OCR
RECOGNISING ACHIEVEMENT

GCE

Biology

Advanced GCE **A2 7881**

Advanced Subsidiary GCE **AS 3881**

Report on the Units

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Oxford Cambridge and RSA Examinations

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

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Reports on Units

Chief Examiner's Report

The *Report on the Units* for June 2006 included a list of questions from the A2 option papers (2805/01 to 2805/05) that would be suitable preparation for all A2 candidates whatever option they are taking. It was clear from this series of examinations that synoptic assessment in the options remains the area that candidates find most difficult. In this series one such question was *Q.6* of *Growth, Development and Reproduction* (2805/01) which was about malaria.

The Examiners work hard to make synoptic assessment in the options related closely to the topics in each option. However, candidates appeared not to spot these questions and in some cases the Examiners were left with the impression that candidates are not even anticipating questions like these. One third of the marks on each option paper is designated as being synoptic. The Examiners appreciate that Year 13 students taking the option papers in the January series may be at a disadvantage compared with the candidates taking the 2805 papers in the June series as the latter have the benefit of more revision time. Also they have the advantage of completing the course and seeing A level Biology in its entirety.

Performance on the synoptic paper itself – *Unifying Concepts in Biology* (2806/01) – was somewhat better in this series. As the report for that paper makes clear, feedback from some of the candidates was encouraging as they found they were able to use the data provided effectively and even enjoyed reading the information about hummingbirds. *Q.4* on that paper gave the candidates a diagram showing the processes that keep a liver cell alive. Candidates were expected to explain how aspects of homeostasis are involved in maintaining a constant concentration of biochemicals within the liver cell. This is a question that would make a good synoptic activity for use during the teaching of Section 6 of *Central Concepts* (2804) especially as it combines knowledge of cell biology, biochemistry and homeostasis. The Examiners noted that cell biology and biochemistry are two areas that A2 candidates find difficult on 2805 and 2806. Previous reports have commented on the difficulties experienced by candidates on synoptic questions that deal with DNA and nuclear biochemistry. It is clear that this trend continues. Teachers and candidates could usefully highlight areas in their A2 course where links with these two topics (cell biology and biochemistry) from AS could be revisited and reinforced.

The Examiners are always concerned about candidates having sufficient time to complete these examination papers. They did not think that time was an issue on any of the papers, although there was evidence that they might have been rushed on *Central Concepts* (2804). This may have happened because *Q.7* followed a blank page and some candidates may have missed it and only found it when checking through their paper at the end of the examination. Candidates should be advised to check the front cover for the total number of questions and then check for questions without answer lines, as these are frequently missed, and questions that appear after blank pages. Care is taken to ensure that questions are set on double page spreads to allow candidates to refer to left and right hand pages together. This is often the case for data questions. However, many candidates practise these questions copied back-to-back and so may not appreciate this. Also many candidates fold their examination papers during the examination and this may be the reason why they do not make obvious points about data because they do not turn over their paper to look again at what was on the previous page.

Past reports have commented on use of English and mathematical skills. In this series, the Examiners felt that use of English was as good, if not better, than in some previous series. The spelling of some specialist terms in *Mammalian Physiology and Behaviour* (2805/05) was a concern, however. There were no complex calculations on any of the papers and candidates generally coped well with those that they had to do. Some candidates taking the A2 Practical Examination (2806/03) seemed unsure about how to calculate the rate of reaction from their practical exercise in *Q.1* as they seemed to think the only way to do this was by calculating 1/*t*. The AS Practical Examination (2803/03) proved to be more challenging than usual. It appeared that the candidates did not benefit from doing preliminary work for the Planning Exercise on

catalase. Perhaps this was because it was a catalase experiment and teachers and centres felt that candidates already had enough experience of this sort of work at GCSE and at AS. *Q.1* of the test included a section on the effect of pH on enzyme activity and *Q.2* was a question on phloem. Both these topics are quite difficult for candidates.

OCR has continued its practice of including some very attractive colour photographs as inserts. In this series there were:

- sieve tube elements in the AS Practical Examination (2803/03)
- meiosis in anthers in the A2 Practical Examination (2806/03)
- an electron micrograph of part of a sperm cell in LS and an electron micrograph of an egg surrounded by sperm in *Growth, Development and Reproduction* (2805/01)
- a coconut flower in *Growth, Development and Reproduction* (2805/01)
- a cheetah skull in *Mammalian Physiology and Behaviour* (2805/05)
- PET scans of the brain in *Mammalian Physiology and Behaviour* (2805/05)

Candidates taking *Growth, Development and Reproduction* seemed somewhat confused with the terms *transverse section* and *longitudinal section*. Asked to draw a transverse section of the part of the sperm shown in the electron micrograph, some of the results were far from convincing and displayed some confusion with these fundamental terms.

The Examiners were somewhat worried about candidates who wrote their Planning Exercises using a word processing package. While the Examiners appreciate receiving word processed work, they do expect candidates to have mastered skills such as using superscripts and subscripts correctly. Many were unable to give the formula for hydrogen peroxide correctly, for example. In some cases this meant that candidates lost marks. Similarly, in the A2 Planning Exercise they often referred to the F^1 and F^2 generations.

Q.1 in the AS Practical Examination involved using sucrase (invertase) obtained from the NCBE. There is a whole series of practicals using invertase at:

www.glue.umd.edu/~nsw/ench485/lab14.htm

These experiments show the effects of all factors mentioned in the specification. With time for practical work at a premium a useful exercise would be to assign the practicals to different groups and then ask each group to report on their results. In the question, the candidates were told that the sucrase was an extracellular enzyme produced by yeast. It is possible to prepare sucrase cheaply from yeast as follows:

* add 10 g dried bakers' yeast to 30 cm^3 0.1 M sodium bicarbonate solution
* incubate at 40 °C for 24 hours
* centrifuge
* decant the supernatant that contains the enzyme.

This preparation will keep for several months in a fridge. The solution will probably need to be diluted immediately before use.

2801: Biology Foundation

General Comments

Some very good scripts were seen from candidates who showed a comprehensive understanding of the subject material and expressed their knowledge and ideas clearly and concisely.

Certain areas of the specification appeared to be less well understood, particularly (but not exclusively) by weaker candidates. These include water potential (Q.1 (b)) and the structure of glycogen (Q.4 (a)(i)). The responses involving those topics showed a great deal of confusion on the part of some candidates.

Candidates should be encouraged to ensure that they present information in as clear and unambiguous way as possible. This is particularly important when considering ticks and crosses. When one is changed to the other, particularly when a tick is changed to a cross, the resulting symbol is ambiguous. Under those circumstances it is assumed that the candidate is undecided and will be requiring the Examiner to make the decision. Such 'hybrid' ticks are rejected. It is far easier and clearer to simply cross out the incorrect answer and write the intended answer clearly and unambiguously alongside.

Another area in which improvement is needed is that of reading the question thoroughly and being absolutely sure of what is required to answer that question. This was particularly evident in Q.2 (b), where many answers simply did not focus on the requirements of the question but simply described the structure of the cell surface membrane or gave details of cell structure without relating them to the roles of membranes. While it is not possible to link this absolutely to misreading of the question, many answers indicated that candidates had the ability to apply their knowledge to the question but did not do so effectively. The problem was not simply 'latching on' to a key word in the question and answering by means of a rehearsed response.

Comments on Individual Questions

Question

1 (a) This was intended as a reasonably straightforward introduction to the paper. Even weak candidates were able to score marks here. Some confusion was evident with population and community and some candidates were determined that 'niche' should be at least one of the answers. The idea of food chains and trophic levels was better understood, although 'primary' was often suggested instead of 'trophic'.

(b) Candidates found this part rather more difficult. Some did not express the concept of water movement in terms of water potential, even though this was clearly stated in the question. Statements that include references to different 'water concentrations' will not be credited. Difficulties arose when candidates incorrectly assumed that flooding by sea water would mean that the plants were flooded with fresh water with a high water potential. Some correctly related the sea water to relatively high salt concentrations but incorrectly stated that this gave the solution a 'high solute potential' and therefore a low water potential. Some simply gave 'either / or' scenarios that did not answer the question. The mark scheme was relaxed a little so that those candidates who had given alternative and contrasting suggestions or who incorrectly stated that water would move into the plant could at least gain some credit for recognising that the problem was related to water movement by osmosis and that this movement takes place down a water potential gradient. A point that has been made in previous reports is that some candidates do not appear to grasp what is meant by 'plasmolysis', thinking that it is a term that can be used interchangeably with 'turgid'. It was not unusual to see a statement such as 'the cells gain water, become plasmolysed and then turgid'.

2 (a) Membranes are one of the most fundamental parts of cell infrastructure, and it was surprising that so many candidates seemed to have little understanding of their structure. Many candidates did well on this question, but there was quite a strong divide between those who knew a lot and the rest, who knew very little.

Many candidates were unfamiliar with the term 'fluid mosaic' to describe the model of membrane structure. The most common incorrect answer to part (i) was 'phospholipid bilayer'. Part (ii) was generally well answered, the most common error being the reversal of glycolipid and glycoprotein as responses to **C** and **D**. Despite having been told in the question that the diagram was of a model of membrane structure, and should have been familiar from every textbook, quite a number described the parts as those of a section through a leaf, with structures such as palisade mesophyll, epidermis and chloroplasts. Others seemed to think it was a cell in itself, and described the phospholipid bilayer as the cell wall, cholesterol molecules as mitochondria or Golgi bodies, and the glycolipids as strings of ribosomes.

(b) This discriminated well. Candidates were expected to concentrate on the roles that membranes play outside and within cells. It appeared that they often knew many facts about either the cell surface membrane or internal membranes but comparatively rarely achieved maximum on both sections. There were some cases where candidates only described the cell surface membrane and completely omitted any reference to internal membranes. Most candidates appreciated that the cell surface membrane controlled the entry/exit of molecules/ions or alternatively, some referred to the partially permeable quality of the membrane. Surprisingly few commented on the membrane separating the cell from its environment. Many realised why the membrane would be selective, but omitted to mention the role of the phospholipids in this function. There is some confusion relating to the role of the glycoproteins acting as receptors. They do not attract or detect molecules. Of those candidates who mentioned the role of internal membranes, most understood that many organelles were membrane-bound and went on to give several examples. There was also some confusion with terminology, examples were:

- cell surface membrane around organelles
- protein tunnels/channels for active transport
- ion pumps for diffusion.

Parts of the cell were anthropomorphised as the terms 'wanting' or 'wishing' were often seen in relation to functions and processes. As stated above, many candidates did not score well on this part of the question as they did not focus on the question set.

3 (a) It was clear that some candidates were not fully familiar with the tests for biological molecules as stated in the specification. Lipid was frequently suggested as an answer to both parts, even though the test for lipid was not included in Table 3.1. Although many candidates were able to identify protein, some were unable to distinguish between reducing and non-reducing sugars, while others tried to indicate the different sugars by name or as 'simple' and 'complex'.

(b) Weaker responses simply repeated the information of colour changes given in the table, rather than relating this to the different concentrations of reducing and non-reducing sugars.

(c) This was dealt with quite well, as only the very weakest candidates failed to make some relevant statement.

(d) Those candidates who appreciated that the colour of milk meant that the colour change to be observed in the emulsion test would not be seen, generally made a suitable comment to that effect. Some, however, simply stated that milk was known to contain lipid, so it would be a waste of time to test for it.

(e) Candidates were aware of the use of calcium in the body. Answers to this part, however, required the use of the ion, rather than where it is found. An answer such as 'found in bones', therefore, did not score. When referring to nerve impulse transmission, candidates should take care in exactly how the information is stated as incorrect statements such as 'maintains the resting potential' and 'carries the impulse along a neurone' are not credited.

4 (a) Much confusion was evident in part (i). It should be made absolutely clear to candidates that glycogen is not starch, nor is it made up of amylose and amylopectin. The confusion probably arises as texts frequently describe the structure of starch and then deal with glycogen almost as an afterthought, likening its structure to that of amylopectin and then stating the few differences between the two. A further reason for confusion is the tendency to refer to glycogen as 'animal starch'. While this can lighten the load of the candidate in dealing with this area of the specification, it has clearly resulted in a great deal of confusion in those candidates for whom the topic is already a challenge. It is suggested that glycogen is covered quite separately from starch in order to help avoid this confusion. Some candidates confused it with cellulose, as β glucose and 180° rotation of the monomers were referred to. Other errors seen were to describe it as a lipid or a protein. There were, however, some excellent descriptions of the molecular structure. The idea of a polymer of alpha glucose units joined by 1, 4 glycosidic links was well known. Detail of the branching was also often included. Some responses included detail of its compact nature or of the glycosidic bond. Candidates should be warned about the incorrect use of lower case 'a' instead of the word alpha or the correct symbol. Most candidates were able to answer part (ii) correctly.

(b) The most common reason for not being awarded the mark in (i) was a lack of units, although some unlikely temperature suggestions were seen. Part (ii) was answered well, with most candidates able to describe denaturation and its consequences. This section was well done even by candidates who struggled with the rest of the paper. A number appeared unfamiliar with the term 'significant' and so began their answer with detail of the effects of a rise in temperature just above the optimum. Candidates were expected to relate the increase in temperature to excessive vibration of the enzyme molecule rather than violent collisions between the enzyme and substrate. Candidates are reminded that substrates do not possess active sites and that a question relating solely to temperature is not likely to require answers relating to inhibitors. Candidates should also be warned to avoid the use of vague statements such as 'bonds were affected' or 'this affects the reaction rate'.

(c) Most candidates answered (i) well, although the answer to (ii) did require candidates to emphasise the need of the liver cells for a lot of energy or ATP. Answers that simply stated that mitochondria produce ATP were not credited.

(d) This was also answered well by most candidates, although care should be taken when spelling terms that can be mistaken for an incorrect answer. 'Meitosis', for example, was not credited as it demonstrated confusion with meiosis.

5 This question discriminated well. Although the 'tick / cross' format of the question might have made it appear to be relatively easy or approachable, careful thought was required in distinguishing between DNA replication and transcription and then considering each of the statements. The previous comments about 'hybrid' ticks should be noted. There was no real pattern about the errors made, apart from statement **H**. Few candidates answered this correctly with two ticks ~ as adenine does pair with thymine in transcription. The statement did not say that adenine pairs with thymine 'only'. Of those who did get this correct, it was often a low scoring answer with apparently randomly placed ticks and crosses.

Teaching tip

Candidates could be given the task of devising questions on different parts of the specification following the format of Q.5.

2802/01: Human Health and Disease

General Comments

It was pleasing to see that all candidates were able to demonstrate their knowledge by achieving some marks on this paper. Candidates were able to score in all areas of the specification and there were no questions or part questions that failed to elicit correct responses from some candidates. Overall the examination paper discriminated well enabling the best candidates to achieve high scores. However, it was noted that few candidates scored highly all the way through the paper – even better candidates appeared to have areas that they had not thoroughly revised and therefore scored fewer marks than in other questions. It was pleasing to see that there was less evidence than usual of candidates losing marks because they were unable to express themselves clearly.

Comments on Individual Questions

Question

1 This was meant to be an easy starter question on diet. It was surprising to find that even the best candidates found the question a difficult one in which to achieve full marks.

(a) A body mass index of 30 or over indicates that a person is obese and the majority of candidates knew this. Some tried to qualify the term by adding 'clinically', which was acceptable, or 'morbidly', which was not acceptable.

(b) As diet **B** was a low fat diet it seemed reasonable that essential fatty acids or fat-soluble vitamins might be deficient. Candidate responses ranged from 'amino acids' to 'energy'. Many candidates wrote simply 'fats' which was not awarded a mark as it was clearly given in the stem of the question. Similarly, the response 'carbohydrates' for diet **C** was not awarded a mark as it was clearly given in the stem of the question. The Examiners were looking for a little more thought from candidates at AS level.

(c) In part (i), the Examiners were looking for the simple principle that if a person consumes less energy they are more likely to lose weight. Most candidates correctly identified diet **B** as the one that would enable most rapid weight loss, but few could explain this by suggesting that it contained less energy than diet **C**. Many candidates, instead, concentrated on the levels of fat in diet **C** suggesting that it would directly contribute to gaining weight. In part (ii), candidates were asked to point out that in order to lose weight a person must consume less energy than they use. It was surprising how many candidates believed that you could lose weight if energy consumed equalled energy used.

(d) Diet **C** was described as a high protein and fat diet with little carbohydrate. Many candidates were able to give at least two potential health problems that might be caused by keeping to such a diet for long periods. Commonly seen responses included deposition of fatty substances in the walls of arteries, high blood pressure and coronary heart disease. Better candidates also suggested that eventual weight gain may occur if energy consumption was not limited. Many candidates used the space to show what they knew about vitamin deficiencies – most of which was irrelevant.

2 Almost all candidates achieved at least three marks in this straightforward question. Most knew that a definition of health includes 'physical' well-being and the absence of 'infirmity' or 'disease'. Some candidates suggested that most energy should come from 'proteins' or 'fats' rather than 'carbohydrates'. Many knew that the diet should only contain a few 'saturated' fats and that the person should exercise for at least 'twenty' minutes three times a week. The most common error was in the last point where responses ranged from '20' to '140' percent of maximum heart rate. The Examiners commented that even the most ardent fitness fanatics should realise that nobody could sustain over 100 percent of maximum heart rate.

