads to wanting to drink / eat (even) more;

3. It must be a clear statement of why this example is positive feedback, not inferred from points 1 and 2

3

(b) 1. (Refractory period) leads to discrete / separate nerve impulses / time when another nerve impulse can't happen;

OR

(Refractory period) limits number of impulses per second / frequency of nerve impulses;

2. When maximum frequency reached / exceeded, no further increase in information / all (higher) concentrations of sucrose seem the same;

2

(c) 1. (Negative feedback) stops desire / wish to eat / appetite;

1. Accept stops dopamine release (in this context)

1. Accept makes them feel full

2. (This) limits amount eaten / stops eating;

2. Accept prevents constant eating

3. Prevents / reduces risk of obesity / too much energy intake;

3. Accept prevents vomiting

Accept descriptions based on what would happen in absence of the feedback mechanism - or if stomach empty for points 1 and 2

3

[8]

Q5.

(a) 1. (Acetylcholine) released from / in presynaptic side;

2. Receptors in postsynaptic (side) / binds on postsynaptic (side);

2. Mark for diffusion only awarded in context of unidirectional movement.

2

(b) (i) 1. Rapid response;

2. Short duration;

Specific wording is not important. It is the principles that matter here.

Points may be made by referring to figures.

2

(ii)

	1	2	3
Percentage	80	0	0

Ignore % sign.

1

[5]

Q6.

(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]

Q7.

(a) (i) where a change triggers a response which reduces the effect of a change;

1

(ii) e.g. sweating, breathing, defaecating, other valid example;

(reject respiration
evaporation not acceptable as a 2nd mark if sweating or breathing given)

2 max

(iii) hypothalamus;

1

(b) (i) pituitary;
(ignore anterior pituitary)

1

(ii) 1. ADH causes vesicles containing aquaporins / aquaporins to be inserted into membrane / collecting duct wall / plasma;
2. water enters cell through aquaporins;
3. by osmosis / diffusion / down a water potential gradient;
4. (from cell) to capillary;
5. via interstitial fluid;

4 max

(c) (i) excessive urination / drinking / diluted urine / thirst;

1

(ii) because males only have one X chromosome / do not have Y chromosome;
a single copy of the recessive allele will be expressed;

2

(iii) recessive alleles can be carried by individuals without showing effects / dominant allele always expressed;
organism that are carriers more likely to reproduce / affected organism less likely to reproduce;
therefore recessive alleles are more likely to be passed on / dominant alleles less likely to be passed on;

3

[15]

Q8.

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]

Q9.

(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]

Q10.

(a) (i) maintaining a constant internal environment;

1

(ii) *one mark for example of factor kept constant; one mark for explaining its importance;*

e.g.
temperature / pH; optimum for enzymes / effect of pH / temperature on enzyme activity;

OR

water potential / blood glucose;
effect of osmotic / blood glucose imbalance on cells;

2 max

(b) cannot interact with / move tropomyosin from binding sites on actin;
(reject active sites)
myosin(heads) do not bind / actinomyosin not formed;
does not activate ATPase / energy not released from ATP;

3

[6]

Q11.

(a) bacteria have ligands / antigens / proteins / glycoproteins / polysaccharides (on membrane / wall);

1

complementary to receptors / fits / binds / attaches to specific receptor

1

(b) enzymes denatured / tertiary / secondary structure altered / altered active sites / breaks hydrogen bonds;

1

prevents named chemical reactions / metabolic pathways;

1

(c) inhibits / kills other bacteria / fungi / decomposers / reduces competition;

1

(d) 1 prepare a bacterial lawn / culture / sample;
(accept mix bacteria with agar / medium)
2 with oil and one with control / water / range of concentrations;
3 appropriate method of standardising how sample applied, e.g. discs / wells;
4 appropriate measure of effectiveness / size / diameter of clear zone;
5 the larger the zone the greater the effectiveness;
6 use of aseptic technique;
(ignore haemocytometer)

4 max

[9]

Q12.

