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Report on the Examination

Biology
Specification B

- Advanced Subsidiary
- Advanced

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Kathleen Tattersall, Director General

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Unit BYB1 Core Principles

General

It was felt that the quality of work on this paper was better than last year. Most candidates attempted all questions. However, there were still some extremely weak candidates whose knowledge and understanding of the module content was not even of GCSE standard. The best candidates comfortably gained over 50 marks and demonstrated a very pleasing grasp of the topics and concepts of this module. Topics that were well-known included protein structure, structure of the gut wall, enzyme theory and elements of chromatography. Questions about the structure of fibrous proteins, nutrient uptake and those that required application of knowledge were more poorly answered.

Quality of language was generally satisfactory, but some candidates are still ignoring the instruction to answer in continuous prose in Section B and, therefore, could not be awarded credit for Quality of Written Communication. There were still candidates who openly admitted that they did not have access to a calculator and who therefore could not complete calculations, and there also seems a reluctance to show working, despite the question asking for it to be shown. Candidates need to show their working because, in the event of an arithmetical error, it may be possible to award some marks for using a correct method.

Section A

Question 1

This question was answered well by most candidates. Part (a) was straightforward, with most candidates gaining two marks. The biuret test was well known but many candidates believe that this test involves heating. Occasionally, the incorrect reagents were used despite the test name being correct. The vast majority of candidates could give the correct colour change. In part (b)(i) candidates need reminding that 'Name' does not mean 'Give the chemical symbol'. Candidates who wrote N_2 therefore did not gain credit. Condensation was well known for part (ii). Part (iii) was generally well answered, with the most common errors being the omission of a double bond between the carbon and the oxygen atoms and showing the hydrogen in the peptide bond with two bonds and acting as the link between the nitrogen and the carbon atoms. Another common error was to show an oxygen bridge, as in carbohydrates.

Question 2

In part (a)(i), it was common to see marks lost by weaker candidates due to insufficient accuracy, with x 6 given rather than x 6.2. In part (a)(ii), candidates often treated facilitated diffusion and active transport as synonymous, with other common incorrect answers being osmosis, diffusion and hydrolysis. In part (b) only the best candidates gained both marks. Most could identify the idea of channel proteins but the explanation often referred to membrane thickness and diffusion, or

concentration gradients, rather than to the numbers or specificity of carriers or the size of molecules. Part (c) proved surprisingly difficult with only the best candidates linking the air with oxygen for respiration. Weaker candidates thought that the bubbles simply were needed to circulate nutrients or that CO_2 is required for photosynthesis.

Question 3

In general, most candidates found this question straightforward and many gained full marks. In part (a) a common mistake was to give villi as the answer rather than referring to the layer itself. Part (b) was rarely incorrect. Part (c) was very well answered with the only common mistake being identifying Y as a villus rather than a microvillus.

Question 4

This question was well answered by the most able candidates. Surprisingly, few candidates gave the correct answer of 82%, with answers ranging from 3% to 100%, indicating a lack of appreciation of what the graph is actually showing. Part (b) showed that, generally, counter-current flow is well understood in terms of the maintenance of diffusion and concentration gradients. There were far fewer diagrams this year but those that were drawn were almost invariably wrong. The most common reason for lost marks was an incomplete answer rather than an incorrect one. Virtually all candidates gained 1 mark in part (c) and many gained 2 marks. One misconception was that membrane thickness has no effect on gas exchange. In part (d), candidates lost marks because they did not use the question stem in constructing their answer. The stem included reference to number of alveoli and their wall thickness as well as oxygen masks. To gain all three marks, reference had to be made to each of these points e.g. smaller surface area, larger diffusion distance and increased concentration gradient. Only the best candidates managed this.

Question 5

In part (a), most candidates knew that the particular shape of a red blood cell increases its surface area and so gained 1 mark. They did not seem to understand that this would increase the rate of gas exchange referring instead to an increase in efficiency. Weaker candidates were convinced that the membrane became thinner and very few referred to increased flexibility as an advantage. In part (b), most candidates gained credit for answers referring to protein synthesis or replication. In (c)(i), most candidates gained both available marks. However, incorrect responses were to draw micelles, despite the question stem stating 'on the water surface', bilayers, inverted monolayers or sunken monolayers - a response which gained 1 mark. In part (c)(ii), only the best candidates saw the principle on which the question was based and correctly gave 0.5 as the answer. A sizeable number knew that the reason was the formation of a bilayer but worked out the value as 2. Weaker candidates simply did not attempt this part. No one attempted trying to work out an answer based upon the number of phospholipids in a red blood cell membrane.

Question 6

The most able students comfortably gained both marks for part (a) and the majority of candidates gained at least one mark. As in Question 2 (a)(ii), there was some confusion between active transport and facilitated diffusion. Part (b) proved difficult for all but the best candidates. There were many general comments about incorrect food or enzymes, which did not gain credit. There were references to sugar diffusing into the bacterial cells causing them to explode, whilst others suggested that the sugar was toxic. Only the very best candidates gained all three marks, as they were confident in expressing answers in terms of osmosis due to a difference in water potential values. Credit was

given to candidates who gave alternative and reasonable responses, e.g. referring to the low pH of jam.