3 This proved to be the first question on the paper which less able candidates found difficult.

(a) The candidates were asked to select from a number of changes to the body that might occur as a result of regular aerobic exercise. Most candidates correctly identified three changes but few were able to correctly identify all six changes from the list. Most candidates knew that there would be an 'increase in the number and size of mitochondria', a 'decrease in percentage of body fat' and an 'increase in size of skeletal muscle'. The changes that were most commonly selected incorrectly were 'increase in number of alveoli in the lungs' and 'change in structure of haemoglobin to become more efficient'.

(b) As ever, the inclusion of a calculation in part (i) proved too much for many candidates and perhaps half of all candidates failed to convert this simple calculation into marks. Biology papers frequently include a calculation and it is an important aspect of modern biology. Centres need to ensure that this aspect of biology is taught thoroughly. In part (ii), candidates were asked to explain how the changes seen in Table 3.2 could contribute to improved performance. The Examiners were looking for comments and explanations about the performance of the athlete. Most candidates appeared to have misread the question and simply described the data in the table with answers such as 'the stroke volume has increased from 65 cm^3 to 90 cm^3'. This is a good answer to a question that begins with the command word 'describe', but does not answer the question starting with the command word 'explain'. Many candidates simply described what they knew about improving fitness levels with little use of the data in the table.

Teaching tip

Use past examination papers to identify the types of calculations that may be asked and give candidates plenty of practice at answering this type of question.

Supply candidates with a list of command words and explanations of what each means. Some centres post these on notice boards as a constant reminder to candidates.

4 This question proved quite difficult for some candidates and many in the middle range failed to score more than a few marks. This question began with an unusual graph (Fig. 4.1) that had two different scales for the vertical axes. Only the better candidates spotted this and made full use of the data supplied. The best candidates were able to read the question carefully and understand what was required before launching into their responses.

(a) Candidates were asked to look at the ratio between the incidence of coronary events and mortality from CHD. This ratio is not constant and actually shows quite a variation between the countries shown. Candidates were asked to suggest why this ratio was not constant. A range of responses was seen with some candidates simply writing down what they had learnt and listing factors that contribute to the risk of CHD. Better candidates were able to suggest that there were differences between the countries that might affect how many people die from coronary events of some kind. Many could identify differences in diet or levels of exercise in different countries with the best candidates also pointing out that the statistics might be inaccurate in some countries.

(b) It was clear from the data supplied that prevalence of smoking varies widely in different countries and this is not always reflected in the levels of heart disease found in those countries. This was one part of the examination in which candidates found it difficult to express themselves clearly. Few candidates gained both marks and many failed to gain even a single mark. The most common error was to consider the figures for China without reference to another country. Many candidates failed to use figures from the graph to back up their comments. Of those that did use the figures, many read inaccurately off the graph or quoted ‘700 000 people’ rather than ‘700 per 100 000 people’ as a figure to support their comments.

(c) As the ‘easy’ part of the question it was not surprising that many candidates did well here. Many could describe steps the government could take to reduce mortality from CHD such as ‘providing free gyms to encourage exercise’, ‘ensuring that food is given health labelling’ or even ‘legislation to ban smoking’. Some candidates gave very vague statements such as ‘encourage people to exercise’ which were not awarded marks as they did not express how this was encouraged.

Teaching tip

Interpretation of unusual graphs make very good homework questions and are an excellent stimulus for classroom discussion. There are plenty of examples available from the web sit that provided stimulus material for this question: www.heartstats.org

5 This longer question about cholera is an old favourite and allowed even the weakest candidates to demonstrate what they had learnt.

(a) It was pleasing to see that centres have been teaching candidates to learn the full name of the pathogenic organisms specified in the Human Health and Disease specification. The majority of candidates could give the correct generic name with only a few using the abbreviation in part (i). In part (ii), the majority of candidates were able to describe transmission as occurring through infected faeces contaminating drinking water in some way.

(b) All candidates were able to give a reasonable account of why it has not been possible to eradicate cholera and one examiner was interested to learn that 'we can now cure mortality but not cholera'. Some candidates could only muster two or three valid points but the majority were able to describe six or more reasons why cholera has not been eradicated. All points on the mark scheme were seen regularly and centres obviously cover this aspect of the specification thoroughly. However, the idea that 'people in LEDCs live in houses made of faeces' suggested that not all candidates learn the detail accurately! Fewer candidates were able to achieve the quality of written communication mark where candidates were expected to use a certain number of scientific terms appropriately.

Teaching tip

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

6 Responses to this question on immunity were variable and often centre specific.

(a) Most candidates could state that plasma cells or B lymphocytes produce antibodies.

(b) In part (i), most candidates knew that the binding site is to attach to an antigen and that the disulphide bridges hold the polypeptide chains together or hold the tertiary structure of the antibody. Few candidates knew that the constant region allows attachment to a phagocyte or mast cell, most stated simply that 'it remains the same'. Many candidates were confused by the function of the hinge region and stated that it 'allows movement' or 'holds the chains together temporarily'. Better candidates suggested that the hinge region 'allows flexibility of the antibody to attach to more than one pathogen'. In part (ii), there was further confusion from some candidates who suggested that the variable region can 'change shape to match different antigens'. Better candidates knew that the variable region 'has a different shape in different antibodies that makes them specific to different antigens'. Some candidates were even able to explain that this was due to different amino acid sequences. This is a part of the specification where candidates must express themselves clearly to ensure they gain the credit they deserve.

(c) In part (i), most candidates could suggest that it took time to produce the antibodies in large numbers but few were able to point out that before antibody production begins the correct cell must be selected through antigen presentation and that clones need to be produced. In part (ii), very few candidates gained more than one mark. Most started the increase in numbers of antibodies on day 30 rather than a little later and few showed that the number of antibodies in the blood remains high for a lot longer after the second infection.

(d) 'Mutation' was the simple answer that the Examiners were looking for in part (i) and many candidates achieved this. Unfortunately, some tried to qualify their answer by stating that it was 'mutation of the antigens' which was not awarded a mark. In part (ii), most candidates could give at least one sensible suggestion regarding what precautions could be taken in a hospital to combat MRSA. Commonly candidates suggested 'using disinfectant to clean surfaces', 'washing hands between patients' or 'isolation of infected patients'. Some candidates failed to achieve a mark because their comments were too vague. Examples were 'clean more often' and 'sterilise the hospital'.

Teaching tip

Encourage candidates to read newspaper articles with a biological or medical content – centres could even create a 'biology news board' and pin up recent articles for candidates to read.

It appears that many centres could devise a more detailed and thorough approach to the teaching of the topic covered in this question.

2803/01: Transport

General Comments

The responses covered virtually the whole mark range. There were relatively few really weak scripts and many of the candidates seemed to be well prepared. A minority of candidates seemed under prepared and either answered many questions incorrectly or left them blank. This did not seem to be attributable to a shortage of time. Legibility was commented on favourably in most cases. It was encouraging to note that the botanical question (Q.4) scored as well as the rest; this has not always been the case. The idea of surface area to volume ratio underpins much of this section of the specification and centres should ensure that the concept is well understood by candidates.

Comments on Individual Questions

Question

1 (a) Although the majority got the correct ratio in part (i), a minority failed to do this section. It was not clear if the candidates failed to spot the question or were frightened by the maths. A number did not follow the instructions to round to the nearest whole number or inverted the answer (1:5). There were even some who replaced the colon with a decimal point. In part (ii), all that was needed was x7. Some candidates who went on to enlarge on their answer lost the mark by getting A and C the wrong way round. x12 was the most common wrong answer.

(b) A surprisingly large number gave the incorrect response of 7.0 cm3 g-1 h-1. This seemed to be due to a lack of careful reading of the data in the question thereby not spotting that the figures were per gram of biological material. As always, centres should stress the need for careful reading of the question.

(c) There were a number of good answers that suggested that candidates have taken on board the comments in previous reports on this type of question. Good responses clearly stated that the surface area to volume ratio would be too small, whilst weaker answers just mentioned area and did not score the point. To score other marks it was important to relate the relatively slow rate of diffusion to the increased distance in larger organisms. Some candidates got confused on the speed idea and stated that the speed of diffusion was slower in larger organisms; something of a misconception. Poorer responses were restricted to rather vague ideas about 'being too big to reach all parts'.

(d) In part (i), a majority identified the structure correctly as an alveolus (though often pluralised and with a variety of spellings) or a squamous epithelial cell. There were, however, many capillaries and not a few arteries, veins, bronchi, bronchioles and smooth muscle. The clue was that red blood cells were not shown in the structure but were elsewhere. In part (ii), the mark scheme allowed candidates to score even if they had identified the structure incorrectly. The question only asked for the features, not an explanation of how they helped. The first marking point on the scheme gave credit for the idea of large surface area to volume ratio. Most candidates only talked about a large surface area; as the question asked about a single alveolus, a moment's thought should have made candidates aware that the absolute area is small. Thin, permeable walls and well vascularised scored marks. Credit was not given for thin membranes, but some leniency was allowed in responses mentioning 'thin cell walls' which were taken as a wall made of thin cells. 'Moist' was allowed, but centres should try to impress on candidates that the moist nature of the alveolar wall is an inevitable consequence of its permeability. Several candidates wrote 'moist to speed diffusion' which betrays a lack of awareness of the simple physical laws governing the rate of diffusion.

Teaching tip

Emphasise the SA:V ratio. Have a table tennis ball and a football. Which has the largest surface area? Which has the largest SA:V ratio? Also stress diffusion in relation to speed and distance.

There is a useful tutorial at: www.tiem.utk.edu/~gross/bioed/bealsmodules/area_volume.html

2 Most candidates scored at least one or two marks on this question. It was decided to allow C or G for the Purkyne tissue. Common errors were to confuse the roles of the two nodes or to state that the fibrous tissue between the atria and ventricles had a conducting role rather than the reverse.

3 (a) Many candidates answered this section well. Some inverted J and K so the Examiners applied the error carried forward rule so that function marks could be awarded. Macrophage was not allowed for J as the nucleus is different and they are not found in the blood. Some weaker answers did not use the term phagocytosis nor describe it, but just said 'destroy pathogens'. Some also thought that lymphocytes produced antigens. If candidates gave a specific type of lymphocyte the function had to match the type stated. No credit was given for erythrocytes

(b) There were a number of good answers, but many fell down by not relating the structure to the function. Also many candidates restricted their answers to oxygen carriage forgetting that red blood cells also carry carbon dioxide and that haemoglobin has a buffering role. A common error was to state that a red blood cell has a large surface area; this is the same misconception noted for Q.1. It is the large surface area relative to its volume which means that haemoglobin is never far from the surface for diffusion of gases. Other misconceptions centred round the oxygen carried; some thought that each red blood cell contained four haemoglobin molecules (or four haem groups) or that each cell could carry four oxygen molecules. There was also some confusion between molecules and atoms. There was a misconception that the biconcave shape allows more oxygen to be carried on the membrane – presumably in the dip? Biconcave was often spelt 'bioconcave'.

(c) Most candidates knew that training at altitude would increase the red blood cell count and many at least implied that the extra red blood cells would remain for a time on return to sea level. Only the best answers then took the story further with sufficient detail when related to an athlete's performance. The Examiners were looking for carriage of the extra oxygen to muscles – not just 'round the body'. The result of this is to allow aerobic respiration to continue longer and delay the build up of lactic acid and the onset of the oxygen debt. Some candidates wrote about more) energy being produced; they should remember that ATP is produced, energy is released or transferred.

4 (a) Most got 'potometer' in (i). There where some 'photometers' and 'pedometers'. Transpirometer was not allowed. Some weak answers to (ii) described possible errors in the experiment. Despite the instruction to refer to the information in the stem of the question, many candidates failed to state that transpiration involves evaporation or the loss of water vapour. This is not the first time that this has been stressed in reports on this unit. Good answers got the idea that the assumption is that uptake and loss are the same, but in fact they will not be as the plant uses some of the water for processes like photosynthesis and maintenance of turgor. A fairly common error was that water is used up in respiration overall. A few got the idea that the potometer does not measure the transpiration of a whole intact plant. It was encouraging on (iii) to see a good range of precautions which suggested that many candidates have actual first hand experience of using this type of apparatus. There is a misconception that repeating the experiment improves the validity; it does not – it improves the reliability of the results. Many also wanted the meniscus set at zero or the 'end of the scale'. It does not matter (within reason) where it is set as long as it is recorded accurately at the start and end of a given time.

(b) Again there were many good responses to (i). Some poorer responses failed to answer the question and compared the two species; others, who spotted the possible reasons for the change in the graph, did not qualify them. Thus 'temperature' was quoted rather than an 'increase in temperature'. The Examiners were looking for a clear link between the factor that changed and the increase in rate. Thus for raised temperature an increase in kinetic energy or evaporation was looked for not just an increase in transpiration (as this was a direct quote from the axis of the graph). A common response, which was not given credit, was to link increased light to increased photosynthesis and thus increased need for water; the data was for transpiration not uptake. A few suggested, incorrectly, that the increase in transpiration was due to an increase in humidity. In (ii), although there were a number of muddled answers and some candidates mixed up P and Q, it was good to see many responses showing some careful thought. There were two possible approaches. Either the leaves may be small but there may be more of them so that there is a larger area, or there may be a higher density of stomata, or Q may show a xerophytic feature. A clear reason why the stated feature reduces (but not stops) evaporative loss was expected. This was not a question about surface area to volume!

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

General comments

The Moderators saw an improvement in the general standard of work submitted. Most centres are achieving a high standard of marking with good quality annotations. In contrast a few centres are using newly qualified teachers or personnel lacking experience in coursework teaching and marking. It is strongly recommended that such centres take advantage of INSET provided by OCR and/or take advantage of the consultation service available to check the suitability of an assessment exercise and the accuracy of the marking.

There were a significant number of incorrect entries where centres intended candidates to carry forward their last coursework score but entered them for new work instead. This causes confusion and delays the process of moderation in general.

General comments on the descriptors

Skill E is, by definition, more challenging than the other skills. It is noticeable that weaker candidates rarely attempt E.7a and E.7b. The former can be comparatively easily achieved by adding a suitable sentence to each improvement suggested.

E.7a	Justifies proposed improvements to the experimental procedures and/or strategy in terms of increasing the reliability of the evidence and minimising significant sources of error.
E.7b	Assesses the significance of the uncertainties in the evidence in terms of their effect on the validity of the final conclusions drawn.

The level 5 descriptors E.5ai and E.5bii cause a number of centres difficulties. Where a candidate has included what is obviously the major limitation, they must explain why it is so and the consequences; centres may not credit this unless the candidate acknowledges it. Similarly E.5bii is often missed by candidates who do well in this context in the 'a' strand.

E.5ai	Indicates the significant limitations of the experimental procedures and/or strategy.	Whilst level 3 might be the identification of all the limitations (problems in the method) in the procedure, level 5 is a clear indication which limitation(s) cause the greatest impact on the data. This can be done by simply ranking the limitations, but other techniques may be used.
E.5bii	Evaluates the main sources of error.	The candidates must explain what impact the main error(s) (inaccuracy in the numbers), has on the data and how it is affected eg if data (raw or processed) is increased/decreased as a result of the error(s).

2806 specific comments

The use of scientific knowledge and understanding (SKU) by a few candidates is causing some concern. Inclusion of material from outside the specification is pointless as it cannot be considered in the assessment process. In fact this would probably result in failure to match P7aii and A7bi because the plan or analysis respectively loose coherence.

A second cause for concern is the often poor quality of SKU used in skill A. Where a candidate has employed a complete investigation for the assessment of skills P and A, it can be that the SKU in the plan is of excellent quality and relevance, but the conclusions are not supported to the same standard. Along the same lines, the majority of centres are teaching the need to use AS and A2 SKU well but candidates commonly offer only AS or A2 SKU to support their conclusions. If only AS SKU is offered then it is very unlikely that A.5bi will be matched quite apart from the synoptic descriptors.

2803/03: Experimental Skills (AS Practical Examination)

General Comments

Centres and Examiners found this to be a very straightforward Practical Examination which presented few, if any problems, in administration or marking. Unfortunately, many candidates found the questions in the Test to be very challenging and the range of marks was not as wide as in recent examination series.

The Examiners noted that centres give their candidates very different levels of support during the preparation for this examination in the January session. Some candidates included detailed check sheets with their plans while others appear to have had no direction at all from their teachers. Generic help sheets such as the one suggested in the Report for January 2006 are acceptable; detailed help sheets that refer to specific issues with the planning exercise being carried out are not. Candidates taking the examination at this time of year should have access to a laboratory to carry out some preliminary work. Some candidates included in their plans such statements as 'before this method is carried out you should do a preliminary study to find out how much ….' The candidates should carry out preliminary work and this should be used to inform the plan. The intention to carry out a preliminary study does not gain any marks.

The Examiners hoped that there would be a variety of approaches to the Planning Exercise, but most candidates went for crushing mung beans and collecting gas in upturned measuring cylinders or gas syringes. A small number used filter paper discs as recommended by SAPS (see Teaching tip) and some measured the loss in mass as hydrogen peroxide is decomposed. Several candidates started off with the correct experiment but later discussed facts relating to the production of oxygen by yeast. Others simply substituted mung beans for liver/potato/yeast in previous class experiments and compounded their error by using incorrect variables such as different concentrations of hydrogen peroxide or enzyme!

