A-LEVEL
BIOLOGY

7402/2

Report on the Examination

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General Comments

Overall this paper produced a good spread of marks. Apart from question 08.3, there was no evidence of any general misinterpretation of questions. However, in questions 05.4 and 06.4 a significant minority of students did misread results presented on graphs. The vast majority of students attempted all of the questions, although a number of students did not complete all parts of question 10. There were some very impressive answers, with students displaying an excellent understanding of the assessed content on the paper.

The responses of students on questions assessing well-established topics were generally far superior to those on topics new to this specification. This was particularly evident in question 09.2 on sympatric speciation, a new topic area. Perhaps this is not surprising as the first series of examination papers for a new specification often cause difficulties for students. In some questions, a relatively demanding mark scheme and assessment of new subject content did contribute to students gaining fewer marks than expected.

Interestingly, on some of the questions allocated four or more marks, students often obtained a lower percentage of the maximum marks where knowledge and understanding was required compared with questions requiring analysis and evaluation. Overall the performance on mathematically based questions was better than expected. However, there was a wide range of performance on questions related to the assessment of practical skills. Poor use of scientific terminology and limited powers of expression often prevented weaker students gaining full credit. This was particularly evident in questions 1, 9 and 10.

Question 1

01.1 Considering that this question required mainly straightforward recall, it was disappointing to note that over 25% of students did not obtain a mark and that only 10% obtained full marks. One of the main reasons for this was the use of poor terminology, particularly when describing nerve impulses as ‘messages’ or ‘signals’. Most responses did refer to chemoreceptors but there was some confusion concerning their role. A minority of students mentioned baroreceptors, often in addition to chemoreceptors. The role of the sympathetic nervous system in increasing the heart rate was the most frequently credited mark point. However, the increase in frequency of impulses from the medulla was only described in the best answers. Interestingly, this question proved to be one of the best discriminators on the paper.

01.2 This question also proved challenging with over a third of students scoring zero. Nevertheless, most students gained credit for describing the action of AMPK in inhibiting the conversion of acetyl-CoA to malonyl-CoA. However, the idea that this would lead to more fatty acids being transported into mitochondria was often misunderstood with many students incorrectly suggesting that transport of fatty acids would be reduced. A common misconception was that glucose would be used as an alternative respiratory substrate to fatty acids. Better answers did refer to increased ATP production from the use of either fatty acids or acetyl-CoA as respiratory substrates.

Question 2

02.1 The idea of reducing the success of reproduction of the mosquito was well understood by the vast majority of students. Any reference to competition was far less often included, resulting in only approximately 10% of students gaining both marks. A significant number of students thought that being infertile prevented sterile males from passing on the virus.

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02.2 This question also proved to be a very effective discriminator. Although over 50% of students obtained at least two marks, less than half of these students went on to gain full marks. The most common omission was not mentioning leaving sufficient time for the mosquitoes to disperse before second sampling. A significant minority also failed to refer to releasing the mosquitoes after first sampling. When provided, the equation for calculating the population size was often correct.

02.3 Very few students gained the mark for this question, with many responses suggesting that sterile mosquitoes could still transmit the virus, or that the overall population size was too large for the method to have an effect. The most common acceptable suggestions involved the radiation shortening the life span of the mosquitoes, or female mosquitoes not being attracted to infertile males.

02.4 Approximately a third of students gained this mark, usually by suggesting that releasing more transgenic males replaced those that had died. Unfortunately, most answers simply referred to mosquitoes dying without any reference to the need to maintain the number of transgenic mosquitoes in the population.

02.5 The vast majority of students gained at least one mark for stating that the number of mosquitoes was lower in the treated area. Over 60% of students gained a further mark for specifying when this reduction in number became significant.

Question 3

03.1 Approximately two-thirds of students did not obtain this mark. Often these students referred to an increase in the Krebs cycle or succinic acid activity, both of which were given in the stem of the question. The most common valid response referred to an increase in aerobic respiration.

