Rewarding Learning

CCEA GCE - Biology
(Summer Series) 2013

# Chief Examiner's and Principal Moderator's Report

biology

# Foreword

This booklet contains the Chief Examiner's and Principal Moderator's Report's for CCEA's General Certificate of Education (GCE) in Biology from the Summer Series 2013.

CCEA's examining teams produce these detailed reports outlining the performance of candidates in all aspects of the qualification in this series. These reports allow the examining team an opportunity to promote best practice and offer helpful hints whilst also presenting a forum to highlight any areas for improvement.

CCEA hopes that the reports will be viewed as a helpful and constructive medium to further support teachers and the learning process.

This booklet forms part of the suite of support materials for the specification. Further materials are available from the specification's microsite on our website at www.ccea.org.uk

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Subject Code 1010
QAN 500/2501/6
QAN 500/2503/X

# GCE BIOLOGY

# Chief Examiner's Report

As in recent summer series, each of the four examination papers in summer 2013 provided further evidence of the high quality learning and teaching taking place in centres taking CCEA A level Biology. In later sections of this report, individual papers will be reviewed in detail. In this introductory section, features common across the suite of papers will be outlined in an attempt to encourage centres and their candidates to improve further on the standard set.

In general, there was little evidence of candidates not attempting all the questions. There were very few large blank spaces in any of the four papers. Furthermore, there was very little evidence of candidates not having enough time to complete their papers.

It is pleasing to note that there appeared to be some improvement in the candidates' knowledge and understanding of key biological terms and definitions. This has been a significant issue in past examination series with candidates often struggling to score well in questions testing this knowledge and understanding. For example, Q1 in AS 1, requiring knowledge and understanding of key terms in mitosis and meiosis, was well done. However, this improvement was not evident in all questions testing this skill. Q1 in AS 2, requiring knowledge and understanding of plant cells specialised for water and solute transport, proved to be more discriminating.

Many candidates lose marks by not reading the question carefully. There were examples of this in each paper and some of these will be referred to in the reports for individual papers. However, an obvious example is Q5(a)(i) in AS 2. In this question candidates were asked to state the *functions* of some components of a blood smear in a photograph. A significant number of candidates *named* the blood components rather than stating their function and therefore lost the three marks available.

The inability of many candidates to effectively answer questions relating to practical work was again evident in this series. Perhaps, this was most evident in Q3(c) in the A2 2 paper where an understanding of the role of a respirometer in determining if anaerobic respiration is taking place was tested. This question was particularly poorly answered with only a very small minority of the candidature obtaining more than half of the marks available for this question part. Very surprisingly, only a small minority of candidates could accurately describe the function of the KOH in an investigation using a respirometer.

There is a requirement for a number of questions to be applied in nature, often involving unfamiliar content, in each of the papers (although the balance increases between AS and A2). There is clear evidence that many of the weaker candidates find this type of question challenging. However, it is very pleasing to note that many candidates performed extremely well in these questions this year. This was evident across the full range of the papers.

As with recent series, the presence of an 'extra lined page' at the back of each paper provides candidates with extra space to complete answers should they run out of space in the main body of the booklet. Many candidates use this page very effectively and appropriately cross reference their answers ensuring that examiners are fully aware which question part the extra information refers to. Additionally, most candidates very helpfully note at the end of the question part concerned in the main body of the paper that the answer is continued on the extra lined page.

The main purpose of adding the extra lined page is to reduce the use of supplementary answer booklets. There is some evidence that this is working but it is clear that many candidates unnecessarily use supplementary booklets (often leaving the extra lined page untouched). Additionally, the supplementary answer booklets are often unattached in any way and

consequently at risk of becoming separated from the main body of the completed question paper. It is also evident that the use of the extra lined page and/or supplementary booklet is centre dependent, i.e. in many centres all the candidates will appropriately use the extra lined page and usually do not need to use a supplementary booklet, whereas many of the candidates in other centres ignore the extra lined page and resort to the supplementary booklet at the first opportunity. It is strongly recommended that centres make all concerned, e.g. their candidates and invigilators, aware of the extra lined page and the benefits of it as opposed to the supplementary booklet. Nonetheless, it is worth noting that the number of answer lines allocated for each question part is under constant review and that there has been a tendency to increase the answer space available for many types of questions in an effort to reduce the issues discussed above.

# Assessment Units AS

## General Comments

Each of the two AS papers were effective in discriminating among the candidature. Each paper had a broadly similar structure to previous papers. In each, there were questions assessing knowledge and understanding, key biological skills (e.g. a graph in AS1 and a table in AS2), practical techniques and the analysis of data. In each paper there was evidence to suggest that many candidates struggled in particular with those questions involving biological information or practical investigations set in an unfamiliar context.

Marks were often lost through not answering the specific question that was asked or providing answers that lacked the appropriate level of detail required. These issues will be raised again in the following sections.

# Assessment Unit AS 1 Molecules and Cells

This was a demanding paper and covered all of the assessment objectives. Candidates were required to recall biological knowledge and to apply their knowledge and understanding in the analysis and evaluation of a variety of stimulus material including diagrams, an electronmicrograph, a graph, tabular data and a calculation. It generated an extremely wide range of marks in the candidature and was successful in discriminating among candidates of different abilities. The paper enabled candidates to show the breadth and depth of their knowledge across the unit content. Some of the questions were more challenging than others, assessing more difficult concepts or the application of understanding to an unfamiliar situation (for example in part (b) of Q2 and in part (b) of Q6).

Many candidates performed well, exhibiting a high level of ability and a thorough preparation for the examination. In particular it was pleasing to see questions involving biological terminology (for example, Q1) showing an improvement on recent papers.

It is also worth noting that there has been a continued decline in the ability of many candidates to express themselves clearly. While this may be penalised within Quality of Written Communication (QWC) in Section B, some ideas were so poorly expressed in Section A that marks could not be awarded, for example in parts of Q2 and 4. Many candidates, including some of the more able, had trouble with spelling and the appropriate use of scientific terms.

Yet again many candidates penalised themselves by not reading the question stem sufficiently well (for example in Q5) or by failing to note all the information in the question.

## Section A

**Q1** This relatively straightforward question assessed knowledge of the processes associated with various stages of cell division. It was generally well done with a large number of candidates scoring 4 or 5 marks. The first and last statements resulted in the most frequent incorrect answers. A significant number of candidates lost the mark for the last statement by not being precise enough in their answer, stating 'prophase' instead of 'prophase 1'. A small number of candidates inserted a 1 or 2 after some of the mitosis answers.

