A-LEVEL
BIOLOGY

7402/2 Paper 2
Report on the Examination

7402
June 2022

Version: 1.0

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General Comments

As in the previous two years, there have been some exceptional circumstances preceding this series of exam papers. The first year of study was disrupted due to the pandemic and, for the first time, advance information was provided on some of the topics on the exam papers. This year, there were some exceptional responses, with students displaying an excellent understanding of the assessed content. Unfortunately, at the lower end of the distribution there was little evidence of progression beyond GCSE. Most of the questions on this paper were very good discriminators, enabling the best students to fully display their skills across the full range of assessment objectives. It was pleasing to note that some of the calculations, particularly questions 04.5 and 08.1, were very effective discriminators.

Apart from question 06.6, there was little evidence of any general misinterpretation of questions. Some students did misread question 01.2 and provided a description of the light-dependent reaction rather than the light-independent reaction. The overall performance on questions related to the assessment of practical skills was slightly disappointing. Although many students could explain some aspects of a respirometer in question 04.2, most students had difficulty providing further details in questions 04.3 and 04.4. A good many students also encountered problems in questions 03.1, 08.1 and 08.2, all related to practical skills.

The incorrect use of abbreviations caused problems for students. Abbreviations for biological terms or chemical compounds are only accepted in answers when they are also used in the specification. Triose phosphate is not abbreviated in the specification. Consequently, in question 01.2, RuBP and GP are acceptable but the use of TP as an abbreviation for triose phosphate is not. However, this year, abbreviations for acetylcholine were accepted in all parts of question 7 as four of the mark points required the term acetylcholine or neurotransmitter. The imprecise use of scientific terminology prevented some students from accessing some marking points. This was particularly evident in questions 07.2, 07.3 and 10.3, where reference to ‘receptor’ was required rather than ‘binding site’. Similarly, in question 10.5, the transcription or expression of genes was required rather than ‘genes being switched on’. In some questions, students included knowledge beyond the requirements of the specification. Unfortunately, in some of the responses this resulted in students including irrelevant information and omitting the factual details required to gain marks.

Question 1

01.1 Despite being a very good discriminator, it was disappointing to find that only one in four students obtained both marks for this question. Almost 56% of students obtained one mark, usually by correctly referring to two of the following: ‘organic,’ ‘respiration’ and ‘calorimetry’. Some students referred to ‘photosynthesis’ rather than ‘respiration’. A far less frequent error was to refer to ‘colorimetry’ rather than ‘calorimetry’. Although many alternatives were accepted for ‘carbon’, this was often the incorrect biological term of the four required.

01.2 This question proved to be an excellent discriminator. However, it was disappointing that 27% of students failed to obtain a mark. On some scripts, this was due to describing the light-dependent reaction rather than the light-independent reaction. More frequently, there was lack of detail in the responses, incorrectly named compounds or reactions, and/or confusion with the Krebs cycle. Fewer than one in ten students obtained maximum marks.

However, 26% obtained at least five of the six marks available. Most of these students did not refer to the release of energy from ATP.
The most accessible marking points (MP) were carbon dioxide reacting with RuBP and the conversion of triose phosphate into a named organic compound. MP 3 and MP 4 referred to triose phosphate and students who only provided the abbreviation TP were penalised one of these marks. As GP *is* abbreviated in the specification, reference to GP was accepted as part of MP 2. However, some students incorrectly named GP as glucose phosphate and so failed to gain this mark. Other common errors included reference to reduced NAD rather than reduced NADP and stating that triose phosphate is oxidised rather than reduced. Less frequently, the enzyme rubisco was linked to an incorrect reaction.

Question 2

02.1 Over 92% of students could correctly identify the equation for identifying how the net production of consumers can be calculated.

02.2 Approximately one in two students successfully completed this calculation for one mark. A few students incorrectly rounded their calculated answer and failed to obtain the mark.

