A-LEVEL
BIOLOGY

7402/2: Paper 2
Report on the Examination

7402
June 2019

Version: 1.0

Further copies of this Report are available from aqa.org.uk

Copyright © 2019 AQA and its licensors. All rights reserved.
AQA retains the copyright on all its publications. However, registered schools/colleges for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to schools/colleges to photocopy any material that is acknowledged to a third party even for internal use within the centre.

General Comments

The mean mark on this paper was lower than last year; however, this year there was a greater range of marks. There were some very impressive answers with students displaying an excellent understanding of the assessed content on the paper. Conversely, scripts at the lower end of the range showed little evidence of progression beyond GCSE. Apart from the fact that around 9% of students did not attempt the last part of the last question, there was little evidence of students not having enough time to complete the exam paper.

There was also little evidence of any general misinterpretation of questions. However, a significant number of students misinterpreted the data provided in Figure 3 and incorrectly suggested that the conclusion in question 04.1 could not be evaluated. One factor contributing to the decrease in the mean mark this year was the poor performance on question 6, which mainly assessed understanding of dihybrid, sex-linked inheritance. The marks achieved were well below expectations and certainly lower than on previous papers assessing the same topic. The performance of students on questions assessing mathematical skills was also disappointing, particularly compared with last year. However, students this year were more adept at describing the process of succession and describing how to determine the population size of a plant species.

There was a wide range of performance on questions related to the assessment of practical skills. Many students had difficulty describing or understanding relatively simple practical procedures even in what should have been familiar contexts. This was most evident in questions 03.3, 07.3 and 07.4. Less surprisingly, perhaps, was the fact that questions requiring application of practical skills in novel contexts proved challenging for all students.

As in previous years, the imprecise use of scientific terminology and limited powers of expression prevented some students from accessing specific marking points. Yet again, examiners commented on the poor standard of handwriting, making it difficult to distinguish between key words such as glucose, glycogen and glucagon. A significant number of answers were submitted in the form of bullet points. Often, these responses lacked the detail required to award full marks. This was particularly evident on evaluation questions.

Question 1

01.1 The process of succession was well known by many students, with almost 44% obtaining maximum marks. This question proved to be a very effective discriminator. Most students knew that succession started with a pioneer species and ended with a climax community. Some students simply referred to primary species/coloniser (for pioneer species) and climax species (for climax community). Many students referred to species, often pioneer species, changing the environment so that new species could colonise the area. In this question, there were fewer students than last year using imprecise terminology such as ‘organism’ or ‘plant’ instead of species, and ‘more hospitable’ or ‘more habitable’ instead of more suitable or less hostile. Relatively few students referred to an increase or change in biodiversity during succession. It was disappointing to note that over 11% of students scored zero, often as a result of providing a description of natural selection or speciation.

01.2 Approximately a third of students correctly calculated the percentage of sunlight energy transferred into faeces and urine of the zebra as being 0.155%. Some students correctly carried out the calculation but did not give an answer to 3 significant figures. Answers given in standard form were often incorrect, eg 1.55×10^{-3}%. Other errors included calculating 58.2% of 12.7% or of 2.1%. Working out percentages of percentages caused many students to be powers of 10 out in their final answer, eg 15.5%, 0.0155%, 0.0015%.

01.3 Approximately 40% of students obtained both marks in this calculation and another 12% gained one mark. A surprising number of students carried out the correct calculation, but then wrote down the answer of 117.54 rather than 177.54, presumably making a transcription error from their calculator. Most incorrect responses calculated either 12.7% of 24 525 to give 3114.675 kJ m^{-2} $year^{-1}$ or 5.7% of 24 525 to give 1398 kJ m^{-2} $year^{-1}$. Another common incorrect calculation involved subtracting 36.1% plus 58.2% of 24 525.

Question 2

02.1 This question proved to be a very effective discriminator. Around 90% of students gained at least one mark and around 30% gained full marks. Many students appreciated that there would be a change in the polypeptide's primary structure. However, a number of these responses were not credited as they suggested that a new amino acid would be formed or produced. Similarly, although to a lesser extent, the mark for a change in tertiary structure was negated by stating that there would be a change in 'the active site'. Other common errors included confusion between amino acids and bases, 'amino acids coding for proteins' and a base substitution causing a 'frame shift'. Students gaining full marks referred to changes in specified bonds rather than general statements on bonds being altered.