Question 7

This question was generally well answered with candidates able to show a good knowledge and understanding of enzymes. Part (a) was almost exclusively answered correctly with only the weakest candidates unable to give 'active site' as the answer. Part (b) was answered reasonably well, with most candidates gaining more than half marks. Only the better candidates referred to a lowering of the activation energy and the release of products because they no longer fit the active site. Part (c) was very well answered but a common mistake was to refer to the attachment of molecule A 'somewhere' on the enzyme, an answer that lacked precision. Another error was to mix up competitive and non-competitive inhibition, resulting in a reversal of the expected answers for molecules A and B. Part (d)(i) was either known or not, and most candidates gained either 2 marks or none. Common mistakes were to refer to enzyme excretion and the fungus eating the products. Part (d)(ii) was well answered by most candidates. Incorrect answers by the weakest candidates referred to the fungus' optimum temperature rather than that of the amylase. Part (iii) generated a wide range of valid responses based on diameter, radius or area. Again, weaker candidates did not divide surface area or distance by the time, simply added up all the results and divided by 4, made arithmetical errors that invalidated their answer, or could not calculate an answer due to the absence of a calculator.

Question 8

This question was challenging, but well attempted by the best candidates; weaker candidates found it very difficult. The least able did not grasp what was expected from part (a); the moderate managed to pick up one mark for identifying the first three amino acids and the last one correctly, but they could not work out the middle sequence. The best candidates picked up both the available marks. In part (b), few candidates gained marks, despite the mark scheme allowing for answers which correctly referred to the potential solubility of the fragments. Part (c) was well known and candidates lost marks for either inverting the calculation or for lack of accuracy in measuring. Candidates should always be encouraged to show their working clearly as asked.

Part (d)(i) was answered better than (b), but there were many similar mistakes. Part (d)(ii) had obviously been well learned and generated many full marks. Candidates were very familiar with two-way chromatography, but common errors were to fail to mention that a different solvent was used second time around. Some referred to a different solution, requiring a longer chromatogram or used an imprecise expression 'turn the paper around/on its side' rather than the expected 'rotate 90^{o}'. The weakest candidates attempted to use digestion with proteases followed by electrophoresis, which is not a modification of the experimental method used, as required by the question. Answers to part (e) were the weakest on the paper, despite the topic being mentioned explicitly in the specification. Few candidates gained more than 2 marks. Many referred to globular proteins or cellulose in their answers. Others were let down by poor expression and/or terminology, for example using the words protein and polypeptide interchangeably. It was sometimes difficult to be sure if the polypeptide or the protein was held together by hydrogen bonds, whether strength derived from the cumulative effect of many hydrogen bonds rather than 'strong' hydrogen bonds. Many candidates seemed to adopt a random 'write all you know about proteins' approach. Hopefully the mark scheme will act as an aid to centres in clarifying what is obviously a difficult area of the specification for candidates.

Unit BYB2 Genes and Genetic Engineering

General Comments

Most candidates demonstrated a good understanding of the principles involved in DNA replication and the use of enzymes in genetic engineering. Unfortunately, only the best candidates explained their understanding of these and other topics with enough precision. Many candidates lost marks by making vague generalisations. Candidates from only a few Centres knew about the use of replica plating, and meiosis would appear to be understood by many candidates at a level no higher than that expected at GCSE.

Question 1

(a) Most candidates correctly identified the stage of mitosis. Some thought it was anaphase, presumably because the chromosomes were not arranged in a straight line. Often answers in part (ii) made a reference to the spindle without establishing its role in separating chromatids. Imprecise references to chromatids 'halving' were not credited. Few candidates drew a haploid set of chromosomes inside the gamete, and very few went a step further to show one representative from each homologous pair of chromosomes.

(b) Many candidates ignored the reference to mitosis given in the question and explained the halving of DNA units in terms of meiosis. Those who appreciated the significance of DNA replication in a cell cycle often failed to gain full credit by incorrectly identifying when DNA replication occurred in the cell cycle.

Question 2

(a) Most candidates gained full marks. Incorrect answers included references to phosphoric acid and ribose.

(b) Most candidates demonstrated a good understanding of complementary base pairing rules, which allowed the majority to achieve at least one mark. Only those candidates who appreciated the significance of the length of the piece of DNA obtained full marks.

(c) A number of answers contained a common misconception that genetically identical cells contain different alleles. Only the better candidates suggested that the expression of different genes causes differences between types of cell. Their explanations were usually very detailed.

Question 3

(a) Most candidates gained a single mark for a 'movement' answer, but fewer achieved the second mark because they failed to be precise in their explanation. Examples included suggestions that male gametes 'do not contain any nutrients', 'contain both X and Y chromosomes' and 'more are released'.

(b) A number of candidates ignored the information given in the table by stating that goldfish eggs are smaller than human eggs. This led some candidates to suggest that more goldfish

eggs are produced because they are smaller. The most frequent answer given in part (ii) that gained a mark was the idea of increasing the chances of fertilisation. Few candidates went on further to discuss relative survival chances of offspring.

Question 4

(a) Very few candidates achieved more than a single mark for this part of the question and most scored zero. There was little evidence to suggest candidates knew much about alleles or loci, which meant they could not apply understanding of these concepts to a problem based in meiosis. These concepts are clearly stated in the specification, but the majority of candidates appear to understand little more than that meiosis halves the number of chromosomes. That gametes contain 23 chromosomes chosen at random from 46 was a popular misconception.

