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CCEA GCE - Biology
(Summer Series) 2015

Chief Examiner's
and Principal Moderator's Report

biology

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Foreword

This booklet outlines the performance of candidates in all aspects of CCEA's General Certificate of Education (GCE) in Biology for this series.

CCEA hopes that the Chief Examiner's and/or Principal Moderator's report(s) 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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Contents

Assessment Unit AS 1: Molecules and Cells	**3**
Assessment Unit AS 2: Organisms and Biodiversity	**7**
Assessment Unit AS 3: Assessment of Practical Skills in AS Biology	**9**
Assessment Unit A2 1: Physiology and Ecosystems	**10**
Assessment Unit A2 2: Biochemistry, Genetics and Evolutionary Trends	**15**
Assessment Unit A2 3: Assessment of Investigational and Practical Skills in Biology	**18**
Contact details	**20**

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GCE BIOLOGY

Chief Examiner's Report

As in recent summer series, each of the four examination papers in summer 2015 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 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 and there was very little evidence of candidates not having enough time to complete their papers. Each paper contained a range of question types, including straightforward recall of content and the testing of important concepts at this level. Furthermore, in each paper there was a range of unfamiliar stimulus material testing candidates' ability to analyse and evaluate information.

Each of the papers proved to be effective in discriminating among candidates of different abilities.

Each year this report underlines the importance of candidates using the 'Extra lined page' at the end of the question paper. When candidates use this extra space they should make it clear at the end of the 'normal' answer space below the question that their answer is continued on the 'Extra lined page'. This extra answer space should be used ***before*** candidates resort to supplementary booklets.

AS Assessment Units

General

Each paper had a similar structure to previous papers and candidate performance was broadly similar to previous series.

Assessment Unit AS 1 Molecules and Cells

This paper provided good coverage of the specification and proved accessible for a wide range of ability levels. There was evidence that candidates, in general, clearly understood what was expected in answering each question and it also appeared that candidates had sufficient time to complete the paper. The paper contained a variety of stimulus material, including an electron micrograph, diagrams, tabular results and prose, and as always, candidates coped well with this.

While some questions were reasonably challenging at this level, e.g. Question 4(c), Question 5(c), Question 7 Parts (b)-(e), others were very accessible, e.g. Question 1, Question7(a). Hence the paper proved discriminating across a range of ability levels.

Q1 As noted above, this question was relatively straightforward and provided a suitable introduction to the question paper, allowing most candidates to display their knowledge effectively and gain full marks. The characteristics of each mechanism of transport across the cell membrane are well known by candidates, which is pleasing to note. A small minority made one or more errors, the most common being to confuse simple diffusion with osmosis.

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Q2 This question discriminated effectively among candidates, in that most were able to correctly answer Part (a) and (c), but not to fully explain the meaning of the term 'fluid mosaic' in Part (b). Many gave suggestions which simply explained why the phospholipids form a bilayer, referring to hydrophilic heads and hydrophobic tails, and others gave rather vague suggestions that 'fluid' referred to the ability of the whole membrane or bilayer to move. While a significant number were able to correctly describe the sideways movement of the phospholipid molecules, fewer achieved the second mark, for relating 'mosaic' to the apparently random arrangement of the protein molecules embedded in the membrane.

Q3 Identification of organelles from electron micrographs is an important skill in the study of cell biology. However, there continues to be significant variation amongst candidates in the mastery of this skill. While many achieved full marks in Parts (a) and (b), many others struggled with identifying one or more structures. Despite the word 'function' appearing in bold typeface in Part (a)(i), a minority of candidates nevertheless gave identifications of the organelles labelled A and B, and therefore lost two marks for misreading the question. Another relatively common error here was to describe the function of the nucleolus as being responsible for the production of RNA, or even mRNA, when the precise function is the production of ribosomal RNA. In Part (a)(ii), the most common error was to identify D as the nuclear membrane, when the correct term (as used in the specification) is the nuclear envelope. In Part (b)(i) many candidates correctly identified these structures as mitochondria, presumably by virtue of their number, their size relative to the nucleus and cristae clearly visible on the interior of the structures. Most went on to correctly describe their function, but a number of candidates were penalised here for loose language. For example, it is incorrect to state that the mitochondria produce ATP *for* respiration. In addition, reference to the production of energy continues to be penalised, as it has been in previous series. In Part (c) most candidates followed the instruction to show their working in this question, which allowed those who did not complete all three processes in the calculation (accurate measurement of the scale bar, unit conversion followed by division) correctly to still access some marks. An error in unit conversion was the most common problem encountered here, compounded by the fact that some candidates insist on recording measurements in centimetres rather than millimetres. This often led to the incorrect conversion of 5cm to 5000μm. Candidates should be discouraged from using centimetres, in order to avoid this error.

Q4 It has been apparent in the past that some candidates do not appreciate the distinction between DNA replication *in vivo* and the process of PCR. In Part (a) while the majority correctly focussed on the former in answering this question, a significant number demonstrated some confusion by, for example, describing the addition of primers or thermocycling. In addition, some thought this question related to mitosis. For those candidates who did not make these errors, this was an accessible question and rewarded those who knew this process in detail. In Part (b) most candidates were able to state at least one way in which DNA replication in cells differed from PCR, although some responses lacked sufficient detail. For example, to state that heat was needed for PCR was considered too vague, since it was not considered an effective comparison between the two processes. Instead, candidates were required to describe the use of heat in PCR to separate the two strands or break the hydrogen bonds in DNA (the role carried out by DNA helicase in DNA replication in cells). Part (c)(i) proved very discriminating, with most candidates gaining a maximum of one mark for a well thought-out suggestion on the mechanism of action of drug A. Only a minority gave good responses for drug B, with many giving vague suggestions about the

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strength of bonds or the problem caused by a larger 'nucleotide' with three phosphates. Part (ii) was a simple recall question, so it was somewhat surprising to see so many incorrect responses.

