GCE

Rewarding Learning

Chief Examiner's and Principal Moderator's Report

Biology

Summer Series 2019

Foreword

This booklet outlines the performance of candidates in all aspects of this specification for the Summer 2019 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.

Contents

GCE BIOLOGY

Chief Examiner's Report

General

This was the second year that all six externally examined papers were available for the (2016) revised specification. Each paper proved to be an effective discriminator enabling the top candidates to show the extent of their knowledge and understanding, yet allowed less able candidates to gain credit in many question parts.

Overall, candidate performance was strong across the suite of papers and this report will provide detailed information on how candidates performed in each paper, information that will be useful to teachers/lecturers and candidates preparing for future examinations in this subject.

Each paper contained a range of question styles, as is required, and as with all papers most candidates performed better in some question types than in others. Consequently, this report makes reference to those areas that were well answered, in addition, to highlighting the question types, and or topics that frequently caused difficulty.

In general, candidates tended to perform better in questions that asked for the recall of knowledge rather than questions based on unfamiliar scenarios. Across this suite of papers, there was evidence to indicate that many candidates failed to make use of question stimulus material effectively; this will be referred to as appropriate in the following report.

Calculations were often poorly done as exemplified by the fact that in ABY21 a two-mark calculation involving percentage increase, in which candidates were asked to give their answer to two significant figures, was correctly answered by less than 25% of the candidature. Across the suite of papers, rounding errors were common. A review of mathematical performance in the 2019 papers clearly highlights the need for candidates to be fully aware of the mathematical requirements of the specification and to be prepared appropriately.

In a small minority of papers, the quality of writing was so poor that examiners had a difficult task attempting to decipher what the candidate had written. Thankfully, this issue was not too common, but where present was a real issue.

Nonetheless, many candidates performed at a standard which is a real credit to themselves and their teachers/lecturers who helped prepare them for these examinations.

Assessment Unit AS 1 Molecules and Cells

Overview

There was good coverage of the AS1 specification in this paper and it was a good assessment of both content knowledge and application, scientific communication and key skills. There were sufficient questions requiring recall level of knowledge to make it accessible to candidates of different levels of ability and this was evident in the good range of results. Equally, there were more demanding questions requiring thoughtful responses that provided differentiation between the top candidates.

It was evident from the majority of candidate responses that students had been well prepared for this paper and that they had completed thorough revision. There was no evidence of students not having adequate time to complete the paper, and they appeared to have clearly understood what was expected in answering each question.

While some questions were challenging, e.g. 3(c)(ii) and (iii), Question 4(c)(ii), Question 5(c) and Question 6(c), other parts were accessible to all, e.g. Question 1, Question 3(a) and (c) and Question 4(a)(ii) and (iii). It is pleasing to note that candidates generally coped well with some of the more challenging application of knowledge questions.

Q1 This was an accessible question and eased students into the paper. A majority were able to identify the appropriate stage and division of meiosis; however, some did not achieve full marks in Part (b), with answers required to state differences between meiosis and mitosis. This was mainly due to replication of the same point, e.g. stating that meiosis had two divisions compared to one and then for the second point stating that 4 daughter cells are produced in meiosis compared to 2 in mitosis.

Q2 Part (a) was quite well answered, with most candidates obtaining at least two of the three marks available. The main reason for not achieving full marks was usually a lack of detail in explaining the role of each structure. For Part (b)(i), nearly all candidates correctly identified the pancreas cell as being the one which produced more proteins to be released from the cell. Many candidates appeared to fail to read the question properly and discussed the answer in terms of quantity of RER, rather than the fact there were more secretory vesicles or Golgi apparatus which are required for the proteins to be released. For the third mark candidates were required to add that the proteins were transported to the membrane for release and this turned out to be a very discriminating mark. Part (b)(ii) required candidates to identify that there was ***more*** SER in liver cells rather than just identifying that SER was present, proving again that lack of attention to detail can cost candidates marks.

Q3 Part (a) was a reasonably straightforward question covering water potential and the majority of candidates correctly completed the calculation. However, a worrying number of candidates failed to complete the second part of the question in which they had to draw arrows to show the direction of water movement; of those who did many often forgot to draw an arrow between B and A. It needs to be emphasised to candidates that they must read questions carefully and they should pay attention to the number of marks awarded rather than the number of answer lines provided. Part (b) was well answered with a majority of students understanding that water moves in the direction of the more negative water potential causing the cell to expand. Part (c)(i) was generally well done. Many candidates attempted to answer (c)(ii) in terms of water potential rather than considering the concentration gradient that would be produced if glucose levels weren't the same; although many still managed to achieve one mark for understanding that glucose would be lost/gained. In (c)(iii) most candidates were able to gain at least one mark and good candidates were able to fully explain why. However, many did not get this second marking point. Too many candidates just stated that blood would enter the fluid, not enough to gain the second mark.

Q4 Many candidates got the name of molecule X the and hydrophobic mark in (a)(i). However, many just referred to water soluble molecules which as a term straight from the stem was not detailed enough to gain credit. Both (a)(ii) and (b) were familiar recall questions and were very well answered. The calculation in (c)(i) was reasonably well answered; however, it is concerning that many candidates rounded 6.67% down to 6.6% rather than up to 6.7%. This is a very basic mistake which at AS level must be penalised by the loss of one mark. Some divided by 0.96 and many within this group did not give each step of the calculation so were not even awarded the first marking point as they did not write 0.06. Part 4 (c)(ii) showed differentiation with vague descriptions of trend being seen many times. Some candidates did not make reference to both variables in their description of trend. Most were able to gain the marking point relating to release of pigment, yet many candidates thought that the absorbance was relating to alcohol absorbance into the cell. Good candidates did very well in this question. The majority of candidates were able to apply their knowledge and (c)(iii) was answered well.

Q5 Candidates tended to either know the immobilisation techniques very well and consequently were able to achieve high marks in this question or they only picked up a few marks in the more open-ended 'suggest' parts throughout the question due to their lack of knowledge of the topic. In Parts (a) and (b), the majority of candidates were able to pick up at least one mark in each part. In Part (b), candidates often named the disadvantage and then described it rather than explaining its impact. Part (c)(i) was generally well answered, the most common incorrect answer being an unqualified 'reused' – the key part of this answer is that the enzymes can be reused because they are retained. In (c)(ii), the disadvantage was usually well answered but the majority of students seemed to think the advantage would be 'no denaturation'. A minority of candidates were able to link the temperature to reduced bacterial growth. Part 5 (c)(iii) provided differentiation, with most candidates gaining the second marking point, but often not getting the first marking point for not answering the question that was asked. Often, they made no reference to temperature and instead talked about flow rate of the milk. The rest of the question was well answered, and candidates were able to apply their knowledge in answering.

Q6 Overall most candidates answered Part (a) very well. Sometimes references to 'more than one' layer of protein or double stranded DNA were seen which seemed to indicate that some candidates identified information from the stem and tried to 'guess' the differences from that. Both parts of (b) should have been straightforward for candidates but often were poorly answered. It appears that once there is an unfamiliar context linked to the common terms of 'endocytosis' and 'semi-conservative replication' candidates struggle to answer the question. In Part (ii), lack of detail and terminology cost candidates' marks; many making vague references to free bases or not stating 'complementary bases pairing rules'. There appears to be much confusion about the role of DNA polymerase with many candidates stating that it joined the two strands together and very few identifying the fact that it catalyses the formation of phosphodiester bonds or even just that it joins the nucleotides together. Candidates did not appear to know which cells were actively dividing in the mucosa in Part (c), and of those who did, often they couldn't explain the consequence in appropriate detail. Answers lacked structure, and many did not ***compare*** and then ***contrast*** in Part (d), with many just describing each of the years separately and leaving it up to the examiner to try and link a comparison which they will not do. Most candidates gained marks in this question, but the standard of answers varied considerably.

Q7 **(Section B)** This was an essay on protein structure which was then to be linked to the structures and functions of collagen, enzymes and haemoglobin. This should have been a relatively straightforward essay, but it showed again an area of weakness for many students when trying to link knowledge to function of structures. A majority of students were able to pick up marks when describing protein structure, a topic which had obviously been well learnt in most cases, but they gave very vague links between the bonds/structures formed and the functions of the named structures. This was especially evident in enzymes where there were many general references to the specific shape of active sites, but no idea of how the bonds formed this and how it linked to the specificity.

Assessment Unit AS 2 Organisms and Biodiversity

Overview

This paper gave candidates of all abilities the opportunity to score throughout and presented a range of questions that differentiated among candidates, resulting in the awarding of marks across the scale. Those obtaining the higher marks were able to use all the information in the question stems and to respond using AS level language to fully answer the question. Less able candidates were able to access the questions but not fully use the information provided or did not use the technical terminology required at this level. There was no detectable pattern of certain question parts not being attempted.