Centres are reminded that they should check the work submitted as the Planning Exercise and make sure that the candidate has signed the declaration on page 2. The teacher should then sign the declaration on page 1 unless he or she has some doubt about the candidate's work. The Examiners would like to thank centres that attached planning exercises by treasury tags to the Tests. Tests should be placed above the Plans.

It was clear from the teachers' results sent with the Tests, that some centres used sucrose contaminated with glucose in Q.1. The instructions made it very clear that this should not be the case.

Comments on Individual Questions

Planning Exercise

Some candidates used their AS knowledge to make sure that substrate was provided in excess during their methods; some knew that it was important to take the initial rate of reaction. If these ideas were explained then checking point I was awarded, although it could have been awarded for other aspects. However, many candidates simply used the information that they had already been given and did not do any further research. The Examiners expected that some candidates might draw on A2 knowledge in this exercise as they were told about respiration and germination in the introductory information. Many candidates did not follow up these hints and there was very little good relevant scientific knowledge from either AS or A2.

Some candidates carried out an experiment and then wrote it up, often including a conclusion, an evaluation and suggestions for further work. They did not express their suggestions for improvements as applying to the experiment that they were supposed to be planning and therefore often lost marking point **J**, and also **A**, **M**, **S**, **E** and **F** if they were not clearly explained. Candidates should be advised against this way of presenting their answers. Many centres use the mark schemes for past planning exercises to train their candidates. Here are some comments on each of the marking points that were used this time.

A Most candidates gained this marking point although some did not homogenise the beans to produce an extract. Simply removing the testa did not satisfy this requirement of the marking point. Nearly all candidates measured the rate of catalysis by measuring the rate of oxygen production. Candidates at a few centres measured the loss of mass of hydrogen peroxide while one, unsuccessfully, attempted to measure the increase in mass of water. There were also a few attempts to place mung beans into potometers – obviously trying to reuse information from last summer's examination. Heating to obtain dry mass was a problem for a few candidates. They knew why it had to be done but did not use their scientific knowledge to work out suitable temperatures, or a way to carry this out without denaturing the enzymes catalase in the beans.

B The majority were awarded this point but a few simply referred to 'the fastest reaction being at the start'.

C The majority gained this mark, the major omission being a lack of apparatus for homogenising beans and/or apparatus for measuring peroxide. Nearly all candidates now produce a list of apparatus. However, candidates from some centres did not do this thus making it more difficult for them to score this point.

D Only a small minority did not score a mark for this point. Those that did not either gave a word equation or did not use the subscript function correctly. The Examiners saw every permutation of the formula for hydrogen peroxide. Candidates should take more care over their word processing.

E Most candidates gained this point, appreciating the need for control of variables during germination and/or during the method for gas collection.

F Most candidates gave at least 5 values of the independent variable. Some only gave four often including dry seeds in their range.

G Very few candidates gave any description of the stages of germination and early growth to indicate the range that they would use. One pointed out that seedlings of the same chronological age are not necessarily at the same developmental stage. A few candidates removed the shoot tips and used these in the procedure. The Examiners expected candidates to germinate their own seeds and choose relevant growth stages. Many seem to have been given some germinating beans without knowing anything about how they had been grown.

H Most were awarded this mark.

I This mark was often not awarded because the scientific information was not then clearly linked to some aspect of the plan because it simply made general references to enzyme action and/or factors affecting enzyme activity.

J Few candidates gave any appropriate reference to previous preliminary work. Many candidates did not *use* the results of their preliminary work to develop their method. They often simply referred to the fact that they had carried out a pilot study and quoted results without saying any more.

K Some candidates included as much detail as possible on safety expecting the Examiner to select what was appropriate. There were some general comments such as pushing chairs under the bench or tying hair back. Some mentioned hydrogen peroxide, but did not say what its problem was or what they would do about it. Tables are useful here to show the hazards and the appropriate precautions.

L Most candidates were awarded this mark. Only a few candidates gave confused or unclear accounts.

M This mark was generally centre-based as some candidates were supplied with either gas syringes or burettes as suggested in 'Instructions for the Planning Exercise and Practical Test' or were aware of them from previous practical work on catalase. Candidates not supplied were obviously disadvantaged.

N Good candidates made very explicit references to secondary sources in their text but these were in the minority, most simply had a bibliography at the end of the report. The question paper itself is not an appropriate reference to include!

O. Almost all included at least one table, but many lacked an independent variable or appropriate units. Many tables were for gas collection over time, with separate tables for each day of germination. Those who managed one table did not realise that the age of the beans (or developmental stage) was significant rather than the day or time of the experiment.

P Most candidates gained this mark as work was usually word processed and consequently much was corrected for spelling and grammar. Marks were still sometimes lost for careless spelling and poor grammar.

Q Few candidates attempted this calculation but those that did invariably calculated the initial rate of reaction using the gradient on a time course graph.

R Only a minority were awarded this mark. Most errors involved plots of oxygen production against reaction time. This mark is awarded for the *final* summary graph not for any graphs that are used during the investigation such as time course graphs to determine initial rates of reaction.

S Only a few good candidates justified the need for using a gas syringe or a burette; most simply stated that they were used because they were more accurate.

T Some discussed the significance of the initial rate of the reaction but did not realise the need to use it in analysing their data. A few good candidates used the information correctly and managed to gain **Q**, **R** and **T** together.

Teaching tip

There is a protocol for an investigation using filter paper discs on the SAPS web site.

Microscale investigations with catalase

www-saps.plantsci.cam.ac.uk/worksheets/ssheets/ssheet24.htm

Practical Test

Question

1 Candidates seem to have performed the procedure very well and almost all gained the expected results. Parts (f) and (g) on page 7 of the scripts were generally poorly answered.

(a) Most candidates got a positive result with glucose and negative results with the rest. Some recorded positive results with sucrose and some with fructose. This should have not happened and it appeared that occasionally fructose and sucrose became contaminated. The correct answer should have been

1.0 g dm–3 for glucose, but in view of the variation seen the Examiners accepted any figure for glucose. Unfortunately, some candidates put units in the body of table, but on this occasion the Examiners overlooked this error.

(b) Almost all candidates followed the instruction to draw a table. Most omitted information about the contents of the tubes or the pH of the solutions, which was occasionally offered and was rewarded. The majority gave the tube number and the concentration of glucose which could still score 5 of the 7 available marks.

(c) Most realised that tube A was included as a control, but the further explanation in (i) was often weakly expressed. Equilibration at a temperature that is near to optimum for an enzyme prompted many candidates to discuss activation energy and collision theory – neither of which were necessary in (ii).

(d) Some facts that could have gained marks for this answer were put into (e) by a significant number of candidates. Many did not read the question carefully and many lost up to 4 marks for relevant information in the wrong place. However, there were very good well reasoned answers that gained 4 or 5 marks.

(e) There were some excellent answers with full marks, but others lost marks through poor explanations even though they obviously knew the facts. Reference to bonds, enzymes and active sites being ‘affected’ was a common fault.

(f) Many candidates did not seem to understand what had happened in tubes C, D and E so found it hard to interpret their results. Many did not know that glucose and fructose are reducing sugars and that sucrose is a non-reducing sugar. In these cases the interpretation of the Diastix results was completely wrong. Some thought glucose was detected because the glucose oxidase on the strip went into the solution – but did not offer any explanation as to why this did not happen in all tubes. One interesting suggestion was that they needed testing strips that had fructose oxidase and sucrose oxidase so they could test for all the reducing sugars.

(g) In part (i), reference to glycoprotein sent many candidates off on a tangent to discuss cell membranes and recognition sites – even to the extent that sucrase was a phospholipid. Good candidates knew the molecule was branched and that the branches were a sugar of some kind – most quoted glucose. Weak candidates just repeated facts given in the question while many said that sucrase contained glycogen. Just stating that sucrase is a glycoprotein was not sufficient. In part (ii), the only mark that was often awarded was for reference to molecular size – usually for sucrose.

(h) The reference to 'evaluation of results' in the question sent many candidates off on a tangent. They gave better explanations of their results here than they had done in (d) and (e) indicating that they had the necessary knowledge, but did not know where to use it.

In the remaining space most gave a good account of limitations and improvements and most of the marking points were seen. There were many vague descriptions of water baths: the Examiners look for thermostatically-controlled water baths. Vague answers failed to score marks. Examples of such answers are:

- 'inaccurate syringes' without reasons for the inaccuracy
- vague references to contamination
- unspecified time intervals
- more pH values without specifying 'wider range' or 'intermediate values of pH'
- more temperatures
- more enzyme concentrations (not appropriate here!)
- more hydrogen peroxide concentrations.

Teaching tip

There is a whole series of experiments on invertase at:

www.glue.umd.edu/~nsw/ench485/lab14.htm

Invertase may be prepared from yeast as follows:

* Add 10 g dried bakers' yeast to 30 ml 0.1 M sodium bicarbonate solution.
* Incubate at 40 °C for 24 hours.
* Centrifuge.
* Decant off the liquid (which contains the enzyme).

This preparation will keep for several months in a fridge.
The solution will probably need to be diluted immediately before use.

2 Generally this question was poorly done with most scoring very low marks – 2 to 4 was the common range, resulting in many final totals being less than expected compared to the quality of the plans and answers to Q.1.

(a) Many candidates scored marks for the drawing of the tissue map, although many ignored the instruction not to draw cells and included xylem vessels in their plan diagrams. Cucurbita has bicollateral vascular bundles and some candidates drew phloem on both sides of the xylem – but whether by accident or good observation the Examiners will never know!

(b) Few candidates carried out this calculation correctly. Many were unclear of the relationship between micrometres and millimetres. The Examiners awarded a mark if the correct procedure was followed for calculating the actual size even if the measurement from Fig. 2.2 was beyond the range accepted.

(c) Many identified cytoplasm and end walls; otherwise most identified structures that were not visible, such as mitochondria, nuclei and companion cells. Some gave features of xylem.

(d) There were very few good answers to this question on transport in the phloem. Most simply defined active transport as requiring energy or had vague ideas of companion cells containing mitochondria and linked this with energy. Good candidates knew about loading of sucrose, active pumping of hydrogen ions out of companion cells and co-transport of sucrose through carrier proteins.

There were many accounts of 'sources' and 'sinks' but without supporting facts. Some candidates wrote answers to different questions that they had obviously rehearsed.

2804/01: Central Concepts

General Comments

Examiners reported seeing many excellent scripts. The answers to the two extended writing questions were in many cases of a particularly high quality suggesting that an increasing number of candidates are able to write well structured accounts of biological processes using accurate technical terminology. There was some evidence that candidates were pressed for time with a number of examiners reporting that candidates had failed to attempt the last question.

Comments on Individual Questions

Question

1 This opening question on coppicing, classification and basic principles of recycling proved to be more demanding than expected.

(a) In part (i) there were many excellent accounts of the process of coppicing. Nearly all candidates realised that it involves cutting the tree down close to the ground and that new growth will form from the stool. Few candidates could accurately express how this process is used in sustainable management. Examiners were looking for a reference to the fact that the process can be repeated every few years or a mention of rotational coppicing. Credit was given to candidates who explained how coppicing could lead to increased biodiversity in woodland for example by increasing the light intensity reaching the woodland floor. In part (ii) examiners were hoping to see a reference to standards providing large planks, or the idea that timber from a standard is going to have a high monetary value. In contrast the coppiced trees would provide a regular income, with the biomass being used for hurdles, fencing etc.

(b) Success in this question was very much centre based. Many students were able to state that members of the fungal Kingdom are eukaryotic and reproduce by means of spores. Far fewer correctly stated that they are heterotrophic, have cell walls made of chitin, store carbohydrate as glycogen and are composed of hyphae. Examiners rejected statements such as 'fungi do not photosynthesise' or simply 'they have cell walls'. Candidates were more successful in part (ii). Most correctly stated that both groups are made up of eukaryotic organisms that have cell walls. Many weaker candidates incorrectly stated that Fungi are photosynthetic.

(c) Examiners were expecting to see references to fungal respiration resulting in the production of carbon dioxide which would then be taken up by the living trees for photosynthesis. Very few candidates answered in this fashion. Most accounts were limited to the fact that minerals are released from the deadwood and are taken up by the roots. The most common mineral mentioned was nitrate but few went on to state what the nitrate would be used for. There were far too many general statements about increased growth rather than precise comments on the formation of amino acids and proteins. Credit was given for correct reference to humus formation and how this improves the soil in a way that is beneficial to living trees. The most common correct answer is that it improves the water holding capacity of the soil.

Teaching tip

Candidates need to learn the key taxonomic features members of the five kingdoms. They need to understand technical terms such as eukaryotic, heterotrophic, hyphae. Few candidates seem to understand that the wall of a fungal hypha consists of chitin not cellulose.

2 This question was testing the candidates understanding of speciation in an unfamiliar situation. The question was set in 2005 before recent conflicting research was published and reported in the popular press on 31/01/2007. This research revealed that many species of seahorse are very promiscuous. However this research was carried out on seahorses in captivity and there is no indication as to whether the same behaviour pattern occurs in the Caribbean.

(a) In part (i) most candidates correctly identified the type of speciation that occurs when there is no geographical barrier to gene flow as sympatric. Similarly there were many good responses in part (ii) with candidates realising that the ranges of the two species overlapped and that there was no geographical barrier between them. Credit was given to candidates who made a correct named reference to an area of the map shown in Fig. 2.1

(b) An explanation of disruptive selection was given in the stem of the question. Candidates were expected to use the information on page 6 of the question paper to answer the question. Successful candidates made reference to the fact that mate selection in seahorses occurs by size, that individuals are monogamous for the whole mating season and that any intermediate sized individuals are at a competitive disadvantage compared with the two extreme phenotypes.

(c) Examiners were looking for reference to the fact that a large female will produce a lot of eggs and that only large males will be able to store all these eggs in his large pouch and fertilise them. Credit was also given to candidates who deduced that if large and small seahorses mate the offspring are likely to be intermediate in size. They then went on to say that these individuals are at a disadvantage and so will not survive.

Teaching tip

Candidates should be encouraged to use the information given in the stem of the question when being tested on unfamiliar material. Candidates should highlight key pieces of information as they read through the question. In many cases the candidates will be expected to make particular use of information provided in bullet point format.

3 Photosynthesis is a topic that is generally well understood by A2 candidates. Examiners reported many excellent answers to this question.

(a) Candidates should realise that when a question is worth three marks they are going to have to write more than the fact that a photosynthetic pigment is a molecule that absorbs light. Credit in part (i) was given to candidates who explained that these molecules will emit 'high energy' electrons and that these are used in the light dependent stage of photosynthesis. Marks could also be gained for correctly stating where the pigments are located in a photosynthetic cell and also for the fact that different pigments absorb different wavelengths of light.

Many candidates lack precision when reading off a graph. They were expected to note that chlorophyll a has a high absorption of light at wavelengths between 450 – 480 nm and between 660 – 710 nm. They could also gain credit for stating that there is low absorption of light at wavelengths between 500 – 620 nm. Many candidates lost marks because they did not state the units.

(b) When describing the role of accessory pigments candidates should realise that it is light **energy** that is passed to the primary pigments not electrons. Accessory pigments absorb wavelengths of light not absorbed by primary pigments. Many candidates incorrectly stated that chlorophyll is the primary pigment and carotenoids the accessory pigment. Primary pigments are forms of chlorophyll a and chlorophyll b is an example of an accessory pigment.

(c) This proved to be a high mark yielding section with above average candidates being able to give excellent accounts of non-cyclic photophosphorylation and the Z-scheme. Fewer candidates could accurately describe cyclic photophosphorylation. Most candidates scored the formation of ATP mark, but relatively few explained that it is formed by a chemiosmotic mechanism involving the pumping of protons into the thylakoid lumen. The energy for this proton pumping comes from the electron transport chain that links photosystem 2 to photosystem 1. There were many excellent descriptions of photolysis and its role in replacing the electrons released when light hits the reaction centre in photosystem 2. A fairly common misconception in weaker responses was that the electrons derived from the photolysis of water were directly boosted by light rather than replacing those lost from photosystem 2. The QWC mark was only awarded where the account was clear, logical and made good use of the correct technical terms.

Teaching tip

Students should realise that the energy for the formation of ATP in photophosphorylation comes from a proton gradient set up across the thylakoid membrane and not directly from the electrons passing down a chain of electron carriers.

4 Examiners were delighted to report that the standard of candidates' answers to genetic problems continues to improve and that a far greater proportion of candidates could successfully tackle the chi-squared section compared to when it was last tested in this component of the specification.

(a) Examiners were looking for crossing over as the correct response to part (i). Candidates who wrote down chiasmata as well as crossing over were not penalised as this was treated as a neutral answer. Chiasmata on its own was rejected. Most candidates correctly identified the stage as prophase in part (ii). In part (iii) examiners were looking for more than simply stating that sister chromatids are genetically identical or that non-sister chromatids are genetically non-identical. Reference had to be made to alleles (not genes) or base sequences of DNA.

(b) Most candidates correctly identified the four possible gametes that could be formed at the end of meiosis.

