A-LEVEL
BIOLOGY

7402/3
Report on the Examination

7402
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General Comments

This paper is synoptic, requiring knowledge from all sections of the specification. Obviously, not every part of every section can be included in one two-hour paper, though the open-ended nature of the essay titles does greatly extend the specification coverage of the paper.

The paper produced a range of marks from 0 to 75 (out of 78), and correct responses were seen to all parts of all questions. Almost all of the marks for factual recall in this paper are in the essay. This means that almost all the remaining questions tested Assessment Objectives 2 and 3, which made them quite challenging for many students. This was most evident in questions relating to new specification content and to practical skills. Questions testing the new mathematical requirements were done rather better than expected after last year's AS performance. Very many students expressed statistical concepts badly, or wrongly. References are made in this report to question parts that discriminated well (or not). These observations are based on discrimination indices calculated from data obtained from the online marking system. These indicate which questions were answered best by students who did best on the paper as a whole.

There were several questions in which some students failed to obey the command word, or to use information or data provided in questions, even when told to do so. It appeared that they frequently failed to read the stems of questions carefully enough, even when words were emboldened. For example, the stem above Figure 3 stated that standard deviations were **not** shown on the graph, yet some students still wrote about standard deviations not overlapping in their answers. Some students attempted rote-learnt answers to questions requiring application of knowledge; for example, question 01.2.

Examiners often commented on poor handwriting; some students appeared to have used a colour of ink that produced very faint script on the online marking system. Examiners can only mark what they can read. If a student has handwriting that is perceived to be a bit difficult to read on paper, it will be even harder to read in a scanned, online form.

Question 1

01.1 This was a factual recall question that discriminated well. Examiners expected students to use appropriate A-level terminology, including references to calcium ions, channel proteins and the (facilitated) diffusion of calcium ions in through the (presynaptic) membrane. Weak answers included statements about calcium crossing the membrane.

01.2 This question required application of knowledge of how myosin and actin interact. Many students treated it as a factual recall question, not infrequently referring to shortening of the sarcomere. The best answers (about 12% of students) scored both marks by focusing on the information given and noted that, in this circumstance, myosin moves past actin and pulls the mitochondrion along.

01.3 Around half of the students obtained one mark for noting that mitochondria produce ATP. Just over 40% got a second mark, usually for relating the use of ATP to some aspect of recycling of neurotransmitter, or the active transport of an appropriate ion. Some students failed to score the point relating to ATP because of references to 'the production of energy', rather than 'the supply of energy'.

Question 2

02.1 Approximately two-thirds of students correctly identified the third statement as the only correct one.

02.2 About 30% of students scored both marks for the calculation and 6% obtained one mark for determining the lengths of the virus and bacterium. The main problem for those who did not score appeared to be an inability to convert between one unit of length and another (mm, µm and nm).

02.3 Many students struggled to express themselves clearly in this question. Some gave an experimental hypothesis and others gave rather vague statements about bacteriophages having no effect. Examiners were looking for a clear statement relating to this context, something along the lines of 'The bacteriophage makes no difference to the number of (live pathogenic) bacteria in treated and untreated mice.'

02.4 / 02.5 These questions showed that few students seemed to have any real understanding of logarithmic scales. It was intended that students would answer these questions by inspection of the graph in Figure 3, not by calculating actual numbers from the log values. (However, credit was given when any student used correctly calculated values.) It was hoped that students would recognise that the log scale gave numbers of bacteria per cm^3 which differed by orders of magnitude. In question 02.4, about 20% of students stated that there would be too many bacteria to count in some samples without dilution **and** few enough in other samples to count without dilution. Very few students used the evidence of the logarithmic scale on the graph to support this. Many students suggested that the range of numbers for **B** was greater than for **A**, and that is why dilutions were needed. These answers ignored the log scale and suggested students just looked at the length of the range bars; obviously, the range of **A** is numerically much greater than **B**. Some students treated the numbers on the y-axis as simple numbers and wrote about the mean of **A** being (about) 8 bacteria per cm^3.
In question 02.5, the misunderstanding of some students about the range bar for **B** ended up helping them. These students often gained the mark for noting a big range of effect of the bacteriophage in individual mice. Many students obtained a mark for noting that the bacteriophage did reduce the number of bacteria. Quite a few also obtained a mark for noting that the ranges of **A** and **B** do not overlap. It was here that a significant minority wrote about SDs not overlapping, even though the stem above the graph clearly states that SDs are **not** shown.

Question 3

03.1 Just over half of students scored both marks. Those who failed to score one or both marks usually gave one or two inorganic ions containing nitrogen as answers. It may be that the references to nitrates and nitrogen in the stem of the question caused some students to think about the nitrogen cycle, rather than biological molecules.

