



General Certificate of Education

Biology/Human Biology
5411/5413/6411/6413

Specification A

Examiners' Report

2005 examination - June series

- 5411 Advanced Subsidiary Biology
- 6411 Advanced Biology
- 5413 Advanced Subsidiary Biology (Human)
- 6413 Advanced Biology (Human)

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Biology/ Human Biology

Specification A

BYA1 Molecules, Cells and Systems

General

Given the very large entry for this unit, it was perhaps inevitable that the quality of work reflected the whole spectrum of ability. The best candidates, as always, demonstrated a sound grasp of factual knowledge and showed understanding of most of the underlying concepts and principles which are introduced in this module. They were also able to apply their understanding to material presented in a novel context and could describe and interpret graphs and tables. Less able candidates encountered a range of problems. Their knowledge was often patchy. While they might demonstrate considerable understanding of some complex biology, this was offset by lack of knowledge elsewhere. There was also a marked inability among those falling within this group to gain credit from questions that involved application and analysis. While marks are not specifically awarded for Quality of Written Communication in this unit, to gain credit, candidates must express their answers clearly and logically, making use of appropriate scientific terminology.

Question 1

This question targeted grade E and most candidates revealed a sound knowledge of the principles and skills tested here.

- (a) The presence of a nucleus was usually correctly identified as being a eukaryotic feature, although there were occasional inappropriate references to cell walls.
- (b) (i) The majority of candidates measured hypha length to an acceptable level of accuracy although errors of a centimetre or more were surprisingly frequent. Most completed the necessary subtraction to arrive at a value for growth but problems were frequently encountered with the use of the scale bar and conversion to micrometres.

(ii) Candidates were expected to provide a method of calculation but a significant number, although identifying the key variables of growth and time, could not supply the necessary idea of growth divided by time.
- (c) It was expected that candidates would draw on their knowledge of the biochemical test for starch in their responses. While most were successful, many answers made no attempt to link this to the context of the question and wrote generally about "doing the iodine test" on "the food" or on "the solution". There was occasional confusion with Benedict's test and the biuret reaction. Some referred incorrectly to the reagent as potassium iodide and a few were rather more concerned about representing their findings than testing for starch.

Question 2

The examiners were pleased to note some evidence of an improved understanding of those aspects of physiology tested in this question. With the notable exception of part (a)(ii), there were many excellent answers.

- (a) (i) Most candidates were able to select the relevant blood vessels although, occasionally, the only reference was to vessel C.

- (ii) It was hoped that the wording would have steered candidates towards identifying the difference in the musculature of the ventricle walls as the cause of the pressure difference. A significant number of responses, however, were based on the importance of the difference. Candidates clearly need more guidance from centres in approaching questions which require an explanation of cause. There were also errors associated with a poor grasp of the underlying physiology with references either to the contraction or pumping of blood vessels, or to differences in oxygen concentration as the significant factor. The majority of candidates correctly identified the atrial pressure as being higher than that in the ventricles and could usually refer to the open atrioventricular valves as providing the necessary evidence.
- (c) The most frequent errors were to identify structure **X** as the sinoatrial node, and **Y** as the sternum or "a nerve". Generally, however, answers were sound.
- (d) It was encouraging to note the many excellent answers which conveyed a sound understanding of the mechanism of coordination and control of the heart beat. There were occasional references to blood flowing from the ventricles to the atria but credit was generally only withheld from those candidates who were able to provide part of the answer.
- (i) References to allowing time for the ventricles to fill were not always followed by a comment on their subsequent contraction.
- (ii) The less convincing answers tended to rephrase the question instead of referring to the significance of the ventricles contracting from the base.

Question 3

- (a) (i) Although the graph in this question was probably unfamiliar, it was pleasing to note from the answers that many could interpret it and clearly understood what was represented.
- (ii) Answers here were seldom so convincing. There was much irrelevant discussion of oxygen uptake and transport. Where carbon dioxide was mentioned, many candidates failed to link diffusion to events in the lungs. Perhaps more disturbing was the widespread misconception that diffusion of carbon dioxide is directly affected by the oxygen concentration gradient. Answers such as "Because oxygen has been taken in, there will be a high concentration so carbon dioxide can no longer diffuse out" were not infrequent.
- (b) The answers which gained credit showed the volume of air increasing during inspiration but seldom drew on the information in the graph to indicate that a maximum value would be reached. The simple strategy of checking on their own inspiration might have helped candidates here.
- (c) Produced many excellent answers and it was encouraging to note so many using such terms as contract and relax, volume and pressure to explain the role of the intercostal muscles. It should be noted however that the specification does not require a knowledge of the roles of the internal and external intercostal muscles and, for some, this extra detail proved their downfall.

Question 4

- (a) Revealed an excellent understanding of non-competitive inhibition and there were many correct answers. Occasionally candidates involved both molecules **A** and **B** or attempted to make up an entirely different molecule which they attached to the side of the enzyme.
- (b) Most answers indicated that fewer collisions resulted in fewer enzyme-substrate complexes being formed, even if this was explained simply in terms of lower kinetic energy, information provided in the question. It should be noted that answers based on an increase in temperature were unacceptable as were those responses based on denaturation.

- (c) Although there were many excellent answers, less able candidates were often unable to apply their knowledge to this unfamiliar example. The most common incorrect responses were based on urea increasing the rate of reaction, either by somehow assisting enzymes in breaking hydrogen bonds in the substrate or in breaking the bonds binding substrates to active sites.

Question 5

- (a) Maximum credit was rarely awarded to answers. Although candidates appeared familiar with the need for initial filtration, few had a clear idea as to what was being removed, with many being of the opinion that it was either "broken organelles", plasma membranes or individual molecules.
- (b) Most candidates answered correctly but some negated their answers by subsequently referring to chloroplasts and cell walls.
- (c) Apart from the few candidates who were of the opinion that centrifugation can only be used to separate membrane-bound organelles, answers were good.
- (d) Most candidates correctly involved the concept of resolution in their responses, but frequently linked this to the wavelength of the electron microscope rather than of the beam of electrons used.

Question 6

- (a) Answers emphasised that the term "organ" is better defined in terms of structure than function. Answers such as that an organ has a "specific function" are true of all levels of organisation from molecule to system.
- (b) (i) Required candidates to draw on the information in the table and their understanding of the structure of capillary walls to suggest the required figure. Better candidates had no difficulty in arriving at an answer of 20 μ m. Those candidates who appreciated that this was considerably larger than the value they might have expected were also given credit, as long as their responses were suitably explained.
- (ii) Incorrect answers were frequent, commonly resulting from either the inability to convert micrometres to millimetres, or to a failure to appreciate that the wall completely surrounds the lumen.
- (c) Produced numerous answers which were based on the use of inappropriate terminology. Candidates should be advised to refer to elastic tissue stretching and recoiling, reserving the terms contracting and relaxing for muscle.

Question 7

- (a) (i) Answers to parts of this question were not infrequently marred by lack of knowledge of the basic structure of cellulose as a polymer of β -glucose. Thus, although all that was required here was to note that both molecules were polymers, many disqualified their answers by referring to cellulose as also being a pentose.
- (ii) Limited question technique frequently restricted the credit available. Many candidates concentrated on functional rather than structural differences. As a consequence, the answer boxes were often so full that they rarely compared like with like and offered a valid comparison. Among the better, more focused, answers were some which unfortunately were a little too concise, referring to hemicellulose as a pentose and cellulose as a hexose. Questions requiring structural similarities are likely to remain a feature of BYA1. Candidates clearly need an effective strategy for answering them.

- (b) Starch and protein were correctly identified by many, but a range of incorrect responses included glycogen, phospholipid and various monosaccharides.
- (c) (i) Answers suggested that, although candidates were clearly familiar with the term "constant mass", they were by no means all conversant with the idea that it represented the point at which all water had been lost.
- (ii) There were many correct answers. Answers to this second part, such as "Going over 90°C would start to boil the water so that we would be unable to calculate the water content" were frequent and suggested that candidates had failed to focus on the information provided in the second paragraph of the passage. The better candidates at whom this question was directed were generally able to point out, however, that high temperatures might lead to other substances being broken down and a consequent loss in mass.
- (d) Although most candidates were aware of the specific nature of enzyme action, they experienced varying degrees of difficulty in relating the general concepts involved to the context of this question. Those candidates who gained least credit were inclined to reword the question and offer an explanation in terms of the lignin covering. Others offered responses centred around lignin acting as an enzyme inhibitor. Better candidates clearly understood the concepts of molecular shape and fit and were able to apply them to this situation.
- (e) Answers to this part of the question ranged from those of the more able candidates who wrote clearly and logically about cellulose structure and function, often with a pleasing level of accuracy and detail, to those which did not gain credit. Among the latter were many who failed to attempt this part of the question and others who confused cellulose with other molecular components of plant cells such as starch and plasma membranes. There was much confusion between hydrogen bonds and glycosidic bonds, and between α -glucose and β -pleated sheets. Other incorrect assertions which frequently arose were that cellulose is formed from alternating α - and β -glucose residues, and that it contains both 1-4 and 1-6 linkages. Many candidates correctly identified strength as one of the molecule's properties and went further in discussing the importance of this in withstanding pressures resulting from osmosis. A frequent error, however, was to assign the function of energy storage to cellulose.

Question 8

- (a) There were many candidates sitting this unit who displayed an excellent knowledge of the facts and principles contained in the module, but who revealed an inability to describe and interpret the data presented in the table in this part of the question. The descriptions revealed that such candidates often failed to appreciate that the experimenters had changed the concentration of oxygen bubbled through the mixture. They also occasionally referred to a decrease in the rate of uptake of potassium ions from 90 to 80 arbitrary units at a 20.8 % concentration of oxygen, further suggesting unfamiliarity with tabulated data. Candidates who recognised the table as relating to active transport, were generally able to produce a convincing interpretation of the figures. Others frequently suggested that potassium ions were used as a respiratory substrate, or combined with ADP to produce ATP.
- (b) An understanding of water potential should have resulted in candidates being able to interpret the graph, even if they experienced difficulties with understanding the ratio on the y -axis. They should also have appreciated that the x -axis represented sucrose concentration, not time.
- (i) Evidence that this was not the case came from the many who suggested that the length of the potato remained the same at a concentration of 0.5 mol dm^{-3} , presumably identifying the point where the graph levelled out.

- (ii) An understanding of ratio was required. Answers based on 180 presumably reflected those who thought that 1.2 represented a ration of 1:2 but other responses suggested incorrect reading of the graph, or the inability to calculate the required length from the correct ratio.
- (iii) Answers need reference to water potential. Responses based simply on concentration were unable to gain maximum credit.
- (c) The saving grace for many of the less able candidates was that some information was provided in the stem of the question, and many of these candidates sought to construct an answer by simply rewording this material. Among these answers, general statements about hydrostatic pressure and osmosis were seldom linked to the formation and reabsorption of tissue fluid. Those candidates who understood something of the processes involved gained some credit, but this was often limited by imprecise use of such technical terms as diffusion and osmosis. The best candidates offered clear and lucid accounts reflecting again the advantages of being able to express their ideas clearly and logically with appropriate use of scientific terminology.

BYA2 Making Use of Biology

General

Overall the standard of scripts seen was pleasing, with many candidates gaining over 50 marks. Such candidates wrote fluently and precisely and had a clear understanding of work covered in the unit. Many answers were more detailed than required by the mark scheme but there was no evidence to suggest that the candidates, by writing extra, ran out of time. Poor handwriting was evident again this year, as was poor spelling. Some candidates used their own shorthand for scientific words. While marks are not specifically awarded for Quality of Written Communication in this unit, to gain credit, candidates must express their answers clearly and logically, making use of appropriate scientific terminology.

Question 1

- (a) Many correct tables were seen, but some confusion between the roles of LH and FSH was evident.
- (b) More able candidates recognised that with few or no follicles remaining, less oestrogen would be produced. However, many less able candidates wrote about having to produce more FSH to try to stimulate the last few follicles.

