OCR
RECOGNISING ACHIEVEMENT

GCE

Biology

Advanced GCE **A2 7881**

Advanced Subsidiary GCE **AS 3881**

Report on the Units

June 2006

3881/7881/MS/R/06

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All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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Advanced Subsidiary GCE Biology 3881

Advanced GCE Biology 7881

June 2006 Assessment Series

REPORTS ON THE UNITS

Chief Examiner's Comments

General comments

The *Report on the Units* for June 2005 included a statement about the problems that many candidates experience in expressing their ideas using accurate English and appropriate scientific terminology. This problem was even more pronounced in the examinations for this session. In many cases, the Examiners were unable to award marks as it was not clear what information candidates were trying to convey. The Examiners often allow some considerable leeway with the spelling of technical terms, but the same leniency is not appropriate when phraseology is difficult to follow. Some of the *Teaching tips* in these reports make some suggestions about how to help prepare candidates for these examinations and make use of questions in so doing. However, the main problem appears to be the fact that few candidates read much biology beyond their course text books. This became evident in those papers that contained information in the form of text, particularly 2806/01 (*Unifying Concepts in Biology*). It is very easy to research information about topic areas that form the basis of these questions and provide students with some background reading. It is clear that they also need to develop reading skills throughout the two years of their Biology course.

Many centres make use of concept mapping and other forms of graphical organisation of information. They often report that this helps candidates talk through topics with each other and with their teachers. This helps candidates to make connections between topics and it helps teachers to identify misconceptions that their candidates may have. One of the synoptic skills listed in the specification involves the drawing of flow charts. In two of the A2 option papers candidates were asked to draw such charts – *Q.5 (b)* on 2805/01 (*Growth, Development and Reproduction*) and *Q.5 (d)* on 2805/04 (*Microbiology and Biotechnology*). The latter was in fact a food web – a task that could be used while teaching section 7 of the 2801 (*Biology Foundation*) specification. When drawing flow charts (or food webs) it is important that certain conventions are followed. Perhaps giving candidates such exercises (as well as drawing concept maps) will help them to organise information and increase their confidence in writing answers.

A perennial problem is the use of the terms *gene* and *allele*. Incorrect use of these terms can mean that candidates lose marks when writing about genetics, selection, evolution and adaptation. This happened in *Q.6 (b)* on 2804 (*Central Concepts*), *Q.5* on 2805/02 (*Applications of Genetics*) and *Q.5* on 2806/01 (*Unifying Concepts in Biology*). *Q.6* from 2804 and *Q.5* from 2806/01 could be used together to help students use these two terms accurately.

The Examiners were surprised how many candidates had difficulty with the terms *biotic* and *abiotic*. This problem emerged in *Q.1* of 2801 (*Biology Foundation*) and *Q.3* of 2805/03 (*Environmental Biology*). In several *Teaching tips*, the Examiners recommend compiling glossaries to help candidates with the relevant terminology.

Mathematical aspects also gave cause for concern. Some candidates realise that there are calculation questions on the Biology examination papers and just leave them out. Sometimes this is because they do not have a calculator with them in the examination. Biology is a very mathematical subject and is one that can be used as a good vehicle for providing practice at basic numeracy and introducing descriptive statistics and statistical tests. It is clear that candidates should be given every opportunity to practise calculations and not shelter behind the adage that 'biologists don't do maths'.

An understanding of the t-test was examined in *Q.1* of 2805/03 (*Environmental Biology*). This question involved comparing limpets in a sheltered and an exposed shore. It would provide a good example to use with candidates who are doing some field work and need to be shown how to use the t-test.

As ever, the Examiners found many examples of excellent work. Candidate performance on 2803/01 (*Transport*) was significantly worse then in previous sessions. The Examiners could not think of a particular reason for this other than the fact that many candidates would have taken this at the end of a lengthy examination session. Many centres make use of the January session for an AS entry and report that this helps focus their candidates on the requirements of examinations at this level.

The Examiners carefully target questions so that each paper assesses a range of skills and has questions designed for different abilities. It was felt that in the *Central Concepts* paper the questions targeted at the top end of the ability range (*Q.2 (a) (ii) to (iv)* and *Q.5*) were more demanding than similarly targeted questions in previous papers, especially in June 2005. This, however, was taken into account in the grading of the paper.

Practical work

The Examiners commented that some candidates appeared to have very little appreciation of the practical work in the sections of the specification that cover respiration and photosynthesis. Some of the learning outcomes require candidates to experience the relevant practical procedures and the Examiners expect candidates to show a good knowledge and understanding of the principles involved. Candidates cannot acquire this knowledge and understanding without carrying out relevant practical work on rates of photosynthesis and rates of respiration. There were two questions in the *Central Concepts* paper on these areas. The responses were mixed and some advice is given in the teaching tips about the practicals that candidates should do.

Synoptic skills

The option papers (2805) always include questions that test knowledge and understanding of the AS specification and 2804 (*Central Concepts*). In addition, they may test the synoptic skills that are identified in the specification for 2806/01. Some of the questions on the options set in this session would make good material to use to develop these skills during the A2 course. Examples are given below.

Option paper	Question	Topic /skill
2805/01	*Q.1*	Cholera (2802) Bacterial growth (2804)
2805/02	*Q.1 (a)*	Genetics (2804)
2805/03	*Q.1*	Sampling, t-test (2804)
2805/03	*Q.3*	Succession and data analysis
2805/03	*Q.5(c)*	Data analysis and evaluation of data
2805/03	*Q.6(b)*	Data analysis
2805/04	*Q.3(a)*	Classification (prokaryotes and plants) (2804)
2805/04	*Q.5(d)*	Drawing a food web (2801)

The series *Skills in Advanced Biology* provides many useful examples of data analysis.

Garvin, J.W. 1986. *Skills in advanced biology 1. Dealing With Data.* Stanley Thornes, Cheltenham. ISBN: 0-85950-588-X. Work sheets – ISBN: 0-85950-589-8

Garvin, J.W., Boyd, J.D. 1990. *Skills in advanced biology 2. Observing, Recording and Interpreting.* Stanley Thornes, Cheltenham. ISBN: 0-85950-817-X

Garvin, J.W. 1995. *Skills in advanced biology 3. Investigating.* Stanley Thornes,

Cheltenham. ISBN: 0-7487-2048-0

A question in these examinations drew on material in this series (*Q.5* on 2805/01 (*Growth, Development and Reproduction*)).

Many candidates lost marks on both AS and A2 papers because they did not read accurately from graphs. This is clearly a skill that needs practice.

Practical Examinations

Several Centres reported that their candidates enjoyed researching the background to the A2 Planning Exercise (which involved kidney function and the metabolism of aspirin) and, on the whole, the exercise produced many high marks. The problem-solving nature of the Planning Exercise was different to the '*investigate the effect of x on y*' that some candidates may have been expecting. In the case of this type of Planning task candidates are not expected to write a prediction.

The biochemistry given in the stimulus material for the Planning task was over-simplified. An erratum was sent to all Centres to clarify the chemistry (e.g. that aspirin does not react with iron III chloride, but salicylic acid does) and ensure that candidates better understood the nature of the task.

Some Centres, unfortunately, experienced problems with the reliability of the enzyme needed for Q1 of the Test. Most of these Centres alerted OCR well in advance of the examination and were given support and guidance. Examiners found the Report Forms submitted by supervisors very helpful. These comments, along with the letters and emails that were received before and after the examination, were taken into account in the marking and grading of the paper.

Teachers and technicians are thanked for raising their concerns about Q1 with OCR and we encourage you to do the same in future.

Judging from comments included in script packets and feedback from centres, the AS examination presented few problems. Timing was not an issue with little evidence that candidates failed to complete the tasks. During the marking It became obvious which centres were more familiar with practical procedures and laboratory work. It seemed that observational skills and making drawings from slides are two areas that centres need to address with their AS candidates.

Some centres prepare their candidates very well for these papers and it is often a pleasure to read the plans and also answers to questions on the Practical Tests that require lengthy answers, such as *Q.1 (c)* and *Q.1 (f)* on the AS Practical Examination.

The Examiners would like to remind centres that it is appropriate to provide candidates with the opportunity to word process their plans. Hand written plans are often poorly organised and presented. Word processing also makes it easier for the candidates to put their details on each sheet of paper by using headers and/or footers. Those that do word process their plans should be discouraged from using tiny fonts, such as Arial 6.

A number of centres submitted work with no signature of authentication by the teacher and others had no signature of declaration by the candidates. These are required by OCR and centres should check that both are complete before sending scripts to the Examiners. If the signature of authentication is missing from a candidate's plan, the Examiners will assume that there is something suspect about the work.

INSET
The INSET team will be presenting the following courses during the Autumn and Spring Terms 2006/07.

Feedback on the AS and A2 Examinations.
A Beginner's Guide to teaching and assessing A2.
A Beginner's Guide to teaching and assessing AS.
Delivering and Assessing AS and A2 coursework.
Preparing candidates for the AS and A2 Practical Examinations.
An introduction to OCR's AS/A Level Biology for newly qualified teachers.

Full details are on the OCR web site.

2801: Biology Foundation

General Comments

Two key aspects of demonstrating understanding of the subject and examination technique were evident in the responses seen this session.

In a number of places in the paper, questions were set in such a way as to require candidates to provide explanations or definitions. There appears to be a trend away from clear and precise explanations. Instead, the trend is towards vague and often confusing or contradictory statements. Candidates should be encouraged to express their ideas and knowledge in as precise terms as possible, reducing the possibility for ambiguous statements being made.
Key command words in a question, such as 'describe' or 'explain', will be used as the basis for the mark scheme for that question. If the question states 'explain', for example, then candidates are unlikely to be credited for responses that simply describe the data or concept.

If a candidate reconsiders a response to a question, particularly if the answer required is a letter or a number, the original response should be crossed out and the new answer written clearly. Although not so much of an issue in this paper, there was one question where altered letters in the answer did not make the candidate's intended answer clear.

Comments on Individual Questions

Q.1 This question was designed as a relatively easy introduction to the paper. However, few candidates scored all the marks for the definitions, often giving vague responses, not using biological terms and providing incomplete definitions. It is noticeable that when material is tested in this way that the degree of difficulty is higher than when candidates simply have to choose a term to match with a definition.

(a) Most candidates gained the mark in *(i)*. It was disappointing to note that the word 'organism' was not used more often to apply a more general definition to the term. Instead, 'animal' was seen frequently. The most common error in *(ii)* was not to include where the role of the organism was to be carried out, for example 'in the ecosystem'. Part *(iii)* was not well answered as many candidates did not appreciate the importance of abiotic / non-living components and their interaction with the biotic components. Poor expression was evident, leading to statements such as 'living and non living organisms' and 'where there are animals and their physical environment'.

(b) Weak responses referred to a population as 'numbers of animals' rather than referring to a single species while a community refers to all the species in a particular place. A significant number of candidates experienced confusion between the biological definition of these terms and the sociological definition of a community being a small section of the human population.

(c) *(i)* was accessible for most candidates, many being able to score maximum marks. One point that was rarely well explained was that only the small amount of energy that is used for growth or building tissue is available to the next trophic level. Many only considered growth as a way in which energy could be lost. Part *(ii)* was targeted as a high level response and many candidates failed to score as they simply described the information. Some candidates commented upon the relative ease of digesting the food, sometimes referring to cellulose, while others made some sensible reference to the caterpillar being able to eat some parts of the tree while the sparrow could eat the whole caterpillar. It was rare to see answer that dealt with both ideas. Most referred to the relative sizes or numbers of the organisms; these ideas were not credited.

Teaching tips

Candidates should appreciate that the same word can have very specific meanings in different subjects and that they should be careful in their use of such terms.

There are a lot of unfamiliar words or definitions in ecology, so a glossary is very useful. Try constructing it in a hierarchical way rather than alphabetically, so that the relationship between the terms can be seen, for example: species, then population, then community, then ecosystem, etc. Cloze passages (filling in the blanks with the most appropriate word) are a good way of testing understanding.

Convert an energy flow diagram into a narrative. Candidates working in pairs could do this.

Provide candidates with the meanings of the command terms as stated in Appendix F in the specification and use exercises to demonstrate appropriate responses. Try giving a sample response to a question, preferably with a partly correct. Supply candidates with a mark scheme for the question and ask them to suggest what mark should be awarded and to identify the strengths and weaknesses in the response.

Q.2 This question involved biochemical tests and the use of a colorimeter.

(a) For many candidates, this section provided them with most of the marks gained in this question. Some good, clear and correctly completed tables were seen and even weaker candidates were able to score at least one mark (usually for lipid). When biuret reagent was not stated, a common error was to name only copper (II) sulphate *or* sodium hydroxide but not both. Addition of Benedict's reagent was common. A variety of incorrect responses for the positive result for protein were seen, often stating red or yellow. Those candidates who stated 'potassium iodide' as the starch reagent were not credited unless they also mentioned iodine, as iodine is the active ingredient in the test. Candidates should be clear about what information the question is asking for. In the case of starch, the positive result was asked for, so a response of 'brown / black' was inappropriate. Presumably the 'brown' was meant to refer to the starting colour, but that was not asked especially as the negative result was given in the table. Candidates should also be careful about giving answers that might be ambiguous. 'Blue' or even 'dark blue' are colours that could refer to Benedict's reagent so were not credited.

(b) This part of the question proved more difficult for the weaker candidates. In *(i)* a number of candidates stated that the same *amount* or *quantity* of glucose solution or Benedict's reagent should have been used. In line with other components of this qualification, candidates are expected to be more precise and to use terms such as *volume* or *concentration*. 'Boil at the same temperature' was a frequent response which was not credited, as presumably the candidates were using 'boil' as a synonym for 'heat'. There was some confusion between reliability and validity in this context, many suggesting that using a control or carrying out repeats and averages were appropriate. Some answers revealed practical experience of the technique and others were well thought out, revealing careful consideration of the data.

A significant proportion of candidates failed to read correctly from the graph in *(ii)*. It was clear from most of the incorrect responses (5.3 or 5.15) that they were looking

at the correct part of the graph but had failed to take into account the scale on the horizontal axis, which was quite clear.

Candidates did not really seem to grasp what was being asked in *(iii)*. There were two successful approaches:

- start with the filtrate following the test for a reducing sugars, hydrolyse with dilute acid and neutralise with an alkali and then test with the colorimeter – the reading gives a direct measurement of the concentration of the non-reducing sugar;
- start with the orange juice, hydrolyse with dilute acid and neutralise with alkali and test with the colorimeter - the reading is a measurement of *both* the reducing sugars and the non-reducing sugars. A calculation would need to be done to find the concentration of non-reducing sugars.

Most candidates described how the non-reducing sugar would need to be treated but few could explain the principle behind it. Those who could give detail of the subsequent test rarely described a quantitative procedure, being content with referring to a coloured precipitate.

Teaching tip

Colorimetry was the basis of part of *Q.1* of the Practical Test in the AS Practical Examination (*2803/03)*. Here it was used to follow the hydrolysis of starch. Centres with colorimeters could use them in these practical procedures.

Q.3 *(a)* *(i)* was generally well answered, although some candidates failed to give a visible feature (despite the instruction in bold) and suggested the presence of various organelles. Some candidates tried to compare the cells with plant cells and referred to cell walls and vacuoles. In *(ii)*, credit was frequently given for the idea that cells in a tissue are performing the same function. Only good answers referred to these cells being of the same type or all epithelial cells. The answers tended to refer to 'similar' cells. Part *(iii)* was generally answered well. The most common error was in referring to the thinness of the exchange surface in terms of cell walls or cell membranes. Candidates should also avoid expressing the same idea in more than one way, such as 'thin epithelial layer' and 'short diffusion path', as it will only be credited once.

(b) *(i)* was successfully answered by most candidates. Responses to *(ii)* were more variable and it was surprising the number of candidates who were unable to correctly identify iron as the ion responsible. Candidates who are unsure of a chemical symbol or formula should be advised to write answers in words, as incorrect symbols or formulae without a word equivalent will not score.

(c) Good candidates correctly measured the line and then calculated the magnification. Incorrect answers, however, were not always supported by working so it was not possible to award even a single mark for a correct method. The most common error was in the conversion of centimetres or millimetres into micrometres in order to divide by 1.5 while there were also some errors in rounding up or down as appropriate. When showing the method, candidates should be encouraged to indicate the units used for measurement as this is not always evident from their conversions.

(d) The extended answer question produced a good range of marks. Good responses clearly outlined the processes of active transport and facilitated diffusion, explaining which ions or molecules needed to use these processes, why they could not simply diffuse through the membrane and which components of the membrane were used for the transfer from one side of the membrane to the other. Those candidates who answered in general terms found it difficult to get some marks as it was not clear whether active transport or facilitated diffusion was being described. Weaker responses tried to link this answer to the movement of gases into and out of the alveoli while others described movement in terms of osmosis. Candidates should be reminded that the use of water potential gradient is only applicable when referring to the movement of water. In this case, reference to concentration gradients should have been made.

Teaching tip

When calculating magnifications or actual sizes, candidates should measure in millimetres. Very often when they measure in centimetres they forget to multiply by 10 000 when converting to micrometres so that their answers are incorrect by a factor of 10.

Q.4 *(a)* In *(i)* the involvement of water in hydrolysis was well understood by many candidates. A significant proportion, however, described its use in the *building up* of a molecule. Candidates were expected to refer to the breaking of a bond rather than simply the breakdown of a molecule. *(ii)* proved to be more challenging. It was not uncommon to see it stated that a low pH indicated increased alkalinity. Good responses linked an increase in acidity with the production of fatty acids, although there were some unscientific explanations such as 'fatty acid tails fall off'. Despite the question stating in *(iii)* that there was unreacted tryglyceride remaining and that no inhibitor had been added, many candidates gave one or both of 'no substrate left' and 'because of an inhibitor' as an explanation. Weaker candidates concentrated on the enzyme, stating that it was 'all used up' or that 'all the active sites were full'. This suggests that they were trying to apply an answer to a question that they had met before rather than understanding the basic principles and being able to apply them to an unfamiliar situation. Those who realised that the pH had become too low found little problem in answering this part of the question.

(b) This part of the question was generally well answered. Candidates were well drilled in their description of the action of a non-competitive inhibitor.

Teaching tip

Candidates could plot the results from Table 4.1 showing the change in pH. They could then use the graph to predict what will happen if the following factors are changed:

- temperature
- substrate concentration
- enzyme concentration.

Q.5 This question gave a good range of marks, with most candidates being able to score at least one mark.

Prophase was most commonly incorrectly identified by the term interphase. Candidates should be encouraged to look at the remainder of the sentence or paragraph to ensure that the answer they have given is the most appropriate.
Some referred to homologous chromosomes rather than individual chromosomes, indicating meiosis rather than mitosis.
Anaphase was incorrectly referred to as metaphase, despite the mention of movement of the chromatids.
The reference to the sides of the spindle was felt to be ambiguous. Candidates should refer to the movement towards the ends or, better, to the poles.
Telophase was not a suitable suggestion for the process of division of the cytoplasm. The term for the process is cytokinesis, although some ingenious candidates decided to combine the two as 'telekinesis'.
When referring to 'identical' in the context of mitosis, the term 'genetically' is expected rather than 'exactly' or 'very'.

Teaching tip

Mitosis is best studied in the context of the cell cycle. A good resource for this is the Biology Project from the University of Arizona:

www.biology.arizona.edu

Q.6 This question was mostly targeted at the top end of the ability range; weaker candidates found it difficult to express their ideas in a coherent way.

(a) This part of the question was answered well by only the most able candidates. It required clear explanation using biological terminology to provide an answer that was not ambiguous. It was evident that many probably understood the principle of semi-conservative replication, but they were hampered by poor language skills. Few candidates were able to distinguish between a DNA molecule and a single polynucleotide strand. In fact, the terms 'molecule' and 'strand' were rarely seen but there were many references to 'half', which did not indicate which half was old and which half was new. Many seemed to think that the complementary strand was pre-formed and simply slotted into place. Some showed evidence of confusion with protein synthesis, referring to mRNA and polypeptide 'strands'.

(b) Most candidates correctly identified **A** as corresponding to Fig. 6.1 and many gave **C** for Fig. 6.2. The discriminator was that some candidates only gave **C** or **E** for Fig. 6.3 while both were required for the mark. Weaker responses included any and all letters, some candidates assuming that all the letters needed to be used. A common error for Fig. 6.3 was to suggest **F**, while close inspection reveals that each polynucleotide strand is composed of both 'heavy' and 'light' nitrogen-containing nucleotides.

(c) Candidates who understood the principles of semi-conservative replication were able to answer this well, even if they had been unable to express themselves clearly in *(a)*.

Teaching tips

Emphasise the importance of using the correct terminology. Choose terms which are consistent throughout all topics relating to DNA in order to avoid confusion. It is suggested that the DNA molecule is referred to as 'molecule' or 'double helix' and the single polynucleotide strands as 'polynucleotide strands' or simply 'strands'. Also emphasise the difference between bases and nucleotides.

Model DNA replication using different colours of plasticene or similar modelling putty to represent the original polynucleotide strands and the new nucleotides and polynucleotide strands. This has the advantage over coloured pipe cleaners as the putty can be rolled into small balls to represent the individual nucleotides. Students could give a presentation to the rest of the class.