02.3 Almost 78% of students gained at least one mark for this calculation and 62% obtained both marks. Correct answers were usually expressed as 88500, less often as 0.0885 million. Sometimes, the same total number in the female breeding herd was used for both 2017 and 2013. One mark was often gained for 1.8975, the number of dairy cows in 2017, while errors were more common when calculating the number in 2013. An extra 0 was added to the figure(s) calculated for 2017 or 2013. Some students correctly calculated both values but then expressed their answer as a 4.89/4.9 percent increase. Unfortunately, 88500 was erroneously transferred to the answer line as 85500 by a surprising number of students. Incorrect calculations included just finding the difference between the total number in the female breeding herd in 2017 and 2013, i.e. 3.45 million minus 3.35 million.

02.4 It was disappointing to find that only 22% of students obtained both marks for this question. The majority of students, 78%, did gain at least one mark for providing a suitable example of how energy is lost, e.g. during respiration/movement, via faeces or as heat. A significant number of students did not obtain this mark as they suggested that energy is 'used in respiration' or that 'energy is produced'. Most students failed to gain both marks as they did not mention energy being lost between trophic/feeding levels.

Question 3

03.1 Overall, responses to this question were disappointing, with 42% of students failing to gain a mark and only 14% obtaining both marks. Despite the wording of the question excluding temperature and pH as control variables, a few students still included them in their responses. However, the most frequent errors were concentration/volume of nitrogenase and volume of liquid culture, despite the stem of the question stating that each liquid culture had the same volume. Another common error was to suggest concentration of ammonium

chloride as a control variable even though this was the independent variable. Other incorrect responses included humidity, water potential and light intensity.

The use of imprecise terminology also contributed to students failing to gain credit. A significant number of students referred to 'amount' rather than concentration or volume. The most frequent correct responses referred to volume of ammonium chloride, time (the bacteria were allowed to divide), concentration/volume of nitrogen and the volume or concentration of bacteria.

03.2 The vast majority of students, 92%, obtained at least one mark, almost invariably for stating that nitrogenase activity decreases with increase in ammonium chloride concentration. Many students, approximately 51%, obtained a second mark usually for indicating that nitrogenase activity was zero at high concentrations of ammonium chloride. Only 8% of students gained maximum marks for also indicating that only one species was investigated or that chloride (ions) may be causing the inhibition rather than ammonia. Students differed in their understanding of the word 'inhibits'; it was thought to mean both a reduction in activity and zero activity by certain students.

Several responses mentioned the lack of a statistical test to determine if the differences in nitrogenase activity were significant. However, this was not credited as the differences in nitrogenase activity are very considerable in the data and a statistical test would not be required. Similarly, 'correlation does not mean causation' was not credited. Students were expected to 'use all the information' to provide a higher-level response, such as the effect on nitrogenase activity may not have been due to ammonia as ammonium chloride was used in the investigation.

03.3 For a two-mark question, this was a very effective discriminator, even though 32% of students scored zero. Most students gained a mark for realising that more ATP/energy would be available if less ATP was being used in the reduction of nitrogen. However, only 28% of students also suggested that the ATP could be used for other reactions or that the rate of respiration could be lowered. As in question 02.4, the misconception that energy is used in respiration was penalised. However, a few students specifically referred to ATP being required for (the beginning of) glycolysis and were awarded this mark. The most frequent correct answers were for growth, protein synthesis, active transport, and movement. A few students mentioned the use of ATP for phosphorylation or for binary fission.

Question 4

04.1 Approximately 68% of students correctly identified the reduction of pyruvate as the process that occurs in anaerobic respiration but does occur in aerobic respiration. The most frequent incorrect response was substrate-level phosphorylation.

04.2 This question was generally well answered and was an excellent discriminator. Almost 88% of students obtained at least one mark and 70% at least two marks. Usually, these were the first two MPs, i.e. the uptake/use of oxygen and the absorption of carbon dioxide by the potassium hydroxide solution. As in previous years, there was some confusion over the changes in pressure/volume within the apparatus. Approximately 45% of students obtained maximum marks. These students correctly referred to a decrease in pressure

and/or volume in the respirometer. A significant number of students suggested an increase in volume and/or pressure, or suggested a vacuum was produced, which was rejected.

