A-LEVEL
BIOLOGY

7402/3
Report on the Examination

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General comments

The entry for this paper was 36 437, substantially higher than in the previous two autumn series, and in line with the last full series in summer 2019.

The general standard of responses was better than in the last two autumn series, with the mean having increased from 30.42 in autumn 2021, to 33.92. The standard deviation also increased from 10.62 to 12.48. The range of overall marks scored was from 0 to 72. Fully correct responses were seen in all parts of all questions.

Given the structure of this paper, most of the marks for AO1 factual recall are in the essay. The remaining questions test the use of skills and knowledge in the contexts of AO2 and AO3. These proved challenging for many students, especially for AO2 this year, with students seemingly misinterpreting questions, and not being able to figure out which part of their specification knowledge they needed to apply.

AO3 knowledge in the context of practical work was better, particularly with question 3. This may be due to this being easily recognisable as one of the 12 required practical activities.

There were issues with students addressing command words correctly; for example 'suggest and explain' or 'explain' questions sometimes yielded only descriptions. Some commands were simply ignored: for example, in **03.5** 'Apart from student errors, suggest **two** explanations why' yielded many descriptions of student errors.

In questions where students were asked to comment on data, rote-learned responses such as 'small sample size' and 'no stats test' were evident, with no consideration of whether these would apply to the question.

Maths skills seemed to be lacking, with a lack of correct rounding causing many students to fail to gain marks. An understanding of how to correctly use the terms probability, chance and significant was generally not seen.

Several questions discriminated well. In this report, references to how well a given question discriminated are based on numerical discrimination indices calculated from marking data, not the opinions of the examiners. The discrimination index is a measure of correlation and indicates the extent to which an item discriminates between high-attaining and low-attaining students.

Comments on Individual Questions

Question 1

With **01.1**, 70% of students were able to correctly identify the three amino acids. The unfortunate inclusion of an extra carbon atom between the first and second amino acids did not prevent the vast majority from scoring well (well over 80% scored at least 1 mark). No students were disadvantaged in any way due to this typographical error. There was some evidence of students reading the amino acids from right to left despite the answer lines stating left, middle and right amino acids. There was also evidence of students not knowing what an R group is.

01.2, that asked for basic knowledge of four biological molecules, was answered poorly, with only 13% scoring all 3 marks, and 30.5% scoring 0 marks. The first row was mostly answered correctly,

but rows 2 and 3 proved harder. Aside from the essay, this question had the highest discrimination index on the paper.

Just under half of students scored both marks on **01.3**. Students who scored 1 mark mostly failed to notice that there are 2 alpha and 2 beta chains.

01.4 showed that most students are familiar with oxygen dissociation curves, and were able to attempt to draw the curve. 44% drew the curve successfully. Those who didn't mostly failed to appreciate that a reduced affinity does not equate with a reduced maximum saturation and produced a curve at higher partial pressures of oxygen with a lower percentage saturation than that for 'normal conditions.'

01.5 discriminated well, with the mark range being roughly split equally. There were many cases where students did not suggest when it would be an advantage to a human for BPG to bind to haemoglobin. Other responses simply repeated the stem by stating 'BPG reduces the affinity of haemoglobin for oxygen' for their explanation. Students also failed to use a comparative word, such as 'more' or 'easier' and just stated that haemoglobin can easily unload oxygen, which it can also do without BPG.

Question 2

02.1 represents the first time that the structure of a Pacinian corpuscle has been assessed. 21% of students were able to correctly name the three structures, with a further 47% being able to name two of the structures. P was often incorrectly named as 'stretch-mediated sodium ion channel.' Q was often just named as a nerve, which is insufficient detail for A-level. R was incorrectly named as a node of Ranvier.

The answer to **02.2** was correctly calculated by 44% of students; of the remaining 56%, most did not know how to calculate percentage uncertainty.

02.3 proved harder than expected for students. Only 42% were able to suggest an explanation. Incorrect responses mentioned eyes being open or the ruler being caught before it was dropped (not true, as it did move). Surprisingly, there were many responses referring to student B not starting or stopping the stop clock accurately, however no stop clock was involved in the students' investigation. Most correct responses were based around marking point (MP) 1.

02.4 was correctly answered for 2 marks by only 16% of students. Many students did not seem to know that speed equals distance divided by time, and students struggled to convert units from milliseconds to seconds.

02.5 proved very difficult for students, with only 0.2% scoring all 3 marks, and 2% scoring 2 marks. Students seemed to repeat answers given for **02.3**. There were many responses that stated the length of the nerve pathway was underestimated; however, to get a speed of 76.2 m s^{-1}, the student's nerve pathway would have to be 10.36 m long to glean a reaction time of 136 ms. There were many answers that failed to consider the context of the question, and put 'low temperature', 'small axon diameter' and 'less myelination.' There was also confusion with reaction time in ms and speed of impulse transmission in m s^{-1}, with lots of responses discussing a faster reaction speed and the effects of caffeine.