03.2 This question proved more difficult than expected with less than 10% of students obtaining all three marks. Many students appreciated that the trained mice could produce more ATP, and some stated they could carry out aerobic respiration for longer. However, when mentioned, anaerobic respiration and lactic acid production were usually described in terms of the control mice rather than the trained mice. Many of the responses included general changes due to training such as more mitochondria, more ‘slow twitch’ muscle fibres, and an increase in the supply of oxygen to muscles.

03.3 Although three out of ten students gained both marks for this calculation, over 50% scored zero. The most common incorrect answer was 83.3 where the students converted the area of the field of view into micrometres and then divided by fifteen.

03.4 Most students gained one mark for describing differences between the samples of muscle fibres from young mice and adult mice. The most common correct response referred to the greater range of diameters of muscle fibres in adult mice. Better answers often provided a numerical comparison of the ranges, to score two marks. However, these values were not always read accurately from the graph, limiting this type of response to one mark. A common error was to refer to the modal values in each group as mean values.

Question 4

04.1 This was generally well answered, with over 80% of students obtaining at least one mark. Most students understood that using a solution of the same water potential would prevent osmosis, and then described the effects on chloroplasts if the water potentials were not the same. Common errors included discussing the effect of osmosis on 'the cell' rather than on chloroplasts and the use of terms such as 'plasmolysed' and 'turgid'. The need for water in photolysis or the light-dependent reaction was also referred to in weaker responses. Some students suggested that the movement of water had to be prevented to avoid changing the colour of the DCPIP.

04.2 This question proved to be more demanding with less than 10% of students obtaining both marks. Many answers simply referred to **Tube 1** as being a control, or that it was set up to allow comparison with other tubes. Some students suggested that it was the DCPIP causing the colour change. However, almost 60% of students gained at least one mark, usually for describing that **Tube 1** showed that chloroplasts were needed to cause the colour change. The idea that **Tube 1** shows that light does not affect DCPIP was less often mentioned.

04.3 Over 80% of students obtained at least one mark for this question, usually for outlining the role of chlorophyll or the light-dependent reaction in producing the results in **Tube 3**. Better students did refer to the reduction of DCPIP by electrons. However, common misconceptions suggested that DCPIP was reduced by protons or by reduced NADP (or reduced NAD). Weaker responses referred to the oxidation of DCPIP by oxygen or the release of ions from chlorophyll.

04.4 Slightly more than 40% of students obtained this mark, often by stating that different chemicals or concentrations of chemicals could be compared as weed killers. Fewer students referred to using IC_{50} as a standard or benchmark. Responses which did not gain credit often simply stated 'for comparison', without qualification, or simply repeated the information provided in the stem of the question.

04.5 Many students provided responses which showed understanding that the light-dependent reaction would not take place, and hence neither would the Calvin cycle. This was then often linked to less glucose being produced for growth. However, many of these answers failed to mention the products of the light-dependent reaction. Consequently, almost 50% of students scored zero. Better answers did refer to ATP and/or reduced NADP not being produced for use in the light-independent reaction. Relatively few students specified that the reduction of GP to form TP would not take place.

Question 5

05.1 Over 80% of students obtained this mark, often for referring to the use of phosphate to produce ATP or DNA, although a variety of other correctly named compounds such as RNA, ADP, TP and NADP were mentioned. A common error was to refer to proteins.

05.2 Almost 60% of students obtained this mark, usually for referring to carbohydrate or sugars. Incorrect responses often mentioned nutrients, water or oxygen.

05.3 Very few students, slightly more than 5%, obtained both mark points for this question. Most students did not refer to biomass as representing the dry mass or mass of carbon in a plant. Alternatives such as the chemical energy store were also rarely credited. However, over 40% of students did provide a definition of net primary productivity in terms of gross productivity minus respiratory losses. This was often provided as an equation. Unfortunately, weaker responses also included loss due to faeces as part of this equation.