02.2 Although almost 90% of students gained at least one mark, only about 12% obtained full marks. The most common response to gain credit was related to 'healthy' or 'normal' red blood cells being produced. Some responses only referred to 'healthy' or 'faulty' bone marrow cells rather than the red blood cells produced by them. Students gaining two marks often referred to a lower chance of rejection when using a sibling as a donor. Students often understood that the bone marrow cells were able to renew themselves and differentiate into other cells, but did not explain that they replicated or divided. Relatively few students referred to no SCD cells or defective polypeptide/haemoglobin being produced.

02.3 This proved more difficult than expected, with less than two-thirds of students gaining one mark and only 5% obtaining all three marks. The most commonly awarded marks supporting gene therapy were for the idea of a reduced chance of rejection and that donors are not required. Arguments against gene therapy usually referred to the 'side effects' of using a viral vector, unknown long-term effects and the possibility of an immune response to the virus. However, correct responses often only included one these points. Surprisingly, very few students appreciated that there was no destruction of bone marrow with gene therapy or that SCD cells would still be produced using this procedure. Some answers failed to evaluate the information and simply provided the method of carrying out gene therapy. Other students confused the procedures and it was difficult to assess the points they made.

Question 3

03.1 Almost 80% of students obtained at least one mark for this question, usually for stating that the shoot tip produces IAA. A significant number simply stated that the tip contained IAA, which was not credited. Very few students referred to mitosis or (cell) division in the shoot tip. Approximately 40% gained the second mark by referring to IAA stimulating growth or elongation of the shoot. Incorrect responses included the idea that the tips were removed to prevent phototropism, to allow the uptake of glucose, or to prevent detection of light. Some students mistakenly thought that the investigation was carried out on shoot tips.

03.2 Approximately 75% of students obtained at least one mark for stating that glucose would be used in respiration or that ATP/energy could be provided. A third of students mentioned both these ideas to obtain both marks. A minority of students incorrectly suggested that glucose would be used in photosynthesis or that 'energy could be produced'.

03.3 This question was the least well answered and least effective discriminator in the exam paper. Approximately 10% of students gained one mark and only 3% obtained both marks. These students realised that the lids on the Petri dishes prevented evaporation of water from the solutions and so maintained the concentrations of the IAA solutions. Very few students suggested that evaporation would alter the water potential of the solutions. Most answers referred to 'preventing contamination' usually in the context of microbes. Some responses referred to preventing oxygen, carbon dioxide or light affecting the investigation. Other incorrect responses suggested that the lid would ensure a constant temperature or humidity or it would 'keep the conditions the same'.

03.4 This question was a good discriminator. Approximately 20% of students gained full marks and almost 83% obtained at least one mark. The effect of increasing IAA concentration on the mean change in length of shoots was clearly described by many students. Failure to achieve this mark was often due to omitting 'mean' (change) or 'concentration' (of IAA) in the description provided. Although many students realised that IAA stimulated growth, only the more effective responses referred specifically to 'cell elongation'. The effect of high concentrations of IAA on roots was appreciated by a good number of students. However, some of these students failed to gain credit by suggesting the length of roots would decrease at high IAA concentrations. More effective responses referred to inhibition of root growth or to a decrease in (mean) change in length of roots. Incorrect responses suggested roots would grow more due to better growth in the dark or increased uptake of glucose. A significant number of answers only discussed the effects of IAA concentration on roots.

03.5 This proved to be a very difficult calculation, with only around 12% of students providing the correct volumes of stock IAA solution and distilled water.

Question 4

04.1 Despite only around 6% of students obtaining maximum marks and about 63% obtaining one mark, this question and the other parts of question 4 were very effective discriminators. High-scoring students displayed a clear understanding of the data and were able to successfully evaluate the conclusion provided. A significant number of students did not realise that the y-axis enabled a comparison with the results at the typical (normal) pH of each tissue. Consequently, they suggested that there were no controls to compare against and that the conclusion could not be evaluated. These students simply stated that there was a correlation between the temperature and force of contraction. Students who did interpret the graph correctly often obtained the first two marking points for evaluating the data. Surprisingly, apart from referring to the investigation only using mouse and rabbit tissues, relatively few students obtained the other mark points. Although the lack of a statistical test was mentioned by some students, very few of these responses linked this to seeing if any differences were significant. Very few students suggested that more pH values should have been used or that the body temperature of the animals is not known. Similarly, few students referred to the investigation being carried out on isolated muscle tissue.