Q5 Parts (a) and (b) were generally well answered. The most common difficulty encountered was in including the correct level of detail for the function of starch, with some candidates losing a mark for describing it as a storage carbohydrate. Since the term carbohydrate was used in the question stem, this only added the idea of storage, so candidates were only awarded a mark for responses which described what it stored, i.e. energy (or glucose). In addition, 'starch grain' was not considered a sufficiently detailed description of the location of starch in the cell. Part (c) proved very discriminating, as is often the case where candidates are required to apply their knowledge of biological concepts in unfamiliar contexts. Few candidates achieved two marks in this question, which required making the general observation that erlose consists of one more monomer than sucrose, and then also describing the structure of erlose in more detail by noting that it had an extra glucose in comparison with sucrose. Many candidates focussed on details such as the position of OH groups, or incorrectly described erlose as containing a pentose sugar (presumably referring to the structure of fructose, a hexose sugar listed on the specification, which forms a five-sided ring structure).

Q6 In Part (a) most candidates were able to gain at least two marks here, with a significant number correctly identifying all three organelles. The most common error was in wrongly identifying B as lysosomes. Part (b) was one of the most challenging questions on the paper, with very few achieving the two marks available. It required candidates to bring together knowledge of the composition of biological molecules with the structure and function of organelles, and this proved difficult for all but the most able students. As with other questions involving a description of a biological process, Part (c) was well answered by a majority of candidates. However it also rewarded those who had read the question carefully and noted that the proteins mentioned were destined to become incorporated into the cell surface membrane, rather than be secreted out of the cell by exocytosis. Many candidates lost the fourth mark for this question through this oversight.

Q7 This question assessed mastery of some of the skills associated with practical procedures, and this is an area which continues to be problematic for many candidates. While graph-drawing skills, as assessed in Part (a), appear to be reasonably well developed, higher-order skills such as justifying the inclusion of certain steps in a method and evaluating procedures are not. It would seem that candidates would benefit from significantly more opportunities to develop these skills. While it is acknowledged that there is a lot of content to be covered in the AS Biology course, these are fundamental skills for biologists and should be developed in the context of carrying out the specified practical tasks. In Part (a) there is evidence that graph-drawing skills are well developed across the candidature, with most achieving at least three of the four marks here. While this was a relatively straightforward line graph (in comparison to some in previous series, where scales were more complex and/or two sets of data may have been plotted), nevertheless it is encouraging to see evidence of candidates following the conventions of the subject in this area. In Part (b) very few candidates achieved full marks and only a minority gained one mark. Answering this question does require a good understanding of the use of the colorimeter and candidates were at a significant disadvantage if they did not have experience of using a colorimeter themselves. In addition, the ability to visualise the appearance of dilute versus concentrated solutions of starch and iodine was helpful. Some candidates

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successfully responded with reference to light being more easily transmitted through a dilute solution, but only a small number developed this response to include a reference to small changes being more easily detected by the colorimeter. Many candidates referred to the rate of the reaction, which was not relevant, and others discussed the need for concentrated solutions for the end-point experiment but not the converse for the colorimeter experiment. In order to 'explain precisely' the selection of a particular colour filter (Part (c)) it is not sufficient to simply quote the learned phrase that, in this case, red is at the opposite end of the spectrum to blue. In addition, there were many responses which lacked clarity and contained inadequate explanations, such as 'the red filter absorbs blue light' or 'it transmits red light'. A variety of correct answers were acceptable, around the idea that changes in percentage transmission through a blue solution are maximised when a red filter is used, since the solution absorbs red light. Part (d) was relatively well answered, with a range of correct responses rewarded, demonstrating that many candidates were familiar with this aspect of the experiment. While making reference to calibration of the colorimeter and/or resetting it to 100% transmission between readings were creditworthy responses seen often, many candidates went on to subsequently lose the mark by stating that water (rather than dilute iodine solution) should be used for this purpose. Very few candidates achieved full marks in Part (e) and a small but significant number did not attempt to answer it at all. For those who did, responses were very inconsistent and included many references to the original experiment described in the question stem (with amylase added to starch and iodine, and time as the independent variable). Some candidates did successfully think through the procedure and made a good attempt at describing the steps involved.

Q8 This question assessed candidates' ability to describe the process of meiosis as a detailed sequence of events and it was clear that the majority had a good recall of the sequence and the main events occurring in each phase. In addition, the purpose of meiosis (producing haploid, genetically variable cells) was explored. This important aspect of the process has been overlooked somewhat by some candidates in previous series and its inclusion here represented an opportunity to reward those candidates who had a full understanding of the process, while still allowing those who were able to recall a detailed sequence of events to score highly. In order to achieve full marks, it was necessary to make at least ten points describing the events of meiosis, and also to explain precisely which stages brought about genetic variation (crossing over in prophase I and independent assortment in metaphase I) and haploidy (anaphase I). Of these three essential points, haploidy resulting from separation of homologous chromosomes at anaphase I was most often missed. As expected, there is significant variation in candidates' ability to describe a sequence of events in detail and this question allowed candidates of varying ability levels to be rewarded for their knowledge. Common errors included confusion over the events associated with each phase (e.g. stating that crossing over begins at metaphase I, or that independent assortment and/or crossing over also occurs in meiosis II) and errors in the use of correct terminology (bivalents/chromosomes/chromatids.)

Quality of written communication was generally good, with most candidates able to organise their response into a logical sequence. A small number chose to include diagrams of some stages of meiosis and while these can be credited for content which matches the mark scheme, candidates must be aware that it is often difficult to include as much detail in a diagram as could be included in a paragraph.

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Assessment Unit AS 2 Organisms and Biodiversity

The candidates taking this paper obtained a wide range of marks. Some obtained 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 appear 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 good standard and there was evidence that the content of the specification had generally been well taught. There was very little evidence to suggest candidates were tight for time during this exam.

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 even though many trigger words were in bold and the language was straightforward throughout.

There was a range of stimulus material for candidates to interpret including photographs, diagrams, graphs and tables.

Q1 This question on the mammalian heart was relatively straightforward and provided a suitable introduction to the question paper allowing most candidates to display their knowledge effectively and gain most of the available marks. In the second question many candidates gave the general answer of 'purkinje fibres' instead of the specific 'bundle of His'. In the third question many confused 'semi-lunar' with 'atrioventricular' valves. 'Chordae tendinae' was not well known by a significant number of candidates and often incorrectly spelt. Also many good candidates misread the fifth and final question and incorrectly gave 'pulmonary artery'.

