A-LEVEL
BIOLOGY

7402/3
Report on the Examination

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General Comments

The paper produced a range of marks from 0 to 69 (out of 78), which is a few marks lower than on the 2017 exam. Correct responses were seen in all parts of all questions. Almost all the marks for factual recall in this paper 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. This was most evident in questions relating to new specification content, practical skills and, especially, the content of the first year of study (Sections 1 to 4). The essay also requires application of knowledge; about half of the 25 marks assess AO2. Good essays demonstrated this primarily in discussing 'importance' at A-level standard. Many students' essays were confined to factual recall (AO1), which limited the mark they could be awarded.

There were several questions in which many students failed to obey the command word, or 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. This often led to poor responses to questions requiring application of knowledge or following a logical line of reasoning based on information provided. Some students appeared to focus on certain key words or phrases and attempted rote-learnt answers to questions requiring application. In answers to several questions, significant numbers of students simply re-stated parts of the stem of questions, or information in diagrams, tables and graphs.

Questions testing the mathematical requirements 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.

As in previous years, examiners often commented on the poor handwriting of many students. 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 harder to read in a scanned, online form.

The paper this year deliberately gave students more room for their answers. This was an attempt to reduce the number of students resorting to additional pages and did achieve this aim. It did, however, make the exam paper physically longer in terms of number of pages.

Question 1

It was hoped that part 01.1 would be a relatively accessible start to the paper but this did not prove to be the case. However, it discriminated quite well. To address this question, students required understanding that positive feedback is something producing a **greater** deviation from the normal state. They were told that positive feedback was involved and then needed to apply knowledge of the principle to this context. Good answers were seen from a minority (13%) of students who gained both marks by stating that osteocalcin causes **more** insulin and this leads to **more** osteocalcin. About 30% gained one mark by giving half the story; for example, insulin leads to more osteocalcin. Many wrote about insulin or osteocalcin stimulating the production of the other but that re-states what is in the diagram, with no idea of 'more'. Many also wrote about one leading to 'further' production but that could be at the same rate. Others rather over-complicated the situation and wrote about β cells, osteoblasts or osteoclasts being stimulated to divide. A few gave rote-learnt answers consisting of definitions of positive feedback but with no reference to Figure 1, or to osteocalcin and insulin. These answers were not credited. In all, 55% of students failed to score.

In question 01.2, 28% of students gained both marks by stating that the acidic pH would change ionic or hydrogen bonds in osteocalcin and this would change its tertiary structure. Nearly 40% obtained one mark for noting only the change to the tertiary structure. Many of the 32% who failed to score used terminology below A-level standard and only made vague statements about the acid changing the shape of the protein. Many wrote about changes to the 'active site' of the protein and did not score. Many students appear to think that all proteins are enzymes and all have active sites. They were told in the stem of the question that osteocalcin is a hormone. As such, it acts as a chemical messenger that binds specifically onto receptors of target cells; in this case β cells. Osteocalcin has a **binding site** (or even sites), not an active site, it is not a catalyst and it doesn't have a substrate. The same misconception was evident in some later questions. The question discriminated well.

Question 01.3 was based upon the specification content that requires understanding of "The action of insulin by controlling the uptake of glucose by regulating the inclusion of channel proteins in the surface membranes of target cells". The specification does not give specific examples of target cells. In Fig. 1, students were shown that osteoblasts are target cells for insulin. In the event, 19% of students obtained both marks by stating that more glucose (for respiration) enters osteoblasts because more channel proteins join the surface membrane. About 20% obtained one mark, for suggesting there would be an increase in the uptake of glucose. These students did not mention more channel proteins joining the membrane. Many thought that insulin opens (existing) channels and others made no reference to channels at all. The nearly 60% who failed to score often gave accounts of control of blood glucose concentration. Others wrote about the conversion of glucose into glycogen, which would reduce glucose for respiration. The question discriminated well.

Question 2

Question 02.1 related to Figure 2, a scatter graph. 41% of students correctly suggested some form of correlation coefficient and the reason that some form of correlation between two variables was being considered. The question discriminated well.

