

Examiners' Reports

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This report on the Examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the Examination.

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Chief Examiner's Report

General Comments

Some general points have arisen from the reports of the Principal Examiners that centres should consider.

In planning the question papers, care is taken to try to ensure that sufficient answer lines or space for calculation is provided. On occasion, however, candidates will find that the space supplied is insufficient, particularly if they have large writing or cross through part of their answer. As examiners initially see just the answer space when marking, it is very important that the location of answers that continue in blank areas of the page or on the additional answer pages should be clearly stated at the space allocated for the answer. It is also very important that the places where the additional answers are written are clearly labelled with the correct question number and part.

Candidates require clear guidance on how to approach questions that require a single answer or a set number of responses. Examiners will mark the first answers given by the candidates. If a single answer is required, then any additional answers that are incorrect or contradict a correct answer will result in no mark being awarded. Where two responses are asked for, examiners will only mark the first two responses. If cue lines are provided, then normally only the first suggestion on each line will be marked. When completing a paragraph by inserting terms into gaps, only one alternative should be placed in a gap. Please refer to the Additional Guidance on the mark schemes for further clarification.

It is evident from the Principal Examiners' comments that candidates normally cope quite well with questions that ask them to recall information in a straightforward manner. The questions in the context of unfamiliar material, applying their knowledge (AO2) and, in the A2 papers, drawing on synoptic knowledge are answered less well. Previous Chief Examiner's reports have summarised the weightings of the particular skills that are to be expected in each of the theory papers. Reference can be made to these documents and the specification for further detail. Candidates need experience in applying their knowledge, particularly in unfamiliar contexts and drawing on material from different parts of the unit and previous units. They should be given the opportunity to develop these skills both during the formal study of a topic and also in the additional work for reinforcement of the knowledge and in internal assessment.

Candidates do not always read the questions carefully. They have a tendency to latch onto a single word without looking at its context. The focus of a question can also be lost if the command word or word that is key to the interpretation of the question requirements is not noted. One good strategy is to underline or highlight the command word, salient facts and key words in the question in order to better focus the response.

While some questions were not attempted, it was only on F215 that a question was consistently omitted, possibly as candidates had not noticed that they were meant to answer on a graph. There is a tendency that if candidates do not see a dotted answer line then they do not realise that they need to provide an answer. Questions that might fall into this category include drawing a curve on a graph (as was the case in the question on F215 this session), indicating specific points on a graph, completing a diagram and inserting a letter or label on a diagram. Candidates should be trained to look at the mark allocations in the square brackets in order to check whether they have attempted all the questions.

It is encouraging to note that centres are using the mark schemes from previous sessions as teaching aids. However, weaker candidates do have a tendency to reproduce a mark scheme as an answer to a question that has a significantly different emphasis than when the topic was assessed on the previous occasion.

INSET

OCR runs courses relating to different aspects of the specification. OCR has a programme of training events for the autumn and spring terms. It is also possible to arrange for in-house courses to be held at your centre, either for your centre alone or in conjunction with other centres in your locality, dealing with your specific requirements. It is therefore likely that such an arrangement could be organised for a date that is more suitable to you than the main training events.

Further details can be obtained from the OCR website www.ocr.org.uk.

F211 Cells, Exchange and Transport

General Comments

Examiners agreed that this paper was of appropriate demand for AS level and comparable to previous papers. Candidates were able to complete all questions in the time available and most attempted every section. It was noted that the balance between plant biology and animal biology was slightly more weighted towards plants than in previous papers.

There were no obvious misinterpretations of the rubric except occasionally where candidates were asked to give two responses to a particular question. Sometimes candidates gave more than the required number of responses and may have lost marks because incorrect responses were written before correct ones. Where two responses are asked for, examiners will only mark the first two responses.

The overall performance of the candidates showed a relatively normal distribution of marks. There was certainly a wide range of ability and attainment. Stronger candidates were able to display their knowledge and attained high marks. The less able candidates were able to achieve some marks in most questions – notably in areas where AO1, recall of knowledge, was being tested. However, these candidates did not fare so well in questions where AO2 was being tested and they were expected to apply their knowledge.

Comments on Individual Questions

- 1 This question was designed to be an easy starter to the examination. The majority of candidates did well in parts (a) and (b) but fewer were successful with the increasingly higher demand in parts (c) and (d).
 - (a) A very straightforward question to start the paper which was correctly answered by most candidates. A few candidates wrote 'meiosis' and there was a tiny minority of ambiguous spellings which were discounted. Incorrect responses included named stages of mitosis (interphase, telophase etc.) and even an occasional 'fission'.
 - (b) Another inviting question in which candidates had to sequence the stages of mitosis. The question was well-understood and the majority of candidates gave correct answers, gaining 4 marks. A significant number of those making errors confused **K** and **J**, the nuclear envelope reforming and the cell surface membrane constricting. Only the weakest candidates gained no credit.
 - (c) This question asked candidates to state what happened in the cell during interphase. It was not so well answered as the previous parts of the question as many candidates gave answers that were too general or too vague: 'the cell does what it normally does' or 'growth and repair'. A good number of candidates described processes such as chromosomes condensing and formation of the spindle, which actually happen during prophase. A number also suggested that DNA replicated, showing a misunderstanding of the link between the DNA and the copying of the genetic material which is mentioned in the question itself. Candidates who did score both marks showed an even mix of all five marking points and a few more able candidates gave details of what precisely happens in the G1 and G2 stages.

(d) The differences between cell division in plants and animals were not well understood. Good candidates were able to state that cell division in plants occurs only in meristems or mentioned that plant cells have no centrioles. Some candidates described the formation of a cell plate and others could state that cytokinesis starts in the middle of the cell rather than at the edges, as in animals. However, only a minority of candidates achieved two marks here. Many candidates demonstrated misconceptions such as 'animal cells undergo mitosis but plant cells undergo meiosis' or vice-versa. Another common error was to suggest that 'plant cells undergo asexual reproduction while animal cells undergo sexual reproduction' or that 'plants can't reproduce sexually'. There were even some responses that confused mitosis in plant cells with budding in yeast. Many candidates described the need for the cell wall to split rather than the need for a new cell wall to form. It is important for candidates to follow the rubric of the question as some candidates gave more than two suggestions and lost out when an incorrect suggestion appeared first.

2 This question contained some easy marks about lung structure and function before progressing into sections on cell signalling and formation of tissue fluid. The context of the latter parts made these parts of the question quite high demand and the question proved to be a good discriminator.

(a) Candidates were presented with a diagram of part of the lung. Most candidates correctly identified structure **B** (the alveolus). However, fewer could identify structure **A** (the bronchiole) correctly. Many thought structure **A** was the bronchus which demonstrates a misunderstanding of the scale of the diagram they were looking at. Some identified it as a blood capillary.

(b) There were many good responses to this question about the features of the alveoli. Candidates were able to show their understanding of the features of the alveoli that enable gaseous exchange, in particular the large surface area. Many also gained credit for describing a thin wall or barrier providing a short diffusion distance. However, there are still many candidates who describe the alveolus as being 'one cell thick' or having a 'thin cell wall'. Some candidates also describe the alveolus as having a thin membrane. These descriptions demonstrate a lack of precision.

(c) This question was about cell signalling in the context of smooth muscle contracting in response to an allergic response. A significant number of candidates did not read the question carefully and gave vague answers about constricting airways, dust and irritants. However, many candidates were awarded two marks for stating that histamine binds to receptors which have a complimentary shape. Candidates were less sure of where the receptors are found – examiners were looking for the idea that they were membrane bound receptors. Few candidates mentioned that the response occurs inside the cell. There is still an issue with candidates using rather vague language such as 'glycoprotein recognises histamine' or 'receptors detect histamine' omitting to say that histamine *binds* to the receptors / glycoproteins. Another common error was histamine attaching to a 'receptor cell'.