The use of modelling putty could be extended to work illustrating DNA's role in protein synthesis. Care would need to be taken to portray RNA as distinctly different. In this way, confusion with the commonly perceived role of RNA in replication could be avoided.

Some web sites which give information about the Meselsohn and Stahl experiment and also include animations are:

www.sumanasinc.com/webcontent/anisamples/majorsbiology/meselson.html

www.mun.ca/biology/scarr/Zonal_ultracentrifugation.htm

www.blc.arizona.edu/INTERACTIVE/DNA3/Replication.html

http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/M/Meselson_Stahl.html

2802: Human Health and Disease

General Comments

The Examiners were pleased with the general level of knowledge displayed by many candidates and most questions were answered well by the better candidates. All questions were attempted and there was no evidence that candidates ran short of time. However, candidates often had relevant knowledge but failed to phrase their answers sufficiently clearly or failed to make a key link in the question and subsequently failed to gain marks. The Examiners noted that significant numbers of candidates lost marks because of a failure to express themselves clearly. For example, in *Q.5 (c)* the answer 'non-athletes would breathe more in a minute' could have referred to 'more breaths per minute' or to 'a higher ventilation rate'; however, it was unclear what the candidate meant and no mark could be awarded. The paper contained a range of question styles, testing a range of skills and the Examiners were pleased to note that candidates scored well in all skills. However, the quality of responses given was often noted to be centre-dependent suggesting that teaching is not uniform in quality or depth of detail. This was particularly noticeable in *Q.1 (c)(i)* where candidates were asked to suggest how vitamin D can be acquired.

Comments on Individual Questions

Q.1 This was about vitamins in the diet. It elicited a wide range of responses but few candidates managed to achieve full or nearly full marks. This is a topic that takes GCSE knowledge and stretches it further. There may be a tendency in centres to rush the topic or to leave candidates to 'teach themselves'. However, there is a high level of specific detail required to achieve full marks and candidates still make basic errors that have been mentioned in previous reports.

(a) Reference Nutrient Intakes (RNIs) provide a figure for the mass of a nutrient that would be sufficient to meet the needs of almost all the population. However, there are certain members of a population who may have special needs. Many candidates correctly picked out age, gender or pregnancy as reasons why people may have special requirements. A common error was to suggest that high levels of activity would lead to a greater need.

(b) The majority of candidates knew that long-term deficiency of vitamin A can lead to scarring of the cornea and to night blindness. Better candidates were able to relate this to the need for rhodopsin. In part (ii) a good proportion of candidates correctly calculated that a minimum of 4.16g of carrot was needed to supply sufficient vitamin A. Most candidates rounded this to 4g which was given credit. Some better candidates, however, pointed out that 4g was not sufficient (being less than 4.16g) and suggested that the nearest whole figure was actually 5g. This was also given credit where the explanation was included. The Examiners noted that the ability of a candidate to carry out this calculation correctly did not seem to bear any relationship to their success in the rest of the examination.

(c) The question about the metabolism and functions of vitamin D was not answered particularly well; candidates clearly need more detailed guidance about these this topic. The majority of candidates appeared to believe that vitamin D is found in sunlight and can be absorbed through the skin. In part *(ii)* many candidates suggested that vitamin D strengthens the bones rather than regulating the deposition of calcium which hardens the bone.

Teaching tip

Information about vitamins A and D is available at:

www.nutrition.org.uk
http://dietary-supplements.info.nih.gov

Q.2 This question about coronary heart disease was generally well answered. Some candidates did not read parts of the question thoroughly and wrote their answers in the wrong context. This affected the marks awarded in some cases and candidates are urged to take time to read each part question very carefully before attempting their answer.

(a) Most candidates knew that smoking and obesity fit into the category of self-inflicted diseases. Social and non-infectious categories were also accepted.

(b) Multifactorial diseases are those that have more than one contributing cause, most candidates knew this although some seemed to think it meant having many effects upon the body.

(c) There were many very good answers to this part question. The Examiners were looking for the direct effects that the components of cigarette smoke have on the heart and circulation to the coronary arteries. Many good answers incorporated extra details that have a less direct effect as well. Weaker candidates described the effects of tar on the lungs and tar being deposited on artery walls which is obviously incorrect. Some candidates did not distinguish between 'to the heart' and 'to the heart muscle' when describing the supply of oxygen. There were also a good number of candidates who described constriction of the veins or capillaries rather than the arteries or arterioles.

(d) In this part question the Examiners were looking for comparisons to be made between the habits of people in different countries. Good candidates achieved high scores but too many candidates did not read the question carefully and simply listed the factors that can contribute to coronary heart disease – this did not accurately answer the question and candidates who knew the correct biology did not gain full credit as a result.

(e) Again, an apparently careless approach to the written answer was the cause of lost marks for some candidates. The answer was not tailored to the precise question which asked for the benefits that an emphasis on prevention would bring. Many candidates simply listed the changes in lifestyle that can help to reduce the risk of coronary heart disease without describing the benefits that these could bring to individuals or to society.

Teaching tip

Ensure that candidates have had plenty of practice at a range of questions and that their interpretation of the question is accurate. This could be achieved by giving the questions to small groups of students who can then discuss an appropriate answer.

Q.3 This was a very simple and straightforward test of candidate's knowledge and recall. As expected, the majority of candidates scored well. Common errors were to write 'virus' or 'bacterium' instead of 'pathogen' and to write 'vital capacity' instead of 'tidal volume'.

Q.4 This question began with non-specific immunity and progressed to testing more specific knowledge about allergies and asthma. Candidates' responses were generally very good and all but the weakest candidates achieved good scores.

(a) Most candidates scored well in this part question on the non-specific action of phagocytes. Most knew that phagocytosis involves the cell engulfing the pathogen and incorporating it into a vacuole. Fewer candidates were certain about the action of lysosomes and some described them as injecting enzymes directly into the pathogen rather than releasing enzymes into the vacuole containing the pathogen. The specific wording of answers was often a cause for concern as candidates described the phagocyte 'engulfing the infection' or 'engulfing the antigen' rather than 'engulfing the pathogen'. This suggests that candidates are not fully aware of the role of antigens on the surface of a pathogen or are confusing the pathogenic organism with the general term 'infection'. The response 'macrophages produce antibodies and shoot them at the bacteria' suggested an innovative evolution of the immune response but was not considered worthy of credit.

(b) The majority of candidates realised that an increase in substances that cause allergy was the reason for the shape of the curve and most could name a suitable allergen. In part *(ii)* most candidates extrapolated the curve accurately but a disappointing proportion of candidates were then unable to read from the graph correctly.

(c) Most candidates successfully named two allergens that cause asthma. Commonly used examples included dust and dust mites, pollen and smoke.

(d) Fewer candidates were able to state two changes to the lungs that occur during an asthma attack. A common error was to describe the lungs or airways 'contracting' rather than constricting. Better candidates were able to write several correct changes in the space provided.

Teaching tip

Modelling of pathogens, antigens and phagocytes using plasticine or suitable everyday objects is a clear way to help candidates understand the processes and structures involved in an immune response.

There are some animations of phagocytosis at:
www.sp.uconn.edu/~terry/Common/phago053.html

Q.5 This longer question about exercise and energy supply proved to be quite discriminating, particularly part *(c)*.

(a) Most candidates were able to understand the information shown in the graph and used figures to illustrate their statements. Many gained full credit here but some candidates simply described the three columns rather than describing the trend shown in the figures.

(b) Candidates gained credit for accurately stating that glycogen is an energy store

which can be converted to glucose for use in respiration. However, a significant proportion of candidates confused the role of carbohydrate stores and anaerobic respiration. These candidates described a process in which athletes started to respire anaerobically when glycogen ran out rather than when oxygen supply was inadequate.

(c) This part of the question proved to be a good discriminator and marks awarded were a good indicator of how well the candidate achieved overall. Most candidates gained some credit but only the best scored full marks. Easy marks were gained by describing increases in breathing rate, tidal volume and stroke volume but some candidates were able to give excellent answers including descriptions of vasodilation in the muscles, larger numbers of capillaries in the muscles and alveoli, and increases in red blood cell number and haemoglobin count.

Teaching tip

Prepare candidates for long answers by setting a question and allowing pupils to prepare their answers in small groups. They can then present their answers to the rest of the class who use a mark scheme to 'score' their answer.

Q.6 Responses to this question on HIV/AIDS showed that there are still a lot of misconceptions regarding this disease. A more detailed and thorough approach in the way that centres approach the teaching of this subject should reap huge rewards. It is probably not wise to assume that candidates have acquired correct information from other courses or sources of information.

(a) Almost all candidates knew that HIV leads to AIDS although not all could write this in full as 'Human Immunodeficiency Virus'. In part *(ii)* most candidates could give at least two ways in which a lack of T helper cells would affect the immune system. The inability of T helper cells to release cytokines or to stimulate macrophages or to produce memory cells were given most often. However, a good proportion of candidates lost credit with vague answers such as 'the immune system cannot recognise pathogens' or 'the immune system cannot work properly'. Part *(iii)* was often well answered but many candidates suggested that HIV can be transmitted through sexual intercourse without qualifying this as unprotected sexual intercourse. Even more concerning was the number of candidates who still seem to believe that HIV can be transmitted by touching, holding hands, kissing and even coughing or sneezing.

(b) This part was less well answered as candidates fail to realise that antibiotics only affect bacteria and that they can be used to help fight off the opportunistic bacterial diseases that affect victims of AIDS because their immune system is weakened. Some candidates seem to believe that the antibiotics boost the immune system to help fight HIV/AIDS.

Teaching tip

There are many resources for teaching this section of *Human Health and Disease* as well as other sections, especially section 1, in *Pandemic* – a resource published by ActionAid. Further details are at: www.globaldimension.org.uk/ResourceDetails.aspx?id=933

2803/01: Transport

General Comments

Responses covered more or less the whole mark range, but the botanical areas were generally more poorly answered in this paper compared with previous sessions. It has been regularly stressed that one third of the specification covers such topics and centres should be aware that the question papers will reflect this balance.

There was a feeling from the Examiners that the overall standard was less good this year. At the lower end the responses were not even of GCSE standard and there seemed to be many candidates who were entered for an examination beyond their academic ability or state of preparation. It was still refreshing to see candidates at the top end showing a wide breadth and depth of understanding.

Once again the ability to spell biological terms correctly was very varied. This can cause problems where there are similar sounding terms and it is difficult to award a mark as it is far from clear that the candidate knows the correct term.

There was some indication that candidates had practised using past papers and mark schemes and then tried to make a previous mark scheme fit the current paper. Whilst it is very helpful for candidates to practise past papers, it is important that they read the current questions carefully and not just pick a past mark scheme from their 'memory bank' which they think fits.

There was evidence that candidates did not understand the difference between the words 'describe' and 'explain' in questions. Too often candidates just described a phenomenon by copying out the question, where the question asked for an explanation.

There did not seen to have been any problem with time on the paper.

Comments on Individual Questions

Q.1 This was not always well done. The accounts of phloem transfer mechanisms were often confused.

(a) Although the correct responses of 'stem' and '**B**' were commonly seen, there were a number of 'roots', 'root hairs', 'vascular bundle', 'xylem' and even 'leaf'. Likewise all the tissues other than **B** were on occasions identified as phloem, with **D** being the most common wrong alternative seen in about 20% of responses.

(b) Every substance on the list was identified by at least some candidates as the carbohydrate transported in phloem. The most common incorrect response was glucose, even when sucrose was mentioned in *(c)(ii)*, followed by starch.

(c) *(i)* Many got this correct. A few inverted their answers. It is important to stress to candidates that in this type of question they check carefully that they have not inverted their answers. **Q** was sometimes identified as a 'sieve tube' or 'sieve cell' which did not gain credit. Centres should ensure that candidates are made aware that a sieve tube is made up of sieve tube elements in the same way that a xylem vessel is made up of vessel elements. Despite being asked to identify the cells, there were those who made responses such as cytoplasm and vacuole.

Some candidates produced excellent answers in *(ii)* which showed a clear understanding of the key ideas of active proton pumping leading to sucrose loading into the companion cell via co-transporters, its transfer via plasmodesmata into sieve tube elements and the movement via the sieve pores between these elements (helped by their relatively scanty contents). Such accounts quickly picked up maximum marks. More often there were vague references to protons, 'active processes' and mass flow without relating them to actual mechanisms or specific cells. Some seemed to think that the sieve tube elements were completely empty or hollow despite the diagram showing some contents. Some muddled up water movement in xylem vessels with carbohydrate movement in the phloem.

(d) This was badly done by very many candidates. The stem of the question states that carbohydrates move from sources to sinks. Many candidates simply copied this out in their answer by saying that a root was a sink when carbohydrate moved towards it and a source when it moved away. Many thought that a root was a source when it absorbed minerals, water or more worryingly sugars, from the soil, or when the root photosynthesised. Very few got the key idea that when an organ is a sink the carbohydrate must be used up for growth / respiration or stored in an insoluble form so that it does not have an osmotic effect. Even fewer got the related idea that when a root is a source, the stored carbohydrate must be converted back to sugars so that it can be transported elsewhere.

Teaching tip

Relate the structure of the parts of phloem to a transport mechanism. To do this a large diagram could be provided and then ask the candidates to annotate key areas on it with information as to how they are related to the transport mechanism.

Q.2 The extended answer question produced a good range and seems to have discriminated at the middle to lower end.

(a) Although many candidates got the correct answer (7) there were a number who failed to follow the instruction to express their answer to the nearest whole number. Lack of care with measuring led some to measure the distance inaccurately and thus get the answer 8 which cost one of the two marks available. Some swapped between centimetres and millimetres in the calculation and made no adjustment for the answer in millimetres. Others multiplied by 12 thus producing a diameter of over 1000mm which their biological awareness should have told them was wrong.

(b) The quality of written communication mark here was for the use of scientific terms and this should have given the candidates a hint that detail of structure rather than generalisations was expected. As is so often the case in this paper the Examiners were expecting to see structure related to function and this was not always the case. Poorer responses tended to be limited to generalised statements that the walls were thick due to high pressure oxygenated blood. Indeed some candidates seem to believe that by being oxygenated, the blood will in some way automatically be at a high pressure. Such responses did not gain credit. The minimum expected was the idea that the thickness of the wall withstood the pressure. At the other end of the scale, good responses clearly described the make up of the three layers of the wall and were able to describe the specific functions of the various tissues. Central to this were the elastic recoil properties of the elastic tissue, the strong nature of collagen and roles of muscle and the endothelium. Common misconceptions were that it is the smooth muscle not the endothelium that reduces

friction, and that the muscular wall pumps blood along. Some candidates thought that there were valves throughout the arterial system. Another common misconception was that the lumen was relatively large to carry much blood, rather than relatively small to maintain, but not to increase, the pressure.

Teaching tips

1. Practise calculations at every opportunity. Always have a ruler and a calculator and always show working.
2. Many candidates thought that the lumen was large. Use suitable photographs to work out the ratios between lumen diameter and wall thickness and between lumen diameter and total diameter of the artery. This can be repeated with a photograph of TS vein. This can help to emphasise the idea that the lumen of the artery is relatively smaller than an equivalent vein.
3. Many topics in this part of the specification ask candidates to relate structure to function. When revising these areas get them to draw up a table clearly relating each structural component to its particular role.
4. It may be possible to get pieces of artery and vein and illustrate certain key ideas by hanging given masses on them and measuring the degree of stretch.

Q.3 All the expected answers here were technical terms and some candidates were so far away in a phonetic sense that marks were lost.

The specification makes it clear that water movement must be explained in terms of water potential. This has been stressed many times in reports. A significant number of candidates talked of concentration gradients and lost the mark.

The apoplastic and symplastic routes (gaps 2 and 5 in the cloze exercise) were known by many, but this was an area where some spellings were so wayward as to loose marks. The endodermis (gap 3) was sometimes wrongly described as the endothelium. There were various ways that gaps 3 and 4 could be completed as shown in the mark scheme. Thus Casparian strip could be credited in either but only once, and endodermis could be credited in gap 4 if gap 3 was blank or neutral.

Teaching tip

When starting any topic get the candidates to produce a short glossary of relevant technical terms and have a spot quiz from time to time.

You may be able to catch their attention by telling them a little bit about the derivation of some names: who were Caspar or Purkyne (or Bohr or Golgi)? Or perhaps even challenge them to find out.

Henderson's Dictionary of Biology is a good resource to use. ISBN: 0-13127-384-1.

Q.4 This question put a slightly different slant on a standard topic: the variation in different parts of the blood system and its causes. This foxed some candidates.

(a) Although the good candidates tended to score all four marks in *(i)*, there were a lot of responses that betrayed either a lack of understanding or an inability to provide standard information when it is asked for in a slightly different way. 'Some' or even 'many' red blood cells was a not uncommon response for the tissue fluid. Would

these candidates have said that red blood cells can pass through capillary wall if asked that question? Again, 'few' was not uncommonly seen for the level of white blood cells in the aorta; why should there be less than in the vena cava? The incorrect response of 'high glucose' in the lymph suggests that some candidates do not appreciate the role of the transport system in supplying glucose to the tissues where it is used. High pressure in the vena cava was sometimes given. Again, would these candidates have said 'high' if asked to describe what the pressure in veins was like?

The mark scheme for part *(ii)* was arranged so that full marks were still possible even if incorrect responses occurred in the table. Only the best achieved this. Too often the answers were a description of the differences rather than an explanation of what led to them. For glucose, the ideas that it is carried in the blood, passes through to tissues at the capillaries and is used for respiration or stored thus being lower in the lymph were credited. There was also credit for ideas that it is absorbed from the gut or comes from the liver which explains its level in the vena cava. A number of candidates thought that glucose was too big to fit through capillary walls or was reabsorbed from the lymph into the capillaries. For pressure, many got the idea that it was high in the aorta as it was pumped from the heart. A number just said it was pumped in arteries with no mention of the heart. Distance from the heart was also a fairly common correct response for the drop in pressure. A lot of responses were along the lines of 'low in the veins as they return blood to the heart'; these did not gain credit. Fewer were able to explain the drop in relation to resistance of the system or increase in capillary volume or formation of tissue fluid.

(b) Good candidates quickly picked up all three marks, often by way of clear accurate equations. For others the process seemed to be a complete mystery. Hydrogen in the blood reacting with something was mentioned, or even hydrogen, carbon and oxygen in the blood reacting. Carbon dioxide reacting with haemoglobin was a common misconception. The enzyme carbonic anhydrase was sometimes given as the reactant or the catalyst for the dissociation of carbonic acid. In a number of cases it seemed that candidates were putting down anything they could remember and hoping some of it was relevant. A number talked about carbon dioxide dissolving to form carbonic acid. 'Going into solution' is not the same as reacting but candidates sometimes rescued themselves with an equation.

Teaching tip

When revising, provide something like the table in the question, but with the boxes enlarged and all the information included. Get the candidates to write a brief explanation of what has brought about the condition stated for each box.

Q.5 This question often rescued the weaker candidates a few marks by their being able to extract information from the circulation diagrams.

(a) The specification clearly states that candidates should be able to describe the external and internal structure of the heart in *(i)*. A significant minority of candidates found this difficult. Although it was expected that **U** would be identified as the right ventricle, it was decided to accept cardiac muscle, but not just heart muscle. A surprising number of responses were right atrium – careful study of the diagram should have shown this to be impossible. There were a small number of left hand sides. A recent paper had a question on the internal structure of the heart with reference to Purkyne tissue. Some candidates decided that this was the same question and named **T** as Purkyne tissue with somewhat disastrous consequences. Part *(ii)* was often well answered with deprivation of oxygen to the muscle leading to muscle death and possible heart attack or equivalent. Some candidates having named the coronary artery correctly then talked in terms of disruption of the electrical events in the heart. Some thought that a blockage here would cause a stroke, or stop blood getting directly to the body, or even cause the heart to burst.

(b) *(i)* The key issue where a closed circulatory system is concerned is that the blood is enclosed in vessels. Some candidates confused this with a double circulation, whilst others stated that **nothing** entered or left the system. This betrayed a lack of appreciation of what occurs at the capillary bed. Parts *(ii)* and *(iii)* were often well answered. Candidates were able to explain that the term double meant that there were two circuits and that in the frog these circuits could 'cross over' as there was no complete separation of the heart into two sides keeping oxygenated and deoxygenated blood separate. Instead a common vessel leaves the single ventricle of the heart. The consequence of this in terms of effectively supplying the tissues with oxygen was clearly explained in relation to the mixing of oxygenated and deoxygenated blood. Very few answers indicated that the candidates had spotted the relatively thin ventricular wall in the frog and the likelihood that pressure would be lower. Some candidates described blood as 'oxidised' rather than oxygenated and lost a mark. Some candidates also lost marks by writing at length about only one aspect. These candidates should have realised that the mark allocation indicated that there would be credit for various aspects of the double circulation.

Teaching tips

1. Provide a series of diagrams of external views of the heart with certain 'clues' on them in terms of some vessels being labelled and ask candidates to indicate areas of the heart wall related to given chambers.

2. When teaching the mammalian double circulation start with brief reference to the single system in fish and the partial system in amphibians. This should help candidates understand the mammalian system in terms of increased efficiency as far as oxygen delivery (and carbon dioxide removal) are concerned.