05.4 This question produced a good spread of marks and some very extensive answers, often continued on additional pages. Over 90% of students obtained at least one mark and over 10% of students gained all four marks. The most common marking points credited related to directly comparing the effect of AMF or phosphate on plant growth, although a significant minority did refer to the lack of a statistical test. Generally, more marks were awarded for describing the effect of increased phosphate concentration on plant growth than the effect of AMF species on plant growth. References to only twenty weeks of growth, or to only shoot growth being considered, were infrequent. A number of students referred to the AMF as plant species and others confused the results between *Scutellospora fulgida* and *Entrophospora infrequens*, probably as a result of the similarity of the hatching on the graph for these two species.

05.5 It was pleasing to note that over 50% of students demonstrated a good understanding of the $\log_e$ scale and obtained both marks for this question. Over 25% percent of students obtained a single mark, often by realising that the calculated $\log_e$ value had to be divided by 140 to determine the rate of shoot biomass production in grams per day.

Question 6

06.1 This was generally well answered, with over 40% of students obtaining both marks and over 80% gaining one mark. Most students stated that type II diabetics produce insulin, although a number of them simply stated that the pancreas is not damaged. The lack of responsiveness to insulin was not always linked to cells or receptors, or was described as a 'resistance' or 'immunity' to insulin. Although students often understood that diet and lack of exercise may be involved in causing type II diabetes, they did not always suggest that exercise and diet may be used in treating type II diabetes.

06.2 85% of students understood that insulin does not activate enzymes involved in the conversion of glycerol to glucose.

06.3 The idea of a transcription factor binding to a gene/DNA/promoter region, which then stimulates transcription by allowing RNA polymerase to bind, was clearly understood and described in the best responses. The inhibition of transcription by transcription factors was referred to less often. Over 50% of students gained at least one mark, often related to the binding process. Many students who did not gain credit limited their explanations to genes being switched on or expressed. Translation to form the proteins linked with pluripotency was often included in these answers. However, a number of students confused transcription and translation.

06.4 This question produced a good spread of marks and proved to be an effective discriminator. Over 90% of students gained at least one mark, and almost a third of

students gained three out of the four marks available. Most students correctly compared the results of group A with group C. Fewer compared group A with group B. A significant minority of students mistakenly took group B results to be those of group A due to not carefully looking at the key provided for the graph; this restricted their maximum mark to two. Mice often became rats during the explanations but this was not penalised! Most students appreciated that the results could be different for humans, and stated that 12 weeks was not long enough to determine long-term effects. Some students referred to the lack of a statistical test, but this was not credited in this question. Similarly, for this investigation, thirty mice was not considered to be a small sample size.

Question 7

07.1 The definition of phenotype was generally well known with over 90% of students obtaining at least one mark. Students scoring zero usually provided a GCSE standard answer in terms of the phenotype representing an observable feature. Responses awarded a single mark usually described the genetic influence on the phenotype. Better answers also included the effect of the environment, to gain both marks.

07.2 Almost 60% of students correctly named the type of gene interaction shown in **Figure 7** as epistasis. Common incorrect responses included dihybrid and codominance.

07.3 Almost 85% of students correctly identified the genotypes provided as phenotypically white and yellow respectively.

07.4 Over 55% of students obtained all three marks in this question which proved to be a very effective discriminator. However, it was surprising to note that over 25% of students scored zero marks on what was considered to be a relatively straightforward genetic cross. It was difficult to give any credit to students who started their answer by providing incorrect genotypes of the offspring. A number of students were unable to determine the correct phenotypes despite having provided the correct genotypes. A few gave the correct genotypes and phenotypes, writing white, white, yellow, green but then gave a 1:1:1:1 ratio. The ratio was also sometimes given as 9:3:3:1 even though the genotypes and phenotypes were correct.

07.5 Approximately one in six students obtained both marks for this question. This low success rate was not due to a lack of mathematical ability, but due to misinterpreting the information provided. Most students mistakenly thought that 36% represented the homozygous recessive genotype and obtained the incorrect answer of 48%. These students often obtained one mark as they showed that 2pq represented the frequency of the heterozygous genotype. Students who realised that that 64% represented the homozygous recessive genotype generally obtained both marks, although occasionally an answer of 0.32 was given which was awarded one mark.