(d) This question about increased permeability of the capillary walls was not well answered by the majority of candidates. Many understood that more plasma may leave the capillaries forming more tissue fluid. However this was rarely linked to increase in pressure and swelling of the tissues or the idea that larger molecules or more white blood cells could enter the tissue fluid. Those who did realise that more tissue fluid would be formed often lost their mark by stating that 'more tissue fluid leaves the capillary'. The most common error was to confuse increased permeability with increased gas exchange. Candidates tried to link oxygen diffusing faster across the capillary wall with more respiration occurring in the tissue cells.

- 3** Candidates were presented with a passage about the carriage of oxygen in a mammal. Some words or phrases had been omitted and candidates were required to write the most appropriate term or phrase in the spaces provided. The majority of candidates were able to score highly in this question. It is worth noting that, despite allowances being made in the mark scheme, some candidates lost marks because of poor spelling, particularly for 'erythrocyte'. A good answer noted that large organisms would have a large surface area to volume ratio, though no credit was given for just mentioning 'a large surface area'. Many were able to state erythrocytes as an alternative name for red blood cells. It was good to see that the word 'affinity' was regularly used for the relationship between haemoglobin and oxygen and that this would produce oxyhaemoglobin. The majority of candidates were able to state that carbon dioxide concentration affected the dissociation of oxyhaemoglobin and that this was called the Bohr Effect; though 'Bohr' was spelt in a variety of ways.
- 4** This question tested candidates' knowledge about transport of water in the xylem.
- (a)** This was a straight forward question. Few candidates made the mistake of giving multiple answers on each line. Many candidates scored the full three marks but there were also a number who scored zero. Cambium was recognised by the majority of candidates, but xylem and phloem were often mixed up and the stem pith was identified as xylem in a number of cases.
- (b)** This question was accompanied by a photograph (on an insert) of steam coming from the cut end of a woody stem. Candidates were asked to describe the features of xylem that enabled the steam to pass from one end of the stem to another. Less able candidates misinterpreted the question and gave an account of the movement of water through the xylem of an intact plant, sometimes even referring to water potential, adhesion, cohesion or mass flow. These candidates need to understand clearly the difference between the command words 'describe' and 'explain'. Generally, however, most candidates answered the question well and gained two marks. The majority referred to an absence of end walls and a tube that was hollow or lacking in contents. A number of students thought that xylem was made up of lignin or referred to lignin as a coating/lining or as the whole cell wall. When 'pits' were mentioned it was rare to indicate they were actually in the xylem vessel walls.
- (c) (i)** Candidates were asked for a simple definition of transpiration. Many candidates scored well on this part question. Most candidates were able to state that water is lost from leaves/aerial parts of a plant, but some only gained one mark as they did not state that it is lost in the form of water vapour. More worrying is that a significant number of candidates described the movement of water through the plant rather than the loss of water vapour from the plant – obviously confusing transpiration with the transpiration stream. Others thought that transpiration was a measure of how quickly water was lost.

- (ii) This question was quite specific to the role of transpiration in driving the transpiration stream. Many candidates knew that there was a reduced pressure at the top of the xylem and most successfully described the cohesive properties of water allowing a chain of water molecules to be pulled under tension up the stem. However, few candidates were able to clearly describe how this reduced pressure in the xylem was created by loss of water vapour in the leaves. Unfortunately, many candidates had not recognised the limited scope of the question and included detailed explanations of water uptake in the roots, creation of root pressure, adhesion and capillary action. These candidates used up valuable time that would have been better spent on other questions. One area of confusion that became apparent in many responses was that movement in the xylem was often attributed to differences in water potential between the top and bottom of the xylem and the resultant osmosis of water up the xylem vessels.
- (iii) Candidates were asked why cut flowers survive longer if the ends of the stems are cut off before being placed in water. Examiners hoped that candidates might have carried out or seen experiments using a bubble potometer and that the experience gained might have transferred to this new situation. Few candidates referred to movement of water in the xylem – simply referring to the stem instead. Of those that did mention xylem, most believed they were removing dead or blocked cells that would now allow water to enter the xylem. However, very few realised that the blockage was caused by air entering the xylem vessels during the time the cut end was exposed. The majority of candidates seemed to think that the greatest benefit was in reducing the length of the stem making it easier for water to reach the top of the flower stem.

5 In this question on cell structure many candidates made a good attempt and there were some good overall scores. Generally marks were lost in the extended answer ((b)(ii)) as candidates seemed unsure of the meaning of the term 'ultrastructure' and concentrated on describing features of the cell surface membrane that enabled phagocytosis.

- (a) (i) Candidates were provided with a colour diagram of a cell and were asked to state features that indicated the cell was eukaryotic. The majority of candidates gained both marks here for stating the presence of a nucleus and membrane bound organelles – although it should be noted that in many cases the spelling of named organelles was poor. A few candidates correctly mentioned cell size. Some candidates thought that ribosomes were only present in eukaryotic cells and others described the differences in DNA between eukaryotic and prokaryotic cells – unfortunately, this was not visible in the diagram.
- (ii) Candidates were asked to calculate the magnification of the diagram. Nearly half gave the correct answer. Of the rest, almost half used the correct method but a mistake was made in the conversion factor. Most candidates were able to gain at least one mark for this calculation. The conversion factor does cause problems but candidates should be made aware that magnifications such as 0.45, 4.5, 45 and even 450 are unlikely to show the level of detail given in the diagram.

- (iii) The roles of the cytoskeleton were well known. Candidates gave responses that described the movement of cell organelles – in particular vesicles - and also described a role in providing strength or shape to the cell. However, some candidates were not sufficiently specific in their responses, stating responses such as 'movement of substances around the cell' or describing 'phagocytosis', 'endocytosis' or 'pinocytosis' but failing to link this with movement of the cell surface membrane. As with other questions requiring two suggestions, some marks were lost by candidates who wrote more than two suggestions, giving incorrect ones first. Candidates should read the question carefully and provide the correct number of responses.
- (b) (i) Most candidates knew the answer to this question, and 'differentiation' was usually spelled correctly. A number of candidates stated 'specialisation' which was not given a mark as the term specialised was given in the stem of the question. Other terms that arose included: 'meiosis', 'mitosis', 'cytokinesis', 'division of labour' and 'totipotent'.
- (ii) Candidates were asked to describe how the ultrastructure of a neutrophil is specialised. Many candidates gained credit by describing the presence of lysosomes and some gained further credit by realising that energy must be involved and mentioning the presence of many mitochondria. Few candidates were able to extend this line of reasoning and describe the need for ribosomes to manufacture the enzymes or Golgi apparatus to package the enzymes. Few candidates gained maximum marks for this question and it may be that many did not understand the term 'ultrastructure' as meaning the detailed structure. A large number of responses concentrated on the fluidity of the cell surface membrane allowing phagocytosis or concentrated on the presence of a lobed nucleus. Some candidates noted the importance of receptors but failed to state the exact location of the receptors which must be on the cell surface membrane. Most candidates could spell the key words correctly for the QWC mark although common errors included 'lysomes'.
- 6 This question included a section covering the 'How Science Works' criteria of the specification.
- (a) (i) The vast majority of candidates knew that water leaves a cell by osmosis. The occasional wrong answers included references to 'transpiration' or 'evaporation'.
- (ii) Candidates were asked to describe the route that water molecules take through the cell surface membrane. Not many candidates gained two marks for this question. A large number did not read the question properly and discussed the routes taken by water through the roots or leaves, mentioning the apoplast, symplast and vacuolar pathways.

Of those who had read the question correctly, there was a significant proportion who thought water could not move between the phospholipids as it is polar. Some were not specific enough in their wording and described the water being able to 'move between the plasma membrane' and did not mention phospholipids. Others described the transport of water by carrier proteins rather than by channel proteins or aquaporins.