(b) Very few candidates failed to gain two marks for this question.

Question 5

(a) Good explanations were often spoiled by references to the movement of chloride ions and water that did not clearly state the direction in which they moved. Some candidates believe that they are trapped or stored inside a membrane rather than affecting the solution inside the cell. Most candidates achieved a mark for the idea of 'thicker mucus'. In part (ii), few candidates referred to a blocked pancreatic duct as the cause of poor digestion. Vague explanations involving a blocked pancreas and references to the liver gained no marks.

(b) The description of mRNA production usually included relevant details about complementary base pairing but the separation of DNA strands was not adequately described by many. Vague references to DNA uncoiling or DNA unwinding did not gain credit. Most candidates calculated the correct number of nucleotides in part (ii). Those who did not tended to divide the number of amino acids by three.

Question 6

(a) Nearly all candidates knew the type of reproduction.

(b) Answers in part (i) usually contained sufficient detail for many candidates to gain two marks. Some lost a mark by making imprecise references to the 'same DNA' or 'DNA has the same composition' to explain the idea of genetically identical cells. The type of cell division was only stated in the best answers. Most candidates suggested a suitable environmental factor or gave mutations as a valid reason for differences between plants in part (ii). Once again a frequent invalid answer suggested differences in alleles as the reason.

(c) Candidates tended not to give reasons that made clear the advantages in sufficiently precise terms. Vague references to obtaining plants more cheaply, ensuring all plants were strong, or knowing what the plants would look like were not uncommon.

Question 7

(a) Very few candidates failed to obtain full marks.

(b) The explanations were generally poor in part (i). Only the best candidates stated that a change in the sequence of DNA bases would change the mRNA codon and attract a different molecule of tRNA. In quite a few answers, mRNA was said to produce rather than order amino acids, and in others a gene was thought to code for a single amino acid. Occasionally, a substitution mutation was confused with deletion and addition mutations, which led some candidates to give a lengthy description of a frameshift and its consequences. Most of the candidates who used the information given in the table achieved two marks in part (ii). Some referred incorrectly to amino acids as the degenerate part of the genetic code.

(c) Most answers gained full marks. This topic seems to be understood well.

(d) The technique of replica plating is not well known. Candidates tended either to score well or not at all. Some excellent answers were observed, often several from the same Centre. Many candidates left a blank space or filled it with irrelevant detail about genetic engineering techniques, PCR or DNA sequencing. Others confused plasmids with living cells by suggesting that plasmids were grown on different media.

Of the candidates who included relevant details, few could explain how a replica is taken or how replica plates are used to monitor the growth of bacteria in various treatments. Some candidates grew bacteria on a mixture containing both antibiotics and still expected to isolate cells containing recombinant plasmids. Others incorrectly believed that cells with recombinant plasmids would grow on tetracycline even though the resistance gene was disrupted.

Question 8

(a) There were many full descriptions of DNA replication with most candidates achieving at least three marks. Some did not gain any marks as a result of confusing DNA replication with mitosis and others described protein synthesis, which restricted them to a single mark for the idea of strand separation.

(b) Only the best candidates were able to provide valid reasons for the steps taken in the polymerase chain reaction. Many candidates suggested in part (i) that the solution was heated to denature enzymes or kill bacteria. Few candidates stated in part (ii) that primers attached to the single strands of DNA or where they attached. Most candidates understood the idea about the stability of enzymes at high temperatures in part (iii) but could not apply this understanding to explain why these enzymes were used in the PCR.

(c) More than half of the candidates failed to calculate accurately the number of copies of the gene produced in the PCR.

(d) Quite a few candidates thought in part (i) that the gene was being produced and not the protein. Most credit was obtained in part (ii) for references to not knowing the long-term effects of the techniques and for well-reasoned explanations of animal rights. Many referred to ‘not playing God’ despite last year's report.

Unit BYB3/W Physiology and Transport

General Comments

Overall, candidates were well prepared for this paper and showed a level of understanding above that normally associated with module tests on physiology. The vast majority of candidates attempted all the questions and there was no evidence of any general misinterpretation of questions. Many candidates displayed good recall of factual details and showed competent analytical skills. However, as on previous tests, questions requiring calculations proved troublesome with a significant number of candidates failing to gain marks due to carelessness. It was pleasing to note the improvement in understanding of topics common to last June's paper, such as the maintenance of breathing, tissue fluid and oxygen-haemoglobin dissociation curves. Section B was particularly well answered with most candidates expressing their ideas in a logical manner using appropriate scientific terminology. Consequently, the majority of candidates gained the mark for Quality of Written Communication.

Question 1

This question was well answered by the majority of candidates with most gaining at least four marks.

(a)(i) Most candidates correctly identified cell A as a sieve element or sieve tube cell. Cell B, the companion cell, was correctly identified by slightly fewer candidates.

(ii) Approximately two thirds of candidates obtained both marks for this calculation. A common error was to omit any units in the final answer. A significant minority of candidates failed to measure accurately the distance between points X and Y, even though the mark scheme provided a generous degree of tolerance.