Q1 Most candidates were able to answer Part (i)(a) accurately with a minority of candidates losing marks for repetition of the same marking point; Part (b) was also well answered. Question Part (c)(i) was equally accessible and generally well answered with only a minority of candidates responding incorrectly using 'behavioural' as a source of evidence to classify organisms. The majority of incorrect responses to (c)(ii) were due to candidates incorrectly assuming that 'mutation' and/or 'evolution' were appropriate answers for the question asked and mixing up why organisms might change with a reason for classification change.

Q2 In Part (a)(i) most candidates correctly selected photograph C as the xerophytic leaf. In Part (a)(ii), many candidates used 'traditional mark scheme' responses to answer the question rather than reading the question accurately and using the photograph to identify features. In (iii), candidates were asked to explain how one of these adaptations reduced water loss, and many lost the available mark by providing a GCSE-level answer – often giving a statement without detailed follow-up linked to reducing the concentration gradient. Part (b) provided some evidence that candidates can use the dedicated specification textbooks in addition to reading around the subject to broaden knowledge.

Q3 This question was based on the cardiac cycle topic in the specification and was not as well answered as had been expected. A number of candidates incorrectly interpreted the cardiac cycle diagram - which was presented in a very common format – and consequently incorrectly identified the closing of the atrioventricular valves and opening of the semilunar valves in (a)(i). In Part (a)(ii), a majority of candidates were able to explain the increase in ventricular pressure between 0.1 and 0.3 seconds as ventricular systole, but fewer were able to explain the increase in atrial pressure between 0.1 and 0.14 seconds as back pressure on the atria from the ventricles; many candidates describing this as atrial contraction. The final Part (b) of this question was well answered, with many candidates able to explain the importance of ventricular contraction starting at the apex, thereby ensuring that all the blood is removed from the ventricles as it is pumped upwards into the arteries.

Q4 In general, candidates handled the range of knowledge and skills required to achieve the higher marks in this thirteen-mark question quite well. In Part (a)(i), a majority of candidates correctly defined the term ecological niche as the role an organism plays in the environment. In question Part (a)(ii), candidates of all abilities were able to use the information in the stem of the question to correctly identify the blanket bog as a rare habitat. A majority of candidates could correctly identify an initiative to conserve habitats and promote biodiversity in Part (b); however, a number of candidates incorrectly provided the name of an organisation - this was also a common error in a similar question in the Summer 2018 paper. In Part (c)(i), a majority of candidates correctly identified the edaphic factors that affect the distribution of plant species in the bog, but fewer were able follow this up with the detail required to obtain the marks for Part (ii). Candidates who achieved a mark here were generally able to determine that plants require specific adaptations to survive in these conditions, but

often were unable to describe the effect of the low oxygen content on respiration or the need for nitrogen fixing bacteria due to the low nutrient content or the role an acidic pH might have, a level of detail required to obtain the second mark. In Part (d), many candidates were able to calculate the percentage decrease in (i); where marks were lost it was often for errors arising from using the data from 2017 rather than 2006. Part (d)(ii) was well answered with appropriate trends identified and information in the stem used to determine the causes of the decrease and increase in population. In Part (iii), candidates across the ability range were able to offer valid suggestions as to why firm conclusions could not be made from the results shown - generally either that there were too few data points or that only two years has elapsed since the introduction of the boardwalk.

Q5 This question was based on a novel setting for the specification topic, transport in plants, and it differentiated effectively as anticipated. A majority of candidates were able to state the function of companion cells in (a)(i) but were often less confident in stating how the ***processes*** of transport in the xylem and phloem differ in Part (ii). Many candidates were able to provide one difference (and obtained one of the two marks available), such as the uni/bidirectional flow, with many losing one or both marks for stating a structural difference and/or the composition of the material being transported. In Part (b), a significant number of candidates were able to suggest an advantage for the blocking of sieve tubes, but many more struggled to suggest a disadvantage, with many incorrectly stating that it would prevent the movement of solutes throughout the whole plant. Part (c)(i) asked students to use the data provided to calculate the time taken for the flow of contents through one sieve tube element. Although a high proportion of candidates were awarded a mark for determining the correct data to use from the table, many were unable to follow through with the correct equation or rounding to an appropriate number of decimal places. In Part (ii) candidates were expected to determine how there are similar translocation rates in each species. In this question, many were able to access one mark in this context, but a significant number lost a mark for comparing the pore size, which is very similar, instead of the tube length. Comparison of the number of pores was the most common correct response.

Q6 This question on global warming was comprehension in style. In Part (a), many candidates were able to pick out that the Mauritian kestrel would be very young when the storms came but were unable to further elaborate on the consequences of this. A majority of candidates were able to access at least one mark (e.g. the inability to find food) but many fewer achieved the full three marks, making this a very discriminating question. Part (b) also asked candidates to use the information available, in this case to answer questions based on CO2 levels. A very small minority of candidates were able to identify that the CO2 levels had been stable for millions of years but has risen in recent times. A higher proportion achieved the mark for the second part of this question (the evidence that increased CO2 levels is a natural occurrence). Answers for Part (c) suggest that many candidates find the concept of ecological range difficult and struggled to explain how global warming might influence this, despite this idea having been assessed several times in recent years.

Q7 The penultimate question of the paper began with a simplified diagram of the aorta with a reference label (endothelium). In Part (a)(i), candidates were asked to identify three of the layers of the aorta. The lumen (A) was correctly identified by most candidates; surprisingly, a large proportion of candidates were unable to correctly identify B as the muscle ***and*** tissue layer - commonly giving only one of these two instead of both - or the fibrous outer layer (C). Part (a)(ii) asked candidates to describe how vasodilation occurs and its effect on blood flow. Lack of technical detail was a key reason for marks being dropped in this three-mark question, which differentiated effectively as only the top candidates were able to fully describe this and access all three marks available. In Part (b) candidates were provided with data in reference to vasodilation but in a novel context. Knowledge of the role of sodium

hydrogencarbonate was generally poor (Part (b)(i)). In Part (ii), many candidates were able to provide reasonable suggestions as to why rat aortas were used - the most common incorrect answer was that it was more similar to the human aorta than a mouse aorta. Part (iii) asked candidates to interpret quite a complex data table to identify trends. In the main, candidates were able to identify one or two of the major trends, but only the most able candidates were able to access the full three marks by comparing the data between conditions. Part (c)(i) was well answered but again only the most able candidates were able to use all the information and correctly describe the role of histamine receptors in vasodilation (question Part (c)(ii)).

Q8 A majority of candidates were able to provide a correct equation for Fick's Law. However, a majority of candidates did not score highly in the remainder of this question for a number of reasons, including:

- poor terminology or lack of technical detail;
- not linking the structure of plant/mammal respiratory systems to the effect on diffusion/Fick's Law; and
- poor knowledge and understanding of the relevant parts of the specification.

Generally, the links between diffusion and the structure was more fully answered in relation to mammals, with knowledge and understanding of this topic in plants tending to be more vague and lacking detail. The effect of smoking on the factors affecting Fick's Law was well answered by only a minority of candidates but, across the wider candidature, answered in terms of general knowledge about smoking with only limited AS level detail.

Assessment Unit AS 31 Practical Skills in AS Biology

Overview

This was the third year in which a written examination was used to assess AS practical skills in the revised specification. As in previous series, the examination succeeded in providing meaningful differentiation across the candidature in the assessment of practical skills.

This fifty-mark paper covered many of the practical activities identified as being part of the AS course. There was a range of question types including outlining 'recipe' practical methods, drawing a scatter graph, interpreting a block diagram, interpreting a range of photographs and interpreting data from tables and graphs.

Q1 This was a relatively straightforward five-mark question covering ecological sampling of animals. Most candidates obtained four or five marks. Common errors included not being specific enough about the type of invertebrate sampled in a pit-fall trap and the failure to recognise that B represented a quadrat. Part (b) was very well answered, with a majority of candidates getting this mark.

Q2 Interpreting a photograph of the TS of a hydrophytic leaf and evaluating a block diagram of this photograph were tested in this question. Many candidates found this novel way of assessing a block diagram accessible with many getting 4/5 marks. Part (a) required candidates to identify two features in the photograph, the photosynthetic layer and a hydrophytic feature. This was done well by a majority of candidates, although a significant number were distracted by the red tinted objects in the photograph and misidentified these as hydrophytic features. Another mistake seen in quite a few papers was candidates labelling the drawing and not the photograph as was asked in the question, and so lost marks. Part (b) was often well done with many candidates easily identifying two out of three errors. Loss of marks was often due to candidates stating stock answers such as 'not clean lines' or that it should have 'straight lines' or the 'absence of labels'. A number of candidates commented on features that cannot be seen in the photograph, such as sunken stomata and therefore failed to gain credit.