- (b)** When asked why plant cells do not burst when placed in water, nearly all candidates gained credit for mentioning the cell wall. A lot of candidates went on to state simply that the cell wall 'stopped the cell from bursting'. Examiners were looking for a little more than a repetition of the stem of the question. The idea that the cell wall is strong enough to withstand the pressure created by water entering the cell was described in a variety of ways by the better candidates. A common error was to suggest that water potentials were balanced and that water did not enter the cell or even leave the cell.
- (c)** **(i)** A high proportion of candidates gained this mark. The most common error was not including the negative value.
- (ii)** Candidates were asked how a graph could be used to make a more accurate estimate from the data provided. This was not very well answered as candidates tended to be vague and found it difficult to express themselves. A small sketch of an appropriate graph would have provided the information to answer the question. Many responses suggested that the student should plot a line graph and draw a line of best fit to work out water potential. However, this gave no valid information about the graph required. Where candidates tried to give further detail, common errors included plotting the axes the wrong way round, plotting water potential against sucrose concentration or plotting sucrose concentration on the X-axis and somehow plotting both water potential and % cells plasmolysed on the y-axis. Of those candidates who successfully described the correct graph to draw, few were able to describe clearly how to read down from the curve to find the water potential at 50% plasmolysis.
- (d)** In this question, candidates were asked to comment on how they could improve the reliability and accuracy of the experiment described. Some candidates still confuse reliability with accuracy and only a small minority of the best candidates gained all four marks. Most candidates gained credit for suggesting that repeating the experiment would improve reliability. Many candidates suggested calculating an average, rather than a mean, and some used the term 'mean average' as if they were unsure of the correct term to use. Candidates also found it difficult to express clearly how they could improve accuracy. It was common to see suggestions about altering the range of sugar concentrations used. Some suggested increasing the range, while others described using intermediate concentrations, which was a good response that was often spoilt by describing this as 'go up in steps of 0.5' when they should have suggested steps of 0.05. Generally, however, many candidates had little idea of how to improve accuracy and suggested things like 'use an instrument with finer scale' or 'use an electron microscope to view cells'.

F212 Molecules, Biodiversity, Food and Health

General Comments

Although the middle mark range on the paper differentiated well between candidates, rarely did a candidate get more than 85 marks and almost none were in the low 20s or below, the latter probably due to the large proportion of Year 13 candidates re-sitting the paper.

Lack of precision has again cost many candidates marks. On many questions, marks were lost by using the word 'amount' rather than 'concentration' or 'numbers'. The word 'amount' is rarely creditworthy in biology as there is almost always a specific parameter in question, for example concentration, number, volume or mass. It has been noted in a previous report that the same candidate can be precise about biochemistry and yet vague about ecology. It was not surprising, therefore, to see a degree of ambiguity in candidates' attempts to discuss biodiversity and species evenness. This session, however, it was also disappointing to see a similar vagueness in a comparison of haemoglobin and collagen. Examples of the misuse of the term 'immunity' occurred in question 6(b). Immunity is a key technical term in biology and, when used in the wrong context, is likely to result in no mark being awarded.

Where candidates had knowledge of a topic from sources other than biology lessons, eg the transmission of HIV, they often found it difficult to phrase answers in a precise enough manner to generate marks.

A lot of scripts showed evidence of mark schemes having been memorised from previous papers. While this is often a fruitful strategy, questions are rarely identical between sessions and if mark schemes are reproduced without understanding they can fail to elicit full marks.

Comments on Individual Questions

- 1 This question discriminated well but candidates found it hard to gain marks on some parts of the question.
 - (a)
 - (i) Most candidates gained the mark, with about half of correct answers using the full name of the virus and half using the abbreviation. The most common mistake involved just putting 'virus' as the answer. Candidates who seemed not to understand the term 'infective agent' and put 'HIV/AIDS' were not credited.
 - (ii) On the face of it, this was a fairly straightforward question but many candidates failed to express themselves clearly. Most scripts picked up at least one mark, but many struggled when attempting to express the transmission of the virus on used needles. Often candidates used 'clean' or 'dirty' to describe the needle. A common error was to simply repeat the wording about transmission in the question and not to clearly state that used needles were contaminated. Many candidates seemed to think that a needle exchange programme would completely prevent the sharing of needles, rather than contributing to a reduction.
 - (b)
 - (i) The majority of students identified the monomers of proteins but slightly fewer were able to state that the monomer of RNA is a nucleotide. The most common incorrect answer was either 'nucleic acid' or writing the individual components of nucleotides.

- (ii) This proved to be very challenging and very few students were able to access marks. The majority of students did not seem to understand how viruses work at all. Many thought that the virus took over the cell machinery, preventing them from performing their normal function; some thought that the virus hijacked the cell's DNA in order to divide themselves; others thought that viral DNA replaced the cell's own DNA. Most candidates simply repeated the question information without taking it further. Occasionally candidates mentioned proteins, but very few made it clear that they were viral proteins.
- (c) (i) This question was answered reasonably well but it was disappointing to see how few students were able to gain the full three marks. Common errors included poor sanitation, being poor, uneducated, overpopulated and the use of imprecise wording, eg being in a crowded area. Surprisingly, very few candidates mentioned absence of vaccination.
- (ii) Responses to this question were mixed. Scoring one mark was common and two marks were not unusual, but very many candidates described the B lymphocyte dividing into plasma cells and memory cells rather than answering the question. Many candidates correctly mentioned cytokines as binding to receptors on the lymphocytes, and some then mentioned that the B lymphocytes then divided by mitosis / underwent clonal expansion. Very few responses referred to specific or complementary shapes in the correct context, or to the location of the receptors.
- 2 Although the topics were familiar, weak candidates struggled with some very basic concepts.
- (a) (i) Because there was some leeway on the mark scheme, most candidates gained one mark. On this occasion, candidates who had not read the question carefully and described a colour *change* were not penalised.
- (ii) The majority of candidates had the right idea about δ^+ and δ^- and many gained the second mark. However, stating that bonding occurred between (hydrogen or oxygen) molecules or ions was a common error.
- (iii) This question was answered well by most candidates and a majority scored both of the available marks – almost always marking point one and one of the other two. On this occasion, although references to denaturation were not credited, they did not prevent candidates from gaining credit for valid statements.
- (b) This question gave rise to a wide range of marks. Common problems included not reading the question carefully enough and dwelling on the enzyme/substrate experiment, leaving too little on the Benedict's test; adding Benedict's to the initial mixture; failing to heat, or boiling, Benedict's. Most candidates identified a colorimeter but descriptions of its use were varied. One familiar error was to describe placing the reaction mixture in the colorimeter and observing a change in absorbance over time. Filtering the precipitate was seen occasionally. Few candidates could take the test as far as the calibration curve and even fewer could correctly describe what to plot on the graph, many plotted absorbance against time. The question itself was very similar to one that appeared in June 2009 and it was clear that a lot of candidates had learned the mark scheme. While such candidates were often able to gain most of the marks available, a lack of understanding meant they rarely scored all seven marks.