(c) There were many excellent genetic diagrams in part (i) explaining the dihybrid genetic cross. Examiners were pleased to see more candidates taking care with the layout of the diagram and the fact that they are matching offspring phenotypes to the correct genotypes. There are still a minority of candidates who use their own symbols for the alleles rather than those given in the stem of the question. Most candidates correctly calculated the expected numbers in table 4.1 and scored the mark for part (i) and the majority of candidates showed the correct working and value for the chi-squared statistic in part (iii). Examiners were looking for reference to the calculated value being below the critical value and that this supported the student's conclusion for the mark in part (iv).

Teaching tip

When teaching problems associated with the different types of genetic cross stated in the specification always introduce students to the chi-squared test as a means of comparing observed and expected data.

5 Examiners reported that the majority of candidates have a good grasp of the biochemistry of respiration. There were many accurate and detailed accounts of oxidative phosphorylation.

(a) In part (i) examiners were looking for reference to decarboxylation being the removal of carbon dioxide and dehydrogenation the loss of hydrogen. Most candidates in part (ii) correctly identified stages P and Q as the sites of decarboxylation in the Krebs cycle.

(b) The majority of candidates correctly stated that one ATP molecule is formed 'per turn' of the Krebs cycle.

(c) When a molecule of acetyl CoA is broken down in the Krebs cycle three molecules of reduced NAD and one molecule of reduced FAD are formed. The correct answers were supplied by the majority of candidates in part (i). Examiners were delighted to see many excellent answers to part (ii). Candidates have a sound grasp of the events taking place in the inner mitochondrial membrane. The most common misconception is that reoxidation occurs in the electron transport chain. Few candidates made reference to dehydrogenase enzymes removing the hydrogen which then becomes split into protons and electrons. Most candidates correctly stated that oxygen is the final hydrogen / electron acceptor and that water is formed.

(d) Candidates were not expected to be familiar with the oxidation of fatty acids. They were expected to use the information in Fig. 5.1 plus the stem of the question to come up with the correct answer. The more able candidates realised that if NAD is being used by enzymes involved in the detoxification of alcohol, less is available for the oxidation of fatty acids. If fatty acids are not being converted to acetyl CoA then fats will be reformed from these fatty acids combining with glycerol.

Teaching tip

Students should be aware that dehydrogenase enzymes on the surface of the inner mitochondrial membrane remove the hydrogen from the reduced coenzymes produced in the respiratory pathway.

6 Success in this question was very much centre based. Some examiners felt that this topic, coming towards the end of the specification, might well have been covered too hastily by some centres.

(a) The majority of candidates were able to successfully match the diagrams in Fig.6.1 with the phases of the action potential shown in Fig. 6.2 and thus score the mark in part (i). In the past, explaining the changes in membrane potential associated with an action potential, as asked in part (ii), has caused candidates considerable difficulties. In this question many made good use of the information in Fig. 6.1 and wrote detailed answers which enabled them to gain full marks. Examiners were pleased to see many candidates referring to voltage gated sodium ion and potassium ion channels in their accounts. Weaker candidates tended to confuse these channels with the sodium/potassium pump.

(b) This section of the question proved to be far more challenging. Answers from weaker candidates were in many cases a copy of what was written in the previous section and they failed to deal with **transmission** of the action potential along an axon. Only a minority of candidates explained how the sodium ions move inside the axon to areas of negative charge (resting potential) a short distance away, thus setting up a local circuit. Only candidates who mentioned this lateral movement of sodium ions were awarded the marking points relating to depolarisation of the adjacent section of the axon. The better candidates provided a good explanation of why the action potential is propagated in one direction only. Most candidates explained that the myelin sheath acts as an electrical insulator and that exchange of ions across the membrane can only occur at the nodes of Ranvier. The fact that this results in longer local circuits was only mentioned by a few candidates. However most candidates made reference to saltatory conduction or described the process.

Teaching tip

Even though the specification refers to transmission of an action potential in a myelinated neurone, to appreciate the role of the myelin sheath and how this structure speeds up the rate of transmission, it is advisable to consider how propagation occurs in a non-myelinated neurone as well.

7 This was the first time that a question had been set on the effect of gibberellins on stem elongation. Examiners felt that it had not been covered adequately in some centres.

(a) In part (i) most candidates correctly stated that a mutation had taken place but few went on to give further detail; for example that this has led to an altered protein or enzyme. Credit was given to candidates who referred to selective breeding from the original dwarf plants. In part (ii) most candidates correctly stated temperature and light intensity as two environmental factors that would need to be controlled although weaker responses mentioned light unqualified and lost a mark.

(b) Many examiners felt that candidates were becoming rushed for time when attempting this section. Many answers were rather sketchy and data quotes from the table were often missing the correct units. Examiners were looking for candidates to realise that the wild type plants showed very little difference in stem growth when treated with the gibberellin. Credit was given if candidates stated that at most stages the plants treated with water were slightly taller. Good candidates pointed out that the data for 18 day old plants was likely to be anomalous. Some weak responses failed to realise that the data for the control needed to be taken into account and thus stated that gibberellin had a large effect on the wild type. Most candidates realised that application of gibberellin to the dwarf plants increased stem length compared with the control plants.

(c) Many candidates realised that the wild type plant produced its own gibberellin or the dwarf plant was unable to produce gibberellin. This response would have gained one mark. Few candidates went on to relate this to the presence / absence of an enzyme involved in the synthesis of active gibberellin.

Teaching tip

When quoting data from a table always state the units.

2805/01: Growth, Development and Reproduction

General Comments

Many candidates were well prepared for the topics within the specification. However, very few candidates were as well prepared for answering questions on synoptic material. Candidates should be aware that 30 of the 90 marks are given for Assessment Objective 4, for which they are required to 'bring together principles and concepts from different areas of biology and to use biological skills in contexts which bring together different areas of the subject'. In this paper, synoptic topics included: respiratory substrates; effects of smoking on the cardiovascular system; the role of membranes; requirement for vitamins in the diet; natural selection.
All scripts were legible and most candidates attempted all the questions.

Comments on Individual Questions

Question

1 (a) This calculation depended on an understanding of the process of double fertilisation. Candidates who realised this generally obtained full marks.

(b) Many candidates were easily able to obtain full marks here. Common errors were to describe the production of the zygote during fertilisation, or to describe the development of the whole seed, rather than just the zygote.

(c) Part (i) was well answered by most candidates. Some candidates still need reminding that energy is released in seeds, not produced. In part (ii) it was disappointing that very few candidates were able to explain that lipids release twice as much energy per gram as proteins or carbohydrates. Just to say 'contain a lot of energy' was not felt to be worthy of a mark.

Teaching tip

In groups, list the ways in which energy is used in different situations:
human fetus, movement across membranes, growth of a child, movement of spermatozoa, germinating seed etc.

2 (a) There were many variations of the 9 + 2 arrangement of microtubules in part (i). Only a small number of candidates correctly drew 9 pairs with one pair in the centre. A fair number of candidates did not understand the meaning of *transverse section*, and drew a longitudinal diagram of a whole sperm.

Although many candidates obtained two marks in part (ii), very few obtained the third mark. This could have been obtained by explaining that mitochondria carry out aerobic respiration to release energy, or that they are closely packed in order to release large amounts of energy.

(b) There were many competent answers, obtaining 6 or 7 marks. The photograph showed spermatozoa on the surface of an oocyte, and the question asked how one sperm penetrates the oocyte. Despite this, a large number of candidates also described capacitation, which mainly occurs in the uterus. Several candidates also described fertilisation after the sperm had penetrated.

(c) A large number of candidates were able to obtain full marks by completing the table correctly. The question asked them to insert a tick or a cross in each box. It was unfortunate that some candidates only completed four boxes, therefore limiting their maximum marks to 2.

(d) It was hoped that candidates would recognise that the protein could bind to a receptor in the ER membranes, so stimulating the release of calcium ions. However, this question was not well answered.

Teaching tip

Practise drawing from micrographs and electron micrographs, annotating the diagrams to show the functions of the structures drawn. Convert drawings of longitudinal sections into transverse sections, and vice versa.

3 (a) Although a few candidates described fertilisation, the majority described pollination correctly in part (i). The table completion in part (ii) was generally well done. Some rather vague descriptions of the relative positions of stamens and stigma were not considered worthy of marks, as they could often be applied to both wind and insect pollinated plants.

(b) Very few candidates obtained all 3 marks for the explanations needed. In each case, the candidates needed to explain why pollen would be more likely to pollinate the stigma of a different plant. To clarify:
(i) the pollen is released before the stigma in a flower of the same plant is mature, but the stigma of a different plant may be mature
(ii) the pollen is likely to be blown by the wind to distant plants
(iii) one flower does not have both stamens and stigma, making it more likely for pollen be carried to the stigma of a nearby plant.

(c) This question was generally well answered. Some candidates wrote about ‘increase in variation’, rather than ’genetic variation’, so missing a straightforward mark.

(d) Structure A is the embryo sac. Incorrect answers included ovule, ovum and ovary. Most candidates drew in a line correctly tracing the route of a pollen tube.

Teaching tip

Examine photographs, specimens and descriptions of a range of flowering plants. Discuss ways in which they are adapted, and whether they favour self- or cross-pollination.

4 (a) Many candidates realised that, as women could be pre-menopausal until 56, or post-menopausal from 43, the menopause could begin between the ages of 43 and 56. A few candidates did not answer the given question, referring to the change in FSH concentration.

(b) As this topic has sometimes cause difficulty in the past, it was pleasing that a good number of candidates gained full marks, by referring to figures, and then clearly explaining the relationship between the two hormones. A few less well-prepared candidates wrote about FSH inhibiting oestrogen after the menopause, not understanding that low oestrogen is caused by the lack of developing follicles.

(c) In contrast to part (b), it was disappointing that so few candidates could explain the relationship between oestrogen and parathormone, leading to the loss of calcium from bones. Candidates were expected to refer to loss of bone mass, or low bone density. The term 'weak bones' is not considered to be worthy of credit.

(d) This synoptic question referred back to the effects of smoking on the cardiovascular system, and it was answered very poorly. There was an easy mark for saying that the risk of heart attacks or strokes was increased, but a surprisingly small number of candidates obtained this mark. A good answer would have been:

'Chemicals in cigarette smoke increase the build up of fatty deposits in the walls of arteries' (1 mark). 'If blood clots occur in coronary arteries' (1 mark), 'they further restrict the flow of blood' (1 mark) 'to the heart, increasing the risk of heart attacks' (1 mark).

Teaching tip

The specifications of 'Human Health and Disease' contain a number of topics that relate to GDR. Spend some time looking through the specifications, listing ways in which health and disease can affect human growth, development and reproduction.
For example:

- Nutrition and its effects on the fetus
- Comparison of gas exchange in the lungs and placenta
- Effects of smoking on the fetus
- Protection against HIV
- Passive immunity passed via the placenta and breast milk

5 (a) The most common correct answer was that stem cells do not have cellulose cell walls.

(b) Most candidates obtained a mark in part (i), usually by indicating that human embryos have a right to life. In part (ii) acceptable medical conditions were those that could potentially be treated using neurones or blood cells. Most candidates gained at least one mark, with common answers being anaemia, sickle cell anaemia and spinal cord damage.

(c) In part (i) most candidates recognised that the twins would be genetically identical.

Many candidates obtained one mark in part (ii) by writing that one twin would obtain more nutrients. Only the better candidates obtained the second mark, by referring to competition for space, disease in one fetus or the different efficiencies of two placentas.

(d) The answers to this question demonstrated clearly that candidates had a good grasp of GDR topics, but were less well prepared for synoptic topics. A good number of candidates across the range gave an accurate description of the effects of alcohol on the fetus, obtaining up to the maximum 4 marks. Only the better candidates obtained the marks on the effects of vitamins. It was common to read very general accounts of vitamins affecting health, but without any specific examples. It was surprising how many candidates think that calcium and iron are vitamins. It was not enough to give the role of vitamins, as the question specifically asked for '*the possible effects on the fetus'.*

The majority of candidates obtained the mark for spelling, punctuation and grammar.

Teaching tip

The potential medical use of stem cells has been much reported in the news recently, with the launch of Richard Branson's stem cell bank. Many websites have articles that could be used. eg http://www.guardian.co.uk/medicine/story/0,,2003502,00.html

6 (a) A majority obtaining 2 marks in part (i) and part (ii) was also well answered.

It was not enough to say that offspring are genetically identical. Candidates needed to explain why this is an advantage; for example, by saying that offspring retain adaptations to their environment.

(b) Several candidates obtained a mark by suggesting a method by which amino acids would be transported across membranes. Only a few good candidates described the hydrolysis of haemoglobin by enzymes.

(c) In part (i) a good number of candidates knew that the error bars were used to show the range of results. Other ways of describing this were accepted. Very few candidates realised that a comparison of the error bars would indicate if the sets of data were likely to be significantly different.

The point in part (ii) was that there was hardly any increase, and that the *P.falciparum* were in the lag phase of growth. Quite a number of candidates tried to compare the two sets of results, though there was clearly no significant difference between the rates of increase.

In part (iii) most candidates were able to quote figures in support of the fact that there was more rapid growth in **A**. Better candidates then went on to explain that there was more ribose in **A**, providing more of this nutrient for *P.falciparum*. They were able to obtain full marks in this way. Disappointingly, no candidates recognised that a lack of ribose in the organisms in B would affect the production of RNA, with consequences for protein synthesis.

(d) The majority of candidates realised that this would prevent movement of water in or out of the cells by osmosis. Many candidates described the possible bursting or shrinking of blood cells (both considered worthy of the mark), but the scientific terms – lysis and crenation – were rarely seen.

(e) A pleasing number of candidates described the natural selection process clearly. Incorrect responses included references to immunity or poor health care.

Teaching tip

Ask groups to research the role of enzymes in a particular area of GDR, and to report back to the rest of the class.

2805/02: Applications of Genetics

General Comments

Among a smaller entry than usual, some candidates had been well prepared for using their knowledge in unfamiliar situations. As in previous years, many of the questions that included synoptic material, which make up 25% of the total marks, were answered less well than those on topics exclusive to this Option. Most candidates answered all parts of all questions and did not appear to have suffered any lack of time. Marks for all questions were spread over a wide range and allowed discrimination between candidates. Technical terms were mostly used correctly, but candidates who misuse the terms *gene* and *allele* put marks at risk.

Comments on Individual Questions

Question

1 Most candidates found this to be an approachable first question.

(a) Most candidates recognised the interaction between the two dominant alleles as epistasis, although some opted for codominance.

(b) The stronger candidates realised that a 9 base pair insertion into the allele would add three triplet codes which could add 3 amino acids to the product or could introduce a stop triplet and shorten the product. Weaker candidates ignored the insertion altogether and wrote answers to questions that were not presented to them.

(c) Most candidates gave correct genotypes for the parents and F1 generation of this cross. The stem of the question said that both parents were homozygous, but a number of weaker candidates ignored this. The ratio of phenotypes was often given as 9:3:3:1 and sometimes as 1:1. Some of the correct ratios did not identify which number applied to which phenotype.

(d) Very few candidates actually wrote that such a population would be a gene bank. However, the reasons for maintaining the population were well known.

(e) There were a number of careless errors in quoting numbers from these simple graphs. Many candidates claimed that as the percentage of white birds in a group increased, so did the damage to feathers, ignoring the last point on the graph.

Teaching tip

Remind candidates that information given in the question is there for a purpose.
Remind candidates that the dominant allele should precede the recessive in a heterozygous genotype, eg Ccli, not cCiI. Also, unlinked alleles should be written CCii and not CiCi.
Warn candidates to look carefully at the scales on graphs.

2 It should not be unexpected, in this Option, to find synoptic questions requiring a knowledge of meiosis.

(a) In part (i) a pleasing number of candidates were able to explain why selective breeding is carried out, writing not only that it was to improve some wanted trait but being more specific in increasing the number of desirable alleles. The weaker candidates missed the clue in part (ii) that the plant almost always self-pollinates. Stronger candidates linked the narrow genetic diversity with this inbreeding. In part (iii). Only the strongest candidates got further than noting that the two species had different numbers of chromosomes. Very few candidates pointed out that the 3n hybrid would be sterile because of the failure of meiosis.

(b) The main steps in cloning plants using tissue culture were well known to many candidates. A few described taking stem cuttings.

(c) Most candidates chose one of two advantages of genetic engineering over selective breeding: the quicker outcome compared with the numbers of generations involved in selective breeding or the ability to add one trait rather than dealing with the whole genotype. The suggested disadvantages concentrated on ethical undesirability and rarely described what might be undesirable.

Teaching Tip

Revise meiosis before starting this Option.
Remind candidates that 'describe' requires some descriptive detail.

3 A pleasing number of candidates were confident in their knowledge of artificial insemination, but had forgotten that amino acids have R groups with different characteristics.

(a) A very small number of candidates in part (i) realised that the protein that was added to the membrane must have amino acids with R groups with negative charges. For a few candidates in part (ii), white blood cells triggered a memory of the immune response and the possibility of attacking haploid gametes as foreign.

(b) Most candidates knew in what conditions sperm are stored.

(c) Some good answers were seen to this question, but some candidates whose spelling was competent, threw away the mark for quality of written expression (QWC) by using bullet points that were phrases rather than full sentences.