Q2 This question on haemoglobin resulted in a wide spread of marks across the candidature. A minority of candidates got full marks. In Part (a) many candidates did not answer with sufficient biological terminology to gain both marks; many candidates missed the conjugated marking point or named the different chains as alpha-glucose and beta-glucose or even referred to one haem group being present in the molecule. Part (b)(i) was not well answered showing some candidates' inability to identify the horizontal axis of a graph. Part (b)(ii) was answered correctly by the vast majority of candidates with as many answering Part (c)(i) incorrectly – lugworm being the most common incorrect answer (instead of pig). Part (d) produced mixed responses and many candidates dropped marks through not including *high/increased* with reference to temperature and/or CO_2 or to state *more* acidic or a *low* pH.

Q3 This question was discriminating as candidates needed to fully read the information provided in the stem and read the questions carefully in order to access full marks. Part (a) was generally well answered with only a small number of candidates giving the species name or both the genus and species name – answers that failed to gain credit. In Part (b)(i) most candidates got one mark but the second mark was lost if they did not specify the predator by name or that the female tended the nest. In Part (b)(ii) a significant number of candidates obtained both marks but a common mistake was candidates not relating the loss of female ducks/eggs/chicks to reduced reproduction in the next generation. In Part (c) a significant majority of candidates lost at least one of the three marks through not being precise enough in their explanations for each practice. Many related ploughing or drainage to loss of soil crumb structure and some left out reseeding altogether.

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Q4 This question tested candidates' knowledge of some important biological relationships and their ability to carry out calculations. Many candidates were able to answer Part (a) correctly through accurately describing the relationship between body mass and respiration rate. The calculation (Part (b)) allowed many candidates to access both marks but a significant number of candidates failed to convert grams to kg so only obtained one mark. In Part (c)(i) a number of candidates incorrectly suggested the dog would have a larger surface area to volume ratio than the mouse although most knew that increasing the surface area to volume ratio increased the metabolic activity in Part (ii). Part (d) discriminated effectively as many candidates failed to focus on the surface area as asked; a significant number of candidates referred to concentration gradients and diffusion pathways showing their knowledge of Fick's law even though this was not required. For those who did focus on surface area the description of the extensive capillary network was often weak with many candidates just stating a good/close blood supply. A significant minority of candidates referred to surfactant as increasing the SA but it in fact maintains it.

Q5 This question tested candidates' practical skills in safely sampling a rocky shore to help test a hypothesis. The majority of candidates accessed the first two marks in Part (a), marks that required relatively straightforward interpretation of the table. Part (b) was much more discriminating as a significant number of candidates couldn't distinguish between appropriate abiotic and biotic factors that could affect organisms' distribution on a rocky shore. Many candidates who could differentiate between these terms then lost marks as they referred to the seaweed being 'predated' instead of grazed. Part (c) was challenging for many candidates despite being a familiar question from previous exam papers. Candidates often lost the first mark through not describing how a belt transect was taken, e.g. the requirement to lay down a line/rope/tape and the failure to include the direction of the line. Many candidates failed to make reference to the identification of the seaweed, e.g. through using a key. A significant number of candidates failed to gain the safety mark as they were too general in their reference to, for example, wearing warm clothes, only sample at low tide, care taken throwing quadrats. Very few candidates appreciated that the reliability of the investigation could be increased by repeating the process further along the shore.

Q6 This wide-ranging question on blood vessels provided the biggest challenge to many candidates. In Part (a)(i) many candidates found the block diagram of an artery in cross section very difficult but many lost the relatively straightforward mark for the use of clear (unbroken) lines. In Part (a)(ii) a significant number of candidates referred to the function of the lumen as opposed to one of the *tissues* labelled in the diagram. In Part (b)(ii) far too many candidates mixed up the terms epithelium and endothelium and made reference to cholesterol/fatty deposits 'sticking' to the wall of the vessel. Part (c)(i) was generally well answered but a minority of candidates suggested that the differences in blood flow caused the different cross-sectional areas of the blood vessels, which is incorrect. Part (c)(ii) was very poorly answered as many candidates gave parts of the answer but not the full detail that was required; for example, many candidates referred to the distance from the heart but not the pressure change or the lumen size and made no reference to friction. In Part (c)(iii) most candidates got one mark for the exchange of materials between the capillaries and the tissues, but with only a minority making reference to more time being available for the exchange as a consequence of the decreased flow rate they failed to get the second mark.

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Q7 The first part of this question was a straightforward calculation on stomatal density which the majority of candidates correctly answered using data from the table. In Part (a)(ii) most candidates also did well showing a good understanding of the link between stomatal density and habitat. In Part (b)(i) many candidates failed to define the term 'transpiration' with the precision required for A-level. A significant number of candidates simply stated that transpiration was evaporation from the aerial parts of a plant which was not enough; others described it as being evaporation out of the stomata, an answer that failed to gain marks. However, the majority of candidates from some centres had clearly learnt an appropriate definition and therefore gained both marks. The three-mark Part (b)(ii) discriminated well with most candidates gaining at least one mark; however, many candidates confused leaf hairs with root hair cells and referenced large surface area and waterup take in the leaf.

Q8 Section B (the essay) was generally very well answered. Part (a) on directional selection was the most discriminating part and many candidates did not explain that in directional selection only *one* extreme normally is better adapted. It was pleasing to see that key terms such as modal value and frequency were used correctly. A small number of candidates mixed up stabilising and directional selection and were therefore penalised. Section (b) was well answered by virtually all candidates, although a minority confused protoctista with prokaryotae. Quality of written communication was very good overall.

Principal Moderator's Report

Assessment Unit AS 3 Assessment of Practical Skills in AS Biology

As in previous years the standard of work provided by the pupils was of a generally high standard and teacher marking on the whole closely adhered to the marking criteria. It was evident that many centres had taken on board the advice given on their TAC6 centre report and implemented the changes for this year. It was also obvious that those centres who had attended the Agreement Trials demonstrated marking more in line with that expected by the moderation team.