Q3 The use of a colorimeter to measure an enzyme reaction was tested in this seven-mark question. In Part (a), a majority of the candidates were able to state that a red filter would be the most appropriate. A significant minority incorrectly chose blue and even green filters. Part (b)(i) tested candidates' ability to identify anomalous result from data and to give possible reasons for this anomaly. Most candidates were able to identify the anomalous result and give appropriate reasons for this. However, some candidates incorrectly suggested human errors which was inappropriate.
In Part (b)(ii), a surprising number of candidates incorrectly linked the very high temperature to an increase in rate of reaction and not the fact that some enzymes would not yet have been denatured. Part (c) proved very challenging for many candidates despite a similar question being asked in a recent past paper. High scoring candidates correctly suggested creating a known range of starch solutions, using a known start concentration and serial dilution and then plotting % transmission against starch concentrations. The starch concentration could then be found by reading the transmission from the graph. Some candidates incorrectly suggested plotting starch against percentage transmission and so lost a mark.

Q4 Question four tested candidates' recall of simple biochemical tests and their positive results in the form of a table. Most candidates were able to obtain 4/5 marks for this straightforward question. The most common mistakes were to leave out either the acid or the alkali in the non-reducing sugar test or to forget to include the start colour of the reagent in the colour change.

Q5 In this question on the heart dissection, candidates had to identify four main features of the dissected heart and describe and explain one difference between the left and

right sides of a dissected heart. Part (a) was surprisingly quite discriminating with a majority of candidates only able to identify a maximum of three out of the four labelled structures. Common errors included the inability of candidates to correctly identify the papillary muscle, often naming it as the bundle of His or septum. Candidates also lost marks if they gave answers lacking detail such as answering ventricle instead of the correct ventricle wall or incorrectly named the AV valve as the tricuspid valve. In Part (b), most candidates got at least one mark even if their answer in Part (a) was lacking detail.

Q6 This six-mark question required candidates to describe the set-up and development of a chromatogram of amino acids. As with pervious papers, candidates did well in this type of 'recipe' method question. Most candidates showed good understanding of procedures involved and many got full marks. A small minority of candidates did not read the question carefully enough and gave answers to the setting up and running of the chromatogram and missed out the development. Some spent unnecessary time on explaining how a Rf value would be calculated. Marks were also lost when important details such as using a pencil to draw the origin line or forgetting to dry the chromatogram before spraying with ninhydrin were omitted. Overall, a very successful differentiating question which rewarded candidates for good recall of a common practical.

Q7 This question on the root tip squash tested several skills including identifying stages of mitosis shown in a photograph, recalling detail of the staining procedure and a magnification calculation. Part (a), identifying and naming stages of mitosis from a photograph, was very well answered by virtually all candidates. The photograph and labelling in the paper were clear and any mistakes could only be due to lack of knowledge of the stages of mitosis. In Part (b) candidates were asked to use the scale bar to work out the magnification of the photograph. This was very well answered by a majority of candidates, not surprisingly as it is a familiar calculation. It is surprising that there were candidates who failed to use the scale bar at all and chose to measure the width of the photograph and used this to calculate the magnification. Part (c) proved to be discriminating. Most candidates were able to give a correct stain; however, a significant proportion of the candidates did not know why the stain was used or gave very vague answers relating to 'seeing' organelles well or to providing contrast. The better candidates were able to precisely state that the stain made the chromosomes more visible.

Q8 This final question on ecological sampling proved to be quite discriminating, with few candidates getting all eight marks. Part (a) tested candidates' ability to draw a scatter graph and then to identify and explain trends in the data drawn. Drawing the scatter graph (Part (a)) was generally well done. However, some candidates did lose marks for joining up the points. A small minority chose to use a three-axis graph despite being clearly instructed on what data to plot. These candidates were only allowed to access the mark for plotting points if these were correct. In Part (b), most candidates did get the trend correct, again as in previous papers the mark was often lost for stating the trend incorrectly with answers such as 'as percentage cover increases, light intensity decreases'. In Part (c)(i), a large majority of candidates were able to name a piece of apparatus to measure light intensity; however, Part (iii) clearly discriminated between candidates who had actually used a light meter and those who hadn't. In this question there was evidence that candidates are still confusing accuracy and reliability. Part (c)(ii) also proved discriminatory as only the top candidates were able to give an appropriate suggestion for the peak in light intensity at 60 m. Many candidates gave vague answers about fewer trees, without the reason as to why there are fewer trees such as trees falling or a fire break. Part (d) was very well answered showing that a majority of candidates could name another abiotic factor that could be measured along a transect.

Principal Moderator's Report

Assessment Unit AS 32 Practical Skills in AS Biology

Overview

The quality of work being submitted and assessed in this unit continues to improve and more centres are carrying out more of the prescribed practicals. Work is generally well presented and where annotation is provided it makes it very clear why marks are awarded or indeed deducted in the candidates work.

When more than the seven required practicals are submitted it would help moderation if it was made clear which practicals are being used for assessment without having to continuously refer to the e-Candidate Record Sheet. For example, the assessed practicals could be presented, where possible, at the front of the folder. It would be preferable, for moderation, if poly pockets were not used for each piece of practical work.

It is good to see centres using practical Lab books and these show the excellent practical work being carried out within centres. It is obvious from the depth of treatment of the practical write-ups that some centres treat the practicals as a teaching and learning opportunity rather than a hurdle to be completed in order to complete the course.

The moderation team would still like to see better quality recording of data in the form of tables and graphs. The quality of these has decreased since the removal of the criteria from the previous specification, however it is felt that these are part of the practical experience and as such should be presented at AS standard. If a candidate consistently produces graphs and tables missing captions and units etc., then at least one mark should be deducted.

It is also important that candidates construct their own results tables (as this can be examined in the theory papers) and not use a pre-prepared table given by the teacher. These could be used to collate class results.

It is also important to note that seven practicals need to be carried out and that one practical cannot be used in two categories.

Identification of Biological Molecules

Generally, centres tended to try and identify unknown solutions or they tried to identify biological molecules in a variety of different foods. The aim of this practical is to use food testing reagents as qualitative tools to identify biological molecules. Unfortunately, there are still some centres where the tests are simply carried out using known food samples/ prepared solutions or there is no clear evidence the practical work has been carried out. It is important the evidence shows a table of positive/negative outcomes and identification of molecules deduced from the results in a conclusion.

Chromatography of amino acids

This practical has caused centres some problems due to a lack of separation of the amino acids. This could be due to the quality of the paper, the freshness of the solvent or the type of amino acids. When there is a problem with the chromatogram candidates should still provide evidence of their own results/chromatogram (copy or photo) and then could be given a copy of another chromatogram to take their measurements from. It is essential a results table is provided, calculations are carried out and amino acids are identified, and this is provided as evidence.

Using a colorimeter

There is scope in this section to use a colorimeter in a number of experiments. It can be used to produce results for a starch calibration curve either by a serial dilution (there is no need to plot a log graph) or by set dilutions. Also, the course of a starch amylase reaction can be followed. It is important to note that this practical cannot be used as an enzyme practical as it does not investigate any factors affecting enzyme activity.

Commonly many centres used the colorimeter to investigate factors which effect the permeability of the cell membrane. For all these options a table of results of raw data and a graph should be drawn as evidence.

Enzyme investigations

There is the potential to submit two practicals from this section, however it is important that a different independent variable is investigated each time. A table of results and a graph should be drawn, and a conclusion given regarding the outcome of the investigation. It is expected at AS level that in the conclusion reference should be made to the effects of pH and temperature on the bonding in the tertiary structure and the specific types of bonds mentioned. It is not enough to just simply state the enzyme becomes denatured.

An immobilised enzyme practical can be used in this section and useful evidence is to provide a photo of the enzyme beads and outcome of the diagnostic strip etc. The conclusion should state the outcome of the investigation.

Measuring cell size

The methods used and the evidence provided varied greatly in this practical across centres. It is important that the candidates show their calibration of the graticule using the stage micrometer and then they use this to calculate the size of a cell. The cells can be provided by the teacher and the outcome could be photographed or a drawing of the cells being measured could be given. In the evidence, candidates should show each step in the calculation when calibrating the eyepiece. Similarly, they should show each step in the calculation when determining cell size using the number of eyepiece units and calibration value. Some candidates simply give the final values for calibration and cell measurement, without showing how the values were calculated.

Water potential of cells and plant tissue

This is a very common practical and many centres still compare the water potentials of different plant tissues. An individual table of results showing raw data is required and this or class results can be used to construct the graphs. As the name of the practical suggests, in order to gain 3 marks it is essential that candidates state the determined water potential and show an understanding in their conclusion as to how this was obtained. Too many centres simply drew a graph of % change in mass against molarity of sucrose and stated this molarity at the isotonic point. This is GCSE standard and not appropriate for AS level.

Solute potential at incipient plasmolysis

As with the water potential this is also another common practical. The same problems exist with this practical as many candidates did not state the solute potential but rather gave the molarity of sucrose at which incipient plasmolysis occurs. The evidence required should include a table of raw data, a graph and a conclusion stating the solute potential and a brief explanation as to how this was determined.