Teaching tip

Point out to candidates that in an answer involving extended writing it is possible to use bullet points, provided that each bullet point, or entry in a table, is a full sentence.
Point out to candidates that starting a question such as (c) with "There are a number of advantages and disadvantages of artificially inseminating livestock" is a waste of time and of three lines.
Remind candidates that in an Option involving genes and their mutations, synoptic questions could easily involve understanding the effect of amino acid structure on the properties of a protein.

4 Many candidates coped well with the unfamiliar data in Table 4.2, but some seemed to plunge into answering the question without reading the information provided.

(a) A pleasing proportion of the candidates were familiar with the harmful effects of inbreeding.

(b) Almost every candidate scored full marks on Table 4.1 in part (i). Stronger candidates realised in part (ii) that the variation was discontinuous, because it related to a single locus and produced discrete phenotypic classes. Weaker candidates tended to write: "It is continuous variation because there are a number of different alleles so it is polygenic".

(c) A pleasing number of candidates deduced that the enzyme was at least partly responsible for self-incompatibility in the field poppy, pointing to the decrease in activity, for S1 pollen grains, in the presence of inhibitor. Only a few candidates suggested that the enzyme was activated when the pollen was incompatible.

A significant number of candidates failed to take any notice of the word 'inhibitor'.

Teaching tip

Encourage candidates to make their own glossary of terms for this Option to help with differences such as between genes and alleles or, in this case, multiple alleles and polygenes.

5 The evolution of antibiotic resistance in bacteria was well known by a pleasing proportion of the candidates. However, careless reading of graph axes reduced the marks that could be given to some candidates.

(a) Weaker candidates tended to write only about increased resistance in part (i), sometimes noting the fall in 1994. Stronger candidates commented on the non-coincidence of the peaks of antibiotic use and resistance. The best candidates quoted accurate figures. In part (ii) many candidates could describe mutation and vertical transmission followed by horizontal transmission. 'Conjugation' appeared as 'conjugulation' more than once.

(b) In part (i) most candidates gained at least one mark for their knowledge of restriction enzymes, although candidates should avoid saying that they 'break down' DNA, suggesting wholesale destruction rather than a cut at a specific site. Again in part (ii), the formation of recombinant DNA was well known by a large proportion of the candidates. A common error was to involve DNA ligase in the hydrogen bonding of complementary bases rather than in sealing the 'nicks' in the sugar-phosphate backbone of DNA.

Teaching Tip

Revise the structure of prokaryotes before starting on the evolution of antibiotic resistance in bacteria so that candidates realise that bacteria do not undergo mitosis.
Revise the structure of DNA before introducing restriction enzymes and recombinant DNA.
Remind candidates to quote from the numerical data given.

6 A few candidates were unfamiliar with cystic fibrosis and described a variety of other conditions.

(a) More than one candidate described the symptoms of cystic fibrosis in detail and wrote only one sentence about gene therapy. Another confused gene therapy with genetic counselling.

(b) Some candidates in part (i) found it difficult to express themselves, writing "The embryo only has allele 2" which could mean that the embryo has just one allele, rather than being homozygous for allele 2. The stronger candidates in part (ii) realised that if allele 2 moved further in electrophoresis than allele 1, then it was the shorter fragment, consistent with it having a deletion.

(c) Correct answers of 0.25 were almost equalled in number by 0.5, with a few other suggestions as minor players.

Teaching tip

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 relevant terms.
Explain to candidates that whilst it is important to write enough detail to make an answer clear, there are no marks for repetition.

2805/03: Environmental Biology

General Comments

Overall the candidates performed well in the paper. Candidates were able to answer parts of each question set and there was no one area that was universally poorly attempted. Both long response questions were answered but sometimes lacked adequate detail.

The basic recall from AS and central concepts units was generally well done but many candidates found it more difficult to explain environmental science when presented in a different context.

For the questions involving the use of data and graphs, candidates performed well and used the data accurately and appropriately. There has been an improvement in responses to this type of question.

Comments on Individual Questions

Question

1 This was one of the weaker sections of the paper. There was much misinterpretation or lack of understanding – particularly about DDT.

(a) Candidates were required to describe and explain the effects of DDT use but very candidates were able to do so. Many correctly discussed the lipid solubility of DDT and the subsequent effects on egg shell thinning and food chain bioaccumulation, but several candidates, wrongly, went on to describe DDT leading to eutrophication.

(b) Most candidates scored 1 mark here with very few commenting on the fact that DDT is still used extensively in other countries. Responses concentrated on the persistence of DDT in food chains and many candidates re-worded responses to part (a).

(c) This question was generally well attempted and most candidates identified that farmers would want to increase yields and so remove competing weeds. There were no responses as to the validity of the data or whether four pesticides represented a good study sample to compare insecticides with herbicides. Furthermore, few candidates described that the difference in usage could have been due to the decreased specificity of herbicides compared to insecticides.

(d) In this question most candidates clearly identified tau-fluvalinate as the most toxic insecticide, as less of the active ingredient is needed in application. Most responses involved correct use of data and units.

(e) Most responses to this question were poor with very few candidates scoring maximum marks. The descriptions into the effect of nitrates on the oxygen carriage of haemoglobin in babies were well done. Many candidates continue to incorrectly describe the link of nitrates to stomach cancer. There is no scientific evidence to link nitrates to raised levels of stomach cancer. The responses to the effect of nitrates on algal growth continue to be mixed with candidates still not understanding the link to algal growth, bacterial decomposition and reduced aquatic oxygen levels.

Teaching tip

Students could extend their knowledge and understanding of pesticide usage and implications on the environment by using the http://www.pesticides.gov.uk/. Defra also has a very easy to access web site which contains up to date information regarding pesticides and nitrates. Pest Control by H.F. van Emden is a very detailed account of all aspects of pesticide use and application and is worth acquiring for the school library as a good reference guide for sixth form study.

2 The animal sampling section was often well covered, but the extended writing section tended to lack sufficient detail.

(a) Most candidates calculated the moth population using the Lincoln Index but many failed to give the answer to the nearest whole number. This is important when discussing the predicted populations of organisms as they tend not to exist as fractions!

(b) Marking moths for a mark and recapture experiment needs to involve a type of paint, such as a cellulose based paint so as not to damage the organism. Credit was given to candidates who correctly identified that the marking needed to involve a non-harmful paint and most described the use of ultra-violet paint. Few candidates discussed exactly how to mark the moths or reference to where the paint was to be placed. In such experiments it is essential to mark an organism in an inconspicuous place which would prevent the organism becoming more likely to suffer from increased predation.

(c) This question was well attempted by most candidates with most describing at least three assumptions regarding the Lincoln Index. This would seem to be a well taught aspect of sampling techniques.

(d) Candidates struggled to give sufficient detail on how to investigate the abundance and distribution of willowherb. Firstly is important to stress that willowherb is a stationary plant and so mark and recapture or the use of nets and light traps would be an inappropriate sampling technique. To study the abundance and distribution of willowherb it is important to grid the area in question and sample it systematically. This could have involved using various transects and quadrat analysis. It would not involve random sampling or the use of random number generators.

Many correctly identified the need for using keys and described how kite diagrams would be used to analyse the data obtained. There did appear to be clear evidence from a few centres that field work had been carried out and that sampling techniques had been thoroughly revised.

Teaching tip

Students should be encouraged to carry out the sampling techniques described in the text and in the specification.
There is a very good web site, http://www.offwell.free-online.co.uk/what_method.htm which allows students to decide on and work through types of sampling technique. The specification states that students should understand how populations could be sampled and it is important that such techniques are practised. This does not need to involve using field study centres as school grounds can be successfully sampled using transects and quadrats.

3 (a) For this question candidates only needed to describe the key features of extensive livestock production, but many attempted to explain these and also to compare with intensive production. As a consequence this question was poorly done. Extensive agriculture occurs over large areas of unproductive land whereby inputs from the farmer are kept to a minimum and yields are generally low.

(b) Candidates scored highly here with most correctly identifying the steep rise in cattle deaths from 1988 -1992 and the sharp decline from 1992 – 1997.

(c) This question involved candidates explaining the term epidemic with reference to cattle and BSE. Most only scored 1 mark here with many candidates going on to explain the term pandemic and endemic. The key is that it is a disease affecting larger numbers of individuals spreading rapidly through a population. A pandemic involves a disease spreading across larger geographical areas and endemic refers to a disease always present in a population.

(d) Most candidates correctly identified the need to remove infected cattle from the food chain and so as to avoid human consumption but very few identified the cull as a way to reassure the general public. One of the key aspects of the slaughter of cattle was to offer reassurance to the public and thus to preserve the beef industry.

(e) Candidates were able to explain clearly how grazing maintains a deflected succession and there were some very good responses here. Named examples were given of the subsequent climax community that such grazed grassland would develop into.

Teaching tip

The following information at http://ec.europa.eu/agriculture/publi/fact/envir/2003_en.pdf is an excellent account of modern agriculture and the European Union. The Defra home page has many links to information on agricultural practices and information for farmers who farm in upland areas with reference to hedgerow planting.

4 Although a few candidates appreciated the principles and practice involved in seed banks, zoos and botanic gardens, there were many weak responses.

(a) Many candidates did not seem to understand the difference between genetic viability and variability or their importance. Viability refers to how well the seeds will survive and pass on their genetic information and variability refers to the mixture of genotypes of the seeds enabling the success of future generations. Most responses described the cold storage and freezing of seeds to ensure viability, but very few discussed the need to repeat the process at intervals by germinating the stored seeds, collecting new seeds and freezing them.

(b) This question was poorly done because very few candidates appeared to understand the term variability. Seed banks maintain variability to ensure that disease resistance genes are present and that, through the process of artificial selection, crops could be improved and help prevent the extinction of species.

(c) Candidates correctly explained that the need for drying prior to seed storage was to prevent the germination process and for the prevention of rot and disease. Several answers were very detailed and included information regarding the action of water on seed enzymes and hydrolysis of food stores. There was a pleasing level of recall from the central concepts topic on homeostasis.

(d) Candidates answered this question poorly with very few identifying the management problems associated with zoos and botanic gardens. Management problems are not the same as problems associated with the actual process of breeding carried out in zoos or the return of species to the wild. Management problems refer to funding, species and genetic resource ownership, how many animals or plants are to be caught and how they are to be caught. Candidates did not read the question carefully and as a result produced a very detailed account on what problems zoos face in returning species back to the wild which was not what the question asked for. Furthermore, very few identified crop improvement as a need for success and the possible benefits of artificial selection.

Teaching tip

Students would be wise to investigate http://www.rbgkew.org.uk/msbp/index.html which is full of information regarding every aspect of seed bank biology and management. There is also information on organising school visits. The book, Biological Conservation by I.F. Spellerberg and S.R. Hardes is an invaluable resource for teachers and students on all matters to do with the conservation of resources. It's text is very accessible text should appeal to inquisitive sixth form students with an interest in conservation. Furthermore, students should be encouraged to use the web sites of zoos such as, http://www.jerseyzoo.co.uk , which contain often detailed information regarding the conservation of animal species.

5 This question proved accessible to many candidates.

(a) Most candidates understood what was meant by the term 'wildlife corridor' and many described these as sites of refuge or retreat for species to avoid predation or to find food.

(b) To score marks in this section candidates needed to describe and explain the changes in the two populations. For example, a candidate might have stated that there was a rapid decline in aphid populations from 4 – 7 weeks as a result of predation. This was generally well done by most candidates although many did not make sufficient references to the data to obtain maximum marks.

(c) Most of the responses for this question regarding disadvantages of biological control involved descriptions of time lags and the predators becoming the actual crop pest. Overall this was well done with most candidates scoring full marks in this section.

(d) In this question very few candidates scored both marks. Many discussed the effect upon pollinators and also the possible reductive effects on biodiversity. Maintaining invertebrate populations is not essential as a source of fertiliser for farmers' fields and this explanation cropped up in scripts from many centres. The key answers involved pollination and biodiversity.

(e) This section was generally well done with candidates clearly understanding the economical advantage to the farmer of growing and selling organic produce. Most identified the health benefits associated with organic produce and linked this to a reduction in pollution and the associated wildlife benefits. Inorganic pest control does not lead to eutrophication as was described by many candidates and the 'feel good factor' of organic crops may well be a good marketing slogan but is not a direct advantage of organic farming. Furthermore, references to perceived improvements in taste and flavour of organic food are also not advantages of organic farming per se.

Teaching Tip

Ecology by M. Begon, C.R. Townsend and J.L. Harper provides a very detailed and scientific explanation of predator – prey relationships regarding biological pest control and is worth consideration. There is also excellent information and links provided from the Soil Association at http://www.soilassociation.org/web/sa/saweb.nsf?Open. Leaflets and data sheets can either be downloaded or purchased to be used as teaching materials.

6 (a) Most candidates were unsure as to how technological advances in fishing could have increased the catch sizes landed. Key to the success of modern fisheries is the improvements in shoal detection through the use of sonar (not radar!), the use of drift nets and the advanced processing capabilities of vessels. It was important that responses were quantified and it was not enough to simply make reference to larger net size. The advancements in fishing have come about through net design and not simply net size.

(b) This suggest question was well attempted with many responses focussing on possible quotas, overfishing or the likelihood of a disease as possible explanations for the decline in fish stocks during the 1990 – 1991 season.

(c) Candidates struggled with this long response question and very few links with AS material were made. The ecological effects of overfishing should have focussed candidates onto food chains, webs, biodiversity and the disruption of ecosystem structure. Very few examples were given, such as cod fishing in the North Sea which is an example described in considerable detail in one of the recommended text books. Overfishing will also disrupt the abiotic components of an ecosystem and constant removal of species will lead to a depletion of vital nutrients needed to ensure ecosystem structure is maintained.

(d) Responses were pleasing here with most candidates describing at least one aspect of a quota system correctly. It was clear that most centres had studied this area of the specification and candidates could apply their knowledge to new situations.

(e) The final question on the paper was done very poorly by most candidates with very few seeming to answer the problem asked. Outlining the factors that needed to be considered when setting up a fish farm was intended to get candidates thinking about the potential environmental problems of fish farms on the local ecosystems. These might include the threats of pollution, disease and escapees and how these could be potentially avoided. Candidates should have been aware of these issues as this topic area is in the specification and it was disappointing to see very few candidates scoring more than 1 mark for this question.

Teaching tip

There is considerable information regarding all aspects of fisheries and aquaculture at http://www.scotland.gov.uk/Topics/Fisheries/Fish-Shellfish. Information is provided at http://oceans.greenpeace.org/en/our-oceans/overfishing and this includes data and research material on all aspects of fishing. Ecology by M. Begon, C.R. Townsend and J.L. Harper also contains very informative accounts of food web interactions and the effects on biodiversity as a result of species loss.

2805/04: Microbiology and Biotechnology

General Comments

Many candidates were well prepared for this examination, displaying a sound understanding of the subject matter and providing answers that were complete and to the point. Using past paper questions and mark schemes is an invaluable learning and revision resource for most candidates and there was evidence that some candidates had used these to their advantage. There were instances where knowledge of a previous mark scheme had been used to answer a question that had been asked from a different angle and required an answer that showed application of knowledge, for example Q.1 (b)(ii) and Q.2. Some candidates were more skilled than others at using the information given in the introduction to a question and other stimulus material to provide an appropriate answer. When approaching exams, candidates should consider the variety of ways that a topic could be tested and should also be prepared to draw together strands of information from areas within the option as well as from elsewhere in the specification. The synoptic knowledge required from Central Concepts (for example in 5.4.1. Respiration and 5.4.3 Populations and Interactions) was considerably better displayed than from the AS specification (for example 5.1.1 Biological Molecules and 5.1.4 Cell Membranes and Transport). Generally, the extended answers were well written but throughout the paper there were numerous examples of incorrect spellings of scientific terms, which seemed even more apparent than previous sessions. There was no evidence that candidates had run out of time.

Comments on Individual Questions

Question

1 This question proved to be accessible for all candidates but was also a good discriminator. There were very few scripts that had left whole sections blank and a number that were able to score 17 or more marks.

(a) Part *(i)* was intended to prompt candidates to draw information from various sections: Microbiology; Large-scale Production and Biotechnology in Food Production and Biotechnology in Industry and Public Health. There were many that scored 7 or 8 marks, giving correctly spelt species names and extra details for the type of microorganism, for example unicellular fungus and yeast. At the other extreme, there were some candidates who did not understand, or were confused with, the column headings. 'Mycelium' appeared in both the '*type of microorganism*' and '*starter culture*' columns on a number of occasions, as did 'yeast' in the '*product*' column. 'Mould' was not accepted for 'fungus'. Common frequent mistakes included the belief that *Saccharomyces* is a bacterium and/or it is used in the production of cheese and that yogurt uses glucose as the sugar source and is produced by continuous fermentation. Where possible, credit was given for close incorrect spellings of the two starter cultures, for example, *Penecillium*, *Pennicilium* and *Fusareum*, but it should be noted that at A Level correct spellings of scientific names are expected. *Penicium*, *Fungarum*, *Fusiurm* were examples of rejected answers. 'Continous' fermentation appeared in a large number of scripts. Part *(ii)* took most candidates by surprise and most answers exclusively referred to the use of microorganisms in biotechnology, which was not quite answering the question. Weaker responses included: technology using biology; using machines; using fermenters or using aseptic techniques. Only a handful of candidates showed a complete understanding to provide some very full explanations.