The variety of practical undertaken by centres at both AS and A2 level is decreasing with the majority of centres investigating water potential, pH and enzymes and membrane permeability at AS and membrane permeability, yeast population and enzyme investigations at A2. It is important that the same investigation is not repeated at A2 level after being completed at AS. Care must also be taken with the amount of guidance given to candidates when preparing them for the coursework assessment. With the same investigations being chosen year after year the candidates' work has become very formulaic and similar and in some cases very similar to what is expected in the centre based mark schemes which are often provided. It is essential (as quoted in JCQ guidelines) that all work completed by pupils is based on their own ideas and thoughts.

There was a greater degree of differentiation this year both within centres and between centres.

The majority of the centres had provided an appropriate hypothesis for the candidates to investigate and this gave them a focus for their interpretation. There were familiar issues with the marking of B1 & B2. It is essential that the candidate's own table of results is assessed and marks can't be transferred from one table to another. Care must be taken by the teacher to ensure the wording of the caption makes sense and accurately conveys the message of the results being presented. Also some lines of best fit were leniently marked.

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The new C1 & C2 marking criteria were well managed by the candidates. Data was used to describe the trend however, candidates should guard against just quoting the results at each value of the independent variable as this does not summarise the overall trend. It appeared that teachers found marking criterion C3 easier to apply.

Again marking of the Evaluation section gives the greatest degree of difference between teacher and moderator marking. In D1 the candidates should refer to the precision of the apparatus and why it is suitable for that investigation e.g. changes in mass in the potatoes is small therefore measuring to two decimal places is important to achieve greater precision. There is no requirement to justify or comment on the suitability of the range; this is assessed at A2 level.

D2 was well managed by the candidates and they seem to have a greater understanding of validity issues in D3. There are still some centres accepting a general statement that ‘they found what they wanted so therefore it was a valid experiment’.

Many candidates in D4 are calculating a range without discussing the similarity or lack of clustering of the results. It is important the variation is discussed with specific reference to the class results being used although this does not necessarily have to refer to the whole range of the independent variable. In D5 candidates are referencing the need or not for further replication to the reliability of the results obtained. This has been stressed for many years in the TAC6 reports and at Agreement Trials.

Chief Examiner’s Report

A2 Assessment Units

General

Each of the two papers contained a variety of questions assessing the different skills which are developed over the course of studying biology at this level. As in previous series, there is evidence that candidates continue to develop these skills to a high level, so that achieving success at A2 attests to a candidate’s ability to apply his/her knowledge in unfamiliar situations and to bring together knowledge and understanding of several topics in order to explain biological processes.

A significant distinction between AS and A2 is the requirement to think more deeply about biology in order to answer questions on A2 papers. It is encouraging to note that many candidates are able to write excellent answers to the more challenging questions, including those which contain novel content. Analysis of candidate performance clearly shows that while a majority of candidates perform well in those questions testing recall and understanding, only the more able candidates perform well in those questions testing analytical and evaluative skills, particularly if the questions are set in an unfamiliar context.

Assessment Unit A2 1 Physiology and Ecosystems

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. Candidates were also tested on their ability to communicate their biological knowledge and understanding of biological principles by selecting, organising and logically sequencing information in a continuous prose question.

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The questions were written and structured in such a way that allowed differentiation among candidates of varying ability. This was reflected in the wide range of marks awarded in this paper.

Q1 This question was well answered by the majority of candidates. In Part (a) most candidates were aware of the increased risk of eye cataracts resulting from increased penetration of UV light due to depletion of the ozone layer. A minority of candidates wrongly thought that sulfuric/nitric acid reacted with water to produce acid rain. In Part (b) a majority of candidates were aware of the link between CFCs and ozone depletion but many failed to extend their answer to describe a strategy for reducing the use of CFCs. However, a disappointingly large number of candidates linked ozone depletion to global warming. The use of catalytic convertors in internal combustion engines, filters or scrubbers in chimneys and renewable sources of energy were all well known by candidates, many of whom gave more than one 'strategy' that could be used to reduce acid rain.

Q2 The majority of candidates correctly identified 'E' as light that missed the chloroplasts/chlorophyll in Part (a)(i). Part (a)(ii) was well answered by a significant majority of candidates. However, a small number of candidates ignored the instruction in the question to 'use the letters given' (in the diagram provided) to construct a formula for GPP. Consequently they stated the formula GPP = NPP + R which they had learned from theory and failed to gain credit for this question part. Part (a)(iii) was generally well answered. Regular spacing of crops/weed removal/pruning of trees and hedges that might shade the crop, were the most common acceptable answers. Some candidates suggested the use of artificial lighting or to use a greenhouse; not surprisingly these answers failed to gain credit. In Part (b)(i) the term monoculture was well understood with most candidates answering correctly. The vast majority of candidates were able to explain that growing the same species of crop year after year damages soil quality by depleting the soil of the specific minerals that this particular plant requires. Part (b)(ii) was less well answered and therefore was an effective discriminator. Few were able to explain that it was the reduced variety of plants/habitat types that attracted a limited number of animal species and consequently resulted in a limited food web, and thus a lower biodiversity.

Q3 In Part (a)(i) a significant minority of candidates described a long day plant without making appropriate reference to the information provided. They often simply stated that long day plants require a longer light period and shorter dark period. This and other similar answers often showed little analysis/interpretation of the data provided in the table. It was therefore appropriate to insist on answers such as 'flowering was only initiated when the light period increased above a critical length'/'dark period decreased below a critical length'. Part (a)(ii) was well answered with most candidates understanding that the photoperiod (and other factors that could influence flowering) could be controlled in a laboratory but not in field conditions. Part (a)(iii) worked well and proved differentiating among the candidates. The majority of candidates understood that additional investigations needed to be conducted to provide a more precise value for the photoperiod required to promote flowering. Additionally, many candidates were able to correctly suggest that smaller photoperiod intervals should be used. However, many did not then suggest the photoperiod range within which these additional investigations should be conducted (12-14 hours of continuous light/10-12 hours of continuous darkness). Consequently these candidates could not be awarded the mark. Part (b) tested knowledge of phytochrome conversions in plants. In Part (b)(i) the more able candidates were able to score both marks but the weaker candidates often picked up one mark and struggled to score a second mark. The