Root tip squash

This tends to be a problematic area mainly due to the lack of success in obtaining clear results from the squash. Candidates should, if possible, take a photo of their squashes even if they don't see any cells undergoing division. This is evidence to show they have carried out the practical (a drawing of their cells would also be sufficient). Candidates can be given a pre-prepared slide or photo from which they could draw and label cells in various stages of division.

Block diagrams

These tended to be leniently marked with three marks being awarded to diagrams which were not representative of the photo/slides used. Also, drawings frequently had individual cells present and, in some cases, they were quite obviously traced. There is no requirement to draw both a leaf and an ileum but if this has happened then it should be clearly stated which one has been used for assessment. A guideline for marking should be taken from the requirements needed for a block diagram question in the exam papers e.g. no sketchy lines. If possible, a copy of the photograph being used for the diagram should be included to help the moderation process.

Heart dissection

There were several excellent examples of heart dissections with candidates making good use of photographs for their evidence. Labelling took many forms with some candidates labelling the photograph and some using cocktail sticks with labels attached to the various parts of the heart. It is expected that candidates label all visible parts of the dissection which are consistent with the requirements of the specification.

The main issue with this practical was either a lack of a drawing of the external view of the heart or that these were often not representative of the heart being dissected. In some cases, these were obvious copies of a textbook diagram of the heart.

It is essential the drawing and the photos are of a heart which the candidate is using for dissection.

Sampling techniques

It is good to see centres still carrying out field trips and ecological investigations. These included sand dune and rocky shore transects and Simpson's Index calculations for biodiversity. When carrying out a transect it is important raw data is included in the evidence and if appropriate a graph drawn. There should be some form of independent variable to be investigated and this should form the basis of a brief conclusion.

If calculating a Simpson's Index value, then the degree of biodiversity should be commented on referencing their calculated value.

Two practicals can be submitted from this category, however it is important a different independent variable is used for each one.

Chief Examiner's Report

Assessment Unit A2 1 Physiology, Co-ordination and Control, and Ecosystems

Overview

Candidates taking this unit obtained a wide range of marks. Some obtained very high marks displaying a sound grasp of the subject content and well-developed skills in application. Many question parts provided an opportunity for less able candidates to exhibit the extent of their knowledge and, although some questions proved to be challenging, none were beyond the ability of the candidature. Overall, there were very few scripts with a significant number of blank spaces and in most question parts candidates attempted a response. Most centres had clearly prepared their candidates to a good standard and there was evidence that the content of the specification had been well taught in general. The mathematical challenge posed in this unit was, relatively speaking, straightforward. There was very little evidence to suggest that candidates were unable to complete this paper on time. 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 some situations, candidates either failed to address the question entirely or only gave partial answers thereby preventing them from accessing all the available marks. Questions in which the candidates had to analyse data again presented problems when candidates had to focus on particular areas of a table or graph to draw out the relationships.

Q1 This question was relatively straightforward, requiring recall of key concepts in the carbon cycle. The complexity of the question was increased by requiring some application of biological knowledge. Many candidates achieved full marks in this question. However, in Part (a), a minority of candidates lost marks due to not identifying correctly the biological processes. In (b) candidates generally gained the mark and Part (c) was usually well answered too.

Q2 This seven-mark question focused on energy transfer. A significant number of candidates misidentified the primary consumer in Part (a)(i) as pondweed; a disappointing outcome given that a GCSE candidate should be able to answer this. The calculations (Parts (ii) and (iii)) were generally well answered, including the rounding required. However, this was to be expected as they were not challenging calculations. Part (b) exhibited a range of marks. Many candidates understood the general concepts of what was asked from them here but in many cases clumsy, broad-brush language was not commensurate with this level of biology. Candidate reference to energy loss without reference to respiration, lacking reference to increased or greater energy loss and ideas like respiration uses energy contributed to mark loss.

Q3 The context of this question regarding the eye was familiar to candidates and provided a range of marks. In Part (a) a disappointingly high number of candidates misidentified the cornea. Part (b)(i) was based on a graph that is common in textbooks and has appeared in different forms in previous series. Consequently, a disappointingly high number of candidates incorrectly identified the rods and cones, indicating that they could not analyse the image provided. In (b)(ii), most candidates correctly identified the blind spot but then went on to answer that this is where the optic nerve is found - this does not adequately explain the absence of the photoreceptors at this point. In (b)(iii), candidates again performed well, although many answers lacked appropriate terminology, such as sensitive/sensitivity when

describing the activity of the rods. Again, use of language in describing the peripheral location of the rods was not particularly good.

Q4 This twelve-mark question tested candidates understanding of succession and proved to be a relatively challenging question for many candidates. In Part (a)(i) most candidates correctly answered secondary succession. Part (ii) was less well answered. A significant number of candidates veered from the information given and began linking nitrogen-fixation occurring in the soil and not the plants and concluding that the process of nitrogen-fixation produces nitrate directly and not ammonia. In (iii) many candidates successfully applied knowledge of ammonification and nitrification to explain the increase in nitrate across the period of the data. The four-mark Part (b) provided a range of marks, with many candidates obtaining marking points 3 and 4. The less frequently awarded marking points (1 and 2) exemplifies the tendency of many candidates to ignore early trends shown in the graph in favour of more general trends across the breadth of the graph. In Part (c), a significant number of candidates failed to discuss the impact of sheep as grazers, although clearly identifying them as such in their answers. Many candidates made reference to the faeces produced by sheep and the impact that this would have. Many candidates failed to provide appropriate detail regarding the type of climax that would result as a consequence of sheep grazing. Candidates also tended to describe the sheep decreasing the shrub and tree population, rather than the impact of grazing on the shrubs and trees reaching full size.

Q5 Biological control was the specification topic tested in this eighteen-mark question. In Part (a)(i), most candidates successfully defined the term pest through appropriately linking the economic impact to the definition. Parts (ii) and (iii) generally yielded responses that did not have enough detail to gain full marks. For example, in (ii) it was necessary to link either small population to the idea that any two insects could breed or indeed that all insects could produce offspring. In (iii), many candidates suggested that crawling would allow escape from predators, but this would be unlikely unless their predators were equally slow moving! Consequently, few candidates correctly linked the crawler stage to distribution and the consequent reduction in competition. Parts (iv) and (v) were generally well answered. In Part (v), it was important that answers referenced the complete life cycle of the ladybird and not just the egg stage. In the four-mark Part (b), a majority of candidates achieved half or more of the available marks in this question, detailing accurately the features of a successful biological control organism. In Part (c)(i) a significant proportion of candidates did not make reference to 'acceptable loss' rather than just the idea of 'loss' - all pest damage will result in economic damage but above the 'economic threshold' it becomes critical. Part (c)(ii) was generally well answered with answers making reference to the ladybirds acclimatising to the habitat and the time taken for the population to increase to a level in which it would impact on the pest population. In (c)(iii), a significant proportion of candidates suggested the resurgence was due to pesticide resistance although this was not indicated by the pattern in the graph; the more likely reason being the reduction in the predator numbers due to pesticide application.

Q6 Although Part (a)(i) had a synoptic element, most candidates correctly identified the amino group as the precursor of urea. A significant proportion of candidates identified another excretory product as creatine, creatinine, water or excess salt in Part (ii). In Part (b)(i), it is pleasing to note that virtually all candidates gave function as asked, rather than just naming the part labelled. However, there was some confusion evident with the functions for B and C often being mixed and, additionally, broad statements such as 'reabsorption of water' are too vague at this level. The mark scheme for Part (b)(ii) allowed candidates to give one of a possible two avenues

of response, that of 'filtration at high pressure' or the more commonly cited 'the passage of molecules below a certain size into the Bowman's capsule'; direction of movement was important to qualify this response. Part (iii) was well answered by most candidates and this knowledge appears to be well embedded across the candidature. In (iv), most candidates could successfully answer that plasma proteins are too large to cross the basement membrane. A significant minority gave blood cells, and this was inappropriate as they would not be considered as a substance. Part (c)(i) was generally well answered and it is pleasing to note that the key trend was usually accurately identified. A minority of candidates lifted answers directly from the table without any analysis, for example, 'when toxicity was high the volume of water was high' or vice versa, answers that did not state a trend since it lacks a relative component. In (c)(ii), many candidates accurately linked the diluting effect of the water on the toxicity of the excretory product. Part (d)(i) was synoptic, requiring an understanding of water potential, and indicated a marked improvement in candidates' terminology when describing changes in water/solute potential. In (d)(ii), most candidates gained the first mark point with an understanding that the water potential gradient resulted in water moving into the gill capillaries. However, many candidates failed to develop their answer to indicate that this increased the volume of water in the shark's blood allowing for the dilution and subsequent excretion of ammonia, instead opting for diffusion of ammonia/urea from the gills.