04.3 Although this question was another very effective two-mark discriminator, it was disappointing that only 67% of students gained at least one mark and 22% both marks. Usually, students who obtained a single mark referred to the distance moved by the liquid. Several students stated the 'volume of the tubing' or 'time' as required measurements despite the latter being excluded in the question. Other frequent incorrect responses included, mass/number of seeds, temperature, volume of oxygen uptake, volume of carbon dioxide produced and the volume/mass of potassium hydroxide.

04.4 In terms of obtaining maximum marks, this proved to be the most difficult question on the paper. Approximately 2% of students obtained maximum marks and only 15% more than one mark out of the three available. The question was also a poor discriminator. There were several reasons for the poor performance of students on this question. The most common was students suggesting that a syringe should be added to the apparatus. The question clearly states that the same apparatus was used and that a change to the 'contents' of the apparatus would be required. Students who suggested the addition of a syringe could only access MP 1, i.e. removal of the potassium hydroxide solution or its replacement with water. Approximately 64% of students gained at least one mark and invariably this was the mark they obtained.

Unfortunately, a significant number of students suggested replacing the potassium hydroxide with a solution that absorbed oxygen. Other incorrect responses included filling the apparatus with water and counting the bubbles of carbon dioxide released, adding limewater, or covering the seeds/KOH with a layer of oil. Several students failed to gain MP 2 as they suggested that the liquid would move to the right which would only occur if anaerobic respiration was taking place. The question states that the student used the apparatus to measure aerobic respiration.

Other incorrect responses included measuring a change in the mass of the seeds or a change in the mass/volume of the KOH. Due to the errors included in many responses, MP 3 was inaccessible to the vast majority of students. Even students who did follow the correct procedure had difficulty clearly expressing how they would use their results to calculate the volume of carbon dioxide produced.

04.5 Approximately 70% of students obtained the correct answer in this calculation. For a single mark calculation, this question was a very effective discriminator. The most frequent correct answers were 3.23×10^{-7} and 3.2×10^{-7}. Most correct answers gave the number in standard form. Some responses included e.g. 3.2 but omitted 10^{-7} or gave the wrong power. Other incorrect responses included
1.55×10^{-5} when students divided 6.2×10^{-4} by 40 (g) and not 48 (hours) or
1.29×10^{-5} when students divided 6.2×10^{-4} by 48 (hours) and not 40 (g) or
5.17×10^{-4} when students multiplied by 40 and divided by 48.

Question 5

05.1 Despite 84% of students obtaining at least one mark and 13% gaining all three marks, this question proved to be a poor discriminator. Many students correctly concluded that *E. rufus* is found in the north/north-west of the island and *E. rufifrons* in the south/south-west to gain two marks. Other students simply stated that the species were separated by

the Tsiribihina river, gaining one mark. Students failing to gain credit often only described distribution in terms of closeness to the coast or water. Fewer students included that the actual distribution was similar/less than expected or similar to the environmental needs of the two lemur species. Many students speculated on the environmental conditions preferred by the two species, e.g. *E. rufus* preferring colder conditions in the north. Occasionally, students omitted to name which species they were referring to. A few students misread the key on Figure 2 and thought that the actual distribution was the opposite of the expected distribution.

05.2 This question proved to be the most effective discriminator on the exam paper. Approximately 86% of students obtained at least one mark, usually for recognising that allopatric speciation or geographical isolation had taken place. Unfortunately, a few students mentioned sympatric speciation.

There was considerable variation in how students obtained two or more marks although the idea of '(different/advantageous) alleles being passed on' or 'a change in allele frequency' was frequently credited. Some students who mentioned or described reproductive isolation suggested that this occurred at the end of speciation and were not awarded the mark. Similarly, the mark for mutation/s was disqualified when students suggested that the lemurs mutated to adapt to their environment or that the conditions caused the mutation/s.