03.2 About 30% of students calculated a difference within the accepted range (depending on where, exactly, they placed the points on the graph).

03.3 This appeared to be an example of where students failed to appreciate the relevance of all the information in the stem of the question. Very many students appeared to interpret the data as what happens if crops are given different concentrations of fertiliser in experiments performed at the same time, rather than changes in response to fertiliser over time. This produced statements along the lines that "more fertiliser produces less crops". It is worth noting that the data include the *fertiliser response ratio*. Historically, students have always tended to perform poorly on any question involving ratios.

Question 4

04.1 Students had more success with this calculation than with the previous two in the paper; possibly this was because they had practised inserting numbers into this equation. It was pleasing to see that 58% of students knew what N and n represent, and could insert their values into the equation and get a correct answer. Another 20% obtained one mark for correctly calculating either the top or bottom number in the equation (but getting the wrong final answer). The commonest error was thinking that N = number of species.

04.2 This question discriminated quite well, even though it involved a well-known method. The commonest error was to count the number (or percentage cover) of each species, when only the number of species is required. If a student wrote about counting the number of species and the number of individuals, they did not get the mark because the examiner had no way of knowing whether or not they understood the difference between the data required to calculate species richness and index of diversity.

04.3 This question discriminated very well, even though 46% of students scored zero. Answers suggested that few students really understand P values, or the nature and purpose of statistical tests. They showed how many think statistical tests demonstrate whether or not results, i.e. the data collected, are significant, or accurate, or reliable. Quite a few followed statements, about the data being due to chance, with observations that this showed the method was incorrect, that the scientists made errors, or that not enough data were collected. The data in Table 2 came from a study published in a peer-reviewed scientific journal. Unless given specific information in a question that indicates otherwise, students should assume that data have been collected, processed and presented correctly. The results of the statistical test in this example indicate whether or not the **difference between** two means is significant or not. It was heartening to find a few students who noted that a t-test might have been used to obtain P; though this was not required to answer the question. Some students got the meanings of ≤ and ≥ the wrong way around. This might explain why quite a few thought that only the change in diversity for Islay was significant. Some students tried to compare 0.001 with 0.05. Many noted that there was a significant change in species richness on all three, but failed to note that there were increases on two islands and a reduction on the other.

Question 5

05.1 It was pleasing to see that nearly all students could name two enzymes involved in DNA replication; 92% got both marks.

05.2 This question discriminated well. 40% of students obtained one mark, usually by noting that phosphorylation of the enzyme caused the active site to be formed, or to become complementary to the substrate. About 38% of students obtained two marks, usually by also noting that phosphorylation changed the tertiary structure of the enzyme (which caused the change to the active site). Some students' terminology was poor and confused, and some referred, wrongly, to phosphate as a competitive, or non-competitive inhibitor. Some failed to mention the active site at all, even though the question asks why enzymes become able to bind to their substrates.

05.3 About 50% of students obtained the mark, by reference to the substrate becoming more reactive, or phosphorylation (of the substrate) lowering the activation energy for the reaction. Quite a few made vague references to kinetic energy changes that were not credited. Some wrongly continued to focus on phosphorylation of the enzyme.

05.4 This was well done by many, with 47% obtaining 3 marks, but still discriminated quite well. Most students appeared to be able to follow the story in the stem of the question and apply some basic principles, such as the mutation leading to a form of ATM unable to bind to broken DNA. Only 3% of students failed to score.

Question 6

06.1 57% of students could do the calculation and obtained both marks. Some wrongly used the diameter of the capillary tube, rather than the radius. Others neglected to multiply by 4 in order to get the rate per hour. In either case, they could obtain one mark.

06.2 This question discriminated well, but only 2.3% of students got all three marks. Many correctly suggested using graph paper to find the surface area of one side of a leaf, but then failed to multiply by 2 in order to get the total surface area. Some students described how they would find the rate of water loss using the potometer and didn't get as far as the leaves. Others described methods not using a potometer to find the rate of water loss. Some wrongly used mass/volume of water lost, rather than rate of water loss.

06.3 This was intended to be a relatively simple exercise in evaluating the method used. Only 17% of students noted that the shoot in the potometer has no roots, which is where water normally enters a plant.

06.4 56% of students obtained one mark by looking at Figure 6 and suggesting the molecules had either similar sizes, or similar shapes. Only 22% suggested both for two marks. There were many references to polarity (either polar or non-polar), but these were not credited. Some suggested that both contained oxygen, as seen in Figure 6, and this would bind to the aquaporin. This was given credit.

06.5 Many students did not grasp the link between the ssRNA, coded for by the foreign gene, and blocking of translation by interference with mRNA. The question still discriminated reasonably well, but 63% of students scored zero. The observed outcome may also be due to this part of the specification not being as familiar to students as more traditional topics.