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majority of candidates understood that the short light exposure within the dark period caused P_{660} to be converted to P_{730}. However only some candidates explained that this was a *rapid* conversion and that the period of darkness thereafter was too short in duration to allow *sufficient* P_{730} to convert back to P_{660}. Consequently the level of P_{730} remained high and thereby inhibited flowering. In Part (b)(ii) the majority of candidates were able to explain that the far-red (FR) light exposure during the dark period rapidly converted P_{730} to P_{660}, thereby 'compensating' for the short duration of the dark period (which in regime 1 was too short for the slow conversion of P_{730} to P_{660} and thereby flowering was inhibited due to the high levels of P_{730} present). The reduction of P_{730} to a critically low level in regime 4 removed the inhibitory effect and thereby allowed flowering to occur. Some candidates did not score the first mark here as they did not emphasise the *rapidity* of the P_{730} to P_{660} conversion when exposed to FR light. Some candidates understood that in regime 1 the high level of P_{730} was inhibitory to flowering. However, too often, they did not explain that this was due to the dark period being too short to allow the removal of *sufficient* P_{730} (by conversion to P_{660}) to remove its inhibitory effect. Many candidates struggled with Part (c). Too often this resulted from not reading the question carefully enough. The question did not ask what caused red-green colour blindness. Instead candidates were asked to suggest how one particular form of colour blindness i.e. the inability to *distinguish* between red and green colours, might occur. This could result for a number of reasons. For example, lack of red *or* green cones, lack of red *or* green forms of iodopsin or the fact that the red and green cones might share common bipolar neurones in the retina. The condition does not arise from the lack of red *and* green cones/lack of red *and* green forms of iodopsin. This would result in the individual not being able to absorb these light wavelengths at all and therefore would not be able to perceive red and green colours at all.

Q4 In Part (a)(i) structure A was correctly identified as microvilli by the majority of candidates. A minority suggested that this structure was villi and failed to obtain the mark. Villi are multicellular evaginations of the mucosa in the ileum. Structure A is clearly evagination of the surface membrane of individual cuboidal epithelial cells in the lining of the proximal convoluted tubule in the kidney. Many candidates were unable to identify structure B as a nucleus. This was very surprising given the clarity of the photograph and that euchromatin and heterochromatin were clearly visible. The most common error was identifying B as a mitochondrion. Part (a)(ii) was generally well answered. The vast majority of candidates understood that the microvilli increased the surface area available for reabsorption of glucose/amino acids/water/salt. Part (b)(i) was also well answered with the majority of candidates correctly identifying the epithelial cells as cuboidal. Some candidates confused these as 'squamous' cells (from the glomerular capillary endothelium). The epithelial cells in the photograph are clearly not flattened and therefore cannot be described as squamous. In Part (b)(ii) some candidates confused the glomerular capillary endothelium with the podocytes in the inner walls of the Bowman's capsule. Consequently these candidates incorrectly suggested that the capillary endothelium had 'filtration slits'. Other candidates suggested that the glomerular capillary endothelium was 'porous' whereas the epithelium of the proximal convoluted tubule was not. In fact both linings are porous! However only the glomerular capillaries have pores between the squamous epithelial cells; no such pores exist between the cuboidal epithelial cells in the proximal convoluted tubule.

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Q5 This question proved discriminating with only a small minority of candidates obtaining more than eight of the twelve marks available. In Part (a)(i) the immediate effect of slurry pollution on BOD in the lake was generally well understood by candidates although a significant number incorrectly made reference to the decomposition of algae. In Part (a)(ii) the majority of candidates understood that both artificial fertiliser and slurry entering waterways would result in increased BOD and therefore gained the 'similarity' mark. However, even though the question stem clearly indicated that the timescales involved were different, fewer candidates were able to explain that the effect of slurry was more immediate; artificial fertiliser takes longer to affect BOD as the eutrophication results firstly in an algal bloom, followed by algal (other plant) death and then decomposition of the algae by bacteria. Only then does the BOD increase as a result of oxygen depletion in the water by the high level of aerobic respiration in these decomposer bacteria. Although many candidates understood that there were larger numbers of aquatic invertebrates than pike (Part (b)), very few were able to suggest that the larger sample sizes available would provide statistically more reliable data. Some candidates were able to correctly suggest that the invertebrates would be easier to catch/monitor than pike. Further, pike could migrate from a particular area or be reduced in numbers for reasons other than pollution, e.g. due to fishing, and therefore would not be a reliable indicator species. Part (c) proved to be very demanding for many candidates. The process of coppicing and its effects on trees was not well understood. Some candidates were able to use the photograph to help them develop sound answers. Some candidates incorrectly thought that the trees were cut leaving only the roots and that 'branches' then sprouted from the roots. The trees are actually cut close to the ground leaving a small stump from which many new shoots grow. In Part (c)(ii) many candidates were able to suggest that coppicing increased the number of habitats available and thereby promoted biodiversity. However, fewer candidates were able to suggest why the number of habitats available increased as a result of coppicing. The most obvious answer is that coppicing increases light penetration to the forest floor, thereby allowing colonisation of woodland floor plants such as wood anemones, wild garlic and bluebells. Consequently a greater variety of animals will be attracted to this area, promoting biodiversity. A few candidates did not even attempt this question and were clearly unfamiliar with the concept of coppicing, even though it is clearly specification content.

Q6 This question on muscle was well answered with most candidates scoring between seven and nine of the eleven marks available. In Part (a)(i) protein A was correctly identified as actin by the vast majority of candidates. In Part (a)(ii) the process of muscle contraction was well explained by most candidates with many obtaining either three or four marks. Part (b), being unfamiliar content, proved more discriminatory although most candidates were able to indicate which part of the trace represented muscle contraction, i.e. anywhere on the downward slope (Part (b)(i)). Part (b)(ii) proved more demanding with many vague answers. Some candidates did not interpret the muscle response to a single stimulus/repeated stimuli. Consequently their answers were generic e.g. a longer 'response'/stronger 'response' with repeated stimuli. Candidates were required to interpret these responses e.g. the muscle remained *contracted* for longer/greater *contraction* with repeated stimuli. Some uncredited answers were phrased solely in terms of the pen position! Part (b)(iii) was often well answered with some candidates showing very imaginative appropriate responses; weightlifting, or variations of this, was a common creditworthy answer. In Part (c) most candidates were able to suggest at least one variable that must be controlled to ensure valid results. For example, use the same concentration of saline solution/use the same

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muscle/ensure that the drum revolved at the same speed. Muscle from the same animal was not an acceptable answer, as this could be different types/sizes of muscle, which of course would respond differently to electrical stimulation.

