OCR
RECOGNISING ACHIEVEMENT

GCE

Biology

Advanced GCE **A2 7881**

Advanced Subsidiary GCE **AS 3881**

Report on the Units

June 2007

3881/7881/MS/R/07

Oxford Cambridge and RSA Examinations

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

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

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General comments

The performance of candidates on the AS papers was very much in line with previous series although weaker candidates found parts of *Biology Foundation* (2801) much harder than usual. This accounts for the slightly lower boundary mark for grade E this time. The Examiners of the A2 papers reported some disappointing scripts from middle to weak candidates. In some cases they were difficult to read and often answers were phrased so poorly that marks could not be awarded. This point is made in the report for the synoptic paper - *Unifying Concepts in Biology* (2806/01). Careful use of words is also highlighted in the report on *Q.1 (b)* in *Biology Foundation*. As ever, the Examiners found examples of excellent work and on all papers there were quite a few high scoring scripts that displayed very sophisticated understanding of the topics in the OCR specification.

In this series, the popularity of the two Practical Examinations continued as entry numbers were slightly higher than in June 2006. There continues to be a slight shift from coursework to the practical examination. However, there are many centres making use of the coursework components and some even mixing coursework and the practical examination so that candidates take one component at AS and the other at A2. In this series, the coursework submitted for moderation was generally of a very high standard – particularly at A2. The marking and annotation was also reported as being very good. Over the lifetime of this specification the moderators have seen a decreasing number of unsuitable tasks set. However, some remain and the report on the coursework highlights three investigations that centres should be careful with using at A2 and also raises the issue of A2 candidates using the same coursework on biochemistry for Chemistry and Biology.

Practical Examinations

The Examiners for the AS Practical Examination reported a number of issues with the preparation of candidates for the two aspects of the examination and these points are highlighted in the report on this component. Some centres appear to give their candidates no help whatsoever with their Planning Exercises so they miss out on the easiest marking points, whereas others appear to be too prescriptive with the apparatus and materials they supply for preliminary work – if this is done at all. Care should be taken not to give away information about the Practical Test.

The A2 Practical Examination gave problems this series. Several centres reported problems locating *Tradescantia spp* that was required for *Q.2* of the Practical Test and some of those that did were not able to generate the expected results. Candidates at other centres where no problems had been encountered in the period leading up to the examination experienced a variety of problems during the Practical Test. Candidates at these centres generated incorrect results and/or took a long time in collecting their results. It should also be pointed out that OCR was alerted to the possibility of a serious breach of security with this examination. The Examiners were asked to collect information from the Report Forms and enclosures with the scripts and these were added to information already collected directly from centres by OCR. Unfortunately, the analysis of all this information showed that there was no clear pattern that would allow OCR to ensure fairness to all candidates if grades were based on the marks from the practical examination. The decision was made to give candidates an assessed mark for the practical paper, 2806/03, based on their performance on the written paper, 2806/01, which they took in the same series. The grade thresholds applied to unit 2806 overall took into account the fact that candidates normally perform better on the practical examination component than on the written paper component. The Examiners were reassured that the outcomes in unit 2806 were in line with previous years.

The Examiners apologise for the problems that were encountered by centres with this Practical Examination. As it happens, the Planning Exercise and *Q.1* both worked well. *Q.2* had been trialled and found to be a suitable investigation, but problems with acquiring what was thought to be a very common plant and asking candidates to make stomatal counts were not envisaged. The Examiners regret all the anxiety and distress that this caused. The report on the examination that appears here is based on the expected outcomes of the practical procedures.

Not enough lines

The new style examination papers state that candidates should only write their answers in the spaces provided and should not write on the blank pages. The Examiners were concerned that many candidates do not have enough space to write their answers. Some candidates write two lines of text to one answer line. This can make the writing so small that it is difficult to read. Some candidates continue their answers at the side of the script and write vertically up and down the page. This can sometimes be difficult to follow. The Examiners are sympathetic to the candidates' need for space, but often they write far more than is actually required. Many have a tendency to rewrite the question before answering it. Several Examiners commented that 'candidates should spend more time analysing questions, thinking and planning and write less!'

Data analysis

All the examination papers are set against the Assessment Objectives given on page 15 of the specification and are checked against the QCA Performance Descriptions that are available at http://www.qca.org.uk

The Examiners continue to find that candidates perform less well on questions targeted against AO2 (Application of Knowledge) than on AO1 (Knowledge with Understanding). Many candidates do not seem to have the necessary strategies to analyse and interpret information provided in tabular and graphical forms or as flow charts or other forms of presentation. In this series, this was particularly noticeable in the A2 papers. Examples were *Q.2* from *Central Concepts* (2804) and *Q.6* from Growth, Development and Reproduction (2805/02).

Synoptic assessment at A2

Synoptic assessment in the Options (2805) is a challenge for candidates. There are several suggestions in these reports for helping candidates get to grips with the biological principles from AS and *Central Concepts* that underpin or link with topics in the options. In this series there was a question on malaria vaccines in *Applications of Genetics* (2805/02) and in *Human Health and Disease* (2802). A2 candidates taking 2805/02 in future series could benefit from using *Q.6* from 2802 in conjunction with *Q.5* from 2805/02 to see that material covered in earlier modules can be used as a context for a question in this option. The synoptic material may also be tested *in the context of topics in the option*.

Precise use of terms

This has been mentioned before! Teachers could well make a hit list of words, phrases and terms that should be used with great care by candidates. Or avoided at all costs. The Examiners do not award marks for statements, such as 'mitochondria produce/create/make energy'. Marks are lost in A2 papers when candidates use the term *gene* when they mean *allele* and vice versa. Often fairly easy marks are lost by use of words such as 'affects', 'effects' and 'influences' when candidates mean 'stimulates'. Noted in the past is the lack of an appropriate vocabulary to describe trends in graphs and tables. The Examiners have also been strict on not awarding marks when candidates use the word 'amount' when they mean

volume, or when it is not clear whether they are referring to volume or concentration. Examiners of a certain age are reluctant converts to using the term 'nutrient'. There are plenty of cases where this is perfectly acceptable, particularly in the section on diet in *Human Health and Disease*, but in other contexts candidates should know and use a better term. This is especially the case when discussing nitrogenous compounds in the context of soil fertility (*Environmental Biology* – 2805/03) and the nitrogen cycle (*Biology Foundation* – 2801 – and elsewhere).

Mathematics

Candidates are often asked to make calculations – there is usually one calculation question per question paper as required by the Performance Descriptions for AO2. The Examiners usually award full marks for the answer to the calculation even if working is not shown. However, many candidates do not arrive at the right answer, but can gain one mark for showing their working. Many questions end with the instruction to express their answer to the nearest whole number or to a certain number of decimal places. Some candidates lose marks because they do not follow this instruction. Simple mathematical skills should be practised at every opportunity through the AS and A2 courses.

Sequencing

In many parts of the specification, candidates are expected to know a series of events and be able to recall these *in the correct sequence*. The cardiac cycle, the immune response, the nerve impulse, transmission across a synapse and muscle contraction are just a few examples. Amongst the *Teaching tips* are several that suggest writing out the stages in the sequence and printing these on cards or arranging them on a whiteboard so that candidates can assemble them in the correct order. They can also use them to construct answers to a variety of questions that ask for different parts of the sequence. It was clear in this series that some AS candidates were unclear about the relationships between protein synthesis, transcription, amino acid activation and translation (*Q.3 (b)* on *Biology Foundation*). Such a sequencing activity would probably help.

Fair test

This is **not** a phrase that A level candidates should use. It tends to be a half remembered concept from Key Stage 3 that is used as a catch all for *accuracy*, *precision*, *validity* and *reliability*. Candidates should be conversant with the difference between *control experiments* and *controlled variables*. Perhaps this is an area that will improve when the students currently doing the new GCSEs with their emphasis on *How Science Works* move on to AS. Centres may find the documents published by the Royal Society of Chemistry useful in training their candidates. They are at:

http://www.chemsoc.org/pdf/LearnNet/RSCmeasurements_student.doc

http://www.chemsoc.org/pdf/LearnNet/RSCmeasurements_teacher.doc

Text books

Some Examiners comment that it appears centres do not have access to good, detailed information about some of the topics in the specification and they admit that the endorsed texts are occasionally deficient in some areas. Teachers should know that many excellent British, Canadian and American college and undergraduate text books have companion websites or have been made available in digital form. Four examples are:

Plant Physiology:
http://4e.plantphys.net

Molecular Biology of the Cell:
http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=mboc4

Microbiology:
http://cwx.prenhall.com/brock

Ecology:
http://www.blackwellpublishing.com/Townsend/Default.htm

The 'wiki' solution

Coursework moderators and Examiners for the Practical Examinations noticed that many candidates give Wikipedia as a source of information. Some teachers and university lecturers have banned students from using this source for serious study. Candidates should be advised that it is not peer reviewed, may be edited by anyone and entries may often show bias. For example, try inserting 'British Isles' into the entry on Ireland and see how long it remains. Although many of the entries on biological topics look authoritative – and often may well be so – candidates should double check against other sources of information and not come to rely on Wikipedia for everything. They may find at university they are told not to! A good reference for this is Wikipedia itself!

http://en.wikipedia.org/wiki/Criticism_of_Wikipedia

However, one of the reports includes a reference to a useful resource on Wikipedia. The wiki philosophy has spread to Biology4all, the website that provides support for teachers of Biology. See:

http://biotutor.wikispaces.com

Biochemistry

The Examiners have noticed over the years that candidate performance on biochemistry at A2 has improved considerably. This is so with photosynthesis and respiration in *Central Concepts* and protein, carbohydrate and lipid metabolism in *Mammalian Physiology and Behaviour* – 2805/05. Candidates are good at describing metabolic pathways and often show good understanding. *Q.3 (d)* on *Central Concepts* was a question about the role of co-enzymes. The good candidates rose to the challenge and thought across both respiration and photosynthesis; weaker candidates struggled with this question which required them to be more selective than usual. Co-enzymes are highlighted in the new OCR specification which is excellent as many candidates did not appreciate the fundamental roles of compounds, such as NAD, FAD and NADP. Candidates who did the A2 Planning Exercise found references to ADP-glucose in the synthesis of starch.

Field work

The place of field work in biology is fundamental. Although there is very little in *Central Concepts* that actually requires candidates to undertake work in the field, there certainly is in *Environmental Biology* (2805/03) and it was obvious that many candidates taking this option did not have a secure grasp of field work and allied laboratory techniques. Much can be done within a few miles of every school and college in the country if a day's excursion or a residential field course is out of the question. Although there is only one learning outcome in *Central Concepts* that deals with field work techniques (5.4.3 *(h)*), there are many other areas of the specification that can be covered in the field and then with follow-up work in the

laboratory afterwards. For example, much of Section 5.4.5 *Classification, Selection and Evolution* can be covered. The value of field work goes far beyond ticking off learning outcomes.

Q.6 in *Environmental Biology* (2805/03) was set on biodiversity in farmland. This is an indicator, perhaps, of the type of question that may appear on AS papers in the new specification that has a large section on biodiversity.

New contexts

The Examiners continue to set questions with interesting stimulus material. For example, this year was the year of the sea slugs (*Q.1 Unifying Concepts in Biology* with its insert of some stunning photographs). Where appropriate these reports include some links to further information if candidates and teachers wish to find out more about the material used in these examination papers.

2801: Biology Foundation

General Comments

Some very good scripts were seen from candidates who showed a comprehensive understanding of the subject material and expressed their knowledge and ideas clearly and concisely. It was disappointing, however, that significant numbers of candidates experienced difficulty in answering specific and detailed questions about certain areas of the specification. This applied particularly, but not exclusively, to weaker candidates. The areas in question include protein synthesis, genetic engineering and the mitotic cell cycle. The responses involving these topics showed a great deal of confusion and sketchy understanding on the part of some candidates.

Candidates should be encouraged to ensure that they present information in as clear and unambiguous way as possible. This is particularly important when considering ticks and crosses, which were required in *Q.2 (a)*, as has been highlighted in previous reports. When one is changed to the other, particularly when a tick is changed to a cross, the resulting symbol is ambiguous. Under those circumstances it is assumed that the candidate is undecided and the Examiner will reject such 'hybrid' ticks. It is far easier and clearer to simply cross out or erase the incorrect answer and write the intended answer clearly alongside.

Another area in which improvement is needed is that of reading the question thoroughly and being absolutely sure of what is required to answer that question. This was particularly evident in *Q.3 (c)*, where candidates appeared to skim through the information, identify the word 'inhibit' and write account of enzyme inhibition. While some of this information could be relevant if it had been placed into the correct context, many responses simply did not answer the question. Another question that highlights this is *Q.5 (b)*. Candidates wrote a full account of mitosis, not appreciating that a particular part of the process was required and that they should focus on the chromosomes.

Comments on Individual Questions

Q.1 (a) Part (i) was intended as a reasonably straightforward introduction to the paper. Even some of the more able candidates, however, were unable to score full marks here. The most common errors were to identify the spongy mesophyll as the lower epidermis and the stoma or substomatal chamber as the cuticle. It was pleasing to see, in (ii), that the calculation was generally well done. Candidates who measured the distance **XY** in mm were at an advantage as they did not need to convert units, which always proves a challenge. Candidates should be reminded that magnification has no unit and answers that included units were penalised. Candidates should also be encouraged to show their working, as a simple error dos not necessarily mean that the mark for working is lost

(b) The definition of a tissue in (b) was generally well known. This question, however, was in the context of xylem, which is a tissue composed of a number of different types of cell. While many candidates scored full marks, statements that indicated that xylem is made of one type of cell were not credited as this does not apply to xylem. Candidates also need to be careful about wording: 'it is made up of different cells' is not quite the same as 'it is made up of different types of cell'. Only the latter scored a mark here. The idea of cells 'working together' to carry out the same function needs to be stressed to distinguish this from cells which are 'all performing' the same function.

Q.2 (a) Candidates should be reminded that certain practical topics may be tested in theory papers if they form part of the specification for a particular unit. One such topic that occurs in this paper is testing for biological compounds, which has been examined many times. Many candidates gave surprisingly poor responses here. In particular, it was disappointing to see so many candidates in (a) who were unable to complete the row for starch correctly. Some candidates suggested heating or boiling with dilute acid for all the tests, as they presumably thought that it would be sure to help. There was some confusion between biuret solution and Benedict's solution, but well prepared candidates experienced little difficulty.

(b) Many candidates answered both (i) and (ii) correctly. The most common error was to name the reaction as a condensation reaction.

(c) It was obvious to the Examiners that some candidates did not read the information in the stem of the question thoroughly. There were clues to indicate that this should be answered in terms of enzyme specificity. Weak responses simply restated the information given: sucralose could not be digested and therefore would not lead to weight increase. Others expressed their answers in terms of the formation of the bond rather than its breakage. Many candidates recognised that the presence of chlorine atoms in the structure was important, but then became sidetracked and answered the question simply in terms of an enzyme's ability to release the chlorine or, if it was released, its potential toxic nature. Those candidates who realised that the shape of sucralose was different from that of sucrose generally went on to discuss the specificity of enzymes and the fact that sucralose would be unable to fit into the active site of the enzyme that digested sucrose as its shape was not complementary. The importance of reading the information supplied very carefully cannot be over-emphasised. It can often allow a candidate to spot the clues provided and to ensure that they do not simply latch onto the first idea that they have, which may not be relevant in the context of the question.

Q.3 (a) In (i), the majority of candidates transferred the DNA code to mRNA with complete accuracy. The most common error was, as expected, to indicate T in mRNA instead of U. Other random errors occurred, not always consistent throughout the sequence. Most candidates appreciated the difference between transcription and translation in (ii), and gave the correct answer. However, some gave the more general response of 'protein synthesis', which was not credited.

(b) Protein synthesis is a challenging topic for many candidates. The inclusion of the diagram was intended to help candidates to organise their thoughts and assist their description. Performance in (i) was variable. The letter that was most commonly identified correctly was **L**, as the ribosome. There was the predictable confusion between anticodon and codon, some candidates giving the same response for **J** and **M** as they presumably thought that they would be credited for one of them. Great care should be taken in the use of plurals. **J** and **M** were triplets of bases, each triplet being a single anticodon or codon, as appropriate. 'Codons' or 'anticodons' implies more than one group of triplets, and only one triplet was indicated on the diagram in each case. Part (ii) did not require a full and complete account of protein synthesis, although this was what many candidates provided. Few appeared to make use of the diagram to assist them, despite the prompt in the question. A number of points could have been picked up from looking at the diagram, such as the idea that two tRNA molecules attach to the ribosome at any one time. The ideas that a DNA or

mRNA triplet codes for a particular amino acid and that the sequence of bases or triplets determines the sequence of amino acids in the polypeptide were not often expressed, even though they should have been the foundation of the answer. The process of translation itself was often dealt with in a superficial and vague manner. Some candidates displayed some alarming misconceptions, such as 'amino acids are formed by tRNA', 'amino acids are made in the ribosome'. They did not make it clear that a specific amino acid is attached to its tRNA molecule (depending upon its anticodon) and then attached to the neighbouring amino acid when the tRNA molecules are at the ribosome. The weakest accounts simply stated that amino acids in a protein were joined by peptide bonds, giving the statement no context whatsoever. Candidates who were confident with the topic were able to score marks easily and they gave clear and unambiguous explanations.

(c) This was answered well by those candidates who read the question thoroughly and appreciated the significance of the information provided. Many wrote about the consequence of inactivating the ribosome in terms of stopping protein synthesis, but this information had been given in the question so was not credited. Candidates were expected to suggest how this inactivation had taken place. Typical suggestions might have been that lectin 1 could bind to the ribosome, distort the ribosome, prevent the mRNA from attaching to the ribosome or prevent the tRNA attaching to the mRNA when on the ribosome. A large proportion of candidates spotted the term 'inhibits' and wrote a general description of enzyme inhibition that was not relevant to this situation. If they linked this to the enzyme peptidyl transferase, either by name or a description of its function, then they could have such information credited, but this was seen very rarely.

Q.4 (a) Despite it being intended as a relatively easy and straightforward introduction to the question, a degree of confusion was evident. A significant number of candidates completely reversed the structural features of prokaryotes and eukaryotes and therefore failed to score any marks. In a question of this type, candidates are expected to make comparative statements on the same line. A statement relating to organelles on the same line as a statement about the cell wall is not considered to be a comparison, even though each statement might be correct for that particular organism. Prokaryotes should be described as having 'no membrane-bound organelles' rather than having 'few organelles'. Candidates seem to use the terms 'naked DNA' and 'free DNA' as interchangeable. The Examiners considered the phrase 'naked DNA' to refer to the absence of histone or protein associated with the DNA in prokaryotes. 'Free DNA' is considered to refer to the lack of a nucleus and would therefore be a valid comparative statement to the presence of a nucleus in the eukaryote. If used inappropriately, these terms did not score. Some candidates did not restrict their statements to structural features and these statements, therefore, did not score.

(b) In this extended answer question, candidates frequently provided two advantages of using genetically engineered insulin. When they were not quite expressing themselves clearly enough, they often gave additional advantages that allowed them to score the two available marks. In contrast, however, there was often confusion between the methods of isolating mRNA and isolating DNA, with answers containing information from both. Candidates knew about sticky ends and often referred to the joining of the human gene with the bacterial plasmid. Very few adequately described the addition of an antibiotic resistance gene to the plasmid in order to identify those transformed bacteria that had taken up the plasmid. References were often vague and confused. Similarly, few referred to the use of fermenters to grow bacteria. Some candidates wrote about gene therapy including some strange references to inserting bacteria or plasmids into the pancreases of diabetics. Gene therapy is not in the specification for Biology Foundation.

Q.5 (a) Part (iii) was the part most commonly answered correctly. A common error was to give 'metaphase' or 'anaphase' for (i). Another error was to give the correct answer (prophase) for (i) and then to assume that the stages were to go in some sort of correct sequence, suggesting metaphase or anaphase for (ii).

(b) Some good, clear and concise descriptions were seen. This is another area of the specification that some candidates find difficult to grasp. Some accounts were muddled and vague, such as referring to chromosomes splitting in half rather than separating into their constituent chromatids. Despite the question specifically referring to the chromosomes, some candidates managed to answer without mentioning chromosomes at all while others mentioned that they were taken to opposite poles and then concentrated on the formation of new nuclear membranes and cytokinesis, neither of which was asked.

(c) Part (i) was mostly answered correctly, although candidates need to be very careful in their positioning of the letter 'a' before 'sexual'. It was clear that, in some cases, candidates were trying to avoid making a decision by leaving at least as much space in their answer between 'a' and 'sexual' as there was between 'sexual' and 'reproduction', i.e. 'a sexual reproduction'. Here, clearly, the intended answer is 'sexual' and was marked accordingly. Most candidates managed to score at least one mark in (ii), either referring to restoration of the diploid number or to the doubling of the chromosome number. Fewer candidates wrote about the formation of haploid gametes in the context of generating genetic variation.

Q.6 (a) Some candidates find answering specific questions on the nitrogen cycle a challenge. Consequently, only those candidates with a thorough understanding of the topic were able to score well in (a). Part (iii) was answered correctly most frequently, although some candidates suggested osmosis as a suitable method; (ii) was also well answered. There was some confusion between nitrification and denitrification and some candidates confused the processes with the organisms that carry out the processes. If in doubt, candidates suggested 'nitrogen fixation'.

(b) This was a good discriminator. It required sufficient understanding of the nitrogen cycle and the ability to apply this knowledge. There was much loose terminology expressed in these answers with 'nitrogen' featuring throughout. Candidates should be aware that the nitrogen cycle relates to the conversion of nitrogenous compounds as well as referring to atmospheric or gaseous nitrogen. As such, they should be discouraged from referring to 'nitrogen'. They

should be familiar with and use the correct nitrogenous compounds in the appropriate places in the cycle. It is all too easy to refer to 'nitrogen' in passing as a generic term, but it obviously leads to its misuse by candidates under examination conditions. As the information given about ploughing-in concerned legumes, which are very much an integral part of the nitrogen cycle, the Examiners were expecting specific references to nitrogenous compounds or naming of the particular compounds rather than simple statements concerning 'nutrients' or 'nitrogen'. Candidates who stated that legumes contain nitrogen-fixing bacteria, often identified as *Rhizobium*, did not necessarily recognise the significance of ploughing-in. The plants, including root nodules, decompose so releasing ammonium ions that are converted into nitrate ions for uptake by the next crop. As the idea of crop rotation required rather more application of knowledge, the concept of 'nutrients' was accepted in this part of the question. Most candidates realised that the fallow year would allow nutrients to accumulate in the soil and many commented that different crops would have different nutrient requirements, but did not often relate this to the different demands made on the soil each year. Weaker candidates used the term 'fertility' extensively in their answers, having taken it from the stem of the question, without explaining what they meant by it. An incorrect idea that was frequently expressed was that different crops give different nutrients to the soil.