(iii) The vast majority of candidates gained the mark for this question by stating that cell A had no nucleus or had fewer mitochondria. Relatively few candidates referred to the sieve plate or limited amount of cytoplasm in cell A. Unfortunately, some candidates suggested that cell A had no mitochondria or no organelles.

(b) Although most candidates gained the mark for this question, it was evident that some candidates were confused between the meanings of 'source' and 'sink'.

(c)(i) At least half the candidates correctly referred to 'radioactive carbon' or '^{14}C'. However, a significant number of candidates failed to obtain the mark as they gave rather imprecise answers such as 'radioactive carbon dioxide' or 'radioactive glucose'.

(ii) Many candidates failed to gain a mark, as they did not refer to measuring distance, often simply suggesting that the time taken for a substance to move from the source to the sink should be recorded.

Question 2

Although this question was well answered, few candidates gained full marks, usually as a result of problems with part (b).

(a) This caused little difficulty with the vast majority of candidates correctly identifying C as a capillary and D as the aorta.

(b) Surprisingly, only a minority of candidates obtained both marks in this question. Many candidates referred to muscle 'constricting', 'expanding' or 'dilating' instead of contracting. However, most candidates did appreciate that constriction or narrowing of arterioles reduced the blood supply to a particular part of the body.

(c) Most candidates obtained the mark by stating that blood flow through the gills reduced the blood pressure in the arterioles supplying the body tissues. A significant number of candidates incorrectly deduced from the diagram that the shorter distance between the heart and body tissues in a mammal resulted in a higher blood pressure.

Question 3

Generally, this was a high-scoring question with the majority of candidates obtaining at least half marks.

(a) The majority of candidates correctly named glycogen and triglycerides as stored compounds used as energy sources during exercise. Common responses not credited included ATP, creatine phosphate and glucose.

(b) It was pleasing to note the improvement in the responses to this question compared with those provided on last June's paper. Most candidates gained both marks by referring to a decrease in pH, muscle fatigue or to the alteration of enzymes or proteins in muscle. Weaker candidates gave rather vague references to muscle cramp or pain but these were far less frequent than on last year's paper.

(c)(i) Despite the apparent simplicity of this question, a significant number of candidates did not gain a mark. By far the most common error was to omit the unit, i.e. 'g'. However, it was also disappointing to note how many candidates could not correctly read the scale on the graph.

(ii) This question proved to be an effective discriminator. Most candidates gained one mark for observing that athletes consumed more oxygen than non-athletes at higher energy requirements. Some of these candidates gained a second mark for stating that lactate is produced during anaerobic respiration. However, only better candidates gained a third mark for explaining that the onset of anaerobic respiration would have been delayed in athletes. A few candidates also referred to the greater yield of energy from aerobic respiration compared to anaerobic respiration.

Question 4

This question proved to be an effective discriminator with the best candidates displaying a thorough understanding of the relationship between blood, tissue fluid and lymph.

(a) Most candidates correctly named two substances, often oxygen and glucose, that would be at a higher concentration in the blood at the arteriole end of a capillary than at the venule end. Incorrect responses frequently included plasma and haemoglobin.

(b) Although there were some very good answers to this question, few candidates gained maximum marks. Most candidates referred to the function of the lymph vessels in returning

fluid to the blood. However, the reabsorption of fluid into the capillary was less well known and was often omitted. Candidates who did refer to this process often mentioned that proteins were retained in the blood capillary but there was some confusion between higher and lower, or more and less negative water potentials. Despite this confusion, these candidates frequently gained the mark for reabsorption of fluid by osmosis.

(c)(i) Most candidates scored one mark in this question by suggesting that the high blood pressure would force out more fluid from the capillary. A significant number of candidates gained a second mark by suggesting that a high blood pressure at the venule end of the capillary may reduce the amount of fluid reabsorbed. Fewer candidates suggested that the lymph system would not be able to drain all the excess tissue fluid rapidly enough.

(ii) Approximately a third of candidates obtained a mark by suggesting that gravity would cause tissue fluid to accumulate in the ankles and feet. Many candidates continued to explain the accumulation of tissue fluid in terms of high blood pressure, having failed to note the context of the question. Only a limited number of candidates suggested that the accumulation of tissue fluid could be due to fewer lymph vessels in these areas.

Question 5

Although a few candidates gained maximum marks on this question, most candidates scored between three and five, depending on their success with the calculation in part (c).

(a) The majority of candidates obtained both marks for correctly identifying the sinoatrial node (SAN) and the atrioventricular node (AVN).

(b) Most candidates correctly described the role of the SAN as a pacemaker, emitting a wave of depolarisation. However, a significant number of candidates simply stated that the SAN causes heart contraction rather than referring to its specific role in atrial systole.

(c)(i) Depending on which part of the graph a candidate selected, a considerable range of answers could be obtained (79 - 83 beats/min). Despite this, a large number of candidates failed to obtain a mark, often giving 75 beats/min as an answer, which has appeared on previous mark schemes!

(ii) Very few candidates correctly answered this question. Many candidates noted the rise in ventricular pressure but did not state that it increases above the atrial pressure.

(d) Quite a few candidates answered this question in terms of why the blood pressure in the aorta has to be higher, consequently failing to obtain a mark. A surprisingly large number of candidates referred to ‘the left side of the heart’ rather than to the ventricle or to a thicker ‘wall’ rather than muscle.