Question 2

- (a) This was well answered by many candidates, but weaker candidates failed to identify the context and suggested that enzymes could be reused, without recognising that stones could be reused too. There were also many references to ‘cheaper’ without any explanation of why this might be the case, for example, in energy savings or less wear and tear on machinery.
- (b)
 - (i) Most candidates gave a correct method here. Most suggested the use of a restriction enzyme.
 - (ii) Some excellent accounts of how an isolated gene can be inserted into a bacterium were seen. Many started too early in the sequence and described the removal of the gene from the fungus. The role of the different enzymes was well known by most candidates, but few had any idea of how to return the plasmid to the bacterium. A few candidates were careless in their answers, using restriction enzymes to cut open the bacterium, rather than the bacterial DNA.
 - (iii) Many candidates suggested the use of a fermenter here, but were vague about the conditions to be used. The term ‘downstream processing’ was also used by many candidates. Some gave lengthy accounts of the use of antibiotics, although still managing to score the marks towards the end of their answers.

Question 3

- (a) Although aerenchyma was given by the most able candidates, incorrect answers were frequent.
- (b)
 - (i) A significant number of candidates understood exactly what was required and gave concise and correct answers. Others wrote about maintaining variables without making it clear that these were the same as in the submerged group.
 - (ii) Most students concentrated on the fact that rice plants produce ethanol during anaerobic respiration and that they are tolerant to it. Few mentioned the function of aerenchyma or the shallow roots.

(iii) Here, many candidates correctly recognised that rice plants could not tolerate consistently high levels of ethanol. Some candidates considered that the plants had used up nutrients.

Question 4

- (a) (i) Many identified the root tip as the region or area where mitosis was taking place.
- (ii) Too many did not know the reason for using a stain and often thought it was to stain the organelles, the nucleus or the cell. Only the better candidates identified its role as staining the chromosomes.
- (iii) Many had the correct idea of producing a single layer of cells so that light could pass through.
- (b) (i) Only the best candidates gave the correct answer here, as few recognised that only during prophase and metaphase would chromosomes be visible as chromatids.
- (ii) Most candidates found this question very difficult and often just repeated the stem, stating that a different root tip had been used. Only the better candidates gave some idea that the garlic may have been growing in different conditions or that it might be genetically different.

Question 5

- (a) Surprisingly few gave the correct response of nucleotides. Many gave one or all of the parts of a nucleotide, or amino acids.
- (b) (i) Virtually all candidates gained two marks for calculating the missing figures.
- (ii) Though most candidates had the right idea, many found it difficult to explain that the bases did not show a 1:1 ratio and were therefore not paired. The concept of base pairing was often omitted.
- (iii) Most candidates could give two similarities. However, the most frequent errors were using uracil as a common base, or misinterpreting the question and giving two differences.

Question 6

- (a) (i) Many candidates realised that temperature would have an effect on the rate of reaction. The idea that only one variable should be changed was well known. However, weak candidates suggested the need for fair testing without further explanation.
- (ii) This was poorly done with many strange responses. Most could give a unit of time but only the best gave a unit of volume or mass as well. Several suggested 'arbitrary units' as the answer. There was also confusion about which gas was produced.
- (b) (i) There were many excellent answers here, with most candidates scoring the mark.
- (ii) Most candidates identified that this was due to a limiting factor but only the better candidates gave sufficient detail to achieve two marks.

Question 7

- (a) (i) Most correctly gave the coding sequence of ACG. The most common incorrect answer involved replacing A with T.

- (ii) Most identified serine correctly.
- (b) There was some good understanding of introns and many identified this correctly as the explanation for the different number of nucleotides. The main incorrect answer occurred when candidates concentrated solely on stop/start codons.
- (c) This was poorly answered by many candidates. Most had some understanding of what was happening but only the better candidates could express this in enough detail to achieve full marks. Weak candidates failed to use terms like codon, anticodon or translation, and often simply restated the question. Many referred to tetracycline carrying a stop codon.

Question 8

- (a) Most candidates made a reasonable attempt at this part of the question with many scoring maximum marks. However many began their answers at the wrong point and gave details of PCR before describing genetic fingerprinting. The order of the process was also often confused, with many separating the strands of DNA before electrophoresis, or putting in a probe at the start of electrophoresis. Another misconception was the use of X-rays to identify the probe.
- (b) Most realised that cells would be removed from the mouth area when brushing the teeth and many then continued correctly to identify DNA as being in those cells. Few showed a better understanding by referring to the fact that the DNA was in the nucleus. The commonest misconception here was that saliva would contain DNA.
- (c) (i) Many realised that PCR was being used to increase the amount of DNA but failed to link this to the low initial amount of DNA.
(ii) This was a challenge for all but the best. The most common correct answer as to the difference was that PCR required heating to break the hydrogen bonds. Many candidates were of the opinion that PCR was conservative replication of DNA, while semi-conservative DNA replication occurred in cells.
- (d) (i) Many realised that, with a small sample, it would take time to copy the genetic material.
(ii) Only the better candidates appreciated that the sample would be contaminated with other DNA, and went on to recognise that it would take time to identify this or remove it. There were many vague answers about contaminants and the need to decontaminate.

Question 9

- (a) (i) This was surprisingly poorly answered. Few candidates could give a full description of the data, most simply giving the response that it increased. Often there was no explanation as to why the yield increased or levelled off. Few related the increased yield to the role of nitrogen in protein synthesis.
(ii) Though many could give two advantages, the responses were often vague. The most common incorrect answer was based on the idea of ‘easier’.
- (b) This is well understood by most candidates and many gained full credit for their responses. Weaker candidates tended to have the algae taking oxygen from the water or fertilisers poisoning the fish. Some candidates showed confusion over which gases are used and produced in photosynthesis and respiration.

- (c) (i) Most gave a wordy account of the shape of the graphs and only those with better language skills gained full credit. The commonest problem was to describe the graph rather than offer an explanation. Weak candidates had the whitefly feeding on the wasp.
- (ii) Most knew what biological control was and gained full credit. A few simply used general terms such as 'organism' or restricted their answer to the whitefly and wasp, as used in the question.

BYA3 Pathogens and Disease

General

Candidates entering this unit varied widely in standard. It was pleasing to see a better standard of preparation this year and many achieved high marks. There was no evidence that there was insufficient time and all questions were attempted. Many candidates found difficulty in expressing themselves in clear English. Some were not concise and their answers extended beyond the space allocated. Others used inappropriate terminology. While marks are not specifically awarded for Quality of Written Communication in this unit, to gain credit, candidates must express their answers clearly and logically, making use of appropriate scientific terminology.

Once again, despite the clear rubric on the front of the paper, many candidates had not brought calculators and were unable to complete the calculations. No concessions could be made for such oversights.

Generally questions requiring only recall of facts were better answered than those where new situations were presented and application of knowledge was needed.

Question 1

- (a) Most candidates were able to explain that the tip was the site of root growth and cell division but fewer knew that a stain was required to distinguish the DNA or chromosomes rather than cells, nuclei or organelles. In part (iii), while many correctly described the cells being separated or formed into a single layer to allow light through, some thought it necessary to remove air bubbles or to break open cells to release the contents.
- (b) Credit was given for correct recognition of the two stages involved; many candidates were unsure of these or were unable to complete the calculation. In the second part, only the very best candidates could supply suitable ideas about genetic variation, differing environmental factors or the role of chance. Many others suggested the differences would be due to the size of the tip, the area of the slide or the stage in mitosis at which the slide was made. Some blamed the observer for miscounting or the poor quality of the microscope.

Question 2

- (a) This proved an excellent discriminator. Some achieved three marks but there was a tendency to include interpretation rather than method or to suggest impractical steps such as adding the test plate to the solution. Flow charts seem to be unfamiliar to many candidates.
- (b) Whilst a few scored two here, many failed to gain marks by discussing enzymes and active sites, failing to realise that antigens with a specific shape were involved.

Question 3

- (a) This part elicited references to lag phases and comments about ‘bacteria having to settle down’. The time taken to reach the digestive system and possible digestion there also appeared. Better candidates mentioned the time required for bacteria to multiply and produce toxins and, less frequently, that release of toxins only occurred at death.
- (b) The practical aspects of this section brought some good, sensible answers. The idea of material dripping from raw meat which contains bacteria was widely given, although some concentrated on the different temperatures in the fridge. Transfer of bacteria by means of dishcloths or the latter providing ideal conditions for bacteria to reproduce was common but in both parts of the

question unqualified 'contamination' gained no marks. 'Germs' is not considered an appropriate term for AS level.

Question 4

- (a) Almost all candidates scored one mark for the idea of bacteria being killed or inhibited but very few mentioned diffusion of the antibiotic. Candidates should note that two marks are rarely given for a single idea in a question of this type.
- (b) Some candidates failed to gain marks by casual references to large or larger clear areas instead of saying this was the largest.
- (c) Some good answers were seen in (i) with firm understanding of translation and appreciation of the consequences of a block on the codons, but a large number confused transcription with translation, codons with anticodons and mRNA with tRNA. In (ii), many candidates scored two marks but some, disregarding the question, wrote about protein synthesis or gave general statements about bactericidal or bacteriostatic compounds. Some were confused as to whether the cell wall or the cell membrane was disrupted.

Question 5

- (a) A wide variety of answers was seen here ranging from no response to amino acids, assorted sugars, a list of the components of DNA and, in a disappointingly small number of scripts, nucleotides.
- (b) A pleasing number of candidates scored two marks here but several went astray as a result of poor maths or weak biology. Part (ii) proved a test of expression and many spent time explaining that the virus DNA was double-stranded or used much of the margin to fit in all their ideas.
- (c) Although a wide variety of answers was possible here, many failed to score marks by referring to base pairs or that both had ribose, thymine or uracil. Candidates should be aware that examiners cannot select correct responses from a long list. A surprising number gave differences instead of similarities.

Question 6

- (a) Although many clear and correct answers were seen in part (ii), there was some discussion of the parasite, or even malaria, coating itself in host antigens or changing its surface cells. The terms 'antigen' and 'antibody' were requirements of good answers.
- (b) About half the candidates answering this question failed to explain that the DNA would be single-stranded and that it would be complementary to, and not the same as, the gene required.
- (c) Whilst many realised that the immune system of children would not be so well developed as that of adults, a surprising number suggested children would be bitten when playing outside or would be unaware of the dangers of mosquitoes.

Question 7

- (a) Few stated that reverse transcriptase was an enzyme or correctly explained its role in using RNA as a template to make single-stranded DNA. Many gained one mark by saying that DNA was produced.

- (b) This question proved difficult for most and even those who understood what was required sometimes found it hard to express their thoughts. Few appreciated that tenofovir would be taken up in place of a base during DNA replication, rendering the product incapable of further replication or transcription. The second part was more straightforward and suggestions about the changing nature of surface antigens or the need to control side-effects appeared often.
- (c) Most candidates achieved one mark here for indications of a weakened (rather than eradicated) immune system but very few correctly described damage to T cells as the contributory factor.

Question 8

- (a) Myocardial infarction was well known by many candidates and maximum scores were common. There was confusion between a clot and atheroma in some scripts and imprecise descriptions of these forming ‘in’ blood vessels or ‘making blood vessels smaller’ gained no marks. Some failed to clarify that heart muscle or tissue rather than the chambers of the heart would be short of blood or oxygen and would die.
- (b) In this section, everyday descriptions of unbiased choice gained marks and many appreciated that it was necessary to compare the warfarin results with a control group. The calculation proved difficult and completely accurate answers were not common. Rounding up at too early a stage distorted the result in many cases even when the correct expression was given.
- (c) Few candidates scored both marks here. A statement explaining the trend was frequently given although some used ambiguous wording such as ‘the heparin would slow the clotting time’. It was important to link the increase in both the concentration and the time. The second mark, rarely awarded, was for noticing the change in rate at 0.2 arbitrary units. Whilst all realised that clots would be dangerous or fatal, many failed to name an actual condition that could result. In part (iii), the cascade effect was known and described but few associated the slowing of the clotting with a shortage of thrombin or fibrin.