(b) Part *(i)* was well known by most, with only some candidates incorrectly assuming that an autoclave could be used for all fermenters or that fermenters should be heated to high temperatures. In *(ii)*, the provision of oxygen for aerobic respiration was commonly correctly stated as was mixing the cells with nutrients. As always, incomplete or imprecise answers, such as 'mixes the contents', 'as oxygen is essential for survival', 'air creates aerobic conditions', were given. There were some good examples of candidates not checking their answers for obvious errors, such as 'mixes cells with *products*' and 'oxygen for *anaerobic* respiration' as well as some unsettling answers such as 'air provides energy' and 'air inspires growth'. 'Respirating' organisms was also seen. In *(iii)*, the best responses gave most of the points considered on the mark scheme and confirmed that some candidates had a thorough understanding of the fermentation process and were able to qualify their statements. Some candidates thought that they were being asked what they would do if contamination occurred or how contamination had occurred, which suggested a lack of understanding of the term '*consequences*'. Vague answers such as 'product….not produced properly / not as wanted' and 'stops it from doing its job' were not credited. There were also many instances of 'effects' instead of the correct 'affects' and poorly considered answers where 'pathogens form' and 'nutrients / products die'.

Teaching tip

Candidates could be set an assignment to write a short paragraph or give a short presentation explaining how the examples covered in the specification could be considered as examples of biotechnology. This could be a differentiated activity with weaker candidates being given the most obvious examples and stronger candidates extended further by being asked to provide additional non-specification examples. It would also serve the purpose of familiarising candidates with the specification.

2 Although the full range of marks was obtained for this question, only the most able candidates earned 15 or more out of the maximum 20. A recall of, and ability to draw from, synoptic knowledge of population growth curves (*Central Concepts*) and the roles of inorganic ions (*Biology Foundation*) was required as well as an ability to assess the validity of experimental techniques and data. A number of candidates made reference to *Chlamydomonas* as a bacterium or as a plant, despite being given the prompt that it was a unicellular alga. Algae are covered in this option (protoctists) and in *Central Concepts* (classification).

(a) A number of candidates found part (a) to be very challenging and this was probably owing to a difficulty in recalling and then applying AS knowledge. There were numerous incorrect suggestions for *(i)*, such as broth, agar, non-complex and artificial. In *(ii),* many candidates ignored the instruction to give **one** role and listed a number of possible roles. Only the first answer of the list was credited. The extent of many answers simply stated that 'it provides nitrogen / sulphur / magnesium / phosphorus', with some going on to give vague qualifications such as 'for growth / healthy functioning / give it the green colour / give strength'. Usually a correct role for ammonium nitrate was given but a common answer was to assume that it provided nitrogen for fixation. There were also indications that candidates had forgotten that the salts were in the growth medium for *Chlamydomonas* and there were other suggestions, including using potassium for penicillin purification. For magnesium there were also some incorrect references to leaves and photosynthesis.

(b) There were some very detailed and knowledgeable accounts of turbidimetry given by a number of candidates, who had clearly carried out experiments with colorimeters. The best answers were clear in their distinction between the main culture in the flask and the samples that were removed, understood the use of a reference (blank) and a filter and gave sequential accounts with good descriptions. Using distilled water in the reference cuvette, rather than the culture medium without organisms, was a common mistake. An incorrect spelling of 'colorimeter' was all too frequently given: colourimeter, colorometer, coloremeter, coliromiter. There was a similar problem with cuvette: curette, curvette, covet, or it was described as a 'square test tube'. More confused accounts gave the impression that all the culture was placed in the cuvette or that the mixing occurred once the sample was in the cuvette. Some volumes used in the cuvettes (for example $1cm^3$) would not have given reliable readings. Some candidates thought that the light source, which was present to allow photosynthesis, was concerned with the absorbance reading. There were instances of a lack of use of scientific terminology and references were not made to absorbance / transmission / optical density but rather to 'how much light gets through'. A description of how to obtain a calibration curve to ascertain numbers of cells was not required as the question only asked candidates to describe the procedure used by the student to obtain *turbidity* measurements. Some candidates had prepared for dilution plating or haemocytometry and gave confused accounts of these methods.

(c) Most candidates were able to gain at least one mark and the Examiners saw the range of expected answers.

(d) Candidates were able to pick up marks in part (d) as most appeared to have a good understanding of population growth curves. *(i)* was almost always answered correctly. In *(ii)* and *(iii)*, a lack of precision led to marks being lost. Stronger candidates gave a good description and explanation of the deceleration phase leading to the stationary phase. Statements such as 'the *graph* levelling out', 'algal growth' and 'birth rate equalling death rate' were not credited. There were also irrelevant references to secondary metabolites and incorrect responses that considered the stationary phase to mean a time when the nutrients present balanced the waste that was produced. There were few attempts to extract data from the graph and it was rare for candidates who did quote figures to correct read the 1.12 au value for turbidity during the stationary phase. Most gave this as 1.1 or 1.05 au. In *(iv)*, candidates did not appear to use the initial information given about sampling times to realise that more readings should have been taken during the deceleration phase, in order to gain a more correct estimate of the onset of the stationary phase. However, a number gained at least one mark for realising that it was not possible to distinguish between living and dead algal cells with turbidity values.

Teaching tip

Population growth curves (covered in Populations and Interactions in Central Concepts) that are seen in text books do not usually show the individually plotted points and so many candidates do not easily relate measurements taken to a constructed growth curve. In practising skill A of the practical component, candidates could be asked to construct their own curve for various examples, with data to plot so that the range of possible time units and population growth measurements is appreciated. Examples are:

- number of viable cells
- haemocytometer counts
- turbidity readings
- biomass measurements
- mycelium diameters.

3 This question required candidates to consider all the topics covered in Biotechnology in Medicine. For this reason, the completed crossword provided useful stimulus material that would help candidates to think in a more diverse way. It was pleasing that there were many high scores for this question. With a lack of careful thought or reference back to the intention of the question, it was very easy to lose marks in all sections of this question and some candidates ended up with low scores for this reason.

(a) The majority of candidates were well prepared and were able to cope with *fusogen* and *hybridoma*, although a few made the mistake of binding antibodies or T-lymphocytes to myeloma cells or fusing antigens with antibodies. Some thought that fusogen was an enzyme. Candidates were less knowledgeable when dealing with *clone* and wrote about clones being identical antibodies. Many failed to link their answer to *monoclonal antibody production* as requested and consequently there were numerous references to genetically identical individuals or microorganisms and gene cloning.

(b) Nearly all candidates selected transducer for (i), with a few incorrectly giving 'biosensor', which did not appear on Fig. 3.1. In (ii), candidates who had fully digested the clue, correctly selected *phage* as both a vector and a contaminant. Many candidates opted for plasmid.

(c) Candidates were expected to approach two areas of biotechnology in medicine by using a common link. For the more able candidate, this proved to be a straightforward exercise and full answers were provided. The mark scheme allowed candidates to gain maximum marks by writing about one *or* both of the two areas in *(i)* and *(ii)*. There were numerous references to immobilised enzymes in pregnancy testing kits despite the information given and many candidates gave confused answers. However, there was more confidence with glucose biosensors and generally a good knowledge of this topic was evident. There were some in *(ii)* who thought that glucose biosensors tested *urine* to give blood glucose levels and others who referred to glucose biosensors detecting diabetes. Some candidates attempted in the space available to write an extended answer about insulin production, which was not required. There were a number of examples of careless mistakes or poor preparation: restriction enzyme used to cut out the insulin gene which is grown in a fermenter; the diabetes gene placed into *Escherichia coli* to make insulin; plasmids combine with insulin; in genetic engineering, insulin is extracted from the pancreas; plasmids can be 'insulted' to make drugs.

(d) This was usually well done with many clear and concise answers. Sadly, some went off task and gave advantages from across the rest of the specification, so there were incorrect references to food and antibiotic production in addition to some who wrote about the advantages of immobilised enzymes.

Teaching tip

Prepared cards with terms and short statements that all link to Biotechnology in Medicine would make a variety of short class exercises. The same set of cards could be
sorted into groups according to the areas covered
used to match terms with definitions
placed into a suitable sequence for each topic

4 This question required candidates to use knowledge and understanding from many areas, including the AS specification. A wide range of marks was obtained, with *(a)* helping most to gain their marks and *(c)* proving to be very challenging for many.

(a) This was the more popular of the two extended answers, with all the available mark points seen and with many candidates gaining a well-deserved maximum 9 marks. Here, there were some very full, fluent and well organised accounts that answered the question, which asked candidates to include explanations of fermenter design as well as downstream processing. The best answers specifically related their points to *penicillin* production. Some wrote at length about the principles of batch culture and the production of secondary metabolites while others gave very general accounts of fermenter designs and descriptions without explanations. A common error was to suggest the use of probes to *control* rather than to *monitor* conditions. There were a number of incorrect statements that related to mycoprotein production and its downstream processing. Most candidates were able to gain the mark for quality of written communication.

(b) A good proportion of candidates correctly described or identified a zone of inhibition and then gave sufficiently detailed answers of the differences in effectiveness with the two bacterial types to gain three or four marks. There were not many who correctly wrote about diffusion of the antibiotic through the agar. A number thought that the fungus killed or inhibited the bacteria and failed to state that the mycelium had released an antibiotic or antibacterial substance. Some candidates incorrectly used the term 'resistance' or 'resistant' bacteria and did not gain a mark as resistant bacteria would have exhibited growth up to the edge of the mycelium. There were other answers seen where incorrect deductions had been made and here there were references to competition, depletion of nutrients and the inhibition of fungal growth by the bacteria.

(c) This proved to be more demanding for candidates, many of whom could not make the connection with AS topics. The information given proved to be difficult for many to digest, possibly because it was a written passage rather a series of diagrams. There were only a handful of candidates who were able to gain all the available marks. The first statement proved to be straightforward for only those candidates who realised that the penicillin was acting as an enzyme inhibitor. Many candidates simply repeated the second statement to gain no marks whereas others realised that they needed to include reference to the influence of penicillin on the formation of a bacterial *cell wall* and the lack of any effect on a fully formed cell wall. There were many incorrect accounts of the events leading to osmotic lysis. A good proportion of candidates thought that there was no longer a cell wall present whereas others wrote about water *leaving* the cell. There were disappointing answers to this synoptic aspect. The most common incorrect answer for the last statement was to state that Gram-negative cells had no murein in their cell walls or that the smaller proportion of murein would lead to less of a problem with penicillin. Where candidates had recalled the additional complexity of the lipopolysaccharide layer in Gram-negative cells, they were able to provide good explanations of the ineffectiveness of penicillin.

Teaching tip

http://helios.bto.ed.ac.uk/bto/microbes/penicill.htm - "The Microbial World: Penicillin and other antibiotics". This is an informative website which gives extra information on the areas covered in *Q.4*, as well as interesting information about other antibiotics, the emergence of antibiotic resistance and the use of antibiotic resistance in genetically modified crops.

5 This extended answer question was intended to be accessible to all candidates and the mark scheme designed to allow for a range of different answers. There were a number of excellent precise and sequential accounts that specifically related to the role of various named microorganisms and enzymes in cheese production. References to the use of genetic engineering to produce chymosin were also seen. Candidates who were well prepared but less selective were able to gain maximum marks but would have lost valuable time writing about the pre-fermentation process, the handling of the curd and the different types of cheese, all of which were peripheral to the question. Almost all candidates were able to display some knowledge to gain at least three or four of the total nine marks. At times answers strayed into the production of yoghurt but here candidates were given the benefit of the doubt and earned the mark points that are common to both fermentation processes. It was hoped that candidates would have been able to name some of the microorganism *species* that are involved in cheese production as well as describe some of the enzymatic changes that occurred to give cheese its overall flavour. Where this was done, it became much easier for candidates to gain the mark for the use and organisation of scientific terms.

6 This question often provided the most disappointing responses and in a few cases was left blank. Here there was no evidence that candidates had run out of time as generally for these candidates the rest of the paper was not fully completed. It was based on learning outcome *(c)* in 5.8.6, which expected candidates to be able to carry out an experiment that made use of immobilised enzymes. It also expected candidates to apply knowledge and understanding from AS Biological Molecules and surprisingly this proved to be one of the most demanding questions on the paper.

(a) The Examiners were prepared to accept all reasonable versions of this experiment in order to cater for the differences in approach of different centres, but were not prepared for the huge variation in answers that were seen. The quality of diagram drawing varied enormously in *(a)*. Some candidates produced almost perfect text book diagrams, drawn with care and skill (for example, a column packed with equal sized beads, all features well labelled), which was satisfying to mark. This was in contrast to those that that displayed a complete lack of diagram drawing skills, with no evidence of use of a ruler, correct label lines and labelling. Although many candidates were able to gain the maximum 4 marks, this was a question that would have benefited from marks also being allocated to the quality of the diagram. Some candidates had not read the question and attempted to draw industrial set-ups for lactose-reduced milk, whereas others produced a diagram labelled for using immobilised amylase and starch solution. Quite a number wasted time by drawing diagrams of all the stages in the production of the immobilised enzymes. A handful of candidates missed the point completely and produced diagrams ranging from microbiological techniques (for example preparing and inoculating Petri dishes) to a fairly well drawn diagram of a cow releasing milk into a bucket!

(b) The mark scheme allowed for any reliable method that could be used to detect that lactose had been hydrolysed and despite being given helpful information, was left blank by many candidates. For those that attempted an answer, the majority did not score any marks and it was rare to see a good answer. Many realised that Benedict's reagent could be used, but failed to state that the test solution should be boiled (or heated above 70 ^{o}C) and either just stated that Benedict's should be added or the solution warmed or heated. Most thought incorrectly that the milk (with lactose) would give a negative result. For those candidates who realised that a biosensor specific to glucose, or Diastix or Clinistix could be used, one mark only was usually awarded because of a failure to go on and state what result would be obtained.

Teaching tip

Revise biochemical food tests and their applications!

The National Centre for Biotechnology (NCBE) has a protocol for the practical activity in this question. See Better milk for cats:
www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/PRACBIOTECH/bettermilk.html

Also appropriate here is Yeast cells and enzyme in the NCBE's Practical Fermentation – available from:
www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/fermentation.html

2805/05: Mammalian Physiology and Behaviour

General Comments

The paper was of appropriate difficulty and comparative to previous papers. Most candidates attempted each part of every question. They had sufficient time to give full responses to each question, there was no misinterpretation of rubric and no parts were consistently left blank. However, question 4 was poorly attempted by many. It was disappointing to see a drop in the quality of spelling, especially of biological terms – in particular, carnassial, biceps and triceps.

Comments on Individual Questions

Question

1 This question provided a fairly easy introduction to the paper. The emphasis was on straightforward recall, allowing most candidates to score reasonably well on each part.

(a) In part *(i)*, most candidates stated that the canine teeth would be used by the cheetah to bite, and to hold and kill its prey, although incisors were occasionally mentioned. In *(ii)*, while many candidates were also able to name the carnassial teeth, the term was frequently miss-spelt. Their role in consuming prey was generally well understood, with good descriptions of their slicing or scissor-like action, enabling meat to be cut into smaller pieces ready for swallowing. Many correct references to the crushing or cracking of bones were seen although some candidates suggested that these teeth would be used for grinding, which was not credited.

(b) The mark scheme enabled candidates to explain the need for panting in a number of ways, although most responses concentrated on processes occurring within the muscle during and after the chase. Many candidates described the generation of an oxygen debt following anaerobic respiration and the accumulation of lactic acid. However, while most appreciated that the lactic acid would have to be removed or metabolised, there were relatively few references to its oxidation back to pyruvate. Some candidates approached the question by stating that panting would cool the cheetah, often giving further detail of the effect of evaporation of saliva from the tongue in aiding heat loss. Few commented on either the re-oxygenation of myoglobin or haemoglobin, or the regeneration of muscle ATP / creatine phosphate stores. A few mentioned CO_2, but none emphasised that it would be extra CO_2, and so missed this mark point.

(c) Although the stem of the question stated that Figure 1.2 illustrated the front leg of a cheetah, a number of candidates named the bones of the hind limb in answer to part *(i)*. Better candidates correctly identified the bones shown although there was occasional confusion between the ulna and radius. In *(ii)*, most candidates were able to describe at least one role of both ligaments and cartilage at synovial joints. A common error was to confuse ligaments with tendons, and the importance of ligaments in providing high tensile strength and flexibility at joints was frequently overlooked. Far more comprehensive responses were seen for cartilage and there were many references to its smooth or slippery properties and its function in allowing frictionless movement thereby preventing wear-and-tear at bone surfaces. Some candidates thought that it would provide lubrication at the joint.

Teaching tip

Have skulls with dentition available to demonstrate the articulation of the jaw and the action of teeth. Allow students to handle the material.

2 The synoptic parts of this question proved to be difficult for some candidates. It should be noted that some of the synoptic material involved is reviewed in recommended texts for this unit.

(a) The factors involved in formation of cancers were understood, in principle, by most candidates, although some neglected to provide sufficient detail for the award of marks. Unqualified references to mutation or cell division/multiplication were not credited. However, many candidates recognised that a tumour would form and that metastasis could ensue. Many also mentioned that carcinogens would initiate the process, or supplied a suitable example. There were surprisingly few references to oncogenes although some candidates offered good additional information, for example that tumours may develop in the blood and lymph.