Question 6

Although very few candidates obtained maximum marks, there were many very good answers showing an excellent understanding of transpiration and water potential.

(a)(i) This caused few problems with the vast majority correctly describing the relationship between the transpiration rate and water potential of cotton leaves.

(ii) Good candidates generally obtained both marks by referring to evaporation and appreciating that water loss lowers the water potential of leaf cells. Weaker candidates often failed to mention evaporation but usually included the latter point.

(iii) The mark scheme required candidates to link the fluctuations in the transpiration rate to the opening and closing of stomata. Only better candidates did this; many simply referred to one of these processes. Answers relating fluctuations in the rate of transpiration to the degree of stomatal opening were credited.

(b)(i) Most candidates correctly described that the loss in mass decreased over the period of the investigation.

(ii) This question discriminated well. Some candidates provided excellent explanations for the change in mass of the leaves in terms of stomatal aperture, water potential gradients and the lack of a water supply to replace the water transpired. However, many candidates described only one of these factors.

(iii) It was pleasing to note that a significant number of candidates correctly answered this question in terms of improving the reliability of the results or reducing the effect of anomalous results. Nevertheless, there were still many answers simply referring to 'fair test' or to 'an average result'.

(c) The majority of candidates had no difficulty describing two xerophytic features of plant leaves, often referring to the presence of a thick waxy cuticle, hairs, sunken or fewer stomata. However, some candidates described xerophytic features of other plant organs, particularly the stem and root.

(d)(i) Most candidates gained a single mark in this question. Better candidates gained both marks, explaining that an increase in temperature provides more energy resulting in increased evaporation. Some candidates explained how an increase in temperature increases the water potential gradient between the leaf and atmosphere.

(ii) Approximately half the candidates linked a decrease in the rate of transpiration to reduced water absorption into the plant. However, only a minority of candidates explained this in terms of a decrease in the water potential gradient.

Question 7

There were some excellent answers to this question with the most able candidates gaining maximum marks. However, for some candidates part (b)(i) proved to be rather difficult and severely tested their understanding of the control of ventilation.

(a)(i) Most candidates gained both marks for correctly describing how haemoglobin loads and unloads oxygen in the body. However, it was also apparent that most candidates do not possess a clear understanding of partial pressure.

(ii) Good candidates clearly understood that the change in the oxygen-haemoglobin dissociation curve would release more oxygen to the respiring tissues. Less able candidates incorrectly suggested that more oxygen would be absorbed in the lungs or that more oxygen would be transported to the tissues.

(b)(i) There were some excellent, extremely precise accounts of the mechanism involved in controlling the breathing rate. Not surprisingly, there were also some very confused

descriptions, which included stretch receptors 'contracting', muscles 'moving upwards and outwards' and the perennial 'messages' instead of impulses. Despite these poor answers, the overall standard was quite impressive with the majority of candidates outlining the main processes involved. Many referred to the medulla transmitting impulses causing contraction of the respiratory muscles and linked the stimulation of the stretch receptors to the lungs inflating. The inhibition of inspiration was less clearly understood.

(ii) Marks were more readily obtained in this section than in part (i). Most candidates mentioned chemoreceptors and described their function in detecting an increase in carbon dioxide during exercise. Many candidates referred to central chemoreceptors in the medulla and to peripheral chemoreceptors in the aortic and carotid bodies. Unfortunately, a significant number of candidates then began describing the control of heart rate instead of breathing rate. Nevertheless, most candidates correctly interpreted the question and showed a detailed understanding of this topic.

Unit BYB3/C Coursework

General Comments

It is important for all centres who are entering candidates for BYB3 in January to send a mark sheet to the moderator, even if all candidates in the centre are carrying forward their marks. Marks should only be recorded on these sheets if new work is being submitted.

Any new marks must come from a different investigation to that carried out last time – it is not possible for candidates to repeat the same investigation to improve their marks. For example, a different enzyme and different factor affecting activity should be investigated.

As the marks at AS for the different skills can be derived from more than one investigation, it is possible to combine new and previously submitted work, when marks for only one or two skills need to be improved. In this case it is important to send all the relevant work, with a clear indication of how the final mark was obtained.

The coursework submitted for AS must come from the AS content of the specification, even if candidates taking BYB3 in January are studying A2 at this time.

As about 95% of candidates carried forward their marks from last summer, it was not possible to discern any trends in the small amount of new coursework submitted. The majority of the work submitted for moderation was within tolerance, with appropriate investigations being carried out.

Unit BYB4 Energy, Control and Continuity

General Comments

Many candidates were excellently prepared for this unit test, with some gaining highly impressive scores of more than 75 out of a total possible mark of 81. It was not unusual for many, if not all, candidates in some Centres to achieve marks of above 60, which is a testament to the way in which they were prepared for a paper that undoubtedly included some taxing questions.

It was, however, disappointing to find that a significant proportion of candidates who took this unit test appeared less than fully prepared. There were instances of candidates who, having produced extremely thoughtful and knowledgeable answers to certain questions, then gave very poor answers to others. The nature of such poor answers did not suggest a shortage of time in the examination, but unfamiliarity with certain subject areas, and such 'shortages' tended to be correlated with Centres. Inadequate preparation appeared to be the problem because the requirement of the questions concerned did not involve application (Assessment Objective AO2) but basic knowledge and understanding (AO1). Evidence of this lack of preparation was noticeable in answers given to questions 6(a), 7(a), 8(b)(i), and 10(f).