2802: Human Health and Disease

General Comments

The Examiners felt that this was an accessible paper with plenty of opportunities for candidates over the whole spectrum of ability to display their knowledge and understanding. There was no evidence that candidates ran short of time and the majority of candidates attempted all questions with varying degrees of success. Overall, the standard achieved by many candidates was very pleasing and it is clear that centres are teaching the specification clearly and accurately. Despite this, it was occasionally apparent that the candidates' own revision had not been sufficiently thorough – as in the case of the candidate who wrote: 'goblet cells are to gobble up unwanted cells'. It is still evident that the responses from a significant number of candidates lack clarity in the use of written English. Where answers are not made clear it can be hard to award marks even though the candidate may have sufficient knowledge and understanding. Indeed, it was noted that there seems to be a relationship between the marks achieved and the ability of the candidate to express himself or herself coherently and concisely in good English. Candidates should be encouraged to read over their answers in order to check the clarity of their explanations.

Comments on Individual Questions

Q.1 This question tested Assessment Objective 1 and was meant to be a straightforward and relatively easy entry into the examination. It certainly proved reasonably accessible to the majority of candidates who could recall some simple facts about categories of disease.

(a) The majority of candidates correctly stated the categories of the named diseases although a number of candidates stated 'genetic' for the first row even though the word genetic was already given. Providing one example of an infectious disease caused no problems. HIV/AIDS, malaria and influenza were most commonly quoted closely followed by TB and cholera. However, completing the table fully and accurately proved to be beyond all but the most able. The definitions of a degenerative disease and a physical disease were often insufficiently detailed. Many candidates defined a degenerative disease as 'the result of getting old' or 'wear and tear' which both fell short of the required answer. Most candidates omitted the idea that a degenerative disease is progressive. A physical disease is one that causes damage or harm to a part of the body. Here, there was often a poor choice of words and many candidates simply stated that physical diseases 'affect the body' or 'change the body'.

(b) Here candidates were asked a fairly specific question – how could members of the medical profession make use of data collected by epidemiologists. A significant minority of candidates had evidently not read the question and gave definitions of prevalence, incidence and morbidity or mortality. However, the majority of candidates were able to give two or three suitable responses. The ideas of targeting funds and identifying those at risk were given most commonly.

Teaching tip

Worldmapper is a collection of world maps, where territories are re-sized on each map according to the subject of interest. Some of the categories are useful for supporting Human Health and Disease, for example Disease, Poverty, Health and Population. These are all available at:

http://www.worldmapper.org/index.html

and can be printed in colour. They would make useful resources for teaching topics in Sections 1 and 6 of the specification for this unit.

Q.2 This question linked some simple structural features of the gaseous exchange system to their functions and then brought in a consideration of the effects of smoking. A clear photograph was supplied as an insert to help remind candidates of some of the structures and tissues involved. The Examiners were disappointed to note that few candidates made good use of the photograph.

(a) In (i), the majority of candidates knew that goblet cells release mucus and that the cartilage is to support the bronchus and prevent it collapsing as air is inhaled. Many candidates found part (ii) more difficult as they expected to describe the effects of cigarette smoke on the functioning of cilia and goblet cells. Their responses describing inactive cilia or excess mucus failed to gain any credit. This question asked specifically for the effect on the structure of the wall of the bronchus. Very few candidates referred to the insert that showed the structure of a healthy bronchus in cross section. A good number of candidates accurately described the reduction in number or size of the cilia and suggested that the goblet cells may be enlarged. A few also pointed out that the smooth muscle would be thicker or that the epithelium may be replaced by scar tissue.

(b) Most candidates realised that the elastic fibres allow the alveoli to expand as air is inhaled and recoil as air is exhaled. The answers were not always well worded and candidates should be encouraged to think through their answers before starting to write. Typical of the weaker answers was the reference to contraction of the elastic fibres. Contraction is an active process carried out by muscle fibres; elastic fibres can only recoil. Some candidates were able to extend their answer by pointing out that the expansion of the alveoli gave a larger surface area for gaseous exchange and that the elastic fibres prevented the alveoli from bursting.

(c) Some able candidates started their response by describing how phagocytic cells release elastase, which damages the elastic fibres in the alveoli. This is accurate in terms of the process that occurs to reduce elasticity, but is not a part of the correct response to the question. These candidates, therefore, lost time in writing something which would gain no credit. They may even have failed to gain all the marks they could, as they did not give a full answer to the question set. Most candidates gained some marks here for responses that described the inability of the alveoli to expand and recoil properly, trapping air which caused the alveoli to burst. The subsequent decrease in surface area reduces oxygenation of the blood and causes breathlessness. The Examiners felt that a lot of candidates had simply recalled answers that they had learnt rather than apply their knowledge to the actual question. The question asked for an explanation rather than a description.

Teaching tip

Use new elastic bands and perished elastic bands to demonstrate the effect of reduced elasticity. Save the inserts supplied with an examination as they are usually very good quality photographs that can be used in teaching. Candidates should use these and photographs of other relevant structures at every opportunity.

Q.3 The Examiners were interested to note that a significant number of candidates appeared to link Q.2 and Q.3 so closely that they carried the subject material from Q.2 to Q.3. A good number of candidates answered part (a) as the 'pulmonary artery' rather than the 'coronary artery'. There is certainly a link as smoking is one of the risk factors leading to coronary heart disease.

(a) The majority of candidates were able to identify the artery on the surface of the heart as the coronary artery; however, the Examiners were fairly lenient in their acceptance of the spelling of the word 'coronary'. A significant minority thought that the artery was the pulmonary artery or the cardiac artery; some even thought it was the aorta. In part (ii), the majority of candidates achieved a mark for using the term 'atherosclerosis' suitably. However, very few candidates were able to describe or explain the process by which arteries become narrowed. There were many responses that suggest deposition occurs on the artery wall rather than under the endothelium. Very few candidates linked the deposition to earlier damage to the endothelium. These are points that have been mentioned in many previous reports.

(b) In part (i), many candidates correctly highlighted that the heart muscle would not receive as much oxygen as it needs, that respiration would be affected and that part of the muscle might die. However, a lot of candidates extended their response to mention angina, raised blood pressure and heart attacks. The question specifically asks about the effect on the heart muscle which was emboldened in the question to help guide candidates. In part (ii), many candidates recognised that a person with narrowing of the coronary artery might have angina or a heart attack. Some candidates described 'chest pains' without qualifying this as chest pain whilst exercising. Many candidates felt that high blood pressure was a symptom. However, this was not accepted as a person does not feel high blood pressure or hypertension, which is known as the silent killer.

(c) Many candidates correctly suggested in part (i) the use of bypass surgery or fitting stents as suitable treatments for narrowing of the coronary artery. Many candidates described bypass surgery as removal of an artery from the leg and replacement of the coronary artery. Veins from the leg are used to bypass the restricted part of the artery. A relatively new technique is to use the mammary artery or some other artery in the chest to divert flow to the heart muscle. Where this was specified it was given credit. Weaker candidates sometimes suggested that advice to increase exercise and eat healthily was suitable treatment. However, this type of advice is not treatment and was covered in part (ii) of the question. The majority of candidates were able to suggest two suitable pieces of advice in part (ii) even if they had already given the advice as a response to part (i). Weaker candidates lost credit if they did not provide sufficient detail in their answers. The diet must contain 'less saturated fat' rather than just 'less fat'. Also, the advice to 'eat less low density lipoproteins' displays a lack of understanding about the origin of lipoproteins.

Teaching tip

Ask students to prepare a step–by–step guide to formation of atheroma and plaque. This could be done as a card sort exercise.

Q.4 This was generally answered very well, most candidates achieved between six and eight marks but very few managed the full ten marks. The Examiners were encouraged by how well this question was answered by even the weaker candidates.

(a) As a very easy starter, the Examiners were not surprised to see the majority of candidates achieve two marks here. It was, however, surprising to see how many candidates responded with 'fibre' as a group of nutrients.

(b) In part (i), weaker candidates simply stated that 'essential amino acids are needed by the body' without elucidating the idea that they must be consumed as part of the diet. This is because the body is unable to produce essential amino acids. Most candidates were, however, able to point this out. In part (ii), most candidates achieved one mark for stating that amino acids are used to synthesise proteins and many gave a number of examples of proteins that are synthesised in the body. However, few were able to achieve the second mark by pointing out that essential amino acids could be converted to the non-essential ones. Quite a number of candidates realised that they needed to write more for a two mark answer and tried to add detail. Many erroneously believed that the essential amino acids could be used to synthesise DNA. Others decided to mention linoleic acid and linolenic acid since they had learnt the words and thought they ought to be used! Some candidates suggested that essential amino acids are needed for 'growth and repair'. This response was felt to be insufficiently detailed to deserve credit at AS level.

(c) In part (i), only the very weakest candidates failed to score a mark while some relied solely on the photograph in Fig. 4.1. Here they could come unstuck by using the term 'stomach' instead of 'abdomen' or not being sufficiently specific with their description. Some candidates were able to provide a long and accurate list of the symptoms of kwashiorkor. In part (ii), most candidates gained credit by linking the age of 6 – 18 months to weaning and a move to a diet that contained less protein. Some candidates seemed to think that kwashiorkor was an infectious disease. They linked this to the idea that children caught the disease because they were no longer protected by the passive immunity provided by antibodies in their mothers' milk.

Teaching tip

The term protein-energy malnutrition is now generally used to refer to both kwashiorkor and marasmus. Kwashiorkor is often associated with weaning and is a total protein deficiency as distinct to marasmus, which is more of an energy deficiency. The diseases can be compared effectively by means of a table. There is a useful factsheet provided by the Food and Agriculture Organization at:

http://www.fao.org/DOCREP/003/X3996E/x3996e14.htm

It is also important to make links to Biology Foundation and the teaching of biological molecules. The links between amino acids and proteins should be clear as should the role of fibre as a form of cellulose, which is a polysaccharide and carbohydrate.

Q.5 This question started with a little data response and interpretation. The message in previous reports to state a trend and back it up with figures seems to have been heard and many candidates did just that. Weaker candidates, however, still fail to quote a pair of figures as a comparison or simply list all the figures without stating what they mean. The Examiners were pleased to see how well the majority of candidates answered part (b).

(a) Many candidates achieved both marks here – usually by stating that Sub-Saharan Africa has a high percentage of people with HIV/AIDS and referring to a pair of figures to compare Sub-Saharan Africa with a Western country. However, some candidates confused numbers with percentages and did not appear to realise that a high percentage could actually be a small number of people or that a low percentage could be a large number of people. Candidates should be urged to read tables of information clearly and to use the units that are supplied at the head of each column.

(b) Candidates seem to be well informed about HIV/AIDS, about how it is transmitted and the reasons why it has greater incidence in certain countries. Many candidates scored well and very few misinterpreted the question. However, the question was phrased in two parts: 'explain why it is difficult to prevent the spread' and 'explain why the increase in numbers is higher in some parts of the world'. Candidates should be encouraged to give responses that reflect this division – some candidates lost credit because their responses failed to describe clearly that conditions are different in some parts of the world and that these differences affect the spread of the disease. It was pleasing to see that all points on the mark scheme were regularly credited and that some candidates gained many marks in excess of the maximum allocated. There remains the issue regarding the use of English and the need to re-read an answer to ensure it says what the candidate thinks it says. A regular entry to the list of amusing responses is 'HIV/AIDS is very popular in Sub-Saharan Africa' and this year we were also told that: 'unprotected sex is a popular way of getting AIDS'. Candidates must be careful about what they write and must be sure that details are correct. One way to lose a mark is to write about the need to use 'contraception' rather than to specify that 'condoms are needed for protection'. Similarly, to state that 'better education is needed' does not specify that the education is about the disease or ways to avoid its spread.

Teaching tip

Prepare candidates for long answers by setting a question and allowing pupils to prepare a plan of their answer. Time spent in planning a long answer can ensure that it is well organised.

Q.6 This question proved to be a good discriminator as is often the case with questions on immunity. Using the context of a possible malaria vaccine did not appear to put any candidates off track.

(a) The 'fill in the gaps' section was well answered by many candidates. The most common error was an inability to recall the name *Plasmodium*. Many candidates used 'malaria' or 'Anopheles'. The second gap often elicited the response 'pathogen' which is typical of weaker candidates who have not understood the difference between the pathogen and the antigens on its surface. The remainder of the paragraph was usually well completed.

(b) The majority of candidates correctly identified antibodies as the answer required.

(c) There was a huge variety of responses in this section. Many candidates gave details of the malaria life cycle and wanted to vaccinate against mosquitoes or even vaccinate the mosquitoes! Marks were also lost due to lack of precision in the descriptions of mutation and antigenic drift. Candidates should understand that it is the causative organism, *Plasmodium*, which has many strains or changes due to mutation, not the disease.

Teaching tip

The following may be a useful resources for this question:
Why don't we have a malaria vaccine at:

http://malaria.wellcome.ac.uk/doc_WTX033040.html

The National Geographic carried an article about malaria in its edition for July 2007. The text and photographs may be viewed at:

http://www7.nationalgeographic.com/ngm/0707/feature1/index.html

Information about the World Health Organization's Global Malaria Programme is at:

http://www.who.int/malaria

2803/01: Transport

General Comments

The whole mark range was used and it was good to see evidence of careful preparation of candidates in many instances. Unlike some previous years, the responses to the botanically orientated question (*Q.*2) were very much in line with the rest of the paper.

Centres clearly use previous papers to practise examination technique, but should stress to candidates that they should not simply try to make a previous mark scheme fit a new question on a related topic. Over the years this seems to have been an increasing trend. Candidates should also be encouraged to read to the end of a question carefully and thus hopefully provide relevant ideas in the appropriate sections.

Comments on Individual Questions

Q.1 This was a case where some candidates did not seem to have read the whole question carefully and thus often provided irrelevant material in the various parts.

(a) A common failing was to describe the fall in pressure over the whole graph rather than to explain the rise and fall in the arteries alone which was clearly stated in the question. An alarming number of candidates never related the rise and fall to the heart at all and talked about the supposed pumping action of the arteries. Good answers related the rise and fall to the contraction (systole) and relaxation (diastole) of the heart or ventricles. Others talked rather vaguely about heart beat without making it clear that they were referring to contraction or relaxation.

(b) As there were three marks here candidates should have been aware that a range of information was needed. Relatively few scored maximum marks here. Again it seemed that some had misread the question and rather than explaining the causes for the loss of pulsatile flow and the drop in pressure, described the reasons why this was needed. Those who were on the right tack tended to relate it to distance from the heart in most cases with fewer getting the idea that the increasing volume of the arterioles and capillaries plays a role. Some seem to think that the overall volume in the capillary bed is relatively low. Surprisingly few mentioned friction or the gradual damping down effect related to reduction in elastic recoil. Some still refer to elastic tissue contracting rather than recoiling.

(c) This was usually well done with candidates relating the thin wall to the risk of damage, or the need to slow the rate to allow exchange. Candidates should be taught to use precise terminology and not just talk in terms of ‘coping’ with high pressure. Although the idea of damage to capillaries was expressed in various ways, the Examiners were not happy with ‘exploding’ vessels.

(d) This was also answered well by the majority of candidates who related the action of skeletal muscle and the one way nature of the valves. Some fell into the trap of talking in terms of smooth muscle in the vein wall having a pumping action or even invoking a pumping action built into the valves themselves. Mention of the contribution made by the negative pressure in the heart/thorax or the residual pressure was less often found.

Teaching tips

1. Candidates should be advised to read a question right through to the end before starting to write an answer to part (a).

2. Be sure that candidates understand the difference between command words like describe and explain.

3. Practice using data such as that in Fig. 1.1 by getting candidates to relate what they know about the structure of the various vessels to the pressure and pattern seen in the graph.

Q.2 It was refreshing to see a botanically orientated question answered well by many candidates.

(a) Most candidates identified phloem correctly but the endodermis was frequently confused with the epidermis and some candidates put A, B, C, D for this.

(b) This was often well answered with the most common correct responses being large surface area, thin cell wall or low water potential. Selectively permeable membranes are features of all cells not just a root hair adaptation and thin membranes or 'one cell thick' were other common errors. A surprising number seemed to think that the root hair was covered in further hairs.

(c) There were many good responses here. The terms apoplast and symplast were treated as neutral as the question asked for a description of the pathways not just their names. Many knew that the water either passes via the cell walls or via the cytoplasm/vacuole. Some seemed to think that plasmodesmata were part of the cell wall rather than the link between neighbouring protoplasts. Vague responses in terms of 'through the cell' or 'around the cell' did not get credit. It was good to see more candidates describing the mechanism in terms of water movement down a water potential gradient than in previous series. There were some who lost marks by writing about concentration gradients. Some carried on to write about the movement up the xylem which was not needed. Not many were able to describe how the tension in the xylem contributed to the water potential gradient across the root. There were also a surprising number of candidates who described the water movement as active. Perhaps they were confused with the active secretion of salts into the xylem allowing water to follow.

(d) Again there were good responses. Weaker candidates did not link the feature to the function. There was some confusion with other plant tissues (phloem being described) or with animal tissues. 'Collagen in the walls', 'thickened with cartilage' and 'muscular walls' were all seen.

Teaching tip

Examine slides of xylem together with photomicrographs and make preparations from macerated wood. Give candidates a list of properties that it might be desirable for a water transport system to possess and ask them to describe how xylem fulfils these properties.

Q.3 The latter parts of this question required precise description and many candidates fell down by making vague generalisations.

(a) Most candidates identified **F** as the SAN; the common mistakes were AVN or atrium with a few thinking it was a blood clot. The most common errors for **G** (the pulmonary vein) were aorta or pulmonary artery.

(b) This part on the relative thickness of the walls was usually well done with candidates relating the different thicknesses to the different distances the chambers had to pump. A common error was to talk in terms of withstanding different pressures rather than needing to generate them. Some lost marks by stating that the atrium just received blood so did not need to generate any pressure. The second part on the Purkyne tissue was not well answered. In some cases it was because the candidate thought it was a muscle that contracted, a blood vessel that took blood to the heart or just a wall separating the sides of the heart. Others appreciated that its role is conduction, but were very vague in explaining this. It is not a nerve so candidates should not talk in terms of nerve impulses being carried. It is appropriate to consider a wave of excitation. The key thing is that this wave of excitation reaches the apex of the heart so that both ventricles contract simultaneously from the base up thus ensuring that blood is pumped out of the heart.

(c) Although most candidates gained one mark here a lack of precision often restricted access to other marks. It would seem that candidates did not look at the diagram carefully and then follow the sequence of events that may happen through in a logical fashion. The diagram shows that deoxygenated blood from the right atrium is likely to pass through to the left atrium resulting in mixing of oxygenated and deoxygenated blood in the atria. Many candidates just mentioned mixing of blood without reference to the atria and some seem to have thought this was the same as the hole in the interventricular septum. Most got the idea that less oxygen may be delivered to the brain but did not follow the route through from atrium to ventricle and out in the aorta. Surprisingly few linked reduced oxygen supply to reduced respiration or to lactate build up due to anaerobic respiration. Some who did mention respiration thought it would stop thereby implying that a migraine is fatal.

Teaching tip

Get hold of some hearts to study wall thickness. Have some information cards with outlines of various heart defects and get students to suggest how such a defect might affect the working of the heart or body by relating it to their knowledge of the functioning of the ‘normal’ heart. As well as PFO, they could consider the ‘hole in the heart’ situation or cardiomyopathy provided they are discussed carefully.

Q.4 The candidates found this a difficult area and relatively few scored maximum marks here.

(a) The majority worked out which curve was for adult haemoglobin and correctly read off the value of 78.

(b) Many candidates saw foetal haemoglobin as 'stealing' oxygen from the adult haemoglobin: they seemed to believe that the foetal form actually drags the oxygen off the adult form. Good answers were expressed in terms of the fact that at the low partial pressure in the placenta, oxygen dissociates from the adult haemoglobin. Due to the higher affinity for oxygen seen in foetal haemoglobin a diffusion gradient is set up allowing oxygen to diffuse across the placenta. Some candidates appreciated that the affinity of foetal haemoglobin would be too high once born and thus not enough oxygen would be released. Some responses also mentioned the problem if the child was female she would need the difference in due course if she had children of her own.

Teaching tip

This is an area of the specification where constant practice of drawing, using and annotating dissociation curves is important so that students understand what the different shapes and relative positions of curves signify.

Q.5 The Examiners noted that the responses to this question were poorer than seen in previous questions of this nature. Few candidates seemed to have a good understanding of basic blood chemistry.

Most candidates had something ending in –ase in the space for an enzyme although a wide range of totally inappropriate ones appeared as well as a number of fictitious ones, such as notacluase. Carbonic acid was not well known. There were quite a few carboxylic acids. Hydrogen carbonate commonly became 'hydrocarbonate' suggesting a basic lack of knowledge of chemical nomenclature. Many candidates solved the problem of what was formed when hydrogen ions combine with haemoglobin by simply running the two words together to get 'hydrohaemoglobin'. The majority of candidates got oxygen released, sometimes by putting it in all the spaces.

Teaching tip

Take candidates through the stages in the uptake and release of gases by haemoglobin in a stepwise fashion and use flow diagrams that the candidates complete.

For questions of this type, train candidates to read the finished paragraph through to themselves to see if it makes sense. There are many of these cloze activities on past papers for this module to use as practice.

2803/02: Experimental Skills (coursework) – see page xx

2803/03: Practical Examination

General Comments

There were several themes running through this paper. The main one concerned cells and cellular functions. Yeast featured in all three questions. In the Planning Exercise, candidates were asked to find the lowest temperature at which yeast cells died. They were instructed to do this by using methylene blue and were given some information about how to us it. As part of their Planning Exercise, many candidates described the processes of aerobic and anaerobic respiration in yeast and referred to carbon dioxide and ethanol. Many stated the effect of ethanol on yeast cells as part of their introduction as they knew this from coursework carried out at GCSE or had found it in their research. In *Q.1*, the candidates investigated the effect of ethanol on the survival of yeast using both the methylene blue technique and checking for signs of respiration. Neutral red is another useful stain and in *Q.2* the candidates were presented with a photograph and a diagram of *Paramecium* that had ingested some yeasts stained with neutral red. This is a standard method for following the digestive process in ciliates, such as *Paramecium*.