**Q2** This question concerning cell membranes proved very discriminating.

**(a)** In part (a) many candidates gave the role of the bilayer (suggesting that they had not read the question correctly). Many others lacked precision in their answers and so lost the mark.

**(b)** Part (b) required candidates to apply their knowledge of the effect of pH on enzymes to the effect of pH on protein carriers. In (b)(i) many candidates simply stated that the 'protein is specific', without explaining that the carrier is complementary in shape to the particular molecule being transported. In (b)(ii) many candidates did not specifically refer to the ionic bonds and many made reference to the active site which was incorrect terminology for a protein carrier. Candidates found (b)(iii) particularly challenging. While there were some very good answers, too many candidates lost marks by vaguely referring to the R-groups without specifying hydrophobic/hydrophilic.

**Q3** This question, which tested application of knowledge of macromolecules and their constituent sub-units, proved to be most challenging for many candidates. While the question was quite straightforward, many candidates did not read the question correctly. Many of the candidates did not realise that they were supposed to be identifying the original organic macromolecules from the statements re: chemical composition given in the question. Frequently monomers were quoted in answers or, worse still, inorganic ions. It showed a high level of differentiation, with many candidates gaining 4 or 5 marks out of 5, yet others got 0.

**Q4** This question concerning DNA technology was generally well answered. However, a significant number of candidates didn't read the whole question and so gave the same answer to both parts (a) and (b).

**(a)** In part (a) most candidates failed to state the essential point concerning how the relevant sections of DNA would be selected by the specific primers.

**(b)** Part (b), concerning gel electrophoresis to separate DNA fragments, Southern blotting and subsequent marking using radioactively/fluorescently labelled probes, was generally very well answered, with the majority of candidates achieving 3 marks out of 3. However many candidates showed a poor ability to sequence the events during this process (for example using the DNA probes before carrying out the electrophoresis). There was also confusion concerning how the labelled sections are visualised (e.g. use of 'X-rays' instead of X-ray film to identify DNA fragments with radioactively labelled probes attached).

**(c)** Part (c) was generally poorly answered. While some candidates clearly communicated why the species were related or different, too many candidates gave vague answers, such as 'fingerprints/profiles similar' (related species) and 'fingerprints/profiles different' (different species). Only a minority of

candidates appeared to be familiar with the language of this topic area, despite the fact that this type of question has been asked in recent papers.

**Q5** This question differentiated well between candidates of differing abilities. The question stem clearly stated that the electronmicrograph was of a mitochondrion that had just divided.

**(a)** However, many candidates failed to read this correctly and so answered part (a) in terms of a cell undergoing division. The most common incorrect answers were identifying A as a chromatid/chromosome and B as the nuclear envelope or as a membrane (not double membrane or envelope).

**(b)** Part (b) was generally well answered although many candidates lost the conversion mark, often because they measured the length of the cell in cm (which did gain the mark). A significant minority were unable to accurately measure the length of the scale bar in mm/cm using a ruler, which is worrying at this level.

**(c)** In part (c) most candidates could correctly identify the phase but failed to explain why the mitochondria divided at this stage.

**(d)** Surprisingly, part (d) was very poorly answered. Many candidates simply stated 'respiration' (rather than aerobic respiration) or 'to produce energy' rather than ATP. A common error was 'production of ATP *for* respiration'.

**Q6** This question involving plant leaves and water potential was well answered by the majority of candidates.

**(a)** Part (a)(i) was amenable to candidates of all abilities. However, (a)(ii) was more discriminating, as many candidates thought that the cuticle *prevented* water loss rather than reduced it and also many failed to mention transpiration or evaporation.

**(b)** Part (b) required application of knowledge. In (b)(i) the majority of candidates were able to calculate the pressure potential ($\Psi_p$) of the upper mesophyll cells and the water potential ($\Psi_{cell}$) of the lower mesophyll cells. In (b)(ii) most candidates could identify and explain the direction of water flow between the mesophyll layers when the venus fly trap is closing. Most candidates who got the direction of water flow wrong usually correctly identified that water flows from an area of higher water potential to one with a lower water potential – possibly because they have difficulty with negative numbers and thought that -150 kPa was higher than 0 kPa. Part (b)(iii) was more discriminating. Many candidates recognised that the lower mesophyll gained water but failed to explain the consequence in terms of increased turgor pressure leading to increased cell size in the lower mesophyll layer. A few candidates considered that the mechanism of closure of the trap concerned the guard cells changing shape and closing the stomata.

**Q7** This question concerning enzymes differentiated very well between candidates of varying abilities. Most candidates could answer some parts of this question and good candidates were able to pick up most of the marks available for this question.

**(a)** In (a)(i) the vast majority of candidates understood the concept of 'activation energy'. In (a)(ii) the majority of candidates were able to provide one similarity and one difference between the lock and key hypothesis and the induced fit model of enzyme action. However, some lost marks by vague references to 'specificity', without explaining the complementarity in shape between the active site and the substrate or by not giving both parts of the difference.

**(b)** Part (b) was generally well answered although in (b)(i) some candidates thought that dropping the fruit increased the kinetic energy and so increased the rate of reaction between catechol and catechol oxidase. In (b)(ii) a number of candidates thought that the metal in the knife acted as a catalyst to increase the rate of browning when the lettuce leaves were cut.

**(c)** In part (c) the majority of candidates correctly identified the copper as a cofactor, although a common error was use of the term 'co-enzyme'.

**(d)** Part (d) was correctly answered by most candidates.

**(e)** In part (e)(i) many candidates did not give the graph a caption but those who did usually gave it correctly. It was very pleasing that the majority of graphs were accurately plotted with both axes labelled. However, many candidates did lose a mark by joining the points with a curve rather than short, straight lines. There were also a few bizarre choices of scale for the y-axis. A minority of candidates chose to draw bar graphs. In (e)(ii) most candidates recognised that at a flow rate of $20mm^3min^{-1}$ no catechol oxidase remained in the fruit juice, although a significant number commented that 'this is the point where concentration starts increasing'. However only the stronger candidates were then able to explain why this was the optimum flow rate in terms of efficiency/more cost-effective (by comparison with the same outcome at the $10\ mm^3min^{-1}$ flow rate). In (e)(iii) most candidates recognised that the concentration increased with increasing flow rate (although a few thought that that increasing concentration caused the increased flow rate!). However only the more able candidates could go on to give a correct explanation.