This paper was the first A2 unit test to be taken by candidates following the new specifications. The novelty of the paper, in being different from earlier AS unit tests, seemed to prove disconcerting for candidates in a small number of Centres. In a few cases it had not been appreciated that the balance of assessment objectives, between AO1 and AO2, is significantly different at A2 compared with AS, such that around 45 of the 80 marks available required candidates to apply their knowledge and understanding, rather than simply to recall information. Candidates undoubtedly find such 'application' questions challenging.

The bias towards application means that more questions need to include information that is unfamiliar to candidates. This inevitably increases the necessary reading time. Using a smaller number of questions can reduce the reading needed, but can result in a relatively large number of marks being awarded on a limited area of the content. Candidates who find such a 'longer' question difficult or confusing, may then forfeit a significant proportion of the marks available.

Very few scripts were illegible or difficult to read. The Quality of Written Communication was assessed using the continuous prose in Section B. The standard was generally satisfactory, with most candidates being able to make their ideas understood. It may be useful for Centres to be aware that many candidates exhibited poor spelling. Generally, spelling that was phonetically correct was not penalised, but in instances involving technical terminology where one term could easily be confused with another e.g. glucagon and glycogen, credit was withheld.

Section A

Most candidates observed the request to keep answers to Section A short and precise.

Question 1

This question concerned the differences in acuity and distribution between rods and cones in the eye. Most candidates were able to identify the receptor cells correctly in part (a), and very few failed to recognise the fovea as the region at 'position 8' on the retina, in part (b). The general level of candidates' responses to part (c) was very good indeed. Many correctly explained that greater detail would be seen at position 8 than at position 12 because of the relative concentration of cones, or in general, of receptor cells. They went on to explain that cones provide greater acuity than rods, and gave the reason for this in terms of retinal convergence. An encouragingly large number of candidates gained full marks on this question which seemed, therefore, to have provided a relatively successful start for candidates.

Question 2

This question proved highly discriminating, especially in part (c). It related to a diagram of chromosomes at meiosis, but only a few candidates appreciated that, since the cell did not contain homologous pairs of chromosomes, it was haploid rather than diploid. Candidates were far more successful in identifying 'centromere' and 'chromatids' in parts (a)(i) and (b) respectively, although some confused centrioles with the former, and 'chromosomes' with the latter. To gain credit in part (a)(ii), candidates needed to explain centromere function in terms either of its attachment to the spindle or its division to enable separation of the chromatids. While many more correct answers to (a)(ii) than to (c) were encountered, many candidates exhibited a substantial and basic confusion about meiosis.

Question 3

This question, which required candidates to understand the rudiments of kidney and liver function, provided them with a simple graph to use as a source of evidence. Most candidates were able to gain the mark for (a)(i), giving kidney function as the removal of urea from the blood and explaining this using relevant evidence from the graph. Candidates found (a)(ii) more difficult, with a surprising number failing to realise that the function of the liver was the production of urea. Some who realised this were still unable to justify their answers using evidence from the graph. A relatively large number of candidates confused deamination with urea production, although such a mistake did not necessarily preclude the award of the mark here. Part (b), in which candidates were required to predict the nature of the graph in different circumstances, proved too difficult for around half of the candidates. Up to two marks were available for part (b), with many candidates gaining both of these.

Question 4

In part (a) candidates were asked to name the relationship between alleles as codominance and in part (b) to give the genotype as X^BY. Equivalent names or notations were accepted. In part (c), candidates were asked to show the genotypes for Offspring 1 and Offspring 2 and the respective phenotypes for the latter, preferably with a suitable ratio as well.

Those candidates who had been suitably prepared for such a genetics question gained most, if not all of the marks available, and maximum scores were frequent. Most candidates gained at least two

marks. A proportion of candidates did not know the name of the relationship in (a), with 'sex linkage' being one of the most frequent wrong answers. The most common mistake in (b) was for a candidate to show an allele on the Y as well as on the X chromosome and, where this error was carried into part (c), the candidate was generally unable to gain further credit.

Question 5

This question concerned photosynthesis and proved to be one of the most demanding questions on the paper. It involved the application of candidates' knowledge and understanding and was designed so that it would not have been necessary for candidates to be familiar with this experiment.

In part (a), those candidates who gained full credit appreciated that the incorporation of radioactive carbon into intermediate compounds in the light-independent reaction would cause them to become radioactively labelled, so that the sequence of biochemical changes could be followed. A common misconception was to suggest that the experiment was a version of a simple one to show that carbon dioxide is necessary for photosynthesis, through simply demonstrating uptake of label by the algal cells. The great majority of candidates managed to gain the mark in (b)(i) for explaining that the reactions would be stopped or that the algal cells would be killed. Enzyme denaturation was another acceptable approach, but credit was not given to the idea that the hot alcohol 'killed enzymes'. Some candidates suggested other wrong answers, the most common involving the idea that hot alcohol was used to sterilise unwanted bacteria in the flask. Far fewer candidates gained the credit available for part (b)(ii), which required them to suggest a suitable reason for the use of a rapid action tap. Acceptable answers included 'because the photosynthetic reactions were so quick', and 'because samples needed to be removed at precise times'. The most common wrong answer was the suggestion that the tap needed to be opened and closed quickly so that non-radioactive carbon dioxide would have been unable to enter the suspension of algal cells and 'spoil' the experiment.