Q7 This fourteen-mark question provided a platform to test candidates' knowledge and understanding of immunity within the context of vaccinations and also herd immunity. Parts (a)(i) and (ii) were each well answered by a majority of candidates. One area which could be improved is candidates understanding of the components of a vaccine as 'dead or attenuated/weakened forms of pathogens/isolated antigens/ modified toxins' rather than 'dead or weakened ***diseases***'. In Part (b) candidates were required to use graphical data to explain herd immunity. Many candidates failed to get awarded both mark points by either not identifying the high level of vaccine uptake reducing incidence of the disease to very low levels or by ignoring the dip in vaccination level and noting this did not result in an increase in incidence of measles. Moreover, some candidates answered in the context of all the data, rather than from 1990-2010 as instructed. The setting for Part (c) was fairly novel, but candidates seemed to work well with these question parts in general. In (i) most candidates recognised the immunity arising from vaccinations as active. Those candidates who did and then failed to give the consequential production of memory cells didn't obtain the second mark. In Part (ii) most candidates understood that the head regions in different flu strains varied or that a range existed. However, fewer candidates realised the significance of not being able to produce complementary antibodies. Part (c) (iii) required candidates to suggest a meaning for the term 'highly conserved', and a good number were able to do so based on the information provided. However, others failed to do so as they did not form an answer from the perspective of protein structure. For those candidates who related primary structure back to nucleotide sequence the mark scheme rewarded them. Finally, in (c)(iv) candidates needed to apply their knowledge to a more difficult concept, as would be expected in the penultimate question. Candidates were asked about the design of a universal vaccine and this required them to identify the stalk as a suitable antigenic agent as it is highly conserved as had been highlighted in the previous question part. Candidates who had instead described the use of a range of antigens were also credited. In this question the second marking point required candidates to make the point that this would lead to the production of complementary antibodies or range of antibodies.

Q8 Part (a) provided a good platform for candidates to discuss their understanding of synaptic transmission and inhibition. Candidates dealt very well with this part of the question and were able to describe the synapse effectively and furthermore could describe the action of an inhibitory synapse and the consequent effect on the transmission of impulses in the postsynaptic neurone. Some candidates were less clear about the influence of inhibition and tended to go down the route of blocking transmission with opiates for example. Poor use of language impacted significantly on some of the candidature. A small proportion of candidates did confuse what they had been asked to do and answered Part (a) from the perspective of impulse propagation within the neurone. However, the nature of the mark scheme did allow them to access some of the available marks. Candidates generally responded well to Part (b) and obtained many of the available marks. Many candidates also included temperature speeding up transmission. However, this is not an adaptation of the neurone rather a consequence of the nature of the organism in which the neurone is found. In general, this question was answered well showing a range of marks and a pleasing number of candidates achieving many of the available marks.

Assessment Unit A2 2 Biochemistry, Genetics and Evolutionary Trends

Overview

This paper differentiated effectively across the candidature with the top candidates providing excellent answers across the paper. All the A2 2 topics were covered to some extent in the paper. Generally, candidates made good attempts in the questions set in unfamiliar contexts. As indicated in the introduction to this report, many candidates struggled with the calculations, including statistics. It is very disappointing to report that less than 25% of the candidature were able to carry out a relatively straightforward calculation involving percentage increase and where the answer had to be given to two significant figures.

Q1 Transcription was the topic for the first question in this year's A2 2 paper. Most candidates obtained at least two of the four marks available, but only a minority were awarded all four marks. A majority of candidates appreciated that X was the template (coding) strand in Part (a), although the more general 'DNA' was not an uncommon answer that failed to gain credit. Part (b) also proved problematic for some candidates. While many candidates were able to work out that there were 18 bases in the section of mRNA shown, answers of 6 were not uncommon (presumingly, these candidates divided the 18 by 3 mixing up number of bases and codons or just counted the bases that were not aligned alongside the DNA). The answer 19 appeared infrequently, with these candidates appearing to also count the 'free' ribonucleotide that has not yet joined the mRNA strand. Part (c) required candidates to outline the role of RNA polymerase and this was the question part most frequently answered incorrectly. Many candidates lost marks by failing to refer to ribonucleotides or RNA nucleotides but a greater number lost the mark by stating that the RNA strand joins/bonds with the DNA template strand. Candidates were not penalised for involving RNA polymerase in the 'lining up' of ribonucleotides alongside complementary bases on the DNA template strand (before making reference to its role in joining ribonucleotides together as the mRNA strand extends), but reference to the mRNA forming a double strand with the DNA template strand was penalised. Part (d) was usually well done with a majority of candidates knowing that transcription takes place in the nucleus.

Q2 This ten-mark question on respiration was well done by a majority of candidates, yet it provided good differentiation across the candidature, with only a very small minority approaching full marks. Part (a) required candidates to state the number of ATP molecules produced in the various stages of respiration. This was well done by those candidates who obviously had a good knowledge of respiration, thereby scoring both marks; nonetheless, marks of 1 or 0 were scored by many candidates. Most candidates were able to pick up both marks in (b)(i), with each of cristae and inner mitochondrial membrane being credited. Parts (b)(i) and (ii) tested understanding of the electron transport chain and each part differentiated effectively. Part (ii) asked candidates to explain how the transfer of electrons leads to the production of ATP. Many candidates were able to answer that carriers/electrons are at progressively lower energy levels along the chain (gaining the first mark) and that energy becomes available as the electrons are transferred (the second mark). Fewer were able to extend their answer to state that at two/three points sufficient energy is given out to produce 2 or 3 ATP. In Part (iii) candidates had to explain why the inhibition of the enzyme cytochrome oxidase prevents the functioning of the electron transport chain. This was generally well done with a large majority of candidates obtaining at least one of the two marks available. The two-mark Part (c) was often well done too. Many

candidates appreciated that carbohydrates (but not proteins or lipids) were able to be used as a substrate in glycolysis (the first mark) and, consequently, could be respired anaerobically (thus gaining the second mark). A minority of candidates have the misconception that carbohydrate yields more ATP than protein or fat.

Q3 Question three was a nine-mark question testing variation, polymorphism, the analysis of data and statistics. Part (a) asked candidates to state two features of sexual variation that increase variation. The most common correct answers were independent assortment and crossing over and a majority of candidates obtained both marks. Many candidates found Part (b) more problematic; a minority were able to state that the evidence for the gene for blood group being polymorphic was that the frequency of each allele was too high (or above 1%) to be accounted for by recent mutation. A significant minority of candidates incorrectly answered that the fact that there were more than two alleles for this gene was the evidence of polymorphism. Part (c)(i) was well done by most candidates, but many lost the mark through loose terminology by referring to blood groups rather than blood group alleles, thereby confusing phenotype frequency with allele frequency. Part (c)(ii) was based on a novel variation of the chi-square test. Most candidates were able to calculate the X^2 value, although a significant number made rounding errors and others assumed that the X^2 value was the final cell in the table, rather than the sum of the final column values. Part (iii) also provided differentiation. Although most candidates were able to work out the degrees of freedom as 2, many fewer were able to state the probability value accurately. It is evident that a significant minority of candidates are not secure in their understanding of the symbols < and >. Candidates should be reminded that if they are unsure of these symbols, they should describe the probability value in words. Part (c)(iv) also provided differentiation with stronger candidates appreciating that the conclusion needed to be based on the purpose of carrying out the test; answers along the lines of 'there is a significant difference between the expected and observed values' were not awarded. Part (v) was generally well answered.

Q4 GM organisms was the focus for Question 4, a fourteen-mark question which provided significant differentiation among candidates. Question 4(a)(i) required candidates to give a function of restriction endonucleases in the development of GM bacteria. Candidates were credited for an answer based on cutting out/removing the desired gene or for making a cut/opening in the bacterial plasmids. While a majority picked up the mark, a significant minority lost the mark by giving more vague answers such as 'producing sticky ends' unqualified. Part (a)(ii) asked candidates to state one use of GM viruses, and in general, this was well answered. In (b)(i), candidates were asked to calculate a percentage increase and give the answer to two significant figures. Both aspects to this appeared to be beyond the mathematical skills of a significant majority of candidates. Part (b)(ii) was usually well answered. Part (c)(i) asked candidates to suggest and explain why inserting desirable genes into small sections of tissue rather than into mature plants was the better option. This question based on an unfamiliar scenario was often well answered with many candidates obtaining at least one of the two marks available. A significant number of candidates were able to answer that the cells in a small section of tissue would undergo division by mitosis and therefore the proportion of 'transgenic' cells would increase as the plant grew. Part (b)(ii) required candidates to explain how the insertion of a herbicide tolerance gene (added in addition to the desired gene), could help identify those tissue sections that had taken up the gene. Candidates who were able to analyse the data provided, and deduce an answer based on first principles, were able to work out that all that was required in their answers was the idea that the sections would be exposed to herbicide and those that survived had incorporated the herbicide gene (and, in addition, the desirable gene). Many answers made reference to the herbicide gene being spliced into another herbicide gene or the desirable gene being spliced into the

herbicide gene, a level of detail or complexity simply not required and usually not being credited. Many responses also failed to be credited with the second mark (the first mark, requiring the understanding that the tissue would be exposed to herbicide was usually awarded) due to references to 'bacteria' or 'colonies' clearly showing a drift away from the context of the question, no doubt based on candidates memories of certain part paper questions! As with (c)(ii), most candidates picked up one of the two marks available in (iii). In (iii), a majority of candidates were able to answer that vectors involved more of an element of trial and error than the direct manipulation of genomes and so obtained the first mark. Many fewer were able to pick up the second mark, linking the use of herbicide genes in vectors to potential issues with the herbicide genes getting into the wider environment. Part (d)(i), relating to the benefits of being able to grow GM crops in very dry soil was often well answered. Many candidates could link this to increased yield (often in developing or famine-risk countries, thereby answering the question in a global context) and the consequence of this in helping stave off starvation. Part (d)(i) was well answered with most candidates referring to the threat to biodiversity.