## Section B

**Q8** This question also differentiated well between candidates of varying abilities and there was a wide spread of marks. While only a few candidates gained full marks, many gained twelve or more. Only a small number of candidates did not attempt the essay. All points in the mark scheme were seen by examiners, although obviously some points appeared less frequently than others. In the section on the role of the nucleus and rough endoplasmic reticulum (ER), only a few candidates mentioned the role of the nucleolus in production of rRNA/ribosomes. Some candidates gave much detail on protein synthesis, despite being told in the question that this was not required. Only the more able candidates recognised that vesicles bud off the ER to carry the polypeptides to Golgi. Many candidates showed good understanding of the forming and maturing faces of the Golgi apparatus and the various roles of the Golgi apparatus. However, some candidates lost marks by being too vague – for example, stating that the Golgi apparatus produces conjugated proteins or glycoproteins but not explaining what modification of the polypeptide arriving at the forming face was required to form conjugated or quaternary proteins. There was much evidence of confusion about the role of both secretory vesicles and lysosomes. Many candidates thought that lysosomes were involved in exocytosis. Others lost the secretion mark by making reference to release of waste products, which is a different role of different vesicles. Quality of written communication was often good, with many well-sequenced accounts that incorporated sound biological terminology. This is an area where standards appeared to be slipping in recent years, so it was pleasing to find some improvement in this examination. Perhaps the inclusion of the diagram had provided a sort of 'essay plan' and so allowed better candidates to sequence more easily.

# Assessment Unit AS 2 Organisms and Biodiversity

A wide range of marks was obtained by the candidates taking this paper. Some obtained very high marks displaying a sound grasp of the subject content and well developed skills in application. Many questions in the paper also enabled less able candidates to indicate the extent of their knowledge and although some questions proved to be particularly challenging, none were beyond the ability of the candidates as a whole. Comments on individual questions and responses are given below.

There were very few scripts with a significant number of blank spaces and in most questions candidates attempted to respond. Many centres had clearly prepared the candidates to a very satisfactory standard and there was evidence that the content of the specification had generally been well taught. However, in covering the specification, centres should bear in mind the three assessment objectives listed in Section 4 of Specification available online. This paper suggested that for some candidates, aspects of Assessment Objective 3 – How Biology Works, proved unfamiliar.

Once again many candidates lost marks due to their inability to express and communicate their biological knowledge clearly and unambiguously, and there was evidence that some candidates did not read the questions carefully enough. In this case they either failed to address the question entirely or only gave partial answers thereby preventing themselves from accessing all the available marks.

There was a range of stimulus material for candidates to interpret including photographs, diagrams, graphs and tables. The skill of table drawing was also tested.

## Section A

**Q1** This was a straightforward recall question and proved to be mostly accessible, although some of the weaker candidates struggled to explain the functions of the cells described. 'Endodermis' was occasionally incorrectly identified as 'endothelium' and sometimes the term 'Casparian strip' was incorrectly used to name the type of cell. The function of the companion cells proved to be problematic for some candidates. Almost all candidates correctly identified the root hair cell and described its function adequately.

**Q2** **(a)** This question proved to be quite discriminating with part (a) testing the concept of experimental validity with which some candidates struggled. A significant number of candidates wrongly discussed the validity problem in terms of how humid incoming air would affect the transpiration rate and despite the term validity being used in the question, there were references to accuracy and reliability in some responses.

**(b)** In general (b)(i) was well answered but this was not the case for (b)(ii) with some confused responses failing to distinguish between transpiration and photosynthesis/respiration. Some candidates merely explained a high water uptake due to a high rate of transpiration, but this was simply a rephrasing of the question so no credit was given for such responses.

**Q3** This was a novel question relating to oxygen transport and produced a good spread of marks across the candidature.

**(a)** In part (a) many candidates correctly identified the particular habitat or metabolic oxygen demand as the reason for the specific haemoglobin level in either fish. Surprisingly there were a significant number of candidates who were unable to describe the conformational change in haemoglobin and the

concept of cooperative binding which leads to the sigmoidal shape of the typical oxygen dissociation curve. In some cases this inability appeared to exist on a centre wide level.

**(c)** Many candidates appeared to misread the calculation question [part (c)] and although many (but not all) obtained a mark for reading from the graph, a significant number of candidates did not undertake the simple subtraction, but rather expressed this as a percentage change which was not required in this question.

**(d)** Part (d) required candidates to make a comparative statement about the two fish in terms of oxygen loading and then relate this to the oxygen levels in their habitat. This was generally well answered but was one of a number of questions on the paper where candidates ignored the detail of the question and answered in terms of the unloading of oxygen rather than the loading.

**Q4** This proved to be one of the most challenging and discriminating questions on the paper, with only a small number of candidates scoring highly, although no sub-part proved to be completely unattainable.

**(a)** The type of selection was often correctly identified [part (a)] but there was frequently a lack of clearly communicated reasoning behind the choice. A common incorrect response was 'natural selection'.

**(b)** In part (b) the ability to read and assimilate novel information provided about Lamarck and contrast this with knowledge from the course content proved to be very challenging for all but the most able candidates and was a good discriminator of ability.

**(c)** In part (c) many candidates did not appear to understand the word 'tentative' with regard to the nature of scientific knowledge, (although this term does appear in Section 4 of the Specification. A number of candidates may not have been familiar with the term but were able to describe the concept from the context of the question.

**Q5** **(a)** Part (a)(i) was a fairly straightforward question with many candidates being able to state the functions of the blood components shown in the photograph. However, a worryingly large proportion of the candidature failed to read the question, and identified the components in the photograph rather than state their function. Part (a)(ii) proved to be straightforward and was well answered.

**(b)** In (b)(i) a significant number of candidates struggled to identify the blood vessel correctly based on the features visible in the photograph. Those who obtained all three available marks were able to use the clue of scale indicated by the labelled nucleus and the size of the blood cells relative to the lumen. The majority of candidates gave a correct response to (b)(ii) but quite a few only responded to half of the question by identifying an adaptation of erythrocytes yet failing to explain it.

**Q6** This was a novel style of stimulus material but in general candidates responded and performed well in this question.

**(a)** In (a)(i) most candidates were able to obtain full marks by correctly describing two ways in which farmers would manage hedgerows in order to maintain species diversity. Part (a)(ii) involved a little progression in difficulty from (a)(i) but again most candidates managed to gain some of the available marks. A number of candidates lost marks through inadequate or ambiguous communication of their knowledge.

**(b)** The concept of an environmental gradient was generally well understood in part (b).

**(c)** The skill of table drawing was tested in (c)(i) and despite this skill being taught and developed for completion of coursework, there were many candidates who failed to obtain full marks. Often the caption (which was provided) was ignored and the quadrat number was listed in the table rather than the distance from the edge of the pond. A highly significant number of candidates failed to include 'number of plant species' as a column/row title. A few candidates bizarrely (and illogically) converted the numerical values to tally marks and constructed their table using these. Part (c)(ii) involved drawing together the information from the map and the table, and there was a mixed response from the candidature. Many candidates failed to describe the relationship adequately, but most managed to identify at least one reason why a low or high value arose at a particular location.