The idea of different selection pressures was generally well known, although some students simply referred to lemurs living in different conditions. Although many students did state that the new species would not be able to (inter)breed to produce fertile offspring, a significant number omitted either the first or second part of this statement. Despite these difficulties, 52% of students obtained at least 3 marks, 35% at least 4 marks and almost one in five students, maximum 5 marks. Quite often, the better responses included all 6 points on the mark scheme. Some of the students scoring zero did not refer to speciation and provided a description of succession.

05.3 Almost two-thirds of students obtained this mark. The most frequent correct responses related to 'not being visible to predators' or 'not affecting survival'. The importance that the mark would not be erased was also frequently credited. Responses which simply stated 'not to cause harm' were not credited. Students who had not read the question carefully suggested giving time for the lemurs to disperse, taking a large sample, and preventing births, deaths, immigration and/or emigration.

05.4 Rather surprisingly, only 45% of students could correctly calculate how many lemurs would have been marked in the second sample. Recalling and/or rearranging an equation caused more problems than expected. This question was a very effective discriminator.

Question 6

06.1 Approximately 54% of students gave the correct genotypes of the ABO blood groups for individuals 1 and 2. The most common error was to show the genotype of individual 1 as I^AI^A or to show this genotype and the correct genotype. Despite information to the contrary in the stem of the question, some students showed the alleles on the sex chromosomes. A few students included the genotypes for the Rhesus blood groups in their answer, which was ignored.

06.2 Despite 62% of students failing to obtain at least one of the two marks available, this question was a reasonably good discriminator. Students failing to gain credit often used individuals 1, 2 and 3 as their source of evidence. These students also displayed a lack of understanding of a pedigree diagram by suggesting that individuals 3 and 4 were offspring from individuals 1 and 2. Students obtaining a single mark usually correctly referred to individuals 3, 4 and 7 as their source of evidence, but then suggested that only one of 3 and 4 was heterozygous. Approximately one in four students obtained both marks. Most of these students obtained their second mark by stating that both 3 and 4 would be heterozygous or would have the recessive allele. Very few students provided the alternative response that all the children of 3 and 4 would be Rhesus positive if the Rhesus positive allele was recessive.

06.3 Again, despite 39% of students failing to obtain a mark, this question was a reasonably good discriminator. Almost 23% of students gained two marks, usually by expressing the probability value as 0.125 or 12.5%. The 38% of students who obtained one mark, often for expressing the probability as 25%, had not included the probability of a male offspring being produced. The most frequent incorrect answer gaining no marks was 50%. This was usually due to students only calculating the probability of individuals 1 and 2 producing a child with blood group A.

06.4 Approximately 82% of students correctly determined the frequency of the I^B allele to be 0.2. The most frequent incorrect response was 0.02.

06.5 Approximately 88% of students obtained at least one mark, invariably by correctly naming the chi-squared test. Nevertheless, this two-mark question proved to be a reasonably good discriminator. Incorrectly named statistical tests included the Student's t-test, Spearman rank, Mann-Whitney and Wilcoxon. There was considerable variation in the range of responses for the number of degrees of freedom. The most frequent incorrect answers were 2, 4, 5 and 0.05. Approximately 44% of students obtained both marks.

06.6 In terms of accessibility, this question caused problems for many students. Almost 12% of students did not provide a response, the highest percentage on this paper. Only 9% of students obtained both marks and almost four out of five students scored zero. The most common incorrect responses included crossing over, linked genes, codominance, independent segregation/assortment, and random fertilisation/fusion of gametes. A significant number of students suggested that the population was small even though it was stated in the stem of the question that the population was large. Some students provided the converse of the points in the mark scheme which meant their responses were in the incorrect context. Correct responses usually referred to one or more of the following taking place: mutation, immigration/emigration and, to a lesser extent, selection. The idea of no random mating occurring was rarely seen.

