A-LEVEL
BIOLOGY

7402/1
Report on the Examination

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General Comments

There was distinct evidence that, for this second series of the exam, students had an insecure grasp of material related to specification topics 1 – 4.

There was also evidence throughout the paper of students not using the information provided in the question stems. If a specific figure or table is referenced in a question, the marks will be directly related to it. If *all* information provided within a question should be used in the answer to a sub-question, this will be specified in the stem of that sub-question.

There was much to read and analyse in this paper and there was some evidence of students running out of time. The paper this year deliberately contained more room for students' answers and centres had been notified of this well in advance. Extra answer lines were provided for many questions to try to reduce the issuing of additional pages. Although this appears to have been successful, it was evident that some students felt the need to fill the additional space. This may have contributed to some writing more than was needed early on in the exam and leading to them struggling to finish within the allocated time. The additional lines are provided to aid the students should they need them; it is certainly not expected that they should all be used, and teachers should emphasise that concise answers are often those that focus on the answer and, consequently, most likely to achieve the marks.

Question 1

This question was loosely based on the skills students would have developed when completing required practical activity 2 – "Preparation of stained squashes of cells from plant root tips; set-up and use of an optical microscope to identify the stages of mitosis in these stained squashes and calculation of a mitotic index". Students should have observed cells undergoing mitosis surrounded by many cells that were not and, therefore, should have considered why they looked different.

Many incomplete answers were seen to question 01.1. Students were required to give evidence **and** to explain that piece of evidence, but often only gave half the story. Some students used Figure 2 rather than Figure 1 and some tried to explain which stage of mitosis was shown, rather than simply that it was happening. Confusion was demonstrated here and in question 01.5 between a homologous pair of chromosomes and a pair of chromatids in a single chromosome. Worryingly, 62% of students failed to score on this opening question; only 5.8% gained both marks.

In part 01.2, 69.3% of students correctly identified that these cells were in prophase.

Within required practical activity 2, students needed to spread the cells out to gain a clear view; question 01.3 was based on a similar principle, but using a different method. It required standard knowledge of osmosis, but the novel context threw many students. The majority could state that the water would move into the cells by osmosis, but then often referenced increased pressure, rather than the idea of the volume of the cells increasing. Some complex, incorrect answers were seen in which students attempted to describe changes in polar interactions between the chromosomes and water, and how these would change.

Question 01.4 tested Assessment Objective 2 (application of knowledge) and there were several parts of the specification from which students could select material to support their answer. 42.2%

did this successfully; those who did not often did not describe sufficiently how a feature would be different along the length of the chromosome to result in the striped appearance. For example, mentioning “histones” or “bases” alone was not creditworthy.

In question 01.5, only 36.9% of students could define the term ‘homologous chromosome’. It is likely that more students could have written about independent segregation or crossing over of homologous chromosomes, but this question revealed that they did not fully understand this biological term. Many students only referred to the origin of the chromosomes as paternal and maternal.

For question 01.6, most students (83.2%) scored at least one mark, but there were many good answers limited to one out of two by demonstration of fundamental misunderstanding. The most common of these was that only eukaryotic DNA is a double helix and that prokaryotic DNA is single-stranded.

Question 2

This question was based on a variant of required practical activity 3 – “Production of a dilution series of a solute to produce a calibration curve with which to identify the water potential of plant tissue”.

Although question 02.1 was based on a more straightforward investigation of osmosis, very similar principles apply to those used when carrying out the required practical. When asked for a method, students must write out what actions need to be carried out as if instructing a fellow student. Generic statements, such as “keep the temperature the same” or “record the mass at set intervals”, were not credited. Instead, students should give specific instructions about how the results would be obtained, for example using a water bath set to 30°C, removing the potato chips every 10 minutes to record their mass, and blotting the potato chips dry with a paper towel.

Question 02.2 was the first question on the paper testing mathematical skills (specifically MS 3.5 and MS 4.1). Students needed to calculate rate of change from a graph showing a linear relationship; this was the most successfully completed part of the calculation, although using the wrong part of the graph or incorrectly reading from the graph was not uncommon. Students also needed to calculate the surface area of the one large cube and the eight smaller cubes, but only a small number of students could do this correctly. Only 5% could correctly combine these to come up with two correct rates per unit surface area. There was a small but sizeable minority of students who did not show the steps in their calculations, but just gave the final (incorrect) answer, meaning it was not possible to award any marks. A small minority wrote descriptions of the change in mass shown by the graph, or explained why the cubes with large surface area would lose mass more quickly, without any calculations, thereby ignoring the question stem. Disappointingly, 56.4% of students failed to gain even one mark for this question.

Question 3

67.1% of students could answer question 03.1, a test of recall from section 3.4.6 of the specification. Once again, many students confused the terms population and community, and the terms species richness and an index of diversity.