**Q7** This was a three-part question based on hydrophytes/xerophytes, classification and photosynthesis.

**(a)** The hydrophyte was generally correctly identified in (a)(i) but the reasoning behind the choice was not always clear. Some candidates based their decision on a comparison between the upper surface of the two plants rather than the upper and lower surface of *each* plant. There were also some responses relating to transpiration rather than gas exchange. Part (a)(ii) was generally well answered but occasionally there was evidence of misreading as candidates referred to *root* structures of xerophytic leaves, features already listed in the table or answered in relation to hydrophytes.

**(b)** In general, part (b) was well answered, with only (b)(iii) causing significant problems to candidates who did not appear to understand the term 'molecular structure'.

**(c)** In (c)(i) many correct responses were elicited, describing the more usual means of varying light intensity in a photosynthometer. Many candidates did well in (c)(ii); it was acceptable to answer in terms of the importance of changing only one variable at a time or by suggesting that increased temperature would raise the rate of the plant's metabolism. There were some vague responses to the latter alternative such as 'the heat would affect the rate of photosynthesis', which were not deemed worthy of credit at this level. There was an explicit requirement in (c)(iii) for a full explanation of the results and the three marks available should have indicated to candidates that they needed to discuss more than one region of the graph. Most candidates obtained one mark for explaining the overall trend of increasing oxygen output with increasing light intensity due to increased photosynthesis, but only the better candidates referred to the balance between respiration and photosynthesis at either extreme of the light intensity or at the compensation point.

## Section B

**Q8** **(a)** The first part of the essay [part (a)] required candidates to discuss the events of inspiration which lead to the creation of a pressure differential. This was accessible to most candidates but a significant minority omitted the level of detail which is expected of an AS level student, and a few had problems with the sequencing of the events, suggesting that the intake of air *caused* changes in pressure and volume. There were also some responses in which candidates incorrectly developed detailed answers relating to gas exchange.

**(b)** A good number of candidates did well in the second part of the essay question [part (b)] which involved discussing the generation of high levels of pressure in the aorta. Despite the focus of the question, some responses had a general discussion of the cardiac cycle without explicit references to the role of pressure in promoting blood flow. However, this topic seems to be well understood by the majority of candidates and the responses were of a pleasing standard across all centres. Full marks for Quality of Written Communication (QWC) proved to be difficult to award in some cases, often as a result of poor sequencing of information or inaccurate terminology.

# Principal Moderator's Report

## Assessment Unit AS 3 Assessment of Practical Skills in AS Biology

Coursework submitted by most centres continues to be of a high standard and, as with previous years, the majority of practicals come from determination of water potential, enzyme investigations and membrane permeability. It is good also to see an increase in the number of ecological investigations being submitted. There are still some cases were practicals are chosen without a hypothesis being given to the candidates and this hampers the depth of biological knowledge needed to satisfy the explanation of the trend. Moderation was aided by the inclusion of centre based mark schemes and clear teacher annotation as to where marks were awarded or deducted; this greatly helps the moderation process. It is important that the coursework being submitted is suitable for AS and that the CCEA guidelines sent to schools are strictly adhered to. Teachers should be fully aware of the need for signatures, both teacher and candidate, on the candidate record sheet (CRS).

Many centres used a template to help the candidates structure their work. However, it is essential (as was mentioned in the CCEA circular) that this is restricted to headings only using the assessment criteria. Too often candidates were directed by questions to give the correct reply without using their own thought processes in the construction of responses.

In some cases the responses given by candidates seemed to closely follow each other and the centre based mark schemes. Whilst TAC 6 comments and agreement trials are there to guide teachers to the standard of marking required, this should not necessarily be replicated by all the candidates in the centre. Coursework should show, like the examined units, some differentiation in marks within a centre.

### Implementation

As mentioned above the pieces of work selected for investigation should be appropriate for AS level and should have a clear hypothesis for the candidates to investigate. Candidates should carry out practical work for the full range of the independent variable and not just replicate one

value. Marks should be deducted here if results are not measured with the required degree of precision e.g. some results only measured to one decimal place while others were made to two decimal places.

### Recording and Communicating

This skill area has improved, however there are still problems with captions (both tables and graphs) and best fit lines. As in previous years, candidates have problems with captions regarding % transmission; a common error being 'a table showing the effect of temperature on the transmission of light...' Also if the average results are being plotted then this should be made evident either in the graph caption or in the labelling of the y axis.

### Interpretation

This section tends to be of a high standard although in many instances, it is too long. The coursework is intended to be written in two or three hours of class time, however in many cases this is obviously not the case. Many centres have marked this in two sections; written communication and trend out of 4 marks and the explanation of the trend using biological knowledge out of 4 marks. This is acceptable as long as it is marked correctly. A common error in the determination of water potential was the confusion of zero change in mass (cross over point on x axis) as the point of incipient plasmolysis. It is important for centres, especially those new to AS level, to ensure marks are awarded at an appropriate level for AS i.e. would a response get equivalent marks in an exam?

### Evaluation of the Design

This section continues to give the greatest degree of differentiation within a centre and between moderator and teacher. The appropriateness of the measurements should reference more clearly the degree of accuracy or the instrument of measurement used e.g. Why is a colorimeter used? Why are masses to two decimal places used?

There are also issues with validity and reliability with these being frequently confused by both candidates and teachers. In many of the practicals being investigated there are clear validity issues and unless these have been clearly controlled then they should be discussed as having a possible bearing on the outcome.

Assessment of the variation of the results should refer directly to the pooled results (inclusion of examples would help to illustrate this) and should not simply be a range calculation. Clustering or lack of clustering of the results should be used to give an indication of the variation; the degree of variation should then be linked to the extent of the reliability of the results and thus whether further replication would be necessary.

# Chief Examiner's Report

## Assessment Units A2

### General Comments

The high quality of answers produced by many candidates in the two A2 papers in the Summer series provides evidence that a significant majority of candidates can cope comfortably with the step up from AS to A2 and the increase in demand involved.

It is pleasing to report that there were many excellent responses to the more complex applied questions testing candidates' ability to apply their knowledge, understanding and skills in unfamiliar settings. This was clearly evident in Q8 (mosquito control and malaria) in the A2 1 paper and also in the final parts of Q7 in the A2 2 paper (the link between pollination rates and seed size in wild garlic).

