OCR
RECOGNISING ACHIEVEMENT

GCE

Biology

Advanced GCE **A2 7881**

Advanced Subsidiary GCE **AS 3881**

Report on the Units

June 2008

3881/7881/MS/R/08

OCR (Oxford, Cambridge and RSA Examinations) is a unitary awarding body, established by the University of Cambridge Local Examinations Syndicate and the RSA Examinations Board in January 1998. OCR provides a full range of GCSE, A level, GNVQ, Key Skills and other qualifications for schools and colleges in the United Kingdom, including those previously provided by MEG and OCEAC. It is also responsible for developing new syllabuses to meet national requirements and the needs of students and teachers.

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

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

OCR will not enter into any discussion or correspondence in connection with this Report.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

CONTENTS

Advanced GCE Biology (7881)

Advanced Subsidiary GCE Biology (3881)

REPORT ON THE UNITS

Unit/Content	Page
Chief Examiner's Report	1
2801 Biology Foundation	2
2802 Human Health and Disease	5
2803/01 Transport - Written Paper	8
2803/02 and 2806/02 Transport/ Uni-Concepts/Skills – Coursework 1 & 2	12
2803/03 Practical Examination	16
2804 Central concepts	20
2805/01 Growth, Development and Reproduction	25
2805/02 Applications of Genetics	30
2805/03 Environmental Biology	33
2805/04 Microbiology and Biotechnology	38
2805/05 Mammalian Physiology and Behaviour	44
2806/01 Unifying Concepts in Biology - Written Paper	51
2806/03 Practical Examination	57
Grade Thresholds	63

Chief Examiner's Report

This was the last full session for the AS units on this specification. It was good to note that the standard produced by the candidates in both this area and the A2 units has been maintained. The examiners again noted a good range of responses with many candidates showing a good understanding of biological principles. There was little to suggest that candidates, in general, were short of time. There were a couple of areas where candidates seem not to have realised that the paper continued to the back page of the booklet and failed to complete that section. Candidates would be well advised to read quickly through the whole of the paper at the start of the examination. This would also allow them to appreciate the whole of a given question before tackling it. Some candidates misinterpret a section of a particular question, answer it and then find that in fact the answer they have given is appropriate to a later section. An example of this occurred in the Transport unit (2803/01) where some answered section 2a with an answer for 2c and then realised their mistake and started again. Another area where candidates sometimes miss marks is where candidates are asked to mark something on a graph or diagram – they should be encouraged to check carefully so that they do not cut themselves off from such marks.

In general it was thought that calculation skills were encouraging although those in the Microbiology and Biotechnology option seemed to cause some problems. It is important that biologists feel confident using basic mathematical techniques.

As has been previously noted, there was sometimes a problem with candidates applying a previous mark scheme to a slightly different question.

The problem of command words and the amount of material required to access the marks remains. We can only reiterate that the specification booklet contains a list of command words with what they imply. Of particular concern this session was the word 'comment'; this is an open-ended invitation to the candidate to recall or infer points of interest relevant to the context of the question. In all cases the candidate should use the mark allocation to assess the detail required to access the marks.

The Principal Examiners on the A2 option papers noted the continuing problems that candidates experience on the synoptic parts of the papers. One can only reiterate the previous advice that these aspects are given as much practice as possible.

Perhaps the biggest concern this session centred on the skills area of the specification. Where the coursework was concerned, the Chief Moderator noted that an increased number of centres were late submitting their work where all material should be automatically sent in, or in returning requested samples. Work was also sometimes rather poorly annotated thus requiring remarking rather than moderation. At the other end of the scale, other centres appreciated the need to meet deadlines and the importance of full annotation of the material. Centres should be aware that deadlines and annotation of material will still be relevant in the practical element of the new specification as it comes on line from September. Where the practical exam was concerned, the Principal Examiner was pleased with the standard that many candidates achieved. One point of concern to the awarding committee was that some centres contacted the board asking for extra guidance to give to candidates on the Planning Exercise. This is clearly not appropriate as it would possibly help some candidates at the expense of others. There is no one 'correct' answer to the Planning Exercise. The additional information provided in the box with the task on page 3 of the planning sheet is not a set of instructions; it gives candidates a starting point for their own research which should provide the background they need to plan a suitable investigation. Plans that show a clear understanding of the issues and adopt good experimental procedures will be rewarded by examiners; we do not expect candidates at this level to resolve all the difficulties where they are faced with a novel context, limited information, and have to complete the work in a short period.

2801 Biology Foundation

General Comments
Some very good scripts were seen, those candidates indicating a comprehensive understanding of the subject material and expressing their knowledge and ideas clearly and concisely. Some candidates experienced difficulty in answering specific and detailed questions about certain areas of the specification. An apparent lack of care in reading the question led to misinterpretation, resulting in some candidates relating correct facts but not relevant to the question that had been asked. The facts supplied often showed good understanding of the subject area but did not address the question that had been set. They frequently indicated that candidates had practiced questions on the particular topic but they then applied those answers to the question on this paper, which was not appropriate.

Teaching Tip

Encourage candidates to go into the examination with a pencil or highlighter. It is useful to highlight a few key words in the question so that the focus of the question is indicated. It is also useful to indicate the command word in this way.
Although care is taken to supply the candidates with adequate answer lines for each question, some candidates habitually use more space than that provided and continue answers on other parts of the page or paper.

Teaching Tip

Encourage candidates to look critically at the number of lines available for the answer, as this helps to give an indication of the detail required in the answer. If they need to exceed this, then they should indicate clearly where the rest of the answer may be found, making sure that this information is as close to the lines provided for the question as possible.

Comments on Individual Questions

Question 1
(a) This question was intended as a reasonably straightforward introduction to the paper. However some candidates were unable to score full marks here. Care should be taken to supply specific answers.
(b) A suitable role for phosphate was generally well known. Many responses for magnesium, however, were vague. For the more unlikely or uncommon roles, examiners were looking for a clear understanding of the role.

Question 2
(a) This question was generally well answered, with most candidates stating a suitable reason. This is, however, a case in which some candidates did not read the question carefully enough and gave reasons for using factor VIII produced by biotechnology rather than animal sources, many of which (such as blood grouping, compatibility or rejection) were inappropriate.
(b) A small proportion of candidates supplied the correct answers. **(i)** had the highest incidence of blank responses of all the questions on the paper. Predictably, some interesting names for enzymes were seen. Some candidates seemed not to notice the phrase ‘transferred into a host cell’ in **(iii)** and gave much detail of joining lengths of DNA.

Teaching Tip

Encourage candidates to use the mark allocation as an indication of the amount of detail required in an answer. Provide at least as many points in the answer as the number of marks allocated to the part question

(c)(i) This question was answered well, the most common incorrect answers being 'nitrogen' or 'hydrogen'. Some answers to (ii) were vague, especially when referring to 'conditions' with no further qualification.

Question 3

(a)(i) This question was answered well by most candidates. Some candidates suggested vacuole or chloroplast, neither of which can be seen in Fig. 3.1 and 3.2. (ii) was also answered well, the most common error being to confuse cell A with cell E for metaphase.

(b)(i) Most candidates gave the correct answer to the calculation. Some failed to round up their answer appropriately while others were awarded a mark for a suitable working where their final figure was wrong. (ii) was also answered quite well, although some candidates thought that the small numbers of cells in a stage indicated that they were spending a long time in that stage. (iii) was more of a challenge, many candidates simply repeating their answer to (b)(ii).Examiners were looking for the idea of the cells not dividing, being specialised or simply that the section had missed the nucleus of many cells. Answers that had the right idea frequently referred to having just divided or getting ready for division rather than stating that the cells were not dividing at all.

Question 4

(a) This question was generally well answered. There was some confusion between transcription and translation, translation and translocation, secretion and excretion.

(b)(i) Few candidates received two marks. Many included T as one of the bases in at least one row. Common misconceptions were that mRNA would be the same as DNA but with U replacing T, or that mRNA and tRNA would be the same but with T in tRNA, or T in tRNA rather than U.

(b)(ii) Answers to (ii) were frequently long and detailed but it was often the case that candidates did not express themselves clearly enough to gain two marks. Even though it was clear that they understood the topic as a whole, they either failed to answer the question that had been set or did not make it clear that a triplet codes for a *specific* amino acid or that the *sequence* of triplets determines the *sequence* of amino acids or the *primary* structure of the protein.

(c)(i) Most candidates could correctly identify the Golgi body or apparatus. The most common incorrect response was 'smooth endoplasmic reticulum'. Responses to (ii) were not as good, with 'sorting' or 'labelling' being unqualified and movement of vesicles mentioned without the idea of the product being contained *in* the vesicles.

Question 5

(a) Many candidates answered (a) by correctly indicating that the addition of water was involved but then did not include the crucial information that the water was used to *break bonds*.

(b) Performance on (b) varied. Most candidates recognised that the heat would denature the enzyme. However, some referred to 'body temperature' or 37^{o}C rather than the extreme heat that the enzyme had been subjected to. Some answered in the context of the

subsequent cooling of the mixture, incorrectly implying that the enzyme was denatured by the cooling rather than by the heating.

(c) This question proved to be more of a challenge. Many candidates did not realise that they could not simply read the figures off the graph in order to answer the question. A further stage of thought was required. A large number of candidates made the mistake of assuming that the graph was describing product formation and so did well to score one mark for the use of a figure. The other main problem was the tendency to describe the concentration rather than the enzyme activity which, although it may have been accurate, didn't answer the question. There was also some attempt to *explain* what was going on in some answers. While these were often accurate, including reference to the alteration of tertiary structure or denaturation, the question was not being answered. It is most important that candidates understand the difference between the command words 'describe' and 'explain'.

(d) This question was either answered well, very superficially or the answer indicated that the candidate had little idea of carbohydrate structure. The most common gross error was to describe starch as a protein, referring to primary, secondary, tertiary and quaternary structure as well as alpha helices and beta pleated sheets. Other answers concentrated on the differences between alpha and beta glucose, often then going on to describe the structure of cellulose. Even those who started out promisingly on a description of starch structure became confused between amylose and amylopectin. Candidates should be careful when spelling certain biological terms, as amylase is not the same as amylose. In order to gain full marks, candidates needed to score some marks for the function of starch as well as its structure. The function was normally well understood, although not always well expressed. The Quality of Written Communication mark was for the correct use of specialist terms, so if an answer was light on relevant content, the QWC mark was unlikely to be awarded.

Question 6

(a) Many candidates scored well on (a). The organism that caused the most trouble was the omnivore, with varying numbers of ticks in varying boxes. The primary consumer, if incorrect, would be placed in trophic level 1. Despite the example having two ticks, some candidates were reluctant to assign an organism to more than one trophic level. Spurred on by the example, some insisted that all organisms should be assigned to at least two trophic levels.

(b)(i) Those candidates who had realised that the question referred to light that had already reached the terrestrial ecosystem were generally able to suggest two suitable reasons. The common error was to refer to reflection from clouds or some other inappropriate answer. In another (more general) context, this would be acceptable but not as an answer to this question.

(b)(ii) This question prompted the answers that candidates had previously rehearsed rather than the answer to this question. Answers centred around the general decrease in energy as you go up a food chain, many examples of reasons for the loss of energy between trophic levels or explanations as to why there is a limit to the number of organisms in a food chain. Candidates were expected to focus on the *difference* between the energy transfer between the various trophic levels and to appreciate that, as ecosystems vary, 10% would not be a typical value for every ecosystem.

2802 Human Health and Disease

General Comments
This year the examination tested a wide range of skills including interpretation of data in question three and evaluation of practical technique in question four as well as the more usual knowledge and understanding.

There was no evidence that candidates struggled to complete the paper in the allocated time and examiners were pleased to see that the majority of candidates were able to demonstrate a wide range of knowledge in all areas of the specification.

All questions were attempted by the majority of candidates. While some part questions were deliberately of lower demand and enabled even the weakest candidates to demonstrate some knowledge and understanding, more difficult parts of the same question successfully achieved differentiation.

One particular candidate response deserves mention. In an answer given for question 3 (b) (ii) the name given to a disease that may result from becoming obsessed with weight loss, 'Anorexia nostalgia', was thought to be a particularly poignant response in this last full sitting for this module.

Question 1

Candidates were provided with diagrams of a goblet cell and a ciliated cell. It was certainly disappointing to find that less than one third of candidates knew that these cells came from epithelial tissue. Many responses named organs such as 'lungs' or 'bronchi' rather than tissues. Most candidates fared better when naming the actual cells and stating their functions. However, a lot of candidates named cell A as 'alveoli' or cell B as 'cilia' rather than a 'ciliated cell'. Also, there were still a number of candidates who seem to think that cilia filter the air rather than beat synchronously to move the layer of mucus produced by the goblet cells.
In part (b) a large minority of candidates described the effect of tar on goblet cells as 'blocking mucus production' rather than 'stimulating increased mucus production'. The effect of tar on the action of the ciliated cells was often described accurately as 'paralysing the cilia' or 'preventing cilia action'. Examiners were not happy to accept 'damaging cilia' or 'destroying cilia' as this question specifically asked for the effect of tar on the action of the cells rather than on the structure of the cells.
In part (c) the symptoms of lung cancer were generally well described with many candidates scoring for 'problems with breathing', 'chest pain' and 'blood in the mucus'.

Question 2

Question (a) proved to be surprisingly discriminating as weaker candidates seemed to think that each disease could only be placed in one category.
In part (b) candidates were expected to state that an inherited disease was passed from the parents via the genes. Many candidates stated that inherited diseases involved the genes but omitted the idea of being passed from one generation to the next – this allows the disease to be confused with a genetic disorder perhaps caused by mutation rather than being passed on. In part (ii) the majority of candidates understood that the man could pass the disease on to his children but few linked this to the idea that he did not know if he was himself in possession of the gene. Some candidates knew from GCSE studies that Huntington's is passed on by a dominant allele while other candidates described the possibility that he may be carrying a recessive allele. Any description of the genetic basis of Huntington's was treated as neutral as this module does not test the principles of Mendelian genetics.

Most candidates were able to suggest one or two advantages and disadvantages of the ability to test for specific inherited diseases. Responses varied a great deal in the quality and precision of wording. Common responses for the advantages were to suggest that people could decide whether to have children, to terminate a pregnancy or to plan for a future life with a disease. Where gene therapy was mentioned it appeared that it was not well understood as candidates still refer to replacing or removing a gene. Common responses for the disadvantages were to suggest that people might become depressed or worry a lot or that they might suffer some form of discrimination. Weaker candidates still make vague references to 'designer babies' or 'playing god'.

Question 3

This question provided some information about dietary requirements and an opportunity for even the weakest candidates to demonstrate their knowledge and understanding. The majority of candidates provided correct responses to parts (a) and (b). However, some candidates answered (a) (i) with 'sugars' – apparently not knowing that sugars are a form of carbohydrate. A number of candidates answered (a) (ii) with 'fats' – apparently not reading the question carefully to see the word 'immediate' supply of energy. The most common incorrect response to (b) (ii) was to suggest that if the 17-year-old girl became obsessed with weight loss she may suffer from coronary heart disease. It is true she may suffer from some form of heart failure, but it is unlikely this would be due to CHD.
In part (c) most candidates described EAR as being an average requirement providing sufficient for half the individuals in a population. However, many omitted to state what was required – energy, or proteins or some other nutrient. In (c) (ii) most candidates were able to suggest that a health professional would use the tables and figures to suggest an energy intake for the girl. However, many candidates failed to point out that the girl should be advised to eat less than the relevant EAR for energy in order to lose weight.
In part (d) most candidates knew that the EAR for a pregnant woman would be higher than normal. However, few candidates gave a satisfactory explanation as to why she would need more energy. Many responses were too vague in nature simply stating that she was supplying energy / nutrients to the fetus. Examiners were looking for a little more detail about what the extra energy or nutrients might be used for – e.g. for carrying the extra weight around or for the development of the fetus. A significant number of candidates appeared to believe that 'near the end of pregnancy' meant that the woman may be producing milk and breastfeeding.

Question 4

In question (a), weaker candidates checked the calculation and concluded that 23% was accurate. However, many candidates were able to point out that the photograph of 70 cells represented a very small sample. Only the stronger candidates suggested that the proportion of cells showing signs of infection may depend upon how long the person had been infected or what stage of the life cycle was represented in the photograph.
Part (b) was well answered with most candidates understanding that the parasite consumes or uses the haemoglobin and takes up space in the red blood cells. Weaker candidates tended to give vague answers such as 'the disease destroys the haemoglobin' or 'bursts the blood cells'. The consequent effect upon oxygen transport and ability to carry out aerobic respiration in the muscles was also well understood.
The majority of candidates tackled both components of part (c) giving some detail about the mode of transmission of malaria and explaining some reasons why attempts to eradicate the disease have failed. It was clear that some candidates had obviously been taught a great deal of detail and had taken the trouble to learn the material thoroughly. However, examiners were concerned that quite a lot of candidates seemed to confuse the transmission of malaria with that of cholera, TB or even HIV/AIDS. Spellings of the word '*Anopheles*' varied considerably and examiners even saw '*Aphrodite*'. There were also a lot of references to 'bacteria', viruses' 'plasmids' and even 'bugs'. Examiners hoped that at AS level most candidates would know that malaria is caused by an eukaryotic organism. Even more candidates had not interpreted the

second part of the question accurately and simply described ways of reducing the prevalence of malaria rather than explaining why these had failed. Answers such as '….catch malaria by sleeping with mosquitoes' suggest that candidates have not read through their descriptions before completing the examination.

Teaching tip:

To revise the infectious diseases, divide your teaching group into groups of three or four. Provide each group with a different question from past papers. Ask them to write their answers in note form on acetate sheets which can later be peer-marked by the class as a whole using the original mark scheme. This enables revision of all the diseases without every student having to write essays on each one and also enhances their understanding of how the mark scheme is applied.

Question 5

Provided candidates with a diagram showing the origin and development of B lymphocytes. Candidates were expected to interpret the diagram and apply their knowledge about the immune system to this diagram. Parts (a), (b) and (c) were answered with varying degrees of success – but the majority of candidates achieved a sprinkling of marks from these questions. The best candidates scored well as expected, but weaker candidates confused antibodies with antigens, used the term 'pathogen' in place of 'antigen' or gave a very vague response about the function of memory cells. The most common errors were to state that memory cells 'produce antibodies' or 'remember antigens'.

In part (d) better candidates gave a detailed account with references to figures from the graph. Weaker candidates failed to note that there were no antibodies for the first five days, that the rise in concentration was steep or that the decline in concentration was slower than the rise. Some candidates had either not read the question or could not distinguish between the terms 'describe' and 'explain'. This lead to detailed descriptions of how the immune system responds to a vaccination which, unfortunately, gained no marks.