Question 02.2 started with an instruction to consider the data in Figure 2. This question tested AO3, the ability to draw conclusions from information and data provided. The data concern the use of Rituximab to treat CLL, a 'real life' context. Many students (57%) obtained one mark, usually for noting that the more CD20 on B cells, the more B cells Rituximab destroys. A further 28% obtained two marks, usually for either noting that in no case are all B cells killed, or that the data do not show the proportion of cancerous and normal B cells killed. Only 5% of students made both points to score three marks. Very few students noted that Rituximab cannot cure CLL. There was a mark available for noting that Rituximab has little effect below 5 arbitrary units of CD20, but few students accurately noted this point in the trend of the data. Many students who failed to score simply described the data, quite often point to point. Others drifted away from these data and speculated on the possible lethal effects of damage to the immune system by Rituximab, meaning that it should not be used. This question was based on a treatment that is used, for a real cancer. Students should assume that doctors and scientists follow proper, ethical scientific and medical procedures and do not set out to kill patients.

In question 02.3, 54% of students calculated the correct difference and expressed it in standard form. One mark was obtained by 6% of students who calculated the correct difference but did not put it into standard form. The question discriminated well.

Question 02.4 discriminated very well. One mark was obtained by 20% of students, usually for either deducing that less CD20 would be produced in people with the *NOTCH1* mutation, or that there would be little for Rituximab to bind to and so few B cells destroyed. 24% of students obtained two marks, usually by making both linked points. Some obtained two marks by noting that the mutation would lead to a change in the tertiary structure of the transcription factor, leading to it not binding to the gene for CD20. Some 14% of students gave the whole story and obtained all three marks. This left 20% who failed to score. Many appeared not to know what a transcription factor is and often wrongly suggested that the mutation would affect the gene for CD20, or the structure of CD20, making it the wrong shape to bind to Rituximab.

Question 3

In question 03.1, it was pleasing to find that 83% of students managed to complete Figure 3 correctly.

In 03.2, only 68% correctly identified crossing over as the process that produced the alleles in the first polar body. This was a little surprising, given how many correctly answered 03.1.

The calculation in 03.3 discriminated well. Two marks were obtained by 30% of students. A further 17% obtained one mark for making some progress with the calculation. This included students who correctly calculated the difference in volume between the nucleus and the polar body, but could not then correctly calculate the number of mitochondria. Others used diameters instead of radii.

Question 03.4 was marred by the number of students who appeared not to have read the stem carefully enough. As in question 2, the information comes from a published scientific paper. The bullet points in the stem state that the nucleus is removed from a donor egg and **this is replaced** by the polar body from a woman affected by mitochondrial disease. Only 3% of students obtained both marks by noting that the egg produced by this process would contain a nucleus from the affected woman and very few faulty mitochondria. Very large numbers of students wrote about how the **nucleus from the donated egg** would not contain the genes to make faulty mitochondria and so this would be a cure. This would mean that the child produced would have the DNA of the donor, not the woman affected by mitochondrial disease. There would be little point in carrying out such a complex procedure to achieve this; a donor egg would suffice. Other students correctly spotted that the egg produced would contain the DNA of the affected woman but, having just calculated the number of mitochondria in a polar body, stated that the polar body contained no faulty mitochondria. This accounted for the 21% of students who obtained one mark. Many students thought that mitochondria are contained within nuclei, or that they are synthesised along with proteins at ribosomes, using mRNA from genes in the nucleus.

Question 03.5 produced an even spread of possible marks. About 40% of students obtained one mark for stating that the faulty mitochondria would produce less ATP. Some 29% obtained a second mark by linking ATP to the energy required for reactions. A few students did recall that ATP is used to phosphorylate substances, to make them more reactive, or helps to lower the activation energy for a reaction. There were pleasingly few references to ‘making energy’. Some students drifted into accounts of how ATP is made in mitochondria, which was more than the question required.

Question 4

In question 04.1, only 11% of students gained both marks. These students wrote about the binding of oxygen leading to a change in the tertiary/quaternary structure of haemoglobin, which then led to the formation/uncovering of a second/another oxygen binding site. Nearly 40% obtained one mark, usually for reference to the change in tertiary/quaternary structure. Many who failed to score wrote about changes in the shape of haemoglobin, making it easier for more oxygen to bind. The first part of this statement contains terminology simpler than expected from A-level students. The second part re-states the stem of the question. Quite a few students only stated that this is due to ‘positive cooperativity’ and failed to score. Some good answers described a change in tertiary structure, leading to the unmasking of a second oxygen binding site and then stated, “This is an example of positive cooperativity.” These answers rather neatly illustrated the point that simply naming a process is not explaining it. The question discriminated well.