- (c) (i) Most candidates were able to describe an increase and many gained a further mark for quoting figures with units. Candidates are advised to avoid using terms like 'about' or 'roughly' when giving figure quotes.
- (ii) This confused a lot of candidates. 'Cofactor' was sometimes seen, with a minority of candidates taking this line of thinking further. It was common to see Cl⁻ described as a catalyst. A disappointingly large number thought Cl⁻ ions changed the pH of the solution towards the enzyme's optimum or, even worse, that Cl⁻ was an enzyme!
- (iii) Candidates familiar with enzyme experiments scored well here (always from the first four marking points), although quite a few stated 'time'. Far too many candidates referred to the 'amount' of enzyme or substrate.
- 3 This question did not allow candidates to write extensively about irrelevant ecology. Part (iii) only yielded marks to candidates who were precise and understood clearly what they were writing about.
- (a) (i) This was generally well-answered and often gained full marks, though some candidates misinterpreted the question and compared which of the two groups were breeding more successfully. Another common problem arose because candidates clearly did not read the question carefully enough and gave data from years other than 1970 to 2000. A large number of answers significantly over-ran the space available. With a mark tariff of only three, this did not represent a good use of candidates' time.
- (ii) Applying ideas is clearly a skill that many candidates have yet to master. Many candidates got credit for 'global warming' or 'climate change' but then missed the opportunity to stress that change was too quick for adaptation. Examiners generally were disappointed that students did not make more use of key terms like *competition* or *adaptation* and instead relied upon vague phrases like 'sub-arctic species aren't used to it'. It was clear that many candidates misunderstood the context and seemed to think that the Cairngorms was not the natural habitat for a sub-arctic species or even that the sub-arctic species had recently been introduced to the National Park.
- (b) (i) Somewhat disappointingly for a simple definition, barely half of the candidates achieved this mark. A large number of candidates used the word 'amount' or even 'variety.'
- (ii) For an idea that has been examined quite recently, it was a little disappointing to see too few candidates gaining full marks. The weakest candidates clearly understood that some notion of random sampling was required but then failed to refer to the idea that this must be linked to the areas being sampled. Marking points five and six now seem to have entered the national consciousness and were well represented. Many candidates recognised the need for repeats but then neglected to talk of calculating a mean. The lack of candidates talking of standardising the use of sweep net does suggest, however, that many centres do not manage to carry out fieldwork.

- (iii) Most candidates appeared confused by this concept. Many did not see the necessity of first explaining what species evenness was and when they did, a poor use of language meant they lost the mark because they talked of the number of individuals in a species rather than *each* species. Even strong candidates rarely gained more than two marks. It was noted that few candidates gained marking point five, suggesting that they do not realise that species evenness is a component of the diversity index. Teachers should be encouraged to both explain the principles and the method of calculation.
- 4 The early parts of this question were straightforward but candidates were challenged in part (c).
- (a) This was well answered, many candidates having rote-learned the definition from the textbook.
- (b) This was, again, generally well answered with most candidates gaining at least three of the four marks available. A significant number of candidates misunderstand the term 'mucous membrane'. Often this feature was not explained with reference to the production of mucus. Candidates should be made aware that *mucous* membranes produce *mucus*. Other common errors included stating stomach, vagina, ear or eye as a feature designed to prevent entry of pathogens, rather than referring to the specific anti-pathogen features ie acid, wax or tears.
- (c) (i) Full marks were rarely achieved for this question. Many candidates failed to use the term 'host' or refer to damage to the host. The rather careless phrase 'live off the host' also cost a number of candidates one mark. Almost all identified the nutritional benefits of parasitism but few referenced warmth, protection or a means of transmission.
- (ii) Washing hands was almost universally quoted but a second mark was rare. The use of antibiotics was an error seen in at least 10% of scripts. Students would benefit from very specific training on where antibiotics are used, and should perhaps be advised not to use the term unless they are absolutely certain it is appropriate. An alarming number of candidates thought it was acceptable to starve children so the parasite had no food.
- 5 Candidates did well when the response required a choice of letters.
- (a) Structure of DNA and RNA has been tested frequently so it was no surprise that this question was well answered with the majority of candidates gaining at least five marks.
- (b) (i) While most candidates had an attempt at this question, only those able to express coherently unambiguous points tended to gain credit. Many referred to common ancestors rather than the closeness of relationships: of course chimpanzees and humans have a common ancestor - they are both chordates. Candidates needed to state that a high degree of DNA similarity means a *recent* common ancestor. Vague references to the life of taxonomists, such as 'they classify organisms' was not credited unless answers referred to the use of data from DNA analysis.

- (ii) A majority of candidates scored one mark. It was hoped that the types of evidence offered by candidates would be distinct, but perhaps the grouping of anatomical, physiological and behavioural features into one marking point made it harder for some candidates, who, having mentioned two of these thought they had done enough to answer the question.
 - (c) J was almost universally identified but T was often overlooked and V given in preference.
 - (d)
 - (i) This was often well answered with reference to evolution of the pine martens since 1948. A disturbing number of candidates thought that pine martens were birds or trees and some thought the museum specimens had evolved.
 - (ii) This was generally answered less well, with many references to speciation or the upsetting of local food chains. A reasonable minority of candidates did gain credit usually for marking point one.
- 6
- (a)
 - (i) This was intended as a straightforward question testing a fundamental point – variation is due to genes and the environment. However, a surprising number of candidates failed to gain both marks. Many candidates gave two genetic reasons and credit was not given for the occasional examples of environmental change.
 - (ii) It was pleasing that the majority of candidates understood what was being asked and could identify either a range of values or a lack of categories as a feature of continuous variation. Few mentioned the relative contribution of genes and the environment.
 - (iii) Most responses were correct. By far the commonest wrong answer was A.
 - (iv) Most candidates were aware that selective breeding can increase susceptibility to disease and a sizeable minority gained a mark by referring to a reduction in genetic variation. It is clear that some candidates have a fundamental misunderstanding of the relationship between selective breeding and mutation, with large numbers identifying a causal relationship between the two. Many candidates who would have gained credit for 'inbreeding' were not awarded the mark because they went on to say that the inbreeding *caused* mutations. Other candidates revealed a poor understanding of the process of selective breeding, and seemed to think it is a hit-and-miss technique where production of a chicken with undesirable features is something to be feared.
 - (v) This part was well answered, with two marks frequently being achieved. The best candidates phrased answers in terms of the benefits to food production of preserving the red jungle fowl but many also gained marks for more general statements about the benefits of biodiversity.
 - (b)
 - (i) Most knew that antibiotics reduce disease, though some negated their responses by stating that antibiotics made chickens 'immune' or 'disease resistant'. Reduced transfer of disease to humans in infected meat was another commonly awarded mark. Unqualified references to growth were not credited – the question stated that they were given antibiotics as a growth promoter. Good candidates were able to explain the relationship between energy used to fight disease and growth.

- (ii) Fewer candidates than expected linked antibiotic use in chickens to antibiotic resistance in bacteria. Some candidates who had the right idea lost the mark by referring to the *disease* becoming resistant rather than the pathogen. References to bacteria becoming 'immune' received no credit. Many responses identified antibiotics in human food as a potential problem. Weaker candidates often referred to animal rights issues and gained no credit.

7 It was a little disappointing to see less evidence of biochemical knowledge and use of correct terms than was apparent in June 2010.

- (a) The majority of candidates were able to gain a minimum of two marks for this question. It was relatively rare to find a response that failed to register a mark. Able candidates demonstrated their understanding of the biochemistry involved in the formation of the different levels of structure and presented their answers in a clear and logical sequence. A number of students failed to follow the rubric linking secondary, tertiary and quaternary with the correct features and so lost a potential QWC mark. The most common mistake was to write about the bonding in their comments on the quaternary, rather than in the description of the tertiary structure. There was some confusion about α and β chains of polypeptides – some thinking this referred to chains of α and β glucose, or to chains of α -helices and β -pleated sheets. This crept into the secondary structure descriptions, with some people describing an α -helix as having hydrogen bonds between polypeptide chains. Candidates were often vague about the haem groups, often describing them as made of iron (apparently only iron), the term Fe^{2+} was disappointingly rare. There was very little mention of prosthetic groups, and a great deal of uncertainty about the number of haem groups per molecule. While a fair number of candidates understood the nature of hydrophobic/hydrophilic distribution on the inside and outside of the molecule, few of them referred to R-groups. Poorer candidates tended to waste time by discussing the function of the molecule rather than its structure.
- (b) It was rare to see a candidate gain full marks for this question. There was a tendency to provide every fact about proteins, rather than be specific about their similarities. Hence few gained the 'helix' mark, usually describing α -helices. Statements were often vague or general and many candidates discussed only hydrogen bonds. Again, there was confusion between the secondary and quaternary structure.