Question 3

Question 3 was generally well answered. It was evident that many students were familiar with the practical procedure required to produce a root tip squash and the rationale for each practical step in the procedure.

Just over 65% of students were able to gain a mark with **03.1**, and some detailed responses that described the breakdown of the 'middle lamella' and 'pectin bonds' were seen. Incorrect responses were based around ideas students had about what acid does, for example 'to kill bacteria, so cells can be easily seen.' Some responses discussed the acid dissolving all membranes, discussed denaturing enzymes but did not qualify this, or gave responses required for **03.2**.

03.2 itself was well answered, with 56% scoring both marks. Incorrect responses centred around removing bubbles or artefacts, or making cells themselves thin or squashing organelles.

03.3 was the most accessible question on the paper, with 75.8% scoring both marks. Those who failed to score 2 marks either got the stage of mitosis incorrect by stating metaphase, or just stated that the centromere splits.

With **03.4**, 41% of students scored the mark. The majority who failed to do so converted their index into a percentage.

With **03.5**, roughly half of students were able to score 1 mark. The main reason they failed to score 2 marks was a lack of understanding that a mitotic index is a proportion, and therefore having more or fewer cells in the field of view would not be a factor affecting the proportion of those cells in mitosis. Despite being told 'Apart from student errors, suggest **two** explanations why', many responses included student error. Students were also told 'Other students in the class followed the same method…' however, there were several responses that stated students used a different method.

Question 4

04.1 discriminated well, and 41% of students provided two correct definitions. Those who failed to get the definition of genome correct often confused it with the definition of genotype, and mentioned all the genes in a species or population. Proteome was harder for students to define, and there was confusion with the definition of phenotype, and a lack of qualification, i.e. students failing to state 'can produce' or 'can code for.'

04.2 also discriminated well, but only 13.5% scored both marks, and 55% score 0 marks. There was a lot of discussion of 'sticky ends', plasmids, restriction enzymes and reverse transcriptase in responses that failed to score. There were many vague, unqualified responses, for example 'DNA is universal', and also many students who disqualified themselves from MP1 by stating 'The genetic code is universal because is it degenerate.'

Students found **04.3** difficult, with only 10% able to score a mark. Many students incorrectly thought that bacteria only have uracil, and not thymine, that bacteria do not have the amino acids required to make a protein, that the human gene would be too long or too big (bacteria can make the largest human protein titin), and that bacteria would not be able to make haemoglobin as they lack prosthetic groups (haemoglobins are widespread in bacteria). Those students who came close to scoring the mark often suggested or explained, but did not do both; for example, just stated that 'bacteria cannot splice' or 'bacteria to not have introns.'

04.4 discriminated well, and 40% scored both marks. Those who failed suggested that regions M and N are start and stop codons, introns and exons, and VNTRs was also suggested for both. More than 5% of students did not even attempt this question.

04.5 was correctly answered by 43.5% of students. Those who failed to score gave vague responses, for example 'to see the gene.'

With **04.6**, only 6% of students scored both marks. There were students who did not understand what the question was asking, seemingly having ignored the first sentence. They confused the enhancer for a promoter. There were many repeats/paraphrases of the stem, i.e. 'so only produced in milk.' Some students thought the only way to extract a product from a goat, if not in the milk, is to kill it, and a large number of students thought if the protein was produced in the milk, goats could pass it on to their offspring. This question had the highest number of non-attempts at nearly 8%.

Question 5

With **05.1**, a third of students were able to score all 3 marks. Those who failed to score full marks either failed to convert their answer into standard form, or failed to multiply by either 95 (the number of minutes between 11.40 and 13.15) or 60 (to convert seconds into minutes). Those who failed to score any marks mostly read incorrectly from the graph.

05.2 discriminated well; however, only 22.75% of students scored 2 marks. $P > 0.5$ seemed to cause a lot of confusion with $P > 0.05$ or 5%. The students who scored 1 mark often only referred to 'the results' rather than the 'difference in results.' Those who failed to score mostly did so for not knowing the symbol > meant 'more than' and read it as 'less than', failed to use the words probability and chance as instructed, or provided very confused language. For example, 'there is not a greater than 95% probability that the results are not due to chance.'

05.3 also discriminated well, but students found it hard to score higher marks, with only 1.68% scoring all 4 marks, and 4.89% scoring 3 marks. There were many cases of students only describing the results, or not explaining the result in Figure 8, i.e. not explaining the low carbon dioxide uptake, and focusing their answer solely on photoionisation. There were also many cases where students failed to gain a mark for using the abbreviation 'TP' for triose phosphate, which is not an abbreviation recognised in the specification. Some students failed to score MP1 for only stating either less ATP or less reduced NADP, but not both. Students also failed to score MP1 if they stated no ATP and reduced NADP was produced, but since the graph shows carbon dioxide is taken up, this would not be true.