06.6 Given the failure of many to comprehend what was required in 06.5, it was not surprising that only 28% of students obtained the mark in 06.6. Many were awarded a mark for suggesting that not all cells of the plant had been transformed by the foreign gene.

06.7 Students performed better on this part. 18% obtained all three marks and only 10% failed to score. The question discriminated well. This evaluation proved safer ground for most, especially since SDs are actually shown in Figure 7. The frequency with which the mark points were awarded coincided with their order on the mark scheme.

Question 7

The essay is a synoptic exercise. Students are expected to bring to bear factual recall of different parts of the specification, and use what they know to illustrate and explain an important theme in the title of the essay. The essay is (approximately) half AO1, factual recall with understanding, and half AO2, application of knowledge. It is the use of what they know to address the theme of the essay title that constitutes the AO2 component.

The essay was marked using a *levels* mark scheme. The statements in each level were based on the *descriptors* used for marking the essay in the previous specification. This suggests that the outcomes for the essay should be similar to those in the previous specification. In the event, the mean mark this year was up slightly on last year's BIOL5 mean, and the standard deviation was also up. As in the previous specification, the essay discriminated well. It should be noted that significant errors and irrelevant passages have significant impacts with regard to the level to which any essay can be assigned. The quality of handwriting, spelling and grammar is not as important as the scientific content of the essay and the use of appropriate terminology. An introduction and a conclusion are not required. We appreciate that students are writing this piece of prose in a limited time and under exam conditions.

Relatively few students included material from beyond the specification (at A-level standard). This was a little surprising since A-level textbooks use many examples, that were in the previous specification, to illustrate important concepts.

Most students attempted question 07.2, 'The importance of diffusion in organisms'. The impression of some examiners was that many of the better essays were written about the other title, 07.1, 'The importance of nitrogen-containing substances in biological systems'.

Common topic areas for 'diffusion' included all of those listed in the mark scheme. The vast majority of students did appreciate the need to write about a number of topic areas. A few wrote at great length about one or two topic areas, frequently gas exchange. This approach is not synoptic in the context of this exercise. The levels scheme defines such essays as *unistructural* and limits them to a mark within the range 6 to 10 (as a maximum). Quite a large number of students wrote essays that were largely at GCSE level and did not score well. Some of the more commonly seen errors related to descriptions of active transport as diffusion, ventilation of the lungs as diffusion and ultrafiltration in the kidneys as depending on diffusion. If written about at length (several lines), these would also constitute irrelevant passages. It was not uncommon to see answers from students who had written about respiration, photosynthesis or transpiration at length, but with no real reference to the role of diffusion in the process.

To obtain more than 15 marks, a student had to discuss the *importance* of the process involving diffusion. Many students just wrote what they knew about processes involving diffusion. The attempts at explaining importance generally ranged from GCSE level upwards. To give an example from one topic area, many wrote about gas exchange in the lungs and then simply said that people would die if they didn't breathe. At the other end of the spectrum, there were students who gave the importance of gas exchange in the lungs in terms of the requirement for oxygen as the terminal electron acceptor in oxidative phosphorylation, which is the major source of ATP that supplies energy for all vital functions. In essence, to obtain good credit the factual content and the explanation of importance had to be at A-level standard.

Common topic areas for 'nitrogen' included the nitrogen cycle, proteins, enzymes, nucleic acids, ATP, DNA replication, protein synthesis, peptide hormones, haemoglobin, photosynthesis and respiration, and muscle contraction. The types of comment made with regard to the 'diffusion' essay all apply here. Some students wrote almost entirely (or even entirely) about one topic, often the nitrogen cycle, and scored poorly. Others identified processes such as respiration and photosynthesis as depending on nitrogen-containing molecules, but didn't identify what they are, or what their specific roles are; they just wrote everything they could remember about the process. Better attempts identified NADP and NAD (and FAD) as nitrogen-containing coenzymes and gave their roles. Others wrote about ATP synthase as a nitrogen-containing protein in chemiosmosis. It was surprising how many wrote about DNA replication, transcription and translation, without making a major point of the importance of complementary base pairing between nitrogen-containing bases. As with the other title, it was the links to the importance that were often weak. To give an example from the nitrogen cycle, students often wrote in some (A-level) detail about stages in the production of the inorganic ions. They would then end by saying that nitrates are taken up by plants and this is important; they might go on to say that it was important to make proteins. Relatively few wrote about a number of nitrogen-containing biological molecules that plants are able to make from the products of photosynthesis (and respiration) after taking up these nitrate ions, which is, of course, a main reason why they are important to us as primary producers.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.