Question 03.2 was the first opportunity on the paper for students to interpret scientific evidence and demonstrate Assessment Objective 3 skills. The question, ‘Do the data in Figure 4 support these conclusions?', should have demonstrated that careful use of these data would be required in the answer. Both conclusions were comparative statements, natural habitat being the *most* favourable and town habitat being the *least* favourable, and so the marking points were linked to comparative statements between the habitats. A description of one habitat alone was, thus, not sufficient to gain credit. Numbers were provided on the axes and so quoting days of the year was expected in the answers. This question provides a good example to demonstrate the importance of using and quoting the correct evidence from the data when trying to support the conclusions. It is also a good example of how times from the x-axis of the graph should be used to illustrate where observed trends begin and end. Some 76.6% of students were able to gain at least one mark; only 7.9% scored four marks.

In part 03.3, the majority of students appreciated that the bees should not be harmed and so gained the first mark. Many students got confused with mark-release-recapture techniques but, since no population estimate was being made in this investigation, this was not relevant.

Question 03.4 was designed to test practical skills with the command 'suggest and explain', so an improvement with a specific explanation of how that change would improve the data was required. It was hoped that A-level students could be specific about why collecting more data would be beneficial. For example, they were told that these graphs were drawn following collection from four data points – students should be aware from their graphical work that this would not result in an accurate line of best fit, or that intermediate points could not be determined from these few data points. Similarly, statements related to the improved *accuracy* of the (mean) data were few and far between; simple statements referring to collecting from more sites, or for more years, are not sufficient to gain marks when asked to give an explanation. Students should be encouraged to use an appropriate term from the published glossary – "to make the results reliable" was not sufficient to gain credit. Very, very few students could use their knowledge of section 3.4.6 to point out that these data would have been more meaningful if numbers of each species had been counted so that an index of diversity could be calculated. Worryingly, 71% of students failed to score here; less than 2% gained both available marks.

03.5 was answered well, with most students (62.1%) understanding the binomial system for naming of species and linking it to their evolutionary relationship. Some students suggested that the two *Andrena* species were unrelated to *Peponapis pruinosa* and that they did not share a common ancestor – this was not creditworthy.

Question 4

This question was based on section 3.1.4.2 of the specification and specifically on the induced-fit model of enzyme action and the research that led to the proposal of this model of enzyme action.

In question 04.1, although many students could describe that the enzyme lowers the activation energy, only 18% could explain that this was due to the enzyme bending the bonds in the substrate. Some students gave lengthy descriptions of how the E-S complex forms, losing focus on the question of how this results in an increase in the rate of reaction.

Questions 04.2 and 04.3 assessed mathematical skills MS 0.2, MS 0.3 and MS 3.1. It was pleasing to see standard form being used successfully, with 71.9% of students achieving both marks for 04.2. Students found part 04.3 more challenging. Many thought they needed to calculate a rate, not appreciating that the y-axis already gave the rate of reaction. Many did not read the correct parts of the graph – at 2.5 mmol dm^{-3} for curve C and at the highest point for curve

L. Credit of a single mark was given if a correct calculation was completed with readings from incorrect parts of the graph, but all readings had to be accurate and this was often not the case.

The key to answering question 04.4 successfully was to use the information provided – that the lyxose binds to the enzyme and that the graph shows that lyxose increases the rate of reaction. Many students started their answer with the idea of lyxose being an inhibitor and reducing the rate of reaction – this limited them to one mark out of three. A significant number of students inferred that lyxose is a respiratory substrate (rather than using the information that it binds to the enzyme), so there would be an increase in ATP levels, so more substrate and hence a faster rate. It was a shame that some students who worked out what was going on did not achieve full marks due to imprecise use of language, for example referring to changing the 3-D shape of the enzyme rather than changing the tertiary structure of its active site. Fewer than half the students scored any marks on this question.

Question 5

64.5% of students could answer question 05.1, a test of recall from section 3.1.4.1 of the specification.

For question 05.2, 67.5% of students achieved both marks. Those who could not define ‘degenerate’ in the context of the genetic code often failed to gain credit through not using appropriate terminology, for example referring to ‘bases’ rather than ‘base triplets/codons’ or stating that base triplets ‘produce’ amino acids rather than ‘code for’ amino acids.

05.3 was an interesting question as it could be interpreted as a straightforward 465 amino acids multiplied by three to give the 1395 bases of the gene. Students could also add three or six bases to this, for a start and/or stop codon. Some students appreciated that a gene would be made up of double-stranded DNA so would comprise double this number of bases – this was also awarded credit. 67% of students could complete this calculation.