Q5 This twelve-mark question tested candidates' understanding of genetics. As with most questions on the paper there were question parts that were accessible to most candidates and other parts that tested even the best prepared. Part (a)(i) required candidates to complete a monohybrid Punnett square and show the ratio of offspring phenotypes produced. For a question assumed accessible to most GCSE students, it is very surprising to note that very few candidates picked up both available marks. While a majority were able to complete the Punnett square, relatively few could clearly link the genotypes produced to their phenotypes and produce an accurate phenotype ratio. Many candidates assumed that the heterozygote 'carrier' was a phenotype, leading to phenotype ratios of 1 : 2 : 1 being a common incorrect answer. Part (a)(ii) also proved problematic for many candidates. Many candidates answered that the fact that Batten disease is very rare is the reason why the Hardy-Weinberg equation could not be used to predict the percentage of Batten disease-causing alleles in a population, thus confusing the difference between the condition being rare and the population being large. This, of course, is incorrect – the answer being that individuals with Batten disease are less likely to reproduce than other members of the population as the condition is life-limiting. In Part (b)(i), correct answers focused on the idea that a sex-linked condition is more likely to appear in individuals of a particular sex; many answers that failed to gain credit stated that sex-linked genes are carried on the sex chromosomes, information that was in the question stem. Part (b)(ii) was generally well done with a majority of candidates producing the two possible genotypes of individuals who have haemophilia. Part (iii) asked candidates to explain why there were very few females with haemophilia. Often candidates lost the first mark through not being detailed enough in their answers and failing to highlight the circumstances required for a female to have haemophilia – i.e. having a recessive allele from each parent. A majority of candidates failed to pick up the second mark through failing to add that the probability of this happening was very low as the condition is relatively rare (as stated in the question stem). Part (c) asked candidates to determine the gametes produced in a dihybrid cross involving a gene which was sex-linked and a non-sex-linked gene; this proved to be too demanding for many candidates. A majority of candidates fared little better in Part (d)(i), in which candidates were asked to suggest and explain the genetic basis of different frequencies of individuals in a population having different amounts of melanin pigmentation. As the graph provided '*looked*' like a graph involving stabilising selection, this was the approach taken by most candidates, rather than focusing on the idea of polygenetic inheritance and the continuous variation that this produces. The question asked candidates to 'suggest and explain the genetic basis of the pattern shown' and it had been hoped that reference to '***genetic basis***' would steer

candidates in the direction of polygenetic inheritance rather than selection. Part (d) (ii) was generally well answered with a majority of candidates appreciating that the environment (sunlight) would lead to a change in the amount of pigmentation in an individual over time.

Q6 Epigenetics, gene expression and microarray technology were the topics for this twelve-mark question. Part (a)(i) – a definition of epigenetics – was well answered by a majority of the candidature. Part (ii) was a four-mark question in which the marks were split between a description of the trends shown in the graph and an explanation of the process and consequence of methylation. Many candidates scored two or three marks with a minority obtaining all four available marks. Many candidates were able to describe the relationship shown in the graph and a smaller number were able to identify that at a critical level of methylation, there was no gene activity at all, i.e. the gene was 'switched off'. A surprisingly small number of candidates stated that the methyl group attaches to the C base. Many candidates were able to extend their answer to explain that the consequence of methylation is that transcription is prevented. Part (a)(iii) was well answered with a majority of candidates being able to name histone modification as another type of epigenetic modification. Part (iv) was less well answered – in this question candidates were asked to explain the advantage of controlling gene expression to an organism. Candidates who were credited tended to focus on the importance of the correct proteins (and in the correct quantity) being produced in appropriate cells rather than those who produced vague answers such as liver cells are only produced in the liver or equivalent. Part (b) tested candidates understanding of the use of microarrays in investigating gene expression. There was a mixed response to question Part (b)(i). A minority of candidates were able to answer that if mRNA was present in a cell then the gene involved must be active. Part (ii) was often well done and a good number of candidates obtained at least two of the three marks available; there was clear evidence that a majority of candidates had at least some understanding of the use of microarrays. Conversely, a small minority of candidates had little understanding of the topic and instead provided accounts of PCR or gel electrophoresis.

Q7 Speciation was the topic for the penultimate question in Section A. For Part (a) candidates had to define the term 'species'. In general, this was well answered but a significant minority of candidates failed to pick up the mark as a consequence of producing answers lacking sufficient detail. Part (b)(i) was a four-mark question testing both candidates' comprehension skills and understanding of allopatric speciation. Most candidates obtained between two and four marks although candidates who failed to refer to the information provided scored badly. The two major errors in understanding involved some candidates describing geographic or reproductive isolation being between '*species*' rather than between '*populations*' of the same species and the geographic barriers being *between* islands rather than *within* the one island (as stated in the question). The three-mark Part (ii) proved to be more demanding and was only well done by those candidates with good analytical skills and a sound understanding of the process of allopatric speciation. While many candidates could answer that in older islands there would have been more time for speciation to take place compared to younger islands, fewer extended their answer to explain that the increased time allowed for increased opportunity for geographical or reproductive isolation barriers to form and that older islands would have a greater range of habitat types thus providing more opportunities for adaptation. Part (c) required candidates to explain why insects are the most successful animal group in terms of number of species. Many candidates struggled with terminology in this question and many responses were too vague or ambiguous, e.g. the idea that individual insects adapted to suit the environment they lived in.

Q8 This eleven-mark question tested candidates' understanding of plant and animal classification and their ability to analyse some complex data. For Part (a)(i), candidates had to state and explain one way in which ferns are better adapted for terrestrial life than mosses (apart from the presence of vascular tissue). This question was more discriminating than expected with many candidates failing to provide the level of detail required. For example, to gain both marks for answering that ferns have (true) roots candidates had to extent their answer to state that these could *penetrate the soil/substratum* in order to reach water or nutrients, thus highlighting the key difference between roots and rhizoids. In Part (ii) candidates had to state how the xylem in vascular tissue provides support in plants. A minority of candidates picked up both marks for this and a sizeable number made reference to turgor in xylem vessels being a means of support; an answer that is clearly incorrect. In Part (b)(i), candidates had to analyse a table comparing and contrasting fern and tree data and then give three conclusions that could be drawn from the data. In general, this was well done. Many candidates picked up the first two marking points, i.e. that trees reach a greater height than ferns and that height : width ratios are lower in trees. A smaller number picked up the third mark – the conclusion that height : width ratios are less variable in trees or that stem width is more variable in trees. In Part (ii) candidates had to use this information to suggest and explain one benefit of trees being able to increase their width. Again, this was often well done with a majority of candidates appreciating that the increase in width gave greater support and allowed trees to reach a greater height. A smaller number were able to extend this to answer that this resulted in the trees accessing more light and as a consequence they photosynthesised at a greater rate. Part (c) was a two-mark question testing animal classification. Candidates had to give one similarity and one difference between methods of support in Cnidaria and Annelida. While most candidates could answer that support in both groups involves an aqueous medium or a hydrostatic skeleton, many fewer were able to obtain the second mark which involved the distinction between support being based on the external medium (in Cnidaria) and internal fluids within the coelom (as in Annelids).

Q9 **(Section B)** The essay section on this paper included a straightforward twelve-mark question on photosynthesis and a more applied six-mark question on leaf adaptations. Part (a) required candidates to give a detailed overview of photosynthesis. Candidates who scored highly in this question demonstrated an excellent knowledge of both the light dependent and the light independent reactions. Generally, answers were extremely well sequenced. Only the better prepared candidates were secure in their understanding of the role of electrons *and* hydrogen ions in reducing NADP to form NADPH and the roles of NADPH and ATP in converting glycerate phosphate to triose phosphate. Part (b) usually proved more demanding with only a minority of candidates scoring four or more marks. Many candidates failed to state which environmental factor would be limiting in the shade and/or the canopy top. Many candidates were able to deduce why leaves are broad in low light intensities but many fewer could state the leaves in this environment are thin as the low intensity of light will not penetrate far into the leaf. Only a minority of candidates could state that leaves in the shade are darker as they have more chlorophyll per unit area. Many candidates inaccurately suggested that the greater number of stomata in the canopy is to allow for higher transpiration rates rather than to allow more carbon dioxide to diffuse into the leaf to prevent carbon dioxide becoming limiting.