Q7 The modal mark for this seven mark question was three, indicating that many candidates found parts of this question difficult. In Part (a) most candidates were aware of the use of immunosuppression in transplant patients, but few referred to the effect of the use of X-rays or immunosuppressant drugs on lymphocytes. Instead, and all too often, candidates simply referred vaguely to 'weakened immune system'. Irradiation, using X-rays, destroys lymphocytes. Immunosuppressant drugs can inhibit DNA replication in lymphocytes and thereby inhibit mitotic division of T-lymphocytes to form Killer T-cells/Helper T-cells, and also inhibit mitotic division of B-lymphocytes to form plasma cells. This therefore inhibits both cell-mediated and antibody-mediated immunity, both of which are relevant re defence against infection with *varicella zoster*. Part (b) also discriminated well with only the more able candidates providing detailed answers. Too many candidates simply referred to the vaccination programme for shingles saving money on treatment of patients, without suggesting how the savings would actually be made. There would be fewer GP consultations required, fewer costly drugs prescribed and fewer hospital admissions. Some candidates thought that vaccination saved NHS money being spent on antibiotics. These of course are totally ineffective against viral infections such as *varicella zoster*. Part (c)(i) was generally well answered. Earlier infection with *varicella zoster* would leave memory B-cells and memory T-cells in the circulation. On re-exposure to the same viral antigen in the shingles vaccine, these memory B-cells will divide rapidly to form plasma cells and result in rapid antibody production; similarly memory T-cells will divide rapidly to form killer T-cells and helper T-cells. Part (c)(ii) was generally well answered. The cell-mediated immune response targets body cells which the virus has invaded and on whose surface viral antigen is presented. The antibody-mediated immune response targets 'free' viruses in the body fluids.

Q8 The concept that prey numbers are larger than predator numbers and that peaks (and troughs) in the predator graph lag behind those of the prey, was well understood by the vast majority of candidates (Part (a)(i)). Part (a)(ii) proved to be differentiating among the candidates. While most candidates described the fall in pest numbers on application of the insecticide, only some identified that pest numbers subsequently increased to above their initial value. This pest resurgence was due to fewer predators being present, as many of these were also killed by application of this broad-spectrum insecticide. Some of the pests survived the insecticide application as they were already resistant to it, due to an earlier mutation. Alternatively, some of the pests may have survived as they were sheltered in some way and therefore not exposed to the insecticide. Too many candidates described the insecticide *causing* resistance. In Part (b)(i) most of the candidates were able to correctly suggest the use of a sweep net or pooter to trap the insects. Part (b)(ii) was generally well answered. Most candidates opted for the small 'range' of these insects as the reason why sampling was restricted to using individual quadrats. Part (b)(iii) was generally well answered. However, some candidates clearly did not know the Lincoln Index formula and numerous erroneous versions were used! For those who had learned the formula, this calculation of the estimated population size of species A was very straightforward. Part (c) was very poorly done. The most common error here was construction of a pyramid containing only the pest (species A) and the predator (species B), omitting the producer! This was penalised. Many candidates were clearly unfamiliar with the characteristic features of protoctistans (Part (d)(i)). Answers most commonly focused on trypanosomes as

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parasites harming their host, rather than describing the generic characteristics of protoctistans. This question required synoptic knowledge from AS 2 and it was disappointing to note that a significant majority of candidates had failed to retain this knowledge from the previous year. In Part (d)(ii) the majority of candidates clearly understood that while sterile tsetse flies can mate with female tsetse flies, no offspring are produced. However fewer candidates were able to explain the consequence of this, i.e. fewer flies available to *transmit* the trypanosomes. Many candidates thought that tsetse flies become extinct because of the introduction of sterile males as they would not produce offspring. However this is only true for those females who mate with the sterile males. Part (d)(iii) was differentiating as many candidates struggled to suggest two valid reasons why the use of sterile males was more effective than using chemical pesticides in reducing the incidence of sleeping sickness. Some candidates correctly suggested that with using sterile males there would be no pesticide resistance/pest resurgence. Some candidates gave the reverse, but acceptable, answer that use of chemical pesticides could result in pesticide resistance/pest resurgence. The majority of candidates who struggled with this question gave answers concerning the ecological impact of using chemical pesticides rather than the *effectiveness* of the technique.

Q9 This free response question concerning how neurones are adapted for their function and how nerve impulses are initiated, propagated and passed on at synapses was generally well attempted by most candidates. Differentiation was achieved by differing levels of detail provided in the candidates' answers. The higher level skill of being able to logically sequence key points was lacking in the weaker candidates. However the general level of knowledge of resting potential, polarised axon membranes while at rest, refractory period, propagation of impulses involving localised circuits, the consequence of myelination and the mechanism of transmission of the impulse at synapses, was impressive. The explanation of how synapses provide co-ordination and control was equally impressive. However, a significant minority of candidates failed to refer to synapses in Part (a) – this was required as candidates were asked to describe how 'nerve impulses are initiated, propagated and *passed on*'. Quality of written communication continues to be a skill that needs much development in some candidates although in many others it was excellent.

Assessment Unit A2 2 Biochemistry, Genetics and Evolutionary Trends

As is normal with A2 papers, this paper covered all the major topics in this unit. The paper contained a wide range of question types including questions that tested recall and understanding e.g. Questions 1, 2(b)(i), 3(d) and Section B (the essay). There were questions that tested the candidates' ability to analyse text, e.g. Questions 4(c) and 5(a), diagrams e.g. Question 2(a), graphs e.g. Question 6(b), tables e.g. Questions 3(c) and 4(a). As is normal with A2 2 papers there were question parts requiring calculations and statistics, e.g. parts of Question 6.