Question 7

07.1 Surprisingly, only 66% of students obtained at least one mark on this relatively straightforward recall question, which proved to be an excellent discriminator. Almost 41% of students obtained both marks. A significant number of students who scored zero referred to the refractory period, concentration/diffusion gradients, sodium ions and calcium ions in their responses, or referred to vesicles without any reference to acetylcholine/neurotransmitter. A common misconception among weaker responses was that sodium ion channels are only present in postsynaptic neurones.

07.2 Again, it was surprising that only 63% of students gained at least one mark on this question. The expectation was that far more students would access MP 1, i.e. naming the type of summation as 'temporal'. There were numerous incorrect alternatives to temporal including spatial, multiple, excitatory, all-or-nothing and saltatory. The explanations provided for MP 2 often lacked detail, with many students simply stating that many impulses or action potentials are required to reach a threshold. Better responses included detail on how sufficient neurotransmitter, entry of sodium ions or increase in membrane potential was required to reach a threshold. Consequently, this question proved to be a very effective discriminator. Approximately 20% of students obtained both marks.

07.3 Interestingly, there was almost an even split between students obtaining two, one or zero marks on this question. It also proved to be a very good discriminator. Although many students realised that antibodies prevented the binding of acetylcholine to the sarcolemma, far fewer referred to receptor/s to obtain MP 1. It was pleasing to note that, compared with responses on previous exam papers, fewer students used the term 'active site' to describe the receptor. Some students suggested that the antibodies block the sodium ion channels. The idea that less/no depolarisation or fewer/no action potentials would be produced was a far more accessible mark point. However, a significant number of students referred to weaker action potentials being generated, which was not credited.

07.4 This question proved to be one of the most effective discriminators on the exam paper. Approximately 31% of students obtained maximum marks and approximately 57% at least two marks. As in question 07.3, many students did not mention receptor/s to access MP 2. Students often appreciated that the drug Mestinon would result in either less/no acetylcholine being broken down or that more acetylcholine would remain to gain MP 1. Many of these students also realised that this would lead to depolarisation or action potentials, to obtain MP 3. One in four students scored zero. Many of these responses thought that MG (Myasthenia gravis) were antibodies or other molecules, or that MG attached to antibodies.

Question 8

08.1 Approximately 34% of students obtained both marks and 19% obtained one mark for this calculation. The most frequent correct answers were 8.07/8.0658/8.06575 $\times$ 10^{-3}. The 10^{-3} was sometimes omitted to only gain one mark or the 10 was raised to the wrong power, e.g. 10^{3} or 10^{-2}. Rounding errors were surprisingly frequent, particularly rounding 8.0658 to 8.06. Errors were also made in converting mg to g. Other errors included dividing 230.45 by 35 to give 6.584 and dividing 35000 by 230.45 to give 151.88 g. Relatively few answers were not in standard form. This proved to be an excellent discriminator, especially for a calculation question.

08.2 Almost a third of students suggested that each rat should receive a quantity of the drug (STZ) relative to their mass or that the dosage injected would allow a (valid) comparison as rats vary in mass. Many students did not obtain this mark as they referred to size rather than mass or did not refer to 'comparison' in their response. Some students simply stated that the dosage had to ensure that the drug caused diabetes in the rats. Other frequent responses suggested that too much of the drug would kill or harm the rats or too little would not be enough to have an effect. Unless these ideas were linked to rats varying in mass, they were not credited. Similarly, responses that only stated that rats vary in mass without further qualification were not credited.

08.3 This question was an excellent discriminator. Approximately 88% of students obtained at least one mark and 10% the maximum five marks. Many students gained a mark for highlighting that the investigation was carried out on rats (sometimes referred to as mice) rather than on humans. The 66% of students who obtained at least two marks often stated that obesity or a high-fat diet was linked to type II diabetes.