Question 8

08.1 The role of reverse transcriptase in forming cDNA, using mRNA, was fairly well understood, with almost two-thirds of students obtaining the mark. Some responses suggested that the enzyme formed RNA from DNA. Others confused the role of the enzyme with that of other enzymes such as DNA polymerase, RNA polymerase, restriction endonucleases and DNA helicase. The enzyme was also linked to forming hydrogen bonds between complementary bases and the formation of double stranded DNA or RNA.

08.2 Slightly more than a third of students obtained the mark for this question. These students often provided detailed answers which explained the role of DNA polymerase, including the formation of phosphodiester bonds. Incorrect responses often referred to DNA polymerase joining bases together, either by phosphodiester or hydrogen bonds. Many other students omitted any reference to either DNA or nucleotides; these incomplete descriptions were not credited.

08.3 It was clearly evident from the responses that most students misinterpreted what was required in this question, or simply did not know why the DNA was hydrolysed. Consequently, only 3% of students obtained both marks for this question, and almost 80% scored zero. A common misconception was that hydrolysis results in hydrogen bonds being broken to make the DNA single stranded, so that primers and/or nucleotides could bind, so that it could be replicated. Another frequent response was that hydrolysis of the DNA would provide an extra source of nucleotides for the Polymerase Chain Reaction. Some responses did suggest that the hydrolysis of DNA would ensure that only the RNA would then lead to amplification of DNA; the mark scheme required students to clearly state that DNA was removed or 'destroyed'.

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08.4 Almost 8% of students did not attempt this question. Despite this, over 55% of students obtained at least one mark for showing some understanding of how to arrive at the correct answer. Students who scored one mark often failed to represent a ratio in the correct format. Common errors were to give the ratio the wrong way round – a ratio in the range from 1:0.67 to 1:0.71 was frequently seen – or not to express the ratio to 1; a frequent response here being 0.054:0.037. One mark was also awarded for incorrect answers which showed that the intensity of fluorescence at which the number of cycles reached 50% of the maximum was 0.24. Another problem leading to an incorrect ratio being calculated was inaccuracy in reading the number of cycles from the graph. These answers often gained one mark, as the intensity of fluorescence was usually correctly shown as 0.24. Despite the steps involved in calculating the correct ratio, almost one in four students obtained a correct answer.

08.5 Less than 50% of students gained this mark. The most common incorrect responses were to suggest that a stop codon had been reached, DNA helicase had become denatured, or that there were no more bases rather than no more nucleotides available.

08.6 Almost 60% of students obtained at least one mark, often for stating that the primers are 'complementary'. However, when referring to the RNA viruses, many students often omitted either the term 'base' or 'sequence', so that only one in five students gained both marks. A typical response was "the primers are complementary to different respiratory diseases". A minority of students incorrectly suggested that the viruses contained DNA sequences.

Question 9

09.1 Less than 50% of students gained this mark. The most common errors included: referring to genes instead of alleles, describing frequency of an allele, or mentioning species without any reference to a population or area.

09.2 Interestingly, this question asked about a new topic on the specification, sympatric speciation, and proved to be the most effective discriminator on the exam paper. Less than 2% of students obtained all five marks, and almost 25% scored zero. The main problem was that many students provided a description of allopatric speciation rather than sympatric speciation, despite the clear direction provided in the question stem. These answers were

limited to a maximum of three marks, but often only gained a single mark. When students did describe sympatric speciation, relatively few mentioned that it occurs in the same area/place/population, and fewer still referred to disruptive selection, although maximum marks could still be achieved without including this latter idea. The most frequently credited mark points related to reproductive isolation, described in a variety of ways, and for providing a definition of a species, i.e. the inability to breed to produce fertile offspring. Better students did appreciate that a mutation would have led to a difference in flowering times, and that different alleles would be passed on in the reproductively isolated sub-populations. Unfortunately, many students referred to genes rather than alleles and thus failed to obtain this latter mark point. For some unknown reason, a significant minority of students thought that palms, having been separated by flowering time, go on to reproduce asexually. A few students misinterpreted the question entirely and provided a description of succession.