Question 9

- (a) Few candidates scored two in the first part and vague references to ‘fighting infections’ were common as was confusion of antigens with antibiotics. In part (ii), some candidates appeared to know the sequence of events but in many cases limited marks were gained because of incorrect biology and discussion of previous infections which ‘the body remembers and is ready to fight off the second time’. B and T cells were confused, the exact role of mitosis was not well known and few explained the specific antibody synthesis by plasma cells. Some answers used bacteria as the infective agent.
- (b) This section scored the majority of the marks for the question in most scripts. Problems arose mainly where candidates failed to apply their knowledge to the situation. As a result, the gene was transferred to a plasmid which was put into maize or left in a test tube. In a few cases, the first part of the question led to suggestions of infecting the maize with various blood cells.
- (c) Several good answers referring to passive immunity were seen here but many failed to gain marks through lack of precision in their answer.
- (d) Examiners were looking for more than a simple response about cost here. Valid ideas on the ethics of this work or the possibility of transferring a disease were awarded marks.

BYA4 Centre-Assessed Coursework

General

The 2005 specification, the new *Guidance for Teachers*, the teacher support meetings and feedback from previous examination sessions successfully combined to provide details of the new scheme of assessment. Most centres were clearly aware of the changes and had made a genuine attempt to assimilate them into their teaching programme. This obviously entailed much hard work in re-writing marking schemes, and developing practical investigations that would better allow the new criteria to be met. The new six-mark scheme has obviously delivered some improvement in discrimination, and this is in no small part due to the fact that teachers have, by and large, supported the idea that coursework should discriminate and not just provide a means for the weakest candidates to score highly.

There was very little evidence of centres marking to the old criteria but what was a problem was the failure of some centres to submit the required evidence for Skills **C**, **D** and **E** at AS level and Skill **D** at A2. This year, a decision was made to allow the centre's marks to stand in such cases, but this will not be the case in future. **In future, where there is no evidence for a skill, a mark of zero must be awarded by the teacher. This is in line with the practice that applies to other skills.**

Assignments were usually appropriate with most being based on investigations of membrane permeability in beetroot, factors affecting the rate of reaction of catalase, or water potential. The tasks set for Skill **E**, however, were not always suitable. There appears little educational justification in requiring candidates to examine materials such as daffodil flowers, fish heads and stem sections. These do not form part of the specification. In addition, the drawing exercise must be sufficiently demanding. The drawing of a single plant cell or red blood cell was clearly inappropriate. *Guidance for Teachers* has a number of suggestions of more suitable material and should be consulted if moderators have commented adversely on choice. Some of the work set for assessment of Skills **I** and **J** remains too general. Essay titles such as 'Coronary heart disease' and 'Biological control', while meeting the demands of the specification in allowing discussion of the ethical, social, economic, environmental and technological applications of biology, provide insufficient guidance and often invite irrelevance and a lack of focus. Again there are a number of suggestions in *Guidance for Teachers* and centres are advised to consult this.

It is important that the coursework is seen as providing a vehicle for the assessment of experimental skills which have developed as the course progresses. There was much evidence this year, as in previous years, that many candidates had failed to acquire some of the necessary skills before being assessed. This was particularly true of those associated with the design of experiments, analysis of the results and evaluation. Where results overall were disappointing, centres would be advised to review their approach. It should also be remembered that the structure of the assessment package allows candidates more than one attempt at a particular set of skills. The identical nature of all tasks submitted by some centres is suggestive of a strategy that perhaps provides too little opportunity for improvement.

Planning - Skills A and B

Most centres provided candidates with a genuine opportunity to plan an investigation although the close similarity of the work submitted by some centres suggests that guidance is at times excessive. Thus it does not seem reasonable for all candidates in a centre investigating, for example, the effect of temperature on amylase activity, to give exactly the same quantities, pH and range of temperatures. Such close similarity suggests excessive guidance. It should also be noted that preliminary investigations are not acceptable and likewise deny candidates a genuine opportunity to demonstrate the planning skills being assessed. It should be entirely possible to propose suitable concentrations, temperatures, pH values and so on without the need for preliminary trialling. Refinement in detail can be carried out after marking Skills **A** and **B**, if it is deemed necessary to amend the plan before implementation. A practice which is increasing, and is clearly unacceptable, is to provide what amounts to a tick list against which the specific requirements of the investigation are checked. Candidates should certainly be allowed access to a suitable

version of the criteria, but excessive prompting merely devalues the task. Once they start work on their plan, candidates should complete it without further assistance.

There were few new issues arising with Skill **A** and most of the instances where the marks awarded by the centre disagreed with those given by the moderator, concerned the required detail. It is all too easy to assume that, because a student is able, he or she would know what to do and therefore the plan must be worth maximum credit. The best test here is to require such detail that another member of the group could implement the work without further guidance. An account which falls short of this cannot gain maximum credit. In addition, instructions are seldom provided for setting up the necessary control experiments.

The marking of Skill **B** gave cause for a little more concern, in that many assessors appear to be of the opinion that any set of results involving the collecting of three sets of data must be reliable and therefore worthy of maximum credit. There are other factors which also affect this and a failure to address these is often the cause of discrepancies between the marking of the centre and that of the moderator. Such factors include the need to rinse beetroot tissue to remove surplus pigment; blotting potato cylinders before weighing; recognising that pushing a bung into a flask will create displacement of gas in the delivery tube and, most frequent of all, that equilibration is essential before mixing reactants in investigations involving the effect of temperature.

Implementing - Skills C and D

Centres are reminded of the need to include evidence of how the mark for Skill **C** has been awarded and, where a group tick sheet is used, enclose a copy with the work of each candidate in the sample with the particular candidate highlighted. The use of combined worksheets where candidates were identified by first name only made moderation unnecessarily difficult. The evidence provided by centres for this skill varied considerably. Most had clearly followed the guidelines in the specification and produced checklists that provided evidence of safe working practice, an indication of the skill with which apparatus was used, and information concerning aspects of organisation. Such checklists were clearly sufficiently comprehensive to provide the necessary support for the mark awarded. On the other hand, the evidence provided by others was minimal. Brief statements to the effect that candidates had "worked safely and methodically throughout" or ticks placed in the appropriate columns of the marking criteria are unacceptable.

Immaculate word-processed copy is not required for Skill **D**. What must be submitted for assessment and moderation are the data recorded at the workbench while the investigation was being implemented. To gain the higher marks, such data must be presented in a table. Lack of suitable headings to the columns should be regarded as haphazard presentation and work should be penalised accordingly. Many centres appeared not to be aware of the IOB conventions on presentation of units. In tables and graphs, they should be separated from the feature with a slash or solidus. If compound units are used, then candidates should make use of negative indices. Rate of water loss, for example, would be written: Rate of water loss/cm³m⁻²h⁻¹. Where these conventions are not followed, such as where the units are bracketed, the performance level must be reduced by at least one mark.

Drawing - Skill E

It is important that a biologist has the ability to observe living organisms or material derived from living organisms accurately. This is the sole purpose of Skill **E**. Work should not therefore be penalised for inaccurate labelling, or for a failure to follow an unspecified set of rules and conventions. Since moderators do not have access to the specimens involved, it would be helpful if centres require a title on drawings. There were instances where it was far from clear as to what was being drawn. Many centres were extremely generous in what they perceived to be a fully accurate drawing. Where, for example, an entire root tip had been drawn, individual cells were usually represented with less and less accuracy as, inevitably, boredom set in. Such work, however, had rarely been penalised.

It is important that, although the task should be suitably challenging, it does not make unreasonable demands on candidates' time and patience. In general whole organs, such as arteries and veins, should

show the distribution of tissues as opposed to the appearance of individual cells. If cells are drawn, such those in a dividing root tip, plasmolysed tissue or the white cells visible in a blood smear, then it is infinitely better to show three or four of these cells accurately than draw large numbers with little attempt to do more than give a general impression of the location and appearance of features such as the chromosomes, cell walls and nuclei.

Analysing - Skills F, G and H

Only hand-drawn graphs are now acceptable for skill **F**, and almost all centres appreciated this requirement. Where graphs had been marked with sufficient care, there was generally close agreement between the marking of the centre and that of the moderator, but it was still common to find unpenalised errors. These most frequently concerned inappropriate extrapolation of curves, but occasionally also involved the use of non-linear scales and the inaccurate plotting of points. As with Skill **D**, it is important that candidates adhere to the IOB conventions on plotting of points and presentation of units. Where these conventions are not followed, such as where the units are bracketed, the performance level must be reduced by at least one mark. Significant problems arise where candidates choose to draw a line of best fit, classifying all points which do not lie on the, often poorly chosen, line as anomalies. Candidates should be discouraged from this approach. Not only is the line chosen seldom appropriate but the labelling and subsequent ignoring of anomalies may create further problems in identifying trends in data and commenting on the reliability of conclusions which may be drawn. The criteria concerning major and minor errors require a little clarification. A graph with a single minor error should gain five marks, while that which conforms to the descriptor and shows minor errors present is worth four marks. Similarly, a single major error results in a graph worth three marks, while that which conforms to the descriptor and shows major errors present should only be awarded two marks.

The standards of performance and assessment of Skill **G** have improved substantially since the inception of the present specification. Most candidates now go beyond translating their data into prose and produced convincing descriptions of the trends and patterns shown by their results. In many cases they were also able to draw on appropriate theory, but there was a tendency to use such information unselectively. As a result, links were not always apparent and observations were seldom explained. This weakness was usually, but by no means always, identified by the centre and marked accordingly. In a few instances, much of the information that formed a lengthy introduction to the plan could have been exploited more effectively in this context. Unfortunately, having already used this information, candidates were reluctant to repeat it.

Skill **H** still produces a challenge to many and only the best candidates addressed all four of the evaluative strands spelt out in the performance level descriptors. Namely:

- the identification of anomalous data;
- the identification of sources of error inherent in the apparatus used and procedure adopted;
- the suggestion of realistic ways in which the effect of these sources of error may be eliminated or reduced;
- the discussion of the relative influences of these sources of error on the reliability of the results.

Candidates frequently only used their graphs to identify anomalous data, yet the raw data often provided more convincing evidence. Such anomalous data should have been identified and reasons for considering them to be anomalous stated. It is not appropriate at this level merely to ring the figures concerned. Many candidates clearly felt a pressing need to identify something as an anomaly. Such comments as "the repeats showed anomalies as the same amount of bubbles were not produced at each repeat" suggest a failure to appreciate the inherent variation in biological data. Indeed, it is likely, particularly with the type of investigation normally set as a task at this level, that genuine anomalies will not be present. Candidates should not be afraid to point this out. Providing that they can support their contention with suitable evidence, they can still gain maximum credit. In addition, it is not appropriate to exclude data from, for example, calculations of means merely on the supposition that figures may be anomalous. Only if there is compelling evidence should such figures be excluded. Handling and measurement errors are not sources of error as such. They are personal failings and do not attract credit.

It is worth emphasising that candidates are unlikely to produce an effective evaluation unless they have implemented the procedure. Provision by the centre of clearly flawed plans which do not conform to good scientific practice and results with conspicuous "anomalies" are not in the spirit of the assessment and should not be used.

Communicating - Skills I and J

Most candidates had recognised the need to reference sources of information within the body of the text and provided a comprehensive bibliography. Sources were generally identified and website addresses were usually sufficiently complete, although there were occasional vague references to AS textbooks and search engines. The least convincing pieces of work were often word-processed but made extensive use of the cut and paste facilities. This approach does not allow candidates to put forward their own arguments and support these with information found from suitable references expressed in their own words.