With **05.4**, the majority of students (60%) were able to score 1 mark for correctly substituting values into the equation. However, students struggled more with stating the correct units, with only 23% scoring both marks. These students understood that dry mass needed to be expressed as mass, per unit area, per unit time. There were some interesting rearrangements of these units, including those that didn't start with kg for what is essentially a measurement of mass.

05.5 did clue students into how to address their responses by stating 'Suggest how this benefits slow-growing, shade-tolerant plants.' However, many responses focused on them not being eaten and therefore surviving, so just repeating the first line of the stem, rather than addressing the slow-growing and shade-tolerant aspects. Many answers centred around herbivores likely being in the shade, or herbivores having easy access to the plants as they will be low down. Herbivores were

also often referred to as 'predators' of the plants. As a result, only 3.5% scored 2 marks, and 74.5% scored 0 marks.

With **05.6**, 16% of students scored both marks, and mostly scored MP3 and MP5. A further 45% scored 1 mark, mostly for MP3. There were many students who gave all three alternatives for MP3 as their answer. Students who failed to score often read the phylogenetic tree the wrong way round, so had ferns as the most recently evolved species. As the question asked students to justify whether data supported a summary, there were rote-learned answers evident such as 'no stats test,' 'we can't tell,' and 'no sample size stated.' Other responses that were stated, but did not score were 'don't know how old the plants are,' and 'don't know how many species there are.'

Question 6

As always, the essay discriminated well. The mean score on the essay was 12.78 marks, this is down slightly from the 2021 autumn series when the mean was 13.16 marks. AO1 was frequently good, but AO2 was largely fairly superficial, as seen by the modal score being 15 marks and 68% of students failing to score higher than this. Material beyond the specification was rarely seen, or at the correct depth to score the highest marks. Some students included some good material from beyond the specification; however, because the rest of the essay was not of a sufficient standard for it to be in the 'extended abstract' level, it could not qualify for the highest marks. Only 0.05% of students scored 25, with a further 0.18% scoring 24 marks. There were many cases where introductions and conclusions had been added. These did not score any marks, are not necessary, and could potentially take up time that students could be using to score marks. This year, there was a much more even split between the number of students choosing each essay title.

With **06.1**, there were some excellent descriptions of the 2nd messenger model and the use of ATP. The use of ATP in co-transport, mass transport in plants, the resting potential and the loop of Henle were also described to the correct depth. Whilst descriptions of the use of ATP in photosynthesis and respiration were generally good, students did not seem to take note that the essay title was the use of ATP, and not how ATP is made. As such, these two specification areas were often supplemented with lengthy (i.e. 1-2 page) descriptions of how ATP is made in the light-dependent reactions, Krebs cycle and oxidative phosphorylation, and therefore were marked as irrelevant. Areas that were less well described included the use of ATP in muscle contraction and general active transport, many students incorrectly discussed the use of channel proteins in active transport. There was evidence of students thinking every reaction is either a condensation or hydrolysis reaction, for example in photosynthesis 'water is hydrolysed.' There were also many cases of very lengthy descriptions of a process, for example protein synthesis, and the only qualification was at the end of their paragraph, where students stated, 'and ATP is needed for this.' There was also a tendency for students to try to address the theme of the essay, i.e. 'the importance of,' by describing another part of the specification they knew about in detail. For example, with protein synthesis, they described the process correctly and the use of ATP within it, but for the importance suggested that without protein synthesis, haemoglobin could not be made, and then outlined in detail how haemoglobin associates and dissociates with oxygen and the importance of oxygen as the terminal electron acceptor. At no point was this linked to the importance of ATP.

With **06.2**, there were a number of excellent descriptions of the Calvin Cycle, the nitrogen cycle, PCR, and negative feedback in either the context of the control of blood glucose or blood water potential. Areas of variable quality included the Krebs cycle, synaptic transmission, the cell cycle, and the cardiac cycle. With the latter, students often failed to mention contraction of the atria or ventricles increases blood pressure, linking pressure change only to the filling of the chambers with

blood. There were occasions where students outlined the whole of photosynthesis or respiration, and not just the cyclic elements of both, and therefore included irrelevant material. There was some confusion with regards to how hexose sugars are made as a result of the Calvin cycle. Interphase was often stated as being part of mitosis. This was not given as a significant error, however students should know that it is a stage of the cell cycle and not a stage of mitosis. There was a number of students who failed to actually make the topic areas they were discussing into a cycle, for example not outlining how ribulose bisphosphate is regenerated to complete the cycle. There was evidence of students thinking certain cycles not detailed on the specification would count as material beyond it, however, these were not at the correct depth. For example, the menstrual cycle and the carbon cycle being outlined at GCSE level at best, and the water cycle being outlined at key stage 2 geography depth. This essay rarely had 'the importance of' addressed at A-level depth, with many AO2 responses solely given as 'without respiration we would die,' 'without muscle contraction we couldn't run away from predators,' and 'glucose is needed for respiration.'

Mark Ranges and Award of Grades

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