04.2 There were some excellent answers to this question, with a quarter of students obtaining maximum marks. These students often provided clear, concise explanations of the effect of a decrease in the concentration of calcium ions on the force of muscle contraction. Three-quarters of students obtained at least one mark, often for explaining that less tropomyosin would remain at the binding site. Unfortunately, a few students referred to 'active site' rather than binding site. Many responses included the role of troponin, which is not required in the current specification. The idea that fewer actinomyosin bridges would form was outlined by many students. Fewer students successfully explained how this would decrease the force of muscle contraction. Many students simply referred to filaments 'moving' or to a 'power stroke' without any further detail. More effective responses referred to movement of the myosin head or to myosin 'pulling' the actin filaments. A significant number of students referred to the activation of ATP (hydrol)ase by calcium ions. Some students scoring zero provided explanations of the role of calcium ions in synaptic transmission or explained how action potentials are produced.

04.3 Only one in two students obtained a mark on this question. Nevertheless, it proved an effective discriminator. Approximately a third of students gained both marks by explaining that NAD would be regenerated to be used again in glycolysis. Incorrect responses included the involvement of the electron transport chain, the Krebs cycle, link reaction and the direct generation of ATP from converting pyruvate to lactate. A significant number of students confused oxidation with reduction.

Question 5

05.1 It was disappointing that only around 44% of students obtained at least one mark on this relatively straightforward question. These students usually referred to the conversion of glycerol, amino acids or fatty acids into glucose. A significant number of students negated this mark point by suggesting that 'glucagon converts' i.e. acts as an enzyme during these reactions. Other students incorrectly defined gluconeogenesis as the conversion of glycogen to glucose or in some instances 'glucagon to glucose'. Far fewer students than expected referred to the activation of enzymes during gluconeogenesis, often simply describing the attachment of glucagon to receptors. A few students suggested that 'glucagon produces enzymes' which was not credited.

05.2 Almost 80% of students gained at least one mark for this calculation and half of these students obtained both marks. Students were often unable to convert nanometres into micrometres, resulting in the correct digits but with the decimal point in many different wrong places. Frequently, 9531 was divided, rather than multiplied, by 3.4. 'Three significant figures' was sometimes misinterpreted as three decimal places, resulting in an answer of 3.241.

05.3 Fewer than half of the students obtained a mark on this question and only about 16% gained both marks. However, it was a very effective discriminator. Many answers were of GCSE standard. Less effective responses simply referred to more glucose being removed from the blood without any explanation of how this was achieved. Some students referred to insulin binding to cells but did not mention receptors, or disqualified the mark by suggesting attachment to an 'active site'. As outlined, uptake of glucose by cells was often mentioned, but only more effective responses referred to the involvement of channel or carrier proteins. Similarly, students appreciated that glucose is converted to glycogen, but again few students referred to the activation of enzymes. Common incorrect responses referred to 'glycolysis', 'glucogenesis' or 'gluconeogenesis' rather than glycogenesis.

05.4 Despite fewer than 60% of students gaining a mark, this question proved to be the most effective discriminator in the exam paper. Interestingly, almost 25% of all students gained all three marks, significantly more than the percentage obtaining one mark or two marks. Almost 9% of students did not attempt this question. Clearly, this question enabled more able students to use their ability to effectively apply their knowledge and understanding of the second messenger model. This resulted in some excellent, detailed explanations. The mark point most frequently awarded was for less glycogen being converted into glucose. Common errors included using the term 'glycolysis', 'glucolysis' or 'glucogenesis' rather than glycogenolysis. Students obtaining two marks often linked less glycogenesis to less kinase being activated. However, although many students referred to less cyclic AMP being produced, only the more effective answers indicated that this was due to less ATP being converted into cAMP.