Question 05.4 showed that multiple-choice questions are not always simplistic or based on recall. This question required students to interpret Table 1, convert the mRNA codon to a DNA base triplet, and also notice in the question that this was a single base substitution. Only 9.6% successfully achieved all of this. The majority of students ticked box 2 that did show a Val to Ala change, but with a mutation in the mRNA (not DNA) and of 2 bases.

The answers to question 05.5 revealed much misunderstanding of the principles of the link between DNA, polypeptides and proteins, as many students discussed the changes in amino acid in terms of silent mutations or frameshift mutations. The instruction to use all the information required the students to look back at Table 1 and use the key showing the properties of the R group of the amino acid. Very few students could apply this information and link the reduction in rate of reaction with the R group of amino acid 279 changing from being negatively-charged to being positively-charged. Imprecise biological language was also often seen, for example omitting to reference the ‘shape’ of the active site and discussing the 3-D structure of the protein rather than its tertiary structure. Just over half of the students (54.2%) managed to score at least one mark here; only 3.2% gained maximum credit.

Question 6

47.2% of students achieved both marks for question 06.1. Many did not use the parent cell in Figure 6 as their starting point, so did not include one long and one short chromosome in their cells (an 'error carried forward' was allowed if the correct daughter cells were then drawn from the student's own cell as shown after the first division of meiosis).

Question 06.2 tested students' understanding of the chi-squared test. The null hypothesis stated 'the proportion of plants will not change from one breeding cycle to the next'. Students, therefore, needed to maintain the proportions from breeding cycle 0 into breeding cycle 1, taking into account that the total number of plants had changed from 54 to 56. 22.3% of students could successfully combine this understanding of chi-squared with their maths skills, using proportions to achieve both marks.

06.3 showed that questions relating to P values are still not being answered well. Too many students still write that the 'results' are due to chance, omitting the essential aspect of it being the 'difference' in the results that is or isn't due to chance. It was rare to see the concepts of probability and chance being appropriately applied. It may be that students have only used chi-squared in relation to genetic crosses and this novel context caused confusion, but students should be introduced to the use of all three required statistical tests in a range of contexts.

Question 06.4 tested section 3.4.4 of the specification, specifically 'students should be able to use unfamiliar information to explain how selection produces changes within a population of a species'. Although the instruction to 'use your knowledge of directional selection' was intended to help students focus their answer, it led to many answers that simply described the outcome of directional selection with no explanation of how it comes about. When attempts were made to give explanations, they were often not linked to this example. Many students suggested that the environment had changed, so that the plants producing 2n gametes had a selective advantage, instead of using the information provided that the scientists used only these specific plants for breeding. The term 'allele', used in the correct context, was seen infrequently.

Question 7

This question was all based on section 3.2.4 of the specification, in the novel context of production of snake antivenom.

There were two parts to question 07.1 – how does an antibody work and what is the difference between passive and active immunity? 28.1% of students could answer both of these correctly. Confusion was demonstrated between antigens on a toxin and antibody binding to a pathogen. Errors resulting in the first marking point not being awarded included describing binding, but failing to discuss destruction, or discussing destruction without reference to binding. Commonly, students used the idea of 'complementary' in place of binding. Those who were not awarded marking point two tended not to make a comparative statement about active and passive immunity, and some made vague statements about active immunity 'taking time', rather than expressing length of time. A mark of zero was commonly the result of confusing active and passive immunity or treating the antivenom as a vaccine which would then trigger an immune response.

In 07.2, many students gave answers relating to not needing to identify the species of snake that had bitten a person, as the antivenom would work against the venom of several species – this was not creditworthy as the question is clearly related to several snakes of the *same* species. A pleasing number of students understood the production of antivenom and appreciated the need for several antibodies to be produced by the animal to be used in the patient. Some suggested that one antibody could be effective against several antigens; this was not given credit. Pleasingly, few students confused antigens and antibodies. Common errors included referring to different forms of venom, which was indicated in the question stem, or failing to include reference to antibodies and instead making vague statements about “being effective against” or “fighting off” or “neutralising/counteracting” the venom. Roughly even proportions of students scored two, one and zero marks for this question.

In question 07.3, most students could complete the required calculation. Even so, many students suggested the rabbit would be better as it would likely be safer for the rabbit as less blood was removed or suggested that the same number of antibodies would be produced in a smaller volume of blood. Of those who did pick the horse, many only stated that more blood could be collected, rather than linking this to more antibodies/antivenom being collected from each animal. 81% of students scored at least one mark here.

Too many generalised answers were given to question 07.4. At this level, a specific reason why it would be ethical to have veterinary supervision in this particular procedure was required. Confusion was sometimes demonstrated here over whether the animals were being administered venom or antivenom.