The majority of candidates realised that the vaccination provided artificial active immunity.

Teaching tip:

Spend a lesson going through the difference between 'describe' and 'explain'. Use examples of graphs and tables of results. Split the graph into sections and ask for your students to describe the relationship between the variables at each section. The peaks and troughs should be emphasised by using figures to describe their position. Then ask them to explain the relationship.

Responses to question 6 ranged from excellent to very poor. Examiners were surprised that less than a third of candidates achieved full marks. The most common error was to state that lactate was absorbed by the cells of the muscles rather than the liver. Some candidates wrote anaerobic in place of aerobic respiration in line two and in the penultimate line candidates confused deficit with debt or even offered the examiner both alternatives from which to select.

2803/01 Transport - Written Paper

General Comments
The whole mark range was used on this paper and there were some excellent answers showing a detailed and clear understanding of the topics. The whole mark range was used and there was no evidence that candidates were short of time. Although there were good answers to the more plant orientated questions, the trend that has been noted before continued in that many candidates found these areas more taxing. It is important that candidates read questions carefully and take note of the command words to avoid writing off the point. Centres should avoid too much rote learning, but challenge students' understanding by approaching topics by asking questions from different angles.

Comments on Individual Questions

Question 1
The aim was to test a variety of aspects of the mammalian vascular system from different angles

(a) Most got the function of the red blood cell correct; but examiners were not accepting 'carry haemoglobin' as that is how it is adapted for its function. Many named the epithelial cell correctly - the commonest incorrect answers being capillary wall or alveolus. The stem of the question asked them to use the information in the diagram. Thus 'ingest bacteria' should have keyed them in to phagocyte, not just white blood cell. The size caused many problems; it was just an exercise in observation, with the with the white blood cell being close to the red blood cell based on the diagram.

(b) The advantage of being able to contain or carry more oxygen or haemoglobin was given by very many candidates, but some got confused by the surface area concept and talked about more surface area to carry oxygen. The disadvantage was less well answered. Many general statements about 'no control' or 'no reactions' were seen rather than precise ideas on a specific aspect of metabolism like protein synthesis that would be lacking. A number seemed to think that without a nucleus the cells would not know where to go in the body or that they would be unprotected.

(c) The scores here were a little below what was expected. Most were aware that haemoglobin would only be found in the red blood cell cytoplasm but some thought it was in the plasma as well and a few placed it in all four areas. A significant number thought that there was no water in cytoplasm and sometimes not in the other areas as well. The least well attempted row was that concerning antibodies. Quite a few candidates seemed to be hedging their bets by doing a hybrid tick/cross. Centres should stress to candidates that these will not get any credit in this type of question.

Teaching tip

The material in this question is very standard material from the specification, but the questions are perhaps coming at it from a slightly different angle. Get candidates to see if they can produce an exam question which tests the material in a slightly different way.

Question 2

It was encouraging to see that overall candidates seem to be getting to grips with water potential terminology and surface area to volume ratio ideas

It was encouraging to see that overall candidates seem to be getting to grips with water potential terminology and surface area to volume ratio ideas.

(a) Many candidates were able to describe the curve clearly and give a suitable data quote. A rapid rate of increase followed by a slower one was perfectly acceptable. About 25% of candidates used steady increase as a synonym for slower rate. This was accepted. Given the scale on the graph, examiners were fairly generous as to where the inflection point came (either in terms of the time or % mass). But candidates should expect and be able to make some reasonably accurate statements form any given scale. This question was a case where a failure to read the question and answer as instructed cost a significant number of candidates. They compared the two curves or explained them. Sometimes they picked up a mark along the way, but the command word here was describe and only the 1 cm cube was mentioned.

(b) Again, there were many good answers here, with a clear understanding of water potential and osmosis. A few had the gradient the wrong way round. Not many mentioned the presence of solute in the potato as causing the lowered water potential and some who mentioned solutes then lost the mark by giving starch as the example. The term 'semi-permeable membrane' still appears. Centres should do their utmost to get candidates out of this habit.

(c) Although there were plenty of good answers here, there was a tendency to leave the key point un-stated and assume that the examiner would work out what was meant. Thus those candidates who did not talk about surface area to volume ratio and give the two values, often failed to get both marks by not following their ideas through. Thus the greater area needed to be linked to its role in osmosis or diffusion. By the same token, the idea of more water entering was not always linked to the greater area. Centres should stress that it is standard convention to refer to surface area to volume ratio, not the reverse. Some thought that the 1 cm cubes had less surface area; they seemed to be confusing a single cube with all 8.

Teaching tip

Get the candidates to carry out this as an actual class experiment and come up with answers to explain the results.

Question 3

(a) About 60% of candidates got both vessels correct, but nearly 20% failed to get either. The usual errors were aorta for pulmonary artery and pulmonary vein for vena cava, but other vessels were named and some inverted the correct answers or just put artery or vein.

(b) About three-quarters of responses were correct with an answer of 75 beats per minute. Most of the rest had multiplied rather than divided so got 48, but the lowest reported value was 0.01 and the highest over 3000. Candidates would be well advised to think about whether an answer they get by some mathematical process is likely to be correct biologically before putting pen to paper.

(c) Common errors to relate the thickness of the walls to the pressure of the blood entering the chambers and thus invoke the idea of stopping the chambers bursting. There is also the misconception that oxygenated blood is per se of a higher

pressure. Good answers were able to talk in term of destination and distance.

(d) Although there were many good answers in the extended writing on the cardiac cycle, there was sometimes a tendency to put down all they knew without reference to the diagram on the instruction to start at point X. There was also a tendency to talk about electrical events even though the question specifically asked that this should not be the case. That being said, those who understood the cycle and could relate it to the diagram often got full marks. A worrying number of candidates seem to think the two sides of the heart do not act together and gave in effect a complete description of the double circulation. Some confused systole and diastole. A number seem to think that the valves in some way carry out the pumping action and a lot seem to think that the atrioventricular valves shut prior to the ventricular contraction. Other errors included having the blood leave the heart in the pulmonary vein and return in the artery or placing the tricuspid valve on the left side and vice versa. About 65% of candidates got the quality mark which required that they started at the point in the cycle requested and had a clear sequence using the terms in the correct context.

Teaching tip

Carry out a demonstration heart dissection or at least view an on line video of one; the latter are easily found by 'googling' heart dissection video.

Question 4

This was the least well answered on the paper. Plant based topics and some asked from a slightly different angle seemed to be the reason.

(a) E was often seen as a stoma rather than a guard cell and a whole range of cells (some even animal, like goblet cells) were mentioned for F. The commonest misconceptions were mesophyll. parenchyma and phloem. Cell parts such as the nucleus, vacuole or starch grains were also mentioned.

(b) The wording in this part of the question was taken directly from learning outcome (b) in the relevant section of the specification. It was disappointing to see how few candidates were able to tackle the question successfully. Successful answers linked the need for carbon dioxide to enter for photosynthesis and oxygen to leave, to the requirement for stomata to be open. Most simply described transpiration with no link to gas exchange or even thought that transpiration was gas exchange. There were a number of answers describing how transpiration sets up the transpiration stream which would have gained marks in section *(c),* but which were not relevant here. Others linked the inevitability of transpiration to environmental conditions. Again this is not what the question asked.

(c) The aim of this question was to get candidates to describe the mechanism of transpiration pull. A recent paper had asked for the pathways of uptake at the root and it seemed as though many candidates thought that this was a similar question. Use of past papers is a useful tool, but candidates should learn not to try to make a previous mark scheme fit a new question. Also this question asked for the mechanism not simply the pathway. A good answer would have started with transpiration at the mistletoe leaves setting up a water potential gradient, drawing water up the xylem and from the tree xylem which is in direct contact. This is possible due to the cohesive nature of water molecules. Many gave detailed descriptions of the pathways across the tree roots. Most did not emphasise that the mistletoe xylem was in direct contact with the tree xylem and osmosis was often

quoted as the means by which water passed down the water potential gradient in xylem thereby indicating that they had forgotten that selectively permeable membranes are not a xylem feature. Cohesion and adhesion were often confused. 'Sucked up like in a straw' may be a helpful way to introduce the idea, but examiners are not happy with it as a scientific description at AS level. The cohesion-tension theory seeks to explain the mechanism, but water cannot be pulled up by a theory which is the way a number of candidates put it.

Teaching tip

When teaching topics, relate them to the learning outcomes in the specification.
When teaching the movement of water up plants, always start with the loss at the leaves by transpiration and relate that back to the setting up of a water potential gradient from leaf to root.

Question 5

The majority of candidates scored something here, but less than 20% got all the answers correct. The items relating to the double circulation and valves were the best understood. Many knew that the artery lumen is relatively narrow to maintain pressure although a significant minority thought it was relatively large or smooth. The smooth muscle was often seen as contracting to move blood and it is still a common misconception that a closed system is one where nothing enters or leaves the vessels.

2803/02 and 2806/02 Transport / Unifying Concepts / Skills – Coursework 1 & 2

General Comments

Pleasingly the majority of work submitted was of a good standard and was marked and annotated to a high standard. Centres where staff are either new to teaching at this level or have not taught this specification before are having difficulties matching the candidates' work to the descriptors. From the moderator's point of view, centres with inexperienced staff are quite obvious. Such centres must take advice from OCR before committing to coursework for A2 this September by using the free coursework consultancy service.

Good investigations

The most popular areas include osmosis and enzymes for AS whilst respiration is the leader for A2, though there are large numbers of original alternatives. Great care should be taken to ensure that the synoptic descriptors can be matched when choosing an A2 investigation. An example would be with photosynthesis where the effect of temperature works well, but the effect of different light intensities or wavelengths often fails to meet the synopsis criteria. Some excellent ecology and microbiology work has been seen again this year; Centres are reminded that module specific techniques such as serial dilutions and aseptic technique are valid scientific knowledge and understanding (SKU) for skill P but not skill A.

Poor investigations

There are still some Centres setting invertebrate physiology investigations to represent human heart function or the effects of exercise or drugs. Similarly some centres are setting perfectly good supportive practical work in human physiology and submitting it for assessment without considering control of variables or the underpinning SKU. At A2 the task must be taken from the appropriate module specification or it will not match the synoptic descriptors and so will not be eligible for high marks in skills P and A.

Intermediate marks

Centres should note that the mark descriptors within a skill area have been written to be **hierarchical**. An **intermediate mark** may be awarded when the work of a candidate exceeds the requirements of a defined mark level but does not meet the requirements of the next higher defined mark level sufficiently to justify its award. Thus, an intermediate mark could be awarded if the work meets half of the sub-descriptors at the higher defined mark level. For example to award level 5 for Planning all the sub-descriptors must be fully met for level 1 and 3 plus either all of the sub-descriptors for P5a, **or,** all of the sub descriptors for P5b, **or** 50% of the sub-descriptors from P5a or P5b (e.g. P5ai, P5aiii, P5bii).

A major cause of adjustment remains the lack of structure to some candidates work. The use of tables to reduce repetition and omission makes the task of presenting work in writing much more straightforward and more representative of candidates' ability. Even the best students sometimes fall into the trap of submitting large quantities of text where digression causes confusion in the writer's mind and masks detail essential to the task. This is particularly true of planning where P7aii and P7b may be lost and in analysis A5bi, A7ai and A7bi often suffer a similar fate. Some suggestions are shown below.

Apparatus list

Item	Quantity	Concentration and volume

The two tables below could also be used to guide candidates, without unfair assistance, in fulfilling parts of P1a, P5b and P7b.

Table to show how concentrations of working solutions will be made

End concentration	Volume of ……	Volume of …….

Table to show reasons for choice of apparatus

Item	What it is used for	Reason for choice

Skills P3a and P7b might be more clearly stated if candidates used a table such as that below. These aspects do not have to be written in continuous prose.

Table to show the variables that must be controlled

Variable	Why it must be controlled	How it will be controlled

Skill E (evaluating) is said to be the more difficult and therefore discriminating part of the coursework assessment. Centres that have adopted the table shown below have had some startling improvements in overall standard of work.

Table to show some possible effects of limitations in the methods

Limitation [E3a]	Error that may have resulted from the limitation [possibly E3bi]	Rank order of limitation <u>with qualification</u> [E5ai]	Suggested improvement [E5aii]	Justification of improvement [E7a]

Statistical analysis is a useful skill and enhances work at this level, particularly at A2. Some candidates spend a good deal of time developing conclusions based on the stats. However, since A5bi and A7bi require relevant SKU, conclusions based on statistical reliability often do not match those descriptors.

Skill Specific Comments

The descriptors that are most likely to cause centres to assess inappropriately are: -

Skill P

- **P3b Decides on a suitable number and range of observations and/or measurements to be made**

Candidates must plan to use at least a range of 5 with 3 replicates, even if the centre would be unable to permit them to carry this out for logistical or time reasons. This must be considered as completely separate from Skill I.

- **P5bii Produces a clear account using specialist vocabulary appropriately**

There are a number of textbooks that offer alternative vocabulary for water potential outlined in the specification. Whatever a centre's professional preferences may be, only that in the specification may be used in assessment.

Skill I

- **I5b ii Records observations and/or measurements in an appropriate format**

The independent variable (IV) must be in the first column and data must be presented in a single table to enable comparison of changes in the IV. Time is not considered an independent variable.

Skill A

- A3a Processes and presents evidence gathered from experimental work including, where appropriate, the use of appropriate graphical and/or numerical techniques.

Where ICT is used to plot a graph, the result must be large enough and have major and minor grid lines for both axes. A good guide is that the reader must be able to extract intermediate data. All other information, labels, units etc must also be provided. There are still quantities of hand drawn graphs that are of a poor standard. In particular the use of blunt coloured pencils or felt pens to plot data points and draw curves produces does not produce a usable graph. Candidates who do not plot adequate quality graphs could fail to match A3a.

A5a carries out detailed processing of evidence and analysis including, where appropriate, the use of advanced numerical techniques such as statistics, the plotting of intercepts or the calculation of gradients.

- ***Whilst candidates are expected to, for example, calculate a mean for A1a, this descriptor requires more advanced maths.***

- **A5bii Produces a clear account uses specialist vocabulary appropriately**

See *P5bii* above.

Skill E

- **E3bi Comments on the accuracy of the observations and/or measurements**

  Accuracy is an assessment of how close the obtained value is to the true value. This can be achieved by the calculation of/comment on the % error, commenting on the accuracy for piece(s) of apparatus, or commenting on how the trend line compares to the theoretical trend line.

- **E5ai 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. Simply ranking the limitations can do this, but other techniques may be used.

- **E5bi Comments on the reliability of the evidence**
  Considering the closeness to the mean, variance, size of the range bars/percentage error/standard deviation/standard error etc can all be used by candidates to assess reliability. If in doubt the Centre should contact OCR.

- **E5b ii 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 e.g. if data (raw or processed) is increased/decreased as a result of the error(s).

There is some confusion between the terms “limitation” and “source of error” and some centres are having difficulty in assessing the hierarchical components of level 5. Centres should consult the coursework handbook for further advice.

2803/03 Practical Examination

General Comments
This paper seemed to be a fair, straightforward paper for the candidates allowing good discrimination. The Planning Exercise prompted a range of answers of varying quality, but as it was an easy exercise to set up many candidates had carried out some preliminary work and showed evidence of this. There were, however, candidates from a number of large centres who produced plans in examination books apparently under test or timed conditions which had been handwritten on both sides of the paper. Handwritten scripts often lacked margins and were sometimes presented in an untidy manner. Plans do not have to be produced this way and it often disadvantages these candidates. Fewer candidates exceeded the maximum word count but a few centres seemed to encourage excessive appendices for risk assessment and preliminary work. The vast majority of candidates gained good results in Q.1 and were able to show a clear trend. Q.1 (c) and (d) gave the best discrimination on the paper. The Examiners had many marking points at their disposal so that all points credited contributed to the final score. Many candidates gained marks in the 20s although few gained full marks. The drawings in Q.2 were poor showing that drawing and observation skills had not been developed as well as they might during the course. The Examiners are sympathetic to the difficulties of including practical skills development in their courses as the time for AS courses has been cut in many centres.

Comments on Individual Questions

Planning Exercise
Over the years the standard of the planning exercise has improved to such an extent that a high proportion of candidates now score full marks. Performance varies a lot between centres and it was very clear from scripts that preliminary work in some centres was more structured than in others and that the degree of support given to candidates by teachers varied considerably. Some candidates included photocopied sheets about casein supplied by centres. This is carrying the support too far as candidates are expected to research their own background information although there was not a great deal available for this exercise.

The overall quality of plans was good. Although there were few plans which scored all marking points, many candidates achieved 16 marks. As usual certain centres had candidates with very good plans but weak tests. In the plans weaker candidates were unable to appreciate the difference between time and rate and consequently missed marking points **Q** and **R**. A significant number of candidates from some centres wasted time and effort on elaborate diagrams of apparatus and tables that justified choice of apparatus and aspects of the method. The rest of the report comments on the marking points **A** to **T**. **A** Almost all candidates produced a workable method including setting up instructions for measuring rates of milk coagulation; most stuck to the suggested method of ‘slide dipping’. Some candidates were not awarded this point for ‘dipping’ slides into boiling tubes or test-tubes. Other candidates not awarded this point used only different volumes of calcium chloride solution to alter the calcium ion concentration. A few candidates used different concentrations of sodium citrate to alter the concentration of calcium ions in the milk which could possibly work if the concentration were small. Few candidates quoted the concentration of calcium in milk which is about 120 mg 100 cm^{-3} (1.2 g dm^{-3}). This information is printed on milk cartons and is readily available from other sources. It was extraordinary that so few researched this seemingly obvious information for the Plan that links with Section 2 of *Human Health and Disease.* **B** The majority made a clear statement relating calcium ion concentration to the rate of coagulation. **C** Most candidates selected appropriate apparatus, but some did not identify these in a list or a table or a section headed *Apparatus*. **D** Most appreciated that coagulation involved precipitation of milk protein by rennin while weaker candidates simply concentrated on describing or listing the factors affecting enzymes in general terms. **E** Although factors to control were often correctly identified, some

candidates simply gave a list of factors affecting enzyme activity, without saying that they would control these factors or keep them constant. Many candidates referred to 'amount of' when they meant volume or concentration but did not make it clear which.