8 Generally, this was a high scoring question, with the majority of candidates gaining four marks. A common mistake was to put 'specific' instead of 'natural' in the fourth space, perhaps due to the students mistakenly thinking that they could only use each word once.

F214 Communication, Homeostasis and Energy

General Comments

Time did not appear to be an issue in this paper as candidates were able to complete all questions in the time available. It was also pleasing to note that the whole paper appeared to be accessible to the candidates as most of them managed to attempt all sections of the questions.

In some cases, candidates misinterpreted the requirements of the question and, while providing accurate biological information, did not actually answer the question. This was particularly noticeable in questions 3(a)(ii) and 5(a)(iii). Candidates are reminded of the need to read the questions carefully and not to attach undue importance to a single word without looking at its context. It has been noted that spelling and grammar seems to have improved. However, there are still numerous crossings out and candidates should be advised to read the question carefully, noting what it requires and to think carefully about their response, rather than just diving in.

Candidates will benefit from making clear indications that their answer may continue on the additional answer sheet and when writing in the additional space, making it clear to which question the answer refers.

Comments on Individual Questions

- 1 This question was designed to be an accessible, although a testing, start to the exam.
 - (a) Many candidates were able to score at least one mark in this part of the question. Few candidates confused ethanol and ethanal. The aspect that was least well answered was the first row, the name of the hydrogen acceptor after glycolysis. This appeared to be misinterpreted by some candidates as the name of the hydrogen acceptor in glycolysis and they therefore incorrectly suggested NAD for both the mammal and yeast.
 - (b) Many candidates were able to relate the release of energy and formation of ATP to anaerobic respiration. Those candidates who were not awarded the mark simply defined the term 'anaerobic respiration'.

- 2 This question assessed both AO1 and AO2 skills, with candidates coping well with all aspects of the question.
 - (a) (i) Many candidates were awarded at least three marks. It is refreshing to note that only the weaker candidates used the terms signal or message rather than impulse or action potential. Rarely did candidates explain that the Schwann cell produces myelin, but they were able to describe how the cell wrapped around the axon to produce the fatty sheath and subsequently provide insulation. Very few candidates went on to explain that the sheath prevented the movement of ions into or out of the axon, but simply referred to the impermeability of the sheath, which was insufficient for the mark to be awarded. The idea of speeding up the transmission of impulses was frequently referred to, but those candidates who quoted speeding up action potentials with no mention of transmission or speeding up conduction without the action potential or impulse being mentioned were not awarded the mark. Saltatory conduction was frequently mentioned.

A mark for quality of written communication (QWC) mark was available in this question and was only awarded if appropriate scientific terms were correctly used in context with correct spelling. Many candidates were awarded the QWC mark; usually for myelin, impulse and saltatory conduction.

- (ii) Most candidates answered this correctly.
 - (iii) Most candidates answered this correctly. Some incorrectly stated facilitated diffusion.
 - (iv) While many candidates could explain the reason for transmission in one direction across the synapse, some did not make it clear that the acetylcholine was *only* released from the presynaptic neurone or that the receptors were *only* found on the postsynaptic neurone. Some misunderstood the question and explained how the refractory period ensured transmission along the axon in one direction only.
- (b) (i) Candidates were required to apply their knowledge and understanding of the generation of an action potential in the postsynaptic membrane to the situation in which this does not happen. There were some good responses in which candidates explained how the atropine competes for the receptor on the postsynaptic membrane and subsequently explained that acetylcholine could not then bind. That the ion channel did not open and so sodium ions could not enter leave the neurone was seen in many answers but the idea of insufficient depolarisation and the inability to reach the threshold potential was less frequently seen. While most candidates appeared to understand the principles involved, weaker responses were imprecise in their expression and might refer to competitive inhibition of active sites which was inappropriate in this case.

Teaching tip:

For this kind of question, where a set of events does not take place, a helpful exercise might be for students to write an account of events in the positive (ie what happens) and then repeat the process by producing a list of events in the negative (ie what does not happen). They could then write their own questions which could help them to identify those that are phrased to elicit the 'negative' answers. Students could then exchange work within the group and comment constructively on each other's answer and question.

- (ii) Weaker candidates struggled to recognise which aspect of their knowledge they should be concentrating on in order to answer this question. Consequently, those answers tended to refer to atropine inhibiting the action of acetylcholinesterase (which would not counteract the effect of the nerve gas, which was already doing this) rather than preventing the binding of acetylcholine to the receptors and therefore preventing the continual firing of action potentials.
- 3 This question presented the main biochemical reactions in what may be an unfamiliar context for some candidates. It required good understanding and the ability to apply their knowledge in order to perform well.
- (a) (i) Most candidates answered this question well, with many scoring full marks. The common errors were to describe X as the link reaction or to reverse the answers for X and Y.

- (ii) Candidates who performed well in this question quickly realised what the question was asking for and that the reason was the involvement of different locations and organelles in the cell. With suitable details of the location of the reactions, these answers could gain full marks relatively easily. A significant proportion of answers either described the individual reactions or attempted to indicate how they interacted by the involvement of the same compounds at stages within the different reactions. Neither of these approaches addressed the question.
 - (iii) Most candidates correctly stated that reaction pathway X was involved in photosynthesis. The most common reason for missing the second mark was that candidates did not indicate that both the reaction pathways W and Y were involved in aerobic respiration; W was frequently omitted.
 - (iv) Most candidates were able to identify at least one product of oxidative phosphorylation correctly. While many correctly identified two products, significant numbers provided further suggestions that were incorrect. These incorrect suggestions commonly included oxygen, carbon dioxide, NADP, reduced NAD and reduced FAD. If an incorrect answer was included then a maximum of one mark could be awarded (as stated in the Additional Guidance column in the mark scheme).
- (b) This proved to be the part of the question that candidates found most difficult. While many candidates had a reasonable grasp of the function of the different coenzymes, the answers commonly failed to provide the biochemical detail required. Those candidates who detailed what each individual coenzyme did often found that they were repeating information that would only be credited once (eg NAD is a hydrogen acceptor ... FAD is a hydrogen acceptor ... NADP is a hydrogen acceptor). Candidates were expected to state what would be supplied by a reduced coenzyme and its destination (eg reduced NAD supplied hydrogen ions for chemiosmosis). The role of coenzyme A was less well described. Few candidates appreciated the recycling of coenzymes or, in the cases of NAD, FAD and NADP, the idea that they could be reduced and oxidised. Some candidates provided detailed information about Rubisco, indicating a lack of understanding of the term coenzyme.

Teaching tip:

When teaching the various stages of respiration or photosynthesis, students can act out the events. For coenzymes, the students can be labelled as the particular coenzyme and can indicate what they carry by using pieces of paper. With other students acting the parts of the electron transport chain and proton pumps, they can indicate what happens to the atoms, ions or electrons. Visualisation can be a great help in understanding.