2803/02: Experimental Skills (Coursework) – see page 174

2803/03: Experimental Skills (AS Practical Examination)

General Comments

This paper was built around the theme of the role of water in plants. However, a variety of other themes recurred throughout the paper including the relative merits of using qualitative and quantitative results. The Planning Exercise involved designing a procedure to investigate the effect of a variable on the rate of transpiration in two plants. *Q.1* of the Practical Test was concerned with the hydrolysis of starch and *Q.2* with plasmolysis in onion cells. There were a number of links between the different parts of the examination. For example, the principle of equilibration often came up in the candidates' plans and was the expected answer to *Q.1 (b)(iii)* of the Test.

The performance of the candidates was very much centre-based. It was clear that many centres take great care over preparing their candidates for the demands of this paper. It was obvious, for example, where recommendations from previous Reports about the Planning Exercise had been passed to the candidates. It was also evident in the Test where candidates had been given plenty of practice in carrying out practical procedures and answering questions under timed conditions. However, the Examiners noted that other candidates were less secure and seemed not to show the skills necessary for success on this paper, particularly in the Practical Test. Candidates from some centres gained almost half their total marks from the Planning Exercise.

The Planning Exercise prompted a variety of approaches. Although it is expected that candidates at one centre will carry out similar preliminary work and be thinking along similar lines it is always encouraging to find that there are differences between their final plans. Centres should allow candidates more leeway in in carrying out preliminary work and exploring different, individual approaches. In some cases it appeared that they had been dissuaded from this. In discussing their preliminary work some candidates honestly admitted that they had tried a particular procedure without success. If they then stated how this influenced their final plan they gained a mark.

There were some problems with the enzyme solution **E2** provided for *Q.1* of the Test. In some centres this did not show any change in tube **C**. The Examiners were aware of this problem when constructing the final mark scheme so these candidates were not disadvantaged. The intention was that candidates would see a gradual change in colour in samples taken from **C** towards the end of the ten minute period.

Centres are reminded to attach the Planning Exercises to the back of the Tests for each candidate. The two components should be attached together fairly loosely. Treasury tags are ideal for this. The two components should not be packaged separately.

Planning Exercise

Inevitably most candidates decided to use a potometer to measure the rate of transpiration. Unfortunately, candidates often misspelt potometer as 'photometer' possibly because this is what their spell checks told them to do! Many candidates commented that this apparatus is used to measure the rate of water uptake, but explained that this was not a significant problem as most of the water taken up is lost in transpiration (checking point **U**). Other methods were seen occasionally; for example, some candidates put their potometer on a balance so that they could measure water loss and water uptake. Some candidates appeared to have been advised to use cobalt chloride paper attached firmly to leaf surfaces, but they were not always very successful at explaining why they were doing this or what information they would gain.

Some preliminary work was seen, but many candidates described the type of preliminary work (often called a pilot study) that they *should* carry out before starting their main investigation. This does not gain a mark (**I**). Group or class preliminary work was seen and this is acceptable. The Examiners did not think that computer simulations were an acceptable alternative.

Some candidates were unsure about the types of plants to choose. In some cases type names, such as xerophyte and mesophyte, were used. Some species were certainly not appropriate for this investigation. The Examiners did not relish the prospect of putting stinging nettles or prickly pears into a potometer. Aquatic plants, such as *Elodea canadensis*, are quite inappropriate. Marram grass was an understandable choice, but unlikely to fit easily into the typical school/college potometer. Better suggestions included the species mentioned in the Instructions – privet, laurel and lime. Some centres reported that holly was a good choice. The point at issue was that the two species chosen should differ in some key feature. Most followed the spirit of the question and chose a named mesophyte and a plant showing xeromorphic features.

Diagrams to support the plans were often poorly drawn. Drawings, photographs and diagrams downloaded from web sites rarely added much to the plans. Photographs of apparatus used for preliminary work were much more useful, but these were not seen very often.

The plans often included lengthy descriptions of all the variables that can influence transpiration. However, the relevant marking point (**E**) was only awarded if candidates stated that these variables needed to be controlled. Some candidates did not realise that they are expected to include five values of their independent variable in their plans (**F**). Some just did one value so would only get one result for each species. Those that investigated wind speed were often restricted by the settings on the fan. This problem was solved very neatly by others who placed the fan at different distances from the potometer and used an anemometer to measure the wind speed. This comprised their preliminary work and from the results they chose five or more different wind speeds by altering the setting and the distance. Many stated that it would be impossible to control factors in a school/college laboratory; one candidate stated that her investigation would be carried out in a controlled room at a nearby university – even giving its web site to vouch for its existence. Most were aware of the need to carry out replicates (**G**).

Plans should be supported by some theoretical work. Most candidates found something suitable and used it to support their predictions (**H**). The information could be used to support the effect of the chosen factor *or* the likely results from the two plant species. Candidates found it difficult to find sufficient information to be awarded this point especially if light intensity was the chosen factor. The other common choice, wind speed, tended to have more detail of water potential gradients. Citing references in the body of the work is something that is neglected by many candidates. Many just include lists of books, articles and web sites consulted without stating exactly where in the plans these have been used. In some cases candidates gave lengthy lists of references and it was clear that these had informed the plan. However, the relevant mark (**M**) was not awarded as there was no indication *in the text*.

Many candidates appreciated the quantitative nature of this investigation. They gave good tables of results (**N**) and explained how results from the potometer would be converted into volumes of water taken up and/or lost. They also realised that it would be necessary to adjust the results to allow valid comparisons to be made between the two species. Many explained that they would use shoots with the same surface area of leaves. Others stated that this would be impossible to achieve so measured the leaf area after taking results and

adjusted results so that they were expressed *per unit area of leaf*. Candidates also calculated *rates* of water uptake or water loss as required by the question. Many gave detailed explanations and were rewarded with **R**, **S** and **T**. Weaker candidates who attempted this explanation were confused with the formula - $2\pi r^2$ and $2\pi r$ were both used instead of $\pi r^2 h$.

Weaker candidates found it difficult to draw up tables for the results that they would collect. As a general rule, candidates should be trained to produce tables that have columns for all the measurements that they record and each column should have a heading with appropriate units. If they expand the table to include calculated values, such as rates, then these must have units too. Graphs were often drawn to show how the results would be interpreted. Some candidates gave time course graphs which were not appropriate for marking point **P**. Candidates should have put the chosen variable, e.g. wind speed, on the x axis and rate of transpiration on the y. On a positive note, it was good to see candidates referring to the inverse square law when dealing with light intensity.

Teaching tips

Candidates could be given a scientific paper to read in order to show them how references should be cited in their plans. Bournemouth University has a brief guide to the Harvard system for citing references:

www.bournemouth.ac.uk/academic_services/documents/Library/Citing_References.pdf

Surface areas of leaves can be calculated by weighing a known area of leaf and using the result to determine the surface area of all the leaves on a shoot if they are all weighed. Alternatively, the outline of the leaves can be drawn on a piece of paper. The shapes can be cut out and weighed. The surface area of the leaves can be calculated from the mass of the paper which is likely to be 80 g m^{-2}. An interesting point in whether the surface area should be multiplied by 2 – for both surfaces. Some candidates looked at the stomatal distribution and decided that there were no stomata on the upper epidermis so the results should be expressed per surface area of *lower epidermis*.

Practical Test

Q.1 This question involved using two different concentrations of a bacterial amylase to hydrolyse starch. Some candidates kept their boiling tubes in the water bath for the duration of the practical procedure (as expected). Others took them out after the period of equilibration and left them in a test-tube rack. This did not seem to cause any great difference in the results. However, in some centres solution **E2** (0.1%) did not bring about a noticeable change. Some centres found this when trialling the procedure and were advised to increase the concentration of **E2** a little.

The mark scheme includes some expected results for parts *(a)* and *(e)*. It should be pointed out that these are included to show the Examiners (and readers of these reports) who may not have carried out the procedure what to expect.

(a) Most candidates included a table of results. The Examiners accepted tables that were organised with time in the left hand column or in the top row. Very few candidates identified the contents of the three tubes although more stated that they were recording colours and time and used these as column/row headings. Most included units but a significant minority did not.

(b) Most candidates realised in *(i)* that tube **A** was included as a control although they were not always so successful in explaining why. A mark was available for stating that the colour from tube **A** could be used to compare with the other tubes. They could have added that this was especially the case with tube **C** where the change was slow. Candidates had more of a problem with part *(ii)* but many stated correctly that starch was prepared in a buffer solution to make sure that the pH remained constant. A second mark was often obtained for some explanation about the effect of pH on enzyme activity. Some referred to pH 5.0 being the optimum pH and in the absence of any information to contradict this, a mark was awarded. It was pleasing to discover that many candidates knew the term *equilibration* in *(iii)*. Other appropriate terms were accepted, but many candidates thought that 40 ^{o}C was the optimum temperature for the enzyme. This was not credited *on its own*, but did not negate the mark for equilibration.

(c) The Examiners read many very successful answers to this question. Some candidates did not explain their results and some did not explore ideas about collision theory, active sites, enzyme-substrate complexes and the hydrolysis of glycosidic bonds in their explanations. However, there were plenty of marking points available for different interpretations of the question; very few exceeded the maximum of nine marks.

Some centres reported difficulties with **E2**. Their candidates often thought that this solution did not contain any enzyme at all or that the enzyme had been denatured. The Examiners did not credit these ideas. Other candidates explained that the concentration was so low that very little hydrolysis had occurred in tube **C**. The mark scheme was adapted to credit this line of reasoning.

Weak candidates were confused by what had happened in tube **B**. Some thought that no reaction had occurred because the colour was yellow from the start. It was for this reason that the candidates were told to test the starch solution at the beginning of the procedure and record the colour.

(d) Most candidates read the values correctly from the graph, although quite a few misread the first number as 2500. The Examiners saw very few lines drawn on the graphs to help read the values. In view of the problems that some candidates had with this question, perhaps they should all be reminded about this.

(e) Graph drawing was much better than in previous sessions. The Examiners made sure that there was sufficient space on the examination paper for sensible scaling of the axes. Most candidates were therefore able to make good use of space and plot points carefully to show the exponential decrease in the concentration of starch – a process that should be shown by a smooth curve. At least one candidate tried to draw a log graph but with little success.

(f) Some candidates fell into the trap of repeating typical evaluation points from previous Practical Tests. Not all of these were appropriate. For example, the question did not ask for limitations of the method followed at the beginning of the question. All of the points on the scheme were found although very few candidates were able to give ten of these. Some wrote at great length about two or three points. They should be encouraged to write

much more concisely in their evaluations and think of a wider range of points to make. It would have been helpful if more candidates had used some sub-headings, such as 'advantages' and 'disadvantages'. It was not always clear which method they were describing and sub-headings would have helped with this too.

The following is a candidate's evaluation. The numbers in brackets refer to the marking points for the mark scheme.

His method allows a quantitative (1) rather than a qualitative way of determining the presence of starch in the solution. This is more accurate (6) and allows you to determine the concentration of the starch (4) not just whether or not it is present. Knowing the concentration allows a graph to be drawn (7) and results to be extrapolated.

His results do not rely on personal opinion of colour change (3) so the experiment can be repeated by another person and the results will be comparable.

However, it takes more time to test the sample using a colorimeter than it does using the method I used (16), this leads to delay during which the amylase is still reacting thus changing the results (15). It also means the tests cannot be as regular which is another disadvantage. The method he used also only tested a single concentration of amylase (14) and did not have a standard solution without amylase in it (13). So changes that might have occurred anyway would be assumed to be the effect of the enzyme.

Teaching tip

Choose some simple practicals that candidates can carry out individually or in small groups. Do not be overly concerned with the accuracy of reliability of the results. Use the procedure and the results as the basis for a discussion of the evaluation. The procedure in *Q.1* could be used in this way and the example quoted above be used as a model answer. Many candidates found it difficult to evaluate someone else's procedure and data rather than their own. Perhaps candidates could work in groups on different practicals, present their results and then evaluate each group's work in turn.

Q.2 Many candidates did not appear to understand the instruction to annotate their drawings in part *(c)* with appropriate explanations.

(a) The standard of drawing was not particularly high. However, it did appear as if most candidates attempted to draw what they could see. Even fairly poor quality drawings gained marks because they met the marking criteria. But many drawings were spoilt by careless errors, such as leaving small gaps between cells, using sketchy lines and making the cell wall too big. Candidates should be reminded that they cannot see the cell membrane at this resolution.

(b) The Examiners decided to mark *(b)* and *(c)* together to a maximum of 10 marks. Only descriptions were credited in *(b)*. Many candidates included explanations dealing with water potential and osmosis in *(b)* instead of putting them into their annotations in *(c)*.

Most were able to describe plasmolysis and some even noticed that there were stands of cytoplasm left attached to the cell wall. Some, however, thought that the cells were shrinking rather than the protoplasm or cell contents. The Examiners were pleased to see that some candidates knew about plasmodesmata.

(c) In spite of the instruction to draw *one* cell, many drew all three as in part *(a)*. Plasmolysis was often shown, more or less clearly, but cell walls were often shown as a single line where they had been shown as a double line in *(a)*. Candidates who realised that this question was about water potential made good attempts at the explanations. Few stated that the potassium nitrate solution was occupying the space between the cell wall and the cell membrane.

(d) This question referred back to the Planning Exercise. Some candidates answered this very well indeed drawing on relevant information from their plans. The Examiners insisted that any reference to a smaller surface area was qualified by reference to loss of water *vapour*. In retrospect this seems to have been unduly demanding and few gained marking point 1. But those who knew their onions gained other points and it was pleasing to see some referring to surface area:volume ratios. Some candidates tried to make a link between this question and *(c)* by referring to water potential gradients which they said would be large between the leaf and the air and small between the bulb and the soil. This did not gain a mark and the Examiners regretted not having an AVP here to reward this idea.

Teaching tip

Place some epidermis from the outer surface of the scale leaf of a red onion under a video microscope or flexicam and irrigate with 1.0 mol dm^{-3} potassium nitrate solution. The movement of the protoplasm should be clearly visible.

2804: Central Concepts

General Comments

The Examiners felt that this paper was slightly more demanding than that of the previous two sessions. Many candidates found it difficult to express their ideas in a clear and accurate fashion. In many cases there was an absence of precision when defining biological terms. There was also an inability to apply knowledge to unfamiliar situations. This suggests that candidates need to be exposed to relevant material outside the core textbooks. It appeared that the questions targeted at the top end proved harder than equivalent questions in the June 2005 paper. *Q.2 (a)(ii)* to *(iv)* proved to be very challenging for many candidates. *Q.5* also proved to be very hard.

Comments on Individual Questions

Q.1 This opening question on meiosis and genetics proved to be a relatively gentle opener to the paper. Most candidates scored well demonstrating a sound grasp of the processes involved in meiosis and the sex-linked genetics of haemophilia.

(a) In part *(i)* most candidates were able to arrange the stages of meiosis in the correct sequence. Most candidates scored three or more in *(ii)*. The process that caused the most difficulty was *centromeres dividing*. The Examiners were looking for candidates to state that this process took place in anaphase II (M). The most common correct answers to *(iii)* were DNA replication and synthesis of organelles. Some candidates incorrectly stated processes going on in prophase I such as condensing of chromosomes or the disappearance of the nuclear membrane.

(b) Candidates produced excellent answers to part *(i)*. They read the instructions carefully and used the correct symbols for both the sex chromosomes and the alleles. The most common mistake was to show alleles on the Y chromosome. Most candidates who made this mistake were still awarded one mark for stating the correct phenotype of individual 9. In general the Examiners were surprised by the relatively small proportion of the candidates who answered *(ii)* correctly. The probability of individual 8 being a carrier of haemophilia is 0.5 or 50%. There was a lack of clarity in many answers to *(iii)*. The Examiners were looking for candidates to state that to be a carrier the individual must be heterozygous. This is only possible for females as they have two copies of the X chromosome.

Teaching tip

When teaching meiosis it is advisable to refer to the cell cycle and include information on interphase and cytokinesis.

Q.2 This proved to be the most demanding question on the paper. The majority of the candidates failed to grasp the difference between true and apparent rates of photosynthesis. Few were able to apply their knowledge of limiting factors to the unfamiliar situation presented in (a)*(iv)*. It was good to see many excellent descriptions of the Calvin cycle in part *(b)*.

(a) Some candidates paid scant regard to the fact that 'tissues' were asked for in *(i)* and gave answers such as 'guard cells', 'stomata' and 'chlorophyll'. 'Palisade mesophyll' was the most common correct response with fewer candidates referring

to 'spongy mesophyll'. In general this section was answered well. Only the most able candidates used the data correctly in *(ii)* to calculate the true rate of photosynthesis. The most common error was to subtract release of carbon dioxide from the net uptake figures rather than adding it. Most candidates seemed thrown by the question in *(iii)*. Many left this section blank. Others gave answers such as 'Yes - it is supported' (or the converse) without any reference to the data at all. Others gave more detailed answers but still with no reference to the data, for example 'reactions will proceed at a faster rate until the optimum temperature for enzymes is reached when denaturation will lead to a fall'. If calculations were attempted the formula was often misconstrued in one of two ways:

- many thought that + 10 meant that 10 had to be added to whatever value was being used for rate of reaction in the top line rather than reading on and seeing that the **t** actually referred to temperature;
- some used the wrong set of figures for photosynthesis taking the net uptake of carbon dioxide rather than the calculated true rate from section *(i)*.

It was pleasing to see that some candidates, however, could draw sound and well-argued conclusions that gained 3 or 4 marks. The final points that linked respiration and photosynthesis to all or some parts being enzyme-controlled were very rarely made.

In part *(iv)*, candidates generally appreciated that photosynthesis rates would be low at this time of the year (autumn and winter) but few went on to say that light intensity was the limiting factor. Many candidates discussed the effects of temperature on enzymes but then did not go on to relate this to respiration or otherwise focused on temperatures not being high for fear of denaturation. Some equated temperature rises with effects on water loss and then incorrectly made the link between water and its requirement in photosynthesis - temperatures too high, lots of transpiration, less water in the plant, therefore less photosynthesis. The main reason that photosynthetic rates fall when a plant is under water stress is that the stomata will be closed to reduce transpiration and this in turn will reduce uptake of carbon dioxide. More able candidates did manage to pick up marks here, but expression of biological principles relating to photosynthesis, limiting factors and respiration was generally poor.

(b) This section was consistently well done by candidates of all abilities. It was pleasing to see so many candidates making points which could easily have gained them credit beyond the maximum of five allowed for the question. Where mistakes were made the most frequent were: misnaming the pathway (photophosphorylation, oxidative phosphorylation, Krebs cycle) and reference to reduced NAD from the light dependent reactions rather than reduced NADP.

Teaching tip

Candidates should carry out experimental work on the effect of limiting factors on the rate of photosynthesis using apparatus such as a photosynthometer (Audus apparatus). See *Q.2* in the June 2002 paper for an illustration of this apparatus (Fig. 2.1) and also:

www-saps.plantsci.cam.ac.uk/records/rec334.htm

When considering their results they should consider whether they have measured the true or apparent rate of photosynthesis. Centres could try using *Cabomba* instead of the ubiquitous *Elodea* in their practical work on this topic. *Cabomba* can be obtained from shops that sell tropical fish.

As mentioned elsewhere, simulations are no substitute for practical work but can often be used to complement practicals or set as homework exercises. A simulation that has proved popular for teaching the area of the specification covered by this question is at:

www.cambridgeassessment.org.uk/research/innovationassessmentlearning/enigma/simulations/

Q.3 On the whole parts *(a)* and *(b)* were reasonably well answered. However there was considerable variation in *(c)*. There was evidence to suggest that knowledge and understanding of the respirometer was based on whether the candidates had actually used the apparatus in practical work.

(a) In part *(i)*, the Examiners were looking for soda lime or potassium hydroxide. The majority of candidates supplied the correct answer. The most common error was to state lime water. Nearly all candidates correctly stated in *(ii)* that substance **A** was to absorb carbon dioxide. Part *(iii)* was less well answered with many candidates stating that the function of the syringe was for introducing oxygen into the apparatus. The Examiners were looking for a reference to resetting the manometer fluid or to measuring the volume of oxygen taken in by the woodlice in given time.

(b) The inevitable reversal of the equation for RQ occurred in *(i)* and many of the weaker candidates simply stated that RQ measured 'the amount of respiration'. All too often candidates stated **amounts** of oxygen and carbon dioxide rather than more accurately stating **volumes**. In *(ii)*, most candidates realised that aerobic respiration was taking place but a significant number stated that oxygen was the substrate rather than carbohydrate.

(c) Some candidates became confused with the follow through from *(b)* to *(c)* describing at considerable length how RQ could be measured using this apparatus, suggesting removal of substance **A** and its replacement with water so that both oxygen uptake and carbon dioxide given off could be measured. Major misconceptions such as woodlice 'breathe out oxygen' or that the apparatus measures the 'carbon dioxide produced' were not uncommon.