Centres did not report any problems with the Planning Exercise and many candidates planned perfectly acceptable methods. However, some were confused over the actual nature of yeast and thought that it is an enzyme! This was a common misconception. Some were also confused about how to use the methylene blue although many realised that it should be added to the yeast *after* a period of treatment in water baths of different temperature. There was a widespread failure to realise that the death of yeast cells might not be instantaneous at any given temperature. The comments below highlight areas of the Planning Exercise that candidates neglect – these are areas that have been reported many times before. It is expected that centres will train their candidates in the ways to approach these Planning Exercises and will show them how to set out their work so that is concise and informative. There are plenty of past paper questions that can be used for this.

The candidates recorded the activity of yeast in *Q.1* by detecting a decrease in pH of the medium, observing the contents of the tubes and repeating the methylene blue test. Many did not obtain the expected results for pH in tube 6 – the tube with the highest concentration of ethanol. This was likely because the candidates sampled from the top of the tube rather than mid-way or after shaking. This was obviously an instruction that should have been added. Also it was unlikely that they took their first sample at exactly 1 minute as instructed. Many thought that yeast dissolved in water but not in ethanol.

The Examiners saw some excellent answers to *Q.2*, but not as many as in previous sessions. The absence of a drawing question probably surprised them and there were no questions that asked them to analyse and interpret something that they had seen. As has been pointed out, this question could have been set on a theory paper although the Examiners thought this unlikely. More seriously, some candidates may have been short of time as scripts were blank or answers looked rushed. In some cases this was because candidates had written at great length in *Q.1 (g)*.

In spite of the difficulties with *Q.2*, the performance of the candidates was excellent with very few low scoring scripts and a large number in the 50's. The Examiners were encouraged to find candidates gaining full marks on both their plans and their tests.

Comments on Individual Questions

Planning Exercise

Methylene blue is a redox dye. It is taken up by yeast cells and it is reduced during respiration by hydrogen ions that would normally be taken up by the co-enzyme, NAD. The reduced form of methylene blue is colourless. Some authorities maintain that yeast cells pump out methylene blue. The candidates did not need to know this information in order to use methylene blue in their planning. However, simple knowledge of respiration would have helped them understand why this dye was used, although it was not necessary for the Plan. Candidates obviously used a variety of approaches when doing their preliminary work. The Examiners always wish that candidates were more lucid about the nature of the preliminary work that they have done. Some *planned* to do preliminary work but did not report any results. 'I will start my investigation by seeing what happens to yeast at 40^{o}C, 50^{o}C, 60^{o}C and 70^{o}C and then I will concentrate on a narrow range (e.g. between 60^{o}C and 70^{o}) and look at 2^{o}C intervals.' This is not preliminary work as rewarded by checking point **J** in the mark scheme. However, many candidates carried out the work described above and discovered that most yeast cells survive a temperature of 60^{o}C, but are all dead at 70^{o}C. They included suitable evidence in a section headed *Preliminary work*. They then planned to look at temperatures between 60^{o}C and 70^{o}C. These candidates did gain **J**. Other preliminary work included finding out how long to leave the yeast suspension in water baths of different temperatures and whether to use glucose or sucrose as the respiratory substrate. Some candidates described quite a lengthy set of prior experimental work which impressed the Examiners. Neglecting this key aspect of the Planning Exercise can make it difficult for candidates to gain some of the other checking points. However, teachers should provide guidance to candidates not instruct them to carry out specific bits of preliminary work.

Candidates who confused yeast with an enzyme often lost marking points **B**, **D** and **I**. They often included much background information about enzymes similar to that which they may have used for their GCSE coursework. Some even wrote about catalase and hydrogen peroxide! Yeast makes heat shock proteins that protect it against the effect of sudden changes in temperature. Few, if any, candidates found references to these during their research.

There were several acceptable approaches to this problem. Some candidates heated the yeast suspension (with or without a sugar solution) and then added methylene blue after a suitable treatment time. They then looked to see if the methylene blue was decolourised or not. The Examiners felt that these candidates should have used at least one tube as a comparator. Some tried this without adding any sugar and found it did not work so they added sugar before or after the heat treatment but before adding methylene blue. Many said that they would use boiled yeast 'as a control', but did not say that they would use another tube of yeast without methylene blue to check for decolourisation. Many in this group timed how long it took for the methylene blue to decolourise. Some candidates added the methylene blue at the beginning of the heat treatment, which the Examiners realised would not work. This group of candidates was not awarded checking point **A**.

A second group realised that they needed to gain some quantitative results so used a colorimeter. The Examiners thought that the turbidity of the yeast suspension would make this unworkable, but credited this method nonetheless. Some candidates experimented with diluting the yeast suspensions to avoid this problem. Others attempted this method as part of their preliminary work and decided it was not going to generate suitable results. Few referred to using a suitable tube as a 'blank' to zero the colorimeter.

A third approach was to use microscopy for direct observation of the cells. Cells placed on an ordinary slide can be dispersed and observed directly. Even a suspension kept at room temperature will contain some dead cells. However, some candidates just stated that they would look for the lowest temperature at which all of the cells were blue. The Examiners accepted this approach for **A** but expected some cell counting for **O** (drawing a table). Some candidates used a haemocytometer in the preliminary work and decided to use this for their cell counts. The Examiners credited this by awarding checking point **M**; they did not expect candidates to give details of how to use the haemocytometer. For those without this piece of apparatus (and there are simulations available – see *Teaching tip*), a pointer eyepiece can be used. As this is rotated in the tube of the microscope the cells that are crossed by the pointer can be scored and the results recorded in a tally table. Alternatively a pointer or an eyepiece graticule can be used to divide the field of view into quarters and the number of yeast cells in each quarter can be counted.

Candidates who justified the use of apparatus, such as a colorimeter or a haemocytometer, made it possible to award **R** for commenting on precision. Some candidates gave '% cells dead and alive' in their table headings without describing how they would determine these percentages. Fortunately, few candidates decided to measure volumes of gas produced by yeast. This approach would have gained few marks.

Many candidates were aware of the problems with their method, particularly the problem of finding the lowest temperature. They were aware that with temperatures increasing by 10^{o}C they were unlikely to discover *the* lowest temperature. Many stated that they would use intermediate temperatures within a narrow range. Fewer were aware of problems of sampling with the microscopy method, but many stated yeast suspensions should not be immersed directly into water baths but heated gradually. They referred to the information provided in the question paper.

Many candidates did not gain credit for giving a safety comment (**K**) as they did not give a specific hazard and precaution. General aspects of laboratory safety do not gain credit and neither do the procedures to follow when there are accidents. A number of candidates thought that doing replicates got rid of anomalies. They should know that anomalies may be excluded from any calculations or may prompt researchers to do even more replicates or examine their procedures carefully. Sometimes so called anomalies lead to discoveries!

Teaching tips

At least one centre used a question on yeast from the A2 Practical Examination paper set in January 2003 as a source of information. The paper reference is 2806/03 January 2003 Q.2.

The Examiners were surprised that many candidates did not find their way to:

http://www-saps.plantsci.cam.ac.uk/worksheets/scotland/yeast.htm

or

http://www-saps.plantsci.cam.ac.uk/docs/Autolysispb.doc

which includes the methylene blue method for testing viability of yeast cells. They did, however, find many other websites, one of the most common being 'The joy of baking'! If this practical exercise encouraged one candidate to experiment with making bread then all is not lost!

Centres should train their candidates in carrying out preliminary practical work and reporting on it. Previous Planning Exercises could be used in this way.

The free demonstration program Bacterial Growth 3 from Scotcal includes a simulation of using a haemocytometer. It is available to download from:

http://www.scotcal.com/

Practical Test

Q.1 This question involved treating yeast cells in different concentrations of ethanol and checking for signs of activity in the cells. Many candidates were well prepared for this question as they had researched many of the aspects of the exercise when carrying out their plans. Those that had done some preliminary practical work and had thought about the biology involved in their planning exercise scored very highly here. The Examiners saw many more candidates reaching maximum marks than before and some of the answers to part (g) were exceptional. The structure of the evaluation exercise (h) helped many candidates to gain marks. In the past, candidates have tended to write at length about a few limitations and rarely give any appropriate improvements. Providing a 'writing frame' helped candidates to focus on four different limitations and give matched improvements.

(a) (i) This question was quite taxing for many candidates who did not realise that adding pure ethanol to the yeast cells would probably damage all of them and would certainly expose them to the same treatment if even for a very short time before the distilled water was added.

(ii) Many candidates realised that testing the pH of the glucose solution allowed a comparison with the results obtained from the different treatments. There were a variety of ways of expressing this idea which were accepted although just identifying this as a 'control' without further qualification did not gain any credit.

(b) In previous practical examinations candidates have often referred to the inaccuracy of measuring volumes with syringes when evaluating the exercise in Q.1. Parts (i) and (ii) required these candidates to explain why they think syringes are inaccurate and to describe how they made the measurements as accurate as possible. Many referred to air bubbles and difficulties with using the scales on the syringes. The Examiners accepted a variety of other explanations although they thought candidates should know that the liquid left in the nozzle when the plunger is fully depressed does not make them inaccurate. Simply 'taking care when using the syringes' did not gain credit. Burette and graduated pipette were the most common answers to part (iii)

(c) Almost all candidates gave a suitable table of results. Many did not give the concentration of the ethanol and some did not give suitable headings for the columns for recording the values of pH. Some teachers and centres reported that tube 6 (100% ethanol) gave a low pH reading. The Examiners think this is because samples were taken from the top of the tube rather than further down or after stirring the contents of the tube. Perhaps this should have been included in the instructions but it was not something that was noticed when trialling the practical. The Examiners solved this problem by giving a mark if the pH of tube 1 was lower than that of tube 5 (50% ethanol) which in almost all cases it was. No candidate realised that the concentration of the ethanol would be halved by the addition of glucose (marking point 4) and perhaps rightly so as the yeast cells had been exposed to the full concentrations for five minutes before the glucose was added.

(d) There were many excellent descriptions of the contents of the tubes; however, many did not distinguish between the bubbles forming in the body of the tubes and the foam or 'froth' (or 'throth') that forms on the top. Most gained full marks here as was the intention.

(e) Instructions 9 and 10 proved to be discriminating. Some candidates did not notice the difference between the samples when viewed under the microscope describing them as blue in each case. Others, who had followed this procedure when doing their planning exercise, had no problem with this and gave good, detailed answers in (g).

(f) A surprising number of candidates thought that ethanol 'breaks down' lipids into fatty acids and glycerol. Many of them saw the reference to the emulsion test and simply stated that 'ethanol emulsifies lipids'. One candidate tried three approaches: 'Ethanol breaks down lipids and causes them to dissolve. This emulsifies them.' Although the right answer is there, it is sandwiched between two wrong answers and no marks were awarded.

(g) This part question proved to be very taxing. The candidates experienced several problems. First they were confused by the results that they had collected and tabulated in (c). Some thought that the low pH was inhibiting the yeast in tube 1 because they were thinking about the effect of pH on enzymes. They did not notice the reference to carbon dioxide at the beginning of the question and apply their knowledge from Transport. Unfortunately some candidates recorded a pH value of 8 for tube 6 and explained the lack of activity in the same way. Some candidates had obviously not used methylene blue in any meaningful way in the preliminary work for their planning and so could not explain the results from (e). The appearance of the tubes (as recorded in (d)) gave candidates more information to use although, sadly, many did not refer to respiration or fermentation and bubbles of carbon dioxide that would have gained them two marks. Most commonly awarded were marking points 8, 9, 13, 14 and 16 which related to parts (d) and (e).

Some candidates took the hint from (f) and explained the effect of ethanol on membranes and showed an excellent insight. The planning exercise and pages 2 to 6 of the test were peppered with clues for this question! However, some of the answers were difficult to follow and the Examiners often had to tease out the marking points from amongst some confused responses.

(h) This format for the evaluation exercise proved to be very successful. Many candidates gave the old standby 'the temperature of the water bath decreased' which was suggested by the instructions and 'use a thermostatically-controlled water bath' as the improvement. However, reference to inaccuracy in measuring and using a graduated pipette had already been covered and was excluded from the question. This did not deter some candidates from discussing this limitation and improvement. Many candidates referred to the deficiencies of using the pH papers and thought using Universal Indicator solution and a colorimeter would be an improvement. The Examiners did not consider that this would work, so looked for a pH meter instead. Many gave this improvement.

Some answers to (h) were left incomplete and it was clear some candidates were rushing to complete the paper. However, there were many others who completed the whole paper and wrote extensively for (g) and (h).

Teaching tips

If candidates have difficulty writing explanations (as in (g)) advise them to look at the beginning of the question. This involves turning back several pages. There they will find clues for their answers as the introduction will tell them what the exercise is about. Candidates could be advised to divide their answer into sections. Here they could have put (c), (d) and (e) in the margin to make sure that they referred to each set of results and observations. Structuring their answer would help considerably.

Use past practical exercises, but replace the evaluation exercise with the format employed in this paper to train the candidates to make several different limitations and find an improvement to match each one.

Q.2 This question departed from the usual format of a prepared slide or temporary mount with or without a photograph or photographs. The Examiners were not convinced that this format proved to be very successful as they did not see the same range of marks here as they did on Q.1 or as they have seen on Q.2 in the past. However, they still saw candidates gaining full marks or nearly full marks, but not as many as in previous years.

(a) Many candidates knew about cilia and were able to gain two of the three marks. They had a variety of ways of expressing the coordinated movement of cilia as shown in Fig. 2.2. 'Mexican waves' were not uncommon and were accepted. Few candidates referred to the role of mitochondria in providing energy and some thought that they were writing about the trachea so included information about moving mucus.

(b) Here again many candidates followed the cues given in the question and wrote answers about 'engulfing' as they applied their knowledge about phagocytes from Transport and Human Health and Disease. Some saw 'phagocytosis' in the question and wrote about white blood cells or lymphocytes and the immune response. Alarmingly many thought the yeast were absorbed by osmosis down a water potential gradient.

(c) (i) Lysosomes were identified by many candidates who gave their site of origin as the Golgi apparatus. A third mark was available for any further descriptive comment such as the lysosomes 'pinching off' from the Golgi apparatus. A few candidates gained this mark.

(ii) This was rather a disappointing question. The most that good candidates could write was 'provide hydrolytic enzymes'. They did not go on to say what those enzymes hydrolysed in the digestion of the yeast cells although some did state that they would digest the cell walls. The Examiners thought the question was at fault here – it should have cued candidates to write about the hydrolysis reactions that they know from Section 2 of Biology Foundation. Candidates who did not do well on (i) often did not pick up any marks on (ii).

(d) Candidates either thought that the little vacuoles would carry undigested material to the cell surface and remove it by exocytosis or they thought they would take digested material to other parts of the cell. Those that followed the latter line of reasoning rarely explained that the surface area for absorption by diffusion would be greater by the formation of these vacuoles.

Perhaps if some had been drawn in Fig. 2.2 it might have prompted this explanation.

(e) Candidates expressed the ideas given in the mark scheme in a great variety of ways. Although the question asked for two advantages they did use a third mark to reward further detail. Some candidates came up with quite imaginative advantages and the Examiners were able to award all three marks available.

Teaching tip

This practical exercise using *Paramecium* and yeast stained with neutral red is one that centres used to do when studying protozoa many years ago. With the emphasis on biodiversity in the new specifications this may be worth using. When looking at *Paramecium*, or any other motile ciliate, it is a good idea to use methyl cellulose to slow them down. Make up a 2-3% solution and add to a small drop from the culture on a slide. It is a good idea to have a range of concentrations of methyl cellulose to use as some may be too viscous.

Paramecium can be obtained from suppliers, such as Blades Biological or Sciento

Blades Biological, Cowden, Edenbridge, Kent, TN8 7DX.
Tel 01342 850242; Fax: 01342 850924; e-mail: info@blades-bio.co.uk
website: www.blades-bio.co.uk.

Sciento, 61 Bury Old Road, Whitefield, Manchester. M45 6TB
Tel 0161 773 6338; e-mail sales@sciento.co.uk.

Another investigation worth doing with neutral red is adding it to a suspension of yeast. Candidates will discover that it is all taken up by the yeast cells as can be seen when spun in a centrifuge or filtered several times. If neutral red is added to some solutions of different pH it is possible to find the pH at which it changes colour. Yeast cells stained with neutral red can then be exposed to buffer solutions of different pH or to weak acids and alkalis and see what happens to their colour. Neutral red stains the vacuoles in yeast cells. The vacuoles are not simply 'bags filled with water' but act as an important part of protein metabolism throughout the cell. Like lysosomes they are filled with proteases. Yeasts can absorb proteins by endocytosis and break them down in the vacuoles perfectly mirroring what happens to them inside the food vacuoles of *Paramecium*!

2804: Central Concepts

General Comments

The Examiners felt that this paper was comparable in terms of difficulty to June 2006. The mean score was slightly lower than last summer and it appeared that candidates had more difficulty than usual in interpreting graphs, drawings and data. In both the extended answer questions there was a lack of precision when using biological terms. Both calculations (*Q.1 (d)* and *Q.6 (a)(ii)*) caused more difficulties than expected. The examination paper seemed of appropriate length and there was little evidence that candidates had run out of time. Candidates did less well on *Q.1*, *Q.2* and *Q.6*. There appeared to be more reluctant resit candidates this time than in previous examination series.

Comments on Individual Questions

Q.1 Success on this question was largely centre based. The Examiners reported that it was clear from answers to (c) which candidates had carried out practical field work as they were able to write knowledgeably about quadrats and transects.

(a) This was a good opening question and most candidates could describe accurately two effects of the pioneer community on the habitat.

(b) This was a more demanding question and only the most able candidates gained full marks. The Examiners thought that many did not see the command word explain as they simply described the information provided. The majority of candidates correctly related the increase in biomass to organisms increasing in number and size. The Examiners were looking for candidates to state that the increasing number and size of plants would lead to greater primary production. Many candidates stated organisms rather than plants and failed to gain the mark. Many candidates related the dip in the species diversity curve to increased competition principally from trees, leading to smaller plant species dying out. Candidates were given credit if they referred to the plateau being the climax community.

(c) There was considerable confusion between climax community and carrying capacity in (i). In section (ii), most candidates gained a mark for stating that the sheep and rabbits would eat or trample the saplings.

(d) Even though candidates were given clear instructions on how to carry out the calculation there was a surprising number of incorrect answers. Many did not include the results for bird's foot trefoil in the total number of hits.

(e) Candidates who were familiar with field work correctly stated that a transect would be carried out across the path to include non trampled areas at the edge. They described how a frame or point quadrat would be used and that either the number of individual plants or the percentage cover would be recorded for each sampling site. Good candidates stated that the transect would have to be repeated further along the path for reliability. Some thought that the birds should be counted obviously forgetting that bird's foot trefoil is a plant.

Teaching tip

If candidates cannot attend a residential field course or undertake a day's field work, they should carry out a small field work exercise to familiarise themselves with the concept of a transect and how to use frame and point quadrats. The fold out identification keys published by the Field

Studies Council are a useful resource for field work. They are available at:

http://www.field-studies-council.org/publications/foldout.aspx

Q.2 The Examiners reported that in general the answers to parts (a) and (b) were much weaker than expected. The concept of limiting factors in photosynthesis is one that most candidates will have studied at GCSE. However, many candidates experienced difficulty interpreting Fig. 2.1 and Fig. 2.2.

(a) The Examiners were looking for light intensity as the correct response in (i). No credit was given for 'light' unqualified. In (ii), many candidates correctly stated that some other factor would become limiting and the better responses mentioned the possibility of carbon dioxide concentration or temperature to gain full marks.

(b) It was clear that many candidates had not studied graphical representations of data from experiments on environmental factors that affect the rate of photosynthesis. Most candidates gained the mark in (i) for correctly identifying experiment 1. However, very few candidates could explain their answer in (ii). This question proved to be a good discriminator at the A/B grade boundary and only the most able candidates referred to experiments 2 and 3 to show that when either carbon dioxide concentration (experiment 2) or temperature (experiment 3) are increased, then the rate of photosynthesis is elevated above levels shown in experiment 1; this shows that either environmental variable could be limiting in experiment 1.

(c) Most candidates answered this section in terms of enzymes becoming denatured at higher temperatures. Those that went on to describe the change in shape of the active site and illustrated their answer by naming an enzyme involved in photosynthesis, such as rubisco, and identifying the reaction that would be slowed down gained full marks. Credit was also given for candidates who suggested respiration would be going on at a faster rate than photosynthesis and therefore net carbon dioxide fixation would decrease. Another way to approach the question was to state at higher temperatures transpiration rates would increase, therefore the plant would shut its stomata and carbon dioxide uptake would decrease.

(d) Many candidates correctly stated that a greater range of wavelengths of light would be absorbed by the leaf and because of this more light would be absorbed. Good responses went on to say that with the extra light energy, more ATP and reduced NADP would be made by the plant. The Examiners were pleased to see some candidates stating that less light would be reflected and this would increase the temperature of the leaf making conditions more favourable for the enzyme driven reactions of the Calvin cycle.

Teaching tip

In questions such as (c) where there are four marks, candidates should be encouraged to think of more than one approach to the answer. Also, when the concept of limiting factors is being taught, candidates should look at experimental data including graphs.

Q.3 The question gave the candidates the straightforward opportunity to express the extent of their knowledge without the problem of applying that knowledge to answer the question. The range of marks was high, suggesting that the question was a good discriminator.

(a) Not many candidates gained full marks. Few candidates referred to adenine being a nitrogenous base or a purine. The Examiners were looking for references to three phosphate groups not phosphate molecules. Some candidates misunderstood the difference between structure and function as they described the function of ATP. Diagrams were often adjuncts to the description and rarely gained additional marks.

(b) Most candidates gained at least two marks with the favoured responses being muscle contraction and active transport. Some candidates gave excellent examples of anabolic reactions. Weaker candidates often gave vague answers such as 'movement, warmth, growth and repair' that did not gain credit.