The essays in both A2 papers were well done by a significant majority of candidates. In general, they were well structured and concisely written, often displaying an excellent understanding of core A level biological content.

## Assessment Unit A2 1 Physiology and Ecosystems

This was the eighth A2 1 paper in the current specification. The mean was broadly similar to previous papers. Candidate marks for this paper were normally distributed and the paper was very effective in discriminating between candidates of different abilities.

### Section A

**Q1** This relatively straightforward three-mark question required basic understanding of antibody-mediated immunity. Not surprisingly, a significant majority of the candidates obtained all three marks. Nonetheless, the range of answers provided indicated that not all candidates are secure in their knowledge and understanding with a significant number being unclear about which cells (the B-lymphocytes) react to the presence of a foreign pathogen and which actually produce the antibodies (the plasma cells). In the context of this question, lymphocytes was not accepted for the first answer; B-lymphocytes (or even B-cells) was required.

**Q2** This question on the efficiency of energy flow proved to be much more discriminating. A significant majority of candidates obtained between three and five of the six marks available.

**(a)** Part (a) was generally well answered with most candidates recognising that X represented the decomposers in (a)(i). Part (a)(ii) was also well answered but a number of candidates failed to interpret the question accurately and described how light could be trapped in the atmosphere or reflected by clouds. The question specifically focused on the loss of energy subsequent to it reaching the 'leaf surface'. The full range of possible correct answers was provided across the candidature. Part (a)(iii) was well answered with most candidates being aware of the role of cellulose in contributing to the inefficiency of energy transfer in herbivores.

**(b)** Part (b) was much more discriminating with only a minority of candidates obtaining both marks. The question specifically asked that candidates link their answer to energy transfer through *trophic levels*. In reality, very few candidates referred to trophic levels at all and only a small minority specifically stated that rice is at a lower trophic level than birds or mammals. A majority of candidates produced quite general answers, referring to there being a loss of energy at each trophic level as opposed to focusing on the significance of rice being at a lower trophic level than birds or mammals, i.e. there are fewer steps involving energy loss. Additionally, many candidates referred to birds and mammals losing energy in locomotion or excretion but very few explained the high proportion of energy lost in maintaining a high body temperature.

**Q3** Q3 covered kidney structure and function. Overall, this question was well answered with a significant majority of the candidates scoring between six and nine of the ten marks available.

**(a)** Part (a)(i) was well answered with most candidates identifying the distal convoluted tubule and the collecting duct in the diagram accurately. Part (a)(ii) was more discriminating with only a minority of candidates correctly identifying the two regions (the proximal convoluted tubule and collecting duct) where most water is reabsorbed. A majority of candidates failed to recognise the importance of the proximal convoluted tubule in water reabsorption: these candidates usually answered C and E suggesting that the Loop of Henle and the collecting duct are the two regions where most water is reabsorbed.

**(b)** Part (b)(i) was well answered by most candidates. The candidates were aided by the inclusion of a diagram representing cells lining the proximal tubule therefore making the description of the adaptations relatively straightforward – for this reason a description and an explanation were both required for each mark. It is pleasing to report that descriptions and appropriately detailed explanations were usually evident. Part (b)(ii) involved the analysis of tabular data. This three-mark question discriminated well with many stronger candidates obtaining all three marks. Many candidates explained the absence of large proteins in the renal filtrate as a consequence of them being filtered out at the point of filtration but were not awarded the appropriate mark for this level of detail. For this mark it was necessary to identify the basement membrane as the effective filter that prevents the large proteins entering the nephron. The selective reabsorption of glucose from the proximal convoluted tubule was well understood but only the most able candidates were able to link the increased concentration of urea to the extensive reabsorption of water.

**(c)** Part (c) was an effective discriminator with only a minority of candidates obtaining both marks. Only the more able candidates were able to identify the link between a longer Loop of Henle and more effective water reabsorption as a consequence of the medulla having an even lower water potential.

**Q4** This question on synapses proved to be an effective discriminator. Candidate responses were normally distributed with most candidates obtaining between three and seven of the nine marks available.

**(a)** The mitochondria and synaptic vesicles in the electronmicrograph were accurately identified by most candidates in (a)(i). Part (a)(ii) proved more discriminating. It was apparent that many candidates had some understanding of why axons were not visible in the photograph; however, an inability to articulate their answer in a precise way resulted in the mark usually only being awarded to the most able candidates.

**(b)** Calculation skills in A level Biology are often discriminating; part (b) proved to be no exception. While many candidates showed understanding of the relationship: speed = distance/time, many struggled with the unit conversion of 20 nm (the width of the synaptic cleft) to $20 \times 10^{-9}$ m.

**(c)** Part (c) involved the interpretation of material (inhibitory synapses) that was likely to be unfamiliar to most candidates. Consequently, this section proved to be very discriminating. A significant number of candidates incorrectly assumed that the neurotransmitter released by the inhibitory neurone blocked the acetylcholine receptors on the post-synaptic neurone. Only the most able

candidates, who carefully analysed the diagram provided, realised that this was an unlikely method of action and consequently produced other, usually correct, options. More candidates were able to deduce that the effect of the inhibitory synapse would be to hinder the development of an excitatory post-synaptic potential through preventing or reducing depolarisation of the post-synaptic membrane and consequently were able to obtain one of the two marks available. Part (c)(ii) also proved difficult for those candidates who struggled with unfamiliar content. While many candidates deduced that the Prozac substituted for the deficit of serotonin in inhibitory synapses, few were able to suggest how it might work. A common incorrect assumption was that the Prozac promoted (as opposed to inhibiting) the development an EPSP in the post-synaptic membrane. As with most 'suggest' type questions, a wide range of reasonable answers, that showed good biological understanding, gained credit in this question.

**Q5** Candidate marks for this question on owl population dynamics were also normally distributed. A small number of the most able candidates obtained all eleven of the marks available.

**(a)** In part (a) the concept of carrying capacity was well understood by many candidates. However, a minority of answers were quite vague with references to 'organisms' which suggested that these candidates were not clear whether the term referred to populations or communities.

**(b)** Part (b) was well answered. However, in (b)(i) a number of candidates misinterpreted the requirement to answer in terms of mortality *rate*, as opposed to when there were fewest owls surviving.

**(c)** Part (c) proved to be more discriminating than expected. Most candidates showed a sound understanding of the mark-recapture technique and the use of the Lincoln Index in producing a reliable estimate of owl numbers in a woodland. However, many answers lacked appropriate detail, e.g. many candidates simply referred to trapping a number of owls as opposed to a large number (or as many as possible, for those candidates who correctly expected owl numbers in a particular area to be relatively low). A significant number of candidates had a good understanding of the requirement to have non-toxic long-lasting (permanent) marking that did not affect survival chances. It is pleasing to record that many candidates tailored their answers to an estimation of owl numbers (as opposed to general capture-recapture procedures) by referring to the use of leg tags or rings as a method of marking.