It was good to see that most would use a water bath for temperature regulation but some thought that only tube **B** should be in the bath and not **C**. Beakers and Bunsen burners are not really acceptable for accurate regulation; neither is changing the thermostat in the room! Surprisingly few candidates gave accurate details of how to use the apparatus and manipulate the results. Most only talked in general terms about taking measurements and recording results without saying what they were measuring or recording. Consequently only odd points were picked up in this section. Many candidates who stated 'measure the distance moved by the fluid' forgot to note the starting point. Many realised the importance of repeats, means and adjustment time. Again weaker candidates talked about using results and plotting graphs without saying *what* to record and *what* to plot. Only the better candidates seemed to realise that time is an important element in calculating the rate. Although many candidates were awarded the marks for use of comparable woodlice for each temperature some were confused with the wording in the question of 'different groups' suggesting the selection of different species or ages for the different temperatures. A 'suitable range of temperatures' was often given without saying what a suitable range was or how many temperatures would be adequate. Once again this emphasised the general vagueness of many of the answers.

However, it is good to record that answers to this question were much better than to an equivalent question on practical work in June 2002 (*Q.2*).

Teaching tip

Candidates should use respirometers in practical work. If simple respirometers are used in the laboratory, students should still be aware of how differential respirometers work, such as the one shown in Fig 3.1. A suitable design for a simple respirometer is given in *Q.1* of the Practical Test for the A2 Practical Examination in January 2006 (2806/03 January 2006).

Q.4 This question was targeted at the lower grades and most candidates scored over half marks. With a little more care and precision when sketching the graph in *(a)(i)* and by qualifying answers in (a)*(ii)* more marks could have been gained.

(a) Part *(i)* proved to be quite a good discriminator with only the better candidates able to put the peaks of the stoat curve lower than those for the lemmings and also position the peaks to the right of the lemming curve. Weaker candidates did not sketch their curve with enough care and went for the symmetrical option usually failing to score either mark. The Examiners were looking for correctly qualified environmental factors, such as more food, fewer predators and less disease in part *(ii)*. All too often candidates simply wrote 'food, predators and disease' thus losing out on three relatively straightforward marks.

(b) A significant number of candidates (occasionally entire centres) explained *interspecific* and *intraspecific* the wrong way around but many partly retrieved the situation by stating correct examples from the East Greenland project thus gaining one mark.

(c) Carrying capacity was generally well defined. Some candidates gave the impression that it was the maximum number of *all* the animals or organisms in a habitat but this was the only common error. Only a few candidates stated that it was determined by limiting factors.

Teaching tips

Students should study examples of population growth in a range of organisms, considering the factors that are acting as environmental resistance. If questions are set on organisms other than bacteria information will be given in the stem of the question. Students should make use of this information when formulating their answers.

In view of the answers to part *(b)*, perhaps candidates should be reminded of the derivation of terms such as internet and intranet to help them remember the difference between interspecific and intraspecific.

Q.5 This question proved to be demanding as candidates were asked in a number of sections to apply their knowledge of kidney physiology and structure to unfamiliar situations. In general, candidates are far too casual in their use of technical terminology resulting in muddled answers.

(a) A minority of candidates correctly stated that the plasma glucose concentration in the renal artery and the concentration of glucose in the glomerular filtrate are 'directly proportional' in *(i)*. Some described a directly proportional relationship and gained the mark but others thought that 'proportional' would do or just said as one goes up so does the other. A surprising number of candidates failed to read the correct answer from the graph in *(ii)*. Incorrect answers ranged from 1.3 to 2.8. The most common error was to read the scale on the x axis incorrectly reading the value as 2.3 rather than the correct answer of 2.6. In part *(iii)*, candidates often failed to state that the carriers in the proximal convoluted tubule would be saturated so that glucose would appear in the urine.

(b) Most candidates realised that protein molecules are too large to be filtered and gained the first mark. However, only a small number referred to the basement membrane being the effective barrier. There were many incorrect references to the slit pores between podocytes and the fenestrations between the endothelial cells of the glomerular capillaries.

(c) This section was very well answered with many candidates giving lots of extra detail about the way in which beta cells release insulin. A few were confused and thought the kidney or liver released insulin or the brain or hypothalamus detected the increased levels of blood insulin. The Examiners were encouraged by the fact that only a few muddled the alpha and beta cells of the islets of Langerhans.

(d) The most common correct suggestion in *(i)* was that the kangaroo rat has long loops of Henlé. A significant number of candidates went on to say that this leads to a high solute concentration in the tissue fluid of the medulla but very few referred to the possible extra permeability of the collecting duct or the possibility of more ADH being produced. In part *(ii)*, the Examiners were looking for candidates to refer to storage molecules in seeds such as starch being broken down to respiratory substrate which is then respired aerobically releasing water. Good candidates explained how water is formed in oxidative phosphorylation.

Teaching tip

Students should be encouraged to study graphical information carefully. They should be encouraged to state accurately the trends that can be seen in the data. When studying kidney physiology it is sensible to consider animals that live in extreme environments and the adaptations of the structure and functioning of their kidneys.

Q.6 There were many excellent answers in *(b)* that demonstrated a sound grasp of natural selection. Many candidates annotated the information on page 18 as they read the question. It was clear that this helped them to phrase their answers. Those who read carefully and used the information did well here.

(a) Many candidates were able to define the term *allele* correctly. Those who failed to gain this mark usually referred to a type of gene rather than a type of *a* gene. A correct definition for *locus* proved more demanding and a common error was 'position of an allele on a gene'. The Examiners were looking for position of a gene or an allele on a chromosome.

(b) Weaker answers to this section were full of repetition and reverse statements resulting in few marks. The best candidates were able to extract the relevant data from the table in support of the statements that they were making. As the quality mark was awarded partly for successfully using the data many candidates disqualified themselves from this as no data was used at all. Candidates who answered only in very general terms also failed to do well.

Most were able to state how the predator would reduce the numbers of the snails that were not camouflaged, but found the link to change in allele frequencies more difficult to make. A significant number discussed frequencies of alleles rather than frequencies of snails and phenotype therefore failing to gain the most obvious mark. Also it was very common to read generalised outlines of the Darwinian theory or of 'survival of the fittest' without reference to the *Cepaea* example in the question.

Marking points 12 to 8 on the mark scheme were very rarely seen, although there were numerous incorrect references made to 'directional' rather than 'stabilising' selection taking place in both habitats. The quality mark for use and organisation of scientific terms was probably awarded less often than in the past.

Teaching tip

When provided with a table of data in the stem of the question candidates should always quote data to illustrate their answer. There will always be marking points allocated for relevant data quotes.

Candidates could be given the information on page 18 of the paper and be asked simply to 'describe' and 'explain' the data. Some differentiation could be achieved by having a list of appropriate terms to use for those who find this activity more challenging.

Q.7 The majority of candidates understood in outline how a synapse works but lost marks through poor use of biological terms and failure to read the question carefully.

(a) The most common correct answers were that synapses convey information between neurones and that they ensure one way transmission of nerve impulses. A number of candidates incorrectly stated that action potentials crossed the synapse. Reference to synapses being involved in summation, memory and learning were made by stronger candidates.

(b) This section was generally well answered by candidates who had *read the question carefully*: they wrote about *events* that take place rather than listing common *structures* involved. Many answers lacked precision by failing to refer to the pre- or postsynaptic membrane. A number of weaker scripts contained references to

vesicles moving across the cleft rather than molecules of the neurotransmitter.

(c) There were many encouraging answers to this section demonstrating a sound knowledge of the functioning of a synapse.

Teaching tip

When studying the synapse it is beneficial for students to look at the effect of various drugs and toxins on the functioning of this structure. A good starting place is:

http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/S/Synapses.html

Candidates could consider the modes of action of agonists and antagonists, for example.

2805/01: Growth, Development and Reproduction

General Comments

There were some excellent, high scoring scripts from well-prepared candidates. In this paper, synoptic material was included on topics including: bacteria, nutrition, adaptations of alveoli, gibberellins and endocrine glands. Perhaps because they are less often associated with topics in this option, candidates did not access material on bacteria and alveoli particularly well.

Comments on Individual Questions

Q.1 This question tested an understanding of sections 1 and 2 of the specification for this option module.

(a) The majority of candidates gave the correct process as binary fission in *(i)*. The most common error was to write 'mitosis'. Part *(ii)* was answered well across the range of candidates.

(b) Part *(i)* was well answered, with most candidates recognising the stationary phase and giving one statement in explanation. In *(ii)*, a good number of candidates explained that the log scale was used because of the very large numbers of bacteria. Credit was not given for saying that the numbers would be too large to count.

(c) About half the candidates were able to obtain at least one mark in part *(i)*. A common error was to draw the curve lower than the viable curve for part of its length. The total count would never be lower. In *(ii)*, a large majority stated that the total count includes living and dead bacteria, but few candidates were able to explain their curve any further than this.

(d) This question was synoptic and was not answered well. The correct answer to *(i)*, condensation, was seen only from the best candidates. A surprisingly large number just gave protein synthesis, which was stated in the stem. Part *(ii)* asked the candidates to describe three ways in which proteins are necessary for the growth of bacteria. Only the best candidates were able to apply this to bacterial structure and recognise that proteins are needed in the cell wall and cell membrane. Quite a large number recognised that proteins would form enzymes, but did not give an example of a use of enzymes in bacteria.

Teaching tip

Log graph paper is available at:
www.incompetech.com/beta/plainGraphPaper
www.csun.edu/science/ref/measurement/data/graph_paper.html

Candidates could use the simulation program *Bacterial Growth 3* from ScotCal to generate some data to plot on a log scale. Information is at:
www.scotcal.com/growth3/index.html
and a free demonstration program may be downloaded from:
www.scotcal.com/growth3/bg3_07.html

Q.2 This question included information on emergency oral contraception.

(a) In part *(i)*, most candidates identified the corpus luteum correctly. In *(ii)*, candidates who realised that levonorgesterol acts in a similar way to progesterone usually correctly described negative feedback of LH and FSH meaning that ovulation is not stimulated. Some weaker candidates wrote incorrectly about the effect of progesterone on the endometrium.

(b) Most candidates obtained two marks by writing about religious beliefs and the idea that this type of contraception may cause an abortion, or may have effects on a woman's health. Very few candidates mentioned that it might be used as an alternative to planned contraception or discussed the issues of availability. It appeared to the Examiners that some candidates did not realise that this was a question with an ethical basis.

(c) Most candidates obtained the mark in *(i)*. It was not enough to say that it can be taken up to 72 hours, it was also necessary to give a reference to effectiveness as well. It was pleasing that most candidates obtained two marks for the calculation in *(ii)*. The most common error was to calculate 85% rather than 15%.

Many candidates recognised in *(iii)* that ovulation and fertilisation may have occurred some time before, and that the woman could already be pregnant after sexual intercourse earlier in her menstrual cycle. Weaker candidates gave rather vague answers about the body rejecting the drug.

(d) About half the candidates realised that if progesterone is not effective, the endometrium will not be maintained, leading to menstruation.

Teaching tip

Aspects of population growth and fertility are covered in some of the booklets in the *Issues* series published by Independence Educational Publishers.
Further details are available at:

www.independence.co.uk

Further information is also available at:
www.nhsdirect.nhs.uk/chq/chq.aspx?classID=12

Q.3 Part *(b)* of this question involved candidates in making many direct comparisons between the placenta and the alveoli. It was disappointing to find many candidates unable to apply knowledge from their AS course to this question.

(a) Part *(i)* was generally answered very well, with two or three marks obtained easily. Very few candidates obtained two marks in *(ii)*. The most common answer was to describe the need for extra oxygen to be transferred to the fetus. A common error was to state that some of the extra blood is needed for the fetus. The likely increase in blood pressure was well recognised in *(iii)*. Unfortunately, a large number of candidates did not read *(iv)* thoroughly. They needed to apply their knowledge of nutrition to the composition of blood, but many gave general answers, describing the need for nutrients in pregnancy. The most common correct answers described the need for iron and protein in the production of haemoglobin. Three marks were rarely given.

(b) Many candidates were able to describe the general similarities between the placenta and alveoli in terms of gas exchange. Aspects that were covered included large surface area and short diffusion distance. Better candidates then gave clear relevant detail on the structure of the placenta and the role of fetal haemoglobin. It was disappointing that so few gave details on the adaptations of the alveoli. This was synoptic material that was not well accessed. As at least one mark on features of alveoli was needed for the quality mark, even many good candidates did not obtain this.

Teaching tip

Candidates could construct tables to compare the placenta and the alveoli. The mark scheme could then be used as an exemplar. It is perfectly acceptable for candidates to answer these questions using a table or any other suitable means of presentation. Candidates could also think of other functions of the placenta and think about how it achieves these functions compared with organs in a child or adult.

Q.4 This question covered botanical sections of the specification.

(a) It was intended that **X** would point to the testa; however, on Fig. 4.1 it clearly points to the nucellus. The Examiners accepted testa as an answer and this was the most common correct response. Otherwise only small numbers gained full marks on this question and there seemed to be a lot of random answers.

(b) The importance of preservation of plant species was well understood, with genetic diversity and use for medicines being the most common answers.

(c) The effect on the testa was well known. Many candidates described the stimulation of gibberellins and then gave further detail on the role of gibberellins, which did not gain credit. This question was only answered well by a minority of able candidates.

(d) Many candidates realised in *(i)* that dormancy allowed germination in favourable conditions, but few gave examples of such conditions. The advantage for dispersal was also well known. In *(ii)*, there were some very vague answers which did not gain credit. However, the role of gibberellins in stimulating enzyme synthesis was explained clearly by a good number. Pre-chilling and scarification were the most common correct answers to *(iii)*.

Teaching tip

The Botanical Society of America has a collection of images online:

www.botany.org/plantimages/

A listing of other such web sites is available at:

www.science.siu.edu/plant-biology/Faculty/nickrent/BotImages.html

Q.5 Some candidates were very well prepared for this topic and it was pleasing to see a good number of candidates with full marks.

(a) A few candidates had not studied the graphs fully and thought that treatment began at day 0. Four marks were available for figures from the graphs and many candidates obtained these easily. However, a significant number gave very general comments without any figures, for example stating that the pulse rate increased rapidly and then decreased. Credit was not available unless figures were quoted. Further marks were then available for explaining how thyroxine caused these changes. At this point, the best candidates often obtained several of marking points 12 to 19 from clear explanations. Weaker candidates either did not give any explanation at all or described the control of thyroxine secretion. Spelling, punctuation and grammar were generally good, with most candidates obtaining the quality mark.

(b) Candidates could have obtained full marks from a flow chart. However, very often a flow chart was an afterthought, repeating what had been written on the lines above. A very large number of candidates began with stimulation of the hypothalamus, obtaining that marking point and the next three, with the best candidates giving some extra details and obtaining well over the maximum of five marks. A few candidates gave completely incorrect explanations, including descriptions of short term ways of increasing the temperature, such as shivering.

Q.6 The Examiners were pleased to see this last question generally answered well.

(a) Many candidates filled in the first and third boxes correctly, but there were many and varied incorrect answers for the second box. At this stage, one cell must grow before dividing to form the eight nuclei of the embryo sac. Most candidates guessed; incorrect responses included ‘mitosis’, ‘meiosis’ and ‘nucleus’.

(b) There were many correct answers to *(i)*, but incorrect responses included **P** = 23 and **Q** = 46. Part *(ii)* prompted many clear and accurate drawings. The majority of candidates obtained a mark for drawing eight nuclei. Labels varied from highly accurate to guesswork. Some labelled the ovum as the ovule.

(c) Many candidates have a good understanding of double fertilisation and obtained the maximum marks very easily. Some candidates gave too much detail on the growth of the pollen tube and stages before fertilisation – just one mark was available for correct detail on these processes.

Teaching tip

Photomicrographs of the stages of ovule development are at:

http://images.iasprr.org/lily/

2805/02: Applications of Genetics

General Comments

A large proportion of the candidates showed good knowledge and understanding of the topics tested in this option module. 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 a third of the total marks, were answered less well than those on topics exclusive to this option. Most candidates answered all parts of all questions and did not appear to have suffered any lack of time. Some candidates did not attempt the genetic diagrams in *Q.1* and some left blank the questions on chemical communication in plants in *Q.5*. All questions allowed discrimination between candidates, with marks spread over a wide range.

Technical terms were mostly used correctly, but candidates who misuse the terms *gene* and *allele* put marks at risk.

Comments on Individual Questions

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

(a) A significant number of candidates did not give parental phenotypes, as asked for in the three crosses. Some candidates started with apparently tetraploid parents (e.g. **Mmmm**) and even when the parents were correct, there were many diploid, not haploid, gametes. Candidates who wrote the gametes as, for example, **Mmmm**, with no spaces or punctuation, were not awarded a mark. An alarming number of candidates crossed male with male plants (female with female was less common). Some chose as parental plants genotypes with two dominant alleles, despite having been told that all such combinations caused premature death of the embryo. A large number of candidates did not relate the genotypes and phenotypes of the offspring, merely listing both, not even in the same sequence.

(b) A pleasing number of candidates were able to explain the importance of keeping seeds of wild relatives of commercial crops. Most candidates stated that one must maintain genetic diversity for future use in changed conditions. Fewer mentioned counteracting inbreeding or potential extinction and that the seeds might include as yet unrecognised traits. Sadly, a large proportion of candidates referred to loss of *genes*, not *alleles*.

Despite having the information that papaya plants could be male, female or hermaphrodite, so that crosses could be made between male and female without emasculation, candidates wasted time and space describing emasculation in *(ii)*. Few candidates selected offspring both for resistance and a desirable commercial trait and very few identified the particular sex of papaya plants in their answers. The most commonly given mark was that the process would take many generations. A small number of candidates described genetic engineering, not selective breeding.

Teaching tips

- Remind candidates that information given in the question is there for a purpose.
- Encourage candidates to encircle gamete genotypes, to avoid any confusion about which symbols are, or are not, included in a particular gamete.
- Discourage candidates from writing out crosses involving more than one identical gamete from a homozygote.
- Remind candidates that the dominant allele should precede the recessive in a heterozygous genotype (**Mm**, not **mM**).

Q.2 It should not be unexpected, in this option, to find synoptic questions requiring a knowledge of the genetic control of protein structure and function from section 5.1.5 of the specification.

(a) A pleasing number of candidates were able to explain heritability as the proportion of phenotypic variation that is due to the genotype, but many thought it to be the likelihood of an individual inheriting a trait from its parents.

(b) The stronger candidates realised that they were dealing with a single gene with a large effect or that it was an example of discontinuous variation. Weaker candidates used their time writing about dominance.

(c) In part *(i)*, an alarmingly large number of candidates wrote that a 'stop' triplet stopped DNA replication, stopped amino acid synthesis or stopped ribosomes from reading mRNA (or even DNA). Some triplets were three amino acids coding for a base. The Examiners experienced a sense of relief when a 'stop' triplet actually stopped transcription, and not translation, but '*an amino acid that stops transcription*' was not uncommon. A few candidates were able to give an example of a 'stop' triplet.

Despite the errors found in *(i)*, many candidates were able to arrive at an incompletely produced protein, which was inactive because a change in shape affected its binding. Common errors in *(ii)* were that no protein was made, or that it was made in two sections.

Stronger candidates remembered the *lac* operon and so referred to a promoter, or an operator or a repressor and in some way encouraged RNA polymerase to bind to DNA when answering part *(iii)*. Answers here were centre-dependent.

(d) Most candidates were able to state, in *(i)*, that both the number of tillers per plant and the number of branches per tiller were increased in the genetically engineered plants. Many supported their statement with comparative figures. There was some confusion between tillers and branches, leading to oddly worded answers such as '....*two branches with eleven tillers and as the branches increase the tillers decrease*'.

Many candidates realised in *(ii)* that the single **T** allele in the genetically engineered plant was having more effect than the two **T** alleles in the wild type plant, but had difficulty finding a reason for this. Stronger candidates suggested that since it would be randomly placed in the genome it might lack normal controls or be inserted after the controls for a frequently expressed gene. Weaker candidates simply stated that introducing the dominant allele would prevent the recessive alleles from working. Some candidates were so sure that epistasis must appear somewhere on the paper that they gave that as their answer.

Teaching tips

- Revise transcription and translation when starting this option.
- Candidates should be encouraged to quote figures from graphs or tables. Care should be taken in reading the axes. In this question, the maximum number of tillers per plant is 28, not the often seen 38.
- Emphasise that heritability relates to a population, not individual inheritance.

Q.3 A pleasing number of candidates were confident in their knowledge of the consequences of inbreeding and of natural and artificial selection.

(a) Part *(i)* presented little difficulty for many candidates who saw that mating success decreased with degree of inbreeding, but a surprisingly large number of candidates misread the value for **C** as 0.45 (or even 0.4). In *(ii)*, many candidates correctly accounted for the inbred butterflies' poor survival as inbreeding depression, with accumulation of deleterious recessive alleles and loss of genetic diversity.

(b) Excellent comparisons of selective breeding with the evolutionary process were seen, with candidates making a number of distinctions between the two. Some candidates tended to describe first one and then the other, leaving the Examiner to make the comparison on their behalf. Weaker candidates tended to write at length about one or two differences, adding nothing to their argument with the extra lines. The mark for the quality of spelling, punctuation and grammar was awarded to the majority of the candidates.

Teaching tip

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.

Q.4 Many candidates were on firmer ground writing about artificial insemination in livestock than they were on the use of IVF in humans.

(a) A minority of candidates thought that *in vitro* fertilisation was '*the fertilisation of an embryo*' or the implantation of an embryo into a surrogate.

(b) The phrasing of the question: '*Suggest why the HFEA restricted the number of embryos that may be transferred .....*' should have led straight to the answer: '*To restrict the number of multiple births'.* Instead, candidates made statements such as: '*When large numbers of embryos are transferred there is a higher risk of multiple births'* leaving the reader to interpret their intent.