The question which proved most discriminating was Question 6, involving respiration, the respirometer and statistics.

Q1 This relatively straightforward question on gene technology proved slightly more demanding than expected with only a small minority of candidates obtaining all four marks. Part (a) proved the most discriminating section with many candidates not secure in their understanding of the term 'transgenic organism'. The key in Part (b) was being able to describe the use of reverse transcriptase, DNA polymerase and plasmids as 'tools' in gene technology. Plasmids seldom gave difficulty but many

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candidates failed to mention that reverse transcriptase catalysed the building of cDNA from mRNA – RNA on its own was a common answer.

Q2 This question on protein synthesis was well answered by most candidates but only a very small minority obtained the full six marks available. In Part (a)(i) most candidates were able to accurately identify process X as translation. Part (a)(ii) was much more demanding and discriminatory among candidates. Only the more able candidates were able to appreciate that the key evidence was that in Proinsulin (the precursor molecule) the two insulin chains and the linking amino acid sequence were all initially produced as one continuous polypeptide. One candidate answered 'there is only one NH_2 and one COOH', which deservedly was awarded the mark. Common answers that failed to gain credit included 'one gene codes for one peptide' (a learned response that showed no use of the information provided) and 'it only takes one gene to code for a small protein that only has 51 amino acids'. Part (b)(i) required an understanding of the role of ribosomes in protein synthesis and in general it was well answered. Part (b)(ii) was more demanding as it required an understanding of the benefits of 'polyribosomes' (many ribosomes working together on one mRNA strand). Many candidates gained one mark but only the very able obtained both marks. Only a small minority of candidates appreciated that it meant that less mRNA needed to be made. The most common correct answers made reference to the fact that large numbers of proteins/polypeptides could be made faster (but not that the actual process of translation was faster). There were some excellent answers in which candidates were able to link the 'hot spots' of protein synthesis to physiological situations where this could be important in the body, e.g. producing antibodies quickly in response to an infection. This was counterbalanced by the many weak answers to this question, including the many references to the 'hotspots' being an industrial application rather than a situation that takes place in cells naturally.

Q3 This twelve mark question on photosynthesis proved to be an effective discriminator; most candidates obtained between four and nine marks. Most candidates answered Part (a) correctly showing a good understanding of the benefits to plants in having a number of different pigments to absorb light energy. Part (b) was more demanding. Most of the candidates who did obtain this mark answered in terms of reduced water loss as a consequence of not having leaves (and stomata). There were many very vague answers referring to 'saving energy'. These vague answers were not rewarded as if the answer focused on reduced metabolic expenditure there also needed to be reference to the fact that photosynthesis gain was reduced in autumn, making a high metabolic expenditure more significant. Part (c)(i) required comparison of pigment colour intensities in both May and October rather than just a range of values lifted directly from the table. Part (c)(ii) was well done by those candidates who could link essential variables to the investigation described. For example, variables linked to using the same tree (reducing variability due to age or mineral availability) were rewarded but not bland references to keeping the temperature constant and so on. Part (d)(i) tested understanding of the fates of the products of photolysis and this was generally well done although many candidates appeared to be confused between the roles of hydrogen and hydrogen ions. In Part (d)(ii) many candidates lost a mark by stating that NADPH 'converts' glycerate phosphate to triose phosphate as they failed to reference its reducing role.

Q4 This eleven mark question covered aspects of protein synthesis and selection within the context of sickle cell anaemia. Parts (a) and (b) were generally well answered with most candidates being familiar with the concepts of base substitution and the 'degenerate nature of the genetic code'. However, Part (c) proved very demanding

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with only a small minority of candidates obtaining more than three of the five marks available. Only the more able candidates were able to appreciate that in Africa it is the heterozygotes (those with sickle cell trait) that are advantaged and selected for; many candidates referred (incorrectly) to the sickle cell allele being favoured. It seems that many candidates failed to effectively assimilate the information in the stem of the question. Although a greater number of candidates were able to describe why the sickle cell allele is reduced in Europe, many answered in terms of the 'normal' allele being favoured (and often failed to reference the sickle cell allele in this context). Surprisingly, a significant number of candidates referred to directional selection taking place in Africa (but not in Europe) which in fact is the wrong way round.

Q5 Parts (a) and (b) required candidates to analyse information concerning ash 'dieback'. Part (a) was a straightforward comprehension question and was often well done showing that candidates were able to pick the key threads of information from the question stem. In Part (b)(i) genome sequencing was quite well known although a minority of candidates referred to the 'sequence of genes' in an organism. Part (b)(ii) was also reasonably well answered although few candidates obtained all three marks. Most candidates deduced that gene sequencing could identify the key genome sequences of 'tree-35' that conferred resistance and that these could be introduced into British ash trees (therefore obtaining two marks). Only a few very able candidates suggested that 'knockout' technology could be used to identify the sequences involved in the Danish trees that were linked to resistance. More were able to refer to the use of restriction endonucleases in removing the critical sequences or describing how these sequences could be inserted into the genomes of the British tees. Part (c) was generally well answered. In Part (c)(i) the most common correct answers focused on the fact that many genes are involved in increasing susceptibility to heart disease and cancer and that environmental factors are often of greater importance. In Part (c)(ii) most candidates appreciated that the use of 'designer drugs' will increase effectiveness of treatment and/or reduce side effects but fewer linked their use to the patient's genome, often producing vague answers such as the drugs being tailored to the 'individual'.