F Almost all candidates were awarded this point with the vast majority appreciating the need for at least five values for the calcium chloride concentration. **G** This was usually awarded with **F** except when candidates simply added different volumes of calcium chloride solution without giving their concentrations. This was usually centre-based. **H** Most candidates recognised the need for three or more repeats to improve reliability. **I** Many candidates quoted general information on milk and/or enzymes with little application to the question set. Most candidates were awarded this mark for describing the role of calcium ions in influencing coagulation through interaction with various milk peptides or acting as a cofactor for rennin. **J** Although the majority made reference to preliminary work and often quoted results, many were unaware of the purpose of a pilot study. Many candidates did not state clearly how their pilot study influenced their final method, so they missed out on the mark. **K** Most candidates gave appropriate safety comments, but many omitted hazards (chemical irritants and allergens) so that just a precaution ('wear goggles or gloves') was given. Some candidates were not specific enough about safety hazards and just gave the usual references to general laboratory safety ('tie hair back and push stools under the bench'). **L** A few candidates were not awarded this mark for poorly constructed methods and for giving liberal use of unqualified 'amount of' reactants. **M** The majority used an appropriate method for observing milk coagulation by dipping slides into beakers of milk or putting drops of milk onto slides. **N** Most candidates were able to give relevant information, but many failed to cite their references in the text, so did not receive credit. This seems to be a perennial problem and one that is easily solved by appropriate advice to candidates who will obviously need reminding **O** Very few candidates, if any, did not qualify for this mark **P** The quality of tables was better than in previous years. However, there were still too many tables with units missing or with inappropriate units. Although these are 'table blanks' column and row headings should be completed correctly with appropriate units. **Q** Candidates had to show how to calculate the rate of coagulation as demanded by the question. This was usually centre-based when many candidates showed how to calculate rate as 1/t. **R** A surprisingly large proportion of candidates ignored graphical presentation of data completely. Many sketch graphs were of variable quality, with some placing time on the horizontal axis rather than calcium concentration. The mark for the graph was only awarded when *rate* was given on the vertical axis, not time. One candidate wanted to plot 'coagulation against morality'. **S** This was usually awarded to candidates who appreciated the difficulty in identifying the end point. Many referred to identifying anomalies, but few appreciated, or commented on, the need to discard these anomalies. **T** This was poorly attempted and was centre-based. References were usually made to the use of citrate ions to remove the calcium ions. Although it was clear that most understood the need to remove calcium ions from milk samples and then add known concentrations of calcium ions in order to investigate their effect many did not comment on this in their Plan. next year.

Teaching tip

The enzyme used in this investigation goes by a variety of names: rennin, rennet or chymosin. The NCBE sells Fromase that some centres used for this investigation. There are several simple investigations which can be carried out using this enzyme. Sources of useful information are:
www.ncbe.reading.ac.uk/NCBE/PROTOCOLS/PRACBIOTECH/PDF/rennet.pdf
and
Gill, J and Saunders, T (1987) Rennin, a neglected enzyme? Journal of Biological Education. 21 (4) 248-250.
The Practical Biotechnology booklet is soon to be removed from the NCBE web site. Anyone looking for Biotechnology resources should consult: www.eurovolvox.org

Practical Test

Q.1

(a) There were a few split tables but many scored highly on the results table. Most common errors were

- not including a column for lipase concentration, consequently missing marking points 1 and 2,
- not recording the results for Tube A as 'no change' and zero (rate) in their table,
- giving times in minutes although the table headings were in seconds,
- recording the rates incorrectly using different numbers of decimal places, for example.

Some candidates referred to ligase.

(b) Graphs were mostly accurate, again scoring highly. The most common reason for not awarding full marks was for not drawing appropriate lines of best fit. Some candidates extrapolated the line after the 5% enzyme concentration; others simply drew lines 'dot to dot' when the points fell on a perfect curve, while many did not start at the origin when plotting the rate.

(c) and (d) The Examiners marked these two parts together since some candidates included excellent information from *(d)* in *(c)*. The original intention was to ask *(d)* before asking candidates to describe and explain their results. In the event this did not seem to matter although the original version had logic behind it. It was pleasing to see many candidates including comparative data quotes for their descriptions of the graph as well as referring to anomalous results. Few identified the lipid as substrate, although many seemed to appreciate that it was the release of the fatty acids from the triglycerides which were responsible for the colour change of the indicator. Some were confused over the pH change and some thought the enzyme had affected the indicator so the milk became visible.

(e) This was a high scoring question - many centres had obviously prepared their candidates for this question with most candidates gaining marking points for the difficulty of identifying the end colour, temperature control, repetitions, contamination, and timing. Whilst many referred to the difficulty in deciding upon the end point many suggested the improvement would be to use a colorimeter. In this case a colorimeter would not be appropriate because of the milk present in the tubes. Fewer mentioned the need for a more sensitive indicator although mentioned that measuring by 'drops' was not accurate. Not all explained both the disadvantages and appropriate improvements, so missed half the possible marks.

Teaching tip The theme behind this paper was calcium. If the Coffeemate™ used to make the milk solution is prepared without calcium chloride, nothing happens when lipase is added. In the same way that calcium is required for the action of rennin, so it is required by lipase. The original intention was to use lipase from pancreas rather than Lipex. This lipase is supplied in powdered form and is the more usual form used in schools and colleges. This works just as well with this investigation as Lipex. The change was made to save any difficulties over the animal source of the enzyme. Lipex is obtained from genetically engineered bacteria and is one of the detergent enzymes recently marketed by NCBE. For more details, see: http://www.ncbe.reading.ac.uk/NCBE/MATERIALS/ENZYMES/washenzyme.html These would make good materials for investigating washing powder enzymes in a variety of courses.

Q.2 Some centres reported difficulties in seeing xylem vessels using the low power objective of their microscopes. The Instructions always refer to low power as a x10 objective lens so that candidates should have been observing the rhubarb tissue with a magnification of x100. The vessels are very clear and the Examiners were surprised by this comment. However, it does highlight the need to make clearer in the Instructions and the Tests which magnification should be used. Some centres also did not appreciate what was intended by 'celery petioles' and wondered where they could be sourced.

(a) The vast majority knew the appropriate calculation and gained at least one mark. However, many did not convert their answer to the correct units.

(b) Almost all gained this mark for identifying the chloroplast as the structure visible within the cells in Fig. 3.1 that shows the cells are from a leaf cell and not a root cell.

(c) Candidates from some centres wrote excellent answers drawing on their knowledge from *Transport* whilst weaker candidates thought the gaps between the cells are for air expansion or the movement of water.

(d) The quality of the drawings was not very good. Candidates gained marks because the requirements of three of the marking points were perhaps not very demanding. However, few gained the marking point for 'clear, continuous lines' something that needs emphasising to these candidates before they take practical examinations in January or June 2009.

(e) Many good candidates were able to score many marks with clear observations of vessels but weaker candidates saw nothing, often describing from theory or imagination.

(f) Many candidates appreciated that lignin is required for strength, waterproofing and preventing wall collapse, but few related to the tension that develops in xylem vessels as a result of transpiration. Weaker candidates often referred to plant and/or stem support.

Teaching tip

Tinned rhubarb is a simple alternative to using macerated stem or root tissue for observing xylem vessels. A good test of skill is to ask candidates to prepare longitudinal slices of vascular tissue of celery petioles that have stood in a dye, such as methylene blue, eosin or a food colouring. The vessels are somewhat easier to see in the celery preparation, but this does take candidates some time and that is a quantity in very short supply in these practical examinations.

2804 Central concepts

General Comments

Examiners felt that the paper was of appropriate demand and that candidates' responses did not show that a shortage of time was an issue. Many examiners commented on the large number of additional sheets used and also the number that were not attached and often inserted by the wrong question, making checking difficult. Centres should instruct candidates to insert any extra sheets in the correct section of the question paper. The extra sheets should be attached with a treasury tag to the script.

Comments on Individual Questions

Q.1 A good introduction to the paper. It allowed all candidates to score some marks but also differentiated well in sections (c) and (d).

(a) The majority of candidates were able to name **P** and **Q** correctly but then often failed to get the mark for R. Common responses which were not credited included unqualified references to 'membrane' and incorrect answers such as 'plasma membrane' or 'cell wall'.

(b) In section (i) candidates struggled, with only the more able gaining the mark. Many did not qualify references to diffusion or exchange of materials and failed to make the link with short distances or rapid movement. Others wrote in terms of mitochondria needing to be 'small to fit into cells'. Weaker candidates sometimes confused mitochondria with red blood cells and talked about the small size allowing 'easy movement through blood vessels'. They occasionally implied that mitochondria needed to be small enough to 'fit through pores in the membrane'. In section (ii) most candidates picked up the idea of folding leading to a larger surface area and often went on to gain the second mark by referring to increased ATP production or to more oxidative phosphorylation. Credit was not given, however, where references to 'increased respiration' were too vague or when candidates discussed the link reaction or the Krebs cycle.

(c) The most frequent errors here were glucose or ATP being given as substances entering the mitochondrion. Candidates often thought of the left hand column in terms of 'products of glycolysis' - hence the inclusion of ATP in answers.

(d) This proved very difficult for the majority of candidates. A common mistake was to ignore the reference to 'equivalent mass' given in the question and to say that fatty acids were simply much larger molecules. With more bonds to break, more energy could be released from them. Others referred to the bonds being 'weaker' or 'less stable' or needing 'less activation energy' and, therefore, easier to break in respiration. Others said that the bonds within the molecule were simply 'high energy' ones. Some answered in terms of hydrogen bonds rather than C-H bonds or just 'hydrogen'. Supplementary points as to why the hydrogen was important were rarely seen.

(e) In section (i) the majority of candidates gained the two marks. They went on to state in section (ii) that different respiratory substrates had different RQ values and could correctly quote these. Fewer students made the link with aerobic respiration. In general examiners felt that candidates' knowledge of RQ values was far more secure than the last time it was tested on this paper.

Teaching tip
Encourage students to relate structure to function in biology wherever possible. Revisit structure of mitochondria when studying respiration. Look at electron micrographs. The following web page has an excellent image;
http://student.ccbcmd.edu/courses/bio141/lecguide/unit1/proeu/dkmito.html

Q.2 This question tended to be well answered with most candidates gaining a higher percentage of marks here than any other question.

(a) In section (i) examiners were pleased to see the majority of candidates gaining at least three marks, with a good proportion gaining a maximum of five. In section (ii) again most candidates gained full marks. Centriole was the most common error for E and some thought G were homologous chromosomes or bivalents. In section (iii) very few accurate answers were given. Many candidates referred to cytokinesis rather than meiosis. Some even suggested that plant cells have no chromosomes despite correctly identifying G in section (ii).
Examiners were looking for the fact that centrioles are absent in plant cell meiosis. Other acceptable responses were that there is no telophase 1 in many plant species and that meiosis is involved in spore formation in plants and gamete formation in animals. In section (iv) a wide variety of answers were given. Many candidates did not read the question carefully enough and did not refer to the diagram. Answers of 2 and 4 were not uncommon. Many examiners felt that haploid was not a term that many candidates were familiar with.

(b) This secured good marks for all but the weakest candidates. Almost all could quote 'crossing over' and many went on to accurately describe the process and at what stage of meiosis it takes place. There were also many references to chiasma(ta). Fewer candidates went on to say that this results in new combinations of alleles. Similarly 'random assortment' was frequently stated or described for metaphase 1 but less often for metaphase 2. Few candidates realised that it is random assortment of chromatids in metaphase 2 rather than chromosomes.

Many candidates referred to mutations but failed to gain a mark as their descriptions were of gene mutations rather than chromosome mutations.
A few candidates gained a further mark by correctly naming a chromosome mutation. To gain maximum marks candidates had to discuss how fertilisation leads to variation. There were many excellent answers referring to the random nature of the fusion of the gametes and mating within the population. To gain the QWC mark candidates had to write a well organised account and include four terms from the following list; crossing over, chiasma(ta), allele, mutation, bivalent, independent / random assortment and gamete. Many candidates gained this mark.

Teaching tip

The correct terminology is very important when it comes to describing meiosis. There is still much confusion between allele and gene, chromosome and chromatid, chromosome and bivalent. There are many excellent animations of the process which help to clarify the differences and support students' understanding of crossing over and independent assortment. A good animation is found at the following link : http://www.johnkyrk.com/meiosis.html

Q.3 This question differentiated well. Candidates scored well in many parts of section (a) and in section (b). Section (c) proved to be more demanding.

(a) In section (i) most candidates gained a mark for correctly stating ATP but a significant number carelessly stated NADH rather than NADPH for the other product of the light reaction. In section (ii) many candidates correctly identified stage **D** as where the products of the light dependent stage are utilised but fewer correctly identified stage **G**. In section (iii) examiners saw a range of answers with all but the weakest candidates gaining credit for referring to use of hexose sugars in respiration. Other common correct answers were conversion to starch, cellulose, sucrose and protein. Examiners were pleased to note that in section (iv) most candidates know that the light independent stage of photosynthesis occurs in the stroma. There was no credit given for candidates who stated stoma. Section (v) proved more demanding. Only the more able candidates were able to work out that the level of RuBP will rise and that of GP will fall because as the level of carbon dioxide decreases, less will combine with RuBP to form the GP even though RuBP is still being regenerated in the Calvin cycle.

(b) The three marks in this section were targeted at E/U grade candidates and examiners were pleased to see the vast majority of candidates scoring full marks. The one common error was for candidates to write 'light' rather than 'light intensity'.

(c) A significant number of candidates failed to read the question carefully enough and wasted space **describing** the data given in table 3.1 rather than producing an **explanation**. Successful answers referred to the temperature rising and this resulting in an increase in transpiration. The maize responds by closing stomata and this reduces carbon dioxide uptake. Credit was given to candidates who mentioned the role of ABA in stomatal closure. Another successful explanation was to link the increase in temperature to increasing rates of respiration as respiratory enzymes would be working at an increased rate. The result would be greater carbon dioxide production by the cells in the leaf and therefore less carbon dioxide needs to be taken up by the leaf.

Teaching tip
Stress the importance of candidates knowing the difference between describe and explain when used as trigger words in exam questions.

Q.4 Examiners reported that many candidates scored full marks on both sections. They used the information in Fig. 4.1 to good effect and many have a well developed understanding of receptors, nerve impulse transmission and how the impulse travels across a synapse.

(a) The mark scheme was divided into nine marking points for a description and an equal number for the explanation. Candidates could score a maximum of four marks in the description section. Credit was given for descriptions that compared the values of the recordings from an individual microelectrode as the pressure was increased and also for comparing readings from the two microelectrodes at the same pressure. Data quotes gained credit but examiners were looking for the correct units to be used. There were many excellent explanations and examiners felt that accounts of depolarisation, repolarisation and hyperpolarisation were much clearer compared with the last time this area of the specification was tested. Weaker candidates tended to confuse depolarisation and repolarisation and had sodium and potassium ions moving in the wrong directions.

(b) Candidates have a good appreciation of the events occurring at a synapse. Many were able to successfully apply their knowledge to this unfamiliar example. Centres should encourage their candidates to always qualify references to the membranes of the synapse by using the terms presynaptic and postsynaptic.

Teaching tip
The following website has excellent animations on many aspects of human physiology including nerve impulse transmission.
http://highered.mcgraw-hill.com/sites/0072495855/student_view0/

Q.5 This proved to be the most demanding question on the paper. This was probably due to the large amount of stimulus material that candidates had to assimilate to answer sections (a) (ii), (iii) and (iv).

(a)(i) Calculating percentage changes has traditional caused problems for candidates on this paper and this question was no exception. Candidates who calculated one of the two values correctly gained two marks.

(ii) The concept of selection pressures was unfamiliar to a number of candidates. A significant proportion of candidates stated features of the finches such as beak length and depth rather than shortage of food and competition from the large ground finch. Examiners credited interspecific competition but rejected competition unqualified.

(iii) From the information provided in the stem of the question candidates should have been able to deduce that following the 1997 drought there were no large ground finches and also the seeds were larger in size and had harder coats. Candidates had to mention one of these for the mark.

(iv) This question proved to be an excellent discriminator. Only the most able candidates could effectively communicate the mechanism for the change in beak size in the medium ground finch population between 2002 and 2005. Examiners were looking for candidates to state that there is variation in the beak size of the medium ground finch population. The finches with the larger beaks would be in competition with the large ground finch. The medium ground finch would be out competed by the larger species. However medium ground finches with smaller beaks would be better adapted to opening smaller seeds. They would survive to reach reproductive age and pass the alleles responsible for beak length to their offspring. This is repeated over a number of generations and results in an increased frequency of the small beak alleles.

(b) Candidates should have deduced from the data that a change is taking place in the size of the beaks of the medium ground finch population. They should therefore disagree with the statement with the reason being directional selection is taking place.

Teaching tip
An account of the research on the Galapagos finches can be found at:
http://news.nationalgeographic.com/news/2006/07/060714-evolution_2.html

Q.6 This question differentiated well. Only the most able candidates gained close to full marks.

(a) In section (i) most candidates answered "predator prey" correctly. The most common incorrect answer was interspecific. In section (ii) many candidates gained full marks but some either just offered an explanation for the graph and a smaller number just described the graph. Many candidates described the full time range of the graph rather than just 1970-85 as was requested in the question. A significant number mis-read the numbers in the moose axis for the wolves. There were many good explanations of the data with correct references to the predator and prey. This section did provide some amusement for examiners with some candidates not knowing what moose were and probably thought it was a misprint calling them mouse, mice or even 'meece'. A few thought moose preyed on wolves and in some responses wolves mutated into foxes!

(b) This section was not answered as well. Some candidates simply repeated the question and a significant number changed the word "inbreeding" to "interbreeding". Most candidates gained one mark, however, for referring to decreased genetic variation as a result of inbreeding.
The greater chance of recessive alleles being expressed in the offspring was only mentioned by the stronger candidates. Many examiners commented that candidates often incorrectly stated that inbreeding caused mutations.

(c) In section (i) examiners were looking for candidates to realise that fat reserves have a role in insulation. In a hot summer this insulating layer would be a disadvantage as it would lead to the moose overheating. Credit was given if candidates referred to fat being respired as a source of water and also if they commented that vegetation would be in short supply and that there would be little extra food to lay down reserves. In section (ii) examiners expected candidates to comment on the moose being weakened by the tick infestation and that their fat reserves would result in them having less energy to escape from the wolves and that less insulation meant that were less able to cope with the winter conditions. With more food available for the wolves they can successfully reproduce and population size will increase.

Teaching tip
When teaching predator – prey relationships use examples other than the Snowshoe hare and the Lynx.