BYA5 Inheritance, Evolution, Ecosystems

General

The unit attracted a candidature of the full ability range. The work of the best candidates was, as always, a delight to read and to mark. It showed a depth of knowledge and comprehension that was not just the result of innate ability, but obviously of interest in the subject and hard work in preparing for the examinations. These candidates read the questions carefully and usually responded in the manner intended, even if they did not score every mark available. There was no evidence of candidates being unable to complete the paper in the time available and the vast majority of candidates attempted all parts of all questions.

Examiners commented, however, that among other candidates, there seemed to be an increase in 'rote responses' rather than specific answers to the question asked. One case in point was the response of many to question 2(b), which asked candidates to apply their knowledge of the nitrogen cycle to explain the benefit of using ammonium nitrate in fertilisers. Very few actually went beyond *describing* the nitrification of ammonium by nitrifying bacteria; only the best candidates *explained* the benefit of supplying ammonium and nitrate ions in the same compound.

In general, candidates scored quite well on the longer questions, with question 9 usually being the highest scoring of the three.

Question 1

- (a) Most candidates were able to offer a correct answer here often referring to light passing through the leaf without striking a molecule of chlorophyll. However, many did not read the question carefully and answered "some light is reflected". Clearly this cannot be an appropriate response to a question that asks about "light entering the leaves of the oak tree".
- (b) A good number scored two marks here, but the question specifically asked about energy loss between trophic levels **A** (the oak tree) and **B** (the aphids). Respiration of the aphids, or movement, were, therefore, unacceptable responses. One misconception held by some candidates was that energy used in growth is lost from the food chain.
- (c) Many candidates merely translated the information in the diagrams into prose without explaining anything. The difference in shape at levels **D** and **E** is due to the fact that a single great tit can support many parasitic mites, but the total biomass of these mites is still less than that of the single great tit.

Question 2

- (a) Nearly all candidates knew that habitats would be lost, and a good number also knew that this would reduce the number of *species* in the area.
- (b) Better candidates realised that both potassium nitrate and ammonium nitrate would release nitrate ions into the soil immediately, and that the ammonium ions in ammonium nitrate could be nitrified by nitrifying bacteria to provide a secondary release of nitrates. Many candidates, however, just did not apply their knowledge to the problem and merely recited chunks of the nitrogen cycle, with some confusion between nitrifying and nitrogen-fixing bacteria.

Question 3

- (a) Nearly everyone knew that the energy from a photon of light excites electrons which are, as a result, emitted from the chlorophyll molecule.

- (b) Most understood that, as electrons pass down the electron transfer chain, they lose energy, which can be used to drive the synthesis of ATP.
- (c) Again, a majority appreciated the role of reduced NADP in the light-independent reactions of photosynthesis in the conversion of GP to triose phosphate and quite a number understood that the conversion is a reduction reaction, with reduced NADP supplying the necessary hydrogen ions. Some thought that reduced NADP supplies energy for the reaction. Others used the terms of phosphoglyceric acid or PGA (for GP) and phosphoglyceraldehyde or PGAL (for triose phosphate) and these candidates seemed to find more difficulty in explaining which substance accepted the hydrogen ions from reduced NADP.

Question 4

- (a) (i) Few candidates appreciated that, although the inheritance of ABO blood groups is an example of multiple allele inheritance, just two of the relevant alleles are present in *all* the diploid cells of an individual; one on the paternal chromosome and one on the maternal chromosome of the homologous pair. Some thought that there would be three, whilst others thought that there would be none, as “the antigens are only displayed on the red blood cells”.
- (ii) A surprising number of candidates confused antigens with alleles and wrote I^A and I^B instead of A and B.
- (b) A good number scored full marks on this part of the question. They deduced that the genotypes of the parents must be $I^A I^O$ and $I^B I^O$ and, therefore, the probability of producing a child with blood group A would be 0.25. Some candidates did not take account of the fact that only half the children would be male.

Question 5

- (a) (i) A good number of candidates spotted that where the ranges of the three armadillos overlapped, no fertile hybrids had been found and recognised that this suggests that they are, in fact, different species. Others just suggested that because their ranges overlap, they must be different species. This is clearly insufficient evidence to make this deduction.
- (ii) Those who realised in (i) that the absence of fertile hybrids was evidence of the armadillos being different species, sometimes went on to suggest that their absence from controlled breeding would be more conclusive proof of this. Others correctly suggested that difference in chromosome number or significant morphological or serological differences could provide further evidence. Some of those who suggested in (i) that overlapping ranges was evidence in itself of the armadillos being different species went on to suggest that the absence of fertile hybrids in those overlapping areas was further evidence, and this was given credit, although it had been the intended response for (a) (i).
- (b) (i) Many candidates completed the first column of the table correctly, but fewer completed the second column correctly. The commonest error was to reverse the generic and specific levels of the binomial *Dasypus novemcinctus*.
- (ii) Generally, only better candidates realised (from their binomials) that the three armadillos belong to different genera and that, therefore, the lowest taxonomic grouping that the three could share is that of family.

Question 6

- (a) A good number of candidates knew that the diagram represented anaphase I of meiosis. Most of these were able to explain that it was anaphase because chromosomes were being pulled to the

poles by the spindle fibres. Some went on to explain that it must be anaphase I because sister chromatids had not yet separated. However, there was a good deal of unclear use of terminology by some candidates, with the terms bivalents, chromosomes and chromatids being interchanged at will.

- (b) Very few candidates were able to describe crossing over adequately and most responses could not begin an explanation without using the term “crossing over”. They were unsure as to when crossing over takes place, the mechanism by which it takes place and just what genetic material is exchanged. Some better candidates could describe the exchange of portions of non-sister chromatids between homologous chromosomes in a bivalent, but, again, most were unsure of the terminology. Most responses awarded full marks were given to candidates who had thought to include a series of labelled diagrams to explain the process.

Question 7

- (a) Many candidates scored full marks on this section. They were able to identify process X as glycolysis and to cite evidence from the diagram, such as the loss of oxygen from pyruvate, to support the suggestion that the conversion from pyruvate to ethanol involves reduction. In part (iii), most realised that the conversion of pyruvate to ethanol regenerates NAD, which can then be used again in glycolysis. The formula for pyruvate was quoted incorrectly in the diagram. There was no evidence from the scripts that candidates were disadvantaged by this.
- (b) Most candidates were able to suggest two similarities between anaerobic respiration in yeast and anaerobic respiration in a muscle cell, but were less well able to suggest two differences. Whilst a good number knew that a muscle cell produces lactate rather than ethanol, far fewer knew that muscle cells do not produce carbon dioxide during anaerobic respiration.
- (c) (i) Many responses made clear that repeating the experiment and pooling results would increase reliability and minimise the impact of anomalies. However, some confused reliability with accuracy, whilst others thought that anomalous results would be eliminated altogether. Disappointingly, very few suggested that a large data set would allow a valid statistical analysis.
- (ii) Many candidates were able to calculate the mean rate of gas production and, of those who did not get this far, most were able to at least calculate the mean volume produced.
- (iii) Many candidates did not read the question carefully enough and based their answers on the amount of carbon dioxide *produced* rather than on the amount of gas *collected*. Good candidates realised that, because the RQ of glucose is 1.0, the volume of carbon dioxide *produced* would be matched by an equal volume of oxygen taken in; there would, therefore, be no net change in volume, so no gas would be *collected*.

Question 8

- (a) Most candidates knew the mark-release-recapture technique, and were able to describe the various steps. However, they did not always *explain* the reasons behind the steps. For example, they did not always explain that the released insects should be left for a suitable period of time *to allow them to re-integrate with the rest of the population*.
- (b) (i) Nearly all candidates knew that there would be only one degree of freedom.
- (ii) Most candidates knew that the 0.05 level of probability is that most commonly used in biological analysis to judge statistical significance.

(iii) Responses to this section were generally disappointing. Most candidates were unable to reason that, because the value for χ^2 is greater than the critical value, then there is a probability of less than one in one thousand that the results are due to chance. They were uncertain as to whether the difference in values of χ^2 implied that the differences in results are due to chance or due to some biological cause. They wrote about rejecting a null hypothesis which had not been stated and also merely that “the results are statistically significant”. Candidates should be aware of the logic that, if χ^2 is greater than the critical value, there is only a probability of (usually one in twenty) that the results are due to chance as the basis for rejecting any null hypothesis and accepting the experimental hypothesis.

(c) (i) A number of candidates realised that some of the biomass produced in photosynthesis would be respired by the plant, but very few actually explained that biomass is lost in the form of carbon dioxide. Most of those who involved respiration in their answers suggested that energy is lost, which is true, but loss of energy does not account for the difference in biomass between gross primary production and net primary production.

(ii) Nearly all knew that a higher net primary production would lead to more dead plants and so more food for the detritivorous insects.

(iii) Most candidates realised that decomposers would respire compounds from the dead plant remains, releasing carbon dioxide, which could be taken in by plants to be used in photosynthesis. However, only better candidates knew that the decomposers were saprobionts and supplied details of extra-cellular digestion.

Question 9

(a) (i) Although most candidates recognised this as a question about natural selection, many did not gain marks by failing to identify the nature of the selection pressure (use of the antibiotic) or to explain how resistance would become widespread. Some candidates answered in a completely different way and, effectively, answered part (ii) by describing the nature of mutations and how they could affect the ability of an antibiotic to bind with receptors in the bacterial membrane. This said, however, there were quite a number of very good responses scoring full marks or nearly full marks.

(ii) Nearly all candidates understood the essential difference between a deletion and a substitution, but many failed to gain marks through confused and careless expression. Some examples of this were:

- deletion involves the removal of a gene/allele;
- substitution involves the replacement of a base in the polypeptide chain;
- all the amino acids after the mutation move up one.

Many candidates did describe the differences between deletions and substitutions correctly, but not all went on to relate this to the effect on the shape/tertiary structure of the receptor site and, therefore, the ability of the antibiotic to bind to the receptor site.

(b) Many candidates, of all abilities, were familiar with the Hardy-Weinberg equations and were able to apply them to the data given to calculate the frequency of the heterozygotes (0.18/18%). The most common error was to assume that the frequency of those homozygous recessive (0.01) in the population is represented by q , rather than by q^2 . Some then used this wrong value to find p and, from that, $2pq$ and so were able to gain some credit for showing elements of a correct method, even though they arrived at an incorrect answer.

BYA6 Physiology and the Environment

General

This unit attracted a sizeable entry, which reflected the whole ability range. As a result, a wide range of total marks was seen, but, generally, all parts of all the questions were accessible to the majority of candidates. Candidates had clearly prepared well for this unit, and were able to demonstrate not only a good knowledge and understanding of topics but, in many cases, analytical and synoptic skills. Both calculations were attempted by the large majority of candidates and mostly candidates gained at least two of the four calculation marks. It was pleasing to see candidates displaying good numerical skills.

One disappointment reported by many markers was the quality of language used by candidates which in certain questions, such as 1(b), 3(c), 6(b) and 9(b) led to candidates who perhaps understood the biology not gaining marks due to the ambiguity of their responses. While marks are not specifically awarded for Quality of Written Communication in this unit, to gain credit, candidates must express their answers clearly and logically, making use of appropriate scientific terminology.

Question 1

- (a) (i) This question was well answered. Only those referring to area **Y** as the 'blind spot' failed to gain a mark. In (ii), generally candidates realised the importance of there being cones at **X** and rods at **Z**. Marks were not given when candidates failed to specify which area they were writing about, **X** or **Z**, when explaining that there were more cones. About a third of the candidates failed to gain the second mark. Candidates appeared to be aware of the greater acuity of cones but did not relate this to the neural connections.
- (b) Many candidates failed to gain both marks for this question. Generally, they appeared to know about the different pigments but expressed themselves ambiguously with regard to how they worked. The 'three types of cone' mark was often not given. Sometimes this was because it was not understood that there were different pigments in different cones but, more frequently, due to poor use of language. 'Cones contain three different pigments' has a common response here. Good answers gained both marks generally in a few, well chosen words.