(c) Most candidates correctly identified the enzyme as ATP synthase. The Examiners also credited ATP synthetase and ATPase. In (ii), only the better candidates gained full marks usually by stating non-cyclic photophosphorylation, cyclic photophosphorylation and oxidative phosphorylation as three ways in which ATP is formed in a photosynthetic plant cell. Credit was also given for chemiosmosis and substrate level phosphorylation.

(d) Good candidates gave excellent, well organised answers and achieved high marks. The majority were unable to separate the various strands in the question. There was confusion between the roles of FAD, NAD and NADP. Linking NAD/FAD to respiration and NADP to photosynthesis was not common. There was a lack of clarity as to whether the carriers transported hydrogen ions, hydrogen atoms or electrons even though the information was in the question: 'FAD picking up electrons in cyclic photophosphorylation' or variations on that theme was a typical response. Many described reduction of the respiratory carriers correctly but they rarely quoted the numbers of FAD/NAD reduced at various stages. Some only wrote about photosynthesis thinking that respiration does not happen in a palisade cell; however, they still managed to bring FAD/NAD into the picture!

Teaching tip

It is important to stress that both photosynthesis and respiration occur within a photosynthetic plant cell. Past questions that might help to reinforce this are 2804 June 2006 Q.2 and 2806/01 January 2005 Q.2. Candidates could use these questions to study apparent and true rates of photosynthesis and the exchanges that occur between chloroplasts, mitochondria and the cytosol in a palisade cell.

Q.4 The Examiners were delighted to see many excellent answers to this question. Many candidates gained full marks. The concept of multiple alleles is taught very well.

(a) Most candidates were able to state correctly the possible genotypes of the chinchilla and agouti rabbits. The most common error was to repeat a particular genotype.

(b) A surprisingly large number of candidates were unable to identify the cross as a test cross or back cross in (i). The most common incorrect response was dihybrid cross. In (ii), there were excellent answers both with and without genetic diagrams. The Examiners were looking for three separate points in a candidate's answer. Firstly that the albino rabbit must be homozygous recessive, secondly that the Himalayan

rabbit can be either homozygous dominant or heterozygous and finally that to have any chance of albino offspring the female must be heterozygous and be carrying the albino allele.

(c) Candidates could gain a maximum of three marks for identifying factors that keep the rabbit population stable. The most common correct responses were predation, disease and competition for food or space. There were many excellent accounts of natural selection that explained how the frequency of advantageous alleles would increase in the gene pool or the frequency of disadvantageous alleles would decrease.

Teaching tip

Candidates should be clear of the difference between the terms gene and allele. When directional selection occurs, it is the frequency of alleles that alters, not the frequency of genes. Candidates will only gain credit in questions on selection if they refer to alleles. Candidates could be asked to work out how the frequency of genes would change. They would then realise that this does not happen and it is the frequency of alleles that changes.

Q.5 The topic of plant growth regulators has never been a favourite topic on this unit, but the Examiners hoped that with experimental data provided in Table 5.1 candidates would be able to make a sound attempt to the long answer question in (c). The Examiners reported that candidates who did make use of the data were rewarded with good marks, but those who chose to ignore the stem of the question and who did not refer to the data scored poorly.

(a) Most candidates gave light, water and gravity as three stimuli that plants respond to. Other correct responses commonly seen were touch, temperature and chemicals. The Examiners did not accept carbon dioxide as an example of a chemical stimulus.

(b) Many candidates gained full marks in this section. Phloem and diffusion were the two most common correct answers. Credit was also given to candidates who stated that plant growth regulators are transported in solution or within the apoplast or symplast.

(c) There were many excellent answers to this question. The quality of written communication was of a high standard and most candidates gained this mark. There were good explanations of the role of gibberellic acid (GA) in seed germination and many candidates gained a maximum of five marks. However, to gain full marks candidates had to make use of the data and also refer to the possible role of ABA. Prior knowledge of the role of ABA in seed germination was not expected, but candidates should have been able to deduce from the data that ABA reduces the production of amylase in seeds and has an antagonistic effect on GA. Candidates who went on to say that ABA reduces the rate of seed germination and prevents seeds germinating when conditions are poor were awarded marks. As is the norm in this type of question marks were awarded for data quotes. Many candidates referred to an anomalous result in the distilled water and/or GA plates. A considerable number also worked out an average value for the clear areas on each plate. Both these approaches gained marks. Good candidates compared the average size of the clear area in plates 2, 3 and 4 with the control.

Teaching tip

Candidates should be made aware that if the stem of the question states 'Using the data…' then marks will be awarded for making relevant data quotes in their answers. It is always useful to look at the pattern in the data to see if there are any anomalous results and then calculate mean values if not given. Anomalous results could be identified on the examination paper to show that they have not been included in the calculation of the means.

Q.6 The Examiners found no evidence that candidates were running out of time when they reached the final question on the paper and there were some excellent answers on renal physiology. Weaker candidates found this a taxing question as it demanded accurate terminology in the answers to gain the marks.

(a) In (i), candidates should have been able to observe that the afferent arteriole supplying blood to the glomerular capillaries is wider than the efferent arteriole carrying blood away from the glomerular capillaries by careful study of Fig. 6.1. This leads to a 'bottle neck' effect causing a high blood hydrostatic pressure in the glomerular capillaries. In (ii), candidates were asked to calculate the effective filtration pressure using the values on Fig. 6.1. There were very few correct answers. Effective filtration pressure is the difference between the blood hydrostatic pressure and the combined pressures of the fluid in the renal capsule and the water potential of the blood.

(b) In (i), most candidates correctly stated that protein molecules are too large to undergo ultrafiltration, but few said this was because they could not pass through the basement membrane. The Examiners did not credit basal membrane which was a common incorrect answer. In (ii), the Examiners were looking for candidates to state that with chronic high blood pressure the hydrostatic pressure in the glomeruli would be even higher than 8.0 kPa and that this would force proteins through the basement membrane. Credit was also given to candidates who stated that long term high blood pressure is likely to damage the basement membrane allowing proteins to leak through into the filtrate.

(c) The Examiners were looking for a detailed description focusing on the endothelium of the glomerular capillary with its numerous gaps; the basement membrane consisting of collagen and glycoproteins; and the epithelium of the renal capsule consisting of podocytes with their 'foot processes'. Candidates should be familiar with this detail from studying the histology of the kidney.

(d) The Examiners were surprised by the relatively large number of candidates who are under the impression that ADH inhibits the reabsorption of water in the distal convoluted tubule and collecting duct. They of course went on to say that the effect of drinking coffee is to produce small volumes of concentrated urine. These candidates failed to gain any marks. Those candidates who understand that ADH increases reabsorption of water and how it does this correctly stated that a large volume of dilute urine would be produced and gained full marks.

Teaching tip

When studying ultrafiltration, candidates should treat this in a quantitative fashion. They should be given values to calculate the effective filtration pressure. It will improve their understanding of the process. Similarly, they should do this when studying filtration elsewhere in the circulation.

It is also a good idea to use some 3D diagrams and drawings to show the relationship between the structures described in (c).

2805/01: Growth, Development and Reproduction

General Comments

This paper attracted a wide range of marks and there were very few blank spaces on the paper. Most candidates were able to write something for nearly every question, which enabled the Examiners to assess and credit their performance effectively, including those candidates who were struggling. The general standard of the answers was good, demonstrating the high quality of many of the candidates sitting this paper.

In those parts of questions that required the recalling of learned information, it was pleasing to note that a large proportion of candidates scored well, demonstrating a good level of preparation and interest. However, those parts of questions that were synoptic proved a greater challenge and were answered the least well.

Teaching tip

Candidates could be encouraged to prepare concept maps or mind maps for various topics during revision; these are particularly effective in sections of the module specification where links need to be made to topics in the AS modules and in *Central Concepts*. They are also useful to link together topics that have been taught by different teachers.

Information about concept mapping and mind mapping can be found at:

http://users.edte.utwente.nl/lanzing/cm_home

and

www.peterussell.com/Mindmaps/HowTo

Several questions involved dealing with data. Many candidates handled the data well and gained credit. Others failed to gain credit by not quoting figures from graphs or tables. Candidates should be aware that when questions are worded to include 'using the data from Fig. 1.1' and similar phrases, credit will be given for inclusion of data, with appropriate units, from the figure.

Attention is also drawn to the mathematical requirements on page 113 of this specification.

Candidates should practise looking at graphs and tables. They should appreciate the difference between 'describe' and 'explain' and be asked to identify the trends and to quote data in support.

Comments on Individual Questions

Q.1 This question was generally well answered by most candidates, with marks ranging from zero to full marks. Those candidates who were well prepared scored particularly well on (a) and (b). Part (c) was also well answered by the majority.

(a) Most candidates were able to gain marks in (i), with well prepared candidates gaining four or five marks. Less well prepared candidates gained at least one mark. Marks were lost due to incorrect and confusing spelling: for

example, there was some confusion between spermatozoa and spermatogonia. Many candidates gained maximum marks in (ii). Marks may not have been awarded due to vague terminology, such as testosterone affects spermatogenesis, rather than stimulates. Also many candidates confused terminology, assuming ICSH was the same as FSH; similarly, there was some confusion between Leydig cells and Sertoli cells. However, the principles of negative feedback were well understood and applied in this context.

(b) Most candidates answered this well and demonstrated at least partial knowledge on the route taken by mature spermatozoa prior to ejaculation. All of the marking points were seen; marks were lost because structures were placed in the wrong sequence. Many candidates exhibited wide knowledge about the secretions from seminal vesicles, prostate and Cowper's glands which was beyond the scope of this question.

(c) There were many interesting and thoughtful suggestions on how to improve a further study of the type illustrated in part (i). Many different examples of the identifiable variables were credited, also many good suggestions on how further study groups could be subdivided according to age and other factors. Incorrect answers were those which implied going back in time and changing the study quoted, or those which would have been impossible to impose upon a study group made of humans, such as 'expose the men to radiation from other sources'.

Part (ii) was generally well answered with the vast majority gaining the available mark. The most popular correct answer referred to mutation in the DNA. Marks were not awarded for vague answers such as 'sperm become damaged'.

Q.2 (a) The mark for this part of the question tended to reflect the candidate's performance on the question as a whole. Most candidates mentioned meristematic tissue and at least one other marking point. Many candidates were able to explain the importance of a sterilising agent, with the stronger candidates describing aseptic technique. The majority of candidates were able to identify cytokinins and/or auxins as growth regulators / promoters / hormones, but tended to confuse their functions or give vague answers about 'causing growth'. The second most common observation was that cytokinins stimulate cell division. When considering the purposes of magnesium, nitrate ions and sucrose, the better prepared candidates had more than enough information in their answers, but it was impossible to give credit where all three substances were lumped together and in terms such as 'nutrients needed for the plant to be healthy'. Each substance needed to be considered separately to gain credit. Many candidates thought that energy is needed for respiration.

(b) In (i), candidates often knew what they wanted to convey but failed to be specific enough to gain credit. Most recognised that grafting is more rapid, but a consideration of desirable characteristics from both stock and scion was often included as the second point, and was therefore rejected unless compared with production from seed. Many knew that size of fruit and yield are important in (ii), but failed to qualify or quantify them. However, there were some good and complete answers where credit could be given. In (iii), all but the weakest candidates understood the principles here, although their expression could have been more precise. Few candidates specifically referred to xylem and phloem vessels being lined up or fusing, but referred to stock and scion fusing. Few candidates made reference to the prevention of infection. Again, many candidates lost marks by using the vague term nutrients, rather

than referring to water, solutes or specifying a particular solute when considering transport in the vascular bundle.

Again, credit could be given for understanding that the stock would produce inferior fruit and that its branches would compete with the scion for resources in part (iv). However, the frequent use of nutrients moving from stock to scion may be a worrying indication that some think that plants feed from the soil.

Q.3 (a) ximately 50% of candidates scored a mark in (i). Many gave structures which were completely unrelated to pregnancy; the most common incorrect answer cited the anterior pituitary as the site of production of chorionic gonadotrophin (CG). Part (ii) was generally well answered, candidates gaining credit for correctly detailing the role of CG in preventing menstruation. Some candidates incorrectly stated that CG inhibits oestrogen, and therefore prevents the build up of the endometrium so that it breaks down.

(b) Most candidates correctly concluded that molecules of CG are small, but many failed to be more precise and give a relative molecular mass or to make reference to ultrafiltration in the kidney. Several stated that the molecules are too big to be reabsorbed in the kidney, indicating a reasonably common misconception.

(c) Most candidates found this particularly difficult. Either candidates completed the flow chart with all three blood vessels correct or none correct. Most candidates could not remember the circulatory system well enough and lost these relatively easy synoptic marks.

(d) Generally candidates described and interpreted the events portrayed in Fig. 3.2 and in the text so gaining between two or three marks. Disappointingly few candidates were able to give further details on antigen/antibody interactions or structure; in fact very few included the word antigen in their descriptions. The most common misunderstanding about the pregnancy test was that the combination of CG with the immobilised antibodies enabled a colour change, rather than the combination of the CG/antibody complex with the antibodies.

Q.4 (a) The vast majority of candidates did the calculation correctly in (i). Any marks not gained were generally due to candidates not reading the question correctly and using the wrong figures to begin with, although this was very rare. Answers to part (ii) varied widely between maximum marks and zero. Many candidates were able to describe how temperature and light affect germination by correctly noting that increasing temperature increases both the percentage of seeds germinated and the rate of germination. Many gave appropriate values from the table. Some candidates were able to describe correctly the effect of increasing temperature on enzyme action. Candidates were less able to describe and explain the effects of light. It was hoped that candidates would recognise that the figures for percentage germination and time taken for germination varied very little when in the dark or in the light. This was generally not the case; once on the wrong track candidates incorrectly deduced that light is needed for germination and so failed to gain marks here. Credit was available for correct use of figures here also.

In both conditions, some candidates tried to link the conditions of light and increased temperature to breaking dormancy, ignoring the fact that the minimum percentage germination was high at 84%. Very few candidates observed that light had little effect on germination in this case and therefore few gave creditable explanations.

In (iii), many candidates correctly identified oxygen and water as being necessary for seed germination. Almost exclusively, all incorrect responses referred to factors sometimes required to break dormancy, such as prechilling and scarification.

(b) Most candidates scored full marks for correctly giving reasons for the gardening tip supplied. A range of answers was given and rewarded. The most common correct responses referred to lack of chlorophyll or chloroplasts and hence photosynthesis due to the absence of light. Commonly, reference was made to the shoots elongating in an attempt to reach light, but surprisingly few gave the descriptive term etiolation.

The most common error was that candidates often referred to the case in light, and then omitted to relate this to the case described, namely germination and initial growth in the dark. For example some wrote: 'light is needed for the development of chlorophyll and for photosynthesis, so that glucose can be produced as a respiratory substrate' without saying that this does **not** happen and leaving the Examiner to infer that this does not happen.

Q.5 Overall, candidates scored quite well on this question with the majority gaining at least half marks. Most candidates seemed to understand the questions and only failed to gain marks due to lack of detail.

(a) Most candidates defined growth as the irreversible increase in dry mass, the most common error was to state that growth is defined as an increase in mass, without the qualifying reference to water content. Very few linked growth to an increase in cell number.

(b) This part was not answered well. A few candidates gained a mark for stating that relative growth curves are more useful for comparing growth at different times during development. Few candidates were able to make the link with comparisons to other individuals or species. A few did state that it shows the efficiency of growth. Candidates found it particularly difficult to express themselves here. The majority simply wrote a definition for relative and absolute growth curves instead of answering the question.

(c) Most candidates got at least one mark in (i), either for noting that ultrasound can be used or using length measurements of the fetus. Some candidates also mentioned repeat measurements. However, few were specific as to which part of the fetus should be measured. Many mentioned weighing the mother before she was pregnant or measuring the size of the 'bump'. Candidates should be aware that the correct terminology should be used even when discussing everyday activities such as this.

Nearly all candidates did well on part (ii), most gaining at least one mark. The majority said that the mother drinking alcohol or smoking will affect the developing fetus; some discussed the further consequences of smoking in detail and gained an additional mark. Some candidates discussed thyroxine and growth hormone and their effects; however, none discussed poor antenatal care or advice.

(d) This part questioned candidates' understanding and required them to link together ideas from other sections. Candidates did not score highly when referring to growth hormone (GH). Some listed the effects of GH including stimulation of protein synthesis and stimulation of bone and muscle growth.

Few discussed the use of fat as an energy source or made reference to increased cell division, although many stated or described surges in GH causing growth spurts. Unfortunately, many candidates also stated incorrectly that GH increases development of the brain and causes the secondary sexual characteristics.

art of the question on the roles of FSH and LH was answered better. The main difficulty was that candidates lumped together the hormones FSH and LH and therefore were not able to gain the marks available for discussion of the roles of each. For example, 'FSH and LH cause testosterone to be released'. However, these candidates were able gain credit for discussion of the more general points, such as secondary sexual characteristics. Generally speaking, candidates were divided into two groups: those who discussed the roles of the hormones in the menstrual cycle without making specific reference to puberty or the start of menstruation, and those who discussed the start of menstruation and the secondary sexual characteristics without detailing the menstrual cycle. Only a few candidates made the connection that FSH and LH cause puberty due to increased concentrations of these hormones.

It should be noted that in this type of question where candidates are asked to detail the action of a hormone, credit will only be given for use of appropriate terminology such as stimulates, causes and inhibits and not for vague statements, such as affects, is involved in and is used to, which do not state exactly what happens.

Q.6 This question was largely synoptic and was answered well in parts. Again, most candidates were confident enough to write something and only encountered problems when they did not fully implement what was required of them.

(a) In part (i), most candidates were able to suggest how milk could become contaminated and many wrote about bacterial infections in the cow being transferred to the milk. Also contamination of milk due to the use of unsterilised equipment, dirty hands and storage tanks was discussed, along with exposure to airborne contamination. In some cases the points were discussed in vague terms or candidates suggested only one cause of contamination. Candidates generally were able to score maximum marks in (ii) as the vast majority described DNA replication and bacteria dividing by binary fission. Many candidates were very confused about the exact mode of replication, however, and referred to the nucleus dividing. Many candidates appear to have a poor understanding of the structure of bacterial cells.

(b) Only the minority of candidates were able to gain more than one mark in part (i). The question asked for two practices that should be put in place in the storage of milk; many candidates failed to do this. For example, the Examiners expected a statement such as 'store the milk for as little time as possible' rather than 'there are more bacteria produced with time'. The one mark gained was usually for the correct statement on storage time given above; candidates often suggested storing at low temperatures, but were not more specific. The data references here were often poor. Many candidates made no reference to the data at all and many of those who did gave incomplete or inaccurate comparisons and so failed to gain credit. The better answers identified the relevant curves and gave correct and valid comparisons on the number of bacteria at specific times.

Although there was much confusion on the method used to determine the number of live bacteria in the milk sample in (ii), many candidates were able to

gain credit by making general references to good experimental technique, such as serial dilution, the use of repeats, the use of a control and using a known volume of sample. Many candidates were also clear that a viable count should be used. Various methods were then chosen to carry out this viable count and many candidates were able to describe correctly how to prepare a serial dilution and to inoculate a suitable agar plate with the milk sample. After incubation, the number of colonies produced could be counted and the count multiplied up by the dilution factor. Other methods given included use of a haemocytometer slide under a microscope to count individual bacteria and turbidity methods – nether of which were appropriate. Wherever possible, positive marking was employed to ensure candidates gained credit for understanding good experimental procedure.

(c) Many candidates were able to make good use of the insert depicting part of the human breast and were able to draw conclusions on similarities and differences in the secretion of thyroxine and milk. Many scored full marks whilst several scored zero.

Many candidates noted that both thyroxine and breast milk are secreted from epithelial cells and are stored or pass into a lumen. Many stated the involvement of the hypothalamus and pituitary gland in controlling these processes, but very few specified the anterior pituitary. No other similarities were offered and many responses were too vague, such as 'both secreted by glands' or 'both controlled by hormones'. More pleasing answers were given in the section on 'differences' and many different points were credited. Several noted that milk secretion is exocrine, whilst thyroxine secretion is endocrine, or more simply stated that the former is secreted into a duct, the latter into the blood. Surprisingly few candidates made the point that milk is only secreted in females; several stated that milk is only produced during pregnancy, rather than after the birth of a child. The good quality of many of these answers was very pleasing.

2805/02: Applications of Genetics

General Comments

Many candidates had been well prepared for this paper and showed good knowledge and understanding of the topics tested. Many had also been well prepared for using that knowledge when presented with unfamiliar situations and data.

As in previous years, many of the questions that included synoptic material, which make up 25% of the total marks, were answered less well than those on topics exclusive to this option module. Most candidates answered all parts of all questions and did not appear to have suffered any lack of time. There was no particular pattern to the sections left blank by individual candidates. All questions allowed discrimination between candidates, with marks spread over a wide range. The mean mark for the paper was lower than expected and this was most likely due to the effect of Q.1 (c)(iii).

Technical terms were mostly used correctly, but candidates who confuse the terms gene and allele, homologous and homozygous, or chiasma and crossing over in a genetics paper put marks at risk.

There was an unfortunate error at the beginning of Q.4 that was spotted by at least one candidate. Table 4.1 shows the target sites of three restriction enzymes not four.

Comments on Individual Questions

Q.1 Many candidates found this to be an approachable first question.

(a) A pleasing number of candidates were able to explain the meaning of the terms linkage and crossing over, but candidates should be reminded that attempting to explain, say, linkage, by saying that the genes are linked is unlikely to attract any marks. Some candidates' explanations of crossing over made it indistinguishable from translocation.

(b) A majority of candidates readily described emasculation, pollination by hand and isolation of plants or flowers. However, a large number of candidates described keeping whole plants sealed into polythene bags for significant periods, rather than bagging flowers. Some candidates strayed into test crossing their plants.

(c)(i) A pleasing number of candidates were able to suggest suitable chance effects such as random fertilisation or the random selection of 50 offspring from each cross. Others, recognising linkage, but forgetting that the question asked about the numbers of one of the parental classes, simply answered 'linkage' or 'crossing over' with no further explanation.

(ii) A large number of candidates had no difficulty in recognising the recombinant classes and performing the calculation.