(c) Most candidates successfully compared the outcomes of single and twin pregnancies after IVF or natural conception in part *(i)*. In quoting figures, very few candidates indeed took any notice of the '*per thousand pregnancies*' of the table heading. A small number of candidates read the figures as numbers of pregnancies. One hopes that the candidates understood that these are mean numbers, given the decimal points.

Candidates lost marks in *(ii)* by repeating statements they hade made in *(i)*, instead of comparing the figures for single pregnancies with those for twins. Many candidates recognised that single pregnancies were less likely to be premature or to result in death of the fetus or neonate. The more confident candidates questioned the significance of the figures.

(d) Excellent answers were seen from a candidature well briefed on the advantages of using AI in breeding livestock. A few candidates misread *advantages* as *disadvantages*. A minority confused AI with implanting embryos into surrogates. This must have been the reasoning behind the answer: '*AI saves the female from the risk of pregnancy.*'

Teaching tip

Encourage candidates to make their own glossary of terms for this option to help with definitions, especially where initials such as IVF or AI(D) are commonly used.

Q.5 It was difficult to believe that many candidates had ever encountered the item relating to chemical communication in flowering plants in the control, coordination and homeostasis section of the specification, 5.4.6 (p).

(a) Candidates gained marks in *(i)* for referring to plant growth regulators, or even to plant 'hormones', and for naming an example. Only the stronger candidates presented further information. The use of the term 'flowering plants' as in the specification, turned many candidates' thoughts to pollination and so plants sent signals to their neighbours that they were ready for reproduction. In *(ii)*, again, there were many signals between plants about flowering. The stronger candidates had plants responding to changes in the external environment, and, more rarely, the internal environment.

(b) Economy of energy was often seen in answer to part *(i)* about production of insecticides by celery; economy of resources or materials was seen much less frequently. A common response was that the insecticide harmed the plant.
The majority of candidates were on familiar ground in *(ii)* in describing the rise and spread of insecticide resistance in an insect population. Candidates correctly identified the insecticide as the selective agent in this example of natural selection. Some insects became bacteria as the answer progressed, even to the extent of horizontal transfer of resistance by conjugation. In other answers insects became plants. The terms gene and allele were often misapplied.

(c) Some candidates confused the chemical signal, jasmonate (**J**), with the insecticide, suggesting that enzyme **E** broke down **J**. Stronger candidates realised that the earworms (often masquerading as earthworms), were responding to the plant's jasmonate by increasing their production of enzyme **E**. Having got that far, marks for the action of the enzyme and reduced mortality (often morality) of those earworms followed easily. Some candidates struggled with the data: 'I was surprised that the mortality was highest when insecticide was present but jasmonate wasn't.'

As always, some candidates described rather than explained the data.

Teaching tips

- Remind candidates that a third of the marks on an option paper are synoptic, and that the material concerned may come from any part of the AS or A2 core specification.
- Remind candidates, also, that the terms gene and allele are not synonymous. The genotypes of diploid organisms, such as the insects in this question, differ in the alleles of the species' genes.
- Emphasise the importance of reading the key words of the stem of the question. A description can never access the marks for an explanation.

Q.6 Many candidates were well briefed on both the formation of rDNA and genetic testing.

(a) Many good descriptions of the role of restriction endonucleases and binding of 'sticky ends' were seen. Many candidates wrote embryo essays spilling into the margins of the page and around Fig. 6.1. Some candidates thought that ligase was necessary for the hydrogen bonding of complementary bases, rather than for restoring the sugar-phosphate backbone of DNA.

(b) Many candidates successfully described the results of the experiment in gene therapy and quoted supporting figures. Misreading the graph axes was surprisingly common. In particular, day 180 was said to be day 150. Answers such as: '*The number of muscle fibres increased in the control, but fell in the treated muscle*.' were a common result of misreading the vertical axis of the graph. A few candidates confused the control and injected muscles.

(c) Many excellent answers were seen, in which a number of advantages and disadvantages were clearly laid out. As in *Q.3*, weaker candidates spent time over-elaborating a few points. The mark for the quality of written communication mark required clarity and a use of suitable terms, such as false positive or negative, quality of life, karyotype, amniocentesis, IVF or others. Most candidates who mentioned chorionic villus sampling spelled *chorionic* as *chronic*. Candidates who presented very terse bullet points tended not to gain marks. For example: '*telling rest of family*' and '*employers/insurers*'. In either case, is there a problem, and, if so, what is it?

Teaching tips

Suggest to candidates that when told that a mark is available for the quality of use and organisation of scientific terms, it is a good idea to use a few terms relevant to the question material.

Explain to candidates that whilst it is important to have written enough detail to make an answer clear, there are no marks for repetition. Starting an answer such as this with '*There are both advantages and disadvantages of genetic screening*', when that is what the question asks for, is a waste of time and of two lines.

2805/03: Environmental Biology

General Comments

Overall the candidates performed well on this paper. 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 answered in sufficient detail.

This paper involved candidates applying their knowledge of biological concepts in new situations, such as in the effects of pesticides on wildlife and the effects of PCBs on organisms. The recall from AS and 2804 (*Central Concepts*) was generally poor with many candidates unable to link information and science together.

For the questions involving the use of data and graphs, candidates performed well and used the data accurately and appropriately. The responses were detailed and the Examiners were pleased with the improvement seen since the paper taken in January 2006.

Candidates thought that the leaching of pesticides into water was a main cause of eutrophication. This mistake was made by many candidates across many centres. However, this was the only error that occurred frequently in the scripts.

Comments on Individual Questions

Q.1 *(a)* Responses to this question on factors affecting the shape of limpets on both shores were generally well done. It was pleasing to see several candidates thinking about the dietary requirements of the limpets and linking nutrient availability to shell size. It was good to see only a few candidates giving light, temperature and heat as answers; most answers were thoughtful and scientifically-based suggestions.

(b) Most candidates described how sampling of limpets could have been carried out in a specific area, but many failed to stress how this could be done randomly. It is important to stress to future candidates that random sampling involves a lack of predictability whereby results are carried out without any systematic pattern. This investigation into length to height ratio of limpets on exposed and sheltered shores would have involved the students dividing the area into grids and within each area using either x, y co-ordinates or random walking to locate the limpets to be measured. The investigation does not involve systematic measurements using line transects, continuous belt transects or interrupted belt transects as none of these methods are random.

(c) For the analysis of the student data in *(i)*, the candidates were required to interpret and discuss the implications of the t-test result. This was generally done well and most candidates correctly rejected the null hypothesis. Candidates who calculated the wrong degrees of freedom and subsequently used the incorrect value from the probability table were not penalised from marks as it was an understanding of the mechanisms of the t-test that was being tested here. Overall it was impressive how many candidates understood the workings of the t-test and even though candidates' mathematical ability was not being tested they were required to work through their explanation logically to gain the full four marks.

Teaching tip

Students need to practise sampling techniques and the use of statistical tests such as the t-test can only really be taught out of the classroom. Field work can still be carried out in the school

grounds and with some imagination both random and systematic sampling techniques can be done. The web site, www.countrysideinfo.co.uk/howto.htm introduces all of the techniques of sampling that A level biologists would be expected to carry out and could be used as a good starting point for teachers.

Q.2 *(a)* Most candidates did well in part *(i)* with most describing or naming the process of bioaccumulation. The key point for part *(ii)* was that mercury is stored and not excreted in fatty tissues and hence it is able to build up in concentration through the food chain. Candidates did not always give the appropriate unit when they quoted the data in their answers and this is something that future candidates should be reminded to do as a matter of course.

Many candidates provided descriptions and explanations of the process without naming bioaccumulation and were still awarded the mark. It was clear from responses that many candidates were unsure of the ecological terminology to apply to this question, for example rudder fish are **not** the primary producers in the food chain. A few candidates, however, did describe the process of bioaccumulation with reference to trophic levels which was good to see.

(b) This question had a mixed response from candidates. Most discussed the problem of pesticide run off and leaching as leading to eutrophication and several went onto discuss the effect of falling oxygen levels and BOD. Most candidates immediately assumed than any substance leaching from the soil into rivers leads to algal blooms. This is obviously not the case. Many good responses were given to this question though with several candidates using examples of how specific pesticides have harmed the environment. Responses relating to effects of pesticide drift on human health were not awarded marks. This was because this is not a direct effect upon the environment and also many of the supposed effects on human health and not proven and are only possible causative factors, such as the links of pesticides on asthma.

(c) The first extended answer question was well answered by many candidates. However, very few candidates annotated the graph and references to data in answers were often inaccurate. Candidates should be made aware that credit can be given for correctly annotated graphs and data quotes. It was important here that candidates identified the key events occurring before and after 24 hours following introduction of the biological control species. The advantages and disadvantages were described in detail and several candidates used case study examples to show how biological pest control species have become pests and led to uncontrollable damage. This showed a good application of knowledge. Biological pest control is not generally considered a quick method of control as many candidates suggested. The time it takes for the predator species to become established and find food sources is slower than pesticide applications.

Teaching tip

There is a wealth of available data from books and internet resources on this topic of biological pest control. Furthermore, Fig. 2.2 would be a good teaching aid to highlight one of the key problems with this type of pest control, namely timings. The Biological Control Virtual Information Center which can be found at:

http://cipm.ncsu.edu/ent/biocontrol/

is a very good starting point for students researching the advantages and disadvantages of biological pest control. Furthermore, the Biozone Student Manual 1 has excellent materials on the biological control of pests in the section on agricultural management. This has many good case studies that the students could reference in answers. See:

www.biozone.co.uk

Q.3 *(a)* In *(i)*, it was important that candidates appreciated that succession is a gradual change in ecosystem structure over time. Furthermore in explaining succession candidate answers should have included references to seral stages, a change *in* the conditions for the next stage, development of soil and the creation of different niches. Credit was given for use of Fig. 3.1 and also for reference to pioneer species and examples of organisms characteristic of each stage. Several candidates used the figure and were credited accordingly. This part was generally well done.

Most candidates were able to use the figure in *(ii)* to describe two changes between mid and late succession. Most discussed the changes in soil structure and composition and it was good to see some detailed answers here.

Part *(iii)* proved difficult and there was some confusion from candidates with many not understanding the difference between biotic and abiotic changes. Candidates need to understand the key difference between biological and the non-living components of an ecosystem. Many candidates describes how there would be an increase in biodiversity as succession proceeds whereas it is clear that the reverse occurs. Systems that are prevented from reaching their climax community such as through the introduction of grazing retain much higher species diversity. Disturbance usually leads to the creation of a variety of niches and hence the potential for greater species diversity.

(b) Many candidates used inappropriate methods in *(i)* to estimate the percentage organic matter in dry soil. It is important that soil is *burnt* and this would require temperatures in excess of 200 ^{o}C. Many candidates described a method involving using temperatures of 105 ^{o}C. This would not be adequate at removing the organic matter although it would remove the water. This suggests that candidates had not spotted the reference to dry soil in the question. Soil needs to be burnt to a constant mass before the percentage change is calculated. It was evident from most responses that the candidates had not had first hand experience of this soil analysis technique.

Part *(ii)* was generally not done well by the majority of candidates. Most failed to understand what the graph was showing and to appreciate that it was highlighting the changes in soil organic level for samples of soils from 1980 to 1995. The graph did not represent one sample of soil as some candidates thought but the results from many samples of soil. Many candidates did not use the data from the graph correctly and there were very few annotations on Fig. 3.2 on the scripts. To be awarded the marks for the question it was important that the candidates referenced the data from the graph. The Examiners wondered whether some candidates did not understand the concept of *top soil*.

(c) Candidates were asked to state two examples of a plagioclimax. Most did this successfully. Many went on to describe methods of how a plagioclimax is maintained which was not demanded by the question. This was what was required

in part *(d)*. Descriptions were not awarded marks, for example where a candidate wrote 'a field where animals have been allowed to graze'.

(d) Responses to this section were very good and many candidates scored highly here. It was pleasing to see the use of case study examples of how a plagioclimax can be maintained and most candidates highlighted the fact that it was human intervention that was the important factor in preventing a climax community becoming established.

Teaching tip

This question highlighted the need for students to carry out a soil analysis and to be able to measure and explain abiotic factors especially with reference to succession. The book recommended below should help teachers or students get to grips with the techniques involved and the importance of analysing different qualities in the soil. Finding the organic content of soils (and also the mineral content) gives candidates plenty of opportunities to practise their mathematical skills.

Palmer, R., Troeh, F. 1995. *Introductory Soil Science Laboratory Manual*. Oxford University Press. ISBN 0-19509-436-0.

Q.4 *(a)* Most candidates obtained maximum marks in *(i)* with most responses highlighting the importance of an unviable population size and the possibility of this leading to extinction. Several used examples to explain the term although very few used the black rhinoceros as an example. There are many reasons for the decline in black rhinoceros numbers although disease is generally considered not to be one of the main reasons for the population decline. Most candidates correctly identified the main reasons in their answers to *(ii)* such as hunting, loss of habitat and use of body parts in traditional medicines.

(b) In this question several candidates made reference to the CITES agreement as being involved in the establishment of breeding programmes for endangered species. Furthermore, candidates describes it as a set of laws which control or ban trade in certain animals. This is not correct and the agreement is purely a legislative agreement to stop trade in endangered animal species. The CITES agreement does not take the place of national laws but provides a framework to be respected by each signatory, which has to adopt its own domestic legislation to ensure that CITES is implemented at the national level.

(c) This question was not well answered and many candidates assumed an Environmentally Sensitive Area (ESA) was similar to an SSSI. Most candidates reworded the stem to the question. The importance of the question was that an ESA is an ecologically sensitive site, threatened by modern intensive farming methods. Furthermore, the land is not protected by laws but by the cooperation of farmers and government to promote farming techniques that do not damage the land. There were some good responses, however, and several candidates correctly described the reintroduction of hedgerows and the reliance on traditional fertilising techniques to prevent the over-application of inorganic nitrogen-rich compounds.

(d) The second long response question was answered well by most candidates; in order to obtain the quality mark they needed to describe three reasons why hedgerows are important to wildlife. Most candidates could describe reasons for

the removal of hedgerows and the responses were sufficiently detailed and well structured. Some candidates failed to stress the importance of the hedgerow to *wildlife* and so went on to discuss the aesthetic qualities that they bring to the countryside. It was important that candidates quantified their reasons for why the loss of hedgerows would be problematic. For example, if a candidate discussed how the hedgerow protects the fields from adverse wind conditions they then needed to say why this was important to wildlife. This was often omitted from candidate responses.

Teaching tip

The main area for concern regarding this question was the issue of ESAs and the confusion that this created in many candidate responses. The use of a leaflet from DEFRA should help clear up the confusion for future students studying this area:

www.defra.gov.uk/corporate/regulat/forms/erdp/esa/erdpesa-notes.pdf

Furthermore, there is a publication entitled, *Our Living Heritage* produced by MAFF which explains the importance of these areas and how they are managed. Further details are available at:

www.defra.gov.uk/corporate/publications/pubcat/rural.htm

Q.5 *(a)* PCBs are present in coolants**,** inks, paints, plastics, electrical equipment, fire retardants and old fluorescent lighting and they have a variety of effects on organisms. Most candidates could identify possible sources of PCBs, but many candidates stated that the main source of these in the environment was through pesticide application.

(b) Several candidates correctly identified that PCBs could act to mutate cells, lead to uncontrolled mitosis and so form a tumour in answer to *(i)*. Very few identified that the DNA structure would be altered and that the result would be a change in amino acid sequencing leading to the incorrect synthesis of proteins. Tumours do not develop from accelerated mitosis as several candidates suggested. Uncontrolled is not necessarily any more rapid it is simply not ordered.

Part *(ii)* was more challenging for candidates; very few scored highly possibly as a result of the synoptic nature of the question. Candidates needed to describe the system affected and then explain one way in which PCBs might act in a deleterious way. No marks were awarded for describing their carcinogenic effects and many candidates incorrectly described how PCBs weaken bones and lead to osteoporosis. Only scientifically proven effects of PCBs on organisms were awarded marks. There were two marks on the mark scheme to allow candidates to extend their answers to other body systems if justified correctly. The Examiners checked to make sure that any links were correct before awarding these marks.

(c) This question proved to be a good discriminator and some candidates produced excellent answers here. Candidates needed to quote figures accurately from the graph in Fig. 5.1 with the correct units and then describe the fluctuating trend seen. Close inspection of the data shows that the mean PCB concentration falls, rises slightly, falls, rises and then eventually falls. There is no definite pattern or trend in the data especially as there is no data for some years. Very few candidates commented on the actual data produced and the validity of the results. The graph was of mean concentrations yet the sample size varied from year to year and no

error bars or standard deviation measurements were shown. This question was particularly good for candidates to comment on experimental data and the validity of research data. This graph and question is a good potential resource for future candidates and for use as a synoptic question.

(d) Overall responses here were good and most candidates could suggest two ways to manage fish stocks. The use of aquaculture was allowed as a marking point as it is a way to provide sufficient food for humans even though it provides nothing for other top predators. Many candidates described the use of quotas, net sizes and leaving areas free of fishing during breeding seasons. Some candidates used examples here to illustrate these methods.

Teaching tip

There is a very good case study from the USA involving the effects of PCBs from a paper mill in Fox River and the subsequent effects on human and animal life. This can be founds at:

www.foxriverwatch.com

This would provide an interesting study into a long-term anthropomorphic pollution problem. This area of study could also be tackled by investigating the effects of PCBs on cetaceans and their subsequent health and reproductive problems.

Q.6 *(a)* This question was attempted well by most candidates. Several used indirect reasons for rainforest decline, such as forest fires, climate change and pollution. Whilst these may have an impact on the actual rainforest specific reasons for the decline were required. Pollution could have been used as a reason for decline if it had been linked to mining and the exploration of mineral resources. The manufacture of chopsticks was a reason discussed by the Examiners.

(b) Most candidates identified the relationship shown in Fig. 6.1, but very few went onto examine the data any further. Careful consideration of the data highlights differences in countries with the same population rate and also with the same rate of deforestation. Very few graphs were annotated and many candidates attempted to explain the data rather than describe it.

(c) This question was attempted well by most candidates and there were some very good responses regarding economic and ethical reasons for maintaining biodiversity. Few candidates discussed the maintenance of sustainable agriculture as a reason to stop the loss of tropical rain forests or the importance of local indigenous tribes. Many described the importance of ecotourism and the potential economic benefits. It should be stressed that there is an overall importance to preserve genetic resources as these may be of future value. The case study of Costa Rica and the ownership of its tropical rain forests by western pharmaceutical companies is a good example of this importance.

(d) Most candidates could identify at least one benefit of increasing waste recycling and most candidates described energy reduction and reduction in land fill as the key benefits here.

Teaching tip

The graph shown in Fig. 6.1 is a very good future teaching resource and highlights the problems when trying to pinpoint and make generalised conclusions from data. The graph could be used to investigate these countries further and find out for example why Gabon, the Democratic Republic of Congo and Cameroon have the same annual rate of deforestation yet neither has the same population growth. What other factors influence the rate of deforestation? The following site:

www.fao.org/sd/wpdirect/WPan0050.htm

is a good start to investigate this problem.

2805/04: Microbiology and Biotechnology

General Comments

Generally, candidates were well prepared for this paper and many had a particularly good knowledge in the areas that had been tested in previous papers. Very good answers were seen to all questions and it was encouraging that, overall, the quality of the extended answers showed an improvement on last year, with a number of outstanding accounts. Spelling, punctuation and grammar skills were of a good standard and the organisation and use of scientific terms was also pleasing, with the result that the majority of candidates were awarded both quality marks. Despite gaining the quality mark for the use of scientific terms, there was evidence that some candidates lacked the confidence to use biological terms to improve the quality of their answers. The term 'inoculum', which appeared in *Q. 1* and *Q.5*, was not understood by a number of candidates. There appeared to be a good grasp of the techniques and processes covered in this option and many candidates were able to apply this knowledge to unfamiliar situations. Candidates that had carried out practical work were able to use their experience to give comprehensive answers to the questions on counting techniques and the use of the laboratory fermenter. As ever, candidates should be reminded that careful reading of the rubric (at least twice) before attempting to answer is an essential examination technique.

Marks were spread over a wide range, with all questions discriminating well, particularly *Q. 1, Q.2, Q.3 and Q.4*. *Q.5*, based on the learning outcome which covers the treatment of domestic and industrial waste, was particularly well done and proved to be most accessible to the weaker candidates, who sometimes produced a better food web than those who were in the top ability range. The synoptic links with 2804 (*Central Concepts*) in *Q.6*, which included references to plant communication, respiration and AS biochemistry, as well as a number of 'suggest' questions, proved to be the biggest challenge for some. Candidates of all abilities had a good attempt at answering all sections of the paper, with the exception of *Q.6*, where a number of weaker candidates left sections unanswered. The fact that most others were able to complete all sections of the paper suggested that the problem was one of difficulty rather than time. It was good to see candidates annotating Fig. 3.1 to help illustrate their answer to *Q.3 (a)*.