Students obtaining more than two marks did so in a variety of ways. Many referred to type II diabetes causing high blood glucose concentration. However, the use of imprecise terminology, e.g. 'sugar' rather than glucose was not credited. Several students noted that the SDs for mean blood glucose concentration and/or mean body mass did not overlap. Unfortunately, a significant minority of students stated that the SDs for body mass did overlap. Students who correctly interpreted the SDs usually correctly referred to a significant difference between the results.

Examiners noted that this year, the incorrect statement 'the results are significant' appeared less frequently in student responses. Fewer students than expected referred to the short-time period of this study or to the long-term effects not being known. Nevertheless, almost 43% of students obtained at least three marks and almost 25% four marks.

08.4 Students found this question more difficult than expected. Approximately 18% of students obtained both marks and 55% at least one mark. MP 1 was awarded most frequently with students stating that type II diabetics produce insulin, or that type I diabetics do not produce insulin. Although many students referred to type II diabetics being 'less/not responsive/sensitive to insulin', most omitted any reference to receptors to gain MP 2. MP 3 was rarely awarded as most students did not refer to pancreatic '<u>cells</u>' not being destroyed in type II diabetics. However, MP 4, damage to these cells affecting other processes/reactions, appeared more frequently. Often these processes were the release of glucagon or digestive enzymes. The 45% of students who failed to gain a mark often stated it was unethical to use rats, that the high dosage would kill the rats and/or that the effect on rats would differ from that on humans.

Question 9

09.1 It was disappointing to find that only 30% of students correctly named the posterior pituitary as the part of the body which releases ADH into the blood. The two most common errors were to omit 'posterior' or to name the hypothalamus. The liver, kidney and pancreas were other incorrect responses.

09.2 This question was a very good discriminator. Approximately 47% of students gained both marks and 78% obtained at least one mark. All the mark points regularly appeared on these scripts. Some students gave one correct sign or symptom, e.g. 'dehydration' and then provided a sign or symptom the complete opposite to that required, e.g. 'concentrated urine' rather than 'dilute urine'. Students failed to gain marks for a variety of reasons. Some students provided two signs or symptoms resulting from an increase in ADH rather than from a decrease. Other students gave the symptoms associated with drinking too much alcohol, e.g. headaches, slow reaction times and dizziness. Incorrect responses also included changes in blood glucose and ion concentration, sweating and fatigue.

09.3 It was very surprising that this question, which relied on recall of knowledge, had the second highest discrimination index on the paper. Approximately 77% of students obtained at least one mark, usually for stating that ADH increases the (re)absorption of water from the collecting ducts. However, a significant number of students suggested that the direction

of water movement was into the collecting ducts, negating this mark point. Many students included aquaporins in their responses, but they did not always refer to 'membrane' to obtain MP 1. Nevertheless, 56% of students obtained at least two marks on this question. Perhaps most surprising was the number of students who did not refer to 'osmosis' for MP 3. Consequently, only 23% of students obtained maximum marks. A few students described the effects of a reduction of ADH on the collecting ducts.

Question 10

10.1 Although only 6% of students gained all three marks and 28% at least two marks, this question was a very good discriminator. Almost 80% of students gained at least one mark, invariably MP 3, by referring to rapid/uncontrollable cell division (of cancer cells). Students who did not obtain this mark often referred to the growth of cells rather than cell division. Very few students obtained MP 1 for explaining what a mutation is. Some students only referred to a change in the base sequence without mentioning DNA. Other students referred to the 'RNA base sequence of a gene' or more frequently 'the amino acid sequence of a gene'. A surprisingly large number of students confused mutation with methylation of DNA. Students were more successful in accessing MP 2, i.e. describing the effect of a mutation on the primary or tertiary structure (of a protein). Most correct responses referred to a change in (the sequence of) amino acids. Answers which only stated that a protein would not be formed were not credited.

10.2 The standard of the answers provided to this question was very disappointing. Only 5% of students obtained the maximum four marks and almost 47% of students scored zero. This includes the 9% of students who made no attempt to answer the question. Nevertheless, this question proved to be an excellent discriminator.

