AQA

A-LEVEL
BIOLOGY

7402/1 Paper 1
Report on the Examination

7402/1
June 2023

Version: 1.0

General comments

There is generally a good level of knowledge about eukaryotic cell structures and what those structures do; however, there is much less precision in knowledge of virus structures.

Some of the questions asked students to look closely at complex data and then interpret the trends shown by more than two variables. Some students did this well; however, many did not seem to know where to begin. The best analyses made immediate references to the information given in table headings and on chart axes. They helped to focus the direction of thinking and helped students cover more of the essential points.

Examiners observed that there was a tendency for many students to use their recall of knowledge and take little notice of the context given in a question. This was evident in explanations for the oxygen dissociation curve and in descriptions of antibody digestion. More than occasionally, this recall extended no further than GCSE level and often included irrelevant information not covered in the A-level specification.

Assessments of the acquisition of practical skills showed there is generally a good level of understanding of the Required Practical Activity 6 (using aseptic techniques). Many were proficient in the practical skill of extracting precise information from tables and graphs, but this did not extend to interpreting the information given on a logarithmic scale. There is also a good level of understanding about control variables and why they are needed in the design of investigations.

01.1

Fewer than 10% of answers correctly identified three structural features found in all viruses. Many referred to structures found only in some viruses, such as reverse transcriptase or lipid envelope. Many incorrect answers named bacterial structures (capsule and plasmids, for example) and some identified organelles, referred to the cell membrane, or flagella. Many students referred to all viruses having DNA or all having RNA, not recognising that some viruses have DNA whilst other viruses have RNA.

For mark point 2, many students recognised the role of attachment proteins but failed to refer to either “receptors” or “binding” and so failed to score the mark. Other students were able to access this mark even though they focussed on a feature excluded from mark point 1; the most common mark here was for the correct role of reverse transcriptase.

01.2

Examiners noted that the definition of acellular was given correctly by only about 15% of students. Successful answers invariably referred to the idea of viruses having “no organelles” or to “no cytoplasm”.

Often acellular was incorrectly defined in terms of non-living features; for example, “viruses are acellular because they need a cell to respire” or “viruses are acellular because they cannot reproduce on their own”. Incorrect answers for the acellular definition also included references to viruses being “smaller than a cell”, being “unicellular” or “not multicellular”. Others implied that prokaryotic cells could be non-living; for example, statements such as “viruses are non-living because they do not contain mitochondria”.

Examiners encourage teachers to review their teaching of the “acellular” concept.

Most students achieved the mark for the non-living definition. Usually this was with explanations involving viruses' "inability to replicate (without a host cell)", or to their "inability to respire".

01.3

About one quarter of students achieved this mark, most often for recognising that viruses do not have a cell wall.

Many students failed to understand what this question was driving at. The reason antibiotics were not effective against viruses was supposed to elicit the idea that viruses do not have bacterial structures. A common answer was that viruses live/hide inside host human cells and so were not accessible to antibiotics. This was more GCSE standard than A-level standard. Few students could name bacterial structures (absent in viruses) that antibiotics target. Some students mistook "antibiotics" for "antibodies" and produced answers that referred to the variability of the shape of antigens on the virus caused by frequent mutation.

02.1

Students demonstrated good knowledge of cellulose structure and applied what they knew to successfully compare cellulose structure with chitin structure. Approximately 40% of students achieved full marks.

Examiners frequently observed correct answers with references made to β glucose, glycosidic bonds, and unbranched or linear structures. Good descriptions of the 'flipping' (or rotation) of alternate monomers were seen less often. The use of the word "molecule" rather than "monomer" (or an appropriately named monomer) was imprecise and did not get credit.

Unfortunately, **Figure 1** was incorrectly drawn – it showed rotation, rather than 'flipping' of adjacent (N-acetylglucosamine) monomers. The mark scheme was expanded to allow descriptions of this rotation, though, as mentioned above, such descriptions were rare. The diagram of the chitin polymer has been corrected in the published version of the question paper.