Teaching tip

Questions in this examination often expect candidates to recall and apply knowledge from different areas *within* the option specification. For example, in *Q.2* knowledge of cheese maturation from 5.3*(b)* was linked to an ability to apply knowledge of counting techniques from 5.2*(f)*. Similarly, *Q.4* used an ability to apply knowledge of 5.2*(g)*, specialist structural features of laboratories, to a plant tissue culture situation (5.2*(a)*). When centres have completed the teaching of this module, they could ask their candidates to summarise the possible links to other areas within the module or candidates could go through a past paper and link questions to learning outcomes.

Comments on Individual Questions

Q.1 Most candidates found this question to be approachable and there were many who were able to gain all the available marks.

(a) This was intended to introduce candidates to the paper by enabling them to think across the specification. Generally candidates were able to assign the correct terms to the definitions, especially part *(iv)*, stationary and part *(v)*, biosensor. A number of candidates did not read the definition with sufficient care for part *(ii)* and quite a few stated 'lipoprotein' for the outer coat of the virus, presumably referring to the envelope possessed by some viruses or 'capsid', having missed reading 'subunit' in the question, or 'amino acid'. Some candidates gave microorganism types or names for part *(iii)*, such as 'yeast' and '*Thermophilus*' or gave the incorrect term, psychrophile or cryophile. 'Biogas' was commonly given for part *(vi)* with methane and methanol also appearing and spellings of gasohol were not always correct, for example, gasol, gashol, gasohol and gassohol were near misses. 'Alcogas' was seen on more than one occasion. The Examiners liked the word 'hydrothermoblaster' as an alternative term for an autoclave!

(b) Candidates appeared to be familiar with the laboratory set-up of the batch fermenter and most made a very good attempt at answering this short extended question. There were some comprehensive accounts, with the stronger candidates covering most of the mark points clearly and demonstrating a good ability to apply their knowledge of the principal differences between batch and continuous fermentation to the laboratory situation. Many candidates found it useful to add to Fig. 1.1 and those who were more vague in their written answers were often able to gain the mark where the Examiners could refer to the diagram for confirmation. 'Inoculum' was mistaken for 'nutrients' on a number of occasions, so that the 'inoculum' was added continuously. At this level, 'food' was not considered to be a suitable alternative to 'nutrients'. Additionally, thermometers and pH probes to *control* temperature and pH respectively were common mistakes. Some candidates were clearly confused, describing the continuous culture set-up as an 'open' system and suggesting that the bung should be removed to prevent it from being 'closed'.

Teaching tip

'Microbiology and Biotechnology' bingo will help candidates learn definitions as well as recognising definitions to which the correct term can be applied. This could be a differentiated activity: candidates could construct their own bingo card and choose their terms from the larger list to put into the grid, or they could be given a pre-printed card. Alternatively, laminated cards with definitions and terms could be paired up by candidates on their own or in groups. Finding the other person in the teaching group with the matching term / definition is another approach that could be adopted.

Q.2 This question was well answered by many for all sections apart from part *(b)(iii)*. A number of candidates who scored well overall, did not think carefully enough at times and lost marks in parts *(a)(i)* and *(b)(iii)* for the reasons given below. In parts *(a)* and *(b)(i)* and *(ii)*, it was pleasing that candidates were confident in applying their knowledge of counting techniques to a new situation and there was evidence that many centres had performed practical work for this topic.

(a) In part *(i)*, the majority of candidates referred to differences in shape of the bacteria in order to gain at least one mark. The idea of using a microscope to make the observations was rarely given, but when mentioned, it appeared to be centre-specific. Although knowledge of the actual shapes of the two types of bacteria was not required to gain full marks for part *(a)*, it was pleasing that a good number were able to correctly describe the shapes. Occasionally some candidates gave detailed descriptions of the Gram staining procedure. In part *(ii)*, most realised that dilution plating would give viable numbers but some did not go on to explain why haemocytometry would be a poor technique to use and may have missed out on the opportunity to gain full marks. Quite a few gave unnecessary detail about dilution plating methods.

(b) In part *(i)*, plate **C** or **D** was usually chosen and accompanied by at least one correct reason to gain credit, demonstrating a good understanding by most candidates. There were some that lost marks by a lack of precision; for example, they failed to state that the estimate involved a **count** of the colonies. Instead they gave vague statements, such as: 'because there are not too many and not too few of them'. However, there were also some excellent complete responses. A handful of candidates thought that the lawns of plates **A** and **B** represented no growth.

The responses obtained in part *(ii)* were disappointing, with fewer than expected carrying out the correct calculations to arrive at the answer. Those candidates who had incorrectly chose plate **E** in part *(i)* were not penalised by using four colonies for their calculation. Linking the data and then 'scaling up' using the dilution factor and the sample volume defeated many candidates at one or both steps. Some credit was given if it was evident to the Examiners that the candidate had considered one or both of these, but at times it was not clear how the candidate had arrived at the incorrect answer. There is clearly a lack of confidence by some candidates in dealing with decimal places and/or negative indices.

In part *(iii)*, some candidates had forgotten that the bacteria were from a cheese sample and based their answers on the fermentation stage. Only a minority of candidates realised that the lower numbers of *Streptococci* were related to the age of the cheese sample, with many suggesting differences in the numbers in the initial inoculum. The points regarding anaerobic respiration and lactic acid production, leading to a decrease in pH and the subsequent inhibition of *Streptococcus*, were lost on all but a few. Some wrote in error about mutualism between the two microbes, which would have led to an *increase* in numbers and others went into some depth on the production of yoghurt. Despite being provided with the information that *Streptococcus* and *Lactobacillus* were lactic acid bacteria, some candidates assumed that the low numbers of *Streptococcus* could be attributed to their reliance on aerobic respiration. Many stated that there was competition between the two species, but knew very little more.

Teaching tip

When it is not possible to carry out the practical, candidates can still learn this topic visually. A demonstration using coloured water as the undiluted sample is a good starter to help candidates understand the concept of the ten-fold dilution. Growth on agar plates is easily represented by diagrammatic examples such as in Fig. 2.1 or by photographs of experiments performed previously. If there are two replicates for each dilution, the value of avoiding plate **E** could be demonstrated if candidates carry out the calculation. Repeated practice at calculations, involving a breakdown of the logical steps to arrive at the correct answer is beneficial for most candidates.

Q.3 In this question, most candidates were able to gain at least half the available marks and many did extremely well to obtain full marks.

(a) Almost all candidates were able to write at length for this extended question and went on to gain the mark for the quality of written communication. Those candidates who realised that they had to apply their knowledge of classification from 2804 (*Central Concepts*) to help them answer this question, gave logical and flowing accounts that were of text book quality and they gained the maximum mark. Many candidates commented on the presence of cell walls to link the microorganisms to plants and recognised the presence of the starch grain in the green alga, as well as noting the lack of a true nucleus and the presence of a cell wall containing murein in *Microcystis*. Few candidates used the terms eukaryotic and prokaryotic even though differences were stated. References to differences in size were credited, but surprisingly few candidates thought or were able to use the scale bars to give correct size comparisons. On numerous occasions, the Examiners had to pick their way through muddled accounts where *Microcystis* was referred to as the green alga, for example, or where the organisms were not singled out for comparison statements. Statements such as: 'they have cellulose cell walls like plants', 'it doesn't have a chloroplast but plants do', left the Examiners guessing as to which organism the candidates were discussing. Weaker accounts simply gave a list of the structures that appeared on the diagrams rather than linking the features to the kingdoms. It was disappointing to see numerous candidates refer to the lack of a chloroplast in *Chlamydomonas*.

(b) This was intended to be a relatively straightforward question where candidates could demonstrate their knowledge of microorganisms featured in the specification. Naming the correct groups was generally not a problem for most although there were quite a few 'yeasts' or 'prokaryotes' for the fungi and some candidates gave two groups for each pair. With the word emboldened, it was hoped that the answer would relate to a **structural** difference. However, this was not always the case and Examiners saw references to types of life cycle and the named hosts for the viruses in part *(i)* and types of reproduction or antibiotic production for the fungi in part *(ii)*. Correct structural differences were frequently given to differentiate between lambda and HIV, but far fewer candidates were able to give a valid difference between *Saccharomyces* and *Penicillium*. There were some unscientific descriptions of lambda, with 'prongs', 'legs' and 'spikes', accompanied by tiny diagrams. As with part *(a)*, the Examiners were unable to award the mark if it was not clear as to which organism a statement was referring; examples of these were: 'has a chitin cell wall', 'has hyphae'. It may be that these candidates had either disregarded the request to state a difference and had given what they considered to be a shared feature, or that they were giving a difference between viruses and fungi.

Teaching tip

Take the opportunity to revise the features of microorganisms wherever they crop up in this option to encourage candidates to see the links between the learning outcomes. 5.1*(c)* covers bacteriophage lambda and HIV, which can be linked to outcomes *(a)* and *(b)*, with a reminder of the problems of bacteriophages in the fermentation industry (food and proteins of medical importance). Similarly, *Saccharomyces*, which crops up in beer and gasohol production, could also usefully be covered in microorganism features or culturing microorganisms.

Q.4 This question, which included the second extended answer, proved to be quite demanding for many candidates. However, overall marks for this question were usually quite respectable owing to good attempts on some sections. Part *(b)* was usually well done by most.

(a) The specification area that includes air flow hoods has not been well tested in the past and the introduction given to the candidates was intended to give them sufficient information to help them apply their knowledge. Most could score at least three marks, but only those that read the information and question thoroughly and thought carefully before constructing their answer were able to gain maximum marks. Future candidates would benefit from using the internet to see the range of air flow hoods that are available.

Part *(i)* allowed most candidates to gain one mark for the idea of contamination, but fewer gave examples of possible contaminants. Part *(ii)* proved to be a demanding question that was well answered by only a handful of candidates. Most simply repeated their answer for part *(i)* and were not able to consider the benefits of the purified air flowing away from the culture area, particularly to prevent potential contaminants released from the worker. The majority assumed that the purified air flowing out through the open front provided oxygen and/or carbon dioxide for the tissue culture. Some candidates thought that the flow hood was the area where the tissue culture developed into plantlets.

In part *(iii)*, about half the candidates realised the dangers of release of *Mycobacterium*. However, a good proportion of these lost marks by assuming that the air in the work area, if contaminated by a pathogen, would be passed through the filter in the hood, where it was small enough to get through and out. A considerable number mistakenly thought that plant tissue culture was also present and the microorganisms would be potential contaminants. Few were specific enough to mention the danger to the worker who was positioned at the front of the unit. A lack of clarity often made the decision to award marks difficult but where possible candidates were given the benefit of the doubt. For example:

'The air carrying the pathogens could not be exposed to humans because they will cause disease. Therefore the air cannot flow past the worker under those circumstances.'

Part *(iv)* was generally quite well answered and marks were only lost by a lack of precision, for example: 'makes the air better for asthma sufferers'. There were some good examples of synoptic knowledge from 2802 (*Human Health and Disease*), with terms like 'immune response' and 'allergens' being used in the correct context.

(b) The answers here were generally good. The best answers included brief elaborations which left the Examiners in no doubt that the answers were correct. Some candidates simply listed characteristics of crop plants that could be genetically manipulated which was not the intention of the question.

(c) This was misread by many candidates, who described features of the fermenter. However, a correct explanation was allowed as an 'error carried forward' mark. This was a section that afforded the greatest variety of answers, ranging from the examples on the mark scheme to incorrect answers such as 'using Bunsen burners to provide an updraft of air'.

(d) This was the extended answer that included a mark for the quality of use and organisation of scientific terms. For those candidates who gave a reasonable sequential account on the correct subject matter, it was a reasonably straightforward quality mark to gain. The production of large amounts of a protein of a medical importance has not been well tested in previous papers. There were some superb answers that covered almost all the marking points from well prepared candidates, but there were also a number of blank or very brief answers. Some candidates incorrectly accounts of the production of monoclonal antibodies rather than of insulin (humulin) or human growth hormone. A few also attempted to write about Factor VIII, which earned them marks if they had used the correct mammalian host cells. The method to obtain the human growth hormone gene was generally weak and did not include a reference to the amino acid sequence. The majority of students either tried to use restriction enzymes to 'cut out' the gene or to use reverse transcriptase to produce cDNA from mRNA (which would have allowed them to gain marks if they had chosen to describe insulin production). With weaker candidates, there were muddled accounts of obtaining the gene from the brains of dead bodies or directly from 'the pituitary gland' or using mRNA from pancreas cells. However, these candidates were usually able to gain their marks for the next stages. Here, there were many excellent accounts of the use of the enzymes, the plasmid vector, antibiotic resistance markers and techniques to introduce the recombinant plasmid into the host bacterium. In the second part of the extended answer, the ability to apply knowledge of fermentation technology was usually lacking in detail and precision and prevented some candidates from obtaining maximum marks.

Teaching tip

http://internal.bath.ac.uk/bio-sci/bbsafe/rafum3_2.htm#tcc
http://ohs.uvic.ca/biosafety/biosafetycabinets.html

are two university websites that have some easy-to-read information about HEPA filters and also outline the difference between laminar flow hoods and biological safety cabinets.

Q.5 This question, often high scoring, proved to be very accessible to the majority of candidates. There was good interpretation of the diagram and the data but an extremely disappointing response to the construction of a food web.

(a) Most were able to gain three out of the four marks, with the most common error occurring in part *(i)*, where many answers gave **D**, the activated sludge tank, to indicate the addition of *Zoogloea*.

(b) This was usually well answered, although carbon dioxide was mentioned by quite a few candidates.

(c) The calculations in part *(i)* were usually correct and most candidates went on to correctly identify the two sewage works that would require tertiary treatment in part *(ii)*. Part *(iii)* was more of a problem for many candidates. A common incorrect answer was lactic acid, while others named carbon dioxide, bacteria, yeast, mould, ketones and even cyanide.

(d) It was expected that candidates would have no problems constructing a food web and for some candidates this was a straightforward way to earn full marks. However, this was not the case for many: a few made no attempt to answer, some wrote out summaries in boxes of the information provided and although many did manage to get the links correct, arrows were drawn in the wrong direction or only lines were given between the parts of the webs. Some added additional arrows to dead cells and detritus but these were unlabelled and mixed with incorrectly headed arrows suggesting uncertainty by the candidates. Incorrect use of arrows was often centre-based. A large number of candidates did not use the available space. Insect larvae were quite often omitted altogether. This question targeted one of the synoptic skills – interpreting and/or completing flow charts. There was a similar question on the January 2006 paper for this option (*Q.6 (a)(i)*).

(e) This question was well done by those candidates who realised that the activated sludge treatment was the *aerobic* secondary treatment and also cued in to points covered in 2804 (*Central Concepts*). Too many candidates thought it was the anaerobic stage of the treatment. Predation, competition, toxins and a lack of nutrients were the most common answers and surprisingly few mentioned overcrowding or a lack of space. Some had missed one of the reasons for sewage treatment and thought that pathogens in the sewage would kill all the microorganisms. Marks were also lost by vague 'unfavourable' conditions and unexplained lists of factors.

(f) Most candidates could gain two or three marks for this question. There were some excellent, detailed accounts that answered the question with ease, but many missed the point about photosynthesis as they moved straight from 'less light penetrating' to 'organisms dying'. A good proportion of candidates gave vague answers with the organisms dying without valid explanations or launched into accounts of algal blooms and eutrophication, having ignored the turbidity problem. Various pathogens, pollution and poor drinking water also appeared in a number of answers. A good many candidates mentioned species swimming out of the area due to lack of food or light and showed an incomplete understanding of the situation.

Teaching tip

Questions involving flow diagrams may be practised in class using sets of cards which may be assembled. The diagrams can be kept separate from the printed information and then assembled together in a completed series. Candidates could comment upon each others efforts in groups.

Q.6 Despite being at the end of the paper and proving to be the hardest question, it was pleasing that many candidates kept going with *Q.6* and maintained the quality of their responses.

(a) These two parts were well known, although a few confused 'wort' with 'whey'
(b) and some gave 'mash' in *(a)*.

(c) Most were able to gain at least one mark for a reference to water but fewer gave a valid temperature or temperature range and only a minority noted an oxygen requirement.

(d) Good responses were either from stronger candidates or were centre-specific. In these cases, candidates gave full accounts and were able to gain all the available marks. Many gained credit for the release of gibberellin by the embryo and the subsequent production of amylase to hydrolyse starch. Fewer, however, could describe the entry of water into the seed, name the aleurone layer or name other enzymes produced and only a minority could link the activity to acquiring products for growth. Amylase catalysing the hydrolysis of starch to glucose rather than to maltose was a common error. Weaker responses did not appreciate the sequence or location of events or simply restated the conditions in the malt house.

(e) This section was well attempted, with many realising that prevention of the growth of the embryo was desired, but prevention of all the sugar from being used up was often missed. Some candidates did not answer the question by explaining that the kilning stage would denature enzymes. Surprisingly few candidates continued to explain that the sugar was required by yeast in the brewing process.

(f) Part *(i)* was only well answered by a small proportion of candidates. Enzymes being 'thermophiles' or 'thermophilic' was rejected. A number of responses thought that the enzymes had come from genetically-modified barley seeds. Part *(ii)* was not well answered. Responses that realised that hot water would dissolve the soluble products in grist were surprisingly infrequent. A popular

incorrect response was that the hot water would kill all microorganisms. Part *(iii)* was attempted by many and the best answers made clear reference to the results of *increased* monosaccharides and amino acids, rather than giving a function. Increased alcohol production was often seen and credited, unlike vague answers such as 'produces more beer' or 'more product'. There were also numerous references to increased sweetness and changed flavour of beer, with a few deciding that the increased amino acids gave the beer a 'meaty' flavour. Some candidates thought that an increased population of yeast would make it 'sink to the bottom' and become a lager.

Teaching tip

Candidates could be asked to mark two different answers for the same question. Both answers reflect a sound understanding, but one shows candidates the wrong way to answer the question, 'Suggest why germination needs to be stopped during the kilning stage'.
Answer 1: *'As the sugars will be respired to produce energy so the embryo can grow into a new plant – this is not wanted. Yeast needs to feed off the sugary wort.'*
Answer 2: *'Otherwise all the sugar will be used up as a respiratory substrate in aerobic respiration for the growth of the embryo. They are required for alcohol fermentation for yeast to make ethanol.'*

2805/05: Mammalian Physiology and Behaviour

General Comments

The paper was of the appropriate difficulty, comparable to those of previous sessions and there was no evidence that candidates had insufficient time to complete all questions. Most candidates attempted every section of each question. There were no obvious misinterpretations of the rubric. There was a good balance between recall and interpretation. The Examiners were concerned about the quality of handwriting though, as some scripts were almost illegible. The poor quality of expression is a cause for concern for many candidates, particularly when they are writing extended answers.

Comments on Individual Questions

Q.1 This was a straightforward recall question that allowed candidates to gain credit fairly easily. Hardly any failed to score any marks on either section.

(a) The vast majority of candidates commented that mechanical digestion involves the breaking down of large pieces, or chunks, of food into smaller ones. However, references to large molecules being broken down into smaller ones did not attract any credit; neither did unqualified references to teeth. Most candidates offered a suitable example of mechanical digestion and many stated that the surface area would be increased.

(b) The difference in the mode of action of endopeptidases and exopeptidases was well understood in many cases. Good candidates were also able to give several examples of both types of enzyme. However, weaker candidates sometimes expressed themselves poorly, such as stating that bonds within amino acids would be broken by exopeptidases, or that the enzymes worked inside or outside of the cell. Only rarely were the actions of the enzymes confused.

Teaching tip

Ask two students to present a comparison between exopeptidases and endopeptidases using whiteboards. They could do this in the form of a table or other way of presenting information concisely and to best effect. There are many pairs of terms in this option that could be used for similar exercises.

Q.2 This question proved to be a very good discriminator, especially for sections *(c)* and *(f)*. It gave a full range of marks from 0 to 14.

(a) Most candidates were able to give at least two roles of cholesterol within the body, frequently linked to the cell membrane. Good candidates offered a comprehensive list of functions, detailing the use of cholesterol in the synthesis of steroid hormones, vitamin D and bile salts, as well as its role in waterproofing the skin. Weaker responses concentrated on the presence of cholesterol in the cell membrane, without reference to its importance in stability or fluidity, or a precise description of its effect on permeability. Some candidates described the functions of HDLs and LDLs, neither of which gained credit.

(b) Almost every candidate was able to offer a suitable heath risk resulting from a high blood cholesterol concentration.

(c) Many candidates appreciated that food consumed might contain either saturated

fats or cholesterol, or both, which would then compromise the reliability of the test, although this was expressed in a number of different ways. References to the effect of food on glucose concentration were not credited. Similarly simplistic references to 'fair testing' were not credited either.

(d) Almost every candidate attempted this section, although some neglected to quote a correct ratio, or failed to round up the figures appropriately.

(e) Correct quotes of figures for both total blood cholesterol and the ratios of HDL:LDL concentration for subjects **A** and **D** allowed many candidates to score two marks. Although many also realised that subject **D** had a greater health risk, this was not always linked to the desired range given in the stem of the question. While some candidates recognised that subject D had a higher concentration of LDL than **A**, the consequences of a high LDL concentration was often poorly expressed; for example, the depositing of LDLs rather than cholesterol in the artery walls, or simply a reference to cholesterol or plaques being laid down in the arteries, or vessels, alone. Many candidates also appreciated the role of HDLs in the removal of cholesterol or plaque from the artery wall although references to prevention of plaque deposition were not credited.