Correct answers to part (c) seemed not to be correlated with performance on the rest of this question. The required sequence was Q to R to S to P and a significant proportion of candidates correctly gave this. Part (d) allowed candidates to bring in their knowledge of the light-independent reaction, as many of them did, but it was also necessary for them to appreciate that a cycle was involved, or that substance Q was being regenerated as fast as it was being used up and hence the steady level of the radioactivity it contained.

Question 6

Candidates who were prepared for this unit test found no difficulty in correctly identifying the three taxa to gain the two marks available in part (a). Part (b) involved the application of knowledge and understanding and almost all candidates were able to gain at least one, and in most cases two, of the three available marks. The correct identification of *Fucus serratus* and *Fucus spiralis* as the two species that were most closely related, according to the data presented, gained the credit most commonly achieved. A second mark was gained if the reason for the identification was also given, i.e., that the cross between these two species produced the highest value (percentage of double-stranded DNA) for the mixing of DNA from different species. Sadly, this was often not given or was inadequately expressed, e.g., this cross gives 'a high value' or 'was 94.6%'. It was possible, even then, to gain full credit by explaining the reason in terms of 'the similarity of DNA' as well as for explaining the similarity in terms of complementarity of base sequences. Too often candidates had not been conscious of the need to provide at least three points in their answer, given that three marks were clearly available for this part of the question. Nonetheless, the examiners were impressed that so many candidates found this application question so straightforward.

Question 7

Part (a) of this question examined an area that a fair proportion of candidates did not seem to have studied. A flexible method of marking was adopted that recognised that candidates might concentrate on different aspects of how 'a change in light intensity results in an increase in pupil diameter'. As a result, suitably expressed elements of the necessary stimulus, receptors, nervous transmission and muscular response could all gain credit and it was pleasing to note the thoroughness of answers provided by many candidates. Many of these candidates went on to gain full credit in part (b). In (b)(i), suggesting the relevant effect (prevention/ promotion of) on one or other part of the autonomic nervous system (parasympathetic/ sympathetic) was sufficient to gain the mark, although suggested explanations offering specific detail were most acceptable. In part (b)(ii), no mark was awarded for merely identifying eserine, but explaining its effect on drug transmission in terms of the transmitter, acetylcholine, and cholinesterase, gained the two available marks.

Question 8

This question tested application using a diagram to model the various inputs and outputs to and from the glucose in the blood circulation. Hence, D represented the liver and E tissue respiration. Candidates scored on this question across the full range of marks. The marks gained most frequently were for (b)(i) ('pancreas') and (c)(i) ('glycogen'). It was not unusual for candidates to gain at least one mark from (d), either for adrenaline ('D') or thyroxine ('E'). Part (b)(ii) generally produced 0 or 2 marks, rarely just one. However, it was less common for candidates to achieve (c)(ii) ('fats' or an equivalent term), and far too few candidates achieved part (a) by identifying carbohydrate in food, or from digestion, as the answer. Disappointing wrong answers that were often encountered included 'liver' for (b)(i), and 'starch' or 'startch'(sic) in answer to either part of (c).

Question 9

A very large number of candidates gave only one element of the required answer to part (a) and, therefore, could gain only one of the two marks available. Most candidates correctly gave the relationship between the frequency of the t allele and altitude above around 400 metres, but ignored the fact that the frequency levelled off at altitudes below 400 metres. This lack of precision in describing a simple pattern was surprisingly widespread.

In part (b), candidates were asked to suggest an explanation for the relationship between allele frequency and altitude, using information provided in the question. Correct answers explained that malaria was likely to be prevalent at low altitude since the conditions preferred by the mosquitoes which carry the parasite, warm with sources of still or slow-moving water, tend to be found here. Candidates were not penalised if they did not know that mosquitoes required fresh, rather than salt, water. They could gain further marks by explaining that resistance to malaria was conferred by the t allele and that, as a result, selection would have operated to favour the survival of heterozygotes and so account for the higher frequency of the t allele at low altitude. Many candidates were able to gain at least two marks here. In some cases candidates did not express their ideas logically and, having begun well, omitted mention of any effect of, or on, the t allele. Some failed to mention malaria or mosquitoes in their answers but still gained credit by dealing with the t allele. In certain cases, however, candidates linked the rareness of the t allele, and thus anaemia, with what they supposed would have been a shortage of oxygen at high altitude.

In part (c), it was rare for candidates to score both marks but many gained one. Acceptable answers included the suggestion that the t allele would not have been present in the new population or that malaria had not been a problem on the mainland. Other possibilities included the idea that the village had been established after malaria was no longer a problem on the island or that it had not been

established long enough for selection to alter the frequency of the t allele in its population. Apart from the common mistake in part (a), referred to earlier, many candidates produced thoughtful and considered answers, with a significant number gaining 5 or 6 of the available marks from the whole question.

Section B

Question 10

The first part of the question involved the results of an investigation of aerobic respiration using mitochondria. The respiratory substrate used at first was succinate, with ADP being added at intervals, after which oxygen concentration fell.