Question 6

06.1 Surprisingly, this question and question 06.2 were poor discriminators. The genotype GgRr (alleles in any order) was credited, in addition to the conventionally recognised genotype of GgX^RX^r (alleles in any order). Despite this, only 57% of students provided a correct genotype. Incorrect responses included genotypes with one allele of each gene, genotypes with a Y chromosome and incorrect dihybrid genotypes.

06.2 The fact that only 18% of students obtained this mark was extremely disappointing. Most students incorrectly suggested that the fact that individuals 1 and 2 produced all grey-bodied offspring was evidence that the allele for grey colour is dominant. The greater numbers of grey-bodied offspring compared with black was also often incorrectly given as evidence.

06.3 Although it was thought that this question would prove challenging, the overall performance of students was well below expectations. Only 5% of students obtained both marks and around 24% gained one mark. A common error was to suggest that the presence of more grey-bodied flies than black-bodied flies indicates that the gene is on the X chromosome. Many other students used incorrect pairs of flies as evidence. More effective responses recognised that the evidence involved: fly 3 (and fly 4) producing a black-bodied female, 9; or fly 2 (and fly 1) producing a grey-bodied male, 5. However, as outlined, only about 5% of students gained a second mark as the vast majority did not refer to allele(s) in their explanations.

06.4 This question and part 06.5 were effective discriminators. There were some very clear, correct genetic diagrams for this sex-linked, dihybrid cross which enabled around 28% of students to gain all three marks. Relatively few students, around 8%, scored two marks. These students provided correct genotypes for the parents and offspring and then made an error with the phenotypes of the offspring. Usually, these errors involved omitting the gender of the offspring or providing an incorrect phenotype for a male offspring. Almost a third of students obtained a single mark, often for providing correct gametes from incorrect dihybrid genotypes. Fewer students obtained a single mark by providing correct genotypes and then incorrectly completing the dihybrid cross.

06.5 Approximately 27% of students obtained both marks using the Hardy-Weinberg equation to calculate the percentage of flies heterozygous for gene **G** as 48%. Approximately 41% of students gained one mark for an incorrect answer but showed an understanding that 2pq represented the frequency of the heterozygous genotype. A significant number of students scored zero as they calculated pq rather than 2pq.

Question 7

07.1 Almost 70% of students correctly identified the chemicals needed for the light-dependent reaction.

07.2 Photoionisation in the light-dependent reaction was clearly described by many students, with 44% obtaining both marks and approximately 77% obtaining at least one mark. Some students limited their description to photolysis and gained no marks. Many students referred to chlorophyll absorbing light and/or light exciting the electrons in chlorophyll. Some answers referring only to chloroplasts or photosystems did not obtain this mark point. Many students referred to electrons being lost or being passed to the electron transport chain. Few students referred to chlorophyll molecules becoming positively charged.

07.3 This question was not well answered and was a poor discriminator. Slightly more than 20% of students obtained the mark. Only the minority of students could clearly explain that pencil was used to mark the origin so that the origin/line was still visible after running the chromatogram. The problem of ink dissolving in the solvent was appreciated by many but the consequences of this were not explained; the mixing of the ink and leaf pigments was not appreciated by most students. Answers often only referred to the ink running/smudging/dissolving in the solvent and affecting results. It was not always clear whether students were writing about pencil or ink.

7.4 Considering this required straightforward recall of required practical activity 7, the responses were often quite poor. Approximately 12% of students obtained both marks and around 45% obtained at least one mark. Many answers only mentioned placing the chromatogram in a solvent, adding a lid and running the chromatogram for a set time or until the pigments had separated. More students obtained a mark for the level of the solvent being below the origin than for marking the solvent front or for removing the chromatogram before it reached the top/end. Some students explained the principle of chromatography rather than providing details on the method. A range of inappropriate solvents were referred to including water, glucose and hydrochloric acid.

07.5 Approximately 66% of students used the given formula and correctly calculated the R_f value of pigment **C**.

07.6 Approximately 46% of students obtained this mark, explaining that different wavelengths/frequencies of light could be absorbed for photosynthesis. Students failing to gain credit often omitted to mention photosynthesis or did not refer to wavelength or frequency of light. A few students suggested the different colours of pigments enabled them to be identified during chromatography.