Question 2

- (a) (i) Most candidates described the relationship. Only a few of the more able candidates gave a credit-worthy explanation. In (ii), there was a greater proportion of valid suggestions though many candidates missed the point completely and wrote about lizard **B**'s superior ability to gain heat. Many candidates failed to identify the higher body temperature in lizard **A**.
- (b) Generally well done with most candidates obtaining both of the available marks, although there were some candidates generating answers based on less movement to save energy.

Question 3

- (a) Most candidates correctly spotted the rise in the partial pressure of carbon dioxide.
- (b) Most candidates produced a good logical account and achieved both marks.
- (c) Again most candidates clearly knew what was expected and produced clear logical answers. Many candidates who produced answers that did not actually relate water loss to spiracles movements failed to gain the second mark. Some candidates confused spiracles with stomata.

Question 4

- (a) This part of the question was well answered with many candidates gaining full credit.
- (b) More than half the candidates correctly identified Na^+ ions as being pumped out of the axon. There were many detailed responses which referred to the three out to two in ratio of Na^+ and K^+ pumped across the membrane for each molecule of ATP hydrolysed, but as these failed to mention the diffusion of K^+ , they only scored one of the two marks available.
- (c) Approximately half of the candidates referred to the phospholipid bilayer and gained one mark. The ‘large size of ions’ was the most frequently given property of ions that necessitated the involvement of proteins. This answer was incorrect.

Question 5

- (a) This was a straightforward recall question and many candidates gave the correct response. The most common incorrect response was ‘hypothalamus’.
- (b) Again, a reasonably well answered question although fewer gave both correct responses
- (c) This question was intended as a straightforward AO4 question and in view of the simplicity of the question and the required responses, answers were disappointing. Few candidates referred to the impulse travelling through the atria and many were confused about the geography of the AVN, Bundle of His and Purkyne tissue. Many became very confused with complex explanations. A few did not know any of the key points. In general, this was not well understood. Although good candidates achieved the maximum mark, this question showed limited understanding of this basic aspect of physiology.

Question 6

- (a) Many candidates obtained the correct answer and were awarded both marking points. The problems encountered by the others usually involved converting the units. Most had the right numbers but the decimal point was in the wrong place in nearly half of them. A small proportion of candidates reversed numerator and denominator.
- (b) Most candidates were on the right lines here but few expressed themselves well enough to get all three marks. There were many poorly expressed answers which often failed to make the necessary comparative statement. Shrews living at high altitudes and flying shrews featured in a number of scripts as did the Bohr shift, despite the information given. Generally candidates understood the principle but experienced difficulties expressing it. It is worth noting that the better candidates usually produced succinct answers which gained all three marks.

Question 7

- (a) Although the correct answer was given by many candidates, a significant minority made arithmetical errors or rounded their answers incorrectly.
- (b) The emulsion test was most frequently cited but the method was often not described correctly. Many of these responses used water or ethanol as the sole reagent or cited an incorrect test. A small minority of candidates gave details of incubating with lipase and testing for pH change, these answers received the appropriate credit.

- (c) A well answered question. Very few candidates gave condensation in part (i). Part (ii) produced some excellent accounts of emulsification and the role of bile in maintaining the emulsion. Few candidates mentioned the effect on pH.
- (d) Microvilli were correctly identified and their function described by most candidates in part (i). Part (ii) caused problems to the weaker candidates and the vast range of alternative answers generated by these candidates indicated that they had not understood the diagram. Part (iii) produced good responses from the candidates who correctly identified the rough endoplasmic reticulum, although a small proportion thought the structure was the Golgi body. Part (iv) was generally poorly answered. The most common incorrect response was facilitated diffusion. Often these responses were given in answers which clearly indicated the size of the chylomicrons and it was interesting to observe the lack of coherent thinking displayed by many candidates.

Question 8

- (a) Although the definition in (i) produced a variety of responses, ranging from the short and precise to the lengthy and rambling, most were acceptable. Part (ii) was straightforward but two common errors were made, sometimes by good candidates. These were to give respiration or urination as responses. The hypothalamus was correctly identified by most candidates.
- (b) Part (i) was well answered though it appeared some candidates may not have noticed the presence of this question at the bottom of the page. Candidates did not usually find (ii) easy. Many used almost all the space writing about ADH without using the required information from **Figure 1**. Where the role of the aquaporins was understood it was not always made explicit in answers. Osmosis was usually considered and most candidates also appreciated that the aquaporins are bound to the membrane facing the lumen of the collecting duct. However, answers which detailed the whole process were few and far between.
- (c) Unfortunately, some candidates gave the impression of applying a prepared answer relating to the presence of glucose in the urine to this question and, obviously, gained no credit. The mark scheme allowed for all the major obvious symptoms and many of the better candidates obtained the mark.
- Part (ii) produced good responses from the stronger candidates but very commonly weaker candidates did not appear to know that males had one X and one Y chromosome while females had two X chromosomes. The responses to (iii) were reasonable. The most common shortcoming was a failure to write in terms of probabilities with many candidates stating no more than that carriers of a recessive allele would reproduce while most of those with a dominant allele definitely would not reproduce. A handful of candidates thought that the question was looking for heterozygote advantage and answered in these terms.

Question 9

- (a) An increase in negativity, representing an increase in tension, was a stumbling block for many candidates. Having set off on the wrong foot they then found it more difficult to answer the question effectively, even though they often understood the mechanics of water transport quite well. Few candidates scored more than one mark for their description of the effects of increasing light intensity. A reasonable number of candidates lost their way in detailed descriptions of the mechanism of stomatal opening. As a result, few candidates scored all five marks although many gained some credit. The contribution of increased photosynthesis to tension is so small that credit could not be given for the suggestion.
- (b) This question produced many simplistic responses which centred around the idea of 'a fair test'. It appeared that many of the candidates knew the answer failed to gain marks for not being sufficiently explicit. Many answers made the connection between humidity and transpiration but went no further.

- (c) Those candidates who correctly identified this question as relating to 'cohesion-tension' theory usually obtained three or all four marks. There was an unfortunate tendency though, also in part (a), to suggest that water moved up 'by the cohesion-tension theory'. Candidates should be aware that simple statements of this nature do not provide the necessary explanation to the question.

- (d) The answers to this question were extremely varied and, to a large extent, centre-dependent. Most candidates correctly identified C4 photosynthesis and then progressed to give more information. A significant proportion of candidates wrote about general xerophytic adaptations rather than photosynthesis. Weaker candidates often spent time writing lengthy answers that contained little worthy of credit.

BYA7 The Human Life-Span

General

Nearly all candidates attempted all sections of all of the questions. The unit provided opportunities for the more able candidates to show their abilities to the full but at the same time allowed the less able to respond and achieve a more limited degree of success. Certain sub-sections of some questions proved to be more testing, for example, those requiring precise descriptions of biological phenomena (especially in synoptic questions requiring knowledge of other modules), such as the immune response, or gene expression in animal cells compared to that in bacterial cells, or the biochemical test for lipids. Knowledge of certain topics, such as muscle contraction in question 9, was generally good.

Many candidates found the handling of data rather challenging and some were let down by mathematical weakness. Appreciation of the relative sizes of molecules – such as inorganic ions, in question 3(c), compared to aggregates of lipid and protein, in question 7(d)(iv) – was a weakness for many candidates.

More precise reading of certain questions might have helped many candidates to exclude irrelevant material from their answers. There were also some examples of candidates writing ambiguous statements in their answers which, of course, could not be rewarded with marks. The onus is on the candidate to make her or his intentions clear and some were found to be in need of more precise communication skills. This was particularly so in descriptions of the trichromatic theory of colour vision in question 2(b) and of the phenomenon of emulsification in question 7(c)(ii). While marks are not specifically awarded for Quality of Written Communication in this unit, to gain credit, candidates must express their answers clearly and logically, making use of appropriate scientific terminology.

Question 1

- (a) The negative correlation shown by the graph was evident to nearly all.
- (b) Most candidates knew that the sperm cell possessed mitochondria which provided a supply of energy, or ATP, to power movement. Although possession of a tail was often referred to, there was usually no explanation offered of *how* this propelled the sperm.
- (c) While most gave crossing over and independent assortment as features of meiosis leading to genetic variation, there were some imprecise expressions of the latter. For example, 'Chromosomes are arranged randomly' could have any of several meanings.

Question 2

- (a) In (i), although most were able to explain that region Y lacked receptors, some fell short by just describing it as the 'blind spot' or as the point where the optic nerve was joined to the retina. Descriptions of the two types of photoreceptors were sometimes less than precise, with some candidates hinting that there were some rods present at X (the fovea) or that there were no cones at point Z. In (ii), while most understood about retinal convergence of rods, or lack of it for cones, some had a fundamental lack of understanding and thought that the reason cones gave more precise vision was due to the way they differentiated between different colours of light. Some candidates included the term 'acuity' in their answers but did not *explain* the basis of this. Others used inaccurate terminology and referred to cones each being connected to a single 'nerve'.
- (b) Many candidates were unable to express their ideas unambiguously regarding the sensitivity of the three different types of cone cells to different ranges of wavelengths – many gave the impression that each cone cell contained three types of pigment thus enabling it to respond to a full range of wavelengths of light.

Question 3

- (a) Many understood how the membrane potential was related to the opening and closing of ion channels for Na^+ and K^+ . A common error was to assume that the condition of the ion channel for K^+ was simply the converse of the ion channel for Na^+ .
- (b) Many gave an incomplete account of how the resting potential was established with answers relating to either the active pumping of Na^+ out of the axon or the passive diffusion of K^+ out due to the greater permeability of the membrane to the latter.
- (c) Some thought this section related to active transport of ions through proteins rather than to facilitated diffusion. Others thought Na^+ and K^+ ions were too large to pass through the membrane (although the same candidates sometimes believed, in question 7, that chylomicrons could diffuse through the cell membrane). Better candidates related the polar or charged nature of the ions to their inability to pass through the phospholipid bilayer.

Question 4

- (a) Most knew that the pituitary gland secretes growth hormone. Common errors included the thyroid and the pancreas.
- (b) Some candidates appeared more concerned that TSH might not be absorbed from the gut rather than that it would be digested. Some made vague references to the TSH being ‘broken down’, but those who gave the names of appropriate enzymes and stated that the TSH would be hydrolysed, or digested, gained more credit. Part (ii) required the application of material covered in modules 1 and 3 on the topics of cell structure and genetic engineering; very few candidates were able to do this. Some answers verged on the absurd, such as ‘bacteria cannot make TSH because they do not have a thyroid gland’, or ‘bacteria do not have DNA / proteins / carbohydrates’, or ‘bacteria would produce antibodies against the gene’. Only the most able knew about the role of the Golgi complex, peculiar to eukaryotes, for the joining of the carbohydrate and polypeptide parts of the TSH.

Question 5

- (a) Many candidates knew the cardiovascular centre was located in the medulla of the brain, although the hypothalamus was a common wrong answer.
- (b) The effect of neurone **A** in the diagram on the heart rate was generally given correctly, probably because the diagram also showed that adrenaline was involved. The suggested role of neurone **B** was often incorrect. More careful study of the diagram would have shown that both **A** and **B** represented sympathetic stimulation and so should have had similar effects.
- (c) Most candidates knew about the roles of the AV node and the bundle of His in conducting an impulse from the SA node to the base of the ventricles. Although many described how the delay at the AV node was helpful in ensuring that the atria had time to empty, the actual passage of the impulse across the atria was commonly omitted.