2805/01 Growth, Development and Reproduction

General Comments

There were very few blank spaces in this question paper, and most candidates were able to provide full answers which often required additional writing paper. The two questions involving a long response provided the opportunity for candidates to demonstrate their knowledge and understanding, and it was pleasing for the Examiners that full and detailed responses were often provided. Less able candidates were also able to express themselves at length, thereby enabling them to demonstrate their knowledge to the Examiners and gain appropriate credit.

Teaching tip

Synoptic areas of the paper are often answered the least well. Candidates should be encouraged to prepare mind maps or diagrams to show interrelations between topic areas, e.g. the interrelationship between general and specific knowledge on mitosis and meiosis. Where candidates are taught the actual mechanics of both mitosis and meiosis , they could also be taught the roles of both these processes in evolution and in gamete formation in both plants and animals.
Two of the questions involved dealing with data. Many candidates handled the data well and it was pleasing to note that they were able to quote figures from the graphs and identify trends.

Teaching tip

Candidates should be aware that when questions are worded to include 'using the data from Fig. 1.1' etc., credit will be given for inclusion of data, with appropriate units, from the figure. Candidates should practise interpreting graphs and tables. They should also practise identifying the 'trend' and quoting data to support their interpretation.

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

Comments on Individual Questions

Q1 This question was answered reasonably well by the majority.

(a) (i) Most candidates were able to fill in the table with the correct site of production of these hormones.
Some confused the *interstitial cells / cells of Leydig* with the *Sertoli cells* in the testis and others quoted the *pituitary gland* as the site of production of GnRH rather than the hypothalamus.

(ii) Describing what is meant by *negative feedback* produced a wide variety of responses, most of which gained one mark at most. Many described homeostasis, and so were able to correctly describe a *parameter coming back to set point / normal*, but few noted that the *change in the parameter* would need to be *detected* in some way. Those candidates who clearly understood the concept were easily able to gain the marks, and gave clear, specific answers. However, many responses lacked this clarity, e.g. *one thing causes another to stop*.

(b) Many candidates confined their answer to describing the effects of *oxytocin* **at birth**, detailing *positive feedback* in this context, which was not relevant. The effects of suckling were described in a less detailed way which indicated that many candidates were unfamiliar with oxytocin in this context. Many failed to state that

oxytocin is *produced in the hypothalamus*, but is *released from the posterior pituitary.* Some candidates also confused the roles of oxytocin and prolactin. Nevertheless, those candidates who were well prepared provided some pleasing and detailed answers for which maximum marks could be awarded.

(c) (i) The most common reason for the loss of a mark when describing why lipids are necessary to a growing baby, was to state that they are an *energy store*, when a more specific reference to *respiration* was required. Many candidates correctly stated that they are required for *cell membrane / phospholipid synthesis*, or that they *insulate* the baby.

(ii) Many candidates correctly stated that essential fatty acids *cannot be made in the body* and therefore gained one mark. A second mark was rarely given, although some Candidates could specifically name *linoleic* or *linolenic* acid for this mark.
A few candidates assumed the question referred to essential *amino acids* and therefore incorrectly answered in terms of proteins etc.

(iii) All but a very few candidates successfully quoted an advantage to a baby of being breastfed. Most candidates stated that *antibodies* were transferred in breast milk, (although some unfortunately used the word antigen), or that a baby gained the *correct balance of nutrients*. A few had no suggestion to offer.

Q2 Generally a well answered question with many candidates obtaining high marks. Candidates clearly find this an interesting topic and were able to demonstrate their knowledge well.

(a) (i) Both marks were awarded in most instances as most candidates were able to give two functions of the amniotic fluid. Some lost marks when they stated *protection*, without making it clear that the protection is from *knocks or bumps* etc.

(ii) Similarly, most candidates were aware that the cervix *dilates* or *widens* to allow the baby to come out. Some failed to gain this mark as they stated that the cervix *contracts* to push the baby out.

(iii) Many candidates gained full marks by describing how the *chorionic villi* and the *microvilli* provide a *large surface area*. Fewer described the close association of the mother and foetus' blood, and fewer still described the diffusion pathway as being short. The most common fault would be to describe diffusion as being *quick and easy,* which is too vague to gain credit
(iv) Most candidates correctly identified differences between the umbilical artery and the umbilical vein, such as *oxygen / carbon dioxide / urea* content for example, but unfortunately many confused the two vessels and consequently failed to gain these two marks. Alternatively candidates failed to make comparative statements, e.g. *contains urea*, rather than *contains* ***more*** *urea*.
Some candidates made reference to foetal haemoglobin having a *higher affinity for oxygen,* which was not relevant here.

(b) (i) The calculation proved taxing for most candidates. Most managed to pick out the right figures to use, but often were unable to arrange the figures in the right way in the formula.

(ii) This section was generally answered well with most candidates able to correctly identify the trend that *as the altitude increases / partial pressure of oxygen decreases the mean birth mass of babies decreases*. Often accurate figures were picked out of from the table to illustrate the trend. Again, failure to quote units was sometimes a problem .

Despite the fact that most Candidates correctly concluded that this trend was due to lack of oxygen, some candidates did not follow through the consequences in a logical way, and so did not gain all the available marks. E.g., some did not make a distinction between the *maternal* and *foetal haemoglobin*, or talk about transfer across the *placenta*. However most stated that the foetus would lack oxygen for *respiration* and that the growth rate would be reduced, although some candidates did not specify why the growth rate would be affected, due to lack of energy.

(iii) Most candidates were able to gain both of these marks. The most common responses made reference to *diet, smoking or alcohol consumption in the mother*. Compared to earlier years, far less candidates lost marks by giving vague answers, e.g. with unqualified statements such as *drinking*.

Q.3 Overall, candidates scored quite well on this question. Again those who were well prepared gained marks easily and there were many good and detailed answers.

(a) It was evident that many candidates did not have practical experience of a procedure which could be used to measure the dry mass, which would have enabled them to include more detail. Nevertheless most candidates managed to gain at least one or two marks for their accounts and nearly every candidate made an attempt to answer the question. Many made good reference to standard experimental procedures like *keeping various factors constant, doing repeats, calculating mean dry mass* and also to using a *large sample* initially.
Explaining how the data could be presented in the form of growth curves proved more difficult for many. Most candidates were able to name the growth curves; *absolute / actual growth, absolute growth rate and relative growth rate*, but many mistakenly explained what these graphs would show rather than detailing how to plot them.
Some candidates concentrated on describing a technique to compare the growth in different concentrations of nitrogen, and plotted curves with nitrogen concentration on the x axis, and whilst some of the marks for experimental procedure could be awarded, the marks for plotting *growth curves* could not.
Only the more able candidates were able to gain maximum marks for the section.

(b) X . The *testa* was usually identified correctly, but Y, the *cotyledon*, produced a range of responses and was often mistaken for *the micropyle*.

(c) A valid reason for not measuring dry mass was almost always given. The most common reason cited was that the plant or organism *can remain alive*.

(d) (i) Many candidates were able to complete the growth rate calculation; some lost one mark by presenting their answer in centimetres rather than millimetres, and a surprising number divided the correct measurements by three rather than two days.

(ii) Describing and explaining the trends in the graphs produced some thoughtful and pleasing responses. Most candidates were able to describe and quote accurate figures from the graph. Some candidates forgot to quote units and so were not rewarded for their observation.

Again, many candidates were able to deduce a relationship between *gibberellin* and the *rate of growth in the hypocotyls* by looking at the graph, and were able to gain marks for this. Few candidates demonstrated knowledge on the effect of *gibberellin* on growth, apart from the statement that it is a *growth promoter/hormone* but several gave good accounts of the role of *gibberellin* in *germination.*

Teaching tip

Candidates should learn the difference between 'describe' and 'explain' as explained in the glossary on Page 117 of the specification. They could then practice answers to questions of this type, possibly by using each of the command words separately on the same question.

Q.4 This question was not answered well in general. Many candidates struggled with the subject matter and demonstrated that they find this topic confusing and difficult.

(a) (i) and (ii). Many candidates struggled to gain more than 5 marks on this question. Generally the better prepared candidates achieved 7 or 8 marks depending on how well they structured their answer. Sometimes, it was evident from the response that candidates were familiar with the topic, but were unable to express their knowledge clearly enough to gain credit.
Several candidates were clearly very confused by this subject. Many wrote in terms of *Far Red light being turned into Red light* and the difference between the light and the phytochromes was not clear to them. Some candidates did not mention *phytochromes* at all, just R and FR, obviously gaining few if any marks. Those candidates who did achieve good scores on this question used the diagram which shows the conversion of PR and PFR written out.

(b) (i) Most candidates did far better here and gave good and accurate descriptions of *translation*, many scoring maximum marks. The majority gained marks for the *mRNA leaving the nucleus, attaching to the ribosome and peptide bonds forming between amino acids*. Fewer candidates wrote about *anticodons* and *codons* correctly. Some candidates confused this answer with *DNA* replication.

(ii) This was generally not answered well with few candidates scoring more than one mark and many scoring no marks. A large percentage simply rewrote the stem of the question referring to *constans is produced in the late afternoon*. Very few attempted to apply their knowledge or to make suggestions about a potential link to phyochromes.

Q.5 (a) Most candidates scored well, demonstrating good basic knowledge of *asexual reproduction in fungi*, stating that *spores/conidia are formed*, or that *budding occurs in yeast.* Most correctly stated that *mitosis* occurred, or that the cells/offspring produced were *genetically identical*.

(b) (i) Many candidates gained maximum marks and were able to recall the stages and processes involved in *anaerobic respiration* in yeast from the *decarboxylation* of *pyruvate* to the formation of *ethanol*. Many correctly identified the role of *NAD* and made reference to *alcohol dehydrogenase*.

(ii) This section proved more difficult and answers rarely elicited maximum marks. Many candidates gained one mark stating that ethanol is *toxic or poisonous* to yeast, although this mark was often forfeit when candidates were content to state

only that it *'kills'* yeast. Some further explanation was expected for the second mark, and only the more able gained this by describing possible enzyme *denaturation / inhibition* or *damage to cell membranes.* Several candidates assumed that a change in pH would result, or that the yeast would *run out of substrate*.

(c) This section tested candidates' ability to organise their knowledge of different parts of the syllabus, and to use specialist terms with precision, where appropriate. This question produced varying approaches; most candidates were able to state that mitosis produces *genetically identical, diploid* cells and that meiosis results in the production of *haploid cells* or *gametes*. Thereafter candidates would either describe the role of mitosis and meiosis in general terms (e.g. *that reproduction by mitosis does not involve another individual,* or there is *no wastage of energy in producing gametes*, or the role of meiosis in *increasing genetic variation* which enables *evolution*. The alternative approach was to quote specific instances, such as the *division of the generative nucleus by mitosis to provide two male gametes* etc. Either of these approaches yielded good marks in many instances. Of those candidates who took the latter approach, many failed to gain marks by not being precise enough about which cells or nuclei were dividing e.g. the *embryo sac mother cel*l or *pollen mother cell* was often simply referred to as the *mother* cell. Many specific accounts of gamete production in plants were confused and lacked clarity, although knowledge of mitosis and meiosis in general terms was good and many candidates correctly identified the roles of *crossing over* and *independent assortment* in meiosis.
Despite the wide ranging nature of this question, many candidates scored well. However, there were many extremely brief responses, which was disappointing.

Q.6 Surprisingly, many candidates were unable to gain many marks for this question. The question aims to elicit specific answers and many candidates, although realising that the question referred to thyroxine, were unable to provide the correct response.

(a) Many candidates scored full marks in this section and most were able to pick out al least two terms correctly from the list. There were few blank spaces.

(b) (i) Many candidates failed to gain the marks here. Many were familiar with the abbreviations TRH/F and TSH, but where the correct names were attempted they were often incorrect e.g. thyroxine releasing hormone / stimulating hormone. Most were able to correctly insert the anterior pituitary gland into the flow diagram.

(ii) The most common cause for the events shown in the flow diagram was often linked to negative feedback, or a drop in / low level of thyroxine in the blood. Less commonly the higher centres of the brain were cited. Some candidates correctly realised that a drop in external or blood temperature would also cause this effect, but many candidates cited low temperatures and so failed to gain this mark.

2805/02 Applications of Genetics

Question 1

This question proved a good introduction to the paper, and for many candidates this was the one they gained most marks for.

(a) (i) (ii) (b)The vast majority of candidates got these right with only small numbers suggesting it could be due to epitasis'.

(c) The cross again caused few problems with almost all students understanding what was required with correct punnet diagrams drawn. Marks were lost when candidates did not allocate genotypes to phenotype.

(d) (i) This question was universally correctly answered.

(ii) Usually correct with small numbers failing to assign it as more than or incorrectly suggesting less than.

(ii) Considering these are really stock answers it was surprising the numbers of candidates who could not link the lack of significance with the difference from expected. Also a number of candidates equated a large probability to mean the two values were significantly different.

(e) Most realised crossing over must have taken place to change the expected allele frequencies. Many were also able to quote a detail of crossing over. Again considering the mapping distance was give it was surprising how few students picked up on the fact the gene loci were well separated.

Question 2

(a)(i) Generally correct, with some errors at cross 2.

(ii) A significant number of students do not understand the concept of polyploidy, most not realizing it took place in mitosis rather than meiosis. Most gained marks for the term polyploidy or the term non disjuncture.

b) Most were able to say in some form the numbers of chromosomes were different, fewer that the gametes had different numbers. Many realized chromosomes could not pair, other there was a lot of mention about "odd chromosomes".

(c) This was generally well answered with most points seen in a number of papers.
The most common were for future use, acts as a source of genetic diversity and climate change. Many candidates however tended to be rather vague talking about just disease or environmental change which were not credit worthy responses'.

Question 3

(a) Few candidates had problems making observations from the graph or quoting figures. Some however used % for the numbers of live offspring which was incorrect.

(b) Most candidates were able to suggest reasons for the success of out breeding, with all answers seen in a range of candidates.

(c) This question caused problems for students who could not differentiate between inbreeding as a necessity rather than a consequences. For instance natural in breeders, or dog breeding do not require inbreeding in the same way if you are the last pair of spix's macaw's on the planet.

(d) Well answered with most students gaining max marks.

(e) (i) Again well answered.

ii) Most points were seen in a number of answers, although few candidates gained maximum marks.

Question 4

(a)This was again well answered by most candidates although a few miss interpreted the question as one about selective breeding. Almost all points were seen in a number of different papers.

(i) Almost all candidates gain maximum marks for this question.

(ii) General terms such damage to the membrane were not excepted because candidates are expected to know the membrane is pierced.

(iii) Most candidates found this very difficult. Very few could see the link between cooling and thawing. There was almost no reference to figs. The main point that was gained was the observation that slow cooling would allow crystal growth.

(c) Most candidates scored well on this question usually mentioning the AVP points, although a significant number tried to discuss biological implications. There were also a few candidates that wrote about IVF rather than AI.

Question 5

(a) Many candidates understood the concept of a receptor and the complementary shapes of this and the avrPphB protein. However a number mixed the bacterial and plant proteins up or insisted on calling the bacterial protein an antigen.

(b) The slightly different context to this question confused many weaker candidates, who resorted to describing the data rather than explaining the process of natural selection. It is worrying that so many candidates still talk about resistance genes rather than alleles.

(c) This question tended to result in some candidates focusing on the word mutation and then writing down everything they could remember about mutation. In many cases including chromosome mutation which is obviously incorrect in a bacteria and negated the gene mutation mark. A small number of students missed the key word and wrote how natural selection could select for resistant bacteria. However many candidates answered this question well having a good appreciation as to the consequence and effects of base additions/deletions/substitutions. However many just used the terms addition/deletion/substitution with no reference to bases. The concept of a stop triplet was well understood, but most insisted on calling it a stop codon which is obviously incorrect if it occurs in DNA. Silent mutations were mentioned by many but obviously irrelevant in this context. Frame shift mutations were again well understood. Better candidates extended their answer to include mutations in regulator genes and the consequences of these.

Question 6

(a) Most candidates were able to list the symptoms of Huntingdon's Disease, the most common answers included description of involuntary muscle movement, brain cell death, mental deterioration and middle aged onset of the disease. There were some unacceptable vague answers which mainly focused on the mental aspects of the disease.

(b) Very few candidates adequately assigned the evidence to either the autosomal or the dominant aspect of heritance. Some students were able to pull out aspects of the data to support their claims mainly relating to the number of sufferers in each generation and the transmission of trait father to son.

c)(i) Most candidates were able to describe the action of restriction enzymes in cutting DNA and add detail such as specificity of cutting at palindromic sites. Candidates did become confused regarding stutter sections and VNTR's.

ii) Most candidates were able to explain that DNA is negatively charged and that small fragments move further. Some candidates confused anode and cathode or talked about a negative anode.

d(i) Usually well answered with candidates realising bands belonged to different individuals.
(ii) Again most candidates atributed the different distances travelled to different length stutters.

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 not one area that was poorly attempted. Both long response questions were answered in sufficient detail.
This paper involved candidates applying their knowledge of biological concepts in new situations such as in the effects of PCBs on ecosystems and organisms. The recall and application of information from the AS units and from Central Concepts (2804) was generally poor, with many candidates unable to link information together.
For the questions involving the use of data and graphs, candidates performed well and used the data accurately and appropriately.
Candidates struggled with the application of their knowledge in unfamiliar settings such as in the estimation of age in whale populations and in the effects of pyrethroids on gamete production.

Comments on Individual Questions

Q.1

(a) Most candidates scored well in this first question with most linking the rise in CFC's and a subsequent photochemical reaction to the destruction of the ozone layer. Many candidates gave accurate equations and reaction details. A good few candidates confused the issue of global warming and ozone depletion.

(b) The most common response here was to ban the use of CFC's and a few candidates described the actions of governments and the signing of international agreements.

(c) (i) Using the table of data it was evident that visible blue or red light has insufficient energy to break the C-C bond. It is this bond that makes up the backbone of all organic molecules. Candidates were penalised for not using units in there answer.

(c) (ii) It was pleasing to see many candidates using the data in the table to link the harmful effects of uv light to the breaking of the C-C bonds and the subsequent effects upon DNA molecules. This was then linked to the possibility of mutations and then linked to potential cancer. Many candidates gave skin cancer as an example of the possible effects of such mutation. It was rare to see the effects of increased uv light on algal metabolism but many candidates described the increase likelihood of cataracts.

Teaching tip
This question was generally well done and it was good to see many candidates using the data provided to help explain their answers. Candidates can use **http://www.epa.gov/sunwise/uvindex.html** and **http://www.epa.gov/Ozone/science/process.html** as excellent introductions to the causes and monitoring of the ozone problem.