(b) While many candidates were aware of the structural changes that would occur in the liver of a person suffering from cirrhosis, some made the mistake of describing physiological symptoms. Most commented that hepatocytes would die and be replaced by fibrous tissue, resulting in the loss of lobular structure. There were some very good descriptions as to how the blood supply would be disrupted and references to the deposition of fat within hepatocytes were frequent (although 'fatty liver' alone was not credited). There was little mention of either inflammation/hepatitis or nodule formation.

(c) The graph illustrating the trends in mortality due to liver cancer and cirrhosis from 1985 to 2001 was generally well interpreted and the vast majority of candidates gained a mark in part *(i)* for commenting that the number of deaths per year declined for cirrhosis while those for liver cancer remained fairly constant. Errors in the expression of the units were common, and some candidates failed to identify years for the figures quoted. Some candidates unnecessarily attempted to describe the small changes occurring in the data for liver cancer. Almost all candidates were able to offer a suitable suggestion in part *(ii)* as to why the number of deaths per year for cirrhosis had decreased. Many commented on public awareness of the danger of excessive alcohol consumption while others recognised the advances in medical treatments for the disease. References to liver transplants did not gain any credit as this is not an option available to most of the population.

(d) In part *(i)*, substances **A** to **D** were generally either all identified correctly or not at all, although occasionally the responses to **C** and **D** were the only correct ones. In *(ii)*, there were some excellent descriptions of the role of thrombin (**B**) in catalysing the removal of a small chain of amino acids from fibrinogen (**C)**, allowing its polymerisation to fibrin (**D**). Nevertheless, any reference to **B** being an enzyme or catalyst was awarded a mark. In part *(iii)*, most candidates appreciated that the absence of Factor VIII would result in an inability of the blood to clot, leading to excessive bleeding or haemorrhaging. Many then went on to mention haemophilia or the possibility of infection of an open wound by pathogens. Most candidates managed to score either one or both marks on this part.

Teaching tip

When starting a new topic, start by reviewing the synoptic material involved. This could be done by giving students some guidelines and getting them to give brief presentation of the key ideas.

3 As with the previous question, the synoptic parts were often poorly answered, particularly *(c) (i)*. These parts were good discriminators.

(a) Most candidates were able to give the frequency at which the ear of the dolphin was most sensitive in part *(i)*. However some misinterpreted the axes and stated 150 kHz. In part *(ii)*, calculation of the percentage increase in hearing threshold proved to be surprisingly difficult. Comparatively few candidates managed to give the correct figure although one mark was awarded for working which was correct in principle.

(b) Many comprehensive accounts of how the cochlea of mammals converts sound energy into nerve impulses were seen, allowing candidates to achieve maximum marks easily. However, a significant number started their response with a description of how sound waves enter the ear and the subsequent transmission of vibrations via the ossicles of the middle ear, which was not required. Nevertheless, most appreciated that the oval window would vibrate and transfer these vibrations to the fluid within the cochlea, which was often identified as perilymph. Good candidates mentioned the organ of Corti and the basilar membrane followed by detail of the arrangement of the hair cells within. There was occasionally confusion between the hair cells and their stereocilia, with some candidates using the terms interchangeably. Depolarisation was only credited when linked to the hair cells, rather than the stereocilia alone, although the mark scheme required the latter to be moved, or bent, by vibrations of the fluid for the award of the point. Better candidates commented that the hair cells would maintain a resting potential and occasionally went on to describe the initiation of a generator potential. On many occasions, the sequence of events leading to the depolarisation of the sensory neurone was omitted, with candidates simply stating that nerve impulses would then be transmitted to the brain via the cochlear, or auditory, nerve. However, better candidates understood that depolarisation of the hair cells would lead to the release of neurotransmitter which would then result in the depolarisation of the sensory neurone and the generation of an action potential. Some good descriptions of how the frequency and loudness of the sound would be detected by the organ of Corti were seen.

The quality mark for this part was awarded for a clear, well-organised account using specialist terms. Good candidates easily gained this mark while weaker ones either failed to use sufficient specialist terms or gave disorganised or inaccurate responses.

(c) Many explanations in part *(i)* of how abnormal connexin26 would be made lacked precision with a large number of candidates neglecting to give any detail of protein synthesis. While some appreciated that the genetic code would be changed by mutation, few gave examples of how changes in the base sequence would arise. Furthermore, relatively few candidates either mentioned or described the processes of transcription or translation. However some appreciated that the primary structure would be different thereby resulting in a non-functional protein. This was expressed in a variety of ways.

In part *(ii)*, the idea of the inheritance of the recessive allele coding for the abnormal connexin26 was often poorly expressed. Candidates frequently confused 'gene' and 'allele' although credit was given for understanding that both parents would be carriers. Good candidates gave accurate descriptions of how a child could inherit both recessive alleles and suffer from sensorineural hearing loss. Some made it more difficult by assuming that the problem was sex linked and that just the mother was a carrier.

Teaching tip

Again, a review of synoptic material via a student presentation a the start of the topic could be useful.

4 This question proved to be surprisingly difficult for many candidates, although the first part concentrated on simple recall. Many candidates failed to score any marks at all and even good ones rarely achieved maximum marks. However, as this question attracted only six marks in total, those candidates who performed badly were not overly disadvantaged.

(a) In part *(i)*, some candidates correctly named the process by which hormones would be released from the hypothalamus as neurosecretion, or exocytosis, although many responses simply stated secretion. Part *(ii)* was often not attempted or candidates suggested hormones apparently at random. Few were able to name a releasing hormone produced by the hypothalamus – the most frequent correct answer was gonadotrophin releasing hormone (or LHRH), although GHRH was seen. Candidates who had given a correct releasing hormone were then able to name the corresponding hormone produced by the anterior lobe of the pituitary gland.

(b) More candidates were able to suggest symptoms that would be expected in a person suffering from diabetes insipidus. Many appreciated that ADH regulates the reabsorption of water in the distal convoluted tubule and collecting duct and extrapolated that a lack of this hormone would lead to the production of copious amounts of urine, and/or frequent urination, precipitating thirst and dehydration. However some candidates concentrated on physiological changes that might occur in the cardiovascular system. These were not credited as they did not constitute symptoms which a patient would present with. Others believed that a lack of ADH would result in oedema and bloating. Some appeared to confuse this condition with Alzheimer's disease, offering symptoms such increased aggression, confusion and memory loss.

5 Part *(a)* of this question required straightforward recall of carbohydrate digestion and the absorption of its products. Similarly, *(b)* and *(c)* concentrated on knowledge of the same part of the specification while *(e)* required recall of muscle contraction. Part *(d)* was more demanding and necessitated application of knowledge to a novel situation. In general, most candidates managed to score well on this question.

(a) The processes of starch digestion and the absorption of its products in the small intestine were well explained by many candidates. Even weaker candidates easily achieved marks by stating that starch would be broken down to maltose, which would be further digested to glucose. Better candidates supplied details of this process, such as the hydrolysis of the glycosidic bonds and the fact that amylase would be present in pancreatic juice. However, many also mentioned the stimulation of pancreatic juice secretion by pancreozymin (PZ) upon the entrance of chyme into the duodenum, which was not required by the question.

The adsorption of amylase onto glycoproteins of the epithelial cells was rarely mentioned although more candidates appreciated that maltase would be attached the cell membranes of these cells, frequently going on to state that this would enhance the absorptive process due to the proximity of the products of digestion to the epithelial cell membranes. Many also commented that the surface area of the villi would be increased by the brush border.

The absorption of glucose into epithelial cells was frequently described in commendable detail. While weaker candidates simply stated that glucose would be absorbed by facilitated diffusion or active transport, many gave comprehensive descriptions of the process of sodium co-transport, easily achieving maximum marks for this part. However, a common error was to state that sodium ions would be pumped into the ileum, rather than the tissue fluid, in order to establish a concentration gradient.

(b) The function of the colon in the absorption of water and mineral ions/vitamins was generally well understood in part *(i)*, although some candidates stated that the colon was important in the storage of faeces. Most candidates were able to describe in part *(ii)* the composition of faeces, including cellulose, lignin or fibre, water, bile salts, bacteria and dead cells, thereby achieving full marks for this part. However, somewhat vague responses were occasionally seen, where candidates stated that the faeces would contain undigested matter, without any further qualification.

(c) The meaning of mutualism was well understood by most candidates. Many commented that it would be beneficial to both the rabbit and the microorganisms, and then went on to describe how each would gain from the relationship. However some made the mistake of repeating the stem of the question, neglecting to give more detail, and some referred to cows, rather than rabbits.

(d) Many candidates struggled with this part and were unable to provide a good reason why rabbits would have to ingest their caecotropes, often simply stating that it still contained nutrients, which was in the question, without offering any extra information. However, better candidates appreciated that further digestion would take place, enabling the rabbits to absorb the products. Many referred to the cow having four chambers to their stomach while rabbits only have one, although the significance was not clear. Good candidates understood that microbial activity in the cow's rumen would allow full digestion, followed by absorption in the ileum while microbial activity in the rabbit would release nutrients after the ileum, necessitating ingestion of the faeces. On the whole, few gained both marks available.

(e) The role of calcium ions in the contraction of skeletal muscle was generally well answered, with candidates giving clear accounts of calcium ions binding to troponin and the subsequent sequence of events. Many started their response with the importance of calcium ions in neurotransmission at the motor end plate, which was not required. Only rarely did candidates fail to score any marks at all.

6 (a) Most candidates were able to interpret the two PET scans and offer explanations as to the differences between the normal brain and that of a person suffering from Alzheimer's disease. The most common responses described the differences in positron emission, often going on to state that there were more healthy cells in a normal brain, or vice versa. Better candidates also mentioned the reduction of brain activity, and occasionally the reduction in blood flow to the diseased brain.

(b) The function of the saline injection was understood by many candidates in part *(i)*, although some simply commented that it would act as a control, without further clarification. Most appreciated that it would provide a comparison for those rats injected with phenserine or that it would prove that the injection alone had no effect. In part *(ii)*, most candidates were able to describe the results shown in Fig. 6.2, stating that the number of errors decreased with the number of trials in both groups and that those rats injected with phenserine has consistently fewer errors than those injected with saline. Few candidates failed to gain a mark on part *(ii)*. The type of learning taking place in this experiment was well explained by many candidates in part *(iii)*. Most appreciated that it would be operant conditioning, although operant learning was rejected. References to habituation, insight learning and classical conditioning were also seen. Nevertheless many candidates went on to describe associative learning, and the fact that rats learned by trial and error, with the reward for the behaviour being the exit from the maze. Despite the fact that candidates had been informed, in the stem of the question, that phenserine acted on acetylcholinesterase, many suggested that the effect of the drug would be to disperse plaques, or reduce the production of abnormal beta amyloid protein when answering part *(iv)*. Many candidates incorrectly thought that acetylcholinesterase was responsible for the synthesis of acetylcholine. Better candidates recognised that phenserine might act as an inhibitor of the enzyme, often describing either competitive or non-competitive inhibition. Many also went on to state that acetylcholine would not be broken down too quickly, so would remain in the synapse. Few references to the improvement of short term memory were seen.

(c) The behaviour shown by the baby in Figure 6.3 was understood by the majority of students. Almost all commented that it was innate, often going on to give further detail, such as it was genetic, or inborn; no learning was required; or that it was a reflex. Many were then able to suggest that the advantage would be to suckle, expressed in a variety of ways. Most candidates were able to gain at least two marks for this part, and many achieved the maximum available.

2806/01: Unifying Concepts

General Comments

This was an accessible paper where the vast majority of candidates earned at least 20 marks, and a significant number of good candidates exceeded 50 marks out of 60. Candidates who sat the examination reported that they found the stimulus material interesting. Q.3 on humming birds was a confidence booster as most candidates found that they had plenty to write here. Candidates also liked the large number of one and two mark part questions in Q.2, as a problem with one part did not preclude their scoring marks on a different aspect of the material. Candidates generally scored well on graph questions and calculations. However, lack of detail and named examples let some down in Q.4, and there was evidence of poor recall of detail of cell biology and biochemistry in Q.5. No question stood out as being particularly hard; candidates generally scored fairly evenly across the whole paper.

Comments on Individual Questions

Question

1 Candidates scored well on this question and most candidates picked up marks for the calculations, interpreting the bar chart and for sketching the line graph relationship. There was opportunity for the better candidates to display understanding of biochemistry and cell biology in part *(d)*, and recall of detail of the mitosis and cancer topic from *Biology Foundation* (2801) in *(a)(i)*.

(a) Most candidates added together the figures at the tops of the columns to arrive at the correct answer in *(i)*. Those who did not do this excluded some of the columns, presumably believing these factors were not environmental or behavioural. The stem of the question described all the factors in the bar chart as being environmental or behavioural. See the teaching tip below. The idea of genetic predisposition was given by large numbers of candidates, who scored one mark out of two for part *(ii)*. Where a second mark was awarded, it was usually for an example of a hereditary cancer, most commonly familial breast cancer. Although some referred to mutation, few qualified this with the term oncogene or referred to the genes that control the cell cycle. A few candidates misunderstood the term *environmental* in the question stem and came up with additional environmental factors such as carcinogens, smoking and asbestos.

(b) Most candidates successfully followed the instructions and calculated the body mass index (BMI) in *(i)*. A few did not square the height figure. Most candidates scored at least one mark although some read the risk figure from the bar for men (1.2) rather than for women (1.45). Some scored the mark for identifying the x axis range within which the woman's BMI fell, and some explained the figure answer in words to earn the second mark. See the teaching tip.

(c) Part *(i)* was a good discriminator of the brightest candidates. Only those with a certain level of sophistication realised that they had to link the age at which menopause began as one variable, with the incidence of breast cancer. The majority of candidates simply said that when a woman reaches menopause her risk of cancer goes down. Virtually all candidates scored a mark in part *(ii)*. Those who did not gain a mark sketched a curve rather than a straight line, despite a clear instruction in the question to draw a straight line.

(d) There were many good answers scoring two marks. Some candidates, however, claimed lipids were soluble in water and suggested that this meant facilitated diffusion via membrane pores would be necessary.

Teaching tip

Candidates should be encouraged to read all parts of the question paper carefully, including the introductory material in the stem of the question. Candidates who looked at the bar chart and jumped to Q.1 (a)(i) missed the information that all the factors were classed as environmental or behavioural and consequently made mistakes.

Candidates should also take note of the number of marks available for each part question and strive to make two clear correct statements if there are two marks on offer, as in Q.1 (b)(ii).

2 This question covered a range of biological ideas within an unusual context. Most candidates successfully displayed knowledge and the ability to assimilate and cross-reference diagrammatic information in at least some of the part questions.

(a) Mostly this was answered correctly. Occasional candidates suggested a name that was not a kingdom, such as 'mammals' in the chemoheterotrophic box. A very few candidates failed to answer this, perhaps because they missed the question. It is a common failing for candidates to rush to the answer lines, meaning they miss out reading the stem material (see teaching tip for *Q.1*) or fail to see a question at all if it does not involve conspicuous answer lines. For advice on how to remedy this problem see the teaching tip below.

(b) Candidates scored quite well on this part question, often gaining a maximum of three marks on the energy section. Candidates with good knowledge of biochemistry from *Biology Foundation* easily scored two or three marks on the carbon section. A large number of candidates thought that respiration is a process that requires energy, rather than it being the means by which energy is made available to cells.

(c) Candidates who understood the nitrogen cycle or the significance of nitrogen as an ingredient of key cellular biochemicals scored two easy marks here. Those candidates who went astray confused nitrifying bacteria with those that fix atmospheric nitrogen in root nodules.

(d) Candidates generally answered both *(i)* and *(ii)* correctly or went wrong in both. One mistake was to identify part of the form of nutrition: heterotrophic for *(i)* and phototrophic for *(ii)* instead of chemoheterotrophic and photoautrophic respectively.

(e) A surprising number of candidates gave an answer to (i) that was not an element, for example carbon dioxide. Sulphur was another common error. Plenty of candidates gave the correct answer – carbon. Whilst part (ii) was generally well done, some candidates lost marks by being vague about the form of sulphur they were discussing (eg elemental S or H2S) or by talking about recycling or passing on some form of sulphur, rather than its being used or produced by a named type of bacterium.

(f) This proved a discriminator, with many candidates failing to synthesise all the relevant information in order to track down the answer as the colourless sulphur bacteria. Some answers gave types of bacteria that are light-requiring, despite being told that the context was deep ocean water. Others suggested non-producers such as *Clostridium difficile*, perhaps because this bacterium appeared at the base of Fig. 2.1 and candidates were interpreting the Winogradsky column diagram as a sort of trophic pyramid with the producer at the base.

(g) Again, this was something of a discriminator. Good candidates often made three points, noting that the two named species of Clostridium are related and therefore both anaerobic, and that a poor blood supply reduces oxygen available, providing the correct conditions for the bacteria. A large number of candidates did not come up with this reasoning but instead gave the idea that poor blood supply impedes the action of the immune system, which was credited as an AVP for one mark.