(a) moves to 40 °C side, then later to 20 °C;
gets lighter in hot side and darker in cool side;
lighter as it absorbs heat / darker as it loses heat;
by conduction / convection / radiation;

3 max

(b) lizard finds favourable environment;
(helps it to) maintain constant body temperature;
advantage of this, e.g. for enzyme activity;

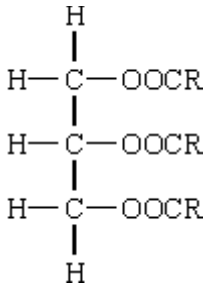
2 max

[5]

Q13.

(a) 3 fatty acids attached;
ester bond correct;

(H on glycerol component, O attached to carbon, R at other end)



2

(b) not made of monomers / many repeating units;

1

(c) (many) mitochondria present in brown fat cells;
mitochondria release heat / energy; (*ignore ATP*)
white fat cells for fat storage / reduced fat storage in brown fat cells;

3

[6]

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) 44% obtained one mark, usually for noting that binding of interferon gamma activated/switched on the enzyme inside the cell. 28% obtained a second mark, usually for reference to there being a second messenger process involved, or describing this. A few noted that ATP would be used in the phosphorylation of STAT1.

(b) It was pleasing to find that 33% could correctly identify the transcription factors. Those who obtained one mark (42%) usually referred to STAT1, rather than

phosphorylated STAT1 in their answer.

(c) 37% obtained two marks for reference to interferon gamma leading to more helper T cells, which then produced more interferon gamma. Some students (41%) only wrote about more of one or the other and scored 1. Poor answers usually consisted of generalised statements about, or definitions of, positive feedback.

(d) 70% of students obtained one mark, usually for stating that the *IRF* gene would slow/stop cell division; essentially stating what a tumour suppressor gene is. Only 20% obtained a second mark for noting that the *IRF* gene leads to the formation of IRF protein that binds to gene B. Very few went on to get the third mark by noting that this binding leads to the death of damaged or mutated (potential tumour) cells.

Q3.

(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.

Q4.

(a) The question asks *‘How do* these data support this conclusion?’ A significant number of students appeared to re-write the question as, ‘Do these data support the conclusion?’, or ‘Evaluate the conclusion.’ In either event, they tended to launch into rote *How Science Works* responses about correlation not proving causation, not enough rats in the study, only one study, the spread of the data, etc. This approach did not gain credit. Many (fifty percent) did obtain one mark for noting the positive correlation between concentration of sucrose and increase in dopamine release. A third of students then obtained a second mark for linking the increase in dopamine to an increased desire to eat. Only a minority obtained the third mark for clearly stating that this was positive feedback because drinking the sucrose leads to wanting to drink more.

(b) About a third of candidates scored 0 because they could not say what the refractory period is, or what it does. Those who had some idea usually wrote about it leading

to discrete nerve impulses, or being a time when no new impulse could form, and scored one mark. Under twenty percent of students were able to link this to a limit on the frequency of nerve impulses, or to a limit in information about concentration that could reach the brain.

(c) Few students failed to score on this question; about a third scored one mark and just over forty percent obtained two marks. Marking points 1 and 2 were the ones most commonly awarded. Only a minority obtained a third mark by making a reasonable suggestion about the importance of limiting eating. A high number of students thought that the stomach, or person would burst.

Q5.

(a) Those candidates who focused clearly on the relevant aspects of synaptic transmission produced excellent answers. Others, however, produced lengthy accounts that included much that was of, at best, marginal relevance.

(b) Although candidates encountered few problems in extracting the relevant information from the graph in part (i), they experienced much greater difficulty in expressing 8 as a percentage of 10 despite, in some cases, identifying clearly on the graph the relevant numbers.

Q6.

(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.

Q7.