Q.2

(a) (b) The calculation for part (a) was very straightforward with candidates having to simply add 8.64 to 8.64. Using this figure they then had to correctly identify the correct degrees of freedom and use the table of probabilities to justify why the pupils' hypothesis was not supported. Candidates could have used any of the probabilities for 1 df with the exception of 0.10 to obtain full marks. Many candidates gave excellent answers to this question.

(c) Due to the printing of the lines on the graph, the x axis scale was not easy to read at first glance and candidates who rushed into this question may have mis-read from the graph. The maximum species count from the graph is between 0.65 and 0.7m^2 and after this there is no increase in species number. Most candidates scored at least 2 marks here although many still did not include units with the data when quoting figures. This is important to stress as this should be a formality at A level.

(d)(i) Many candidates correctly identified plagioclimax as a plant community maintained by management with far fewer suing the word deflected succession.

(d)(ii) For this question it was clear that many candidates did not read the information in the stem of the question. Management methods for a sand dune ecosystem will be quite different from a forest for example and it would be quite difficult to clear fell grasses from a sand dune! There were many good answers though and the most common included burning, mowing and allowing visitor trampling. Several candidates named specific dune ecosystems and gave detailed accounts of the management used. This suggested that these candidates had either researched this topic in detail or made good use of fieldwork opportunities.

(d)(iii) This question involved candidates applying their ecological knowledge from AS and central concepts and linking this to an area of deflected succession. Many candidates struggled here and many appeared confused as to why biodiversity should rise after prolonged grazing. Very able candidates described the creation of new habitats, increased links to food webs brought about by a reduction in competition for certain named resources. Few candidates used overly technical terms and very few used the term niche. This was a disappointing question as it was apparent that much of the fundamental ecology taught in prior units had not permeated into the understanding of environmental biology.

Teaching tip

The best way to teach this is to do field work and experiment with quadrats and counting species either in the school grounds or during a field work activity. The area to be sampled can be any patch of land as the students are there to learn the appropriate techniques. Data can be provided separately for students to analyse at a later time. The following site http://ed.fnal.gov/ntep/f98/projects/fnal/student/skills/quadrat.shtml has some excellent resources that can be adapted for use with students.

Q.3

(a) Many candidates did not use the information given in Table 3.1 to comment on the implications for future limits to waste. Furthermore, many candidates did not realise that the data referred to limits of the amount of waste that could be sent to landfill in the future for the 3 regions in London. What should have been clear was that all 3 regions need to reduce the amount of waste sent to landfill and that there is a need to recycle more and reuse waste.

(b) This first long answer question proved difficult for weaker candidates. Many failed to describe how liquid pollutants may enter ecosystems but instead concentrated upon airborne pollutants. Many candidates described how liquids may be leached into water courses and then went on to explain how these pollutants might bioaccumulate through food chains. Some candidates took the opportunity to discuss euthrophication in great detail which did not answer the question. Slurry has a high nitrogenous content and is a pollutant if it enters water systems. Fertilisers however, run-off and pass through soils and these can lead to many environmental problems but they are not classed as pollutants unless directly dumped into a water course.

(c) Candidates struggled here to explain or state how the effects of liquid pollutants may be reduced and many candidates simply describing how to prevent global warming by reducing carbon dioxide output! It was good to see some answers describing the use of fines and legislation to prevent pollution spillages and also to see some good descriptions of potential pollution treatment such as through the use of reed beds.

Teaching tip

The following site, http://www.naturegrid.org.uk/rivers/gt%20stour%20case%20study-pages/plln-lfll.html has some excellent information and links describing the science and the issues regarding landfill in the UK. Futhermore, an interesting link for recycling is http://www.recyclingconsortium.org.uk/community/rife.htm which contains some useful information and data that can be manipulated.

Q.4

(a) Most candidates were able to explain two implications for farmers working within an ESA and it was pleasing to see many using the stem of the question to suggest that farmers should mot drain the land.

(b) This question allowed candidates to describe the effects of eutrophication in a concise way and most were able to link the problem of these chemicals being highly soluble and therefore likely to leach through soil into water courses and so lead to algal blooms and their subsequent detrimental effects.

(c) Candidates had to explain how SSSI's differed from ESA's in how they protect the environment and so were comparing the remit of these two types of legislation. This proved difficult for many and most of the responses missed the point of the question. Many responses correctly identified that SSSI's have a significant research value and also a much tighter framework of laws and regulations compared to ESA's.

(d) This was well done by most candidates and most showed that they had spent some time researching this area of environmental biology.

(e) Part (e) was particularly well done by most candidates of all abilities with most students correctly identifying how voluntary organisations fund themselves and carry out their work. This was particularly pleasing because this aspect of the specification has not been questioned upon for many years and candidates showed a really detailed knowledge of the subject matter.

(f) Candidates here had to concentrate only on the negative aspects of captive breeding with respect to the bittern population. This proved quite a challenge for many as this was an extended answer question. There is still some confusion over the effect of inbreeding and the potential increased risk of deleterious alleles and potential increased susceptibility to disease. The cross-over of knowledge linked to 2804 was not good and candidates did not show a clear grasp of synoptic appreciation.

Teaching tip
Most zoos' in the UK have excellent web sites such as http://www.marwell.org.uk/default.asp?css=1 which contains many useful links to conservation programmes and also has information regarding the topics of endangered species and inbreeding. Environmental Science by Kevin Byrne has an excellent chapter on the roles of zoos and the possible negative effects of captive breeding.

Q.5

(a) For this question candidates had to correctly identify that the pattern of pilot whale catch fluctuated continuously from 1950 until 2000 and that also this catch was more often than not above the sustainable catch level marked S on the graph. Very few candidates used paired data quotes in their answers which would have been a fairly straightforward way of obtaining 1 mark.

(b) Candidates struggled here to identify that it would have been the density dependent factors affecting the whale population that the authorities would have taken into account when setting the sustainable catch. That is factors such as disease rates, food source stability and the actual size of the population are all important. Candidates should have looked at maximum sustainable yields when considering fishing quotas and the same principles would have applied here.

(c) This part of question 5 was done very poorly by many candidates. Many forgot any relevant knowledge from 2801 and 2804 but also they ignored some of the simple experimental procedures that should be commonplace for an A level science student. Here candidates needed to take a range of tissue samples from different whales, measure the chromosome lengths using a suitable microscope and compared these to findings from whales of known age. This data could have come from captive bred species. It was disappointing to see so many candidates fail to transfer their skills here and use some science to explain this particular problem.

(d) This was a fairly straightforward 3 marks for many candidates although to obtain the maximum they had to describe how they would have used the Lincoln Index to calculate the population size.

(e) The second long answer question was well done by most candidates with many describing in detail how fish stocks are maintained to promote sustainability. Many used case study examples and some centres had clearly spent time researching this area of environmental biology. It was also good to see some candidate responses describing how consumer pressure and also the marketing of certain species could help in conserving some specific fish stocks.

Teaching tip

Some supermarkets have excellent web sites such as http://www.waitrose.com/food/foodissuesandpolicies/sustainablefishing.aspx which not only explains its approach to sustainable fisheries but also has links to other key topics in the environmental biology specification. Furthermore, the following site, http://www.riverocean.org.uk/Sustianablefishing/sustainablefishing.htm have excellent links and lots of information about all the key aspects of fishing, fishing policy and sustainability that would allow students to research this topic fully.

Q.6

(a) Many candidates struggled with the concepts in this question and for the first part many did not link that pesticides in sheep dip might actually being a threat to invertebrates in the stream despite the fact that they are used to kill pests on the sheep – no doubt invertebrates. Candidates should have been aware of the toxicity of these chemicals and also of their ability to dissolve in water and so spread through waterways.

(b) This part of the question was well done by many candidates with them correctly identifying that there would be less pollution, fewer treatments for the sheep and therefore less potential threat to the environment. Some candidates also linked this potential vaccination to improved health for the farmers and the possibility of marketing meat from the sheep as organic.

(c) Candidates attempted this question and many showed some good recall from 2804. The possibility of interfering with the production of gametes may well have not completed meiosis and so resulted in a reduced number of gametes which may well have had the wrong chromosome number. There were many references to ploidy levels and examples of particular chromosome mutation syndromes.

(d) This final question on the paper was poorly attempted by many candidates who simply needed to describe the effects of directional selection on invertebrate populations as a result of pesticide application. Candidates knowledge and recall from 2804 was very poor and candidates often discussed the passing on of resistant genes or individuals and not of advantageous alleles.

Teaching tip

There is an excellent resource at http://www.nfuonline.com/x9623.xml which has a downloadable leaflet and a poster about the issues of sheep dip. These would be an excellent way to introduce this topic to pupils and then lead into the areas of pollution, pesticides and also intensive agriculture – all covered in detail in this specification. There is also information at www.defra.gov.uk/Environment/water/ground/sheepdip/pdf/poster.pdf which would support the materials from the National Farmers Union.

2805/04 Microbiology and Biotechnology

General Comments

There was evidence this session that a number of candidates were well prepared and had made particularly good use of past paper questions and mark schemes. Equally, many candidates would have benefited from better preparation and in these cases produced responses that were lacking in both detail and the good use of scientific terminology. Practically all candidates made attempts at every section throughout the paper and there appeared to be sufficient time to complete the paper. Whether factually correct or not, the quality of spelling, punctuation and grammar in the extended answers was generally very pleasing. Most candidates were able to answer within the space provided and there were fewer instances where candidates wrote too much for no gain. This paper contained two very different calculations and the best attempts were made at the magnification calculation, indicating that this type of question has been well practised by candidates. Many candidates struggled with the application of synoptic AS knowledge, particularly on the components and structure of membranes, in Q.4 and it was disappointing that knowledge of plasmids, as well as the genetic code, was considered to be very poor in a significant number of cases. In addition, not all candidates are making good use of the figures and tables accompanying questions and candidates should be reminded that they should scrutinise these and make good use of them as essential tools to enable a complete response to a question. Some candidates had clearly worked hard and learned chunks of the text book but were not able to analyse the requirements of the question and wasted time giving irrelevant details. Candidates should also be reminded that, although there is an endorsed text book for this option, the questions set are based on the learning outcomes and assessment objectives as outlined in the specification. The specification contains a reading list for this option.

Comments on individual questions

Question 1

This short question produced the full range of marks, but with surprisingly few gaining maximum marks. In (a), candidates were given the cue that bromelain had a similar action to papain enzyme and there were many mark points available to cater for different approaches to the answer. Those candidates who had a good AS knowledge of enzymes and protein digestion gave four acceptable mark points within the first three lines. At the other extreme some simply rewrote the cooking hint without providing explanations. Unfortunately others gave word-for-word textbook accounts of the processes that occur in animal carcases whilst in storage and hence wrote about autolysis. This suggests that they had made good attempts to learn the section of the textbook but had not taken on board the requirements of the question. In these instances, candidates were possibly able to gain some marks with knowledge of the action of proteases and an example of a protein digested. In (b), (i)(iii) and (iv) were usually known by all, with a proportion losing the mark in (iv) with an incorrect spelling of 'rennin', giving the name of the circulating blood enzyme 'renin' instead. (ii) and (v) were the least well known answers. Knowledge of air lift (loop) fermenters used in mycoprotein production appeared to be centre-specific, but stronger candidates within other centres were also able to gain the mark, possibly by having retained the information from past paper practice. Common incorrect answers for (v) were 'lactic acid' and 'ethanol'.

Teaching Tip

Descriptions such as those in Q.1 (b) are useful learning tools that can be used in a variety of ways, for example, as a starter or summary test for a lesson or for a class activity where each student has a card with the description that another student has to answer. Students could be asked to construct one or more correct descriptions as part of their homework assignment. Initially, the descriptions could be on just one topic within the option and then this could extend to cover the whole option.

Question 2

This proved to be an accessible question for the majority of candidates and many gained 8 or more marks, mainly from providing a thorough account of binary fission. Knowledge of plasmids varied from thorough to hazy to non-existent. A similar question to (a) had been given previously and with a poorer overall response, so it was very encouraging that improvements were seen in this area. Stronger candidates used Fig.2.1 to confirm the sequence of events occurring and work out that plasmids were able to replicate independently of the main genetic region (nucleoid). Here, there were excellent responses and Examiners could reward their efforts with maximum marks. The mark scheme was flexible and allowed for 'mesosome' or 'cell membrane attachment point'. For those candidates that were not well prepared, and who had clearly forgotten their AS and option topic knowledge of prokaryotic cell structure, it was incorrectly assumed that there was a giant replicating plasmid that was attached to a plasma membrane infolding (mesosome) surrounded by smaller plasmids. More thorough accounts wrote about semi-conservative DNA replication and there were more candidates this time that understood that the *elongation* of the cell allowed the separation of the two DNA molecules attached to the *separating* infoldings of the plasma membrane. Hence there were fewer descriptions of DNA molecues 'jumping to the other mesosome'. The formation of the septum was usually well understood although in some accounts the word 'septum' also appeared for the attachment point of the DNA to the cell membrane. Details of the cell wall formation were not usually given. Plasmids replicating independently was well known by many but there were also long text book accounts of how plasmids were transferred between bacteria, so that paragraphs regarding conjugation, transduction and transformation were not relevant to the question. Almost all candidates gained the additional mark for the quality of spelling, punctuation and grammar. In (b) there were some good explanations of the benefits of plasmids as vectors in genetic manipulation, but these were frequently followed with poorly-worded examples, for example, 'can be used to make insulin / HGH', 'can be used to treat diabetics'. Better answers wrote about plasmids containing 'genes coding for insulin / human growth hormone' being taken up by 'bacterial hosts' that could then lead to gene expression. Most candidates correctly cued into the harmful effects of plasmids containing antibiotic resistance genes, having been prompted in the stem of the question and good answers were able to gain the full marks by explaining the difficulties in treating infections caused by pathogens as well as showing an understanding of the spread of resistance. Few wrote about the knock-on effect of the disease then being able to spread to other people if the bacteria were not killed by the antibiotics. Some answers also included background knowledge of MRSA infections. More vague answers wrote about plasmids causing disease or causing harm, which was not credit-worthy. Part (c) was straightforward for many candidates in that they had read the question properly and understood how to answer. It was disconcerting how many wrote about features of meiosis, such as the 'pairing up of homologous chromosomes', 'crossing over of genetic material' and 'chromosomes separating'. A good proportion of candidates wrote about features of mitosis **not** occurring, for example 'there is no spindle formation', 'centrioles do not move to poles', but they did not qualify this by stating 'in bacteria' and therefore were not able to be awarded 'ora' marks. In these cases, Examiners are not at liberty to assume that the candidate really did know the answer but had got it the 'wrong-way-round', especially as many gave one correct feature of mitosis and then two negative answers.

Teaching Tip:

Mesosomes are no longer considered to be part of the normal structure of prokaryote cells and are thought to be artefacts from chemical fixation when preparing specimens for electron microscopy. This topic provides a good class discussion about observations that lead to hypotheses that are eventually discounted by further scientific investigation. It also enlightens students about the 'delay' in current scientific developments getting into print in text books.

Teaching Tip

To help students approach Q.2(c) in the correct manner, ask the following:
"List three features occurring at lunchtime that are not observed during an exam."
Most students will answer with statements such as 'eating', 'drinking', 'talking', 'laughing', rather than saying 'silence', 'writing', 'invigilators walking around'.or
"List three things in your kitchen that are not found in the bathroom." Most should answer in the correct way.

Question 3

Well revised candidates, who were also clued into the protoplast investigation described in the second part of the question, had no problems in gaining near maximum marks. However, this question did prove to be difficult for many candidates, although there were parts that were accessible to all and attempts were made at every section. An outline knowledge of plant tissue culture was required and many candidates had not revised this learning outcome sufficiently. Candidates were provided with a description of protoplasts in the introduction and Fig. 3.1 also helped to give a visual stimulus. Part (a) was well done by many, often centre-specific. Those candidates who had actually carried out haemocytometry, or who had seen a demonstration, may have felt more confident in tackling this part-question. (a)(i) was generally an all-or-nothing response: either candidates understood about the importance of maintaining protoplasts by suspending in the correct water potential or they missed the point entirely and thought that the sucrose was a respiratory substrate. (a)(ii) and (ii) were well done. Some candidates concentrated on the 'agitating' part of (ii) while others on the 'gently': either approach could gain the mark. Many candidates were not well-practised and found (b), the calculation, difficult. Hence there were many who scored no marks. It was also very disappointing how many could not correctly count 14 protoplasts using the north-west rule, especially as an almost identical calculation has occurred in a previous paper. Those that made a good start then failed to give the answer per cm^3 and only gained one mark. In (c), there were four easy marks to be gained by those who had revised their work and had read the question. Others wrote at length about how to *obtain* the protoplasts and some gave totally irrelevant accounts of streak plating. (d) was not particularly well done, but the most common correct suggestions were: the ease of transferring in genes for genetic manipulation of crop plants when the cell wall was removed; and the ability to fuse protoplasts for heterokaryon formation. Answers that stated that more could be formed or that only protoplasts were disease-free did not gain credit. (e) was well-answered and by far the most common variable and justification given was temperature and its effect on enzyme action. More vague statements like 'amount of preparation' only gained one mark if the justification provided a more detailed explanation. In (f), it was not uncommon for candidates to gain maximum marks and many obtained four or more. Some candidates failed to 'comment' and only 'described' the results. Where these were correct, there were still four available marks. The best answers showed an understanding of enzyme action and the components of the fungal cell wall as well as good powers of deduction. It was very pleasing to see that better candidates could conclude that the fungal cell wall contained glucan in addition to chitin. At the other extreme, many thought that glucanase action provided glucose for the protoplasts to grow and there were also accounts of the enzymes acting as inhibitors. Some

responses commented fully and questioned the validity of using haemocytometry and the lack of further information. Only a few noticed that the presence of lipase would cause a *lowering* of numbers by damaging the phospholipid bilayer of the exposed membrane, most assumed that the lipase somehow prevented protoplasts from *forming*. Weaker responses showed that candidates had missed point of the investigation entirely and wrongly assumed that the enzymes were used to provide products for fungal growth and reproduction.

Teaching Tip

Students should be reminded of the help given in the 'Glossary of Terms used in Question Papers' on page 107 of the specification:
'Comment' is intended as an open-ended instruction, inviting the candidates to recall or infer points of interest relevant to the context of the question, taking account of the number of marks available.