(iii) The question asked for annotated diagrams of chromosomes to explain the results of the test crosses shown in a table. A significant number of candidates drew genetic diagrams with Punnett squares. Of these, many showed an unlinked dihybrid cross giving a 9:3:3:1 ratio of offspring with no relevance to the data given. Marks were awarded to candidates drawing genetic diagrams in which the linkage was clearly shown: e.g. (AB)(ab) x (ab)(ab). It was very difficult, in some of the answers showing chromosomes, to determine whether the candidate was showing two chromatids of one chromosome or the homologous pair of chromosomes. What appeared to be a centromere was often labelled 'chiasma'.

Teaching tips

- Remind candidates that information given in the question is there for a purpose.
- Encourage the use of brackets in showing linked alleles: (AB)(ab) not AaBb.
- Encourage candidates to draw homologues, each with two chromatids, when demonstrating crossing over.
- Identify items clearly when annotating a diagram.
- Use string, wool or plasticine models of chromosomes when teaching crossing over to reinforce understanding of the process.

Q.2 A very pleasing number of candidates proved to be conversant with the procedures involved in selective breeding.

(a)(i) Attempts to outline the principle of selective breeding produced at least one mark for many candidates. Some candidates found it difficult to express the idea of selecting as parents those individuals which show the desired phenotype to a greater degree than other individuals.

(ii) A large number of candidates were able to explain the use of progeny testing in selective breeding, although the wording used by some suggested that it was a male's ability to mate that was being tested rather than his ability to sire offspring with desirable phenotypes. Some candidates merely 'looked at' the progeny, with no suggestion of assessing or measuring the phenotypic trait under review. Candidates should be aware of the difference between sex limited and sex linked traits.

(b) Most candidates based their answers on the example of breeding Siberian foxes that was provided and seemed to have enjoyed so doing, although some foxes became wolves by the end of the process. Weaker candidates often selected suitable animals, but then 'selfed' them or forgot to mate them. Some took up a great deal of space writing about IVF procedures. A few candidates concentrated on procedure and offered no explanation of the differences between selectively bred and wild animals. A few candidates focused largely on explaining heritability.

The mark for the quality of spelling, punctuation and grammar was awarded to the majority of the candidates, although there were very many selectively bread animals.

Teaching tips

Point out to candidates that in an answer involving extended writing it is possible to use bullet points, or to divide the page into a table, provided that each bullet point, or entry in a table, is a full sentence.

There is a very cute photograph of these Siberian foxes at:

http://www.modernpooch.com

Q.3 Some candidates were determined to convert the procedure shown in the diagram into IVF using male and female buffaloes.

(a)(i) The majority of candidates suggested treating the cow with hormones to make her superovulate. Some weaker candidates thought that the cow should then be inseminated.

(ii) Only the stronger candidates remembered the existence of mitochondrial DNA and realised that although the nuclear DNA of the cloned embryo was only from the buffalo, some mitochondria were buffalo and some cow. Weaker candidates insisted that there were still chromosomes in the cow cytoplasts and talked about mutation or about meiosis and recombinants.

(iii) A majority of candidates recognised that the surrogate was treated with hormones so that an embryo could successfully implant in the uterus. Only the strongest mentioned the effect of the hormones on the uterine lining. Some wrote that the hormones prevented the surrogate from rejecting the embryo as foreign. Some thought that the purpose of the hormone treatment was to get the surrogate to superovulate.

(b) Those candidates who took note of the flow diagram provided realised that no female buffalo, let alone fertile female buffalo, was needed and that genetic diversity could be maintained by cloning from all existing animals. Weaker candidates concentrated on the surrogates and that no female buffalo would be put at risk in mating or pregnancy, but seemed to think that the starting point was fertilised buffalo eggs.

(c) A large number of candidates were able to give three ways of setting up a gene bank for the buffalo, although some candidates extracted and stored DNA. Several, careless of the last four words of the question, wrote 'botanical garden'. The two word answer 'frozen zoo' needed more information.

Teaching tips

Remind candidates to look carefully at any diagrams, graphs or data given. A question that then refers to that information is not an open invitation to write anything that the candidate knows about the topic. Candidates could be given the information and the diagram (without the questions) and be asked to describe and explain the biological principles involved. Then they should look at the questions and decode what information is required to answer each part question.

More information about this interspecific nuclear transfer can be found at:

http://www.newscientist.com/article.ns?id=dn2670

http://www.publish.csiro.au/?paper=RDv16n1Ab57

Q.4 A pleasing number of candidates were still familiar with the gene manipulation involved in the synthesis of human insulin by bacteria from Biology Foundation.

(a)(i) Many candidates, looking at the diagram provided, described two characteristics of a restriction enzyme's target site for two marks, but some thought the question referred to the enzyme's active site. A common mistake was to state that the target site consisted only of the three or four nucleotides of the sticky ends.

(ii) Some candidates became entangled in sticky ends, claiming that because the ends left by the two enzymes were the same, then they could not join. Some thought that one of the enzymes left blunt ends. Very few candidates stated that the two enzymes left the same sticky ends, but a pleasing proportion joined the sticky ends through hydrogen bonding between complementary bases.

(iii) A number of candidates ignored or overlooked this question. A surprisingly large number were deluded by the coding in the middle of the strand into cutting the DNA in three places, not two. Some cuts were made showing blunt ends, but the enzyme makes a staggered cut.

(b) Some very good answers were seen, drawing on synoptic material and describing the use of several enzymes. Weaker candidates reiterated the information they had already given in (a)(i) or described the roles of restriction enzymes in their bacterial source.

The mark for the quality of the use of scientific terms required a clear description of the roles of different enzymes with appropriate use of terms, such as endonuclease, DNA ligase, terminal transferase, reverse transcriptase, DNA polymerase, sticky and blunt ends, nucleotide and base.

Teaching tip

Remind candidates that an answer may need to be inserted into a diagram or table and not just to look for dotted answer lines. When there is a mark in brackets at the right hand side, then an answer is needed somewhere.

Q.5 There was considerable confusion about prokaryotic and eukaryotic resistance and also about the difference between resistance and immunity.

(a)(i) Despite the first sentence on the page, the wording of this question and their knowledge of cells and malaria from the AS course, a number of candidates immediately wrote that Plasmodium was a prokaryote and then went on to describe antibiotic resistance in bacteria, with R plasmids and

conjugation, horizontal and vertical transmission.

Candidates who avoided this heffalump trap mostly referred to mutation and survival of resistants. Stronger candidates continued with mention of natural selection, selective agents and selective advantage.

(ii) This question was often done badly. Forgetting any information about vaccines from the AS course, candidates converted this question into one of resistance to the vaccine (often calling it a drug or an antibiotic). Mosquitoes featured in some answers. Only the strongest candidates mentioned that the parasite was hidden from the immune system inside cells. Those who knew something about immunity got to the idea that there were so many antigens that a vaccine would be difficult to produce.

(b)(i) Some candidates simply named a mutation without any indication of its effect, but a pleasing number of candidates were able to describe a suitable mutation resulting in no production at all or production of a shortened or different protein.

(ii) A large number of candidates focused on the mutated transmembrane protein and suggested that therefore there was no binding to the red cell, or that it was an essential channel, carrier or pump. A few suggested that if the parasite did not multiply in the liver it would not be available to infect red cells. A surprisingly common answer amongst weaker candidates, forgetting AS knowledge of malaria, was that there was no infection because red cells do not have a nucleus, that haemoglobin is too acidic for the parasite or that oxygen (or iron) killed the parasite. Red cells often had cell walls.

(c) Most candidates concentrated on three obvious points from the data: that 100% of the mice became resistant when two booster inoculations were given; that when only one booster inoculation was given the percentage of resistant mice fell to 70% and that there was no need to have more than 10 000 mutants in each inoculum. A common weak answer ran as follows: 'It works because when the mice are not inoculated they all get infected and the more they are inoculated the better it works'. Some candidates appeared to think that the percentage values given represented infected mice, rather than protected mice. A small number of candidates thought that the data showed that the mice caused the reduction in numbers of the mutants. Mice salivary glands featured in some answers.

Teaching tip

Remind candidates that 25% of the marks on an option paper, such as this, are synoptic, and that the material concerned may come from any part of the AS course or Central Concepts. For further information about malaria vaccines see the teaching tip for Q.6 of Human Health and Disease.

Q.6 Candidates who were familiar with an immune response (Human Health and Disease) and with the regulation of blood glucose concentration (Central Concepts) were able to use that information in this question.

(a)(i) Some very good answers were seen to this question. Errors included thinking that the HLA alleles controlled blood type or that they coded for antibodies rather than antigens. Some candidates thought that it was the alleles, displayed on the cell surface, that were rejected. Some islet cells had cell walls.

(ii) Again, some very good answers were seen referring to the number of loci, their linkage, the number of alleles at each locus and the number of possible combinations of these. Some candidates also mentioned the shortage of registered donors.

(b) Most candidates realised that the higher the blood glucose concentration, the higher the concentration of insulin. A few candidates had this cause and effect the wrong way round. Stronger candidates referred to the promoter switching on transcription. A pleasing number of answers included appropriate reference to the figures given.

(c) Most candidates concentrated on the removal of daily insulin injections and the improvement in quality of life. A few raised ethical objections to the therapy. Some who focused on the fluctuations in blood glucose shown in the graph and the time taken to reach normal concentration had forgotten what happens normally after a glucose meal. The insulin was often said to be 'breaking down the glucose'.

Teaching tip

Remind candidates to use units when quoting from numerical data.

2805/03: Environmental Biology

General Comments

Overall the candidates performed well in the paper with many scoring good marks on all questions. Candidates were able to answer parts of each question set and there was not one area that was poorly attempted. Both extended answer questions were tackled in sufficient detail although many found gaining the quality mark for use of scientific terms in *Q.2 (d)* quite difficult.

Recall from AS and *Central Concepts* was better than in the January examination, but there were occasions when candidates did not link the underlying biological principles to the information provided.

For the questions involving the use of data and graphs, candidates performed well and used the data accurately and appropriately. Candidates performed poorly when answering questions based on practical knowledge; it was evident to the Examiners that candidates in several centres have not done little or no field work.

Comments on Individual Questions

Q.1 This question centred on a comparison between soils in Malaysia and the UK.

(a) Most candidates were able to describe at least one method of soil pH measurement. Very few described how equipment would be calibrated or the importance of taking repeat measurements. It is important that candidates stress that to calibrate a pH probe or a pH meter they should use solutions of known pH to act as standards.

(b) This question produced some good responses with many candidates relating the percentage of clay in the soil to the decreased permeability. Many went on to describe the permeability with reference to particle size and also linked available air space to the degree of water percolation.

(c) This was a poorly answered synoptic question with very few candidates making the links between waterlogged soil, low oxygen availability and reduced aerobic respiration for active transport. Less active transport in the roots would result in a reduction in ion uptake by the plants. Many candidates answered this question with reference to osmosis and diffusion and hence scored poorly here.

(d) Candidates offered very limited responses to a fairly straightforward question into the effects of acidification. Very few made reference to low pH and aluminium ions and their subsequent effects. Explanations of the effects lacked detail and were vague. Most responses for the explanation into the effect on growth of forest plants were simply statements regarding damage to leaves. This was a poorly attempted question.

(e) Colour differences in soil are due primarily to the mineral and organic matter content or a result of the underlying bedrock. Many candidates made reference to iron being a mineral that would have coloured the soil red.

Teaching tip

It was clear from many of the candidate responses for this question that few centres had carried out soil analysis and used simple techniques to determine factors such as soil pH. Inexpensive apparatus can be used by candidates to practise techniques using local soils. This will give them a greater appreciation of the skills involved in soil analysis.

The following website:
http://www.bbc.co.uk/gardening/htbg/module1/soil_types1.shtml

contains some useful information for students as an introduction to soils and their properties.

Q.2 The question tackled a variety of issues from Section 5 of the specification for the option module.

(a) Candidates showed a good understanding of CITES and the issues regarding endangered species. Most candidates could explain that an endangered species is one that has a low number of individuals and that has reached a point whereby extinction is likely.

(b) The CITES register does not ban hunting or poaching but seeks to place limits or restrictions on trade and so prevent the destruction of a particular species. Many candidates produced some detailed responses here.

(c) This question was well attempted by most candidates with many correctly answering this from a synoptic point of view. Many linked population separation and loss of genetic diversity, but few then went on to discuss this in any more detail with reference to the effect upon the musk deer species. Many candidates confused allopatric and sympatric speciation and the level of detailed knowledge from Central Concepts was limited.

(d) Most candidates were able to describe the problems associated with the reintroduction of captive bred deer into the wild. Few, however, described the details of how such a programme might be set up. The use of scientific terms was very limited and few candidates were awarded the quality mark. This question should have been accessible to the whole range of candidates as has been the case in the past. The Examiners were disappointed to see such poor responses.

Teaching tip

There is some excellent information at
http://www.ukcites.gov.uk/default.asp

and also in

Spellerberg, I.F., Hardes, S.R. 1992. Biological Conservation in Focus. Cambridge University Press. ISBN 978-0521397865.

These sources will help to further develop candidates' understanding of the topics of endangered species and conservation. Furthermore, there is a good example of the effects on allopatric speciation in lions in the Ngorongoro crater in Tanzania. There is much evidence and data that

can be obtained on this study such as found at:

http://www.ntz.info/gen/n00443.html

Q.3 The question centred on nitrous oxide which is an ozone depleting gas, a greenhouse gas and a cause of acid rain.

(a) This question involved candidates reading the information regarding the grassland study carefully. Many identified variables but reproduced information in the stem of the question and as a result did not score highly here. Most candidates identified variables, such as size of plot and time of treatment, which would have been important in ensuring that the results were valid.

(b) In (i), most candidates were able to explain the importance of plot **A** acting as a control plot allowing a comparison to be made and the background level of nitrous oxide to be calculated. There were many good answers to (ii) with candidates showing excellent knowledge and understanding of the nitrogen cycle and associated bacteria. There were many references to legumes and also to named bacteria.

(c) Candidates were able to identify two other possible sources of oxides of nitrogen and it was good to see many different responses given here.

(d) Responses to this question were often very detailed with many linking a rise in nitrous oxide to an increase in global warming. Consequences of this were then discussed in great detail. Candidates also correctly linked possible consequences to an increase in acid rain and ozone destruction.

Teaching tip

This question involved the gas nitrous oxide that can also destroy ozone in the upper atmosphere. The following site:

http://www.ciesin.columbia.edu/docs/011-466/011-466.html

describes how this process can occur and why emissions of nitrous oxide need to be regulated. Q.3 could be used as a lead into the teaching of climate change, global warming, acid rain and ozone depletion and is a different angle from the usual route of carbon dioxide and CFCs.

Candidates could be set the task of compiling a table to compare the main gases that have effects on the atmosphere. A good place to start is the Atmosphere, Climate & Environment Information Programme run by the Atmospheric Research and Information Centre (ARIC), at Manchester Metropolitan University:

http://www.ace.mmu.ac.uk/index.html

Q.4 Recycling is a topical subject and much in the news. Candidates had few problems with this question.

(a) Candidates were awarded one mark if part of the calculation was completed correctly and there was much evidence to suggest that many did not have a

calculator as they showed their working, but failed to write down the answer.

(b) This question was answered well by most candidates with many scoring highly. It was pleasing to see many candidates using local examples of recycling schemes as well as examples of the re-use of materials. Many used the example of labels for re-using envelopes.

(c) Incineration of waste and its associated problems was the most common response given by candidates here. Many incorrectly linked incineration with the release of methane and then went onto discuss the effects of global warming. Methane is not the main gas released during incineration of waste. Very few candidates cited any other form of waste disposal such as sea dumping.

(d) Most candidates produced well structured answers here with almost all awarded the mark for quality. Many described the process of land reclamation from former industrial sites from the first stages of assessment through to removal of industrial waste to the planting of large shrubs and trees. Some candidates deviated here and went on to discuss succession and re-worded answers to questions from earlier papers. Overall though this was a topic area that seems to be well covered in most centres.

Teaching tip

Q.4 was well done by many candidates and there is a wealth of information to aid the understanding of the issues relating to recycling and waste reduction. The following websites:

http://www.recycling-guide.org.uk

and

http://www.recycle-more.co.uk

are good starting points as is this guide:

Reduce, Reuse, Recycle!: An Easy Household Guide by Nicky Scott (published by Green Books in 2004. ISBN 978-1903998403). It would be good to introduce different methods of waste disposal to candidates and consider their detrimental environmental effects. There is much evidence on the dumping of munitions and military hardware in the North Sea and this is a different route to use when studying this topic area. The following website:

http://www.manxman.co.im/cleague/archive/bombs.html

has interesting case study material for students to examine and evaluate.

Q.5 This question adopted a novel approach to environmental biology.

(a) This was generally well done with most candidates scoring at least one mark for suggesting either that ecosystems are always in a state of change and therefore it is difficult to provide a value, or that it is simply impossible to estimate certain services and so rate ecosystems accordingly.

(b) This involved candidates thinking carefully about the nature of the data and piecing together clues from the information in Table 5.1. Many missed the key statistic showing that open oceans are so vast and therefore much more likely to have the

greatest contribution to the total value of all ecosystems surveyed and reported in Table 5.1.

(c) Most candidates gave more than two reasons why tropical rainforests might have a higher estimated economic value than temperate forests with many citing the examples of potential medicinal cures, value of hardwoods and also the importance of agriculture. There were many examples given by candidates to justify and illustrate their answers, such as specific types of agricultural businesses that occur in tropical rainforests.

(d) As in part (c) this was well done by many candidates with most identifying the importance of the alluvial deposits for agriculture.

(e) It was pleasing to see candidates scoring highly in this topic area and describing in some detail how fisheries could be managed sustainably. Most were able to explain quota systems and how fleet sizes could be managed to protect fish stocks. This seems to be an area of the specification that is well taught in centres and accessible to most candidates.

Teaching tip

In this question, candidates had to use data and comment on the value of ecosystems. This is an important skill to master especially when considering the conservation needs and status of individual species or whole ecosystems. The following website:

http://www.ecosystemvaluation.org/big_picture.htm

is an excellent introduction into this complex field of environmental biology.

Q.6 Biodiversity is a key topic in the new AS specifications. This question made candidates think about biodiversity in the context of agriculture in the UK.

(a) Candidates approached this from several different angles and the mark scheme was sufficiently broad to allow access to high marks. Many described how to take a belt transect through a field with strips and through a field without strips and at intervals use a quadrat to assess biodiversity. It was interesting that many candidates described more than one method in their answer and often confused the application of a particular method. It was evident from looking at the responses from many centres that field work is not being taught other than from a text book. This question is very straightforward and should have posed little trouble for a candidate who has developed practical skills in field work. See the teaching tip for Q.1 of Central Concepts.

(b) This question was answered in quite some detail by most candidates with many discussing the effects of competition between hedgerow plants and those in the field. The candidates discussed what the plants were competing for.

(c) This was answered poorly with few candidates looking beyond the destruction part in the question. Very few responses centred on the effects on pollinators or predators and the consequences for ecosystems.

(d) Part (i) was attempted very well and there were three fairly straightforward marks available here. Many candidates answered this question using DDT as an example and described egg shell thinning. Very few candidates suggested that this was because the birds had eaten seeds treated with DDT. Many discussed the overall loss of insect food in the ecosystem as a whole and it was pleasing to see candidates thinking through their answers here. There were some good references to predator prey relationships in (ii) and candidates made a good attempt at suggesting why increases in magpie and sparrowhawk populations might not be the cause of a decline in farmland bird species.

(e) This question produced some mixed responses from candidates and proved very difficult for the weaker ones. The key answers to the question involved the principle that there would be less niche overlap due to dependency on different resources, less interspecific competition and therefore a greater ecological diversity. This was very synoptic and involved careful consideration of some of the key concepts in Populations and Interactions in Central Concepts. There were some excellent examples though and many made reference to Gause's exclusion principle.

Teaching tip

This question was very much centred on a good understanding of competition and predator prey interactions. A look at the following text:

Essentials of Ecology by Colin Townsend, Michael Begon and John Harper (Blackwell Science, 2nd edition 2003, ISBN: 978-1405103282)

or investigation of its companion website:

http://www.blackwellpublishing.com/Townsend/Default.htm

will give students a good understanding in this key area of ecology. Furthermore the RSPB has some excellent resources for teaching at:

http://www.rspb.org.uk

which will allow students to research into some of the causes of bird population decline and link these to other topics in the Environmental Biology specification. The Farming and Wildlife Advisory Group provides a useful service to farmers and landowners. Their website is a useful source of information:

http://www.fwag.org.uk

2805/04: Microbiology and Biotechnology

General Comments

The majority of candidates appeared to have a good grasp of the specification for this unit and had made use of published mark schemes. There was an improvement in the recall and use of synoptic strands and the calculation was more successfully tackled than on previous occasions. Most candidates attempted every section of this examination, with *Q.1*, *Q.2* and *Q.4* proving to be most accessible. Many candidates would benefit from improving their skills in handling questions such as *Q.3*, *Q.5 (b)* and *Q.6* where

- considerable information was given to be assimilated before they could go on to apply their knowledge when responding and,
- it would be good practice to refer back to the information in order to verify that the response suited the introductory information.

The extended answer questions were accessible but challenging and required thought and organisation in their responses. For this reason, it was considered appropriate to provide candidates with some useful stimulus material as a prompt to encourage them to cover a range of points. There were some outstanding examples of this in *Q.2 (a)*. The quality of handwriting proved to be very problematic for Examiners on a number of occasions and these also included scripts with very small writing, writing two lines to one, or in tiny spaces vertically down the side of the paper. The mark allocation gives a good guide to the length of response required and in most cases the best answers were to-the-point and concise. The majority of candidates appear to have had sufficient time to complete the paper.

Comments on Individual Questions

Q.1 This question required candidates to recall knowledge from Biology Foundation and there were many who were able to gain 12 or more marks.

(a) (i) and (ii) were usually correctly labelled although there was considerable variation in the structures that were drawn on Fig. 1.1, ranging from text book quality to enormous ribosomes and barely recognisable mitochondria. Wherever possible, the Examiners tended to be generous in this respect. It was expected that the cell wall and plasma membrane should have been drawn in if used as part of the answer for (i). Some candidates wrote the correct label inside the diagram over their drawing of the structures, which is not good practice. A few candidates used a label line to Escherichia coli, but failed to label the common structure in Saccharomyces cerevisiae and a number thought that S. cerevisiae had circular DNA and mesosomes in common with E. coli. Some failed to remember that S. cerevisiae is a fungus and drew in a chloroplast. It was rare to see a candidate confuse the two microorganisms. Spellings of the structures were sometimes incorrect and Gogli, Golgli and nucleas were seen on more than one occasion. (iii) proved to be straightforward for many, mistakes occurring for others in converting from cm or mm to μm.