Question 8

08.1 This question and parts 08.2 and 08.3 proved to be effective discriminators. Surprisingly, few students could clearly explain what a DNA probe was, omitting the key ideas of single-stranded and complementary bases. Consequently, only around 11% of students obtained both marks and around 35% one mark for their definition. Many students simply repeated the role of DNA probes as outlined in the stem to question 08.2, i.e. to detect specific base sequences of DNA. A significant number of students provide details on the labelling of probes or confused them with marker genes.

08.2 Almost 70% of students obtained at least one mark for this question, invariably for referring to the use restriction endonuclease/enzyme to cut the DNA into fragments. The most common incorrect named enzymes were DNA helicase, DNA polymerase and reverse transcriptase. A significant number of students suggested heating the DNA to break it down. Centrifugation, PCR and the use of probes were also suggested. Approximately 36% of students gained a second mark for describing that the DNA was cut at specific base sequences or at recognition/restriction sites. Responses referring to palindromic sequences or to the breakdown of phosphodiester bonds were also credited. Many students who did not obtain this mark often only referred to 'specific sequences' or named incorrect bonds in the breakdown of DNA.

08.3 Approximately 55% of students understood that single-stranded DNA was required so that the DNA probe could bind. The attachment of the probe was described in a variety of ways, including hydrogen bonding, base pairing and DNA hybridisation. A significant number of students stated that the treatment would expose the bases, but did not refer to attachment of the probe. Some students suggested the attachment of DNA for replication or RNA for transcription.

08.4 The idea of comparing the volunteers' lanes with lane 1 was often awarded so that approximately 60% of students obtained at least one mark. The idea that the lengths of the DNA fragments in lane 1 were known was less often clearly stated. This resulted in only about 24% of students gaining both marks. Many answers explained how the fragments are separated based on the negative charge of the DNA and size of the fragments, without explaining how the size of the viral fragments could be determined. Lane 1 was frequently described as a control containing the five different viral fragments or known viral fragments. References to the lane 1 fragments containing different numbers of VNTRs was not uncommon. A few students suggested that the fragments in lane 1 contained RNA rather than DNA.

08.5 This question was not well answered and was a poor discriminator. Surprisingly, only about 17% of students correctly identified the volunteers with 250 base pairs or 535 base pairs.

Question 9

09.1 This question proved to be a very good discriminator. Approximately 10% of students obtained all five marks and 92% at least one mark. Most students referred to using a grid or dividing the marsh into squares or sections. A minority of students suggested using a belt transect, which was credited. Most students also obtained a mark for describing a method of obtaining random coordinates, invariably by using a random number generator. There were some responses that suggested randomly throwing quadrats, although these were fewer than in previous years. The most frequently awarded mark point was for counting the number of sundews in a quadrat or for determining the percentage cover. However, a few students suggested counting sundews in a transect or a 'Punnet square'. Many students appreciated that a mean number or mean percentage should be calculated, but did not indicate that a large sample size was required. Some spent considerable time describing how the percentage cover in a single quadrat could be determined without explaining how the mean percentage could be calculated. Many students did not provide a valid method for calculating the total number of sundews in the marsh. A common response was to suggest 'scaling up' from the mean number but without any detail on how this would be achieved. Fortunately, compared with previous questions on this topic, very few students suggested the 'mark-release-recapture' method. Interestingly, a few students

switched from sundew to 'mildew' during their description. Students were not penalised for this slip up.

09.2 Despite attempts to make the mark scheme as accessible as possible, almost 70% of students failed to gain a mark on this question and only 5% obtained both. Most explanations were very imprecise, with the digestion of insects releasing 'nutrients for growth' a common response. Many answers referred to nitrates or ammonium ions as products of digestion, which were not credited. It was not uncommon for students to suggest that saprobionts were involved in digesting the insects. Students gaining both marks often referred to the 'digestion of proteins' providing amino acids for the sundew. Accepting 'phosphate' as a product of digestion enabled a significant minority of students to gain one mark.

Question 10

10.1 This question and parts 10.2 and 10.3 proved to be effective discriminators. Approximately 84% of students obtained at least one mark on this question and 11% obtained maximum marks. Most students gained a mark for referring to 'saltatory conduction' or for describing this process. Many of these students then explained that the transmission of nerve impulses would be slowed due to damage to the myelin sheath. Many referred to 'action potentials' which was credited, but a few students referred to 'messages' or 'signals' which were rejected. Only a minority of students referred to the neuromuscular junction or sarcolemma to obtain maximum marks. A few answers focused entirely on the process of muscle contraction and how paralysis affected the actin and myosin filaments.