In part (a), the majority candidates realised that inorganic phosphate was added so that the ADP might be converted into ATP. Candidates were less secure about part (b), however. A significant proportion wrongly believed that oxygen was used to combine with carbon atoms in the Krebs cycle to produce carbon dioxide. Quite a number thought that oxygen was produced in the process of aerobic respiration, which they confused with photosynthesis. Fully correct answers, explaining the use of oxygen in oxidative phosphorylation and its joining with hydrogen to form water at the end of the electron transport system, were disturbingly rare. Candidates tended to gain more success in the next two parts, even where they had been confused in (b), since recognising that the same amount of ADP was added in (c) and realising that oxygen was limiting at Z when compared with Y in (d), were credit-worthy answers.

Part (e) proved challenging. Only a minority came up with creditable responses to part (e)(i), although a wide range of possible approaches was credited. Candidates frequently mentioned that glucose would not be able to enter the Krebs cycle because it would first need to be broken down into pyruvate and that the necessary glycolytic enzymes would not have been available in the medium. A typical correct answer to part (e)(ii) was to 'add cytoplasm so that the enzymes would be present, and the oxygen concentration would then fall'.

In part (f), candidates had to describe and explain how muscle contraction is brought about. In the question stem, the device of invoking the possible effect of adding ATP to a muscle was used to focus candidates' answers on the actual contraction of muscle, rather than on its innervation. This seemed generally to succeed and many candidates gave good accounts of the structure of muscle, the sliding filament theory and ratchet mechanism. The roles of ATP, calcium ions, and tropomyosin frequently figured. The answers of some candidates who seemed to have been taught beyond the specification about the role of troponin showed confusion. Many candidates were able to score the full six marks available for this question.

Question 11

This question involved epistasis and was based on the effect of two different enzymes in a biochemical pathway determining flower colour. Those candidates who were confident about genetics found little difficulty in gaining all 15 available marks in this question. In some cases, however, candidates answered in terms of monohybrid inheritance, even though two separate genes were clearly implicated. Some candidates gave answers in terms of multiple alleles, or even sex linkage, in which it appeared that they had confused the concepts of allele and gene.

In part (a), candidates could receive full credit by using a number of different approaches to explain how the two genes were involved in producing differently coloured flowers. Some candidates

concentrated purely on the alleles and their effect on the two enzymes and the pigments produced, whereas others tackled the question only in terms of the flower colour produced by different genotypes. To gain all six marks available it was necessary for candidates to explain aspects of both.

In part (b)(i), the parents were Aabb (red-flowered) and aaBB (white-flowered). Good answers to part (b)(ii) showed the purple-flowered offspring as AaBb, and proceeded to derive the offspring 2 ratio of 9:3:4, purple: red: white, showing appropriate working. Examiners were surprised and pleased to find that it was not impossible for candidates who had achieved no marks in (b)(i), having offered answers that were totally wrong, to recover and gain full credit in (b)(ii).

In part (c)(i), three different genotypes, aaBB, aaBb, and aabb, were required for the single mark. A proportion of candidates failed to score because they omitted one of these. In part (c)(ii), candidates gained credit by suggesting the addition of the red pigment, K, to extracts of each homozygous type of white petal, going on to achieve full marks for explaining that the extract of the aaBB petal would contain enzyme 2 and that this would catalyse the conversion of K to L, turning the extract purple. In contrast, the other white petal from the aabb flowers would remain red after K had been added. The most commonly encountered wrong approach was for the petals somehow to be 'crossed'.

Genetics questions, as a rule at this level, tend to produce extremes of either very low or very high marks, depending on candidates' understanding of the topic. This question, in requiring quite different skills in its three main parts, proved an exception to this, with many intermediate scores being achieved as well. Where candidates understood the concept of dihybrid inheritance and associated enzymes, answers were very good indeed and showed an improvement in the general standard seen at Advanced level in recent years.

Mark Ranges and Award of Grades

Unit/Component	Maximum Mark (Raw)	Maximum Mark (Scaled)	Mean Mark (Scaled)	Standard Deviation (Scaled)
BYB1 Core Principles	66	66	34.1	10.8
BYB2 Genes and Genetic Engineering	66	66	28.3	9.7
BYB3/W Physiology and Transport	66	50	35.0	10.1
BYB3/C Coursework	30	30	19.2	4.4
BYB4 Energy, Control and Continuity	81	90	42.9	14.1

BYB1 Core Principles (11281 candidates)

Grade	Max. Mark	A	B	C	D	E
Scaled Boundary Mark	66	45	40	35	30	26
Uniform Boundary Mark	90	72	63	54	45	36

BYB2 Genes and Genetic Engineering (2673 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	66	39	34	29	24	20
Uniform Boundary Mark	90	72	63	54	43	36

BYB3 Physiology and Transport/Coursework (1963 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	80	58	51	44	38	32
Uniform Boundary Mark	120	96	84	72	60	48

BYB4 Energy, Control and Continuity (7357 candidates)

Grade	Max. mark	A	B	C	D	E
Scaled Boundary Mark	81	55	47	40	33	26
Uniform Boundary Mark	90	72	63	54	45	36

Advanced Subsidiary award

Provisional statistics for the award (910 candidates)

	A	B	C	D	E
Cumulative %	10.5	27.1	50.6	72.8	90.2

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.