Question 6

- (a) Although most candidates knew that the disaccharide found in milk was lactose, far fewer could identify the missing polysaccharide as cellulose.
- (b) Those who had correctly identified cellulose in part (a) were more likely to get this section correct as they also knew that cellulose was indigestible by humans. Better candidates gave the added

detail that this was due to the lack of an appropriate enzyme to hydrolyse the cellulose. Weaker candidates thought that dietary cellulose was present in too small a quantity to be of significance. Those who did not know that carbohydrate **B** was cellulose became particularly inventive in their reasoning, imagining that these polysaccharides must be low in energy content, or that since we could get enough energy from starch and glycogen, we had no need of these other polysaccharides.

Question 7

- (a) Calculations of the recommended daily lipid intake were often incorrect, a common error being to disregard the given energy content of one gram of lipid. Some spoiled their answers by inappropriate rounding or by compounding rounding approximations in a two-stage calculation.
- (b) Many candidates did not know the details of the emulsion test for lipids. Benedict's, the biuret test and the iodine test were all suggested.
- (c) In (i), although most recognised that digestion of a triglyceride was an example of hydrolysis, there was the inevitable confusion with condensation, while some even thought it was a reduction reaction. Part (ii) was generally well answered. Most knew the role of bile in the emulsification of lipids, although some spoiled their answers by referring to breakdown into smaller 'molecules' rather than just physical breakdown into droplets. Most candidates understood the concept that smaller particles would have a larger surface area and those who could relate this to improved access by lipase then scored full marks. The beneficial alkaline nature of bile was also referred to by some. A few made the error of stating that bile *contained* lipase.
- (d) In (i), most knew that the microvilli shown in the diagram would increase the surface area for absorption of the products of digestion. However, in (ii), the identification of **R** and **S** was rarely correct. **R**, the tissue fluid, was sometimes thought to be 'cytoplasm', a 'blood vessel', or merely a 'space'. **S**, the lymph vessel or lacteal, was thought to be a 'blood vessel', a 'lysosome', even the 'small intestine'. In part (iii), many recognised organelle **U** as the rough endoplasmic reticulum and knew that the protein part of the chylomicron would be made here, better candidates emphasising the part played by its ribosomes. Some correctly suggested a role in transport, perhaps mentioning vesicle formation. Others incorrectly thought triglycerides were synthesised here, despite the indication in the diagram that this was fulfilled by the smooth ER. It was evident in (iv) that many candidates had no appreciation of the size of the chylomicrons – despite having been given the information in the stem to section (d) that they were composed of *many* triglyceride molecules and were surrounded by proteins. Hence, 'diffusion', 'facilitated diffusion' and 'active transport' were not sensible answers. Better candidates knew that such large structures could only leave the cell by exocytosis.

Question 8

- (a) The calculation of the rate of oxygen uptake by the fetus from the given data demonstrated some muddled thinking on the part of many candidates. Many failed to realise that the difference in oxygen content of the umbilical artery and vein represented the amount taken up by the fetus at the placenta. A further difficulty was relating the fetal mass in kilograms to the rate of uptake per gram. Relatively few arrived at the correct answer.
- (b) In (i), most candidates ignored one essential detail of the question regarding *the tissues of the placenta itself* and concentrated on oxygen uptake by the fetus in general. Others failed to emphasise that the placenta's high rate of oxygen uptake was due to it having a *high* rate of respiration and thus requiring a *large* amount of energy or ATP for such processes as active transport to the fetus, or for the synthesis of hormones. Similarly, in (ii), the emphasis was on physiological changes in the *mother's* body, which was often missed and led to irrelevant details being given about processes in the fetus. Correct answers most commonly related to the growth

of breast or uterine tissue, to increased cardiac output and to increased muscular effort involved in moving a heavier body.

- (c) Those who realised that this section required implicit understanding of Fick’s law applied to the rate of diffusion at the placenta had few problems and scored full marks. Hence a high surface area was achieved by folding villi or microvilli; the countercurrent blood flow resulted in maintenance of a high concentration difference; and the thickness of the surface had a low value.
- (d) When interpreting the fetal and maternal oxyhaemoglobin dissociation curves, many candidates demonstrated appropriate use of the term *affinity*. Only careful candidates were able to describe clearly how the graph actually showed this. Many forgot to state that this meant oxygen would be transferred from the mother to the fetus.

Question 9

- (a) Clearly, many candidates had forgotten the details of the immune response. The most common correct points given by candidates were that the injected proteins would act as antigens and that the antibodies produced would be specific to the antigen. Details of the roles of B cells and plasma cells were known by relatively few.
- (b) A full answer to this section required reference to several different aspects – the resolving power of the electron microscope, the need for tissue to be alive to demonstrate a physiological process but to be dead to be viewed in the electron microscope, and the specificity of antibodies (with gold particles attached) to label only certain structures. It was rare to find such a holistic view. Some candidates appeared to have forgotten about the existence of the transmission electron microscope, explaining that only the outer surfaces of muscle fibres could be observed rather than any cross-bridge cycling that occurred within them. Others erroneously felt that, although the resolving power of the electron microscope was good, it was not good enough to observe cross-bridges between muscle protein filaments.
- (c) The roles of calcium ions and of ATP in muscle contraction were generally well known by most candidates. Some over-emphasised the part played by calcium ions in transmission of the impulse to the muscle rather than in the contraction process itself. However, details of the removal of the blocking molecules from sites on the actin and the combination of the myosin head with these sites, followed by movement and release of the myosin head, were generally included. A common omission was that ATP would need to be split into ADP and phosphate if its energy were to be made available.

BYA8/W Written Synoptic Paper

General

Overall performance on this unit depends, as it does on other units, very much on thorough preparation. Better candidates showed not only an excellent understanding of the principles which were tested, but also a mastery of the skills which should have been developed during the course, and sound question technique. Such candidates performed well on all three questions. Those whose preparation had been less thorough displayed uncertainty over basic concepts such as the role of lipids in cells, respiration and photosynthesis, diffusion and digestion. They showed a lack of understanding of the use of tables and graphs to present data, and frequently failed to gain marks through poor question strategy. Thus in Question 2, for example, many answers failed to follow the instruction and make reference to plasma membranes in muscle other than cardiac muscle, did not relate Fick's law to the buccal cavity as required, or offered explanations of the converse situation when required to explain why absorption was of little importance in the mouth. Marks are specifically awarded for Quality of Written Communication in the essay, but candidates should remember that elsewhere in the paper they must also express their answers clearly and logically, and make use of appropriate scientific terminology, if they are to gain credit.

Question 1

- (a) Candidates encountered more difficulties than expected with what should have been a straightforward first part to the question. Although there were those who gave the obvious answers of lipid being a component of plasma membranes and a potential respiratory substrate, others apparently failed to note the cellular context of the question. They offered such suggestions as insulation and protection, clearly relating their answers to the function of the entire organ rather than of its component cells.
- (b) Many candidates clearly appreciated the amount of water in tissues varies and produced excellent responses to this part of the question. Answers along the lines of "not taking water into account" demonstrated some understanding of the underlying concept, even if they were not then developed sufficiently to gain credit. The concept of dry mass was, however, clearly unfamiliar to those who invoked "absorption of water by substances" or "substances being hydrolysed". In addition there were numerous vague references to fluids, liquids and blood.
- (c) Part (i) was generally answered correctly although there was a tendency to do no more than rewrite the question and explain that the reason was simply that the liver contained large amounts of carbohydrate. Part (ii) revealed a widespread failure to consider the data with sufficient care. Given that the figures represented percentages, it would be extremely unlikely for all three of the components to have decreased during the twelve hour period specified. However, most candidates with a reasonable knowledge of the control of blood glucose recognised that the likely decrease in carbohydrate could be attributed to conversion of glycogen to glucose. Only the better candidates pointed out that the percentage of the other two components would be likely to rise as a result of the fall in the percentage of carbohydrate.
- (d) Better candidates clearly identified the analogy here and were able to take the mark-release-recapture technique derive an appropriate equation. Unfortunately, many clearly relied on recall since there was little attempt to show how the expression had been derived. This was unfortunate because a high proportion of answers were almost correct, suggesting that candidates had been working along the correct lines and might have otherwise been awarded one of the two available marks.
- (e) There were many correct answers to part (i), some candidates even pointing out the similarity between the situation described here and emigration. Where credit was withheld it was frequently because of uncertainty over the location being described. Thus, instead of referring to the small

size of amino acid molecules allowing movement out of the blood, candidates not infrequently simply referred to passage through plasma membranes. Less able candidates often failed to appreciate the salient point of the argument and discussed difficulties of analysis because of the presence of amino acids in the blood or hydrolysis and condensation removing or adding to the water content of the plasma. Most candidates answering part (ii) recognised that there would be insufficient time for the injected protein to mix thoroughly and providing they expressed this idea with sufficient clarity, were able to gain credit. Only the very best, however, were able to go beyond this and relate the resulting value of **D** to the estimate of the total volume of water in the plasma.

- (f) In their answers to part (i), relatively few candidates identified chlorophyll concentration as an indicator of the autotroph population, but those who did were generally able to link phosphate concentration with increased plant growth. Many responses, however, were based on attempting to establish a more direct relationship between the variables by suggesting, for example, that as "chlorophyll contains phosphates, it is found in areas with the most phosphate". Occasionally, more able candidates introduced unnecessary complexity in attempting to link photosynthesis, chlorophyll and the generation of ATP. It was surprising how many candidates produced lucid accounts of eutrophication in **Question 3** but failed to identify the key elements of the same topic in part (ii). There was widespread failure to specify that the bacteria concerned would be decomposers which reduced the oxygen concentration by increased respiration.
- (g) There was no direct linear relationship between the two variables in the table and candidates should have approached this problem by suggesting a method based on plotting an appropriate graph and extrapolating the resulting curve of best fit. Many of responses involving calculation were based on incorrect assumptions about the nature of the relationship.

Question 2

- (a) This part of the question was generally well answered with many broadly correct statements about water potential and osmosis. It should be noted, however, that the specification requires an understanding of water potential. Questions of this nature should therefore be explained in terms of this concept rather than tonicity or concentration. The reasons suggested for the bursting of red blood cells did not always make the required reference to volume or pressure, and a number of candidates failed to gain credit because of loose expression.
- (b) Many candidates experienced difficulties in translating the information provided in the passage into an appropriate diagrammatic form. Although they generally appreciated that high intake would be harmful, curves indicating the harmful nature of low doses were infrequent. Less able candidates gave the impression of relying on uncertain recall and a variety of inappropriate curves appeared in their answers.
- (c) This question differentiated particularly well. The majority of candidates referred to the presence of proteins or receptors in the plasma membrane of the cardiac muscle cells. Fewer candidates commented on the concepts of shape and fit which underlie specificity. Clear statements about the absence of receptors on other types of muscle were relatively rare.
- (d) A statement of Fick's law was frequently either used as an introduction to the answer to part (i) or appeared in the margin. It gained credit providing that the variables in the expression were linked to the rate of diffusion and not simply equated to "Fick's Law". Relatively few candidates then progressed to link surface area, concentration gradient and thickness of the exchange surface to appropriate characteristics. A good answer to part (ii) required reference to the lack of digestion in the buccal cavity and molecule size limiting uptake. Some candidates, despite the information provided in the passage that the mouth leads into the buccal cavity, were clearly uncertain of its whereabouts or functions; others studiously ignored the specific requirements of the question and sought to explain why other regions of the gut were of greater importance.

- (e) This was another question where attention to the context and information provided in the passage should have provided the necessary direction for the answer. As it was, only the better candidates were able to point out that veins do not convey blood from the buccal cavity to the liver, a site of detoxification. Much misunderstanding was apparent with many answers phrased in terms of avoiding enzyme breakdown or acid hydrolysis elsewhere in the gut.