In 07.5, very few students could give a complete account of the humoral immune response in this context, but those who could (7.3%) gave some excellent answers. It was rare to see the idea of specificity to the venom antigens being key to the B-cells cloning, and confusion was demonstrated between T-cells and B-cells and which produced antibodies. About half of the students achieved the second marking point for recognising the two differentiated forms of B-cells, but beyond this many did not achieve any further marks due to vague statements or misconceptions. A small number of students demonstrated a more detailed understanding but still did not obtain marks due to key ideas being missed. Examples included the idea of specificity of T/B-cells missing from their answer for marking point 1, mitosis/cloning missing from marking point 2, or one of the ideas of high concentration or ‘quickly’ missing from marking point 3.

Question 8

This question was all based on section 3.3.4.2 of the specification, linked to interpreting evidence from tracer experiments.

The majority of students limited their answer to question 08.1 to a description of the data rather than an explanation. They simply stated that radioactive carbon dioxide was not visible throughout the plant in A and therefore had not been transported through the phloem. As this question required the students to explain the results, all the marking points required use of the students’ knowledge. The first point was for the idea that the radioactive carbon dioxide would be used in the leaf to produce sugar in photosynthesis. The second point was then that sugar is transported in the phloem. If the first point was not appreciated, then students could score the second marking point for appreciating that mass flow/translocation happens in the phloem and that is what has stopped in this case. The alternative valid approach to the question for marking points 3 and 4 was not seen. Nearly 60% of students failed to make any headway in this question.

In question 08.2, many students could use the standard deviations to explain that there was no (significant) difference between the water content of the leaves. Some did suggest that this showed they were ‘not very different’ or were ‘similar’; this was insufficient to gain credit. As with question 08.1, this part required students to explain the data, so answers required application of knowledge in the context of the question. Some did not sufficiently link their knowledge that water moves to the leaf in the xylem with these data to achieve the second marking point, i.e. that water is still moving into the leaf in the xylem.

Figure 10, in question 08.3, was a complex graph, with much to interpret. Many students did not relate this investigation to that in Figure 9 and discussed heat-treatment half way up the plant that, therefore, affected young leaves at the top of the plant more than the old leaves at the bottom of the plant. This would gain marking point one and many students gained this mark for a description of the difference in effect of heat treatment on old and young leaves. Some excellent answers were seen, with students fully understanding the differences in transport mechanisms in old and young leaves, but many were thrown by the ratio data on the y-axis and struggled to access most of the marking points. Pleasingly, just over 10% of students were able to score at least three marks here.

Question 9

Despite question 09.1 testing recall (AO1) from section 3.1.5.2 of the specification, only 24.4% of students achieved all three marks. Many answers included DNA helicase ‘hydrolysing’ hydrogen bonds, which was not given credit. Answers often also included DNA polymerase catalysing the formation of complementary base pairs, or hydrogen bonding between bases; this statement negated mark point 2.

Question 09.2 was another that required explanations of results, so the students were expected to use some knowledge within each marking point. Able students responded with clear explanations about the effects of the antibody and how the RNA could prevent translation using correct technical language and an appropriate level of knowledge for an A-level question. Some answers were very good indeed. Many answers, however, were descriptions of the data without any explanation. A very high proportion of students (15.4%) made no attempt at this question.

Question 10

Question 10.1 demanded recall from section 3.3.2 of the specification; 25.6% of students gained five or six marks. Many, however, omitted any reference to the structure at all and it was surprising that very few students elected to draw a labelled sketch to show the gross structure. Many lengthy answers were seen detailing exchange of gases and the features of the alveolar epithelium, neither of which was required by the wording in the question. Many answers included tracheoles as a part of the human gas exchange system. Inhalation tended to be described in the best detail. Marking points 3 and 5 were often not awarded because of a lack of precision in describing the role of the pair of antagonistic intercostal muscles. Many students conflated the two, and referred to them generically. The relaxation and contraction of the diaphragm and its corresponding shape were frequently confused. For example, students referred to the 'flattened' or 'domed' shape of the diaphragm without stating how that occurred. This question had the highest discrimination index of the paper.

In question 10.2, although many students could demonstrate knowledge of phospholipids and triglycerides individually, they struggled to complete the required ‘compare and contrast’ command. When this command is used, every marking point requires a comparative statement that must be clearly made by the student: examiners will not infer links between separate statements – in this case, separate descriptions of phospholipids and of triglycerides. Many students did not include glycerol in their structure of the phospholipid. Some students were distracted into discussions of applications for the molecules, and their energetic values.

Question 10.3 showed that most students had learned the components of lactose and knew that it would be formed in a condensation reaction, although some omitted that this would result in the formation of a glycosidic bond. Fewer students knew that the lactose would be joined to a polypeptide in the Golgi apparatus. Many described that it would be found on the cell-surface membrane, and some tried to describe where on the polypeptide the lactose would be attached, rather than where in the cell as required by the question. Nearly half of the students scored at least two of the four available marks.

Mark Ranges and Award of Grades

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