(b) There were many good accounts of the advantages of the electron microscope, with the very best answers going on to give examples of ultrastructure pertinent to the two microorganisms. A common misconception is that the mitochondrion and Golgi apparatus are not visible under the light microscope. Weaker responses repeated in various different ways the same sentence about seeing more details or gave vague accounts of ‘seeing small objects better’. Also, many stated that it was an advantage for specimens to be dead so they would not be moving and be in better focus, or that EM colour enhanced images were better than those with the light microscope.

(c) (i) was not a problem for most candidates, glycogen being better known than polyphosphate. Poor responses for glycogen included stating that it would be broken down to starch and then glucose or that it would be used as energy, rather than an energy store. There were many who thought that phosphate was required for the synthesis of amino acids or proteins. (ii) was well answered, the majority writing about the space-saving feature of compact granules.

(d) Insulin was commonly known as one useful product, but it was surprising that human growth hormone was not always given despite being mentioned in the specification. It was disconcerting that monoclonal antibodies and penicillin as products of E. coli were given by many. Some candidates had noted 'genetic manipulation' in the stem of the question but had not registered that 'medicine' was also there and so gave general answers that linked to E. coli as a useful organism for genetic manipulation.

Teaching tip

An understanding of orders of magnitude and performing interconversions is challenging for many students.

http://en.wikipedia.org/wiki/Orders_of_magnitude_%28length%29

presents orders of magnitude in an imaginative way and allows students to 'visualise' size by giving examples. A cut-down version could be produced and then added to by students to summarise size with respect to organisms and cell structure.

Q.2 This question included an extended answer which expected candidates to draw from many different areas within the Biology specification. There was a wide range of quality of answers but there were many candidates who gained 14 or more marks.

(a) Questions centred on the concerns about genetic manipulation and biotechnology have been set previously, but in a more directed way. Candidates had an opportunity here to discuss issues that they had covered during their course and in their own research; the mark scheme was flexible and included many points on a variety of issues. Almost all candidates gained the mark for the quality of written communication. It was unfortunate that a minority chose to write more about the benefits of the technology and the Examiners tried hard to search for any relevant comments in amongst the benefits. However, the depth of understanding and knowledge, and ability to express ideas fluently in writing, was evident for a considerable number of candidates, who were able to include many more points than the maximum allowed. At the other extreme, there were some accounts that were overly dramatic, with descriptions of humans being cloned, populations being wiped out and every GM crop 'escaping' and causing disease. Weaker responses showed a lack of understanding: a plant with a gene that encodes for the Bt toxin was thought to be resistant to herbicide; genes 'escaped' from the GMO and caused disease; humans became antibiotic resistant on eating GM foods. Some sentences lacked full explanations (this was especially apparent in many answers that used bullet points), for example 'Organic farmers don't like it because GM crops give higher yield' would not score unless the candidate went on to explain the loss of profit to the organic farmer's business. Also, attempting to link too many things into one sentence lost candidates marks owing to lack of clarity. For example, 'Once recombinant DNA is released into the 'wild' there is no control over

it and may mutate to form plants that are resistant to herbicide, so weeds outcompete crops', glossed over a number of mark points but with no clear evidence of understanding.

(b) The production of mycoprotein is in the specification but there were clearly some aspects of the process that have been covered in more detail than others. There was sufficient information included in Fig. 2.2 to remind candidates of the airlift loop fermenter, but in (i) it was surprising how many did not appear to understand fully the design of the fermenter. The heat exchanger was often mistaken for a heater that provided a warm convection current to rise or to mix the culture with the nutrients; a number of candidates considered that the uplift was due to the steam that was used in the downstream processing. Credit was only given where more detail was supplied than simply 'sterile air in'. Very few responses considered the venting of exhaust gases at the top, which served to promote a denser culture medium that sank to the bottom of the loop past the nutrient inlet. Given that large-scale production of penicillin from the filamentous fungus Penicillium successfully uses motor-driven stirrers, stating the problems that occur when scaling up a fermentation process, namely tangling with the filamentous hyphae or heat production from the motor, were not required. There were a number that thought that the design of the fermenter meant that there was no space for a stirrer. It was rare for a candidate to gain three marks for (i). Naming and stating a function for compounds **X** and **Y** in (ii) and knowledge of continuous fermentation in (iii) gave many candidates a straightforward six marks although it was not uncommon to see Fusarium given for either **X** or **Y** and oxygen, rather than ammonia, for **Y** in (ii). Any reasonably detailed suggestion was accepted for (iv), with some responses giving knowledgeable accounts of the symptoms of the presence of excess RNA in the body. 'Harmful to the body´ required some additional qualification before the mark was awarded. For the large minority who failed to gain the mark for (iv), the most frequent incorrect response suggested that RNA reduction was to prevent the fungus from growing or carrying out protein synthesis, showing a clear lack of understanding. Almost all candidates scored well on (v), with only the odd candidate explaining that red meat was healthier than mycoprotein.

Teaching tip

Individuals or groups of students could take one of the headlines given in Fig. 2.1 to research and report back. This could be newspaper, internet and book research in addition to written and verbal questionnaires. Many of the Key Skills criteria, especially in Communication, can be covered in this exercise.

http://www.genome.gov

links to the National Human Genome Research Institute website (US) that contains a huge amount of information. One of the educational resources provided is an Online Education Kit: Understanding the Human Genome Project, which allows downloads of a CD-ROM about the subject. One section, Ethical, Legal and Social Implications (ELSI) of Genetic Knowledge includes a short video which introduces some of the associated issues.

http://www.beep.ac.uk/content/42.0.html

is a website for the Bioethics Education Project. It includes discussions and interactive exercises on the Human Genome and Genetic Technology. Within these are sections on pharmacogenetics, GM crops, GM proteins and cloning.

Q.3 This question was mainly based on practical techniques and observations. Candidates who were practised in these skills, and understood the reasons for procedures, were able to perform well once they had digested the information given at the start. A number of the mark points were easily derived from the text on page 8 of the paper.

(a) Many candidates realised that replicates were being carried out in (i) but did not state this and lost an easy mark despite giving a good explanation linked to reliability. 'To find an average' was not the reason for carrying out replicates in this instance and 'to make it a fair test' was also given by many of the weaker candidates. Most of these struggled to gain any marks. Sadly, in (ii), what was considered to be a generous mark (lactose sugar was mentioned in the stem of the question) was only gained by about 50% of the candidates, the remainder hedging their bets on glucose. There were many good answers for (iii). Once candidates had realised that the streak plating procedure was required (again, this information was given in **stage 2** in Fig. 3.1 but missed by many) most were able to gain three or more marks. Knowledge of correct aseptic technique was good. A small diagram to summarise streaking helped many here. A description of ten-fold serial dilution was not required but was the only response provided by a considerable number of candidates. Again, for (v), the answer could be gleaned from information given and many gained the two marks although it was unfortunate that a number thought that E. coli was Gram-positive. Many missed the fact that a student had designed the procedure and the question asked for 'microscopical observations that you would record'. These candidates wrote about prokaryotic features as seen under the electron microscope. Some gave detailed description of the Gram staining technique or the features of a Gram-negative cell wall.

(b) Many were able to gain the two marks for stating dilution plating as being important to gauge the number of live bacteria present. Haemocytometry as a method of direct counting gained a mark, but turbidimetry was not appropriate for flood water and did not score. Some candidates incorrectly thought that 'serial dilution' is another term for 'dilution plating'.

(c) Again, information given at the start of Q.3 pointed candidates in the right direction and there were some excellent logical accounts given. The term 'inhabitant' of the gut was misinterpreted by quite a few candidates as 'inhibitor' and some responses tried to link acid gas production with problems in the gut. Others had forgotten that the water sample was from flood water and stated that the sewage treatment plant had not successfully treated the drinking water. Too many missed the point that E. coli served as an indicator organism of water contaminated with sewage, which could potentially contain pathogens, and wrote about high levels of E. coli only causing disease. In some of these cases, the benefit of doubt was given and a mark was awarded.

Teaching tip

Photocopy Fig. 3.1 onto one side of an A3 sheet of paper. Ask students to complement this on the other side with a set of explanatory diagrams.

The Centers for Disease Control provided some information on E. coli in the flood waters following Hurricane Katrina. Information is here:

http://www.bt.cdc.gov/disasters/hurricanes/katrina/ecoliqa.asp

An article about the risks of disease following the recent flooding in Britain is here:

http://news.bbc.co.uk/1/hi/health/6917124.stm

Q.4 The majority of candidates displayed a sufficiently sound knowledge of glucose biosensors and their advantages over the Benedict's test to enable them to gain at least five of the available eight marks. Higher scoring responses gave the extra detail that was required and made use of synoptic knowledge from AS.

(a) Part (i) posed few problems for most candidates but in (ii) a mark was lost by many for failing to describe the diffusion of glucose through the membrane or mention that other components of blood were not small enough to pass through. A minority of candidates thought that if other substances passed through then they would interfere with the events occurring on the biological recognition layer. This missed the point that the immobilised enzyme was specific only to glucose. Practically all candidates earned two marks in (iii).

(b) The specificity of monoclonal antibodies to a particular antigen was well known, so that most candidates gained at least one mark. Weaker responses confused the antibody for a lymphocyte or hybridoma cell. The best responses went on to explain how the features enabled the biosensor to operate successfully.

Teaching tip

The traditional glucose biosensor is an ideal topic for synoptic links to Biology Foundation. Ask students to construct an initial concept map with all the main AS links, such as membranes, diffusion, biological molecules, biochemical tests and enzymes, and then map further with extra points. For example 'enzyme' would have the terms: glucose oxidase, active site, ES complex, specificity, biological recognition layer, immobilised, etc. The map could then form the basis for students to construct an essay on the topic, aiming to include a particular number of the given terms in their assignment. This could easily be a differentiated exercise.

Q.5 For many candidates, this proved to be quite a challenging question concerning viruses, possibly because it brought together knowledge and understanding from many different areas within the AS and A2 specifications, notably from cell division in Biology Foundation and aspects from Human Health and Disease. The insert was useful in answering all parts of the question, but only a few candidates appeared to make complete use of it.

(a) One of the most surprising incorrect concepts favoured by many candidates was that bacteriophage lambda was only able to enter a lytic life cycle, despite the

specification asking candidates to be able to 'describe the life cycles of the lysogenic bacteriophage λ, and the Human Immunodeficiency Virus'. Although many candidates correctly identified specific host cells for both viruses, there was a tendency, in the similarities section, to refer to both viruses binding to cell membranes or both to cell walls, or referring to both viruses as phages. The requirement by HIV to synthesise DNA from its RNA was well known but DNA for lambda was less well known, with some answers stating 'RNA or DNA'. There were a number of accounts of HIV attaching to antibodies on the host cell. Many thought that circularisation of lambda DNA was the equivalent of lambda becoming a plasmid that then combined with host DNA. There were numerous incorrect spellings of lysozyme and confusion of lysozyme with lysosomes. Strong candidates had no problems constructing fluent, comparative sentences stating differences between the two viruses, whereas others varied in their ability to cope with this style of question despite being knowledgeable in the two life cycles as separate entities.

(b) In the AS course, many candidates will have considered viruses as one of the list of 'factors that can increase the chances of cancerous growth'. Fig. 5.2 explored this idea further. Although a high level response was required to gain maximum marks, it was pleasing to see a number of candidates demonstrating an excellent understanding and including four or five of the mark points in their answer. However, many others gave vague suggestions or incorrectly used the information in Fig. 5.2 to give very confused accounts.

(c) Yogurt production appears to be well understood and this part was usually very well attempted. The most frequent incorrect statements assumed that the bacteriophage would compete for nutrients with the starter culture or that the bacteriophage itself would somehow cause a disease in the humans that subsequently consumed the yogurt. Interestingly, many of the candidates that produced these statements had shown an understanding of the life cycle of bacteriophage lambda in part (a).

(d) For some reason, a substantial proportion of candidates produced responses geared toward finding a cure for HIV/AIDS, despite being asked to state one aspect of the life cycle of either of the viruses that would be of interest to the genetic engineer. However, a number of candidates did gain the two marks by recalling insulin production and noting the usefulness of reverse transcriptase in producing cDNA from RNA. Others were sufficiently cued in to suggest that the ability of lambda to insert genes into bacteria would make it an ideal vector for the insertion of a desirable gene into a bacterial host.

Teaching tip

The answers below are good examples of three candidates who have some knowledge of the life cycles of λ and HIV. Candidates 1 and 2 have attempted to answer the question; however, Candidate 1 has then failed to give sufficient detail to gain many of the available mark points. Candidate 2's account gained full marks even though it was not a 'model' answer. Candidate 3's attempt to answer the differences section, in particular, was poor.

In order to improve their question response skills, get students to use the mark scheme to mark the following answers.

Candidate 1

similarities Both viruses combine with the genetic material of the host cell. Both viruses are replicated with the host cell DNA. Both viruses use the components of the host cell to make new virus particles. Both viruses initially combine with receptor proteins on the cell membrane of the host.

differences A bacteriophage inserts its genetic material into the host cell through a hollow tube whereas the membrane of HIV fuses with that of the host cell in order to release its genetic material into the cell. The HIV also injects the enzyme reverse transcriptase into the host cell the bacteriophage doesn't. Bacteriophages only infect bacteria. HIV targets cells of the immune system. When the new bacteriophages exit they cause the cell to burst. HIV exits the cell encapsulated in a section of the host cell's cell membrane.

Candidate 2

similarities Both have a specific (target) host cell. Bacteriophage λ and HIV both bind to a specific receptor site on their host cell. The nucleic acid from each virus is injected into the host cell with use of enzymes. Both viruses take over the metabolism of the host cell, synthesising viral nucleic acid. New virus particles assemble and leave the cell, which is destroyed.

differences HIV enters by endocytosis – the two membranes fuse. HIV has single stranded RNA as its genetic material and must form double stranded DNA using reverse transcriptase before it is able to take over host cell's metabolism. Bacteriophage λ DNA as its genetic material and forms a circular band of DNA before it can take over host cell's metabolism. Viral DNA does not enter the nucleus of the host cell (helper T cell) in the HIV life cycle. Bacteriophage λ incorporates its DNA into the host cell DNA (host cell is a bacteria). New HIV particles leave the cell by budding off, taking a piece of the host cell membrane with them. Bacteriophage λ produce lytic enzymes using the host cell's metabolism and burst out of the cell.

Candidate 3

similarities HIV and λ bind to the plasma membrane. Genetic material is inserted into the cell. Both are parasitic and end up destroying the cell.

differences HIV binds to specific receptors on the plasma membrane. Nucleocapsid is inserted into the cell. It is a retrovirus and contains only RNA. Using reverse transcriptase it incorporates itself into the chromosome and this is replicated each time the cell divides. It can lie dormant for several years before lysis occurs. In λ lysis occurs immediately and the cell is destroyed by enzymes which the viruses genetic material codes for. λ spreads as it changes the bacterial DNA to produce hundreds of viruses which are spread after lysis.

Q.6 The challenge of assimilating the information given in this question proved to be quite daunting for some of the weaker candidates and there were a number who gave half-hearted or wildly incorrect responses and did not score well. At the other extreme, many candidates gained all or most of the marks. For parts (b), (c) and (d), there was considerable flexibility in the mark scheme to enable candidates to gain marks for sensible ideas and suggestions.

(a) For candidates with a good knowledge of biological molecules, Fig. 6.1 provided enough stimulus for them to gain full marks in (i) and (ii). Popular incorrect responses for (i) included the molecules at the end of stage 1 or substances like 'sludge', 'dung', and 'vegetable peelings'; incorrect answers to (ii) were 'anabolic' and 'condensation'. Most candidates were able to name one acceptable bacterium involved in anaerobic digestion in (iii), but a substantial minority incorrectly named E. coli.

(b) Generally, most candidates gave sufficiently detailed suggestions to gain marks. Qualified statements such as 'uses up waste organic matter that otherwise would need dealing with', or 'burning produces less carbon dioxide which contributes to pollution' were more deserving of the mark than 'easier to get hold of'' and 'less pollution'. Some candidates thought that biogas production was synonymous with gasohol production.

(c) This was well answered by most candidates. Where full marks were not obtained, this was mainly because the response only included one or two main points that had been over-elaborated.

(d) Candidates that were able to gain all the marks concentrated on the fermenter operation rather than the design; all the points suggested on the mark scheme were seen. Holding time (length of time the mixture remains in the digester), is an important factor in biogas production and it was quite rare for candidates to give this particular response. Where Examiners felt that there was something written of some merit, one mark was given for the combination of reason and explanation.

Teaching tip

http://www.adelaide.edu.au/biogas

is an excellent, highly informative website, the 'Beginner's Guide to Biogas'. There are many links to other useful sites, one of which,

http://www.ruralcostarica.com/digester-video.html

has two short videos on the installation of biogas digesters in rural Costa Rica as well as giving information about biogas projects in the country.

2805/05: Mammalian Physiology and Behaviour

General Comments

The paper was of appropriate difficulty and most candidates attempted every section. There was sufficient time for candidates to complete the paper.

The Examiners commented on the low standard of English demonstrated by a number of candidates that prevented them from expressing points clearly and accurately. This was particularly evident in the extended response sections where spelling was inadequate, punctuation was lacking and specialist terms were often omitted. A number of candidates also had very poor handwriting, making it difficult and time-consuming to decipher their answers.

Candidates should be reminded that knowledge of AS material, as well as Central Concepts, is essential for many parts of this option module.

Comments on Individual Questions

Q.1 Although (a) was an easy introduction to the paper, candidates found the subsequent parts more demanding.

(a) The parts of the synovial joint labelled **A** and **B** on the diagram were generally correctly identified in (i), although the cartilage and synovial fluid were occasionally confused. Candidates were not required to specify the type of cartilage present in the joint. Rarely, the cartilage was named as joint capsule or synovial membrane. In part (ii), the roles of cartilage and synovial fluid were generally well described and few candidates failed to score any marks on this section. Most appreciated that the cartilage would reduce friction at the joint surface, often expressed in a variety of ways, although references to friction-free movement were rejected. The function of synovial fluid in lubrication was also frequently mentioned. References to shock absorption were accepted in connection with either component. Better candidates understood the significance of synovial fluid in delivering nutrients to the chondrocytes.

(b) In this section, candidates were expected to select a country and suggest reasons for the frequency of femur fractures. However, where candidates failed to identify a specific country and made more general responses, credit was given for correct linked statements. The relevance of calcium in the diet, argued either from the standpoint of reduced uptake increasing the incidence of fractures in Germany or Sweden, or the reverse for Spain and France, was by far the most common answer. Candidates often continued to link calcium uptake with dietary vitamin D. Many commented on the level of sunlight in the various countries, again in connection with vitamin D and calcium uptake. Suitable references to the average age of the population, the percentage of women within the population at greater risk and the relevance of load-bearing exercise were also often seen. Only better candidates were able to score full marks and weaker ones gained limited credit for statements that were not correlated with either a country or the likelihood of fracture.

(c) Many candidates were able to suggest at least one advantage of the in vivo technique to culture bone tissue for transplantation in (i). Most understood that there would be a low risk of infection or that the new tissue would not be rejected by the patient. Some also commented that a donor would not be required or that this method could provide an abundance of fresh bone tissue. Credit was not given for vague references to ethical issues. Part (ii) required synoptic knowledge of cell production and the processes involved. The vast majority of candidates gained a mark for naming a cell, usually an osteoblast, which would be able to divide. Good candidates went on to state that this cell would undergo mitosis to produce two genetically identical cells. Credit was also given for a suitable detail of interphase, such as semi-conservative replication, the production of new organelles or mention of cytokinesis, although these points were seldom seen.

Teaching tip

The International Osteoporosis Foundation provides information about the impact of osteoporosis on human populations. Together with information about the disease there are many useful statistics similar to those used to give Fig. 1.2.

http://www.iofbonehealth.org/home

Facts and statistics are available at:

http://www.iofbonehealth.org/facts-and-statistics

Q.2 In general, those candidates who had thoroughly revised the eye did not find this question difficult.

(a) This required candidates to fill in a table suggesting reasons for the differences in sensitivity in dim light and in visual acuity between humans and dogs, in terms of the structure of their retinas. It was anticipated that candidates would refer to the relative abundance and location of the rods and cones although answers were sometimes vague or not suitably qualified. While most candidates were aware that humans have fewer rod cells, accounting for their reduced sensitivity in dim light, many failed to comment on the distribution of the rods within the retina, i.e. in the periphery and not in the fovea, whereas references to simply more or many rods in the dog were credited as it was not expected that candidates would have detailed knowledge of the canine eye. More candidates were able to score marks for the differences in visual acuity by stating either that humans had cones in the fovea whereas dogs had fewer cones, or alternatively, that humans had many cones whereas dogs have no fovea. Generally, most scored at least one or two marks although relatively few gained the full marks available.

(b) Most candidates were able to offer suitable suggestions as to the advantages of being able to focus on distant objects, predominantly in allowing them to spot both prey and predators. References to avoiding danger were also credited. However, some concentrated on expanding their response of the need to see prey (for example, its function in survival) while neglecting to suggest a further advantage.

(c) This was a fairly straightforward question in which candidates were asked to

outline the processes taking place during accommodation in order to focus on a near object. Most understood that the ciliary muscle would contract, loosening the tension on the suspensory ligaments that would result in the lens becoming thicker, rounder or more convex. However, references to the ligaments 'relaxing' were rejected. Good candidates also mentioned that the change in shape of the lens would allow greater convergence (refraction or bending) of light rays. Candidates usually lost marks for failing to provide sufficient detail of the mechanisms involved and some confused the ciliary body with the suspensory ligaments.

(d) Candidates were provided with a diagram of the cerebrum with areas relevant to the question clearly labelled to help them structure their answers. The mark scheme provided a number of marking points for both detail of events taking place in the retina as well as the processes occurring in the cerebrum. As reading would require reasonably high light intensity, candidates were expected to concentrate the first part of their answer on changes happening in the cones, rather than the rods. However, references to rods were not penalised.