Question 4

As with the previous question, sections that required analysis and interpretation were not well tackled by many candidates. Although there were many high scoring responses to this question, the level of thought required for (e), which had a large synoptic element to it, proved to be too much for all but the strongest candidates. (a) (i) and (iii) were well answered by most but responses for (ii) were sometimes too vague ('avoids pollution', 'less harmful to the environment'). The link to reducing the Greenhouse Effect was not well understood: carbon dioxide emitted by the combustion of ethanol is offset by the uptake of CO_2 for photosynthesis by the plants that are used as substrates for the fermentation or in the distillation of ethanol. Many thought that no CO_2 was emitted. Common credit-worthy points included reference to renewable resources, less need for fossil fuels and lowered acid gas / nitrogen oxide / sulphurous oxide emissions. (b) was not a problem for the majority of candidates, who understood well the advantages of enzyme immobilisation in manufacturing industries. In (c), candidates were expected to extract the relevant data in Table 4.1 and use this in their answer to the question. This was an opportunity to provide data that showed a contrast between their chosen strain and the others. Answers such as '…..is quite tolerant to ethanol', 'has a range of carbohydrates that can be used' were not helpful unless the advantage of this over the other strains was evident. Some candidates linked temperatures to favourable population growth of pathogens. The ability of cells to flocculate is a desirable characteristic in alcohol production as separation of biomass from the product is easier and also immobilisation is likely to be more successful. All the mark points were seen by the Examiners and there were some very comprehensive and sensible reasons provided. Most candidates gave a reasonable suggestion for (d). In part (e), many candidates were only able to gain the easy two marks available for (i), having continued to (ii) and (iii) with no great understanding of the situation. Here, they simply repeated some of the information provided in the introduction. Some candidates thought that an increased tolerance to ethanol meant that more ethanol could enter the cell. (ii) credited answers that supported or did not support the statement. It was hoped that candidates would think back to AS and recognise that oleic acid was a fatty acid and therefore a component of phospholipids, with the bilayer hydrophobic core formed from the hydrophobic fatty acid tails. From here, they could go on to speculate on effects of the longer hydrocarbon chain or the switch from saturated palmitic acid to unsaturated oleic acid and the resultant 'kink' provided by the double bond. Equally, by noting that ergosterol and hopanoids are similar to cholesterol, candidates were expected to apply their knowledge and write about the stabilising effects on the membrane of the two molecules. A few candidates remembered that alcohol is used in the alcohol-emulsion test as a solvent for lipids and were able to speculate about the effect of alcohol on the phospholipid bilayer with increased proportions of oleic acid.

Teaching Tip

The production of 'biofuels' has now become very topical. Q.4. may be a good starting point for discussions: problems of laboratory to pilot to full-scale production; the different features that need to be investigated; the social, economic and environmental effects of crop production, manufacture and use of biofuels.

Question 5

Generally, this question proved very accessible to candidates and there were some very good answers. Many gained 17 or more marks. Candidates were required to refer to Fig. 5.1 throughout the question. In (a), the enzymes **P** and **R** were usually known but **Q** was less easy to discern and DNA ligase was given rather than DNA polymerase. Some candidates named the same enzyme all three times in the hope of gaining at least one mark. The large number of amino acids in human factor VIII was spotted by many candidates in (b) and a good proportion of these realised that there may be too many amino acids to analyse. Some responses gave confused answers, assuming the gene was made of 2232 amino acids. The genetic code, Table 5.1., provided in (c) was frequently well used to gain the full three marks in (i) but Examiners also reported that there were a number of candidates who left this blank or who only gave a single letter for the RNA sequence, from the first position column, for each of the amino acids, and then the single complementary base letter for DNA. Some candidates were able to correctly use the code for the RNA sequence but did not correctly provide complementary triplets for the RNA, instead repeating the RNA sequence and replacing uracils with thymines. It was not unusual for Examiners to spot a mistake of one base in an otherwise correct answer and this carelessness cost the candidate one (or more) marks. Only those candidates who were familiar with the features of the genetic code were able to cope with (ii). A reminder of the degenerate nature of the code was clearly visible to candidates in Fig. 5.1 and many gained a mark by giving a valid example from the table. Diabetes was well known in (d) but haemophilia was more elusive and answers such as Down syndrome, Huntingtons disease and sickle cell anaemia were seen. Knowledge of Factor VIII is required as part of a learning outcome in the Foundation module of AS. The quality of responses for (e) was generally very encouraging and there were some very thorough accounts given that included descriptive sentences that were backed up with explanations. Insulin production following genetic manipulation is one example of a protein of medical importance that could be used in this option, but it is a learning outcome from AS so candidates should have been more than capable of tackling this extended answer. More candidates than usual were awarded the QWC mark for the organisation and use of scientific terms. However, it was disappointing how many candidates decided to use restriction enzymes to 'cut out' the insulin gene from pancreatic cells, having failed to notice, or choosing to ignore, the information in Fig. 5.1, which clearly started with mRNA. Only a handful of candidates explained that the gene coding for human insulin contained introns that were not recognised by host bacterial cells. Knowledge of gene insertion into a cut plasmid by complementary base-pairing, followed by DNA ligase action to seal the sugar phosphate backbone There were some good accounts of methods employed to screen for successful recombinant hosts .A very small number of candidates decided to write about either HGH production (but here they could still gain some of the marks) or monoclonal antibody production. Also, a significant minority thought that the recombinant plasmid containing the gene coding for insulin was injected directly into human hosts with diabetes. Some candidates ignored the instruction that information about the large-scale fermentation was not required and wasted valuable time writing about this.

Teaching Tip

20 pieces of oval card approximately 15cm long can be shared out among the class and each one could have written on it the three letter symbol for each of the twenty amino acids. Spread these in a line along the floor or a bench. 64 pieces of rectangular card of the same size can then be shared out among the class (e.g. three each) and on each of these all the possible codon combinations can be written (needs organisation!). Each student could then be asked to place their 'codon cards' under the corresponding amino acid. This is a good visual stimulus to appreciate the degeneracy of the genetic code and can lead to student's constructing their own sequence of nucleotides for a particular amino acid sequence.

Question 6

Most candidates were able to gain 5 or more marks for this question, mainly owing to a reasonable attempt at (e). Confusion between bacteriophage tail fibres and pins caused problems in (b) and (c) but even in these cases stronger candidates were able to gain at least 8 or 9 marks. Many candidates made a good start in (a), correctly measuring the diameter and realising that magnification could be obtained by dividing the image length by the actual diameter. Examiners were able to award a mark at this point. Some could continue to make the conversions to arrive at the correct answer for the full two marks but others floundered. Calculations of this type are still a challenge for many candidates. Well-researched candidates and candidates from particular centres were able to provide the correct answer to (b). Most thought that **A** had tail pins but the correct term is tail *fibres*. 'Legs', 'spikes' and 'spiky things', were other suggestions. There were some correct suggestions for (c) and many understood that there had to be some connection by the base plate or tail pins to the bacterial cell in order for entry of viral DNA to be facilitated. Many candidates realised that the DNA of lambda circularises and so would be difficult to distinguish from a plasmid and were able to score one or both marks. A good proportion did not answer the question and stated that the phage DNA incorporated into the host genome. This would enable easy recognition of a plasmid from the viral DNA. Part (e) was a good finish to the paper as most candidates obtained 4 or 5 marks. Only half of the responses correctly identified the outer covering of HIV as an envelope: a protein coat was commonly given. As there were more marking points than the maximum allocated to this section, candidates were still able to score full marks.

Teaching tip

http://www.asm.org/division/m/foto/UrLamMic.html
http://www.asm.org/division/m/fax/LamFax.html

are pages from the same website of the American Society for Microbiology. These provide useful information about bacteriophage lambda and an excellent electron micrograph of the wild-type lambda.

2805/05 Mammalian Physiology and Behaviour

General Comments

It was agreed by examiners that the paper was of appropriate difficulty and comparable to those of previous sessions. Candidates were able to complete all questions in the time available and most attempted every section.
There were no obvious misinterpretations of the rubric except occasionally where candidates lost marks because they had not focused correctly on the command word at the start of the question. Candidates need to be aware of the important differences between the words *describe*, *explain* and *suggest*. The word *suggest* is often a trigger for candidates to display their knowledge of other parts of the Biology specification such as AS material and Central Concepts. The overall performance of the candidates seems to be in line with the performance in previous years, with a relatively normal distribution of marks. There was certainly a wide range of ability and attainment. More able candidates were able to display their knowledge and attained very high marks. The weaker candidates had noticeably patchy knowledge yet on a few questions their knowledge was excellent, for example the detoxification of alcohol (4c).

Comments on Individual Questions

Q.1 This question was designed to provide an easy introduction to the paper and included a synoptic section.

(a) (i) Candidates were presented with a photograph of a fennec fox and asked to suggest how it is adapted to locate its prey. In the majority of cases, responses began with a comment about the fox's ears. Most candidates noted the size of the ears, although 'large' alone was insufficient detail for the first point which required further qualification, such as outer or external ear, or pinna. Many continued to explain that the large pinnae could direct sound waves into the auditory canal, expressed in a variety of ways but few commented on how both ears would function in the determination of direction. There were many references to the large size of the eyes or that they faced forward, although further detail of how these features may be useful in the location of prey was scarce. Many provided an explanation of how the eye would be adapted for night vision although this was not relevant to the question. Some candidates suggested that the fox would have a keen sense of smell. Other visible features were described, such as sharp claws, narrow snout and bushy tail although these were linked to catching, rather than finding, prey, so were not credited. References to camouflage were also ignored.

(ii) The most common suggestion as to how the ears of the fox are adapted for temperature control was a mention of the large surface area for heat loss, although references to sweating were rejected. Alternatively, some commented on a rich blood supply which would allow heat loss through radiation.

(b) This section tested synoptic knowledge from Central Concepts. Most candidates understood that the allele for deafness would be recessive, and that to produce a deaf offspring, two parents with normal hearing would each have to possess a recessive allele. References to 'gene' were penalised once. Many candidates used a genetic diagram to good effect although some attempted to link the alleles to the sex chromosomes, despite being told in the stem of the question that the condition was not sex-linked. Others used the convention for incomplete or co-dominance which was not credited but marks were subsequently awarded for technical accuracy. On the whole, even weaker candidates managed to score at least two marks.

(c) Better candidates described how yawning or swallowing would open the Eustachian tube thereby equalising the air pressure on either side of the tympanic membrane. References to balancing the pressure between the middle ear and atmosphere were also accepted, however, many failed to link the action with the opening of the Eustachian tube. Others erroneously commented that pressure would be equalised between the middle and inner ear. Statements concerning the 'popping' of ears or the blowing of air through the nose were ignored.

Q.2 This questioned the ability of candidates to apply their knowledge in a variety of ways and to analyse novel data.

(a) A photograph of the upper and lower jaw of the llama (*Llama glama*) was provided as an insert and candidates were required to complete the dental formula of this ruminant. Many were able to identify the number of canines and incisors although there were occasionally errors in the number of premolars and molars on the upper and lower jaw. Nevertheless, many candidates quoted the total number of teeth correctly.

(b) (i) While many candidates were able to calculate the percentage of time spent ruminating between 1800 and 2400 hours, some added the number of minutes incorrectly or divided this figure by 350 minutes rather than 360. However, where an incorrect response was seen, credit was given for either the correct total mean time spent ruminating or the total number of minutes, provided that this figure was multiplied by 100 to give a percentage.

(ii) The vast majority of candidates understood that the premolar and molar teeth of a ruminant would be worn down by the grinding action required for the mechanical digestion of grass. Many also commented that these teeth would need to grow constantly therefore necessitating a blood supply which would provide the teeth with nutrients and oxygen for continued growth to take place.

(c) (i) The identification of the mucosa and smooth muscle on the micrograph of a section through the colon was variable. Many candidates believed that the mucosa also included the submucosa, or did not label the smooth muscle appropriately. However, many candidates were able to label at least one tissue correctly.

(ii) Most candidates were able to explain how the folding of the colon enabled it to carry out its functions. The majority commented that the folding would increase the surface area, often continuing to state that this would increase the absorption of water, minerals or ions. References to the absorption of the products of digestion were infrequent and ignored.

(d) (i) The role of the naturally-occurring bacteria in the stimulation of an immune response was generally poorly understood. Many candidates appreciated that the bacteria would be seen as foreign, but further qualification, such as a foreign antigen or protein, was omitted. Some commented that the antigen would be on the cell surface membrane, although this was rejected as bacteria would have a cell wall and a capsule. Some appreciated that a white blood cell would recognise the foreign antigen although often a suitable cell was not named. However, some correctly identified a T cell or macrophage, going on to state that this would result in the stimulation of a B cell, which would divide by mitosis and produce antibodies. Only better candidates referred to plasma cells arising as a result of clonal expansion or simply by mitosis. Occasionally, candidates described a nervous, or hormonal, response rather than an immune one.

(ii) Most candidates understood that the secretion of ions into the lumen of the colon would lower the water potential, although some made incorrect references to the solute potential, believing it to be increased, rather than lowered, by an influx of ions. There were relatively few statements concerning the change of water potential in the epithelial cells. Nevertheless, most candidates appreciated that water would move into the lumen down a water potential gradient, or from high to low water potential, although references to movement of water down, or along, concentration gradients were rejected.

(e) This section was often poorly answered, with candidates offering vague statements concerning the relaxation of smooth muscle or the fact that more matter from the ileum would be allowed to accrue within the colon. Some candidates appreciated that peristalsis would be reduced, or stop, but relatively few linked this to the consequence of faecal matter moving more slowly through the colon enabling more time for water to be absorbed. Consequently, full marks for this section were rarely awarded.

Q.3 This question proved to be possibly the best discriminator of the paper. In general, only the better candidates managed to achieve a reasonable score.

(a) (i) This section was introduced by a brief description of how the growth of antlers of the red deer in early summer required the mobilisation of calcium stores from other parts of the body, such as the ribcage. Candidates were then asked to explain how the bone cells in the ribcage and bony projections of the skull are used to enable the rapid growth of antlers. It was anticipated that candidates would describe the respective roles of the osteoclasts as osteoblasts in these two tissues and comment on how their actions would contribute to antler growth. However, few candidates made creditworthy statements as to the actions of these two cell types, often offering general statements as to their functions without linking them to either the ribcage or the skull. As candidates had already been told that calcium moves from one area to another in the stem, a mark was available for suggesting how this might happen although few mentioned that calcium ions would be transported in the bloodstream. Many candidates incorrectly thought that the osteoblasts must be transported in the blood to the antlers. The expected references to the hormones calcitonin and parathormone did not materialise.
On the whole, only better candidates managed to achieve the full three marks for this section.

(ii) The roles of calcium in the bone were better understood, and many candidates stated that calcium ions would form calcium phosphate, which would contribute to the rigidity, hardness and compressive strength of the bone. References to calcium phosphate forming 60% of bone mass were also seen. Many candidates gave a list that included general roles of calcium ions, such as in muscle contraction, which

gained no credit.

(b) The structure of glucosamine was illustrated in figure 3.1 and candidates were asked to describe how this structure differed from that of alpha glucose. While most candidates appreciated that there was an amino group on carbon 2, many neglected to state that it had replaced an OH group. Some also suggested that there was a reversal of the H and OH groups on carbon 1.

(c) Table 3.1 provided information on the results of a clinical trial carried out to determine the effectiveness of glucosamine and non-steroidal anti-inflammatory drugs (NSAIDs) compared with a placebo. The question then required candidates to describe and explain these results. Many candidates made the mistake of simply repeating what had been given in the table rather than making comparative statements. Nevertheless, many appreciated that glucosamine had the greatest effect in maintaining the distance between knee joint cartilages, and was therefore the most effective treatment, although this was not always linked either to its effect in retarding the degeneration of the cartilage or the fact that a smaller decrease in the gap would contribute to less friction and thus reduced pain. Many also recognised that there was greater pain relief with both glucosamine and NSAIDs although there were relatively few comparisons with the placebo. However, many understood that the slight reduction in pain reported by those taking the placebo was as a result of the placebo effect, described in a variety of ways. Some candidates erroneously believed that a decrease in distance was a positive feature, going on to state that the placebo had the best effect.

(d) The first free response question in this paper concerned the processes involved in the shortening of the sarcomere during contraction in a skeletal muscle. Candidates who had learned the material well quickly reached the maximum marks available for this section.

Most began their response with the release of calcium ions from the sarcoplasmic reticulum although some gave comprehensive accounts of the processes taking place at the neuromuscular junction, which were not required. Many the went on to comment that calcium ions would bind to troponin, causing it change shape and tropomysosin away from the myosin head binding sites on the actin filament, allowing the formation of actomyosin cross bridges. However, some thought that the calcium ions would bind to tropomyosin or stated that active sites on the actin filament would be revealed, both of which were rejected.

There were many good descriptions of the sliding filament theory although the role of ATP during this process was sometimes confused, such as candidates stating that the myosin head required ATP to bind or providing details of ATP hydrolysis out of sequence. Nevertheless, good candidates understood that ADP and inorganic phosphate would be released following the tilting of the myosin head, to be replaced by another molecule of ATP which would be hydrolysed to provide energy for the release of the myosin head from the actin filament. Many references to the role of the myosin head as an ATPase were also seen.

The quality of written communication mark was for the use and organisation of scientific terms. Candidates were required to use at least three technical terms, in the correct context, and present their response in a clear and logical sequence. Weaker candidates failed to achieve this mark and occasionally it was not awarded to better candidates if the sequence of events was too muddled.

Q.4 Many candidates were able to display much knowledge in this question.

(a) The use of the pupil response test in determining blood alcohol content was described and candidates were asked to explain how the reduction in pupil diameter in bright light is brought about. Good candidates began by stating that the light stimulus would be detected by the retina, or the rods and cones, and that an action potential, or impulse, would be generated. However, in some cases the impulses entered the spinal cord or the central nervous system, neither of which was sufficient for the award of the mark. Many appreciated that motor impulses from the brain would travel via the parasympathetic nervous system, or vagus nerve, to the muscles of the iris. There was occasionally confusion as to which muscles would contract, although many candidates understood that the circular muscles would contract while the radial muscles would relax. Weaker candidates thought that the ciliary muscles would contract or that changes in lens shape would control the pupil diameter.

(b) (i) This section required candidates to examine a graph of the percentage of volunteers *correctly* identified as being over the legal limit using the pupil response test versus time after drinking and describe the relationship between the two. Most stated that the number of correct identifications decreased over time although some candidates phrased their response in terms of diminishing accuracy as the time after alcohol consumption increased, which was an acceptable alternative. Some stated that this graph was showing how long it took for these volunteers to be under the legal limit following alcohol consumption, rather than the accuracy of the test, which did not earn credit.
Many then went on to quote two paired figures to illustrate the trend that they had described. Some also appreciated that the graph was non-linear, commenting that the decrease was rapid during the first hour then started to level off thereafter.