- 4 This question dealt with the nature of ADH, its role and possible fate. It required candidates to draw on material from previous units and relate this information to material from this unit.
- (a) This part question was well answered. The vast majority of candidates gained two marks and several could have been credited for three had the question paper allowed. Most appreciated that water would enter the red blood cells and that this would lead them to swell and possibly burst. Only a few mistakenly thought that water would leave the cells, often also incorrectly referring to plasmolysis. Some failed to be awarded the mark for swelling or bursting by suggesting that the cells would become turgid; this was considered to be a contradiction and negated the mark. References to water potential needed a clear comparative statement for a mark to be awarded. Candidates who simply restated the question by saying that there was a 'high water potential in the plasma', without discussing the situation in the red blood cells as well, gained no credit. Some candidates seemed to focus on the reference to ADH given in the question context and then failed to pick up on the key requirement here to 'explain the effect on blood cells...'. Therefore, answers that discussed the detection of the change in water potential leading to a reduction in ADH production with the resulting effect on urine production did not gain credit. A few candidates misread 'blood' as 'body' and referred to general effects in surrounding tissues. Some incorrectly answered in terms of possible blood pressure changes, suggesting that blood cells would then 'move too quickly' or that capillaries would burst. A few candidates failed to state that the water would enter the cells, for example 'water would enter it'. As the question refers to both blood cells and plasma, 'it' does not give a clear enough indication of direction of water movement.
- (b) For those candidates who recognised from Fig. 4.1 that ADH is a protein, this was a very straightforward question. Others struggled and a wide range of incorrect answers were seen. Given that the first part asked for a 'monomer', a surprising number of candidates gave responses such as polysaccharide or polypeptide that implied little understanding of this term. Common incorrect answers for the name of the bond included polypeptide, glycosidic and hydrogen. Some candidates stated that the bond was covalent without giving the further detail required.
- (c) Many candidates picked scored at least six marks here. Common errors included osmoregulatory rather than osmoreceptor; brain rather than hypothalamus; duct or neurone instead of axon; unqualified references to the pituitary; surface rather than membrane; diffusion instead of osmosis. The question had asked for the *most suitable* term, so candidates should consider whether their proposed answer is indeed the best. Candidates are reminded that multiple contradictory answers in one gap will not gain credit.
- (d) A large number of candidates understood the sequence of events here very well and gave answers which could have been credited in excess of the maximum three marks as they dealt both with events in the liver and excretion via the kidney. Some, however, mistakenly thought that the ADH was removed directly from the collecting duct into the urine. They had failed to note that the question referred to where ADH left the 'blood'. Some said that it left as urine rather than *in* urine and so were not awarded this mark. A few believed that the hormone itself returned to the hypothalamus for 'recycling'. Occasionally candidates answered in terms of 'why' ADH should be removed and not 'how'. A few candidates failed to sequence their answer correctly, stating that the ADH was excreted by the kidney before being dealt with by the liver. At A2, candidates are expected to refer to ADH being hydrolysed rather than 'broken down'.

- 5 This question dealt with adrenaline, how it affects target cells and its interaction with the nervous system in the control of heart rate. Candidates needed to draw on some AS knowledge in order to fully answer the question.
- (a) (i) Most candidates correctly identified adrenaline as the first messenger and cyclic AMP as the second, although there was occasionally confusion with adenylyl cyclase being named as either the first or second messenger. It is possible that some candidates misinterpreted the title Fig. 5.1 as referring to the last of the diagram sequence only and thus selected their answers only from the components labelled on this part of the figure. The stem of the question clearly states that the figure represents a sequence of events.
- (ii) This question generated many half answers, with candidates referring to the production of glucose or the breakdown of the polysaccharide. It was far less common to see the added detail that would trigger the awarding of a mark. In common with question 4(d), at this level candidates should be using the term hydrolysis. As the question referred to a liver cell, candidates were expected to identify the relevant polysaccharide. The term *glycogenolysis* was used infrequently, but was occasionally confused with *gluconeogenesis* or *glycogenesis*. Very few candidates attempted to name appropriate enzymes, but unfortunately mostly with errors.
- (iii) Misinterpretation of the question was common. Weaker candidates simply listed the different effects on different tissues without suggesting how this might be achieved. Good answers stated that the tissue might have either different cell surface receptors or that adrenaline binding to receptors might generate a different second messenger. Many candidates also gained a mark for commenting that different enzyme reactions might be activated as a result of adrenaline stimulation.
- (b) Some very good answers were seen that scored full marks, many achieving up to seven or eight of the marking points available. Relatively few failed to mention both hormonal and nervous mechanisms; of those who did, it was generally the hormonal mechanism that was omitted. Most candidates stated that adrenaline would increase the heart rate although some also went on to describe the effects of other hormones, such as thyroxine and cortisol. Some candidates thought that the cardiovascular centre is situated in the hypothalamus and often candidates simply referred to the medulla oblongata alone as being responsible for the nervous control of heart rate. Few correct references to the SAN controlling the frequency of waves of excitation were seen although many understood that the SAN was the pacemaker and fewer appreciated that it would have a nervous connection, expressed in a variety of ways.

While many commented on how changes in either blood pressure or pH and carbon dioxide concentrations would be detected by receptors in the aorta or carotid artery, some made the mistake of saying that these receptors would detect any changes in the parameter they were monitoring rather than specifying that chemoreceptors would detect low pH or high CO₂ concentration and that baroreceptors would detect high blood pressure. Some also commented on stretch receptors in skeletal muscle, which were not relevant. Most candidates made correct links between the accelerator and vagus nerves and the heart rate, often giving more detail, such as naming the neurotransmitter released at the end of each nerve. Weaker responses simply described the cardiac cycle without supplying any further detail. AS material about conduction from the SAN to the AVN, Purkyne tissue etc, had been well remembered although was not relevant here.

Many candidates were awarded the Quality of Written Communication (QWC) mark for the correct use and spelling of technical terms, including adrenaline. Candidates should take care when spelling technical terms and with their writing. It was often not possible to credit terms towards the QWC mark simply because two or three letters ran together in a word, were indistinctly formed or letters had been over-written, all of which made interpretation of the intended spelling impossible.

6 This question required candidates to analyse and process data, linking it to photosynthesis, synoptic material relating to transpiration and experimental design (AO3).

- (a) This question was not well answered by many candidates. Some miscalculated and/or made errors in rounding. One commonly derived wrong answer was 224% and another was $(93 \div 208) \times 100 = 44.8\%$. Candidates were expected to calculate the difference in the mean thickness of the leaf ($208 - 93$) and to express this as a percentage of the shade leaves $(115 \div 93) \times 100$. Full credit was given for those candidates who expressed the difference as a percentage of the sun leaves in order to reward them for being more competent at performing this type of calculation. It should be noted that on another occasion when candidates are asked to calculate a percentage increase or decrease, then dividing by the correct number would be essential. It is worth reminding candidates that processed data should either be expressed to the same number of decimal places or to one additional decimal place than the raw data. Many candidates failed to add the units (%). Whilst this did not lose them marks on this occasion, it should be noted that this may not always be the case in future questions.

Teaching tip:

Manipulation of data is an essential skill and can be tested both on theory papers and in the practical skills Tasks. Candidates therefore need plenty of experience in the processing of data or practical results. A folder of data can be compiled for students that can be used as the basis for performing various processing tasks.

- (b) Most were awarded a mark for commenting on the additional CO₂ provided by the larger mean number of stomata, but a few missed out by not stressing that they allowed *more* carbon dioxide to go in or be absorbed. For the explanation mark, many candidates referred to increasing photosynthesis without mentioning light-independent reaction or Calvin cycle; vague references to 'photosynthesis' are not really good enough at this level. However, the idea of limiting factor was well appreciated and clearly well taught. Very few students were commenting on the reduction in transpiration, with some writing a description rather than a clear statement. Some candidates were just missing the point that the question refers to the *lower* side of the leaf and were just addressing the mean number of stomata, so were referring to increased transpiration rate, which was not appropriate. Some candidates referred to sheltered stomata but comment on diffusion shells was not seen. A common incorrect reference was that of letting in light.

- (c)** Many candidates were awarded a mark for correctly referring to the sample sizes of the sun and shade leaves. Some, however, made vague statements that did not convey the required clarity. Few candidates suggested actually measuring the thickness of the cuticle. Candidates were often not awarded this mark because they referred to using leaves with the same cuticle thickness rather than a quantitative measurement. Candidates referring to replicates or repeats needed to clearly state or imply that they are to be carried out with plants of the same species or in the context of the complete investigation. Answers often implied altering controlled variables in addition to light levels such as plant species, however this extends the investigation rather than focusing on improving this investigation. The standard ideas of controlling factors such as temperature would not have been relevant for this investigation and so were not credited.