Some students failed to score the mark for the "1–4 bond" because they referred also to "1–6 bonds"; this suggested they had encroached into ideas about starch structure. In addition, many referred to hydrogen bonding between glucose chains, which is not a structural feature shown in the Figure. Consequently, examiners suggest it would help to remind students that they need to respond to what is being asked in a question and not look to include additional answers.

02.2

Many students showed a good recall of tracheoles and understood gas exchange principles in insects.

Unfortunately, some answers focussed only on the role of spiracles in the tracheal system, so did not refer to an adaptation of a structure at an insect's gas exchange surface. Examiners also observed answers explaining how water movement from tracheoles affected the rate of gas diffusion, which, again, is not related to an adaptation of the gas exchange surface. Similarly, explanations of how insects conserved their body water in the tracheal system scored no marks.

Highly branched tracheoles was a frequent correct answer, with many going further to explain how this adaptation increased surface area leading to rapid diffusion. Some failed to score the explanation mark by referring to increased gas exchange rather than to increased diffusion.

Examiners encourage teachers to highlight the difference between these terms and when to apply them. The idea of a short diffusion pathway was seen in most correct explanations.

02.3

Fewer than 5% of students achieved all 3 marks.

Approximately half of the students mentioned a “water column”; some went further to refer to “cohesion caused by H bonds” but very few considered how tension was created.

A common misconception was observed in those answers which referred to the translocation process, including to “source and sink” ideas and sugar movement in xylem vessels.

03.1

This question required students to identify a eukaryotic cell structure from an unfamiliar diagram.

Students’ knowledge of the composition of eukaryotic cell structures is particularly good. The mark was achieved by 90% of students, with the most frequently given correct answers being mitochondria, rough endoplasmic reticulum and nucleus.

Examiners observed quite a few answers that referred to plant cells and more occasionally to bacterial cell structures. Consequently, incorrect answers included vacuole, cell wall and plasmid.

03.2

The functions of the Golgi apparatus are known well. Most answers (60%) achieved both marks for the idea of processing or packaging proteins and lipids. Many students gave two correct Golgi actions but only one function; for example, “processing lipids” and “producing glycolipids” covers a single Golgi function, so achieved just one mark.

Few students mentioned glycoprotein or glycolipid production. Golgi vesicle production and lysosome formation are functions known by many students.

A surprising number of students thought ribosomes are made in the Golgi apparatus.

03.3

This question was answered correctly by 70% of students.

03.4

Approximately half of the students achieved the mark.

The most frequent correct answer was 8 381 400. The correct use of standard form and correct rounding were often observed. Many students successfully calculated the number of malaria cases outside of Africa but did not use 61% to show the proportion of those cases caused by *P. vivax.*

Examiners noted frequent use of incorrect mathematics which included: finding 67% (6% + 61%) of 13.74 million, calculating the sum of 61% and 6% of 229 million, finding 61% of 229 million.

03.5

This question discriminated well. 40% of answers were awarded either 3 or 4 marks.

There was a lot of evidence in answers of students using stock phrases about natural selection with no context given. For example, some students wrote "variation exists, and people with favourable alleles survive and reproduce and pass on these alleles, so the allele frequency increases". These students could not access mark point 1 or 2, as there was no mention of mutation or to the context of "malaria or *P.vivax*". Examiners encourage students to tailor their answers to the given context.

Many referred to mutations without stating that the mutation produced an allele (of a gene) and so did not gain a mark. Many also failed to score a mark by referring to survival being assured by a "resistance gene" rather than by a "resistance allele"; the confusion between "gene" and "allele" shows a common misconception. Some referred to mutations producing "desired characteristics or traits" with those characteristics enabling people to survive; again, no marks were awarded for these. Occasionally, the mutation was said to occur in the *P. vivax* organism, so missing the whole point of the question. Some mentioned immunity rather than "resistance" and went further to provide detailed but irrelevant accounts of active or passive immune responses. Some students suggested that the resistance allele died because of suffering from malaria.

04.1

This question differentiated well although many otherwise good answers made no mention of osmosis as the process of water movement.