Very few candidates mentioned that cone cells would absorb light that would then result in iodopsin changing shape. However, some appreciated that there are three different types of cones. Good candidates commenced their response with a description of how light would cause a hyperpolarisation of photoreceptive cells, thus preventing the release of neurotransmitter, resulting in the stimulation of bipolar and/or ganglion cells. Others began by stating that an image formed on the retina would cause impulses to be transmitted along the optic (or optical) nerve, to the brain. Credit was also given for naming the neurotransmitter secreted by the photoreceptive cells or commenting on its inhibitory nature.

Most candidates understood that these impulses would be conveyed firstly to the visual sensory area, then relayed to the visual association area, often providing further detail of their respective functions. Some also appreciated that these areas were located within the occipital lobe. Vague references to these areas out of sequence were not awarded any marks. Many went on to gain a further mark for stating that the memory for words was essential in recognition and comprehension of the word.

In general, weaker candidates tended to concentrate on the cerebral aspect, neglecting to give detail of the changes taking place in the retina. Nevertheless, most candidates managed to gain at least three marks while good ones easily achieved the maximum available.

A mark for the quality of written communication was available for spelling, punctuation and grammar. Many candidates were awarded this mark although some lost it for the use of bullet points without complete sentences, several spelling errors of common words or for poor punctuation giving excessively long sentences.

Teaching tip

Success in part (d) was essentially a matter of sequencing the events correctly. The various parts of the answer could be put on cards and then sequenced by candidates. They could also consider how many of the events are required to give a satisfactory answer to the question that gains maximum marks. The cards could be made by taking points from the published mark scheme.

There is an interesting article on vision in dogs at:

http://www.eyevet.info/coile1

and much information about eyes in different species at:

http://ebiomedia.com/gall/eyes/eye1.

Q.3 This was a very straightforward question with three parts concentrating on recall, one on data interpretation and one requiring the labelling of structures on a micrograph. Many candidates were awarded full marks and even weaker candidates were able to score 10 or more marks out of the 17 available.

(a) Most candidates were able to identify an epithelial cell and a gastric pit on the micrograph of the stomach lining. Almost all candidates labelled both structures in the figure.

(b) The function of hydrochloric acid was generally well understood and the mark scheme allowed a number of correct responses. Most candidates stated that the acid would kill any bacteria or microorganisms present in the food while others commented that it would activate pepsinogen to pepsin or provide the optimum pH for pepsin or lipase. However, some candidates simply mentioned that the acid would provide the 'best conditions' for these enzymes or failed to name an appropriate enzyme, thereby losing the mark. No credit was given for the breaking down of the food or the destruction of germs or pathogens. Many candidates were also able to describe the role of lipase in the digestion of lipids although references to emulsification were rejected.

(c) Many detailed explanations as to how the stomach protects itself from the acid and enzymes secreted by the gastric glands were seen. Most candidates mentioned the secretion of alkaline mucus by the goblet cells although weaker ones failed to make any further comment on its significance. Many also understood that it would provide protection against autodigestion or acid erosion, frequently adding that the hydrogen carbonate ions would neutralise stomach acid. Some also commented on the secretion of pepsinogen, which would only be activated once in the lumen. There were relatively few references to gastric secretion taking place after food had entered the stomach.

(d) The majority of candidates were able to interpret the data presented in Table 3.1 with ease. Responses often started with statements concerning the inability of gastric juice to digest cabbage either in the test tube or the stomach, with the further qualification that there were no enzymes capable of hydrolysing cellulose or carbohydrate, although seldom was cellulase mentioned. While surprisingly few candidates commented that gastric juice contained a protease

that would digest the beef, most noted that digestion was fastest in the stomach at 37°C. Many understood that mechanical digestion accounted for the faster rate in the stomach compared to the test tube at the same temperature, although references to chewing or mastication were not credited as the beef was inserted through the fistula, bypassing the mouth. There were some vague answers concerning slower digestion at lower temperatures without any mention of the temperatures used in the experiment and some candidates inappropriately compared the stomach at 37°C to the test tube at 20°C. Nevertheless, most appreciated that 37°C would be the optimum temperature (or very close) for the protease enzymes or explained that increased kinetic energy would allow faster formation of enzyme-substrate complexes. Many candidates also gained a mark for quoting correct pairs of figures to illustrate their answer.

(e) The features of the ileum which make it a much more efficient absorptive surface than the stomach were often described in considerable detail. Most candidates commented that the villi and microvilli would substantially increase the surface area over which absorption takes place, thereby easily gaining the first three marks. However, references to cilia (or even 'microcilia') were seen. The last mark was more difficult and only better candidates offered further mechanisms. The mark scheme allowed for a number of different responses including the presence of transport, or carrier proteins ('channel' protein was rejected); the abundance of mitochondria in epithelial cells to provide energy for active transport; the network of capillaries and lacteals within the villi for rapid absorption of the water and lipid soluble products of digestion respectively. Only rarely did candidates score fewer than two marks here.

Teaching tip

For those wishing to read more about Dr. William Beaumont and Alexis St. Martin go to:

http://www.james.com/beaumont/dr_life

where they will discover that the patient outlived the doctor and died in 1880 at the age of 86.

Table 3.1 could be given to candidates to discuss or to describe and explain without the accompanying question. This would make a good starter activity.

Q.4 Part (b) of this question proved to be an excellent discriminator as only rarely did candidates attain full marks.

(a) While many candidates were able to name hormones **Q** (glucagon) and **R** (insulin), they were occasionally reversed. 'Glucagon' was sometimes incorrectly spelt, thereby losing the mark. Adrenaline was an acceptable alternative to glucagon.

(b) This was frequently poorly answered, with candidates simply listing the roles of the liver in carbohydrate metabolism without relating them, as instructed in the question, to the information in Fig. 4.1. However, better candidates understood how carbohydrate metabolism would alter in response to changing blood glucose concentrations. Many candidates gained marks for stating that glucose would be converted to glycogen if blood glucose increased, going on to add that the reverse would happen if blood glucose decreased. Although some related these metabolic reactions to changes in insulin or glucagon concentrations, few provided detail of the mechanism by which this would occur, i.e. that the reactions would be initiated by the binding of the appropriate hormone to its receptor on the hepatocyte membrane. Better candidates were able to describe the functions of the hepatocyte in more detail, such as increased uptake of glucose and its increased use in respiration in response to insulin stimulation, or gluconeogenesis in response to glucagon.

(c) Most candidates understood that transamination consists of the conversion of one amino acid to another, often going on to describe how the amino group would be transferred from an amino acid to a keto acid which had already been synthesised. Many appreciated that this was necessary if a particular amino acid was in short supply while another was in excess of requirements, although some erroneously thought that certain amino acids would be absent from the diet so they could only be synthesised by transamination. References to the synthesis of essential amino acids gained no credit.

(d) e the specification does not require detailed knowledge of the ornithine cycle, it was clear that many candidates were very familiar with the mechanisms involved. Maximum marks were often gained in this subsection for stating that ammonia would be combined with carbon dioxide, via the ornithine cycle using ATP, to form urea. Some candidates also supplied further detail of the intermediates. The excretion of urea by the kidneys was also mentioned.

The fate of pyruvate was less well understood. Some commented that it would be converted to glucose via gluconeogenesis, although this was not credited without reference to triose phosphate. Nevertheless, some stated that it would be converted to acetyl CoA and then enter Krebs cycle. While a significant number of candidates appreciated that pyruvate would be used in respiration, they were required to specify that this would be aerobic, or name an aerobic pathway, such as oxidative phosphorylation, before the mark was awarded.

Teaching tips

Teachers and students requiring some online support with the biochemistry in this module may find it at:

http://www.elmhurst.edu/~chm/vchembook

and

http://ull.chemistry.uakron.edu/classroom

The metabolic pathways chart published by Sigma Aldrich is also available online at:

http://www.sigmaaldrich.com/Area_of_Interest/Life_Science/Metabolomics/Key_Resources/Metabolic_Pathways.

and other charts are available at:

http://www.iubmb-nicholson.org

Q.5 This question was surprisingly poorly answered by a number of candidates, particularly the data manipulation in (c)(i).

(a) Most candidates appreciated that the cerebellum of the chimpanzee is relatively larger than that of a cow because of the more complex movements carried out by the former, requiring a greater degree of coordination. However, this was sometimes described in terms of balance, which was not creditworthy. Many also commented that chimpanzees occupied an arboreal habitat (expressed in a variety of ways). There were a few references to more neurones being necessary in the chimpanzee cerebellum in order to allow them to carry out more complex manoeuvres and occasionally candidates mentioned the use of tools or hand-eye co-ordination in these mammals.

(b) This allowed most candidates to score at least two marks, predominantly for stating that an increase in carbon dioxide concentration would cause an increase in both heart rate and breathing rate. Many then carried on to mention that more carbon dioxide would be expelled as a result. Better candidates understood that the increase in carbon dioxide concentration would be detected by receptors in either the medulla oblongata or the carotid/aortic vessels, and some identified these as chemoreceptors, thereby gaining an extra mark. Good candidates provided greater detail of the mechanisms involved, such as increased impulses from the medulla to the sino-atrial node initiating both an increase in heart rate as well as greater force of contraction or stoke volume. Similarly, some recognised that not only would the breathing rate be increased, but also tidal volume. Many appreciated that these mechanisms would be brought about by sympathetic stimulation, although some then negated the point by stating that the impulses would be transmitted via the vagus nerve, rather than the accelerator or phrenic nerve. However, there were a number of irrelevant statements concerning the pituitary or adrenaline secretion. Relatively few commented that the carbon dioxide concentration would be restored to normal via homeostasis or negative feedback. The involvement of the intercostal muscles and diaphragm was rarely mentioned and hardly any candidates referred to an increase in either hydrogen ions or hydrogen carbonate ions.

A mark for quality of written communication was available for a well organised answer, using specialist terms. Many candidates failed to gain this mark as insufficient specialist terms were used.

(c) The calculation of the percentage change in functional capacity after 28 weeks for the patients treated with the drug proved to be highly problematic in a number of cases. Many candidates made the mistake of dividing the mean score after 28 weeks by 54 instead of that at the start of the trial (33.0). Some failed to subtract the mean score after 28 weeks from the score at the start, or failed to divide it by the latter. Others did not express their answer to one decimal place, as instructed by the question. However, provision was made in the mark scheme to allow one mark for any reasonable attempt to be credited, even if the final answer was incorrect.

In part (ii), Table 5.1 provided data obtained from a trial using a drug claimed to have a beneficial effect in patients suffering from Alzheimer's disease. Candidates were required to compare the data from treated and untreated patients and describe the results. Marks were awarded for a correct comment on each of the parameters investigated: change in memory, functional capacity and hours of nursing required. A comparison of paired data was also credited. Many candidates achieved full marks for recognising that while the drug did not prevent the progress of the disease, it slowed the development of the symptoms, then going on to describe each parameter in further detail. However, some candidates simply listed the data for each parameter while neglecting to make a comparison between treated and untreated patients.

Teaching tip

The Alzheimer's Society provides information on the drugs available to treat the disease. See:

http://www.alzheimers.org.uk/After_diagnosis/Treatments/info_drugs.

and

http://www.alzheimers.org.uk/After_diagnosis/Treatments/info_drugs_addendum.

This is a very topical subject and candidates could research the recent media coverage of this area.

Q.6 While parts (a), (b) and (c)(i) and (ii) of this question were reasonably straightforward, (c)(iii) and (iv) were good discriminators. Only better candidates were able to gain any marks, particularly for (iv).

(a) The majority of candidates were able to state both the conditioned stimulus and the conditioned response in the experiment described in the stem of the question. However, some believed the conditioned stimulus to be the electric shock rather than the red light.

(b) Most explanations of how a rat can learn to press a lever in a Skinner box were sufficiently detailed to be awarded full marks. Indeed, many candidates offered excellent accounts, achieving the maximum with ease. Weaker candidates understood that the lever would initially be pressed by accident, resulting in a reward although they often failed to provide any further detail. Better candidates appreciated that the behaviour would be repeated, due to positive reinforcement, frequently then going on to provide a correct statement about associative learning. Some candidates described experiments requiring rats to avert negative stimuli, e.g. learning to avoid electric shocks, or pressing a lever to escape the cage, although these responses were marked in context and awarded marks wherever appropriate.

(c) Only rarely was the dorsal root ganglion correctly identified in (i). However, this mark was targeted at the A/B grades so required the precise structure. Nevertheless, most candidates were able to name the relay neurone or gave other acceptable alternatives. Some candidates made the mistake in (ii) of describing the reflex arc rather than explaining its significance. However, the majority appreciated that the brain would not be involved, or gave other suitable alternatives for this marking point; many continued to comment that the

response was instinctive and would be rapid to prevent injury. Few references to the fact that the reflex would be short lived were seen, although some candidates stated that it is stereotyped behaviour.

Although candidates were required to outline the events taking place in the membrane of the sensory receptor in response to pressure in (iii), some misinterpreted the question and proceeded to give an account of depolarisation as a result of stimulation by a neurotransmitter or by an impulse arriving at a node of Ranvier. Nevertheless, good candidates recognised that pressure would lead to distortion of the membrane of the receptor resulting in sodium channels (or gates) opening, allowing the rapid influx of sodium ions and subsequent depolarisation. However, some confused the movement of the sodium ions or negated the point by mention of simultaneous movement of potassium ions. There were hardly any references to a generator (or receptor) potential, but some candidates appreciated that the threshold would have to be reached, or exceeded, in order for an action potential to be generated.

Part (iv) was a particularly good discriminator, targeted at the A/B grades. Weaker candidates simply stated that the reason that impulses can only travel in one direction was due to the receptor being at one end of the reflex arc and the effector being at the other. However, good candidates mentioned that the refractory period, or hyperpolarisation, would prevent another action potential being generated immediately after depolarisation had taken place. Better ones provided a detailed explanation of the one-way transmission at synapses, understanding that only the presynaptic knob would contain neurotransmitter vesicles (presynaptic membrane was rejected) and that only the postsynaptic membrane contained receptors for the transmitter.

2806/01: Unifying Concepts in Biology

General Comments

This paper challenged candidates with a broad range of subject material and types of question, stretching candidates of all abilities. The vast majority of candidates completed the paper and wrote freely in all sections, indicating that they felt comfortable with the stimulus material provided and confident about having a go at the questions. Many were let down however by sloppy, imprecise English, in particular discussing 'it' without specifying what 'it' was. In some questions the identity of 'it' was not apparent from the wording of the question. Candidates should be encouraged to identify precisely what they are discussing and ideally to write in full sentences. The Examiners found that candidates tended to score well on *Q.1* and *Q.3*. Candidates found the graphs in *Q.2* quite difficult and the botanical nature of the question made it less accessible than other questions on the paper. *Q.4* and *Q.5* proved difficult.

Comments on Individual Questions

Q.1 Candidates scored well on this question, showing a good grasp of the principles of adaptation, experimental design and natural selection.

(a) Most gained two marks for saying the shell is a defence for the snail but that the sea slug needs poison as a protective device instead. Some also pointed out that the bright coloration acts as a warning.

(b) Candidates generally scored two or three marks, most often for the idea of repeats or for using a larger number of fish in the experiment. A number attempted to say that the experiment should be tried with different species of fish but instead wrote 'types' which did not score. The word 'control' alone did not score as candidates needed to describe a suitable control experiment. Relatively few candidates identified variables that should be controlled, though those that listed some scored two easy marks. Very few candidates came up with a better way of measuring the dependent variable for mark point 1.

(c) Most candidates gained one mark in (i) for the idea that the shared pattern minimises attacks by predators; many also scored a mark for stating that the predators or fish have to learn or remember the pattern.

Part (ii) was done well with most candidates having a good idea of how evolution by natural selection operates. Where marks were lost it was for lack of precision, e.g. mentioning mutation without qualifying it as a random or chance event, or talking about the passing on of the gene rather than a particular allele. Candidates needed to couch their argument in terms of the situation given, that it was the red-spotted individuals who survived, bred and passed on their alleles, and the red-spotted allele that increased its relative frequency in the population (or the reverse – the extinction of the white allele for example). A general answer with no reference to the context given did not score well.

(d) Many answers focused on the algae, not the sea slug. The biology of photosynthesis in the algae was therefore discussed without stating which photosynthetic products the slug gained. Another common error was to describe the slug as autotrophic and not to distinguish between the two partners in the symbiotic relationship. Many candidates who realised that the slug would gain food from the algae did not score since 'food' alone was too vague. The expectation here was that candidates would demonstrate knowledge from Central Concepts of named products of photosynthesis that could benefit the slug. It was also expected that they would give the precise uses of these products in the slug.

Teaching tip

Candidates must apply their knowledge within the context given in the question. This was also particularly important in Q.3.

The most precise biological term should be used and biological detail should be included wherever possible. Examples are:

- allele not gene,
- sugars or starch not food.

Clear sentences that identify a definite subject should be used. Sentences where the word 'it' recurs frequently are quite likely to lose marks because the sense of the candidate's answer is not clear.

Q.2 Most candidates scored patchily on this question that tested knowledge of experimental design and transpiration, though there were some very good answers.

(a) In (i), many candidates stated correctly that there is variation in stomatal size and that a large number of measurements ensures a reliable mean, which is not unduly affected by extreme or unusual results. Problem areas here were that some candidates thought the words 'accurate' and 'precise' mean the same as reliable or representative. Another problem was those candidates who had not fully absorbed the information given and who thought the experiment involved counting the number of stomata rather than measuring their dimensions.

Vague answers, such as 'makes it easier', did not score in (ii). Good answers included those that referred to stomata opening and closing under the microscope, means of measuring (ruler and appropriate calculation) or marking off the stomata already measured on the photograph and the fact that the photograph can itself be enlarged and is a permanent record. Few candidates realised that the heat from the microscope lamp could be a factor in causing the stomata to shut and that a photograph taken immediately minimises this problem.

(b) Many candidates correctly deduced that length x width gives the area of a rectangle and not that of the oval shape shown in the picture; some wrote vaguely about some stomata not being fully open.

(c) A proportion of candidates did not answer the question given in (i) but instead described and tried to explain the two graphs often going into unnecessary detail about the mechanism of ABA action and the closing of stomata. The decrease in water potential when the plant was not watered needed to be explained in terms of less water uptake at roots and less movement in the xylem, while loss of water by transpiration and use of water in photosynthesis continued to occur. The resistance to air flow graph shows that stomata were not fully closed on days 3, 4 and 6 at least, but many candidates wrote sweeping statements about all stomata being closed, stopping all transpiration.

In part (ii), candidates successfully related the decrease in water potential to the rise in ABA and resistance to air flow, and the positive correlation between ABA and resistance. In this question where support for a hypothesis was asked for, candidates needed to be careful to describe the trends shown on the graphs, e.g. ABA rises, rather than jump forward to the deduction that ABA is synthesised at this time without the supporting evidence from the graph. Few candidates raised the idea that correlation alone does not necessarily prove a causal link.

Teaching tip

Candidates should be encouraged to think about experimental design during their practical work and should be familiar with the reasons for taking a large number of measurements in order to calculate a reliable mean. Candidates, as ever, need to read the questions carefully and frame their answer to the exact question asked.

There are concise accounts of stomatal mechanisms at:

http://www-saps.plantsci.cam.ac.uk/records/rec106.htm

and

http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/G/GasExchange.html#Opening_stomata

Q.3 This question was very well done by the majority. Eutrophication was generally well known and most candidates were able to integrate their knowledge of the properties of water with the information given in the question.

(a) Most candidates are able to describe the stages in eutrophication, and the word itself was widely known and generally correctly spelled. A significant minority, however, thought that photosynthetic organisms (here algae) use up the oxygen, instead of aerobic decomposer bacteria. Some candidates did not apply their knowledge within the framework given, which was a coral reef. They therefore referred erroneously to plants despite three types of algal producer being named in the question. Vague comments about 'organisms and animals dying' did not score. The food web provided the candidates with examples of animals likely to be adversely affected by the oxygen depletion, and with named examples of populations that would be affected by population increases or decreases lower down the food web.

(b) Candidates needed to explain the features of the organisms listed by naming and describing or explaining the properties of water that allow these organisms to live in

the way they do. A standard answer on the properties of water without reference to the stimulus material scored at most one or two marks. A glaring example of this kind of rote learning incorrectly applied was seen in the many candidates who referred to water's surface tension as being important for pond skaters, which bore no relation to the marine context given. Part of the challenge of this paper is for candidates to apply their knowledge within new contexts.

Many candidates scored full marks with ease as they worked methodically through the examples, naming the organisms and identifying the relevant property of water. Occasionally marks were lost by candidates referring to seaweeds as plants. Another error that cropped up was the idea that food particles for filter feeders dissolve in the water. Poor basic science vocabulary also let some candidates down as they were not able to use the words solvent and solute correctly. Candidates who were not awarded the quality mark generally had near illegible handwriting or wrote too little for the mark to be assessed.

Teaching tip

Candidates should be encouraged to make use of the factual material given within the paper and to integrate their own knowledge within the specific context given.

Candidates could be given the bullet points from the question together with a list of the properties of water. They could then match them and use their matched lists to plan an answer to this question.

Q.4 The concepts tested in this question were not particularly difficult yet many candidates struggled to recall and make sense of DNA replication and meiosis.

(a) Candidates who gained marks generally referred to the difference between prokaryotes and eukaryotes, or to junk DNA or fossil genes. Many weaker candidates clearly did not understand the question; they also did not understand the term genome. They therefore argued that humans are larger and have more cells, therefore more DNA, or that we make more proteins and so have more DNA, missing the point that the extra number of functional genes in humans accounts for these differences.

(b) Candidates who lost marks here either were unable to understand what is meant by 10^9 or they omitted units.

(c) A description of semi-conservative replication was required in (i). The most frequently recurring mistake was to refer to the DNA double helix or DNA molecule as a 'strand'. Candidates should know that the two polynucleotide chains are referred to as 'strands' and that together they form the DNA molecule. Candidates generally need to be more specific and biochemically precise in their descriptions; for example they should state that hydrogen bonds between the two strands break, rather than to say 'it splits'.

In part (ii), many candidates correctly referred to crossing over and a large proportion knew that this takes place in prophase. Those who named the wrong stage of meiosis mostly stated metaphase. Few could describe accurately the process of crossing over, however. A careful description of crossing over needed to state that non-sister chromatids are involved. A common error amongst candidates was to assume that the terms 'crossing over' and 'chiasmata' are synonymous, which they are not. Candidates who scored two marks in (iii) generally stated that the axial element facilitates the binding together of the homologous pair in order that crossing over may take place, though some correctly referred to the importance of synapsis for later segregation of the homologous chromosomes and some to the role of the axial element in packaging and supporting the chromosomes.