F215 Control, Genomes & Environment

General Comments

This was the second time this paper has been taken and candidates were able to complete all questions in the time available and most attempted every section. However a third of candidates missed the graph question where no dotted lines marked the need for an answer, and a handful also missed the table calculation, presumably for the same reason. These candidates would have scored more highly if they read the whole question paper and followed all instructions. There is a tendency for candidates to focus on the dotted line answer line and to read only part of the information presented, limiting their understanding of the context of the question and the quality of their written response.

It was also noticeable that candidates could produce well-rehearsed answers when questions were asked in a familiar way, for example, explaining the working of the *lac* operon. Conversely, questions requiring candidates to draw aspects of knowledge together from different areas of the specification caused problems for many, for instance, being required to name organs in the thorax made up of the three different types of muscle. Teachers should be aware that 20% of the marks available on this paper are for synoptic understanding and that this requires candidates to have a working knowledge of the AS and F214 learning outcomes.

The overall performance of the cohort taking this paper showed a normal distribution of marks, spread over a large section of the available mark range. It was, however, a testing paper, both in terms of the degree of sophistication of understanding required of some familiar topics like ecology, and in its coverage of material new to core A2, such as PCR and gene cloning. A significant number of students were also re-taking this paper. Consequently no students accessed marks in the nineties on this occasion, unlike in June 2010.

The additional space at the back of the paper was frequently used by candidates but they must indicate clearly if an answer is continued here. Candidates are not advised to write below the lines, above the lines or in the margins without clearly indicating in the given answer space where the continuation of the answer can be found.

Comments on Individual Questions

- 1 Question 1 explored links from a range of learning outcomes to milk and lactose, covering the selective breeding of dairy cows, the evolution of lactose tolerance in adult humans, and lactose digestion by bacteria. Candidates scored well throughout this question, with (c)(i) being the hardest question and parts (b) and (d) the easiest.
 - (a) (i) Artificial selection of dairy cows is referenced on the specification (section 5.1.2 (s)) yet few candidates had knowledge extending to three traits related to optimum milk production. There were inappropriate references to features important in beef cattle like meat quality, musculature and the size of the animal. Poor exam technique let down some, as they quoted appropriate parameters like “milk yield” without suitably qualifying their answer, for example “high milk yield”. A third error that cropped up was confusion between the terms resistance to disease, which was a good answer involving a gene-based trait, and immunity to disease.

- (ii) A third of candidates missed this question. Those who did attempt it scored well. Most drew a normal curve and also shifted it significantly to the right of the original.
 - (iii) Good attempts were made to list modern techniques used in selective breeding. AI and IVF were the most common correct answers. A number of candidates erred by giving either a detail of, or a specific method of cloning (eg nuclear transfer), rather than just saying cloning.
- (b)
- (i) Most candidates defined mutation appropriately. Candidates should beware of using vague terms like genetic code and genetic coding. They need to reference the base, nucleotide or DNA sequence and explain that in mutation it is changed.
 - (ii) The situation described clearly involved a selective advantage in being able to digest lactose, so while evolution and natural selection were the correct answers, given by the majority, genetic drift was not. Candidates originally study evolution at AS and meet genetic drift in preparing for this paper, so the high prevalence of this error points to candidates focusing too narrowly and not realizing that 20% of the marks on the F215 paper are synoptic in nature.
- (c)
- (i) Adequately defining the terms structural gene and regulatory gene is quite tricky, though many candidates managed to put their understanding into words appropriately. Some had difficulty transmuting their understanding of the *lac* operon into this general context. One teaching point to get across is the need to state whether it is the gene itself or the gene product that is being referred to in any scenario involving the interactions of genes and the proteins they code for.
 - (ii) Most candidates realised that the bacteria changed or removed the lactose, but very few went on to speculate what the products could be, or to point out the high nutritional value of dairy products, so one mark out of two was the norm.
- (d) The *lac* operon was well understood and well explained by the majority, though weaker candidates confused translation and transcription, mRNA and RNA polymerase, and the regulator gene and the repressor protein.
- 2 This question was concerned with the three types of muscle.
- (a) This question required candidates to organize their knowledge in a table of boxes, similar in format to a question on this paper in June 2010. The top row, requiring information about the structure of the muscle types, scored better than the bottom row, concerning function. The best candidates gave very clear descriptions of the cells - most commonly identifying whether the cells were striated or not, and the number of nuclei they contain. A few mentioned that cardiac muscle cells are branched and have intercalated discs. Quite a few candidates seemed to misunderstand the idea of the function of the muscle types however, and simply said where the muscle type could be found rather than saying what it actually did. While some correctly stated that voluntary muscle moves bones and that cardiac muscle pumps blood, far fewer could give an example of what involuntary muscle does in the body, with the few who scored mostly describing or naming peristalsis in the gut.

- (b)** In this question, candidates were asked to 'think outside the box' and to name locations of the three types of muscle within the thorax. Over the course of the AS and A2 courses, candidates should have come across relevant examples, for example in arteries and bronchioles (smooth muscle), the heart (cardiac) and intercostal muscles and the diaphragm (striated). Many candidates found this cross-relating of information difficult, with heart being the commonest correct answer. It was not unusual to see muscles in the limbs and in the abdomen being named here, indicating that many candidates are not sure where the thorax is. A significant number erroneously thought that the muscles involved in breathing were of smooth muscle type.
- (c)** Even weaker candidates had a go at giving the letter from the labelled diagram of the part of the brain corresponding to a list of three actions. Two thirds of answers were correct, with no one action proving any more difficult to link to brain anatomy than any other.
- (d)** Most candidates expressed the idea that humans are more closely related to monkeys and went on to explore similarities between the two species, including the idea that this would mean the results of tests on monkeys would be more applicable to human beings. Fewer candidates gave a good argument for and against the use of monkeys in research. Candidates need to avoid vagueness and to be more specific when they are asked to state an opinion on an ethical question like this, for example in this case identifying how the testing could benefit humans, and explaining how the procedure is cruel to monkeys.
- (e)** This extended writing question was well answered by most candidates, with scores generally being around five out of nine, and with the best answers scoring maximum marks. Candidates were required to link the physiological events of the fight or flight response to the control mechanisms behind it, with mark points relating to these two aspects arranged in two lists. It was common to see reference in candidates' answers to the sympathetic nervous system and the hormone adrenaline from list one, with the best answers also describing the site of production of the hormone, the influence of corticosteroids and details of the events at the sympathetic neuromuscular junction as well. Candidates who got confused and talked about the parasympathetic system also being active, lost the mark for identifying the sympathetic as the branch of the autonomic nervous system that was active. A small number of candidates thought that the fight and flight response were opposites – ie that the fight response was stimulated by the sympathetic system and caused an increase in heart rate (for example) whereas the flight response was stimulated by the parasympathetic system and caused a decrease in heart rate. The most common effects of the fight and flight response (list two) referred to by candidates were the increase in heart rate, dilation of the pupils, increased ventilation rate and reduced activity of the digestive system, plus correct descriptions of the redirection of blood flow.