Assessment Unit A2 31 Practical Skills in Biology

Overview

This was the second time this sixty-mark paper was taken by candidates. There were a range of question types including describing 'recipe' practical activities, identifying structures in electron micrographs, calculations, statistics and for the first time a question testing the candidates' ability to write a bibliography. Overall, candidates did very well in this paper, with a significant majority of candidates obtaining marks between 30 – 50, with the top candidates scoring 55 or more.

Q1 This six-mark question tested candidates' ability to interpret a photographic section through the back of the eye. Very few candidates picked up the full six marks, and a significant number scored half or fewer marks. In Part (a), most candidates could identify the sclera as layer Y, although often the spelling of sclera left a lot to be desired. In (b), a majority of the candidature were able to state that the choroid had either a vascular role or it prevented (or reduced) internal reflection in the eye, thereby obtaining the first mark in this two-mark question. Many fewer could extend their answer to gain the second mark, with a minority of candidates appreciating that the prevention of internal reflection ensured that a clear/precise image is achieved. Bipolar neurones or nuclei were common answers in Part (c), but a very small minority were able to put these together to gain the mark. Part (d) also proved testing with, again, only a minority of students identifying where the light-sensitive pigments would be found. Part (e) also proved challenging for many candidates with transmission electron microscope (TEM) being the most frequent (incorrect) response. Only those candidates that took account of the magnification involved (x100) were able to deduce that the answer was light microscope. This question part should serve as a reminder to candidates, that when asked a question of this nature, they must use all the information available in coming to an answer.

Q2 The second question on the paper was a question testing candidates' understanding of gel electrophoresis. This was well done by most candidates, with a majority obtaining at least four of the five marks available. In Part (a), most candidates could identify the gel and the anode. A small minority identified Y as an electrode, an answer that was not credited (although positive electrode was). A significant majority of candidates could answer that the electrical current in the set-up has a role in moving DNA down the tank, consequently causing the DNA fragments to separate (Part (b)). In (c)(i), a majority of candidates appreciated that fragments are separated on the basis of size/charge (with smaller fragments travelling further across the gel). A small number of candidates failed to gain the mark as they referred to *bands* being separated on the basis of size or charge. In general, candidates found Part (c)(ii) more difficult. Candidates most secure in their knowledge were able to answer that the more dense bands had more fragments (of a particular size).

Q3 The third question on the paper tested candidates understanding of using a respirometer to calculate RQ values. Part (a) required candidates to describe how the RQ of maggots could be calculated using apparatus shown in the paper. This was generally well done with many candidates achieving at least four of the five marks in this part. A significant majority of candidates could state that with KOH in the respirometer, carbon dioxide would be absorbed and that the movement of the coloured liquid (towards the maggots) would represent the amount of oxygen used in respiration. Most candidates appreciated that the distance the coloured liquid moved would need to be calculated, but fewer stated that time was also a factor that needed measurement or control. Most candidates were able to add that the KOH would need to be removed to allow the carbon dioxide to be measured. While most candidates could state that the RQ value is the carbon dioxide produced divided by

the oxygen taken in, only a minority were clear in their understanding of how the carbon dioxide value could be calculated. Many understood that (when the KOH was removed or replaced with water) the dye remaining in position indicated that carbon dioxide output equalled oxygen input, but many fewer had a good understanding of how an RQ value of less than or more than 1 could be calculated. Part (b) asked candidates to suggest an advantage of using several maggots rather than one. Many candidates appreciated that with only one maggot the coloured liquid would move very little and that several maggots would contribute to greater differentiation and that the influence of the degree of precision possible in reading of the scale would be reduced. Alternative answers such as provides greater reliability, the variation in living organisms and works faster (important in a school setting) were credited with the mark but answers such as an average can be calculated or doesn't rely on one maggot were not. There was evidence that some candidates were not secure in their understanding of terms such as validity, accuracy and reliability.

Q4 This four-mark question tested candidates' knowledge and understanding of E-strips as a mechanism for testing the effect of antibiotics on bacterial growth. Part (a) asked candidates to describe and explain the results shown by a diagram of a Petri dish containing an E-strip placed on agar containing a bacterial 'lawn'. The ability to communicate effectively was important in this question. Most candidates were able to answer that the minimum antibiotic concentration that was effective in preventing bacterial growth was 12 (or that concentrations of 1 – 11 had no effect). Fewer were able to state that with increasing concentration above 12 the effect was greater as shown by an increasing size of bacteria-free area. Only a very small minority were able to extend this to explain that the increasing clear area was due to the antibiotic being able to diffuse further across the agar (due to being in higher concentration in the E-strip at higher concentrations). The one-mark Part (b) asked candidates to suggest one advantage in using E-strips over the more traditional use of paper discs. Candidates were rewarded for answers such as clear areas can be compared more easily or that it is easier to work out the minimum effective concentration but not for more vague answers such as it is more accurate, more sophisticated or than fewer agar plates were necessary.

Q5 Chromatography of plant pigments was the topic tested in this nine-mark question. Most candidates scored well overall, with Part (c)(ii) proving to be the most discriminating. A significant majority of candidates were able to identify that the pigments separate during the running of the process (Part (a)). Part (b) required candidates to describe how this stage was carried out, and also to describe how Rf values are calculated. A significant majority of candidates were able to describe how the chromatogram was lowered into the tank (or other appropriate apparatus) making sure that the level of solvent did not reach the origin/baseline and that the chromatogram should be removed when the solvent approached the top of the chromatogram. Additionally, most could add that the solvent front needed drawn on to the paper and also that the Rf value is the distance moved by the pigment divided by the distance moved by the solvent front. Fewer candidates were able to describe how the chromatogram was suspended or supported within the tank or that a consistent approach needed to be taken when calculating the distance moved by the pigment (i.e. that the pigment should be measured from the leading edge or the centre). Part (c)(i) required candidates to identify a controlled variable appropriate to this investigation. Candidates were rewarded if their variable related to either the chromatography process (e.g. same solvent used or same method used to macerate leaves) or to the sampling of the leaves in the two seasons (e.g. leaves taken from the same tree or the same position on the tree). Generally, this question provided little difficulty for candidates. However, Part (c)(ii) did prove more demanding. Those candidates who obtained both marks often focused on the idea that in autumn pigments would have a reduced concentration or that there would be fewer pigments

present (many suggested that with leaves being orange/red in autumn there would be less chlorophyll or (proportionally) more carotene/xanthophyll due to the chlorophyll being broken down or withdrawn into the tree). Less able candidates tended to focus on answers such as the Rf values (of the same pigments) would be different or that there would be no pigments at all as the leaf was dead.

Q6 With fourteen marks this question was the longest on the paper. Haemocytometer technique, serial dilutions, calculations and statistics were all tested. While very few candidates obtained in excess of ten marks, a relatively small number obtained fewer than five. Part (a)(i), requiring candidates to identify the position of the counting grid on a haemocytometer, proved to be an effective discriminator. While a minority of candidates could do this accurately, many placed their X in the space between the grid and the coverslip or even on the coverslip itself. While a number of candidates were clearly unsure where the counting grid is positioned, it would seem that a number of candidates lost this mark through a lack of care in identifying the correct position. In (a)(ii), a majority of candidates could identify a strategy to avoid the double counting of cells lying across the grid lines on the haemocytometer. In the two-mark (b)(i), candidates were asked to explain why it may be necessary to dilute phytoplankton samples before adding them to the haemocytometer. While a majority of candidates were able to obtain the first mark through explaining that there would be too many cells to count accurately, fewer obtained the second mark by appreciating that this was would be the situation even using the smallest (type C) squares on the haemocytometer. Part (ii) required candidates to explain why during dilution a saline solution should be used rather than water. A majority of candidates made reference to phytoplankton living in salt water, seas or oceans, but only a minority extended this to explain that in (fresh/pure) water the phytoplankton would take in water by osmosis (and subsequently lyse) – it was this biological explanation that gained the mark. Many candidates (though certainly not all) were able to explain how to dilute a sample by a factor of 100 in (b)(iii). In Part (c)(i) most candidates were able to calculate the number of phytoplankton using provided haemocytometer data, thereby gaining both marks. The final statistics section of this question was usually well done. In Part (c)(ii), a majority of candidates could state an appropriate null hypothesis; where the mark was lost it was often for failure to make reference to the biological material (the phytoplankton), or more often, a vagueness about the independent variable, e.g. (no significant difference) at *different* temperatures. In Part (d) most candidates were able to calculate the *t* value accurately, picking up both marks. Fewer were able to identify accurately the probability of the calculated *t* value (Part (e)) and there was sufficient evidence to suggest that many candidates are not secure in their understanding of probability and how it should be stated. Candidates should be aware that they will be credited with stating probability in words as an alternative to using symbols. In Part (f), candidates had to state their decision about the null hypothesis and then give an appropriate conclusion for this investigation. While many picked up the first mark through rejecting the null hypothesis, a very small minority were able to give an appropriate conclusion for the investigation and consequently obtain the second mark. Many candidates who did extend their answer beyond rejecting the null hypothesis, made reference to the fact that there were more phytoplankton at 30^{o}C than 25^{o}C; however, this was not sufficient to gain the second mark. In the question stem it made it clear that the investigation was testing 'the effect of temperature on the *rate of growth* of phytoplankton populations.' Answers such as 'at 30^{o} C there was a faster increase in phytoplankton numbers or a faster rate of population growth' were required for the second more discriminatory mark.