Approximately 21% of students obtained a single mark on this question. This mark was often obtained for including the use of PCR to amplify the DNA sample or by outlining how mutations could be identified, e.g. by fluorescence/radioactivity, etc. The use of restriction endonucleases/enzymes was often omitted, or their role was incorrectly described. Some students named other enzymes, helicase and reverse transcriptase being the most common. Although the term electrophoresis appeared on a regular basis in responses, many students did not describe its role in separating the DNA fragments. Some students were able to obtain the alternative option to this mark point by including the use of a microarray.

There was considerable confusion between DNA probes, primers, and marker genes. Even when DNA probes were used in the correct context, a significant number of students did not refer to binding. Fortunately, the mark scheme did not insist on 'DNA hybridisation', the terminology included on the specification. This would have further reduced the accessibility of this mark point.

Weaker responses included the use of a gene machine, an electron microscope, electrolysis, plasmids, recombinant DNA technology, and the ELISA test. A few students attempted to describe DNA sequencing as a method to screen the DNA for all the mutations. These attempts were generally unsuccessful. Some students obtained a mark for comparing the DNA sequence with known DNA sequences of the mutations. However, there were several references to the 'amino acid sequence of genes' which invalidated this mark. 32% of students obtained at least two marks on this question and 15% obtained at least three out of the four maximum marks available.

10.3 As with most of the comprehension questions, this was another very effective discriminator, despite only 7% of students obtaining all three marks. Most students, 75%, obtained at least one mark, usually for MP 2, i.e. drugs preventing the binding of oestrogen (to the receptor). Many of these students also referred to the drugs binding to the (oestrogen/ER) receptor or transcription factor to gain MP 1. However, some students simply stated that the drugs acted as competitive inhibitors without any reference to binding, or they omitted 'receptor' or 'transcription factor'. A few responses suggested that the drugs bind to oestrogen. There were also some references to 'active site' and enzyme-substrate complexes, which were rejected. Nevertheless, 48% of students obtained at least two marks. Rarely was the third mark point credited without maximum marks being achieved. Only the best responses included any reference to the promoter or to RNA polymerase. These students displayed an excellent understanding of how the drugs are effective in the treatment of ER-positive breast cancers.

10.4 49% of students used the information in the passage to obtain both marks. These students appreciated that the high/increased (concentration of) PSA could be due to an enlarged prostate and/or urinary infections. Only 15% of students obtained a single mark. These students often did not refer to a high/increased PSA (concentration) for MP 1 or only referred to 'infections', which was insufficient for MP 2. 36% of students failed to obtain a mark. Many of these students suggested reasons why PSA would not be present, or present in low concentrations in blood. A number of these responses suggested that the prostate does not receive a blood supply.

10.5 This question proved far more difficult for students than 10.4 and was a far more effective discriminator. Only 5% of students gained the maximum three marks and 37% at least one mark. Almost 10% of students did not provide a response, but there was no evidence to suggest that this was due to lack of time. Many responses provided general facts concerning epigenetics without answering the question. Although several students knew that methylation and acetylation may be involved, they did not provide sufficient detail to access any of the mark points.

Students who did gain credit often did so by describing the effects of methylation. Responses gaining two marks often suggested that drugs could decrease methylation of tumour suppressor genes, inhibiting transcription of these genes. There were far fewer references to oncogenes despite the specification referring to 'abnormal methylation of tumour suppressor genes and oncogenes'. Perhaps not surprisingly, MP 4, relating to acetylation was awarded less frequently. The use of imprecise terminology, e.g. genes being 'switched on or off' rather than referring to the transcription/expression of genes prevented some students from obtaining an additional mark. There was considerable confusion between oncogenes and proto-oncogenes (not on the specification). As in question 10.1, a surprising number of students suggested that epigenetic changes cause mutations.

Mark Ranges and Award of Grades

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