- 3** This ecology question was a serious test of candidates' understanding of energy flow through different ecosystems and food chains.
- (a)** As the ecosystems included two distinct climatic regions in addition to two distinct types of vegetation, candidates needed to compare the tropical to temperate ecosystems in addition to a comparison of grassland to woodland & forest. Few responses did this successfully. Good responses mentioned the increased light intensity & temperatures in the tropics leading to faster photosynthesis & hence biomass production. In the forests, greater biodiversity, humidity and shelter were issues rarely described. Grassland having increased competition for space was not appreciated, candidates more often referring incorrectly to the height of trees or availability of water.
- (b)** Use of a calorimeter to measure energy content of organic material was not well-known. A few candidates were confused about the difference between dry biomass and energy content.
- (c)**
- (i)** The majority of candidates were able to calculate the conversions as 22 for perch and 1 for cow, but a significant minority missed the question as no dotted answer lines were provided. This is a serious defect in examination technique.
- (ii)** Numerous candidates did not take note of the word *mammal* in the question and made irrelevant comments about perch and grasshopper. Others wrote in general terms with no reference to the mammals and data in the table. A few failed to distinguish between the different trophic levels of the two mammals listed, and lumped them together as though all mammals occupy the same trophic level. The difference in conversion to biomass between the carnivore (bobcat) and the herbivore (cow) was therefore not often clearly explained. The data in the table provided information to do this in terms of absorption and egestion percentages. Reference to the digestibility of meat as opposed to cellulose in plant material was fairly frequent however, and this scored even if phrased in general terms (carnivores versus herbivores) without reference to the data provided.
- (iii)** It was extremely rare for the correct choice of the grasshopper to be made. There seemed to be a lack of understanding that a primary consumer would have more food available and with a reasonable percentage conversion rate would pass more food energy directly to humans through only one stage of the food chain. A number chose the cow despite it having the lowest conversion to biomass. The majority incorrectly favoured perch, even though there would be significant losses of food energy during two stages of the food chain, gaining one mark only for recognising that it had the highest percentage conversion rate in the table.

- 4 This question tested the skills of describing and explaining a graph and explored candidates' knowledge of the use of fermenter technology in producing penicillin on a large scale. The question was fairly well answered on the whole but a significant number of candidates thought that *Penicillium* was a bacterium and others implied that penicillin was a living organism.

- (a) (i) Candidates were presented with a graph showing how the nutrients lactose and ammonia decrease over time, while fungal biomass and later the concentration of penicillin rise. Most candidates were able to describe the changes in concentration of lactose and ammonia. However, too many candidates were not precise enough in reading figures from the graph. Figures should be quoted as accurately as possible and certainly to the nearest scale line, and not be rounded up or down to the nearest multiple of five or ten as some candidates are doing.

Fewer candidates were able to explain the changes in nutrient concentration, especially in the case of ammonia where very few could relate NH_3 to a named nitrogen-containing molecule within the fungus. The most commonly awarded mark in this section was lactose being used in respiration. Many did not realise that both lactose and ammonia are used to make biomass and to make penicillin. Indeed, some candidates did not realise that lactose and ammonia were nutrients at all, with a few thinking that the ammonia was a waste product of fungal metabolism.

- (ii) This was quite well answered by many candidates who understood the differences between batch culture and continuous culture. Some candidates lost marks by not distinguishing between lactose, ammonia and biomass in their answer, or by stating what would happen to the curve for lactose only rather than for both lactose and ammonia as was requested in the question.
- (iii) Plenty of candidates gained full marks, for saying that penicillin is produced after the main growth phase of the fungus, when nutrients are declining. Some correctly quoted the onset of penicillin production as being after 24 hours but a worrying number read the x-axis of the graph as 20 or 22 hours. Some candidates referred to named stages of the *Penicillium* growth curve but got the name of the stage wrong, and missed out on a mark.

- (b) (i) This was well answered, with many responses gaining three out of three. The only question-specific error here was to elaborate too much on a single reason and therefore miss out on marks for discussing a variety of reasons for the need for maintaining aseptic conditions. The confusion between *Penicillium* and penicillin also cropped up here, as did the assumption that *Penicillium* was a bacterium despite the question stating it is a fungus.

- (ii) This was relatively well answered, with many candidates gaining all three marks. Temperature, pH and oxygen were the factors most commonly given, with correct reasons for controlling each factor supplied.

- 5 The enzymes used for genetic engineering were well understood but candidates showed a lack of understanding of the detail of cloning genes.

- (a) The most common correct answers were plasmid (D) and restriction enzyme (B). Common errors were stating RNA polymerase instead of DNA polymerase for A and RNA transcriptase instead of reverse transcriptase for E. Good candidates scored four or five marks out of five.

- (b) Few students achieved more than two marks for this testing question. Most students correctly stated that insulin is synthesised in the pancreas, and so gained one mark, but only a small percentage of these mentioned that the mRNA of insulin is found there also. Very few students understood the relevance of white blood cells as being an easily obtainable source of DNA. The error very commonly encountered was that as white blood cells are involved in fighting disease, this must somehow make them a good place in which to find genes implicated in disease. An extremely widespread misapprehension which needs to be addressed in teaching is that there are different genes in different cells. Candidates should understand from work on stem cells and mitosis that the body is a clone of genetically identical cells, but this question indicated that around nine students in ten do not believe this to be the case.
- (c) This extended writing question set candidates a tough task as they had to highlight differences between the two techniques of gene cloning and then present their answers in terms of how each technique scored in terms of advantage. While the candidates who did best on the paper as a whole did score reasonably well on this extended writing task, full marks were rarely given, and the majority of candidates scored two or three out of eight marks. Many candidates quoted at length from the table of information given but failed to do any comparative analysis. Others highlighted differences but pointed out which process was at a disadvantage, although they had been asked to highlight advantages. Some interesting errors and irrelevancies included the candidates preoccupation with *in vivo* cloning being more 'natural' compared to *in vitro*. Another common statement was that *in vivo* allows the gene to be expressed and to get protein at the end, compared with PCR which only gave the DNA, showing a disregard for the instructions in the question. Candidates who did compare often contradicted themselves as the essay progressed by stating *in vivo* was cheaper at one point and later stating that *in vitro* was cheaper. A few students did recognise that PCR was used for forensics but without understanding why. It is hoped that the markscheme will help centres and candidates analyse the pros and cons of the two methods for future use.
- 6 This question explored a variety of learning outcomes, focusing mainly on the section four of the specification on plant coordination and animal behaviour. It is important that candidates learn about the types of behaviour in the context of real examples of behaviour in named animals.
- (a) Candidates needed to choose one or two-word answers for (a), so most had a go and there were few blank answer spaces. Sources of error and lost marks were misspelling of tropism, the giving of examples of tropisms and plant hormones instead of the generic term, 'senescence' instead of deciduous, 'sustainable management' instead of conservation, and the use of the term 'ammonification' instead of nitrogen fixation.
- (b) (i) The commonest incorrect answer here was to mistake 'habituation', an example of learned animal behaviour, for 'habitation' with answers concerning ecological habitat parameters. In those responses that gained some or all of the marks, a definition of habituation in general (which was not required) was usually followed by description of a correct example, but over half of the examples failed to include the animal's normal response so full marks were rare. A few candidates simply wrote 'an animal...' without naming the chosen example. The range of examples offered was disappointing, with humans failing to wake up in response to the noise of traffic or trains after a period of getting used to this stimulus being the most popular one. Some nice invertebrate examples were seen occasionally, involving ragworms, earthworms and snails becoming habituated to shadows or to touch.

- (ii)** Skinner boxes were commonly correctly referred to here but again candidates frequently missed out important information pertaining to description of a real example. They may not have specified the animal, the voluntary initial behaviour or the nature of the reward or punishment. 'Pavlov's dogs' were described on several occasions but these answers received no marks as this is an example of classical conditioning, not operant conditioning, and the elements in the sequence of learning are quite different.
- (iii)** It was surprising how many candidates did not name a primate. By part (iii), they may have forgotten that they were being asked to describe an example of social behavior in primates. It is worth pointing out to candidates that in questions of this type, they should refer back to the main stem of the question before each sub-part. Some candidates also found it difficult to describe a discrete social behavior (eg grooming) but were given a mark for describing social interaction in general (eg living in groups). The importance of the behavior was usually a credit-worthy statement about increased protection from predators or better chance of finding food.

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