(f) Weaker candidates found this section challenging. Some responses failed to gain any marks for repeating a method of reducing blood cholesterol concentration already given in the question. Good candidates suggested that the drug might impede absorption from the gut or enhance uptake by the liver or by adipose tissue. Many offered other plausible suggestions, such as the increased synthesis of bile salts, steroid hormones or vitamin D. References to increased breakdown of cholesterol in the bloodstream or enhanced excretion by the kidney gained no credit. Only rarely were full marks awarded.

Teaching tip

Visit the following website: http://heart.healthcentersonline.com/cholesterol

for further information about this topic.

Q.3 This question was a quite a good discriminator. Weaker candidates gave very confused accounts of the role of the ear in position and movement and some erroneously described the detection of sound by the cochlea.

(a) The detection of high frequency sounds by the cochlea, or a suitable structure within, was appreciated by the vast majority of candidates. However, the precise location, i.e. near the oval window, was not always clearly expressed and weaker candidates failed to score this mark.

(b) Most candidates understood that the sound waves would hit the insect and be reflected back to the bat. However, references to echoes, without further clarification, were not accepted. Many stated that the time taken for the bat to receive the reflected sound waves would give an indication of distance, although mention of louder sounds signifying that the insect was closer was relatively rare. The mechanism by which the bat could locate the exact position of the insect was not always well explained and some candidates failed to state that the difference in

the time it took for the sound waves to reach each ear was crucial in the detection of direction. Some commented on the bat's large pinnae although there were surprisingly few references to the fact that they would move.

(c) Many candidates scored the mark for this section, in some cases giving a mixture of Latin and common names for the ossicles, either of which were acceptable. A surprising number were unable to spell correctly even the common names for the ossicles.

(d) Some candidates misread the question completely and gave a detailed explanation of how sound waves would be detected, gaining no credit. Others were not precise in identifying which structures were concerned with position and which with movement, often stating that they had a function in both. Most understood that the structures were fluid-filled, although endolymph was not always mentioned. Good candidates gave a comprehensive account of the roles of the utriculus and sacculus as well as the semicircular canals, easily gaining maximum marks.

A common mistake was to confuse the structures within the semicircular canals and utriculus and sacculus. The cupula and ampulla were also occasionally muddled. Nevertheless, most candidates stated that the hair cells were responsible for sensing movement of the macula or cupula but only a minority mentioned that the stereocilia would be pulled in order to initiate depolarisation. Comments on the transmission of action potentials or impulses to the brain were frequent although there fewer references to the vestibular nerve. Overall, candidates either had a good grasp of the mechanisms involved or were unable to provide a coherent response. This section was often left blank by weaker candidates.

Few candidates were awarded the quality mark, even for good accounts, as technical terms were often misspelt.

Teaching tip

Use stringed musical instruments to demonstrate amplitude and pitch. Follow this by using a signal generator and an oscilloscope or modern equivalent.

Q.4 This question often allowed candidates to score high marks, although weaker ones found some sections difficult, particularly *(b)* and *(c)(iii)*.

(a) In part *(i)*, structure **A** was frequently identified as the islets of Langerhans although candidates found structure **B** more difficult to name, with blood vessel or capillary being the most common incorrect response. The difference between the terms endocrine and exocrine was generally well understood in *(ii)* with many candidates easily gaining the maximum marks available. Some candidates did not confine themselves to the pancreas. The functions of the two glands were occasionally reversed although candidates were still able to achieve two marks for 'errors carried forward'.

(b) Candidates who had revised the hormonal control of digestive secretions scored well on this section, giving clear accounts of the secretion of secretin and CCK in response to the arrival of acidic chyme in the duodenum as well as their effects on the composition of pancreatic juice. However, a number of candidates simply referred to nervous control, often starting with the sight and smell of food. Others commented on the consequence of food arriving in the stomach rather than the

duodenum. There were many incorrect answers referring to the role of gastrin.

(c) In part *(i)*, many candidates correctly described the hydrolytic actions of lipase and amylase in this synoptic section while weaker responses named the macromolecules the enzymes would hydrolyse without reference to their products. Some candidates stated that amylase would convert starch to glucose, or even sucrose, rather than maltose, thereby failing to gain any credit.

Ultrasound was the most frequent method offered for the diagnosis of a blocked pancreatic duct in *(ii)* although testing for fatty stools also featured fairly often. Some candidates suggested that urine samples should be analysed, which was not credited, neither were references to concentrations of enzymes in faeces or examination of faeces without any further qualification.

In part *(iii)*, the consequence of a blocked pancreatic duct on the pancreas was often poorly expressed and a number of candidates believed that pancreatic juice would be acidic and that the acid would result in damage. Similarly, references to alkalinity did not attract any marks. Good candidates stated that the enzymes in pancreatic juice would be responsible for damage to the pancreatic cells and many went on to comment on the activation of proteases, or named examples, and their effect on proteins within the cell. A mark was also awarded if candidates described the action of lipase on the lipids in the cell membrane.

Teaching tip

Try this website: www.vivo.colostate.edu/hbooks/pathphys/digestion/pancreas
for more information on the topics in this question.

Q.5 This was a high scoring question, with many candidates obtaining maximum marks on both sections for clear and detailed accounts.

(a) Many candidates appreciated that the central nervous system is protected by bone although there were some vague responses where candidates failed to distinguish between the brain and spinal cord or which bony structure surrounded them. Fewer references to the meninges were seen but those candidates who named them generally went on to state their role in the secretion of cerebrospinal fluid and the function of the latter in shock absorption. Some candidates confused CSF with synovial fluid.

(b) The vast majority of candidates understood that the autonomic nervous system is subdivided into the sympathetic and parasympathetic components, frequently going on to explain the effect of each on the sino-atrial node and heart rate. However, unclear references to increasing or decreasing the heart rate gained no credit. Hardly any candidates confused the two systems. Good candidates named the appropriate neurotransmitters and mentioned the role of the medulla oblongata in the coordination of heart rate under different physiological conditions. Many also appreciated the myogenic property of cardiac muscle. References to the length of the preganglionic fibres in either system were very infrequent although comments on the secretion and effect of adrenaline were occasionally seen.

Some candidates went into considerable detail about the detection of changes in carbon dioxide or oxygen concentrations in the blood by chemoreceptors or the role of baroreceptors in monitoring blood pressure. Others commented on the effect of exercise on heart rate but generally these candidates gained full marks for the

control mechanism.

On the whole, even weak candidates managed to gain at least three marks on this section, while most scored five or more.

The quality mark was usually awarded where there was sufficient text although some candidates lost this mark for a number of spelling errors of non-technical terms. Very occasionally, the candidates' handwriting was so difficult to decipher that Examiners felt that the award of the quality mark was inappropriate.

Teaching tip

A sequential topic such as this could be taught, and revised, using cards with various stages written on. Shuffle the cards and get students to lay them out in the correct sequence.

Q.6 This was a tougher question for most candidates with many missing out sections, although easier marks were available in the last section.

(a) Collagen's role in providing high tensile strength was well understood by most candidates, although some erroneously stated that it would also be important in withstanding compressive forces, negating the mark. Few candidates went on to score any further marks for this subsection. There were some references to collagen allowing bone to 'give a little' which the Examiners felt was too vague for the award of the 'flexible' marking point. Relevant detail of the structure of the collagen molecule which would contribute to its tensile strength was rare, although some responses did comment on the abundance of glycine in the amino acid sequence which would allow tight coiling in the secondary structure.

Many candidates recognised that calcium phosphate would provide compressive strength and some also went on to state that it would confer hardness and/or rigidity on the bone. Full marks for this section were hardly ever given although better candidates frequently scored two or three.

(b) There were a number of very good descriptions of the synthesis of collagen in bone, with candidates easily reaching the maximum mark available. However, there was confusion between osteoblasts and osteocytes and weaker candidates failed to make any mention of tropocollagen or its secretion into the matrix. References to collagen being a fibrous protein were surprisingly infrequent.

(c) Most candidates appreciated the uses of calcium ions at synapses and in muscle contraction although some gave inaccurate statements which gained no credit, such as calcium ions causing the excretion of neurotransmitter vesicles into the synaptic cleft, or calcium binding to the myosin heads. Nevertheless, most were able to gain at least one mark. The role of calcium ions in blood clotting was very rarely seen although there were one or two references to insulin secretion.

(d) The bone cells **A** and **B** were correctly named in many cases. There was occasional confusion between osteoblasts and osteoclasts, or the term osteocytes was used instead of one or other cell, or (rarely) both. Very weak responses identified the cells as compact and spongy bone, or other totally inappropriate structures.

(e) The significance of the absence of oestrogen in the development of osteoporosis proved to be difficult for some candidates in part *(i)*. There were vague references to the synthesis of the cells **A** and **B** themselves, rather their activity. Some candidates believed that oestrogen would promote osteoporosis or either contains calcitonin or is a precursor in its synthesis. Nevertheless, good candidates recognised that calcitonin synthesis or activity would be inhibited, while that of parathormone would be increased. They frequently went on to describe the subsequent effects on the functions of the osteoblasts and osteoclasts. Many also offered a correct comparative statement concerning the relative activities of the two cells.

Almost every candidate was able to offer at least two ways which would protect against osteoporosis in *(ii)*. The mark scheme was generous in the number and variety of marking points such that many candidates were able to achieve full marks within the first three lines of their response. Most candidates made some comment about the value of HRT in postmenopausal women, administered in a variety of ways, such as patches, tablets or injections. There were also many references to the importance of a diet high in both vitamin D and calcium, as well as the use of vitamin and mineral supplements. The beneficial effect of regular exercise was frequently mentioned although the fact that the exercise should be weight- or load-bearing was rarely stated. However, some candidates did recognise that this would serve to increase bone density. Other responses, such as a reduction in caffeine intake and giving up smoking, were also credited.

Teaching tips

This topic would benefit from some practical work. Pig's trotters could be dissected to show joint structure and the properties of collagen as displayed in the tendons.

Coloured plasticine could be used to make tropocollagen strands which could be twisted and linked to make collagen fibres.

Q.7 Some candidates who did badly on the rest of the paper did surprisingly well on this, perhaps having done Psychology as well, or because it was possible to reason some of the marks.

(a) Stronger candidates explained that chimpanzees could use unrelated learnt behaviour to solve problems. Many candidates went into full details of chimpanzees joining two sticks together to reach a banana. Many lost marks by not using the term 'insight learning' or by referring to trial and error learning.

(b) *(i)* Many candidates lost marks by explaining the results rather than describing them. A tendency to use vague terms such as 'as time went on' instead of 'as the number of trials/repeats increased', not appreciating that it was the repetition not the duration of time that was significant. Many candidates explained why the mouse chose **B** rather than stating that it entered **B** rather than **C** more often towards the end. Most candidates got at least one of the two marks for this part.

Many candidates failed to appreciate the significance of a control experiment in *(ii)* and described completely different experiments, such as a Skinner box, or using food or smells instead of companion mice as a reward, or using mice in two chambers, etc. Several candidates decided to replace the companion mouse with a cat! Surprisingly few mentioned using the same apparatus and same conditions,

though quite a number mentioned doing the same number of trials. Many made general statements such as 'carry out the same experiment' or 'use the same method'. Hardly any mentioned using a different mouse so it would not have learned from the previous experiment. Some even talked about using rats rather than mice.

In part *(iii)*, many candidates lost marks because they did not choose a control experiment in *(ii)*. Where they did get part *(ii)* correct, and had a control with no companion mouse, most were able to mention that the mouse would go into each chamber an equal number of times. A minority stated that the mouse would not go into either chamber.

Very few candidates did well on part *(iv)*. Even better candidates failed to use the scientific terms for classical conditioning, such as 'conditioned response' or 'conditioned stimulus'. A significant minority failed to compare the two processes, simply describing one or the other. Better candidates were able to mention operant conditioning and go on to make a correct statement about associative learning.

Teaching tip

A useful website that could give background into the use of operant conditioning in the training of animals is: www.wagntrain.com/OC/

2806/01: Unifying Concepts in Biology

General Comments

Candidates showed pleasing levels of knowledge and understanding on *Q.1*, *Q.3* and *Q.4* dealing with whole organism biology and ecology. Many also showed good comprehension of *Q.2* and *Q.5*, but lack of knowledge of basic biochemistry and cell biology exposed weaknesses in parts of *Q.2* and *Q.5* for many candidates. The pattern seen in the January examination was again apparent. Candidates had trouble recalling material from 2801 (*Biology Foundation*) and also to some extent from 2802 (*Human Health and Disease*). Preparation for the synoptic paper needs to include thorough revision of the AS syllabus. The other noteworthy feature of candidates' performance is how poor language skills prevent candidates being able to explain what they understand from graphs, tables or text. The Examiners thought that weaker candidates struggled to find words to express concepts as they did not have a sufficiently broad vocabulary of scientific terms. It was clear that many of these candidates had some understanding of the concepts but were hampered by their poor expression.

Comments on Individual Questions

Q.1 Candidates of all abilities made a positive start to the paper here, using skills of observation, calculation, knowledge of experimental design and data handling skills to score well.

(a) Most candidates obtained two marks for observing and describing differences between the photographs of the species of *Tradescantia*. Vague terminology such as 'furry' and stems or leaves that were 'thicker' was favoured by candidates but was credited. More specific botanical language such as *succulent* and reference to internode spacing was unfortunately very rare.

(b) The vast majority correctly calculated the mean numbers of stomata for the two species in part *(i)*. In part *(ii)*, a large proportion of candidates were able to suggest two sensible precautions. In some cases candidates did not make straightforward use of the technical term 'same magnification to be used', but struggled to convey the same idea of parity of sizes of field of view in layman's language, occasionally failing to explain the idea adequately. Weaker candidates frequently lost marks by trying to explain scientific concepts in inadequately specific language. For example, in this question the idea that the experimental leaves came from plants grown in the same environmental conditions was credited, but the simplistic 'come from same place' was not.

(c) The candidate was presented with a wealth of data and information and had to sift out and link the significant points. Comparing the averages for temperature and rainfall, the latter was the significant difference between the habitats of the two plant species, and the dry aspect of the Mexico habitat should have been related to observable xerophytic features of *T. sillamontana* seen in the photograph and its mean number of stomata given in the table. Most candidates drew attention to relevant xerophytic features, though few used the technical terms *xerophytic* or *xeromorphic*, and many candidates scored full marks here. One point to note here is the wording of the question. The focus here is on 'how each species is adapted to its natural habitat', i.e. on morphological features of the two plants, whose significance should be related to climatic aspects of the habitat. Simply quoting climate data from the table did not score marks here. As usual, careful reading of the question was essential for success.

(d) Additional data on the photosynthetic rates of the two plants in relation to light intensity was here presented as a graph. The question was not simply to compare the patterns shown by the plants, but to relate this to knowledge of the plants' habitats. Key information (open versus shade) appeared in the preceding section of the question and was picked up by most candidates, though not all gave both pieces of information to score a comparative point (see teaching tip). While many candidates are at home with describing relationships shown on a graph and with picking out the most significant data points from a curve, many are not. Teaching tips to improve graph skills are included below. A last observation on candidates' responses to this question is the surprisingly large number who attempted to give coordinates for a significant point but failed to read the values from the axes of the graph accurately. Candidates should strive for accuracy if a point falls inside a graph square, and should estimate how many decimal subdivisions of a square are involved. For example, at 100% light intensity *T sillamontana* has a photosynthesis rate of 6.3 arbitrary units.

Teaching tips

Making comparisons

Ideally candidates should be trained to make clear matching comparisons by reference to both elements compared, for example, 'A is like … but B is like …', or 'A does … whereas B does …'. Using a clear logical sentence structure like this will enhance candidate's ability to pick up marks where a comparison is required.

Graphs

Candidates should be trained to describe a relationship shown on a graph in the form 'As the x axis parameter increases, the y parameter … (increases / decreases / stays the same)'. For example, in *Q.1 (d)* a mark was scored by stating 'As light intensity increases, the rate of photosynthesis of *T. sillamontana* increases'. The same skill was required in *Q.5 (c)*. Where a curve on a graph shows an up and down pattern, candidates need to be trained to pick out the peak (or peaks) accurately and to identify it/them as such using terms such as 'peak' or 'maximum'. To identify such a point on a graph, an x axis and a y axis value need to be given. Any data points quoted will not score if units have been forgotten.

Candidates should be encouraged to annotate graphs on the paper in order to identify key coordinates with accuracy.

There is plenty of information about the genus *Tradescantia* at:

www.desert-tropicals.com/Plants/Commelinaceae/Tradescantia.html

Q.2 Candidates read text detailing work on DNA vaccines and were required to show understanding of the principles involved by reference to their knowledge of biochemistry and immunity from the AS modules. While better candidates showed good knowledge and understanding, weaker candidates struggled here.

(a) The mark scheme lists 12 concrete differences between the structure of (plasmid) DNA and protein structure, and this list is not exhaustive since some additional points (AVPs) were credited too. Good candidates might refer to four or five differences in the course of an answer, particularly if they were in the habit of making clear-cut comparisons of the type described in the teaching tip for *Q.1*. Many candidates, however, scored one mark or less on this question, revealing a lack of knowledge of a very fundamental part of biology – the structure of DNA and proteins. An alarmingly common mistake was to confuse the circular plasmid with a whole cell and to give an answer such as 'no nucleus'.

(b) Less than half of candidates could define the word antigen in *(i)*; confusion between antigen and antibody was common. The usual, inadequate definition given involved description of self and non-self antigens. Part *(ii)* proved the lowest-scoring sub-question on the paper, with perhaps one percent of candidates making any creditworthy suggestion. The knowledge required to explain the difference in effectiveness of a cell-based antigen as opposed to a humoral one was the distinction between the cell-mediated and humoral arms of the immune system, for example by reference to the stimulation of T cells versus B cells. The relative life-spans of the antigens could also have been commented upon.

(c) Part *(i)* required knowledge of the role of a promoter region. The majority of candidates had that knowledge (some making a link to the *lac* operon context). However, precision of language again let some candidates down. Transcription is relevant here, but translation is not. DNA is transcribed into mRNA. Erroneous statements included the idea that DNA was copied or replicated, or that mRNA was transcribed. The enzyme involved here is RNA polymerase, not DNA polymerase, nor RNA transcriptase (a name that seems to have been invented by candidates out of confusion with reverse transcriptase), nor is it customarily referred to as RNA synthetase.

Part *(ii)* was a high-scoring question. The point that including two antigens could confer immunity to two different diseases or strains of a disease was commonly made, as was the point that having a double vaccine saved time and/or money. A significant minority of candidates misspelled the word 'strains' of disease as 'strands', which did not score. Weak candidates talked about becoming immune to two antigens but struggled to jump from the word given in the question (antigen) to a word of their own such as disease, infection, pathogen or strain. See the teaching tip below.

Good candidates knew the functions of the Golgi apparatus in *(iii)* and were able to apply their knowledge to the context of this question. Weaker candidates who knew something of the Golgi simply wrote out a text book answer that did not fit this context, for example that the Golgi manufactures lysosomes (not relevant here) or that it makes vesicles for exocytosis. Perhaps a subtle point, but candidates needed to make it clear that vesicle membrane containing antigen is incorporated

into the plasma membrane. The secretion of the *contents* of the vesicle by exocytosis was not relevant. There were some candidates who appeared to have no knowledge of the role of the Golgi in any context.

(d) Many candidates managed one or two reasonable suggestions, with the idea of mutation occurring being a common one. Unfortunately, the mutation answers had little contextual substance, such as the idea of the plasmid inserting into a chromosome and disrupting the expression of a human gene, or the idea of transformation of bacteria by the plasmid resulting in a more virulent pathogen. The irreversibility and ethical ramifications of DNA vaccines were also commented upon.

Teaching tip

Candidates should be made aware that simply re-quoting the question or question stem will not score marks. They should be encouraged to think of linked words or concepts. The question generally is a springboard which they can use as a starting point to display their own knowledge. They should check that they have not merely copied question text or written it in a slightly different way, but have supplied new information drawn from their study of the specification or from their reading around and beyond the specification. This advice applies also to *Q.5 (b)(ii)*.

Q.3 This question was very well-answered. Knowledge of the respiration pathway from 2804 (*Central Concepts*) appeared to have been well-learned and was detailed in good answers to *Q.3 (a)*. Ample mark points allowed many candidates to score full marks on *Q.3* (b) and the majority also correctly interpreted the information given to gain full marks on *Q.3 (c)*.

(a) Good answers applied knowledge of glycolysis to this context of bacteria making lactic acid. A logical approach was required. Candidates were expected to outline the conversion of starch to maltose and then to glucose with reference to hydrolysis and then outline the conversion of glucose to pyruvate during glycolysis. In some answers new molecules sprang into being with no link to a starting or previous point. A surprisingly common area of confusion was for candidates to think that lactate and lactic acid are two different molecules, rather than to realise that one is the ionised form and that the two terms can be used interchangeably in most biological discussions at this level. Quite a number of candidates made good use of summary diagrams showing the pathway of reactions.