For question 04.2 (and 04.3), it was not assumed that students would have used a haemocytometer; in fact, it was hoped they had not. About 11% of students were able to calculate the correct answer and express it in standard form. Some 40% obtained one mark for answers that were not in standard form, ignored the dilution factor, or failed to use the depth of liquid. Use of powers of 10 caused problems for many and quite a few answers had negative powers of 10.

Questions 04.3, 04.4 and 04.5 required students to evaluate methods used by a doctor (AO3), on the basis of information provided. In question 04.3, 46% of students gained one mark, usually for correctly deducing that the method would avoid counting cells twice. The second mark was harder to achieve and only 12% obtained both marks, usually by reference to getting consistent/more accurate results. A few did correctly deduce that the method avoids dealing with counting fractions of cells.

Question 04.4 required students to recall that there are (many) fewer white blood cells than red blood cells. Quite a large number did, but did not link that to this context, where enough white cells would be seen with only 20 times dilution; or too few would be seen with 200 times dilution. Some 35% did make the required link and obtained the mark. Many students tried to associate the dilution factor with the size of white blood cells compared with red cells but this would not affect the number of cells visible for counting, which is the key point.

Students were more successful with 04.5. Nearly two thirds knew that white blood cells have a nucleus (and red cells do not) and would thus be made clearly visible by the stain.

Question 5

Questions 05.1 and 05.2 required students to evaluate methods used by scientists (AO3), on the basis of information provided and their own knowledge. In question 05.1, 38% of students correctly noted that cell membranes have a phospholipid bilayer or are made (mainly) from phospholipid, and then suggested that the detergent would dissolve the phospholipids (in water). Some 30% obtained one mark for the point about phospholipids but then wrote about breaking down the membrane, or even hydrolysing it. Students were expected to use the information given and pick up on the fact that the detergent dissolves lipids (in water). The question discriminated well.

In question 05.2, it was apparent that most students are not familiar with ultracentrifugation as a method for separating molecules. Nearly 60% did obtain one mark, for stating that CENP-W would separate on the basis of its mass/size/density/weight during centrifugation. Only 7% clearly expressed the idea that separating *molecules* requires centrifugation at very high speeds. Many students wrote apparently rote-learnt answers about cell fractionation and separating organelles; many referred to CENP-W as an organelle. There were some really good answers in which students wrote about removing organelles by spinning at low speeds and then separating molecules in the supernatant by spinning at very high speeds.

Question 05.3 produced the best discrimination on the paper. It was pleasing to see that many students had at least some understanding of RNA interference. About 17% of students obtained all three marks. They clearly stated that the siRNA binds to mRNA for CENP-W and this prevents the mRNA from being translated. They then linked this to a reduction in CENP-W and a resulting reduction in tubulin production. About 16% obtained two marks, usually for a reduction in translation and the subsequent reduction in CENP-W and then tubulin. Many of these students wrongly thought that siRNA would prevent transcription, with a lack of mRNA leading to reduced translation. Students who failed to score (37%) were very confused about what siRNA binds to and where. They were often unclear, or wrong, with the contexts for CENP-W and tubulin and the reasons for their reductions. A few students gave apparently rote-learnt accounts of how siRNA works, with no references to CENP-W (or tubulin), and failed to score.

Question 6

On reflection, in question 06.1, it would have been better not to try and 'help' students by splitting the answer space into µg and g^{-1} and just let them answer as they saw fit. In any event, the question discriminated well. Some 22% obtained both marks, 44% one mark and 31% failed to score. All three marking points appeared with roughly equal frequency. Quite a few students seemed to miss the point entirely, writing about µg being used because ammonia is a small molecule.

Question 06.2 proved much more difficult than expected. Many students appeared to have difficulty extracting data from the graph, often apparently mis-reading the scale. 20% of students obtained both marks. Another 13% obtained one mark because they calculated the correct number but made a mistake with the units. The commonest error was to use a solidus to represent 'per'; so, /day instead of day^{-1}. For many years, AQA has followed the convention of using a solidus to separate units from the name of whatever is being presented. In this case, that would mean, "Difference in rate / µg g^{-1} day^{-1}". The question did discriminate reasonably well.

Question 06.3 proved too challenging for most students. They were asked to identify evidence that supported the idea of different communities of bacteria in soils A and B. This would suggest that the bacteria (bacterial populations) in each soil would be those adapted to a certain soil pH. Many misinterpreted the graph at the start and thought that ammonia was being made; thus thinking A+B gave the fastest rate. Others focused almost entirely on how much ammonia was left at the end of 20 days and/or described the lines on the graph. Some 29% did note that the mixture of A and B had the slowest rate of breakdown of ammonia and obtained one mark. Another 15% obtained a further mark by deducing that it must be bacteria from soil B that weren't working well at pH 6.9; or that only bacteria from soil A were working. Only 3% obtained all three marks by linking their deductions to bacteria from soil B having the fastest rate of ammonia breakdown in their own soil condition (pH 4.3).