(ii) The vast majority of candidates were able to score both marks for suggesting two advantages of using the pupil response test instead of the blood alcohol test. The fact that the test would be very quick to perform was the most common response and there were also many comments that it could be done by the side of the road with simply a torch, obviating the need for expensive equipment and trained personnel. Other suggestions, such as the non-invasive nature of the test, it is cheap to perform or that there would be no risk of infection, were also seen.

(c) The mechanism of detoxification of alcohol in hepatocytes was well understood by many candidates who offered comprehensive accounts of the oxidative pathway, its intermediates and the enzymes responsible for each reaction. However, some believed that ethanol would be converted into pyruvate before entering Krebs' cycle or that it would simply be turned into fatty acids or glucose.

(d) Many candidates appreciated that excessive alcohol consumption can lead to fatty liver due to the build up of reduced NAD, limiting the amount of oxidised NAD available for other reactions in the hepatocytes, such as fatty acid oxidation. Further comments concerning the resultant accumulation of fatty acids and their conversion to triglycerides, or lipids, were also seen. Some candidates made the mistake of describing the histological changes that would take place in the liver, such as the replacement of dead hepatocytes by scar tissue and the loss of lobular structure, although this was irrelevant to the question.

Q.5 This question provided candidates with the opportunity to recognise structures presented in a new way and identify them. It also gave them the chance to display their knowledge of Alzheimer's disease in a straightforward way.

(a) (i) Figure 5.1 showed a computer assisted tomography (CAT) scan of part of a human vertebral column. Candidates were asked to name the parts of the vertebra labelled A and B. Most candidates recognised that A was the centrum although fewer were able to name B as the neural spine; one of the more common mistakes was to refer to it as the transverse, or spinal, process. Some candidates mistakenly just named the vertebrae or simply left the section blank.

(ii) While most candidates appreciated that X was the dorsal side of the scan, their reasons were not always creditworthy. It was expected that they would comment on one of the labelled structures (rib, aorta) or refer to part B which they had named in (a)(i). There were a number of references to the roots of the spinal cord, although these were not visible.

(b) The majority of candidates were able to describe at least one role played by the intervertebral discs in the vertebral column, generally by reference to their function in the movement or flexibility of the column often then stating that they would act as shock absorbers or reduce friction (although friction-free movement was rejected). Some offered more vague responses concerning support of the spinal column or protection of the spinal cord, which were not credited.

(c) Many candidates appreciated that stem cells could be used to replace damaged cells within the spinal cord but frequently neglected to mention a suitable cell, such as neurone or Schwann cell. References to osteocytes and osteoblasts were ignored as the question stated that the injury was to the spinal cord rather than the spinal column. Only a minority of candidates commented that stem cells would divide by mitosis and even fewer commented that they would differentiate into the necessary cells or that differentiation would be stimulated by surrounding damaged tissues.

(e) The second free response question on the symptoms, treatment and prevention of Alzheimer's disease was generally well-answered by almost all candidates. The mark scheme was adapted such that candidates were only able to gain the full marks available if they attempted to describe some form of treatment. There was a maximum of three marks each for symptoms of the disease and preventative strategies although the wide variety of alternatives provided in the mark scheme allowed even weaker candidates to achieve several marks fairly easily.

Many candidates also gave comprehensive descriptions of the post mortem histology seen in the brain of sufferers, although this was not relevant to the question.

The most common symptom described was the loss of memory, either short term or long term, followed by personality changes which would be experienced by sufferers. However, there were also many references to confusion, hallucinations, paranoia and loss of coordination, speech and cognitive ability.

Treatments frequently concerned the administering of an acetylcholinesterase inhibitor; many candidates often continuing to comment on the fact that acetylcholine would then remain in the synaptic gap for longer and be able to stimulate more action potentials. Very few references to the inhibition of the enzyme responsible for converting APP into abnormal beta amyloid protein, thereby reducing its quantity, were seen although there was occasionally mention of vaccines to break down plaques.

Most candidates were able to offer a number of suggestions as to how the disease may be prevented, predominantly for keeping the brain active by a variety of way, such as crossword puzzles or sudoku. Avoidance of blows to the head also featured highly as did the need for regular exercise, a good diet and a healthy lifestyle, although the two latter points were considered too general for inclusion in the mark scheme.

The quality of written communication mark for was spelling, punctuation and grammar. Candidates who had written more than 15 lines usually achieved this mark.

Q.6 This was a straightforward question, involving data interpretation, and recall of both unit and synoptic material. Most candidates were able to score marks on most sections with relative ease.

(a) (i) Candidates were asked to study the graph of data recorded during an investigation into rat behaviour in a Skinner box and then describe and explain the results. Those who had thoroughly revised the topic scored maximum marks quickly, firstly for noting that the frequency of lever pressing increased over time, often backed up by quoting suitable figures, then continuing to give a comprehensive explanation of the behaviour observed. Even weaker candidates appreciated that the food pellet constituted a reward for pressing the lever and would cause the rat to press the lever again although relatively few commented that the reward would act as a reinforcer. Many stated that the experiment was an example of operant conditioning and went on to give further detail of associative learning as a result of trial and error. No references to the rat being hungry were seen.

(ii) Most candidates were able to state some aspect of the equipment or the animal used that should remain the same in a control experiment. Many also commented that there should be no food, or reward, when the lever was pressed. However, some suggested that negative reinforcement should be used or that time delays should be introduced before the rat received a pellet.

(iii) Suggestions as to the expected results from the control experiment were often vague. Better candidates appreciated that the pressing of the lever would remain random, or that no pattern would develop, in the absence of a reward.

(b) In this synoptic section, candidates were required to recall the mechanisms of enzyme inhibition. Many offered a good account of both competitive and non-competitive inhibition, occasionally commenting that either could be reversible or irreversible. However, a common fault was to state that the competitive inhibitor should be the same shape as the enzyme's active site, rather than complementary to it.

2806/01 Unifying Concepts in Biology

General Comments

This paper followed the four question format pioneered in January. Less context material to absorb and process allows candidates plenty of thinking time to recall their knowledge from different areas of the syllabus, to apply their skills and to make synoptic links. Candidates scored significantly better on the June 2008 paper compared with that of the previous summer where the established pattern of five questions was used. It is intended that four questions on this paper will become the norm.

Comments on Individual Questions

Q.1 This was the highest scoring question on the paper. Candidates interpreted a range of stimulus material and used it as a starting point for displaying their knowledge of classification, evolution and speciation.

(a) Candidates had to sift through the information given to identify a correct animal for each group. Most did very well but a significant number failed to identify the third animal, one threatened by competition from a recently introduced species, with wolf (already extinct) and grey squirrel (itself introduced) being common wrong answers.

(b) The third marking point - that two species are the same genus because they share the name *Cervus* – was frequently not accessed as the majority of candidates do not know the hierarchical Linnaean classification system well enough to apply it. Candidates incorrectly stated that both being *Cervus* meant they were the same family, species or even subspecies.
However most candidates were familiar with the idea that there are exceptions to the strict definition of a species and that reproduction to give fertile offspring can occur between closely related species. They therefore wrote about two species interbreeding but poor structure of their answers often let candidates down, as they did not make clear which two species were the ones that could interbreed. See teaching tip below.
Some good candidates did speculate that those that could interbreed must have the same chromosome number or have the same breeding cycle.
A number of candidates discussed interspecific competition as being a problem that could affect the red deer gene pool and failed to score.
Some knowledge of the British fauna and flora was useful as candidates with very little general knowledge of our native species thought that deer were carnivores.

(c) Mostly done well with the majority of candidates scoring 2 marks, though a few candidates seemed not to have access to a calculator. There is always a two mark calculation on this paper and candidates are advised to bring a calculator into the exam.
Two errors were common however. Some calculated a percentage out of the total number of species for both countries (79) instead of the total for Great Britain (53). One candidate revealed the confusion behind this by writing in the margin that she was unsure whether Great Britain included Ireland as well. Pains had been taken in writing the question to make this point clear, and the information at the top of the graph clearly referred to “Ireland compared to the neighbouring island of Great Britain”. Short introductory statements like this are frequently not properly read or absorbed by candidates anxious to get on with the paper. However it must be stressed that no superfluous material is included on a paper and every part of the question stem should be read with the utmost care to equip a candidate to answer correctly.

The second common error was to give a final answer to one or two decimal places, again a case of a candidate losing marks through not reading the question properly. The instruction "to the **nearest whole number**" was given in bold type to aid the candidates.
A more serious source of error was those candidates who added together some of the columns but left others out, apparently thinking certain groups such as bats and insectivores were not mammals. While this again reflects a very poor general knowledge of the British fauna, it also once more pinpoints the importance of reading the question properly. The introductory sentence states that the figure "shows the number of species of different types of terrestrial mammals", clearly indicating that all six of the groups were in fact types of mammal.

(d) Very few candidates were able to link together the information they had been given to come up with a plausible explanation involving the differential migration of species to Great Britain and Ireland during the last Ice Age, ideas covered by the first four mark points.
A few scored for suggesting that Ireland being smaller might account for its species impoverishment, though a follow-up reason for this was not expected since the positive correlation that exists between the size of a land mass or area of habitat (a "virtual island" like a patch of forest) and its species diversity, is beyond A level.
The AVP was extended to include the idea, commonly suggested by the candidates, that a different range of species might have survived in the South of England below the edge of the ice sheet whereas these species might not have survived in Ireland where glaciation was shown on the map as total. Errors that crept in here were discussion of "mammals", "animals" or "the mammal population" rather than species. Candidates should have learnt at AS that a population is a group of organisms belonging to the same species.

(e) This was done well on the whole. However the differences given needed to be clearly visible in the photographs, not imagined (e.g. comments on the thickness of the coat, smoothness of the coat and length of the whiskers were not credited). Teaching tips have been given in the past on this report concerning the structure of a statement describing a difference, but still candidates are failing to take this advice. Both animals must be mentioned, either with a clear statement describing each (Irish has a dark / uniform / reddish coat, Brown has a light / speckled / golden-brown coat) **or** a comparative term should be used, typically a comparative adjective (darker, bigger, shorter). In this case the subject that is darker, bigger or shorter needs to be clearly identified. "It" here would refer to neither hare, since the question does not name either hare. Obviously terms like "less" and "more" can also be used to describe a difference. It is frustrating to see candidates throwing away marks because of poor English skills in that they are unable to clearly state "X is like …., Y is like ….." or to say " X is …...er than Y".

(f) There were plenty of good answers where candidates had got to grips with the scenario presented in the question and were synoptically linking their own relevant knowledge to the new situation. However, weaker candidates identified the right area of the syllabus but quoted notes or text book ideas without applying them to this situation. They therefore referred to a geographic barrier but suggested it could be a mountain or lake, instead of realising that the barrier was the sea between the two islands. Some described allopatric speciation but then went on to suggest that perhaps in this situation sympatric could have happened instead or as well, negating their mark for correctly identifying the geographic separation idea.
The idea of different selection pressures was often implied rather than stated, and a common mistake amongst weaker candidates was that this 'caused' mutations. Good answers established that the islands were separated and that conditions would be different on both, and went on to suggest an example of how conditions might have differed (e.g. predators, climate, food supply) and explain the principles of natural selection within this context.

Teaching tip

Candidates must note the grammatical structure of the question. Too many start their answers with "They…" or "It…" and either there is no clear "they" identified in the question (as in 1a, where three species of deer were mentioned) or the "it" they mean is not the object of the question (as in 3a where protein is named first in the question and would form the subject of an answer beginning "It…"). To avoid this sort of confusion which leads to marks being lost, candidates should be trained not to start answers with pronouns but to clearly state the subject of their response sentence. e.g. "The Sika deer and Red deer are…" and "Protein is…".

Q.2

(a) Generally well answered, most candidates gained all 3 of the D (description) marks. Many candidates came close to achieving D5, the data quote, but missed out the years or the % units. A few candidates missed the word 'trends' in the question, and did not look at how the figures changed across the table, but either compared men and women or different categories with each other (e.g. fewer people are underweight than acceptable). A minority of candidates were unable to clearly express the trends they sought to highlight due to poor English – see teaching tip below. A few candidates did not notice that they were asked to describe trends common to BOTH men and women (**both** was highlighted in bold in the question). Some candidates predictably did not complete their answer by suggesting any explanations for the trends, but used up all the space on the description task.
Most candidates who did offer explanations were able to refer to an increase in food or fat consumption but some lost this mark by not being specific enough and just referring to an "unhealthy diet". Similarly some referred to increased "drinking" rather than increased alcohol consumption for E3.

(b) Again some candidates missed marking point 4 because they failed to include the % sign for their figures quote. The marks most commonly achieved were 3 and 4, with few considering the underweight and acceptable figures. The answer "57% of women are overweight or obese, 67% of men are overweight or obese" would score only one mark, not two. Candidates need to state their own value judgement (which figure is more or less), not just to quote figures without any interpretation of them in the context of the question. The answer "67% of men are overweight or obese, whereas only 57% of women are" would score two in contrast, since the more/less relationship has been made clear by the "whereas only". An ideal answer would be "More men are overweight or obese (67%) compared to women (57%)."

(c)(i) The idea of a control was well understood as was the need for something to compare with. A control group is not the same thing as a control variable. Some candidates were aware of the psychological effects of a placebo.

(c)(ii) This was poorly answered, and the quality of answers was rather centre dependent. There were few references to statistical tests. Better candidates showed an understanding of how the range of the results affects our interpretation of the mean.

(c)(iii) This was also poorly answered. The question was designed to introduce a synoptic element of candidates linking this experimental situation with their knowledge of atherosclerosis from the Transport module. Few candidates however made the link with heart disease, and some candidates mentioned cholesterol as causing CVD but did not state "HIGH" concentrations of cholesterol were responsible. A worrying number thought that high cholesterol was a direct cause of diabetes.

(d) Very few candidates wrote less than ten lines (which is the minimum needed to assess the QWC mark). Despite some common misconceptions, such as the idea that MHCP made the receptors on liver and muscle cells respond to insulin rather than it being MHCP itself that bound to the receptors, many candidates still managed to score maximum marks. Some weaker candidates however thought that the mode of action of MHCP was that it stimulated receptors on pancreas cells, leading to increased insulin production.
Good knowledge of how insulin regulates blood glucose concentration was shown by many. Data from the table could have been used (worth two marks) and often was, but sometimes it failed to score as the % sign was missing. In general however, answers were not well structured and candidates frequently repeated information from the question. Few wrote about the effects/symptoms of diabetes. A few candidates lost marks because they confused glycogen and glucagon, or the effects of insulin and glucagon.

Teaching tip

Candidates could be taught to distinguish between statements like the following, which were given in answer to 2a (describing trends common to men and woman shown in the table).

Correct answer: The percentage of people at acceptable weight has decreased.
Incorrect attempts: (In both men and women) the acceptable weight has decreased.
The trend for acceptable weight men and women has decreased.

Correct answer: The trends that are common to both men and women are…
Incorrect attempt: The trends that are both common to men and women are…

Similarly in 2b:
Correct answer: More men are overweight.
Incorrect attempt: Men are much more overweight.

Data quotes must include units.

Q.3 This question tested a knowledge of basic biochemistry in the context of the Hershey-Chase experiment, which was assumed to be unfamiliar to most candidates. Candidates were also given the opportunity to demonstrate the skill of converting pictorial information into a reasoned written explanation. As despite repeated advice to the contrary, candidates are still not revising AS biochemistry in sufficient detail for this paper, many weaker candidates did not score well on this question.

(a)(i) See teaching tip for Qu. 1. Surprisingly few candidates could identify two structural features of proteins or DNA.

(a)(ii) Three features of bacterial cells not shared by viruses were required here. Again, a surprising number of candidates were groping in the dark. Some listed eukaryote features while others (although this was not penalised) introduced a double negative into their answers (given the structure of the question) so ended up saying that bacteria have “no cell wall, no cell membrane,” etc. Candidates who made this mistake due to poor English comprehension skills were given the benefit of the doubt on this occasion, but candidates need to check that their answers make sense in the context of the question when they re-read their answers at the end of the exam.

(b i) Most answered correctly but wrong answers included “disulphate” and “covalent”. The latter was not specific enough.

(b ii) Most candidates understood the question to mean which of the three parts of a nucleotide connect (via oxygen atoms) to the phosphorus atom, and correctly answered sugar. The commonest error was to qualify the sugar wrongly, either as a hexose or as ribose.

(c i) Most candidates scored at least one mark for describing the importance of the radioactive isotopes as markers or tracers. Candidates who have benefited from seeing videos or past questions where radioactive tracers are used were at an advantage here. Some candidates became bogged down in the experimental detail here rather than the principles behind the method. Very few mentioned that you could label different parts of the molecules (DNA and protein) to distinguish between them.

(c ii) Candidates who can write clear short sentences in a logical order are best-equipped to pick up all the marks in a question such as this. Most have the right idea and some understanding of how the experiment worked, but phrasing the answer clearly was a challenge to many. The ideas “radioactive” and “new” (phages) were needed to explain how the DNA is passed on to the next generation.

Q.4 Here candidates were tested on central ideas about the relationship between DNA and protein and the importance of protein structure, and on the principles of experimental design. The authority with which candidates can criticise experimental design seems to be centre dependent. The information given in the question was complex and only the brightest followed a logical path through the information and data to correctly evaluate the hypothesis about oxidative damage and lifespan in part (b i). Around a third of the candidates did not have the understanding of oxygen dissociation curves necessary to complete the graph in (c).

(a) Good candidates scored four marks easily. Candidates who failed to score well generally did not make mistakes, they just failed to provide enough factual information, giving up too soon after a couple of cursory statements. The syllabus material tested here is so basic that even weaker candidates should have been able to dredge up relevant points from the knowledge accumulated from two years study of A level. Candidates need to be taught that on the synoptic paper they should try

to identify what parts of the syllabus are being targeted, in order to help them to retrieve the relevant information. Mind maps might help (for example the word protein should have cued candidates to make the link to enzymes, and from there they should be able to discuss the importance of the three dimensional structure of the active site).

(b)(i) Candidates should be encouraged to trust their instincts. Occasionally data is presented that actually contradicts a hypothesis, as here. Some candidates seem unwilling to conclude that the answer can be "No" and they hedge and contradict themselves. Candidates who were struggling by this point would have done well to re-read the information given carefully, to establish the logic of the experimental design in order to interpret the results correctly.