Q7 This question testing understanding of redox reactions proved to be an effective discriminator, with a minority of candidates struggling with the earlier question parts in particular. In (a)(i) only a small minority of candidates could identify the dependent variable in this investigation. While many candidates appreciated that the colour change of methylene blue was significant, many fewer added that the time over which this colour change took place was important. Part (ii) also proved demanding for many candidates with answers such as the use of only three temperatures and/or the use of water baths being common, although they were not credited. The answers that were credited were the facts that the peas were soaked, and that they were ground-up and that the methylene blue was dilute. Some capable candidates went on to accurately explain why these features would ensure reactions would take place quicker, but this was not necessary. The four-mark Part (iii) also proved challenging for many candidates; most obtained some marks, but only a very small minority picked up all four. Candidates were awarded with stating that the dye would be reduced/change colour or that there was more dehydrogenation at 20/40^{o}C (compared to 40/60^{o}C); a large majority of candidates picked up this mark. Fewer were able to develop this to explain that at optimum temperatures, enzymes would be more active/have more kinetic energy. A majority could also state that at 40/60^{o}C the blue colour of the dye would disappear more slowly or not at all. The fourth marking point was very poorly answered with a significant number of candidates failing to provide a more detailed answer than at high(er) temperatures enzymes would be denatured. In (b)(i), most candidates could link homogenisation to the use of a mortar and pestle or a blender and so gained the mark. Part (b)(ii) was also quite well done across the candidature; many candidates could deduce that homogenised leaf material would contain mitochondria and that reactions in these could also reduce the methylene blue.

Q8 The final question in the paper included a short comprehension and the requirement to produce a bibliography from information provided. In Part (a), a significant number of candidates could deduce where high concentrations of antimicrobial substance could be found in a plant and, in addition, a reason for it being there. The most common correct answers were the root and the reason being the large number of bacteria that live in the soil (as indicated in the text). Other suitable answers were rewarded including, on the leaf surface around stomata, as this is where microbes could gain entry to the plant. Part (b) asked candidates to write a bibliography for the three books included in the passage. Those candidates who were familiar with this procedure often picked up all three available marks but a small minority appeared to have little idea of how to go about producing a bibliography and they failed to gain any marks. To gain full marks, candidates had to include author's name, date of publication, title of the book and publisher. The important thing was that the format was consistent throughout and there was no required order for the various components. Candidates were not penalised for including or not including page numbers – as long as if included the format was consistent. The most common error among those who could write a bibliography in a consistent way was not including the full title for Dale's book.

Principal Moderator's Report

Assessment Unit A2 32 Practical Skills in A2 Biology

Overview

The overall standard of work presented was very good with some centres submitting work of excellent standard. The detail of the work submitted varied considerably, from those that offered only the basic information expected to some through assessments of the findings. This demonstrates how some centres use the practicals; some for practicing application-type questions as well as re-enforcing biological knowledge, whilst others use them to just cover the minimum points required.

As with AS level practicals the standard of some of the tabular and graphical presentations were below the standard required for A2 level.

Candidates used photographic evidence to good effect to show the outcomes of their practicals and in most cases the evidence provided was suitable for assessment.

In some centres there was an issue with a consistency in the volume of work presented and the marking of the work. It is important that internal standardization is rigorous as failure to do so could have a major impact on the moderation of the work.

Microbial techniques

There are two options within this category.

Preparation of a streak plate: there were varying degrees of success for this practical with some centres achieving very good isolate colonies and others being less successful.

Photographic evidence is a good way of illustrating the outcome of the plate, however if this is not possible candidates should draw the outcome from their own plate and not just use a diagram from a book. Also, a brief description of the outcome should be provided e.g. 'why is the technique used, was there isolation of a colony or was there any contamination?'

Antibiotic resistance: As this is a GCSE practical, in order to make this A2 standard, candidates should prepare their own bacterial lawns on which they can test the antibiotics. Either different ones can be used, or different concentrations of a particular antibiotic can be investigated. Evidence for this could be a picture of the plate or drawing and a brief description of the outcomes. If the clear zones can be measured, then the results of these should be tabulated.

Antimicrobial action

This was a very common practical submitted by many centres and as with the other microbial practicals there were varying degrees of success. Although plant extracts can be used from pre-prepared samples, it is essential that candidates extract at least one plant sample themselves. Mint leaves and garlic cloves have proved successful in this respect.

Evidence can take the form of a photo or drawing of the plate and a conclusion, based on their outcomes must be presented. Again, if it is possible to measure the clear zones then these should be tabulated.

Population growth

This was a popular practical and was well presented by the centres. Calculations of cell populations using the haemocytometer tended to be accurately carried out by the candidates. In some cases these were incorrect but had not been checked by the teacher. The calculation is an essential part of the evidence and so should be checked by the teacher. In this practical it is important that an independent factor which might influence population growth (of yeast) is investigated and that a simple count of yeast population from a flask is insufficient. Most centres investigated the effect of temperature or food concentration and another option would be oxygen availability by using different sized beakers/flasks.

It is important the evidence submitted shows a table of raw data, calculation of the populations, and a brief conclusion explaining the outcome of the effect of the independent variable on the population growth. This could reference how temperature would affect reproduction or population growth, or that increased food availability will affect the carrying capacity thus the potential size of the population.

Respirometer

It is possible in this practical to use a simple version of the respirometer which is more likely to give reasonable results in order to calculate RQ values. Many centres used germinating peas/seeds but a good alternative is the use of maggots which are metabolically more active, thus giving readings over a shorter period. If using one respirometer for the whole class, then it would be more appropriate to re-set the apparatus to try and obtain more than one set of readings thus allowing a variety of readings within the class.

Evidence should include a table showing the readings, calculations for the oxygen uptake and carbon dioxide production and calculation of RQ values. Then in the conclusion reference should be made to the nature of the substrate being respired and under what conditions.

Role of hydrogen acceptors

This was less common as a practical although there was good variation in the methods chosen by the centres which did complete it. Photographic evidence is a good way of demonstrating the practical was undertaken along with a table of results. Candidates again should produce their own table of results and not just copy the table in the guidance booklet. A brief explanation should be provided as to the outcome of the results.

Chromatography

This was a very commonly submitted practical and was generally well presented by the candidates. Whilst a simple practical to carry out many centres struggled to achieve full separation of the pigments. Candidates should not be penalised if they don't get separation and they can be given a copy of another chromatogram to allow them to calculate Rf values.

Evidence for this experiment should be a copy/photograph of the original chromatogram, a table showing their measurements, calculation of Rf values and an attempt to identify the pigments. This might not be possible based on the Rf values but could be possible due to colour and sequence of separation.

Working with DNA

There are two options within this category.

Extraction of DNA is a cheap and simple practical with many different methods available. Many centres encouraged their pupils to use photographic evidence of the outcome and this is a good way to demonstrate completion of the task. A brief method should be given but more importantly candidates should give a brief explanation as to the purpose of each of the steps.

The alternative practical is to carry out gel electrophoresis. This is more expensive and more difficult to carry out but is probably more rewarding in terms of developing practical skills which will be useful at university. There are many kits available in order to carry this out and some places run courses where candidates get an opportunity to carry out a DNA digest and separation. Evidence could include a photo of their gel and a description of the separation of the bands.

Dissection

This can be a small animal or insect, an organ or a leaf scrape. A heart can be dissected if it was not used for AS level.

There were some excellent dissections of rats with good photographic evidence. However, it is important the candidates draw the dissected rat with the internal organs displayed and labelled. Some centres cut the rat open but left the digestive system intact. This should be removed, or the mesentery broken to allow the intestines to be displayed openly. Some of the drawings were not representative of the dissection.

The leaf scrape is a simple and cheaper alternative to dissection of a mammal and as with the other dissection a drawing should be made of the scrape as seen under the microscope. Photographic evidence is also helpful.

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