Question 06.4 discriminated quite well and showed which students were able to use data presented in logarithmic form. The examiners allowed calculations of changes in numbers of copies of mRNA, or calculation of percentage changes. 42% of students obtained both marks. Some 7% of students obtained one mark for calculating one correct change. Some who failed to score used the 'power' numbers as simple numbers; so, for species S they said the fall was 2 and it was the same for species T. One mark was awarded if they gave an answer of 100 times with no further explanation.

Question 06.5 was the worst answered on the paper and 11% did not attempt it. This might indicate that more guidance should have been included in the stem of the question, or it should have been worth only three marks. All four marking points were seen but students often focused on one or two at great length. Since the command word was 'explain', there were only four marking points, for four marks. Few students noted that the population growth could not be determined using the method outlined because at no point were the bacteria counted. The method simply gives an indication of the amount of amoA enzyme produced. About 28% obtained one mark, usually for noting that the number of mRNA molecules produced might well vary from cell to cell. Some 8% obtained two marks, often for the previous point and suggesting that it is not known if there is a link between expression of *amoA* and population/cell growth/division.

Question 06.6 tested knowledge of aseptic technique and its use in the context used in the question. The examiners expected students to suggest methods for sterilising whole bottles before use. Many students wrote about flaming the necks of the bottles, ignoring the inside (and outside). Others made vague references to 'heating the bottles', with no detail about how or to what sort of temperature. The mark scheme gave acceptable examples such as autoclaving, using boiling water and washing in alcohol. 36% of students obtained one mark, usually for suggesting a suitable method for sterilisation. The explanations of the reason for sterilising were usually very weak and did not link directly to this investigation. So, most explanations were restricted to statements about getting rid of contaminants or bacteria. The examiners were looking for ideas relating to the removal of bacteria that might compete with or kill the bacteria being studied, or removal of other bacteria that might produce amoA. Only 4% of students made these sorts of statements.

Question 7

The mean mark for the essay was down slightly compared with last year, at 13.3 compared with 14.1, but this was very similar to the mean marks for the essay in the previous specification. Examiners reported that many students wrote essays that were, essentially, limited to factual recall (with some understanding, so AO1). The accuracy and depth of recall appeared to be better in relation to topic areas from specification sections 5 to 8. Attempts to discuss the biological 'importance' of examples cited was absent in many essays, or restricted to GCSE standard or below. About half of the marks for the essay are for application of knowledge (AO2), which is where discussion of 'importance' is required. If 'importance' is not discussed to a modest A-level standard in (at least) four topics, then the levels mark scheme limits a student's maximum mark to 15; this is still 60% of the marks available.

The levels mark scheme makes references to 'several topics' being covered in order to qualify for the top two levels. The 'commentary' on the levels scheme defines 'several' as at least four topic areas. It was pleasing to see that there were few essays in which students wrote at length about only one or two topic areas, which would have limited them to a maximum of 10 marks. Students might be well advised to write about five (or even six) topic areas, as a form of insurance. The best topic area accounts are what decide the mark awarded.

Attempts to include material beyond the specification were rare. To achieve 24 or 25 marks, the contents of an essay must meet all the criteria for the 21 to 25 (extended abstract) level **and** contain material that is beyond the specification content and at (at least) A-level standard. Quite a few students wrote about material that is not in the specification but in very general terms, such as might be used by any person who had not studied A-level Biology. Where relevant material was included, it often consisted of examples that were required knowledge in the previous specification; for example, the effects of cholera toxin on the lining of the intestine in the essay about control of movement. Many textbooks contain these previously required examples and their use constitutes a perfectly valid approach to novel contexts for the essay.

07.1 The importance of the control of movement in cells and organisms.

More students chose this title. Many showed a reasonable level of factual recall. The range of topic areas written about covered the whole list given in the mark scheme, with 19 of them frequently seen. In the essay, we do not expect all of the detail that might be required in a more focused question in Section A of this paper, or in other papers. We do require detail that relates to the theme of the title, in this case, the *importance* of the control of movement. It was the importance that was often missing. A few examples may be useful to illustrate the problems.