10.2 This question proved more difficult than expected. One reason for this was that a significant proportion of students focused on 'heart rate irregularities' without due consideration to how Guillain-Barré syndrome was involved. Consequently, they provided explanations of how changes in impulses from the SAN, rather than to the SAN, could cause heart rate irregularities. Not surprisingly, this led to only about 4% of students achieving maximum marks and only around 44% of students obtaining at least one mark. Students who did use the information in the passage often obtained a mark for referring to impulses going to the SAN. Many of these students referred to the autonomic nervous system but not specifically to the sympathetic or parasympathetic pathways. Some students did not gain mark point one as they suggested that no impulses would be transmitted to the SAN. More effective responses referred to fewer impulses from the medulla or cardiac centre.

10.3 Approximately 63% of students obtained at least one mark for this question and around 21% gained maximum marks. The best responses demonstrated a clear understanding of the method of action of this drug. However, many students wrote that mRNA was inhibited but without any indication of how, so only gained the mark for the idea of preventing translation. Some students had not carefully read lines 13-15, so seemed unaware that the drug contained single-stranded DNA molecules or that it inhibited mRNA. The drug was often thought to be complementary to the DNA coding for huntingtin, binding to that DNA and so preventing transcription of the DNA to form mRNA and hence reducing the concentration of huntingtin. The single-stranded DNA was also replicated in the patient's cells and then transcribed and translated to form larger amounts of a different protein rather than huntingtin. Other students thought that as the drug contained single-stranded DNA, this would only produce half the amount of mRNA and so half the amount of huntingtin. Other suggestions were that the drug either contained small interfering RNA (siRNA) or single-stranded DNA that was used to produce siRNA. The drug was also said to bind to promoter regions or transcription factors to prevent transcription of the faulty allele into

mRNA. It was also suggested that the DNA was complementary to the huntingtin protein. Occasionally transcription and translation were confused.

10.4 This question caused few problems for most students, with 87% obtaining at least one mark and just under half obtaining both marks. However, as with question 10.5, it proved to be a poor discriminator. Many students correctly suggested that the huntingtin protein would still be produced. The short period of the trial, the small sample size and the fact that the mutation would still be present were also frequently credited. Relatively few students suggested that the treatment could not be considered a cure as brain damage may have already occurred. Responses which did not gain credit often limited suggestions to the allele being passed on to offspring or to 'resistance' to the drug developing.

10.5 Only around 14% of students gained both marks in this question and 61% at least one mark. Although many students realised that the drug could be digested, not all these responses gained credit. The main reason for this was that, despite being told that it contained single-stranded DNA, many students referred to the drug as being a protein or named inappropriate enzymes digesting the drug, such as proteases. Although more effective answers referred to the cerebrospinal fluid bathing the brain, imprecise responses such as bathing the nervous system were not credited.

10.6 Despite only around 42% of students obtaining at least one mark and around 16% two marks, this question was a good discriminator. The effects of increased methylation and increased acetylation on transcription/gene expression were well known by many high-scoring students and, sometimes, correctly linked to early/late onset of symptoms of Huntington's disease. Marking points were often not awarded due to omission of DNA/gene/allele when describing methylation. It was not always clear where the methylation or acetylation was occurring. The increased/decreased was not always included, particularly with methylation. The methylation also occurred at the promoter region or in a gene that inhibited the gene for huntingtin. Increased methylation was sometimes believed to increase transcription. Answers that gained zero marks usually realised that epigenetics was linked with the environment and often included the fact that the base sequence was not altered, but did not include any correct detail, other than the gene being switched on or off. Environmental factors such as smoking, toxins and stress were sometimes linked with onset of the disease. Some answers were linked to DNA replication rather than transcription. Reference to epistasis occurred on a few scripts. Increased mutations and the addition of extra CAG repeats also featured. Some answers that correctly described how methylation/acetylation caused the DNA to be more/less tightly wound around histones gained no marks, as neither the molecule being methylated/acetylated nor transcription/gene expression was clearly mentioned.

Mark Ranges and Award of Grades

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