Question 10

10.1 Over a third of students obtained both marks for this question, for answers of 19.41/19.4% or 19.47/19.5%, depending on whether the student used 7 x 52 (weeks) or 365 as the number of days in a year. Almost a third of students gained one mark for correctly calculating the increase in AD cases per year as being 1 048 320 or 1 051 200, depending on the number of days used. Incorrect rounding to give 19.46% was quite common, to gain one mark.

10.2 The majority of students gained at least one mark for stating that less acetylcholine would be broken down, or that more acetylcholine would be present. Almost half of these students obtained a second mark for stating that the acetylcholine binds to receptors. However, only 10% of students obtained maximum marks by describing how an impulse would be produced in the postsynaptic neurone. Many students did appreciate that sodium ion channels would open, but then failed to mention that sodium ions would then enter to cause depolarisation.

10.3 Over 50% of students scored zero for this question, usually due to answers lacking complete explanations for the valid suggestions they outlined. Less than 2% of students gained both marks. The most frequently credited response was that isolation had resulted in a small gene pool or low genetic diversity. Poor use of terminology also prevented many students gaining both marks. Invariably, students referred to the gene or mutation, rather than the allele being inherited from a (common) ancestor. There was also considerable confusion in the use of the terms inbreeding and interbreeding. There were also many responses which referred to genetic bottlenecks, the Founder effect, and an increase in the rate of mutation in isolated areas. A significant number of students suggested that the late onset of AD enabled individuals still to reproduce and pass on the mutation. This would explain why the frequency of the mutation had not been reduced (part 10.4), rather than why there is a high frequency of this mutation to begin with.

10.4 Almost a third of students obtained both marks, clearly expressing the idea that, due to the symptoms of AD developing late on, affected individuals would have already reproduced. Over 50% of students scored zero, often providing responses that suggested that the mutation was not harmful, or indeed that it was beneficial. An improvement in health care was also provided as an explanation for the frequency of the mutation not being reduced. Students obtaining one mark often did not refer to the late onset of AD, but did understand that individuals with the mutation could still reproduce and pass on the allele.

10.5 Over 50% of students scored zero on this question. Many of these responses suggested that differences in the 'level' of acetylcholine, or exposure to mutagenic agents, caused the variation in the age at which the mutation is expressed. Over a third of students obtained one mark, usually by naming an environmental factor such as diet, smoking or stress. Answers specifically referring to epigenetics for at least one mark were infrequent. These responses often gained a second mark, 10% of students, for mentioning methylation or acetylation. Students who described these processes generally provided correct details.

10.6 Almost three out of ten students obtained one mark for explaining the sample size of 204 in terms of two copies of chromosome 14 or two copies of an allele. A common error was to refer to two chromatids. Explaining why there were only 74 potential AD cases when 75 mutations had been detected proved very challenging, with only 2% of students gaining this second mark. Many students suggested that the allele causing AD is recessive, despite line 18 of the comprehension passage stating that it is dominant. A common misconception was that one individual was heterozygous for the condition. Other incorrect responses focused on AD not having yet developed, or attempted to explain the data in relation to the degeneracy of the genetic code.

10.7 Over 10% of students did not attempt this question, and over 5% omitted the parts 10.5 and 10.6. It seems likely that some students had difficulty completing the paper, but it was also evident that these last three questions were demanding. Only 25% of students obtained a mark on this question. Almost all of these students gained one mark for realising that the GCA triplet would occur in a number of different places. Half of these students then explained that you could not then determine if the mutation was present or not. As in part 10.6, a number of incorrect ideas were linked to the degenerate nature of the genetic code. The misconception that probes were being used to sequence the whole genome arose, so lots of different primers would be needed and it would be very time consuming and costly. The probe was sometimes thought only to be able to identify the mutation if the gene had been expressed to cause the disease, or that the probe would not bind because the mutation had not occurred yet. A surprising number of students said the sequence of the mutation was not known, so therefore a probe could not be made, or that the mutation was different in different people.

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.