Many students wrote about gas exchange in the lungs, writing about movements in ventilation and movements between the alveolus and blood. In many cases where the factual recall was accurate, the importance of gas exchange was given in terms of "you need oxygen to respire, or you die." A minority of students wrote things such as "oxygen is required as the final electron acceptor in aerobic respiration, which produces most of the ATP we need to stay alive". The latter approach was what examiners consider creditworthy.

Other popular topic areas were nerve impulses and synapses. Many wrote at length about the ion movements involved in an action potential, even discussing the refractory period. In most cases, the importance was given in terms of "nerve impulses are needed so you can react/move/sense things". A few students wrote about the importance of the control of ion movements in terms of the all-or-nothing production of separate nerve impulses, travelling in one direction, with the frequency of impulses carrying information. Many students wrote about synaptic transmission in reasonable detail and gave importance in terms of "this allows nerve impulses to cross and allows us to move/ to react." Some students wrote about how the events at a synapse resulted in the control of unidirectional movement (of information) across the synapse, and/or about how the events controlled the relationship between (discrete) nerve impulses arriving at the synapse and events at the postsynaptic membrane. Some students wrote about the events at the synapse in terms of the roles of summation and inhibitory synapses in control of reactions to stimuli.

Movement in terms of circulation of blood and the control of heart rate were also popular topic areas. In both cases, where factual recall was adequate, the importance was often given in terms of "it's important to get rid of carbon dioxide, which is toxic". Some students wrote about the formation of excess carbonic acid during exercise, its possible impact on blood pH and thus on proteins and their tertiary structures. The situation was much the same with accounts of the control of blood water potential. Many students got very confused about what happens where and how in the kidney. In the event that they did give a reasonably accurate account of how water is reabsorbed, they usually just stated "it is important, so you don't get dehydrated". Some students wrote about the possible impacts on cells and tissues of changes in the water potential of the blood away from the normal value.

Similar issues to those outlined above were found with all the other topic areas. It should be noted that the 'importance of control' could be addressed in terms of events within a process, or the process as a whole. Photosynthesis can be taken as an example. Many students wrote about movements of electrons and protons in the light-dependent reaction and the production of reduced NADP and ATP. They could have written about the importance of the elements that control the ion movements through membranes, or the importance of the products in the light-independent reaction (to reduce GP to triose phosphate). However, the importance of control would have to be discussed explicitly, not just implied by writing a series of factual statements.

07.2 The importance of interactions between cells and between organisms.

Although this title was less frequently chosen than 07.1, examiners reported that they saw more good essays with this title. Perhaps this title made it easier to discuss importance. There was one fairly common problem that examiners identified in essays. The title requires discussion of interactions <u>between</u> cells, not <u>within</u> cells. Some students included one or more paragraphs relating to interactions inside cells, such as respiration, photosynthesis and muscle contraction. Although these may have been factually detailed and correct, they were classed as irrelevant and limited the level an essay could be awarded.

As with the other title, the range of topic areas written about covered the whole list given in the mark scheme, with 17 of them frequently seen. One topic area of particular interest was energy and ecosystems. Many students wrote about food chains and webs but at GCSE level. In the new specification, food chains and webs are only mentioned in the context of energy transfers, related to productivity and production. Very few students attempted this approach.

As with the other title, relatively few students addressed the *importance* of interactions. As an example, the immune system was often chosen as a topic area. Many students demonstrated rather flawed understanding of the roles of the various cell types involved. Where there were reasonable factual accounts of a response to a pathogen, the importance was usually given in terms of "this stops you getting sick". Some students wrote about memory cells and rapid response to future infection by the same pathogen. Surprisingly few made any reference to the importance of vaccinations and vaccination programmes. Students could have addressed importance in terms of the importance of the various cell types in the control/production of an appropriate immune response.

Mass transport in plants was also a popular topic area. Many gave quite good factual accounts of transpiration and/or translocation. The descriptions of importance tended to be in terms of transpiration being important to get water for photosynthesis and translocation getting sugars to cells. Some students did write about the importance of transpiration in terms of replacing water that is inevitably lost by evaporation and diffusion during gas exchange, or in maintaining the water content and potential of leaf cells, or in bringing up (e.g.) nitrate ions from the roots. In translocation, some students noted that root cells cannot photosynthesise and require sugars from the leaves for respiration. Some wrote about the sugars being stored as starch as an energy store for future use, or used to make (e.g.) cell walls during cell division.

Similar issues affected the other topic areas that students wrote about.

Mark Ranges and Award of Grades

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