Teaching tip

One way to avoid missing questions or stem material is for candidates to place a ruler horizontally across the page, and to move it down slowly as they read, to ensure they take in all the written material step by step. Some careful candidates also highlight or underline key words in the text as they work through. Annotating graphs, tables and diagrams is also a good approach.

3 This question seemed to give all candidates the opportunity to describe the data and make valid inferences based on their knowledge of biology.

(a) Most candidates scored at least two marks here. Candidates who amplified their answers about flight with statements about muscles requiring ATP gained extra marks. The Examiners were of the opinion that there was reluctance amongst candidates to underpin their explanations with appropriate biochemical detail.

(b) Most candidates scored the maximum three marks here for description. There are areas that could be improved:

- candidates should use words such as highest, peak, maximum, lowest, smallest and minimum instead of just 'high' or 'low'
- data quotes should always be accompanied by units whenever appropriate.

Candidates were less successful at linking the three areas together into a valid explanation. Many quoted the stem of the question from page 9 and wrote about saving energy; it was expected that they would use the extra information about body mass to state that this energy is stored as fat or another energy-rich food store in the birds' bodies. Candidates did not seem to have an overview of the energy conversions that occur, eg from a chemical form in the birds' food to kinetic energy in muscle use or thermal energy for keeping warm, or back to stored chemical energy in body fat.

(c) Again, some candidates wrote vaguely about energy without specifying its form and relating it to the birds' food intake and ability to use or store body fat. Many candidates correctly worked out an answer that gained the first two mark points. Those who tried to relate feathers to insulation often completely contradicted their reasoning in part *(d)*, since a low body mass will make temperature regulation harder and will not therefore benefit the bird with less feather insulation.

(d) Good candidates scored three marks for picking out the two relevant links from the data in support of the hypothesis and added a data quote with units in support. Many candidates left their answer after finding one correct link and did not support with data, meaning they scored only one mark. This relates to the teaching tip on tailoring the answer to the number of marks available (see *Q.1 (b)*). Surface area to volume ratios are studied in *Transport* (2803/01), but few candidates seemed aware of how this ratio affects heat generation and loss.

Teaching tip

When describing relationships shown on graphs, candidates should be advised to give support in the form of accurate figures and always include full units as given on the x and/or y axis labels.

4 Candidates who applied their basic AS level or even GCSE knowledge to interpret the diagram scored five or six marks. Simple comments about the diffusion of oxygen from the alveoli to the blood and its transport as oxyhaemoglobin to the liver earned several marks. Similarly candidates could have described carbon dioxide entry into the blood and its transport to the alveoli, or the absorption of glucose at the gut and its transport to the liver for respiration or storage.

Candidates who did not do well offered no named examples of substances following the transport routes shown in the diagram. Without named substances to discuss these candidates could not offer any detail about mechanisms by which substances cross membranes and are transported in the blood.

A good strategy was to focus on the metabolism of the liver cell and how it uses glucose and oxygen and produces carbon dioxide and water. Stating that the use of the raw materials produced a diffusion gradient and that the oxygen and glucose then diffuse into the cell, explained how a relatively constant level of these biochemicals is maintained. It also led back to a description of how the supply of these raw materials is maintained in the tissue fluid and blood. Similarly, the creation of diffusion and osmotic gradients for carbon dioxide and water explained how constancy was maintained and naturally led onto a description of the mechanisms by which these substances are transported away and excreted.

Few candidates said what tissue fluid is or how it is formed; in some cases candidates were not familiar with the idea of tissue fluid as they referred to it as part of the bloodstream.

A number of candidates rightly attempted to put in relevant detail about the storage of glucose as glycogen in the liver and the effect of the hormone glucagon in reversing this process; they lost marks by being unable to spell glycogen and glucagon correctly. Another misspelling that appeared was ‘deanimation’ for deamination.

Teaching tip

Candidates should expect to be asked to interpret stimulus material using their own knowledge. Here they were not asked to describe the diagram, but to use the diagram to answer a question. The diagram gave hints as to the areas of physiology that should be used in the answer.

5 The range of marks scored on this question was large. Simple links to knowledge of cell biology and genetics were missed by many. Answers to part *(d)*, requiring candidates to describe an experimental protocol, were strongly centre-dependent, suggesting some candidates have acquired a good knowledge of the principles of experimental design while others have little idea about controlling and measuring relevant variables.

Some mistakes were related to candidates failing to appreciate that the onion bulb is only one part of an onion plant, although they were given this information. Some candidates attempted to cross-pollinate bulbs or seeds. Although it had little impact on marks awarded, many candidates showed little awareness of the growing season of plants, misunderstanding the term *overwintered* and clearly not realising that onion plants are grown in the summer and that the bulbs are lifted and stored to provide a supply during winter and spring.

(a) Very few candidates applied material from *Biology Foundation* to specify in detail how the tonoplast must be broken for enzyme-substrate complexes to be formed to yield the products. Most candidates managed one or two marks, however. Candidates need to be aware that where they are analysing a passage of text, as here, they must not just paraphrase the text but must add their own knowledge in explanation of what is being described. Here, knowledge of cell structure and enzyme function was necessary to show a full understanding of the text.

(b) Many candidates recognised the name pyruvate and suggested that this substance might be used in respiration, earning one mark. More imaginative suggestions as to why the concentration of precursor chemical might fall appeared occasionally in candidates' answers.

(c) Many candidates scored full marks in part *(i)* for outlining the principles of selective breeding. Specific details were rare. The term directional selection was rarely used; some candidates who came near to scoring an AVP for commenting on the changing frequency of alleles missed the mark by stating genes rather than alleles. 'Reproducing', which could be sexual or asexual, 'fertilising' and 'germinating together' onions were given instead of 'interbreeding' or 'cross-pollinating' on occasion and these answers did not score. Many candidates correctly suggested in *(ii)* that sulphur concentration of the soil could be reduced. Those who said 'no sulphur' were not credited since candidates should realise that sulphur is an essential element in two of the amino acids commonly found in proteins and that plants that lack sulphate in experimental conditions show deficiency symptoms.

(d) The quality of answers was very variable. Some candidates picked up on the determination of pyruvate concentrations as a way of identifying mild and strong onions or a range of strengths of onions for the independent variable. Well trained candidates also commented on the need for repeats to check reliability or to find a mean; they also referred to the need to control other variables. Two marks were available for two named variables to be controlled. Few candidates however stated how rotting could be measured. Even a method as simple as counting the numbers of onions that showed signs of rot eluded many candidates. Fungi and bacteria as the agents that bring about rotting were rarely mentioned.

Teaching tip

Candidates should be taught to apply the principles of experimental design to new situations. They should understand that in most experiments an independent variable is varied according to values or categories decided by the experimenter, there must be a way of measuring or deciding on these values or categories and also a method of measuring the results (dependent variable). Other variables that should be kept the same (controlled variables) should be listed. Principles and terms such as repeats, reliability and accuracy should be used where appropriate.

2806/03: Practical Examination

General Comments

Candidates were not always well prepared for the examination, especially in centres that had small entries. It was felt that some candidates had not revised topics from the AS specification and from Central Concepts (2804) prior to the examination and could not cope with questions relating to these specifications. Many of the weaker answers were more appropriate to Key Stage 3 than A2.

Question

1 was an investigation into the effect of increasing concentrations of sodium chloride solution on the rate of respiration of yeast. This did not cause any problems, although some centres appear to have given candidates glass tubing of different lengths or variable diameter, which made their results difficult to interpret. However, most candidates managed to obtain the correct trend in their results.

2 tested an understanding of meiosis and did not present many difficulties.

Comments on Individual Questions

Planning Exercise

This differed from previous examinations in that it was a two-part exercise involving up to three different experiments. Most candidates gave good general plans but failed to supply the necessary detail.

Some good preliminary work was done by candidates who planted tomato seeds at different light intensities and temperatures and were able to find the optimum conditions for their breeding experiment, including the likely time required for germination. These candidates gave the results from their preliminary work and used them to inform their plans. Others were able to establish these values from their background research, but not all explained how they would use this information, and some even failed to use their researched values in their plans.

Candidates did not indicate where they had used information from secondary sources. This could be given as a reference in the text or as a footnote at the end of the page linked by a superscript number. Many candidates gave bibliographies at the end of their plans but did not show *in their text* where they had used these secondary sources.

The Examiners noted that a number of candidates did not have sufficient knowledge of plant reproduction. Some thought that as tomato plants were self-pollinated they were reproducing asexually and producing identical offspring. Conversely some did not realise that the F_1 generation did not need to be cross-pollinated to gain the F_2 seeds. Many failed to collect and grow the seeds from the F_1 and F_2 generations; most did not consider the need for a large quantity of seedlings in order to identify stem colour accurately. It was common for candidates to grow only one, three or five seeds for each generation. It was good to see some candidates referring to reciprocal crosses.

The theory of inheritance was well documented but not always with understanding. Many unlabelled Punnett squares and genetic diagrams were presented without explanation. A few candidates thought that these would do as a substitute for carrying out the breeding part of the investigation.

The chi squared test was frequently given as a test for the significance of the results, but again there was not always an explanation as to how this would be used in the investigation. The Examiners felt that information about the test had often just been copied from a text book.

In an attempt to control variables some candidates measured daylight intensity and room temperature before planning their experiment so they knew the likely range to use in their experiment. Candidates who stated that temperatures above 35°C would denature enzymes and then subjected their seeds to germination temperatures between 0°C and 80°C had not really understood the nature of the problem they were set to solve, but were merely relying on ideas gained from previous experiments on enzymes. Possibly they were thinking that plant enzymes and mammalian enzymes have the same optima. Even candidates who read the seed packet and established that the optimum temperature for germination was between 18°C and 30°C failed to select their temperatures within this range.

The use of plastic bags instead of muslin bags to isolate flowers and prevent cross-pollination was not accepted.

Some candidates used their imagination and thought up reliable methods of identifying differences in stem colour. These included taking photographs with a digital camera and identifying the purple colour using the red/green/blue values from a computer graphics program. This enabled them to obtain a numerical result to the problem. Others made their own colour charts with a range of up to ten different shades of purple and green and allocated a number to each shade of the range. Less inventive candidates merely recorded the colour observed as light or dark purple.

The Examiners felt that use of a colorimeter was not appropriate for this experiment as the volume of pigment obtained from young seedlings would be too small to give an accurate measurement of absorption.

Practical Test

Question

1 Many candidates did not realise that the principle examined here was the effect of solutions of decreasing water potential on yeast cells. This was clear from answers to part *(f)*.

(a) Candidates frequently failed to construct their tables of results following the usual criteria. The Examiners were looking for the independent variable - concentration of sodium chloride - to be given in the first column of the table, followed by time, distance and rate. The correct unit for rate was often omitted. Many candidates headed the first column as ‘test-tube’ despite the fact that the reaction did not occur in a test-tube. This error was often carried forward to subsequent questions where they referred to tube letters instead of salt concentrations.

The calculation of rate caused problems for some candidates who had only learned it as 1/t and had taken all their measurements of distance at 10 minute intervals. Many calculations were not corrected to the same number of decimal places. Candidates were expected to follow the convention of recording time in seconds. Some results were confusing when it was not clear if the time was recorded in minutes and seconds, or minutes and fractions of a minute.

Very few candidates realised the effect of dilution when they added the salt solution to the yeast suspension.

(b) Most candidates were able to orientate their graphs correctly and made sensible use of the space available. Some chose scales that made it difficult for them to plot their points accurately. Many failed to join plots with straight lines between points or use lines of best fit; extrapolation beyond 20% NaCl was common.

(c) Most candidates commented accurately on the pattern of their results and recognised the anomalies. Some gave comparative data as evidence to support the trend but many referred to tube letters instead of salt concentrations. Rates were often quoted without units.

(d) Most realised that accumulation of carbon dioxide was increasing gas pressure in the syringe and displacing the yeast suspension.

(e) Candidates seemed to expect that all the subsections of *Q.1* were going to be related to the same theme of carbon dioxide production and many gave the same answer in two or more parts. It was clear that candidates need more training in reading and interpreting questions. Candidates read the reference to oxygen in the question and many attempted to describe the role of oxygen in respiration, giving details of glycolysis, Krebs cycle and electron transfer systems, without mentioning the production of carbon dioxide at any stage in the sequence of biochemical reactions. Others merely listed the stages with no explanation of their significance. Good candidates were aware of the production of carbon dioxide and named the appropriate stages of respiration where carbon dioxide is produced. They referred to both aerobic and anaerobic respiration.

(f) Many candidates thought the increasing salt concentration was causing a change in the pH of the yeast solution, while others discussed disruption to sodium and potassium pumps. Very few linked the salt concentration to osmosis and the consequent effect on the yeast cells, and even these candidates were unable to explain water potential gradients correctly. Some candidates tried to relate the decrease in respiratory rate to a link between salt and the *HAL1* gene mentioned in the next question.

(g) Appropriate genetic explanations were acceptable to this question. Candidates could have drawn on their knowledge of genetic engineering from *Biology Foundation* (2801) and *Central Concepts* (2804) to suggest that the transgenic tomato plants may have had only one copy of the gene *HAL1*. This would make the plant effectively heterozygous, so that some of the offspring would not inherit the gene.

(h) Generally candidates were able to identify limitations in their apparatus but did not explain why it was a limitation. It was not sufficient to state that syringes gave inaccurate measurements, without explaining that it may be due to air bubbles that cannot be eliminated, foaming of the yeast, or variation in the way the meniscus is read. References to timing and measuring difficulties should indicate why it is a problem and the solution needs to be more scientific than 'getting someone else to help'. The use of a thermostatically-controlled water bath was hardly appropriate for this investigation.

Teaching tip

There is more information about HAL1 at:

www.plantphysiol.org/cgi/content/abstract/123/1/393
www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed&pubmedid=1505513

2 Candidates were given a very big clue as to the nature of this question. As the Planning Exercise was about genetics it can hardly have come as a surprise to find a question on meiosis!

(a) This involved drawing a pollen mother cell at the prophase 1 stage of meiosis from a section of an anther. Most identified the correct cell but the quality of drawing was variable. Candidates need to practise drawing what they see under the microscope rather than their memory of a text book drawing. Many had drawings with overlapping or broken lines. Chromosomes were often shaded or only shown as single lines with no thickness. Nuclei were often drawn too large relative to the size of the cell. Many failed to recognise the nucleolus; others found centrioles in this plant cell. Many failed to draw or correctly label the cell wall. Annotations were rarely attempted and when given they often referred to the process of meiosis and not the parts of the cell that the candidate could see. A good candidate was able to identify a shortened chromosome and one that was thinner and longer.

(b) Few candidates explained that they were looking at a thin layer of the cell. A few knew that they were looking at a section at one focal length. Most gave incorrect answers referring to haploid and diploid chromosomes.

(c) The most common error in *(i)* was to describe the processes occurring during prophase and anaphase instead of the observable differences between the slide (showing prophase 1) and the photograph (showing anaphase 1). Most realised that the chromosomes were in different parts of the cell and some noticed that the nuclear membrane was not visible in the photograph. Generally candidates were able to give a good description of meiosis in *(ii)*, but many forgot that they were looking at a plant cell and failed to realise that the spindle does not form from centrioles. The Examiners were disappointed to see many references to the separation of chromatids rather than to the separation of homologous chromosomes.

(d) Most candidates recognised the significance of the haploid and diploid number of chromosomes and made a link with genetic variation.

Teaching tip

The image used for Fig. 2.2 comes from a very useful web site that has numerous images of meiosis in Lilium. These could be used to supplement slides showing different stages of meiosis. See: http://images.iasprr.org/lily

The homepage has a number of useful links: See: http://www.iasprr.org

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

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u	entry
2801	Raw	60	48	43	38	33	28	0	20224
	UMS	90	72	63	54	45	36	0	
2802	Raw	60	42	38	34	30	27	0	6707
	UMS	90	72	63	54	45	36	0	
2803A	Raw	120	95	85	75	65	55	0	772
	UMS	120	96	84	72	60	48	0	
2803B	Raw	120	95	85	75	65	55	0	1270
	UMS	120	96	84	72	60	48	0	
2803C	Raw	120	86	78	70	62	54	0	1116
	UMS	120	96	84	72	60	48	0	
2804	Raw	90	65	57	50	43	36	0	11343
	UMS	90	72	63	54	45	36	0	
2805A	Raw	90	61	54	48	42	36	0	110
	UMS	90	72	63	54	45	36	0	
2805B	Raw	90	65	57	49	42	35	0	45
	UMS	90	72	63	54	45	36	0	
2805C	Raw	90	56	51	46	41	37	0	173
	UMS	90	72	63	54	45	36	0	
2805D	Raw	90	68	59	51	43	35	0	186
	UMS	90	72	63	54	45	36	0	
2805E	Raw	90	66	58	51	44	37	0	515
	UMS	90	72	63	54	45	36	0	
2806A	Raw	120	90	81	72	63	55	0	1261
	UMS	120	96	84	72	60	48	0	
2806B	Raw	120	90	81	72	63	55	0	60
	UMS	120	96	84	72	60	48	0	
2806C	Raw	120	83	75	67	59	51	0	666
	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	16.5	33.3	53.0	74.6	93.0	100.0	701
7881	12.2	46.8	68.1	87.2	94.7	100.0	202

3881
701 candidates aggregated this series

7881
202 candidates aggregated this series

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

Statistics are correct at the time of publication

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