Question 3

Essays remain extremely variable in quality. For some candidates they provided the saving grace and did much to redeem the limited quality of the two structured questions. Others proved themselves unable to recall basic A-level knowledge, and produced superficial and poorly constructed accounts. The biggest single factor in limiting the marks awarded was undoubtedly the ability to base the essay on appropriate, detailed biology. Thus, for example, many of the essays on bacteria ignored the detail of genetic engineering, nutrient cycles and cellulose digestion which form a major part of the A-level specification and, instead, centred their essays around such topics as yoghurt and cheese production. Essays generally met the requirements for breadth although some devoted so much time to scene setting and significance that they left themselves little time to consider more fundamental issues. There is little doubt that plans would have helped here but these were often conspicuous by their absence. Given the pressure of writing under examination conditions, the quality of written communication was usually sound, often better than that displayed by the same candidates in **Questions 1 and 2**. The use of technical language, however, was less impressive and a lack of understanding of the terms "ion" and "bacteria" provided an obvious handicap.

A. Inorganic ions include those of sodium, phosphorus and hydrogen. Describe how these and other inorganic ions are used in living organisms.

Certain topics lent themselves to excellent accounts of how inorganic ions are used physiologically - nerve impulses, nephron function, absorption in the intestine, root pressure and guard cell activity. These topics enabled candidates to demonstrate what they knew and how well they understood the processes concerned. There were many detailed and accurate accounts concerning the roles of sodium and potassium ions in the transmission of nerve impulses and of calcium ions in synaptic transmission. Less able candidates sometimes confused the roles of the ions or the parts played by diffusion and active transport. The movement of ions in the counter-current mechanism of the loop of Henle also appeared frequently, but here confusion over detail was more apparent.

The identity of inorganic ions and their names produced problems for some in describing the role of ions in the synthesis of biologically important molecules. Phosphorus, for example, was commonly identified as the ion important in the synthesis of ATP and phospholipid. This lack of understanding occasionally led to much irrelevance, especially where discussing hydrogen bonding in DNA, or the importance of carbon, oxygen and hydrogen in macromolecules.

The role of hydrogen ions gave scope for some sound biological detail in descriptions of the role of reduced coenzymes in photosynthesis and respiration. Few candidates considered the importance of hydrogen ions in changing the pH environment of enzymes, but many discussed the buffering effect of haemoglobin when describing the transport of carbon dioxide as hydrogencarbonate in the blood.

B. Bacteria affect the lives of humans and other organisms in many ways. Apart from causing disease, describe how bacteria may affect the lives of humans and other organisms.

Although this option was frequently chosen by less able candidates, overall it was impressive to note that many identified the key areas of nutrient cycling, mutualistic relationships and the uses of bacteria in enzyme production and genetic engineering, and wrote about these topics with conviction.

Better candidates demonstrated a good understanding of the role of bacteria in the nitrogen cycle although the origins of ammonia were often omitted from discussion. A number of frequent misconceptions studded the work of less able candidates; denitrifying bacteria were considered to play a key role in

"restarting" the cycle, nitrifying bacteria commonly converted nitrates to ammonium compounds and nitrogen fixation involved the conversion of "nitrogen in lightning" to nitrates.

There were many excellent accounts of the role of bacteria in ruminant digestion. The best of these not only considered cellulose hydrolysis but also discussed the production of fatty acids, and the conversion of ammonia to urea and its subsequent secretion in saliva. More limited candidates confined their answers largely to the bacterial digestion of cellulose. These accounts were characterised by superficiality rather than by error.

Genetic engineering provided a third line of approach and, again, there were some very good accounts where candidates showed a secure understanding of basic principles. The less convincing accounts showed confusion over detail. Not infrequently, the role of restriction enzymes was held to be to remove sections of DNA from plasmids, and many considered the role of genetically engineered bacteria to be in producing many copies of the gene coding for insulin. In addition, some of the terminology was heavily reliant on the use of molecular "glue" and "scissors" than on the relevant enzymes. Some good accounts were subsequently spoiled by the introduction of poorly remembered examples from the food industry: yoghurt, cheese and, not infrequently, yeast in the production of alcohol.

BYA 9/W Written Synoptic Paper

General

Overall, a wide range of marks was obtained, but it was disappointing to note that many candidates were limited in their knowledge and understanding of biology at A-level standard. The essays proved to be less of a challenge than they have been in recent years as essay writing techniques appear to have been worked on in many centres.

Arithmetical work continues to challenge a number of candidates, especially when it is in the form of a formula based on prior knowledge. A more worrying trend was the basic misunderstanding between atoms and ions which was demonstrated in the essay.

Question 1

- (a) Many candidates recognised that this was a question about cells, and answered suitably in that context. Weaker candidates simply suggested 'for energy'. A similar number tried to apply more basic knowledge and made unsuitable suggestions about insulation, presumably in reference to nerve cells.
- (b) While some candidates expressed themselves clearly regarding the variability of the water content, a large number mentioned either the water within the chemical structures, or talked about fluid making up amounts of the total without thinking that it might vary. Quite a lot did not appreciate that dry mass was the mass without water
- (c) (i) This question was soundly answered by most candidates. Only a tiny minority were inclined to confuse glycogen with glucagon.
- (ii) Only the most competent at maths recognised that if the percentage of one substance, the carbohydrate, goes down, then the percentage of the other two must rise relatively. However, despite this, many candidates did recognise the drop in carbohydrate levels, and were able to offer an explanation that involved the fate of the glucose and the part played by glucagon. A large number thought the question was about the changing respiratory substrate as the time since a meal lengthens. Many candidates believed that gluconeogenesis would occur within a few hours of fasting. This suggested that they had failed to read the question carefully enough.
- (d) A pleasing number of better candidates were able to recognise the similarities between the blood sampling scenario and the mark-release-recapture technique of ecological studies. Some wrote out both equations to ensure accuracy. A large number appeared to invent extravagant equations which bore no relationship either to the scenario or to any previously studied work. The rest simply guessed.
- (e) (i) Many candidates showed they knew that amino acids are smaller than proteins, but they were not always able to recognise the significance of this. A number suggested that they would be used for protein synthesis, although there was no suggestion of this in the question. A large number made suggestions about solubility, but this was an unacceptable alternative to molecule size. They instead related their answer to osmosis in the false belief that proteins are insoluble.
- (ii) Most candidates used their knowledge of mark-release-recapture, and the text to help them answer this question. They were able to see the need to mix the solutions, but only the very best candidates were able to suggest what effect there might be on the results if mixing was not adequately carried out. Some made some progress by suggesting the results would be affected but were unable to hypothesise as to how.

- (f) (i) Despite the fact that this question related to the physical composition of the atmosphere and the way it changes with altitude, many candidates of all abilities offered answers relating to haemoglobin and its changing affinities to oxygen. A lot of candidates simply thought that both properties went down, but failed to offer any explanation.
- (ii) Similar answers were offered for this question, with unsuitable comments on affinity. Weaker candidates clearly expected to be able to repeat what they had learned rather than construct an answer to a specific question. Correct answers often only referred to the effect of altitude or the effect of being pregnant rather than both. Only the best candidates recognised the value of being able to compare standardised data.
- (g) The vast majority of candidates had clearly never been offered the opportunity to find intermediate values by plotting and reading a graph. This tended to be offered as an answer by whole centres, and not by others even if the candidates were otherwise capable scientists. Long descriptions were offered as to how to manipulate the data, or the intervals between, to come up with the correction factor. Such answers did not take into account that the data were non-linear. Many offered the answer when only the method was requested.

Question 2

- (a) This question prompted sound answers from many candidates, who offered competent answers referring to water potential, osmosis and the effects of increased pressure. A lot of answers offered the water potential of water, and weaker candidates expressed this in an unsuitable manner by using the term ‘water concentration’. Similarly alarming were the candidates who thought that the movement of oxygen was either significant or a component of osmosis. A few, disappointingly, think that blood cells have walls.
- (b) The graph was quite challenging to many. They mostly recognised the advantage of a small increase but not the disadvantage of a large increase. Few graphs took into account the fact that low levels of iron are not beneficial.
- (c) This question was generally well answered, with a good level of understanding of proteins, and the significance of fitting and binding to some but not to others. There were only minimal levels of confusion with enzymes and their active sites. A large number of candidates did not explain why digitalis only affects cardiac muscle.
- (d) (i) Many candidates were pleased to meet a question on Fick’s Law, and there were many instances of candidates quoting it perfectly. Some were too keen to get on and failed to gain the mark awarded for stating that the equation they quoted was related to the rate of diffusion, and not to the Law itself. Answers referring to the buccal cavity were mixed, with comments about diffusion pathways being most frequently encountered. There was a tendency to consider the concentration gradient between the mouth, were there was a lot of poison, and the blood stream where there was little, without suggesting that the constant flow of the blood played a significant role. A surprisingly large number of candidates think the buccal cavity is lined with villi and microvilli, confusing this concept with the lower reaches of the alimentary canal.
- (ii) The idea of molecules being too big was offered by many candidates, as was the suggestion that digestion had not taken place. Some were inclined to describe what did happen further down the gut rather than what did not take place in the buccal cavity, a matter of straying too far from the question.
- (e) Long rambling answers about the journey around the body were common here, and some of these recognised that the parts of the alimentary canal which were not passed through might be significant. Very few stopped to be more precise in their thinking, and therefore failed to link the

work of detoxification to the liver. Large areas of the gut were lumped together for general 'processing' activities.

Question 3

The essays varied greatly in length, biological content, breadth and relevance. Many essays showed good evidence of planning in a way which would clearly be useful to the author. Some candidates failed to plan at all. Others wasted a lot of time writing out summaries of the topics of the specification at great length, much of which was irrelevant. While candidates might wish to think through what they have been taught it should be emphasised that there is very little to gain spending time learning such a list of topics by rote.

The competence with which the scientific terminology was used was pleasing, with many technical terms being used in the majority of essays. Weaker candidates tended to relate their work in everyday language, especially when writing about the symptoms of disease.

A) Inorganic ions include those of sodium, phosphorus and hydrogen. Describe how these and other inorganic ions are used in living organisms.

Excellent candidates wrote well structured, logical and readable essays which competently made detailed reference to the use of ions. They had a clear understanding of the nature of ions, correctly recognised the part they played, and were able to describe the relevant processes in detail. Weaker candidates were uncertain of the nature of the 'ion' and therefore included irrelevant work.

Almost everyone chose to describe the events which lead to the transmission of an impulse along an axon, usually followed with the processes which take place at the synapse. Many of these sections were very sound, but where weakness was apparent it was often in the role of potassium ions. Other frequent choices included the role of calcium in the contraction of muscles and the clotting mechanism of the blood.

Nitrogen ions were referred to only in the best essays.

There were references to the control of pH, but this was often as part of a paragraph on the transport of blood gases which, although competent on the role of hydrogen ions in displacing oxygen and in the formation of hydrogen carbonate ions, failed to recognise that this process actually buffers the blood. Some wrote of the acidic conditions in the stomach. There was some confusion over the relevance of hydrogen bonding. Irrelevant work on water was occasionally offered. The importance of the processes of oxidation and reduction were shown in sound descriptions of their role in respiration and photosynthesis.

The role of phosphate ions in ATP was recognised, but weaker candidates wandered off the point with lengthy explanations of the role of ATP. Only a few mentioned the role of phosphorus in DNA.

Other topics included the role of calcium ions in fertilisation, and in making bacterial cells competent to take up plasmids.

B) The effect of bacteria on the lives of humans and other organisms.

Excellent candidates wrote detailed, well balanced essays on a suitable range of bacteria, correctly recognising the relevant microorganism, and describing in depth their effects, mostly on humans.

Most candidates appreciated the role of bacteria in DNA technology, and even in weaker essays the processes were well recounted. In these cases this was often the most detailed part of the essay. Most related their work to the production of human insulin, but some weak candidates thought that the bacteria themselves were injected into diabetics. A few used GCSE knowledge to write about the production of yoghurt and cheese.

There were many accounts of the nutrient cycles, with most detail being supplied on the nitrogen cycle. While some candidates were very familiar with the various different bacteria and their specific roles, there was also much confusion. The role of denitrifying bacteria was commonly disregarded. Decomposers were mentioned.