(a) Although the definition in (i) produced a variety of responses, ranging from the short and precise to the lengthy and rambling, most were acceptable. Part (ii) was straightforward but two common errors were made, sometimes by good candidates. These were to give respiration or urination as responses. The hypothalamus was correctly identified by most candidates.

(b) Part (i) was well answered though it appeared some candidates may not have noticed the presence of this question at the bottom of the page. Candidates did not usually find (ii) easy. Many used almost all the space writing about ADH without using the required information from **Figure 1**. Where the role of the aquaporins was understood it was not always made explicit in answers. Osmosis was usually considered and most candidates also appreciated that the aquaporins are bound to the membrane facing the lumen of the collecting duct. However, answers which detailed the whole process were few and far between.

(c) Unfortunately, some candidates gave the impression of applying a prepared answer relating to the presence of glucose in the urine to this question and, obviously, gained no credit. The mark scheme allowed for all the major obvious symptoms and many of the better candidates obtained the mark.
Part (ii) produced good responses from the stronger candidates but very commonly weaker candidates did not appear to know that males had one X and one Y chromosome while females had two X chromosomes. The responses to (iii) were reasonable. The most common shortcoming was a failure to write in terms of probabilities with many candidates stating no more than that carriers of a recessive allele would reproduce while most of those with a dominant allele definitely would not reproduce. A handful of candidates thought that the question was looking for heterozygote advantage and answered in these terms.

Q8.

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.

Q9.

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.

Q10.

This question produced a wide range of marks. Nevertheless, it was generally well answered by the majority of candidates.

(a) (i) Although many candidates obtained this mark, there were a number of vague definitions which did not clearly link homeostasis to the internal environment.

(ii) Candidates had little difficulty giving one example of homeostasis, usually referring to thermoregulation or control of the blood glucose concentration. Most candidates who obtained a second mark referred to the effect of change of temperature on enzyme activity.

(b) There were many excellent descriptions of the role of calcium in muscle contraction. However, there were a few common errors and omissions. There were frequent

references to ‘active site’ rather than ‘binding site’ and a significant number of candidates did not mention actin. A minority of candidates attempted to answer this question in terms of the role of calcium in synaptic transmission.

Q11.

(a) Answers were generally good but some candidates confused the position of ligands and receptors. Some candidates did not know that humans are mammals.

(b) Most candidates gained the mark for enzymes being deactivated but then failed to describe a specific relevant effect.

(c) Some candidates appreciated the use of exotoxins. Incorrect responses suggested that they digested organic material as an aid to nutrition.

(d) This question was well answered across the whole ability range. Most candidates had seen or done a similar experiment and described the method well.

Q12.

(a) Most candidates scored one or two marks here. Almost all got the simple mark for describing the movements of the lizard from 20°C to 40 °C and back again. Somewhat fewer got a second mark for referring to the idea that the lizard gained or lost heat from or to its environment, depending upon where it was. A minority of candidates got a third mark for noting the changes in shades of grey of the lizard. Very few made any reference to the way in which heat might be lost or gained by the lizard.

(b) A majority of candidates obtained one mark for the idea of the lizard’s behaviour allowing it to control or maintain its body temperature. Many then obtained a second mark for linking this to enzyme activity or some aspect of metabolic rate.

Q13.

(a) Most candidates made an attempt to add three fatty acids to the glycerol but fewer could then draw the correct bonds.

(b) The concept of a monomer was generally poorly understood, with glycerol and fatty acids often referred to as the only two monomers making up the triglyceride. Many candidates referred to the presence of different R groups being the reason for the molecule not being considered a polymer.

(c) Very few candidates appreciated the white fat cell’s involvement in fat storage. Although most noted the mitochondria in the brown fat cell and associated this with respiration, the process was not linked to energy or heat release but often to active transport. Some candidates were confused over basic concepts involving energy, referring to ‘creating’ or ‘making’ energy.