(b)(ii) Again, candidates needed to go back and scan the information given to find the descriptive points here. Many came up with the different ages and different sizes of the experimental organisms. Fewer candidates scored for explaining why their criticisms were valid, although the simple "not a fair test" idea was quoted to advantage by some. Taking the matter of the different ages of the animals, it was not enough as an explanation then to make a vague generalisation like "their age could affect how much free radical damage they receive". With the information given, they should have been able to identify that the mole rats were older and therefore might be expected to have accumulated more free radical damage, in other words, to commit themselves to a clear explanation of how in this situation the uncontrolled variables might skew the results. Comments on habitat were again frequently not followed through with an appreciation of how this would affect the concentration of oxygen the animals were normally exposed to, given the central importance of oxygen and aerobic respiration to the generation of free radicals. Had candidates not read the stem of the question at the top of page 14, they would not have picked up this crucial idea of course.
Candidates who seemed to be functioning on "autopilot" with respect to suggesting improvements to experiments mentioned the need for repeats or "more experimental animals". No information was given in the question on the sample sizes used, other than "mice" and "naked mole rats" so it was certainly not true to say that only one of each was used.

(c) Over half the candidates drew an S-shaped curve to the left of the mouse curve and scored a mark. Some made the wrong decision of going for the right side, and a few drew a line that crossed the mouse line at some point, showing very scant knowledge of the material being tested. A very tiny minority of candidates failed to turn the page and finish the question.

2806/03 Practical Examination

General Comments

This Practical Examination centred on aspects of excretion from the last section of *Central Concepts.* Candidates probably guessed that *Q.2* was likely to be about the histology of the kidney, but they rarely applied the information they had used in their Planning Exercises to the question on glomerular filtration rate (GFR) in *Q.1*. Performance, as in previous series, was often better on the Plans than on the Tests although there were many excellent scripts that showed good performance on both parts of the examination. Plans tended to be very centre-specific and dependent on how teachers had interpreted the task and the quality of the guidance given to the candidates. When carried out, preliminary work was often not clearly described. However, there were examples of preliminary work with data tables and graphs that showed a very good understanding that informed the Plans. Examiners award marks if candidates describe clearly any preliminary work or relevant previous practical work they have undertaken and if they make clear the qualitative or quantitative results that they obtain. Many Plans were bedevilled by the word 'amount'. In an exercise such as this, 'amount of urea' refers to its concentration. But often candidates use 'amount' when they mean volume. The Examiners penalised use of this word when it caused confusion. The quality of written communication was very variable. Spelling mistakes, poor use of a spellchecker, typographical errors, mistakes with chemical formulae ('HCL'), inconsistent or incorrect use of superscripts and subscripts were all relatively common. Punctuation was poor. There was some evidence that candidates were dashing off something for the examination rather than being concerned about its quality – this was evident from gaps in the text where candidates intended to insert a piece of information or some art work but had just forgotten. This is disappointing considering that this exercise involves report writing to a deadline – a common requirement of the world of work. "Text-speak", such as 24/7, meant automatic loss of one of the quality marks. Some candidates did not have a good overall view of the Plan – not realising that it came in two sections – determining a calibration curve and collecting and testing urine from human subjects.

Comments on Individual Questions

Planning Exercise

The Examiners expected candidates to use one of two methods. The Instructions hinted strongly that candidates would prepare a calibration curve using a range of urea concentrations and then use this to determine the urea concentrations of urine samples. The inclusion of ethanoic acid in the Instructions was a hint that candidates might also use the method employed in *Q.1* of the June 2006 A2 Practical Test that involved acidifying urea concentrations, adding Universal Indicator solution, adding urease and then timing to a certain colour. In the event most candidates used the first of these methods. Results from June 2006 showed that the method would only be appropriate over a narrow range of urea concentrations, but candidates could have diluted their samples so that they gained results in the range. Details of the calibration curve method are given by P.W. Freeland (1) and it was good to see that some centres had this book and made it available to their candidates. Otherwise information about this is difficult to find, although the web site www.chemguide.co.uk provides some useful information about titrations

Some thought that the Planning Exercise was too chemical for biologists, but an important aspect of the task was based on enzymes from *Biology Foundation.* The Examiners did not think that asking biology students to carry out a simple titration was too difficult a task. Also they could have investigated this using a technique from a previous examination paper (June 2006) that relies on knowing the principles of following an enzyme-catalysed reaction (5.1.3 (d)).

Candidates with a strong chemistry background did decide to use a different approach dispensing with the calibration altogether. They hydrolysed the urea with urease and then titrated directly, using their knowledge of calculations to determine the urea concentration. The Examiners made sure that all checking points were available to these three approaches.

Once candidates had worked out the chemistry involved, they tackled the task well. The biology to be used was very straightforward and many described deamination, urea synthesis and the ornithine cycle clearly often relying on their textbooks or web sites such as the Virtual ChemBook: www.elmhurst.edu/~chm/vchembook which is a good source of information for much of the biochemistry in AS and A2.

Candidates were less successful at using their knowledge to explain how urea passes from the liver to kidney and what happens within the kidney so that it ends up in urine. This was about the only aspect of the A2 course that the examiners could find to use for checking point **I**. Some had ammonia travelling to the liver – a comment that Examiners thought had been copied from a Wikipedia entry. Candidates often included much background information on enzymes from AS here. The Examiners did not think this was relevant. However, at least one centre considered using immobilised urease, which was a nice bit of lateral thinking. Many did not consider putting the urea/urease reaction mixture in a water bath, although those that did often discovered the high optimum temperature for urease and kept the mixture in a water bath at 50^{o}C or above.

A major fault with many plans was that candidates omitted to leave the urea/urease and urine/urease reaction mixtures for long enough for the reaction to reach completion. Some candidates investigated this in their preliminary work and found that it needed at least 20 minutes to an hour. Some followed the reaction by using an indicator or a pH meter. This was a common way of obtaining **J**. Those that didn't often wrote 'add the urease and then carry out the titration...' without giving time for the reaction to complete. Some left it to go to completion but did not indicate how they would know. Many experimented with different indicators and others went as far as gaining results for a calibration curve. Candidates who carried out genuine preliminary work and reported it in full often scored better than those who did not. Most chose a minimum of five different concentrations of urea, but the Examiners insisted on one of them being greater than 2.5 g 100 cm^{-3} as it was likely that with high protein diets the urea concentrations in the urine was going to be in excess of the normal range quoted in the Planning Exercise. Instructions for preparing dilutions were often included, but sometimes the final concentrations were omitted so that **F** could not be awarded.

Some candidates went into great detail about the selection of human subjects for the investigation and the conditions under which they would be involved. Many referred to their AS knowledge of Dietary Reference Values or used information about Recommended Daily Allowances to decide on the range of protein intake to use often in the form of 'protein shakes'. The Examiners considered five different protein intakes to be the minimum required here to show a trend. Many just chose 'high, medium and low' as their intakes and therefore lost **G**. Others gave values in terms of grams of protein per kg body mass. Many also controlled other aspects of the diet. Some went further and thought it necessary to control exercise which might influence the use of amino acids in the body and temperature which would influence sweating and the concentration of urea in the urine and its loss in sweat. Keeping experimental subjects in captivity seemed to be taking this idea too far! However, testing for the 'baseline' urea content of urine seemed a good idea; although many stated that they would collect 'morning urine' or made other comments about the timing of urine collection they had to explain why this was necessary in terms of fluctuations in the concentration or urea to gain **S**. Few candidates realised that the concentration of urea is not the best outcome variable to record and considered how to calculate a rate of excretion as mass of urea excreted per unit time. Extremely few took their plans this far, which was a great disappointment showing that candidates do not think through a problem to completion. On the other hand some did consider the variables that they would not be able to control for this part of the Plan and they were rewarded with **U**. Often it looked as if they had been prompted to do this by their teachers as responses tended to be centre-based.

The standard of presentation in tables was variable. Units were often missing. Sketch graphs do not need to be very detailed, but they certainly should have the variables and the appropriate units. There was much confusion here between volume and concentration in deciding on variables to include in the tables and graphs.

The quality of referencing was very variable. Some candidates obviously consulted a wide range of web sites and found much information but none of it was cited in the Plan. Others have used a textbook and one web site, made good use of the information and cited their sources. This is the minimum that is required and seems an easy way to gain one mark (**N**). Candidates obviously need to be reminded of this. Consulting the article by Crayford *et al* (2) is a good way of doing this.

Teaching tip

1. Freeland, P.W. 1985. *Problems in Practical Advanced Level Biology.* Hodder and Stoughton, Sevenoaks. ISBN: 0-340-33563-7

Redrafted this appears in: Teacher Materials Biology 2 (OCR) CUP. 2006. CD-ROM ISBN-10: 0521674573 ISBN-13:9780521674577 details are at:

www.cambridge.org/uk/catalogue/catalogue.asp?isbn=0521674573

2. Crayford T, Hooper R, Evans S. Death rates of characters in soap operas on British television: is a government health warning required? *British Medical Journal.* 1997;315:1649–1652.

www.bmj.com/cgi/content/full/315/7123/1649

Practical Test

Question.1 Some centres were concerned that the procedure did not always give exactly the same results each time. However, it is very unlikely that this procedure will always generate exactly the same results given its subjective nature. The Examiners found that candidates from centres that reported difficulties prior to the examination often recorded excellent results that gave five points falling on a curve and they were able to estimate the concentration of the unknown with a great degree of accuracy. Some even carried out a second run of results which were concordant. Part *(i)* had a very generous allocation of marks (6 max) to allow Examiners to reward all the points candidates were likely to give to this challenging question. Some candidates responded well giving up to four points, but others simply went down well trodden paths or took one idea and wrote about it at length.

(a) Tables were generally satisfactory but often candidates forgot to record the concentrations of the sucrose solution. It is a good idea to record the tube number or letter as well since this quickly identifies the tube. There was some confusion over how to write the units: the following were acceptable g 100 cm^{-3}, g per 100 cm^3, g / 100 cm^3 The last of these should be discouraged as the solidus (/) should be used to separate what is measured from the unit in which it is measured. Some candidates calculated rates by 1/t. This was not necessary. Sometimes these were plotted in the graph and were accepted.

(b) Many candidates produced excellent results with very pleasing graphs. Common errors here were

- using difficult scales which compromised the accuracy of plotting data points,
- drawing lines of best fit that extended beyond the plotted points,
- not showing the intercept for **F**.

Some candidates plotted tube letters along the horizontal axis. Much against their better judgement the Examiners applied the error carried forward rule to graphs that showed this major error

(c) The Examiners awarded a mark for determining the concentration of **F** correctly from the graph using the timing given in the table. They also awarded a mark for reporting a result within the range 1.5 – 2.5 g 100 cm^{-3}. The final mark here was giving the unit. Many candidates gained all three marks, but there were also many who did not gain a result within the accepted range.

(d) The Examiners were surprised to find few candidates able to calculate the result as 50 mg cm^{-3}. Near misses were out by an order of magnitude.

(e) The candidates had to calculate the glomerular filtration rate (GFR) from the formula given. Initially the Examiners considered asking the candidates to use their own results for **F**, but providing results was a much easier to task to mark. They were surprised at how few could substitute the figures into the equation correctly using their answer to *(d)*.

(f) Most candidates referred to the volume of urine here. They did not state that the concentration of sucrose in the urine would depend on the volume of water in the urine. 'Urine dilutes urea' was not uncommon.

(g) Almost all candidates recalled that sucrose is a non-reducing sugar and explained that its glycosidic bond is hydrolysed to give glucose and fructose. It was encouraging to find candidates responding well to this synoptic question. Some stated that 'boiling is necessary to denature the enzyme and stop the reaction' which suggested to Examiners that candidates had used the method using sucrase (2803/03 January 2003) as part of their course.

(h) For the evaluation, the Examiners awarded a maximum of six marks for a discussion of the reducing sugar test and the procedure followed. Many candidates scored at least four here. Some continued onto white space on the question paper although they often wrote at great length rather than being concise. Most of the points given in the mark scheme were found, although few commented on the difficulty in obtaining accurate results from this subjective method so that small differences in determining the 'end point' could influence the accuracy of the estimate of the sucrose concentration in **F**. This is a point that has been made in Examiners' reports before. Candidates did not have the opportunity to carry out a 'dummy run' to improve their determination of the 'end point'. In the Plans many stated that they would carry out a rough titration first.

(i) In answering this question few appreciated the idea that sucrose was being used to measure filtration rate. Some candidates recalled that GFR is also determined using inulin (**not** insulin) which is a polysaccharide of fructose. This is described in some textbooks and was the basis of *Q.1* in the synoptic paper (*Unifying Concepts in Biology*) in June 2003. Sucrose, like inulin, when injected into the body remains unused. It is small enough to be filtered and is unlikely to be reabsorbed from the filtrate. This makes it a suitable substance to use. Candidates were much more focused on faults with this method rather than its suitability. For example, many said that it would depend on the volume of water drunk, but in fact it is independent of this. Again another point that could have been appreciated from the Plan. Including a control was not appropriate, but carrying out the test on others most certainly is.

Perceptive candidates stated that the method would be prone to errors if glucose appeared in the urine as that would contribute to the reducing sugars tested by Benedict's. Some mentioned diabetics in this context. However, glucose may appear in the urine for other reasons, such as during exercise or during pregnancy.

Teaching tip

The idea for this investigation came from the following paper:

Winkler, A.W and Parra, J. (1937) The measurement of glomerular filtration. Creatinine, sucrose and urea clearance in subject without renal disease. Journal of Clinical Investigation. 16(6): 859–867.

http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=424925

The method employed here was also used for an AS practical in January 2003. Instead sucrase was used to hydrolyse sucrose. The method described there is a good way to show the effect of sucrose concentration on the rate of an enzyme catalysed reaction.

Question .2 The Examiners were disappointed with the standard of many of the drawings in part **(b)**. Too often the candidates relied on textbook diagrams or forgot to use their knowledge to find suitable cross sections of tubules to draw. Microvilli are not visible as separate entities. Cell membranes between the cells of the renal tubule are not visible. Nucleoli are very clear in these cells. That said, labelling and annotations were often good.

(a) Candidates had to look at the cortex under low power and make a plan diagram to show the distribution of renal capsules. Some drew the limits of the cortex within the circle provided and then showed the capsules as circular or near circular. Others presumably drew the outline of the Bowman's capsules as banana or boomerang shapes. The Examiners rewarded candidates who drew the capsules as having different sizes dependent on how the section had gone through them and not all circular. Most gained at least three marks here if they followed the instructions.

(b) As said above, drawings were not always very convincing. Some were partial LS views and the cells drawn were more like those from loops of Henle or collecting ducts. Shading must not be used in these histology drawings. Those that shaded the nucleus were not looking carefully to see the abundant nucleoli in these cells. Many said they could see mitochondria. However, knowledge was good and labelling was often very good. Annotations were often about the colour of the brush border, cytoplasm or nucleus. Some gave information about the shape of visible features or gave details of functions – neither were acceptable. There was some confusion between the basement membrane and the basal membrane. The former is very clear in these slides as a thin blue area around the cells. This is composed of protein fibres. The basal membrane is the outer membrane of each cell and it is not composed of protein fibres.

(c) Most candidates gained two marks here for giving two differences between the medulla and the cortex. However, some referred to size not structure. References to blood vessels rarely gained any credit as they were not qualified correctly.

(d) Calculation of the actual size of the nucleus in *(i)* was not done very well with few candidates gaining two marks. Many gained one mark by dividing by 7500, but then did not follow instructions carefully and express the answer as a whole number. Many candidates stated that mitochondria produce ATP but very few saw the emboldened word **many** in *(ii) and* said that they produce *much* ATP for these actively metabolising cells. Many were able to explain why ATP is required by these cells.

(e) Answers were often very detailed possibly because the question was anticipated by much that had gone before especially the Plan. Better candidates had already secured full marks for the question by this time, but others gained valuable marks here. Most candidates explained how ADH is responsible for the membranes becoming permeable to water to produce a concentrated urine. Few explained that when ADH is not secreted the membranes are impermeable and dilute urine is the result. Few if any mentioned the diffusion of urea into the medullary tissue that helps to lower the water potential. There was much confusion between the terms *wall* and *membrane*. For example, vesicles carrying aquaporins often fused with the *walls* of the collecting ducts. They don't they fuse with membranes. As it says in the mark scheme '*if candidates use 'wall' they mean the cells lining the collecting duct'*. The Examiners were disappointed to find references to 'water concentration gradients' rather than to water potential gradients.

Teaching tip
The following web site has many excellent electron micrographs useful to support teaching of animal histology.

www.uni-mainz.de/FB/Medizin/Anatomie/workshop/EM/EMAtlas.html

Teachers could use the mark scheme for part *(e)* with their students to show them how to focus their answers on the question. There were many discussions of negative feedback and the roles of the hypothalamus, osmoreceptors and the pituitary gland in the answers to this question. All were irrelevant. The preliminary information in italics about *wall* and *membrane* would also be useful to discuss with students who often use the word *wall* carelessly in this context.

Grade Thresholds

Advanced GCE (Subject) (Aggregation Code(s))
June 2008 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A	B	C	D	E	U
2801	Raw	60	45	39	33	28	23	0
	UMS	90	72	63	54	45	36	0
2802	Raw	60	47	43	39	35	31	0
	UMS	90	72	63	54	45	36	0
2803A	Raw	120	97	87	77	67	57	0
	UMS	120	96	84	72	60	48	0
2803B	Raw	120	95	85	75	65	55	0
	UMS	120	96	84	72	60	48	0
2803C	Raw	120	94	84	74	65	56	0
	UMS	120	96	84	72	60	48	0
2804	Raw	90	67	60	53	46	40	0
	UMS	90	72	63	54	45	36	0
2805A	Raw	90	63	55	48	41	34	0
	UMS	90	72	63	54	45	36	0
2805B	Raw	90	58	51	44	37	30	0
	UMS	90	72	63	54	45	36	0
2805C	Raw	90	64	57	51	45	39	0
	UMS	90	72	63	54	45	36	0
2805D	Raw	90	60	54	48	42	36	0
	UMS	90	72	63	54	45	36	0
2805E	Raw	90	62	55	48	41	34	0
	UMS	90	72	63	54	45	36	0
2806A	Raw	120	89	81	73	65	57	0
	UMS	120	96	84	72	60	48	0
2806B	Raw	120	89	80	71	63	55	0
	UMS	120	96	84	72	60	48	0
2806C	Raw	120	86	77	68	60	52	0
	UMS	120	96	84	72	60	48	0

Specification Aggregation Results

Overall threshold marks in UMS (ie 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	16.6	34.0	53.1	70.9	85.4	100	19941
7881	25.8	48.3	69.0	85.8	96.7	100	16210

36151 candidates aggregated this series

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored.

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553