**(d)** Part (d) was the most discriminating part of the question. A number of candidates appeared to misunderstand what was meant by 'population strategy' in (d)(i); however, K-selected was correctly given by the more able candidates. Part (d)(ii), a question requiring good interpretative skills, proved challenging to even the more able candidates. Only the more able candidates were able to appreciate that the question required an understanding of how a named density-dependent factor controlled *owl* numbers; a significant number of candidates explained how predation by owls could regulate *prey* numbers. Many able candidates identified a possible density-dependent factor, e.g. food availability being the most common correct answer, and were then able to explain that when owl numbers were high, owl mortality would increase due to competition for food, thereby keeping owl numbers stable. Only a very small minority of candidates obtained the third marking point – the idea that when owl numbers were low then owl mortality would be reduced, preventing owl

numbers from dropping too low. A number of candidates incorrectly answered this question along the lines of natural selection and survival of the fittest.

**Q6** Candidate performance in this question on auxins was also normally distributed. Most candidates scored between four and eight of the ten marks available.

**(a)** In part (a), the mechanism by which auxin promotes cell elongation was generally well understood. Most candidates recognised that the cell wall becomes more flexible but answers were often not detailed enough to obtain the second mark. While many candidates were aware that osmosis had a part to play in cell elongation, only the better candidates were able to describe that the water entering the cell provided the turgor force necessary.

**(b)** Many candidates referred to light being a controlled variable in (b)(i) but did not explain why the investigation was completed in darkness. The aim of the investigation was to demonstrate that the observed curvature was not a consequence of light, but due to the greater concentration of auxin on the left hand side of the decapitated shoot (due to the asymmetric placement of the auxin-containing agar block). The interpretation of the graph in (b)(ii) produced some good responses. Many candidates were able to relate the increase in curvature to cell elongation but a smaller number were able to fully describe the effect of increasing concentration of auxin. Those candidates who accessed the third mark (an explanation of why the angle of curvature decreases at high auxin concentration) often described the auxin being in such high concentrations that some of it diffused across to the right hand side of the decapitated stem. Some candidates referred to the auxin diffusing across to the *illuminated* side of the shoot – these candidates were penalised as the investigation was completed in darkness.

**(c)** Part (c) was quite well answered although those candidates who referred to the root *decreasing* in size at 1 ppm were penalised as this is inaccurate – at 1 ppm concentration the growth of root sections is less than control sections (without auxin); nonetheless, there is some growth. In (c)(ii) many candidates failed to provide evidence from the graph that auxin was produced in the apical meristem and then travelled down to the root.

**Q7** This question on nutrient enrichment of water was well answered by many candidates. A significant number of candidates obtained either five or six of the eight marks available.

**(a)** Part (a)(i) appeared reasonably straightforward yet proved difficult for many candidates. Very general or vague answers failed to get credit, e.g. 'improved soakaway systems' – without giving any indication of how this could be achieved. A number of candidates appeared to confuse septic tanks with slurry tanks. Part (a)(ii) was well done. Most candidates now are very familiar with the concept of eutrophication (nutrient enrichment) leading to algal blooms and the subsequent decomposition of algae by aerobic bacteria producing anoxic conditions. Part (a)(iii) required descriptions of how farmers can reduce the level of water pollution caused by artificial fertiliser. This was also very well done with a majority of candidates obtaining both of the available marks.

**(b)** Part (b) proved to be much more discriminating. Some candidates seemed to be unclear what 'fixing nitrogen' actually meant. Many candidates answered that the role of the *Anabaena* was to convert nitrates in the water into nitrogen

gas (denitrification) or that they used up the nitrate in the water to form protein. This was a difficult question part requiring high-level conceptual understanding. It was anticipated that this question would only be well answered by the most able candidates, and so it proved.

**Q8** This fifteen-mark question on malaria required the analysis, interpretation and evaluation of unfamiliar data. Candidate outcomes were normally distributed with most candidates obtaining between six and ten marks. It is pleasing to note that there were some excellent responses by many candidates showing high levels of understanding and excellent interpretative skills.

**(a)** Responses to part (a)(i) indicated that many candidates are not secure in their understanding of parasitism. Correct answers indicated that a parasite lives in or on its host over a period of time (making a distinction from a predator) and that it causes the host harm. Many candidates simply referred to a +/- relationship which was not enough. Part (a)(ii) was usually well answered and most candidates were able to accurately describe the link between reduced red blood cell number and a lack of energy. Part (a)(iii) was more discriminating. Many candidates understood that if mosquitoes were more likely to target humans with raised blood temperature (often due to malaria) then there was an increased chance of a mosquito picking up the *Plasmodium* parasite. Very few candidates extended this to explain that this would result in a higher proportion of mosquitoes carrying parasites therefore increasing the rate of infection of new hosts. Many candidates incorrectly answered in terms of the higher human temperature leading to higher metabolic rates in the parasites allowing them to reproduce faster, and therefore spreading through the body faster!

**(b)& (c)** Part (b)(i) was well answered by those candidates who appreciated that the question focused on the ethics behind using DDT in certain circumstances. The ways in which DDT can cause ecological harm [(b)(ii)] was often well answered. Part (c)(i) required skills in the analysis of tabular data. This was generally well done but it is important to emphasise that marks are not awarded for simply repeating the data values in the table, i.e. some degree of interpretation/summarising is necessary. A number of candidates also misinterpreted the column heading 'Number of fresh mosquito bites' as 'Number *of children with* fresh mosquito bites'. It was therefore a common error for candidates to state that '71% of children (189/266)' were bitten in the control group, whereas only '41% of children (94/197)' were bitten in the group using nets (without insecticide spray)! There were many innovative and good answers to (b)(ii) suggesting factors that may have contributed to variability in this investigation. Proximity to mosquito breeding grounds was the most common but there were many other excellent answers. Part (b)(iii) required candidates to suggest how the control group in the investigation could have been selected. This proved to be more discriminating with many candidates discussing the use of random sampling techniques rather than focusing on factors pertinent to this particular investigation, e.g. a child from the same family or same village. The second mark was for explaining why the factor chosen is important, e.g. a child from the same family or village will have the same proximity to mosquito breeding grounds. Part (c)(iv) was generally well answered.