Teaching tip

Replication of DNA could be revised when meiosis is tackled in Central Concepts. The terminology of DNA and meiosis should be learnt carefully. Candidates need to make considered decisions about when to use the words chromatid and chromosome; they should be aware of the significance of the difference between sister and non-sister chromatids.

Q.5 This question ranged freely over different areas of the specification and introduced the technique of RNA interference as a means of silencing genes and some of its possible therapeutic applications. Good candidates scored steadily throughout the question, though an understanding of the final experiment eluded all but the best. Weaker candidates showed alarmingly poor recall of AS material.

(a) After two years of study it was disappointing that only around half of the candidates could suggest the name of an enzyme that might be found in liver cells. The most common correct answers were alcohol dehydrogenase and lactate dehydrogenase. Rather than recalling relevant information, for example the enzyme catalase that many candidates use in practical enzyme work, some candidates resorted to wild fictitious guesses like 'liverase'.

Most candidates scored at least one mark for stating that an acute disease is short term and a chronic disease is long term, but a large number of candidates thought that acute and chronic diseases differ in their severity rather than in their speed of onset and timescale. The common misconception is that a chronic disease is more severe than an acute one, and that 'you can die of a chronic disease but not an acute one'.

(b) Some candidates ignored the word 'function' in (i) and gave a structural difference between DNA and mRNA which did not score. Recall of the different roles of DNA and mRNA was very weak among some candidates. One problem area is the use of the terms 'transcription' and 'transcribed'. DNA is transcribed into mRNA, and the word is used in the passive. Candidates tend to state that mRNA 'transcribes' the DNA, rather than that mRNA is itself the product of the transcription process. Some candidates confuse not just transcription and translation, but protein synthesis itself with DNA replication.

Many candidates gleaned the correct information from the question to score both marks in (ii); they stated that an siRNA molecule is double-stranded and that it is shorter than mRNA.

(c) Candidates who were on the right track often scored all three marks with ease for a careful description of complementary base pairing. Some candidates seemed not to realise that this familiar process was occurring here. One error that cropped up was candidates who incorrectly mentioned the base thymine in the context of the two types of RNA. Both have uracil instead.

(d) This was poorly done by a majority of candidates, who were unable to see the two major differences between the receptors that had a bearing on the success of the in vitro experiment or a possible in vivo therapy. In part (i), the non-division of the macrophages meant that the siRNAs would continue to act in silencing the gene and preventing its expression as a receptor to which HIV could bind. By contrast, mitosis of the T lymphocytes would dilute the effect of the siRNA molecules, weakening their silencing effect. In part (ii), the significant point was that CCR5 does not have an important role in immunity so silencing it will not cause harm to the person. Very good candidates scored here but they were in a minority.

Teaching tip

The structure of DNA and its roles in replication (Q.4) and protein synthesis should be revised carefully before the synoptic paper is taken. The relationship between DNA and proteins comes up on this paper again and again and an understanding of this central idea in biology is crucial.

There are articles on RNA interference at:

http://www.wellcome.ac.uk/doc%5Fwtd004556

http://www.wellcome.ac.uk/doc_WTD023713

2803/02 and 2806/02: Experimental Skills (Coursework)

General comments

The general standard of work and marking has again been high with the majority of centres providing well annotated samples for moderation. The inclusion of comprehensive tick sheets and additional information which increased the clarity of marking has been of particular use in supporting professional judgements. Centres are performing well and have a solid appreciation of the specification and the skills descriptors. The comments that follow are directed towards the minority of centres, but will inform the majority, perhaps, of aspects they had not considered.

General comments on administration

The form CW/AMEND is issued by moderators for a variety of situations. Most are to rectify a simple arithmetic or transcription error. However, some are raised to cover the new mark where a centre has been requested to re-mark the work of one or two candidates. The moderation process cannot change a centre's rank order of candidates, so sometimes where a serious mismatch is discovered the use of re-marking and a form CW/AMEND reduces or removes the potential impact on other candidates. Centres are urged to ensure the new marks are returned to the moderator as soon as possible when this happens.

Where more than one teacher marks the work, it is particularly important that internal moderation within the centre eliminates differences in professional judgements before the marks are submitted to OCR and the sample sent to the moderator.

Form CCS 160 Centre Authentication Form *must* be submitted with the sample to be moderated. Only teachers who have directly supervised or marked the work should sign it. Its purpose is to remove unnecessary doubts the moderator may have about the veracity of the work submitted. If the form is inadvertently omitted, the moderator will request it, and results could be late arriving whilst its appearance is awaited.

Centres are asked **not** to pack scripts in folders, wallets or plastic pockets. All relevant work for each candidate should be stapled in a single pack behind the coursework cover sheet. Any other format slows down moderation and can sometimes result in misplaced or muddled work.

General comments on investigations

Any investigations where two variables are considered at the same time or where the scientific knowledge is not in the specification are best avoided.

The choice of an ecology investigation is probably best limited to A2 and **must** be centred on the specification as required by the descriptors P3aiii, P5aiv, P7aiv, A3bii, A5biii, A7aiii and A7biii. Centres should consider a pragmatic approach to quantity of written material submitted by candidates carrying out these investigations, particularly on field courses where the sheer mass of data can be prodigious.

Investigations that are best avoided for 2806/02 are: -

- a lipase investigation where bile salts are **not** considered;
- the effect of temperature on respiration;
- the effect of light intensity or wavelength on photosynthesis.

In the first two cases candidates usually end up planning and/or carrying out an AS enzyme practical where the A2 centred scientific knowledge and understanding (SKU) is virtually non-existent and so must be scored at max 4 for both skills P and A. In the third case relevant AS SKU is difficult to find and usually results in max 4 for skills P and A.

General comments on descriptors

Centres are referred to the *Report on Units* for June 2006 where the descriptors that are most likely to cause centres to assess inappropriately are explained in more detail (see pages 77 and 78 of the June 2006 report). Copies of this report are available form the subject officer at OCR or the report can be downloaded from the OCR website at:

http://www.ocr.org.uk/Data/publications/reports/GCE_Biology_Report_June_2006.pdf

A number of scripts were seen this year where the centre had produced extensive annotation of *every* descriptor *except* P3b and yet had awarded this point. Quite large adjustments can result from this simple error. A general rule for candidates planning range and replicates is 5 x 3. Clarity is the essence here; the candidate must state unambiguously his/her intentions whilst the centre may not infer P3b from a results table. If the Skill I used does not have three replicates, an appropriate mean cannot be calculated making A1a difficult to award; some parts of the 'b' strand of skill E become more challenging too. There are exceptions to the 5 x 3 pattern for P3b, but these all require discussion with the subject officer at OCR before the exercise takes place.

A5a (carries out detailed processing of evidence and analysis including, where appropriate, the use of advanced numerical techniques such as statistics, the plotting of intercepts or the calculation of gradients) cannot be awarded for a perfect graph whether it follows Institute of Biology guidelines or not.

2806/02 specific comments

It is becoming more noticeable that a small number of centres who enter 7881 Biology and 7882 Chemistry are attempting to use the same piece of coursework for both 2806/02 (Biology) and 2816/02 (Chemistry) where 2815/02 Biochemistry is the link. In this situation almost all centres will have experienced a significant adjustment because the scientific knowledge and understanding (SKU) carry different points of emphasis and are not transposable between units. Where the SKU does not fully match the level 5 descriptors a maximum of 4 marks may be awarded for both skills P and A. The biochemistry in the Biology specification is found in 2801 (*Biology Foundation*) and therefore would not be usable at A2 other than as synoptic SKU. Centres are very strongly discouraged from this practice.

The investigation of respiratory quotient is a good A2 practical exercise. Some centres have been permitting candidates to use water and glucose as substrates for yeast and therefore, not matching P3b (decides on a suitable number and range of observations and/or measurements to be made). It is suggested that an adequate variety of germinating non-photosynthetic seeds could be used where candidates would then be able to consider the effect of the major energy storage compound(s) in each.

This year some investigations into the *lac* operon using lactose and yeast have made interesting reading. Centres are advised that Analar lactose could produce much more realistic results as impurities (other carbohydrates) would not have been present to be respired. If centres wish to use an original investigation such as this, they are recommended to use *E. coli*. A suitable protocol is at:

http://www-saps.plantsci.cam.ac.uk/worksheets/scotland/lac.htm

2806/03: Practical Examination

General Comments

The thread running through this practical examination may be summarised by the following paragraph.

While investigating the water relations of floating leaf discs in the late 1940s, P.E. Weatherley found that fully turgid discs gained in mass when floated on a 5% sucrose solution. He later discovered that the leaf discs absorbed sucrose and used it to make starch in the dark. The production of starch in leaf discs requires a supply of energy and this is provided by ATP generated during respiration. Most of the ATP is generated during oxidative phosphorylation involving proton gradients. Photophosphorylation in chloroplasts also makes use of proton gradients. Respiration requires a supply of oxygen that is made during the light-dependent stage of photosynthesis or is absorbed through stomata. Guard cells make use of proton gradients and ion flow to maintain a state of turgidity.

The Planning Exercise required candidates to design an investigation to find the effect of two variables on the rate of starch synthesis in isolated leaf discs. This involved choosing a continuous variable and a discontinuous variable to investigate from a list supplied. This exercise, however, was not an investigation into photosynthesis.

The practical procedure in Q.1 involved looking for a colour change in an indicator solution and calculating rates of reaction. Candidates were supplied with a lettuce leaf extract in a 10% sucrose solution that had been left in the light, and were required to make five dilutions of this extract. Samples of the different dilutions were acidified with 0.05 mol dm^{-3} sulphuric acid and then a solution of potassium manganate VII was added. The reaction mixtures were kept in the light and a colour change from pink to colourless occurred as the reaction progressed. The rate of the reaction depended on the intensity of pigmentation in the lettuce extract and also on the concentration of pigments in the filtered extract. The practical procedure works well and the lowest concentration should give a result within 10 minutes.

In Q.2, leaves of Tradescantia kept in three different solutions were used to make temporary mounts. Counts were then made of the numbers of open and closed stomata. Candidates had to use information provided and their knowledge of active transport, membranes proteins and water potential to explain the results. They also had to make a drawing of a stoma with its surrounding epidermal cells.

Comments on Individual Questions

Planning Exercise

Candidates were asked to write a Plan to investigate the effect two variables on the rate of starch production in leaf discs. Candidates were required to choose a continuous variable - concentration of a sugar solution or the diameter of the leaf discs - and a discontinuous variable - different types of sugar or different species of plants. Candidates were also expected to select a range of five values for their continuous variable and two values for the discontinuous variable.

The basic strategy involves destarching plants for a minimum of 24 hours by leaving them in a dark place. (In reality leaves are rarely destarched after 24 hours – longer is required.) In minimum light, a cork borer is used to cut the required number of discs from the leaves. The discs are then floated on the appropriate sugar solution in Petri dishes, with the upper epidermis upwards to allow gas exchange for respiration. The complete experiment must be carried out in the dark to prevent photosynthesis occurring.

Research shows that it takes a long time for starch to be formed in the discs – a minimum of 12 hours and often several days is required.

The rate of starch production can be measured by removing the discs at regular time intervals and determining the first appearance of starch in the leaf discs using the starch / iodine test. Alternatively, all the discs can be removed after a set time and the area that has starch can be measured. Starch tends to form first at the edges of the discs and confirms Weatherley's observation that sucrose is absorbed through the cut edges of the discs not through the surfaces. It is also possible to count the numbers of starch grains in the leaf discs after staining with iodine using a microscope.

Alternative methods of estimating starch production are the measurement of dry mass before and after immersion in the sugar solution and the use of a colorimeter to estimate the density of the black coloration after addition of the iodine solution. The latter method involves homogenising the leaves, testing with iodine and placing cuvettes of the homogenate in the colorimeter.

When writing a Plan to investigate the *rate* of starch synthesis, candidates need to be aware that the time taken for the first appearance of starch in the leaf discs can be converted to a rate. One way to do this is to find out how long it takes to obtain a positive result with the starch test and then to calculate the rate as 1/time. Alternative methods of estimating starch production, such as the measurement of dry mass gain, counted starch grains or the use of a colorimeter, require that results are taken over a period of time. From these results the rate can be calculated as the gradient on a time course graph. This means that candidates need to plan to set up many discs and harvest them at intervals.

The theoretical knowledge that underpins the Plans could involve some of the following:

- differences in leaf structure, such as density of cells;
- the entry of sugar molecules into cells through transport proteins;
- the conversion of disaccharides to monosaccharides so that the latter may be used in starch synthesis;
- respiration providing ATP necessary to phosphorylate hexoses prior to starch synthesis;
- the structure of starch molecules (amylose and amylopectin);
- the formation of glycosidic bonds;
- 1:6 glycosidic bonds and the branching structure of amylopectin providing many end points for addition of glucose;
- the role of enzymes in starch synthesis, e.g. starch synthase;
- the use of starch by leaf cells during the destarching process.

Teaching tip

Candidates should be encouraged to include the tabulated results of their preliminary investigations, or results obtained from research, and explain how they used them to make decisions regarding the final Plan. This helps them to focus on the strategy that they should use in their Plans.

Candidates who submit 15 to 20 pages per Plan are unlikely to be giving relevant information; they should be discouraged from making use of tables for information not usually presented in tabular form, as a way of limiting the number of words actually written as text. They should be encouraged to look at the information they are giving and remove the irrelevant material from their Plans. Candidates should be discouraged from using very small fonts.

Candidates may use the SAPS protocol for investigating starch production in leaf discs:
http://www-saps.plantsci.cam.ac.uk/worksheets/ssheets/ssheet20.htm

It should be noted that this procedure also uses leaf discs floating on water and in the light to see if starch is produced under these conditions. It is.

The paper written by P.E. Weatherley which gives useful background information.
P.E. Weatherley. Preliminary investigations into the uptake of sugars by floating leaf discs. New Phytologist, Vol. 53, No. 2 (May, 1954), pp. 204-216.
This may be downloaded from:

http://www.blackwell-synergy.com/doi/abs/10.1111/j.1469-8137.1954.tb05236.x

There is also a useful web page at:
http://www.andrewgray.com/essays/starch.htm

If candidates scroll to the bottom of this web page they will discover that this was originally written as a university essay. It is to be hoped that candidates who use this site checked the information against other sources.

Teachers setting this investigation as a practice may bear in mind that it is also a useful synoptic exercise and might like to use a question from a synoptic paper with it: 2806/01 January 2005 Q.2.

Practical Test

Q.1 The reduction of acidified potassium manganate VII has been used before in practical investigations as it is a simple procedure that candidates can carry out within about 20 minutes or so. The purple pink solution of potassium manganate VII is reduced to a colourless solution of manganese ions. In this case, hydrogen ions are provided by the photolysis of water during the light-dependent reactions that occur in the grana of the chloroplasts.

(a) Candidates' results should be tabulated well and with the independent variable in the first column (in this case the concentration – not volume – of leaf extract). The time should be correctly recorded in seconds for concentrations of leaf extract from 50 to 20 arbitrary units (a.u.), but recorded as >10 minutes for the 10 a.u. concentration. Candidates should calculate rates to at least one decimal place and their figures rounded up or down correctly. Candidates should give the units in one or more of the headings - units should not be included in the body of the table.

(b) The graph should show the independent variable (rate or time) on the y axis and the dependent variable (concentration of leaf extract) on the x axis. Sensible scales should be chosen for the graph so making it easy to plot the points accurately, and an accurate line of best fit drawn through the points. In this investigation, a straight line drawn through the points is not appropriate as a curve is quite evident. When drawing graphs, candidates should not extrapolate their lines beyond the plotted points.

(c) In this question, candidates were required to explain the results in terms of photolysis and the concentration or number of chloroplasts. The role of potassium manganate VII acting as a hydrogen acceptor in place of NADP

should also be explained. For this question, candidates need to understand that a longer time does not mean a faster rate of reaction.

(d) In part (i), candidates were required to understand the significance of sucrose solution in maintaining the same water potential or solute potential as the stroma. Explanations that relate the uptake of water to the osmotic disruption to chloroplasts would gain credit. However, incorrect explanations referring to the plasmolysis of cells, or to sucrose supplying the energy for photosynthesis would not gain credit.
In (ii), candidates should appreciate that the reaction would have proceeded more quickly if distilled water had been used to dilute the leaf extract. As water is a substrate for photolysis, the reaction would be faster, and the rupturing of the chloroplasts would expose the thylakoid membranes to the manganate ions.

In the Planning Exercise, sucrose may be chosen as one of the sugars that is converted to starch. In Q1 of the TEST, sucrose is used as an osmoticum to ensure that the chloroplasts remain intact. Candidates should note the different time scales involved and the fact that the conversion of sucrose to starch involves complete cells, not isolated chloroplasts.

(e) Many candidates are confused by 'a control' and 'a controlled variable' and so refer to keeping variables constant, such as the temperature, pH or distance from the lamp. Even when candidates recognise what is required, they often omit the necessary detail to gain full credit e.g. 'no leaf extract', 'no potassium manganate VII', or 'use just sucrose' without stating that all the other ingredients need to be present. Good responses may refer to keeping all the tube contents identical, and then doing the experiment in the dark to prove that light was required for photosynthesis, or, to carrying out the experiment with sucrose and no leaf extract, to prove that the chloroplasts were essential.

(f) In this question, the discussion should focus on the limitations and likely sources of error and on suggested improvements to the procedure e.g. the suggested use of a colorimeter and a thermostatically-controlled water bath. The mark scheme lists a number of limitations and sources of error that candidates and teachers will find helpful.

Teaching tip

Candidates should be given practice in recognising trends in graphs and knowing when they should use a curve rather than a straight line of best fit. Practice at past questions should help here. Suitable examples are:

2806/03 January 2004 Q.1, June 2004 Q.1 and June 2006 Q.1.

Q.2 The advantage of using Tradescantia leaves for observing stomata is that they are visible without pulling off the lower epidermis. Temporary mounts of the lower epidermis taken from leaves of broad bean were used in a previous paper (2806/03 January 2003 Q.1). This involved immersing the leaf 'pulls' in different solutions and observing the opening and closing of stomata. The candidates made the leaf 'pulls' and immersed them in the solutions and the changes happened very quickly. In this question, Tradescantia leaves were immersed in different solutions and exposed to light for an hour before being observed.

(a) In part (i), candidates were required to calculate correctly the mean percentage of open stomata. The expected results show a higher percentage of open stomata in **X** than in **Y** and **Z**. In part (ii), candidates were required to give explanations for:

- many open stomata in **X**;
- few open stomata in **Y**;
- few open stomata in **Z**.

The information provided on page 8 of the paper could be used by candidates when answering part (ii). Candidates were not expected to know about the stomatal mechanism but were expected to apply their knowledge of transport proteins, membranes, turgor changes in plant cells and water potential gradients. In addition, pumping protons is a concept that could be mentioned in the Plan, as respiration is the source of energy for starch synthesis, and also in the explanations for Q.1. The expected results in **Y** can be explained by the selective nature of the channel proteins for potassium ions. The channels do not allow the movement of sodium ions, or the movement occurs very slowly and is not sufficient to lower the water potential of the guard cells. Candidates should know about the selective nature of channel proteins from the work that they do on membranes in nerve cells.

In **Z**, the high concentration of hydrogen ions in the external solution makes it difficult for the guard cells to pump hydrogen ions from the interior of the cells to the outside. In addition to this is the effect that low pH may have on membrane proteins or on enzymes within the guard cell.

Guard cell chloroplasts have grana but lack the enzymes for the light-independent stage of photosynthesis. Part (iii) asked why guard cells have chloroplasts even if they do not carry out the light-independent stage of photosynthesis. Photophosphorylation occurs in the grana and this makes ATP available for the transport proteins in the cell surface membranes of the guard cells. In other cells, the ATP generated during light-dependent stage is used in the light-independent stage.

(b) In this part, candidates were asked to make a high power drawing of two guard cells and the epidermal cells on either side of each guard cell. The guard cells should be drawn with rounded ends that clearly meet together at either end of the stoma. The inner walls should be shown as being thicker than the outer walls. The adjacent epidermal cells are either square or rectangular depending on their orientation with respect to the guard cells. They are not hexagonal or shaped like jigsaw pieces.

Advanced GCE Biology (3881 / 7881)
June 2007 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u	entry
2801	Raw	60	46	43	38	33	28	0	18169
	UMS	90	72	63	54	45	36	0	
2802	Raw	60	44	39	34	29	25	0	27236
	UMS	90	72	63	54	45	36	0	
2803A	Raw	120	93	82	71	60	49	0	12155
	UMS	120	96	84	72	60	48	0	
2803B	Raw	120	93	82	71	60	49	0	1055
	UMS	120	96	84	72	60	48	0	
2803C	Raw	120	92	81	71	61	51	0	14163
	UMS	120	96	84	72	60	48	0	
2804	Raw	90	60	52	45	38	31	0	10115
	UMS	90	72	63	54	45	36	0	
2805A	Raw	90	65	58	51	44	38	0	2112
	UMS	90	72	63	54	45	36	0	
2805B	Raw	90	59	51	43	36	29	0	1435
	UMS	90	72	63	54	45	36	0	
2805C	Raw	90	64	58	53	48	43	0	1005
	UMS	90	72	63	54	45	36	0	
2805D	Raw	90	58	52	46	40	34	0	985
	UMS	90	72	63	54	45	36	0	
2805E	Raw	90	67	60	54	48	42	0	9946
	UMS	90	72	63	54	45	36	0	
2806A	Raw	120	83	74	65	56	47	0	6794
	UMS	120	96	84	72	60	48	0	
2806B	Raw	120	86	74	65	56	47	0	349
	UMS	120	96	84	72	60	48	0	
2806C	Raw	120	72	62	52	43	34	0	7350
	UMS	120	96	84	72	60	48	0	

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3881	300	240	210	180	150	120	0
7881	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
3881	17.5	34.9	53.3	71.0	85.7	100.0	20388
7881	26.0	47.4	68.1	85.3	96.4	100.0	15824

3881
20388 candidates aggregated this series

7881
15824 candidates aggregated this series

For a description of how UMS marks are calculated see;
http://www.ocr.org.uk/exam_system/understand_ums.html

Statistics are correct at the time of publication

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