Q6 Analysis of candidate responses suggest that Question 6 was the most demanding question on the paper. It was a long question (sixteen marks) covering the structure and role of ATP, the use of a respirometer, a calculation and statistics. Most candidates scored between five and eleven marks with very few obtaining anything approaching full marks. However, no question part was inaccessible as marks were awarded for each question part to at least some candidates. In Part (a)(i) most candidates answered adenine correctly, although 'adenosine' appeared frequently in scripts. The hydrolysis of ATP was well known Part (a)(ii) and the advantages of using ATP (Part (a)(iii)) was also often well done. Part (b) involving the analysis of data from respirometer data was often poorly answered. In Part (b)(i) many candidates understood that carrying out the investigation in the dark would prevent photosynthesis but fewer were able to accurately and concisely describe how photosynthesis taking place would affect the results. Part (b)(ii) discriminated very effectively and some of the excellent answers produced included 'takes Variety A longer to adjust to new conditions, 'Variety A may have been stored in cooler conditions', 'photosynthesis may have continued for longer in Variety A'. The most able candidates were able to appreciate that the answer required a factor that would cause Variety A to absorb oxygen (in respiration) slower at the *start of the investigation only* as the data clearly shows that after two hours Variety A absorbed oxygen more quickly that Variety B. Part (b)(iii) was well done by the more able candidates but

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many candidates lost one mark by giving the answer as 4.2 (rather than 0.42) indicating that they had divided only once by ten (rather than the twice required). Part (c) provided the full range of marks across the candidature. Many failed to gain the mark for stating the null hypothesis, often through lack of detail in Part (c)(i). The t-test calculation was often well done in Part (c)(ii). In Part (c)(iii) many failed to state the probability value accurately. Some candidates stated that p was less than 0.1 (rather than being greater than 0.1) and others expressed their answer only in terms of 0.05 (the normal critical value in investigations). Many candidates obtained one of the two marks available in Part (c)(iv) by stating that the null hypothesis was accepted. However, very few were able to explain the consequence of this in the context of the question. Candidates who stated that the null hypothesis was accepted often went on to note that 'therefore there is no significant difference between the mean numbers of mitochondria in the cells of A and B' – as this was an alternative to the first marking point (that the null hypothesis is accepted) it failed to gain credit. Answers that did obtain the second mark made reference to 'the difference in growth rate/respiration is not due to the number of mitochondria' or that 'the difference in growth rate/respiration must be due to another factor'.

Q7 This question was well answered with a significant majority of candidates obtaining at least ten of the twelve marks available. A small number of candidates lost marks through not being able to answer the questions in the context of sex-linkage. A minority of candidates dropped a mark in each of Parts (b)(i) and (c) through not linking the offspring genotypes to their phenotypes. Candidates should be aware that listing a range of phenotypes in random order is seldom sufficient; it is necessary to link particular phenotypes produced to the genotypes presented in the Punnett square/genetic diagram. Part (d) was well answered showing that many candidates appreciate the advantages of using *Drosophila* as a means of demonstrating principles of genetics.

Q8 The essay (Section B) produced a full range of responses from the candidates. A small minority of very able candidates achieved full marks with most candidates falling within the range eleven to sixteen. In general, Part (b) – evolutionary progress across the animal phyla – was better understood than the evolutionary trends across the plants (Part (a)). Consequently, Part (a) was more discriminatory. In Part (a) many candidates failed to develop their answers fully, e.g. noting that ferns and angiosperms had vascular tissue but failing to explain the consequence of this, e.g. allowing the development of greater size or less reliance on turgor. Some candidates lost out through not being specific enough about where a particular feature developed, e.g. the presence of stomata and a cuticle to reduce water loss in evaporation needed to be linked to the ferns (and angiosperms); reference to angiosperms on their own was not enough. Part (b) was usually well done with candidates showing a good understanding of the main evolutionary trends across the animal kingdom.

Principal Moderator's Report

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

As in previous years the standard of work provided by the pupils was of a generally high standard and teacher marking on the whole closely adhered to the marking criteria. It was evident that many centres had taken on board the advice given on their TAC6 centre report and

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implemented the changes for this year. It was also obvious that those centres who had attended the Agreement Trials demonstrated marking more in line with that expected by the moderation team.

The variety of practical undertaken by centres at both AS and A2 level is decreasing with the majority of centres investigating water potential, pH and enzymes and membrane permeability at AS and membrane permeability, yeast population and enzyme investigations at A2. It is important that the same investigation is not repeated at A2 level after being completed at AS. Care must also be taken with the amount of guidance given to candidates when preparing them for the coursework assessment. With the same investigations being chosen year after year the candidates' work has become very formulaic and similar and in some cases very similar to what is expected in the centre based mark schemes which are often provided. It is essential (as quoted in JCQ guidelines) that all work completed by pupils is based on their own ideas and thoughts.

Candidates and teachers seemed to embrace the new marking criteria for A1 developing the hypothesis. There was at times confusion between the hypothesis in A1.2 and the prediction and A1.4. It is possible that the candidates have answered both in the same paragraph and could be marked as such.

In A2 it is important that candidates choose their own range for the independent variable. This should be justified by attempting to give reasons for their choice e.g. for membrane permeability it could be limiting the temperatures to those where they think the membrane might start to break down and where complete breakdown will have occurred. In A2.4 the key variables are to be justified as to why they are controlled and not how they will be controlled e.g. differing volumes of water could dilute the pigment released from the beetroot.

The main change in A3 is the justification of the statistic chosen. It is expected that candidates have some understanding as to what is the most suitable statistical test to use to test the data they are collecting. Some indication of the nature of the data e.g. continuous or discrete, a range or a comparison of two values, should be included in their reasoning for their choice of statistic.

The same problems which arise in AS for implementing and recording occur in A2. Again the main culprit for difference in marks awarded by teacher and moderating team is the caption.

The calculation of the statistic being used for evaluation was well carried out by the candidates although in some centres the presentation of the statistical parameters could be clearer. When using a 't' test the probability value must be quoted. When confidence limits are presented unequal plotting of the bars indicates either a plotting error or an error in calculation. This should be penalised.

Candidates have a better understanding of assessing the reliability with using the statistics compared to AS level. There is no need to when commenting on the reliability to discuss possible errors etc. as this is more a question of validity. A simple recognition of the need or not for further replication based on their assessment is all that is required.

The completing of the criteria in C3 has improved over the last few years. Candidates have a good understanding of the appropriateness of the range and the comment on the measurements is the same as that at AS level. There is no need in C3.2 to justify the factors to be controlled; it is an opportunity for pupils to identify from the teacher/class method any variables that should be controlled. In C3.5 the pupils should suggest a possible prediction or give a range of the independent variable when they suggest another independent variable.

As with AS there was a greater degree of differentiation within and between centres compared to previous years.

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