## Section B

**Q9** The essay question concerning adaptations in the mammalian eye was generally well answered by the majority of the candidates. Although many candidates did do well in this question there was a good spread of marks.

**(a)** In part (a), a number of candidates mixed up the role of the ciliary muscles and the muscles in the iris.

**(b)** Part (b) was also often well answered and it was pleasing to note the many good suggestions for how the eyes in nocturnal animals might be specialised. A common answer that was not given credit was that 'the eyes of nocturnal animals have more rods than cones' (this is also the situation in other mammals) – references to only (or mainly) rods being present was given credit.

# Assessment Unit A2 2 Biochemistry, Genetics and Evolutionary Trends

This was the fourth paper in the current specification assessing this unit. The paper assessed all the major topics in this unit and contained a balance of familiar and unfamiliar content. As in previous A2 2 papers statistics was assessed.

The question part that appeared to give most difficulty to many candidates was Q3(c) involving the use of a respirometer to determine if anaerobic respiration is taking place. This highlights an overall feature that questions relating to practical work are often poorly done at A level. The poor answers to Q3(c) were particularly surprising as the use of the respirometer is one of the few practical investigations specified in the A2 2 unit. It can only be concluded that many candidates relied on their AS knowledge of the respirometer, in effect making this question part largely synoptic.

## Section A

**Q1** The first question on photosynthesis proved more discriminating than expected with candidate performance being normally distributed around a modal mark of three.

**(a)** Part (a), requiring knowledge of where the light-dependent stage takes place proved straightforward for most candidates.

**(b)** In part (b) many candidates failed to appreciate the significance of the word 'increased' in the question. Detailed accounts of light harvesting and the light-dependent stage were not enough on their own – it was important to answer the question as it was asked.

**(c)** Part (c) was well answered by many candidates. There was good understanding that different pigments are adapted to absorb light at different wavelengths and that the light mainly used is from the red and blue parts of the spectrum (with green reflected).

**Q2** This nine-mark question provided the full range of marks awarded with the candidate performance being normally distributed.

**(a)** The cross-section of the platyhelminth was well known in part (a) as were the benefits of dorso-ventral flattening. Some candidates focused on the dorso-ventral flattening providing short distances for gas exchange (to all cells) and others on short distances for the transfer of nutrients from the gut to body cells – either alternative was acceptable.

**(b)** Part (b) on the coelomate nature of annelids was less well done. Only a minority of candidates could accurately define 'coelomate'. Most candidates understood that it was a cavity but very few were able to explain its precise position, i.e. *within* the mesoderm. In (b)(ii) vague answers, e.g. support, were common when describing the advantage of a coelom – in this example, reference to a hydrostatic skeleton was required.

**(c)** Part (c)(i) required a description of extracellular digestion with specific reference to the earthworm. This proved to very discriminating with many weaker candidates answering that digestion took place outside the cells/body. The correct answer required an understanding that digestion did occur outside the cells but within the gut. Part (c)(ii) was usually well answered and most candidates had a sound understanding of the advantages of a 'one-way' digestive system.

**Q3** This question on anaerobic respiration proved to be very discriminating. The majority of candidates scored five or fewer of the nine marks available.

**(a)** In (a)(i) the process of glycolysis was correctly identified by most candidates. Part (a)(ii) was well answered by the top candidates but others tended to produce vague responses. While many recognised that the production of lactate allowed NAD to be regenerated, only the best answers developed this to explain that the regeneration of NAD is necessary to allow dehydrogenation in glycolysis to continue. Many candidates showed good understanding of terms such as 'oxidation' and 'dehydrogenation'.

**(b)** Part (b)(i) was well answered but a significant number of candidates appeared to have the incorrect impression that when anaerobic respiration is taking place in muscles, aerobic respiration has stopped! Many candidates had some understanding of the concept of oxygen debt in (b)(ii).

**(c)** However, part (c) proved to be very discriminating. While the top candidates achieved three or four marks, many other candidates typically achieved only one mark (often for stating that the movement of the coloured bead needed to be measured per unit time). Many candidates thought that the apparatus needed completion (by the addition of an extra tube to negate the effects of temperature or pressure). It is important that candidates are aware that examination questions can be based on any type of respirometer (there is no specific type recommended) and that it is understanding in the context of the apparatus used that is being tested. Very few candidates could accurately describe how a respirometer works, let alone describe how it could be used to show if anaerobic respiration is taking place. Very surprisingly, a significant number of candidates described how KOH absorbs *oxygen* in their accounts. The candidate performance was particularly disappointing in this question part as up to four answers worthy of credit could be selected from a range of eight possible alternatives.

**Q4** This question on protein synthesis and the use of DNA sequencing in selective breeding was well answered by many candidates. A majority of candidates obtained five or more of the nine marks available.

**(a)** In (a)(i) the terms transcription and translation were well understood but relatively few were able to state, in (a)(ii), that reverse transcription would be required for the conversion of mRNA to DNA.

**(b)** In part (b) the function of tRNA was well understood and there were many detailed, logically arranged answers. Most candidates focused on the

complementary nature of the binding between codons and anticodons but other aspects of the tRNA role was often overlooked by many candidates. These included the transport role of tRNA in bringing the amino acid to the mRNA and the fact that the tRNA returns to the cytoplasm to repeat the process after delivering an amino acid to the mRNA.

**(c)** In part (c) most candidates recognised that a gene/DNA probe was the answer in (c)(i) but the use of the probe in the conservation of the Californian condor birds [(c)(ii)] was less well done. In reality, many candidates lost marks by not answering the question in the specific context that it was asked. It was important to recognise that the probes would allow homozygous dominant individuals to be identified and that these birds could be used in breeding progammes with, over time, the frequency of the lethal gene in the population being reduced. Converse answers were also credited (i.e. identifying heterozygotes and not using these in breeding progammes).

**Q5** Q5 proved to be accessible to the majority of candidates. Most scored between seven and twelve of the twelve marks available.

**(a)** Part (a) focused on the ABO blood group system. Parts (a)(i) and (ii) were well answered but a significant number of candidates failed to obtain the third mark in (a)(ii). To obtain this mark it was important to link the four phenotypes to their particular genotypes, i.e. clearly showing which blood group each genotype produced. Part (a)(iii) involved an element of synoptic assessment and proved to be more testing. Many candidates mixed up antigens and antibodies and others were not clear which antigen(s) each group carried.

**(b)** Part (b) was a relatively straightforward Hardy-Weinberg problem that was often well answered. Most of those candidates who lost marks in the calculation assumed that the frequency of the recessive allele (0.150) represented $q^2$ rather than q.