There were frequent descriptions of disease, most commonly Salmonella food poisoning and Tuberculosis, but few could name Mycobacterium. *E.coli* was sometimes mentioned in the context of Salmonella. Weak candidates offered lengthy descriptions of HIV, AIDS, the common cold, Plasmodium and Schistosoma. There were a few excellent descriptions of the ways in which the TB and Salmonella bacteria work, but also many confined themselves to very general descriptions of symptoms.

A lot of comment was made about ‘good and bad’ bacteria, information apparently more readily gleaned from watching TV than studying biology.

BA89/C Centre-Assessed Coursework

General

Many of the general issues raised in the report on **BYA4** are equally relevant in the context of A2 coursework. This report should therefore be read in conjunction with that for **BYA4**. Most centres were clearly aware of the changes to the scheme of assessment and had made a genuine attempt to meet the new requirements in a modified teaching programme. This obviously entailed much hard work in the development of practical investigations that would better allow the new criteria to be met. The greater range of marks available in the new six-mark scheme was clearly used but, although there were fewer instances of maximum marks being awarded, discrimination was still not as good as had been hoped for. The suspicion remains that in trying to do the best for their candidates, some centres have again erred on the side of generosity. There was very little evidence of centres marking to the old criteria but what was a problem was the failure of some to submit the required evidence for Skill **D**. This year, a decision was made to allow the centre's marks to stand in such cases, but this will not be so in future. **In future where there is no evidence for a skill, a mark of zero must be awarded by the teacher.**

Assignments were usually appropriate, with much of the laboratory-based work centred on factors affecting the rate of fermentation in yeast, bacterial growth or digestive enzymes. Centres are reminded that they should try to avoid the situation where the same task is set in consecutive years. It is important that an element of unpredictability is introduced into the task, otherwise coursework will rapidly lose credence as a genuine test of practical skill. They should also bear in mind that one of the key principles in the new assessment scheme at A2, is that of ownership. Although it is acceptable, following a review of the plans submitted, for the class to derive a common approach allowing the rationalisation of apparatus and the pooling of results, it is essential that candidates have direct input into the resulting modification. The substitution of an alternative plan, prepared solely by the teacher, is unacceptable. The new guidelines have had some influence in standardising the use of fieldwork for assessment at A2, but it is important that the specific tasks selected provide a genuine vehicle for the assessment of the experimental skills which should have been developed as the A2 course progresses. There was much evidence this year, as in previous years, that some candidates went on field courses immediately after completing the AS examinations. For these candidates assessment was seen as an integral part of these courses. It is quite clear that this strategy is unfair on candidates in not allowing the acquisition of adequate statistical techniques or essential synoptic knowledge before assessment.

It should also be remembered that the structure of the assessment package allows candidates to complete more than one investigation. The identical nature of all tasks submitted by some centres is suggestive of a strategy that perhaps provides too little opportunity for improvement.

Planning - Skills A, B and C

There are two elements to **Skill A**. The production of a title forming a clear focus for investigation and justification of the experimental approach adopted. Most candidates were able to produce a title that at least met the requirement of providing some indication of the problem under investigation. However, centres are reminded that they need to include with the work for moderation, a copy of the scenario from which candidates have derived their titles. Without this, fair moderation is virtually impossible. Although more centres are clearly aware of the requirement of justifying the procedure adopted, lengthy theoretical introductions still appeared. The extensive plagiarising of information from websites may result in limited interpretation of results. Candidates are often reluctant to use such material in explaining their observations. Centres should note that the descriptor for a mark of 6 requires justification to be comprehensive. This was not always the case.

Where investigations were laboratory-based, there were few issues with **Skill A** which have not also been considered in the report on **BYA4**. Particular care needs to be taken that, when awarding the higher marks, sufficient detail is provided and consideration given to maintaining all variables, except the specific independent variable under consideration, constant or controlled. Ecological

investigations, however, were more inclined to fall short of the requirements in the descriptors and were often assessed generously. The new descriptors make it clear that maximum credit can only be awarded in situations where the candidate provides full details of the method of selecting the site and additionally considers variables which might reasonably be associated with changes in the independent variable, and which would require consideration in the interpretation of the results.

The main issues arising with Skill C essentially concerned reliability. As with AS, there are factors other than the number of repeats which influence reliability and these should be addressed. For example, where candidates chose to investigate factors affecting respiration in yeast and elected to measure the rate of carbon dioxide production, they should have ensured that some effort has been made to produce anaerobic conditions. They should also have recognised that pushing a bung into a tube would have created a pressure surge and displaced the gas in the delivery tube. Candidates are required to specify the number of repeats that it would be necessary to carry out to collect sufficient data for an appropriate statistical test. Centres should note the requirement here. Credit was frequently incorrectly awarded for references to ensuring reliability by planning for three repeats.

Implementing - Skill D

Centres are reminded of the need to include evidence of how the mark for Skill D has been awarded. Where a group tick sheet is used, please enclose a copy, with the particular candidate highlighted, with the work of each candidate in the sample. The use of combined worksheets where candidates were identified by first name only made moderation unnecessarily difficult. The evidence provided by centres for this skill varied considerably. Most had clearly followed the guidelines in the specification and produced checklists that provided evidence of safe working practice, an indication of the skill with which apparatus was used, and information concerning aspects of organisation. Such checklists were clearly sufficiently comprehensive to provide the necessary support for the mark awarded. On the other hand, the evidence provided by others was minimal. Brief statements to the effect that candidates had "worked safely and methodically throughout" or ticks placed in the appropriate columns of the marking criteria are unacceptable.

Analysing - Skills E, F and G

The new criteria for Skill F provide greater clarity and it is encouraging to note that candidates from many centres showed evidence of being able to construct a null hypothesis, select and carry out an appropriate test and explain its results in terms of chance and probability. Not all candidates met these requirements, however. On occasion there was no evidence of a null hypothesis, and interpretations sometimes lacked the necessary references to chance or probability. Most candidates selected the test from those recommended in the specification but there were some who chose other approaches. While this is acceptable, centres are reminded that increasing the complexity of the task places additional burdens on candidates. Thus, those of more modest ability undoubtedly find it much easier to calculate standard error and 95% confidence limits and interpret the figures obtained, than they do to carry out a series of t-tests. They also tend to make fewer arithmetical errors with the former. The practice of looking at the data on which the test statistic is calculated, labelling low and high value anomalies, and then ignoring them in carrying out the calculation is unacceptable. This is a major error resulting in conclusions which are likely to be invalid and must be marked accordingly.

In most cases, candidates were able to draw on appropriate theory to explain the results of their investigations, but, as at AS, there was a tendency to use such information unselectively. In general, Skill F was characterised by a lack of focus and, as a result, some extremely lengthy conclusions failed to link biological concepts and principles to the results of the particular investigation.

The practice provided at AS tends to result in A2 candidates producing more convincing evaluations of their work (Skill G). Nevertheless work of poor standard was still encountered and this was particularly true where centres substituted a teacher's plans for those produced by candidates. It is worth repeating

here that it is not acceptable to provide plans which are lacking in scientific rigour, and then merely to reward candidates for pointing out their deficiencies.

Mark Ranges and Award of Grades

Unit/Component	Maximum Mark (Raw)	Maximum Mark (Scaled)	Mean Mark (Scaled)	Standard Deviation (Scaled)
BYA1	75	75	38.3	14.6
BYA2	75	75	42.2	15.2
BYA3	75	75	32.5	13.9
BYA4 Coursework	60	60	47.5	9.0
BYA5	75	75	34.9	12.0
BYA6	75	75	38.3	12.0
BYA7	75	75	34.5	12.0
BYA8/W Written	60	60	29.9	10.4
BA89/C Coursework	42	60	48.9	8.7
BYA8	-	120	78.8	16.2
BYA9/W Written	60	60	25.0	10.2
BA89/C Coursework	42	60	46.6	9.6
BYA9	-	120	71.7	16.7

For units which contain only one component, scaled marks are the same as raw marks.

BYA1 Molecules, Cells and Systems (19185 candidates)

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	53	47	41	35	29
Uniform Boundary Mark	105	84	74	63	53	42

BYA2 Making Use of Biology (18415 candidates)

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	58	52	46	40	35
Uniform Boundary Mark	105	84	74	63	53	42

BYA3 Pathogens and Disease (5115 candidates)

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	54	48	42	37	32
Uniform Boundary Mark	105	84	74	63	53	42

BYA4 Coursework (20637 candidates)

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	60	56	51	46	41	36
Uniform Boundary Mark	90	72	63	54	45	36

BYA5 Inheritance, Evolution and Ecosystems (8435 candidates)

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	49	44	39	34	30
Uniform Boundary Mark	90	72	63	54	45	36

BYA6 Physiology and the Environment (10292 candidates)

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	51	46	41	36	31
Uniform Boundary Mark	90	72	63	54	45	36

BYA7 The Human Life-Span (2348 candidates)

	Max. mark	A	B	C	D	E
Scaled Boundary Mark	75	51	46	42	38	34
Uniform Boundary Mark	90	72	63	54	45	36

BYA8 Synoptic Assessment (Biology) with Coursework (10302 candidates)

		Max. mark	A	B	C	D	E
BYA8/W Scaled Boundary Mark	raw	60	41	37	33	30	27
	scaled	60	41	37	33	30	27
BA89/C Scaled Boundary Mark	raw	42	39	36	33	30	27
	scaled	60	56	51	47	43	39
BYA8 Scaled Boundary Mark		120	97	89	81	73	66
BYA8 Uniform Boundary Mark		120	96	84	72	60	48

BYA9 Synoptic Assessment (Human Biology) with Coursework (2376 candidates)

		Max. mark	A	B	C	D	E
BYA9/W Scaled Boundary Mark	raw	60	41	37	33	30	27
	scaled	60	41	37	33	30	27
BA89/C Scaled Boundary Mark	raw	42	39	36	33	30	27
	scaled	60	56	51	47	43	39
BYA9 Scaled Boundary Mark		120	97	89	81	73	66
BYA9 Uniform Boundary Mark		120	96	84	72	60	48

Advanced Subsidiary award Biology

Provisional statistics for the award (14289 candidates)

	A	B	C	D	E
Cumulative %	18.9	36.1	53.5	69.2	83.0

Advanced Subsidiary award Biology (Human)

Provisional statistics for the award (4484 candidates)

	A	B	C	D	E
Cumulative %	7.5	19.7	34.2	50.2	68.7

Advanced award Biology

Provisional statistics for the award (10372 candidates)

	A	B	C	D	E
Cumulative %	23.2	45.0	64.7	81.7	93.6

Advanced award Biology (Human)

Provisional statistics for the award (2410 candidates)

	A	B	C	D	E
Cumulative %	10.6	27.2	47.9	67.2	85.7

Definitions

Boundary Mark: the minimum (scaled) mark required by a candidate to qualify for a given grade.

Mean Mark: is the sum of all candidates' marks divided by the number of candidates. In order to compare mean marks for different components, the mean mark (scaled) should be expressed as a percentage of the maximum mark (scaled).

Standard Deviation: a measure of the spread of candidates' marks. In most components, approximately two-thirds of all candidates lie in a range of plus or minus one standard deviation from the mean, and approximately 95% of all candidates lie in a range of plus or minus two standard deviations from the mean. In order to compare the standard deviations for different components, the standard deviation (scaled) should be expressed as a percentage of the maximum mark (scaled).

Uniform Mark: a score on a standard scale which indicates a candidate's performance. The lowest uniform mark for grade A is always 80% of the maximum uniform mark for the unit, similarly grade B is 70%, grade C is 60%, grade D is 50% and grade E is 40%. A candidate's total scaled mark for each unit is converted to a uniform mark and the uniform marks for the units which count towards the AS or A-level qualification are added in order to determine the candidate's overall grade.