(b) Those few who did not score well on this question mostly omitted to read the question properly. The word ‘and’ was in bold type and candidates were asked to explain **and** suggest why the findings were important to society. Attempting to answer both parts of the question gave most candidates full marks. The likelihood of this was less for candidates who restricted their answer to **either** explaining **or** suggesting implications for society. Knowledge of enzymes denaturing at high temperatures put most candidates on the right track for explaining the findings. For marking point 3, however, candidates needed to say **either** that the heat denatured enzymes **or** that it killed microbes. It is not acceptable to talk about enzymes being killed or microbes being denatured. Some surprising conceptual errors appeared in some answers, including the suggestion that global warming is likely to result in air or soil temperatures reaching 120 ^{o}C, or that the findings revealed that polylactic acid drinking cups would be unsuitable for holding hot liquids (implying that hot drinks are likely to be heated to 120 ^{o}C, a temperature in excess of the boiling point of water). A distinction should be drawn for candidates between biodegradable, meaning elements are returned to the air or soil via natural cycles, and recycling,

meaning human re-use of a material.

(c) Most candidates correctly identified microbial respiration as the process responsible for the changes in gas composition and temperature in the grass heap, and went on to explain how this had happened in terms of respiration using oxygen, producing carbon dioxide and releasing heat. The most common error was to attribute the changes to the grass heap photosynthesising. Accurate reference to the figures from the table (with units) scored here. Weaker candidates did not quote the figures but made statements like 'this explains the drop in oxygen concentration' when no actual explanation, such as the using up of the oxygen or a reference to aerobic respiration was given. Candidates should be encouraged to say that heat is *released* rather than *produced* in an exothermic reaction such as respiration.

Teaching tip

Language

In some cases technical or specific words scored in this question where non-technical terms did not, for example, 'biodegradable' and 'decomposition'. Candidates could be encouraged to maintain a vocabulary of biological words and terms. Teachers of candidates whose first language is not English might have noticed the vast amount of terminology an A level candidate is required to master in Biology, which can be an arduous process for a candidate coming to it as a foreign language. Having said that, candidates for whom English is their first language also frequently struggle with the volume of new words introduced in topics such as biochemistry and cell biology, and those with learning difficulties in particular might find keeping a checklist of new words and their meanings a great help.

Q.4 This question had a whole organism focus and gave all candidates the scope to score some marks.

(a) Most candidates scored one or two marks. A problem with describing a difference from the graph was for candidates to use words like 'quickly' and 'faster', implying that they thought the x axis measured time, which it did not. See teaching tips on graph skills for *Q.1*. Correct explanations largely focused on the differences in oxygen partial pressure of the air and water habitats. Some candidates were distracted by the information that lugworms lack red blood cells.

(b) Very good candidates scored full marks, many scored half, most scored some. Comparative description of the two organisms was good, but would be improved in many cases by candidates following the advice in the teaching tip for *Q.1* – that is, to deliver clear comparative statements referring to both A and B, or in this case 'The mammal has … and / but / whereas the lugworm has …'. Relating the adaptations to the habitats was generally overlooked in part *(b)*, although there were marks available for making links here and the word adaptation appeared in the question. There was evidence that candidates had not read and absorbed the information given in the stem, as for example many thought the lugworm relied passively on water flowing into its burrow, whereas in fact the stem stated that the worm 'moves its body so that a current of seawater passes down its burrow, over the worm', and this active ventilation movement was a point of similarity with mammalian breathing. A technical term that was conspicuous by its absence in poorer answers was the word diffusion; references to concentration gradients were also missing. A last observation is that many candidates seemed to have a very dismissive attitude to the structure and physiology of the lugworm, assuming that it

was little more than a lump of undifferentiated tissue small enough to rely on diffusion for all its transport needs. It was widely assumed that worms lacked hearts and blood vessels, for example. While candidates are not required to study the physiology of invertebrates, the degree of ignorance and the general assumption that anything non-mammalian is somehow poorly equipped for life, was worrying.

Teaching tip

Extended answer questions are more likely to score well if candidates organise their material in some way. For example, here a paragraph on differences and another on similarities would have been a suitable structure. Too many candidates wrote rambling descriptions of each animal separately and failed to draw attention to the differences and similarities in pair-wise comparative points (see the teaching tip for *Q.1* above). For similarities the word 'both' is most useful to make the point that a shared feature is being described. For differences the form 'A … but B…' is most useful. Tabulated answers can also be effective. See the teaching tip on *Q.3* in the report on 2805/03 (*Growth, Reproduction and Development*).

Q.5 Candidates struggled to draw on knowledge of mitosis, meiosis and cell biology from 2801 (*Biology Foundation*). The general grasp of the principles of natural selection was better, but weaker candidates ran into difficulties with a graph that required good language skills to translate its meaning into clear prose.

(a) The two parts of *(a)* should have been straightforward, drawing on knowledge of 2801 (*Biology Foundation*) and 2804 (*Central Concepts*), but many candidates made heavy weather of them. The phrase 'genetically identical' should be familiar to candidates, and they should realise that while possessing 'same DNA' or 'same alleles' conveys this idea, saying that the organisms have the 'same genes' or 'same chromosomes' does not. Candidates who failed to distinguish between the terms *gene* and *allele* penalised themselves - see the teaching tip below. Very few candidates mentioned 'mitosis' in connection with clones. The advantages of cross-fertilisation, more often presented as advantages of sexual reproduction *per se*, should have led to standard information on increasing genetic variation with reference to the meiotic mechanisms by which this is achieved. Again, very few candidates mentioned meiosis or any event within meiosis. It seems candidates focus on the question context and do not see the openings and opportunities for using their knowledge from the specification to explain what is going on. Careful context-based answers scored, where for example it was argued that variation enhances the chance of some variants being able to survive, and that this provides scope for adaptation to a changing environment. Poor answers suggested a higher rate of mutation, often giving organisms purely favourable mutations that automatically equipped them better for life, despite the environment not changing.

(b) Part *(i)* proved to discriminate between A and B grade candidates and the rest. These good candidates drew on general knowledge, e.g. ice crystals are sharp, ice expands as it freezes, and a clear knowledge of cell structure to devise a suggestion as to how ice ruptured the lysosomes. A typically vague answer from a weak candidate who lost this mark would be to paraphrase the information given in the question stem and simply say 'ice damages cells'.

The temptation to re-quote the question stem from information in *(ii)* proved overwhelming for many candidates. While the statement that 'hydrogen cyanide inhibits enzymes necessary for oxidative phosphorylation in mitochondria' formed a

useful prelude to an argument for good candidates, by itself this is a simple re-phrasing of the information given. To answer the question it needs to be explained that this inhibition applies equally to both the plants (clover) and the herbivores that eat the clover, as they share the same respiratory pathways and mitochondrial function. Extrapolating from the information given allowed many candidates to deduce that a lack of ATP resulted, and better candidates went on to describe a specific energy-requiring process that would be impeded by a lack of ATP.

(c) Careful training in describing a graph (see the teaching tip for *Q.1*) would have helped candidates comment sensibly on this data. The y axis measures the percentage of plants **unable** to make hydrogen cyanide and this negative feature (inability) confused some candidates, or was misread as the percentage of plants that were **able** to make HCN. Here suitable coordinates to quote would be those at the two extremes of the temperature range. Another significant point to comment on is at 2 ^{o}C where there is wide variation in the ability of populations to make HCN. A common error was to identify 0 ^{o}C, rather than 2 ^{o}C, as the threshold temperature.

(d) Good answers here combined a clear understanding of the graph data with recall of the standard stages in the evolutionary process – survival of those possessing an advantageous feature, reproduction and a change in allele frequency leading to a change in phenotypic frequency – here, more cyanogenic clover plants. Some candidates did not perceive that cyanogenesis was an advantage in killing or deterring herbivores but were worried that it was a disadvantageous feature that killed the clover plant, rather than damaging selected leaves or parts of the plant that had sustained herbivore attack. Poor language skills led weaker candidates to begin by arguing one position and then to directly contradict themselves later on. Marks are not awarded where two statements directly conflict with each other.

Teaching tip

Candidates need to be aware of the important distinction between the terms *gene* and *allele*. Confusing these two led to marks being lost in *Q.5 (a)* and *Q.5 (d)*.

Candidates should be alerted to the fact that the labels on graph axes are of great importance and that these should be quoted in full when describing patterns on a graph. Candidates lose marks by incorrectly abbreviating graph axis labels (e.g. *partial pressure of oxygen* in *Q.4* being reduced to 'pressure', *percentage plants unable to make HCN* in *Q.5* being reduced to '%'.

Candidates should be aware that if they contradict themselves they will not score marks, so should learn to follow an argument through to its logical conclusion, and be on the alert for conflicting statements.

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

General Comments

The general standard of candidates' work and the marking of it have again been high. As with previous years, there are still a number of areas where Centres could streamline the marking process and improve their candidates' scores at the same time.

Centres are again strongly advised to use writing frames, particularly with their weaker students, who often become confused and lose their momentum when writing solid text. Separating or breaking down tasks in this way can result in a dramatic improvement in work that is likely to gain grades D, E or U. Work is also much easier to mark.

When deciding on a coursework investigation, Centres should not make the task over complex by adding extra hurdles. A good example of this might be at AS where osmosis is an ever-popular choice. It is adequate simply to consider material from a single plant type in solutions of different water potential; comparison of two or more types of tissue or plant can confuse candidates and sometimes result in unfairly high demands in the marking process. The addition of an economic or dietary aspect such as import costs or energy values is excellent education, but makes for a poor coursework assessment. The inclusion of a carbohydrate test might add stimulation and purpose to practical write-ups, but again, adds extra hurdles for candidates who often struggle with a basic task.

The choice of an ecology investigation is best limited to A2. These investigations **must** be based on one or more learning outcomes from within the A2 specification, as required by the descriptors P.3aiii, P.5aiv, P.7aiv, A.3bii, A.5biii, A.7aiii and A.7biii. Centres should consider a pragmatic approach to the quantity of written material submitted by candidates carrying out these investigations, particularly on field courses where the sheer mass of data can be prodigious. This year the record was held by one Centre where candidates each submitted over 40 pages of data tables for Skill I with a dozen or so graphs for Skill A. A sensible limit might be 10 to 20 sides of A4 including tables and graphs.

There is a temptation for Centres to round marks up where a candidates has just failed to match a subdescriptor. If this happens routinely it can take the Centre out of tolerance leaving no margin of difference in professional judgements between the Centre and Moderator.

Skill Specific Comments

The descriptors that are most likely to cause Centres to assess inappropriately are:

Skill P

P.3b Decides on a suitable number and range of observations and/or measurements to be made

Candidates must **plan** to use a range (independent variable) with at least **five** 'steps', with **three** measurements (dependent variable) of each 'step' in the range, even if the candidates would be unable to implement this amount of data collection. The plan must be considered as completely separate from what is assessed in Skill I.

P.5bii Produces a clear account using specialist vocabulary appropriately

Centres and candidates **must** make sure that the guidance in the specification on the use of water potential terminology (learning outcome 5.1.4 (c) from Unit 2801) is followed.

Skill I

I.5b ii Records observations and/or measurements in an appropriate format.
The independent variable (IV) must be in the first column and data must be presented in a single table (that is, all values of the IV are presented in one table).

Skill A

A.3a Processes and presents evidence gathered from experimental work including, where appropriate, the use of appropriate graphical and/or numerical techniques.
Where ICT is used to plot a graph, the result must be large enough (covering one A4 page) and have major and minor grid lines for both axes. A good guide is that the reader must be able to extract intermediate data. All other information, such as labels and units, must also be provided. Moderators also continue to see hand drawn graphs that are of a poor standard. In particular the use of blunt coloured pencils or felt pens to plot data points and draw curves does not produce a usable graph. Candidates who do not plot adequate quality graphs could fail to match A.3a.

A.5a 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
Whilst candidates are expected to, for example, calculate a mean for A.1a, this descriptor requires more advanced mathematics. A list of suitable ways to match this descriptor is available from OCR.

A.5bii Produces a clear account uses specialist vocabulary appropriately
See *P.5bii* above.

Skill E

E.3bi Comments on the accuracy of the observations and/or measurements
Accuracy is an assessment of how close a measured value is to its true value. This assessment can be made by calculating and/or commenting on the percentage error, by commenting on the stated accuracy of piece(s) of apparatus; or by commenting on how a trend line produced by the candidate compares to its theoretical equivalent.

E.5ai Indicates the significant limitations of the experimental procedures and/or strategy
Whilst E3a can be awarded for identifying **all** of the limitations (problems in the method) in the strategy, level 5 requires a clear indication of which limitation(s) have caused the greatest impact on the quality of the data collected. Simply ranking the limitations can do this, but other techniques can be used. Many candidates use a writing frame to match many of the descriptors for Skill E and indicate in it the most important limitation(s) and/or rank them from most important to least important.

E.5bi Comments on the reliability of the evidence
Candidates may comment on the spread of their results about the mean and/or plot range (or error) bars on their graphs. They may also calculate standard deviation or standard error and comment on the results of their calculations.

E.5b ii Evaluates the main sources of error
The candidates must explain what impact the main error(s) (from E5a) have had on the data, for example if the measured values are over- or underestimates of the 'true' values.

There is some confusion between the terms ‘limitation’ and ‘source of error’ and some centres are having difficulty in assessing the hierarchical components of level 5. Centres should contact the Subject Officer for more detailed help than can be given here.

Administration

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.

Some Centres are members of a consortium. This year it became evident that some consortia had changed since last year, but no information had been forwarded to OCR. In the worst case this could have resulted in adjustment as a consequence of failure to internally standardise candidates. Centres must update information of this nature as changes occur, by initially contacting the Subject Officer.

2806/03: Experimental Skills (A2 Practical Examination)

General Comments

Q.1 relied upon the effect of urease on urea producing ammonium carbonate. To monitor the course of the reaction the mixture was artificially acidified with ethanoic acid and Universal Indicator was added which turned from pink to green/yellow as the reaction progressed. The 'potency' of urease varied depending on its source so that in a number of Centres it was less 'potent' than was intended. OCR provided these Centres with a number of alternative ways of ensuring that the urease worked as required.

Q.2 was straightforward. Candidates seemed to have no difficulty in completing the examination in the time available and despite the difficulties outlined above, the examination as a whole generated many high marks.

Comments on Individual Questions

Planning Exercise

Unlike most previous Planning Exercises, this one set candidates a problem to solve and the lack of any obvious hypothesis or prediction to test caused some concern. However, Centres are reminded that the '*Mark Descriptors for Experimental and Investigative Skills*' (in Appendix C of the specification) only require candidates to make a prediction '…*where relevant*' so candidates should be aware that on occasions therefore it is not appropriate to include one.

The marks were largely allocated for submitting a plan which would allow the salicylate content of urine to be determined and by simply subtracting this from the amount in the initial dose, allow the amount remaining in the body to be determined. The strategy for achieving this relied upon drawing a calibration curve of either:

- the volumes of iron chloride added to known concentrations of salicylate to reach an end point via titration, or
- absorbance / transmittance against known concentrations of salicylate using a colorimeter.

The huge majority of candidates chose the second strategy. Once this had been described it could then be applied to an individual. Some candidates required the use of over 100 carefully selected subjects who were to be detained in controlled conditions and then given an overdose of aspirin before being asked to provide urine specimens on cue. Though not penalised for this approach, neither was it rewarded.

In fact, this Planning Exercise was very straightforward and allowed an objective assessment of candidates to be made. Most, rightly, chose three measurements of five different known concentrations of salicylate with which to draw a calibration curve. They then showed how these results would be tabulated and the axes that would be used to illustrate them.

Strangely, the identification of relevant variables that should be controlled when producing a calibration curve remains problematic. Many candidates did not identify the need to keep the following constant:

- volume of iron (III) chloride
- concentration of iron (III) chloride
- volume of salicylate to which the iron (III) chloride is added
- the length of time before placing the samples in the colorimeter.

Instead, candidates focused on variables such as keeping their subject (or subjects) in constant surroundings, giving the subject(s) the same diet and a defined amount of water to drink at proscribed times.

There was a lack of clarity over how to estimate the amount of aspirin/salicylate in a urine sample. Using the calibration curve to assess the percentage of aspirin in a urine sample and multiplying this percentage by the volume of the urine gives the mass of aspirin in the sample. Subtracting this from the initial dose gives the amount left in the body.

Equally lacking was reference to *how* preliminary work and/or the use of a secondary source influenced the Plan. These references could be provided simply by means a footnote at the bottom of each relevant page.

On this occasion candidates were largely able to write about what they had done rather than what a third party would do. As a result the submitted plans contained fewer grammatical

errors than in the past and were written concisely. Candidates should always remember that they are writing something like a recipe and should try to make their methods as accurate and precise as possible so that they can be followed by someone else. Just like a good recipe

Practical Test

Q.1 *(a)* Most candidates confidently tabulated their results. Most were alert to the convention of placing the independent variable (in this case the concentration of urea) in the first column of the table and confining units to column headings.

(b) Most candidates illustrated their results as a graph reasonably skillfully with the independent variable on the x axis and the dependent variable (time taken or rate) on the y axis. Similarly, most candidates scaled their axes although some did not. A small number of candidates used time and rate as their axes. A few who drew the right axes the right way round insisted on drawing a straight line despite incontrovertible evidence of a good curve – and some drew a curve with something reminiscent of a blunt wax crayon.

(c) Most candidates commented accurately on the pattern of results and the good candidates recognised that here was an example of the effect of increasing substrate concentration on the rate of reaction and having obtained the beginnings of the characteristic curve, commented on it.

(d) Most candidates had no problem with using the graph to estimate the concentration of the unknown. The Planning Exercise definitely helped with this question.

(e) This was a straightforward question that asked why urine may be more concentrated. It often elicited the correct responses of dehydration and a high-protein intake.

(f) The majority of candidates answered this question, about the effect of a lack of ADH, knowledgeably and fluently. Perhaps having access to their Planning Exercises may have helped. Centres are reminded that it is permissible to have these available for candidates to refer to during the Practical Test. A few candidates confused diabetes insipidus with diabetes mellitus.

(g) The expected response to the question in *(i)* concerning the addition of acid was that it would allow the reaction's progress to be followed. This was much more often expressed in the form ‘so that a colour change could be observed’ which was accepted. Many candidates thought the acid provided the optimum pH for urease. In *(ii)*, most candidates thought of the likelihood of too much acid denaturing the urease and the better candidate addressed how this would occur.

(h) Maybe it is wishful thinking on the part of the Examiners that the wording of this part of the paper is cueing the right response, but it is noticeable that in recent papers candidates have become increasingly adept at evaluating the procedure and suggesting appropriate improvements. As in June 2005, most of the limitations and improvements on the mark scheme were identified by most of the candidates.

Teaching tips

- Centres are strongly recommended to train candidates to record time in seconds.
- Candidates should be trained to scale axes appropriately (they should avoid the sort of scaling that results in ten squares defining an interval of three integers - this invites inaccurate plotting of coordinates).

Q.2 *(a)* A few drawings of the kidney suggested textbook diagrams drawn from memory; some drawings were unrecognisable, but most were acceptable. A few were very good and recorded accurately what had been seen. When labelling a surprising number confused cortex and medulla.

(b) Most candidates commented the presence of Bowman's or renal capsules in the cortex and ducts and loops in the medulla. One or two thought that the pelvis was made of bone.

(c) Examination of slide **S2** with a hand lens as well as a microscope revealed that the plane of the cut across the kidney section **S1** was made transversely to give **S2**.

(d) Drawings of cross sections of collecting ducts were often sketchy. Whereas labels identify, annotations describe. However, most candidates that did annotate gave text book accounts of the functions of the labelled structures. One candidate identified ribosomes but was trumped by the candidate who spotted glucose molecules.

Advanced GCE
June 2006 Assessment Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u	Entry
2801	Raw	60	44	39	34	29	24	0	19368
	UMS	90	72	63	54	45	36	0	
2802	Raw	60	44	39	34	29	25	0	26750
	UMS	90	72	63	54	45	36	0	
2803A	Raw	120	89	78	67	56	45	0	13287
	UMS	120	96	84	72	60	48	0	
2803B	Raw	120	89	78	67	56	45	0	948
	UMS	120	96	84	72	60	48	0	
2803C	Raw	120	87	76	66	56	46	0	12375
	UMS	120	96	84	72	60	48	0	
2804	Raw	90	62	54	47	40	33	0	10685
	UMS	90	72	63	54	45	36	0	
2805A	Raw	90	68	59	51	43	35	0	2155
	UMS	90	72	63	54	45	36	0	
2805B	Raw	90	62	55	48	42	36	0	1462
	UMS	90	72	63	54	45	36	0	
2805C	Raw	90	69	63	57	51	46	0	1027
	UMS	90	72	63	54	45	36	0	
2805D	Raw	90	68	61	54	47	40	0	1178
	UMS	90	72	63	54	45	36	0	
2805E	Raw	90	66	57	48	39	31	0	9681
	UMS	90	72	63	54	45	36	0	
2806A	Raw	120	88	79	70	61	52	0	7525
	UMS	120	96	84	72	60	48	0	
2806B	Raw	120	88	79	70	61	52	0	371
	UMS	120	96	84	72	60	48	0	
2806C	Raw	120	89	80	71	62	54	0	6880
	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	17.1	33.4	51.5	69.6	84.7	100.0	19425
7881	23.8	45.9	67.2	84.6	96.0	100.0	15915

For a description of how UMS marks are calculated see;
www.ocr.org.uk/OCR/WebSite/docroot/understand/ums.jsp

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