**Q6** Candidate responses in this ten-mark question were normally distributed with a significant majority of candidates scoring between five and seven marks.

**(a)** Most candidates answered 'aneuploidy' correctly in part (a); it is pleasing to note that most candidates were able to spell the term accurately.

**(b)** Parts (b)(i)-(iii) were also well answered.

**(c)** Although part (c)(i) proved relatively straightforward, (c)(ii) proved much more demanding for many candidates. Most candidates were able to state that geographical isolation was a feature of allopatric speciation (but not of polyploidy). However, many candidates failed to describe reproductive isolation in context. Many answers described how the different species were reproductively isolated *following* speciation rather than the reproductive isolation (following geographic separation) being a *requirement for* speciation. Only the top candidates clearly described the differences between allopatric species and polyploidy rather than a general account of allopatric speciation. Part (c)(iii) asked for a commercial application of polyploidy. There were a wide range of answers including 'bananas' and 'bramley apples'. These answers on their own were meaningless and did not gain credit.

**Q7** This question covered a range of topics and skills. Reproduction in flowering plants, data analysis involving both a table and a graph and statistics were all addressed in this eighteen-mark question. It proved to be a very discriminating question which produced the full range of marks.

**(a)** In part (a) many candidates were able to identify the generative nucleus and the embryosac but many fewer were able to describe the events between pollination and fertilisation with accuracy. There were many accounts which provided the general thrust of what would take place but lacked accuracy in terms of terminology and/or sequence.

**(b)** Part (b)(i) was well answered and candidates were able to deduce from the information provided that when there is only one seed in an ovary there will be less competition for nutrients and therefore the seeds will generally have a greater dry mass. In (b)(ii) many candidates were able to state a suitable null hypothesis. The calculation of a *t* value in part (iii) was more challenging for many candidates. While there were some excellent answers many candidates were unable to calculate the *t* value. Even when the *t* value was correctly calculated many candidates were unable to accurately state the probability value and carry this through to make the correct decision about the null hypothesis and the conclusions that could then be drawn about the seed masses in the two categories. In part (v) candidates should have been aware that a two mark question required more than 'the null hypothesis was rejected'.

**(c)** In (c) (i) most candidates were able to explain that the data could be considered reliable as there was a large sample size; very few gave the alternative answer that the use of dry weight values eliminated any variability due to moisture content. Part (ii) was often well done with many candidates accurately describing the differences between seed mass in the two sampled areas. However, it is important to note that just stating numerical values without any description did not gain credit. Part (iii) proved to be discriminating; many of the more able candidates were able to produce excellent explanations to account for the differences in seed mass in the two areas.

## Section B

**Q8** In general, there were some excellent answers describing procedures involved in gene isolation and transfer and the benefits and issues that surround gene technology.

**(a)** Answers were particularly good in part (a) – obtaining and transferring genes. Most candidates focused on the transfer of genes into bacteria with relatively few describing the transfer into plant or animal cells or transfer during gene therapy.

**(b)** The answers in part (b) were more variable; the benefits and potential problems arising from the production of transgenic organisms and from gene therapy was less well known. A minority of candidates did not make clear the distinction between genetically engineered microorganisms (GEMs), genetically modified (GM) crops and transgenic animals – the different categories of organisms were often used interchangeably. Some candidates also included a lot of detail on other aspects of molecular biology such as genome sequencing and genetic screening that were not relevant in this question. The best answers in in this question were those that were concise, followed a logical sequence and used the relevant terminology accurately and appropriately; some of the best answers were outstanding.

# Principal Moderator's Report

## Assessment Unit A2 3 Assessment of Investigational and Practical Skills in Biology

It was felt by the moderation team that the quality of marking was better overall this year; many centres are taking on board the comments from their TAC 6 feedback forms and information gained from attending agreement trials. The main issue for concern amongst the moderation team is the amount of guidance being given to the candidates. It has been found that candidate responses across several teaching groups are very similar in their wording and are also very similar to the centre based mark schemes provided by the centre. It is important for teachers to realise they should closely supervise candidates work to avoid copying. Writing frames should only contain the assessment criteria thus avoiding over directing the pupils to the right answer.

### A1 Develop a Hypothesis

The standard of biological knowledge provided by the candidates is generally of a very high standard and as with previous years it is very voluminous in nature, often with large amounts of irrelevant information provided. The discussion should link directly to the development of the hypothesis tying in the relevant background knowledge.

As with AS the plan is expected to be completed in a two or three hour time slot and should be written in the classroom.

### A2 Plan a Procedure

Plans and methods are frequently written in the past tense thus suggesting they are written after the practical has been completed. It is essential that the planning sections (A1, A2 and A3) should be written prior to the practical being carried out and the range chosen be suggested by the candidate. If results need to be pooled then a standard practical can be given to the candidates after they have completed their plan.

### A3 Planning for Analysis

Pupils should choose their own statistical test for analysis based on their choice of independent variable being investigated. This can be changed when the common procedure is issued. The main concern for the moderation team was the lack of appropriate justification of the statistical test being chosen. This should link to the type of data that is being recorded and the range of the independent variable e.g. confidence limits would be used for a range of continuous data.

### B1-B2 Recording and Communicating

Many problems that exist here are common to AS and have been mentioned in the AS report. The table of results should be the candidate's own results and should include the raw data being collected.

### C1 Analysis

This continues to be well carried out by pupils; however there are still issues with captions on graphs which frequently do not mention means or confidence limits. In the examinations candidates are expected to use the terms 'significant' and 'mean' when writing a Null hypothesis and so should similarly be penalised if they are not mentioned in this section.

## C2 Interpretation

Most centres have grasped the assessment of reliability; however there is still an issue with some centres where there is no direct reference to the statistics calculated from their own results. A common mistake with regards to the comment on the reliability was the statement 'my results are very reliable but this could be improved by further replication'. This should be penalised.

Whilst in many cases it is appropriate to repeat the biological knowledge given in the development of the hypothesis, there are times when the results found might need a different approach to explain what was found e.g. if not mentioned in their plan candidates would be expected (if their results suggest) to determine a temperature at which the greatest change in leakage of beetroot pigment occurs and thus greatest disruption of the membrane. If in these cases this is not attempted then the candidates should be penalised.

## C3 Evaluation

As with previous years this section provides the greatest number of discrepancies between teacher and moderator. Where appropriate the candidate should suggest possible changes to the range investigated i.e. a narrowing of a pH range to more closely determine an optimum. The appropriateness of the measurements has the same problems which are dealt with in the AS report as are the problems with validity.

There were some issues with the outline of another independent variable to be investigated. An attempt at a prediction and/or a range of the independent variable should be given.

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