Examiners encourage students to become more aware of the hints made in questions and then to respond to those hints. For example, a hint about water absorption in the ileum should promote ideas on water movement by osmosis and lead naturally on to the consideration of water potential differences. Instead, many students incorrectly suggested diffusion was the method of water movement and tried in vain to link these ideas to a longer diffusion pathway.

The direction of the water potential gradient or the direction of water movement was not always made clear. This often made it difficult for examiners to decipher precisely where water was moving from; for example, "water moves in the ileum" or "water moves out" were common imprecise answers.

04.2

The question differentiated reasonably well, although few answers (<15%) achieved full marks.

Nicely articulated answers demonstrated that some students had a sound understanding of how to apply knowledge of passive immunity to these data. At the other extreme, many lengthy answers contained no more than descriptive recall of active immune responses and scored no marks.

Ideas covering mark point 1 were often omitted or they explained that the antibodies destroyed the pathogen rather than destroying the toxin. Few answers contained accurate, detailed knowledge about the role of antibodies in neutralising the effect of toxins.

Many students successfully used the Figure to link the presence of antibody to the prevention of diarrhoea and often went further to suggest that those with the infection and diarrhoea were the patients to be offered treatment. Some misinterpreted the Figure by suggesting antibody injections had elevated the blood antibody concentrations, so did not appreciate that the changes in blood antibody concentrations shown in the Figure were a patient's natural response to the infection (before antibodies were given artificially).

Examiners noted that many students did not link their good knowledge of immunity to address the context of passive immunity. For example, they gave a detailed and irrelevant account of the clonal expansion theory of B and T cells. This suggested to examiners that more opportunities provided in teaching for students to apply their understanding of immunity, rather than only learning facts about it, would help students to answer questions set in an unfamiliar context, such as in this *C. difficile* scenario.

04.3

This question discriminated well, but many answers achieved no marks. This was either for not considering digestion at all, or for not recognising that antibodies are protein, or for describing the absorption process.

Most students who did appreciate that the anti-toxin antibody was a protein gave full descriptions of how proteases would digest it. Some confused the roles of exopeptidase enzymes and endopeptidase enzymes, so achieved no marks for mark point 2 and mark point 3. Those students who achieved mark point 2 invariably went on to also achieve mark point 3, so in this respect the question did not differentiate as effectively as was planned.

Some lengthy descriptions of digestion, given at no more than GCSE level, made general statements about the effect of stomach acid on protein digestion and gave irrelevant accounts of absorption. Some answers referred to incorrect enzymes, such as amylase.

A common misconception was seen in answers where enzyme action hydrolysed amino acids rather than hydrolysing the bonds between amino acids. Often the correct proteases were listed without going any further; for example, by not referring to the breaking of "bonds" or not identifying the substrates and products.

When only one mark was achieved, this usually came from knowing that peptide bonds were hydrolysed.

05.1

This question was designed to test knowledge of a required practical activity. The mark scheme was identical to the one used for a similar question set in 2022.

The question discriminated quite well, although a surprising number of otherwise good answers contained illogical steps (such as using a loop to spread 100 mm^3 of culture), which suggested not all students had done the practical.

Many answers reached the maximum of 3 marks easily and demonstrated there was sound knowledge of the principles. Frequently, these answers referred to "disinfecting the surface", "flaming the (bottle) neck" and "using a sterilised spreader".

Incorrect steps in aseptic technique achieved no marks, such as: flame the lid, flame the (agar) plate, sterilise surfaces, and upward air movements killed bacteria. Other answers which gained no marks included: wear gloves, hold the plate away from the face, work quickly (with the lid off), sterilise all equipment, and close windows. Examiners noted many examples of lengthy explanations. These explanations achieved no additional marks because the command word used in this question was "describe".

05.2

This question tested students' mathematical skills required to use an unfamiliar equation, to change the subject of that equation, and then manipulate figures using basic number skills. It discriminated reasonably well, with 60% achieving full marks and a further 15% performing at least one of the maths steps successfully.

Examiners noted that the full range of correct rounding was given for the final calculated number. Some students failed to successfully rearrange the equation but achieved one mark for showing evidence of using the equation to calculate πr^2. Others used the correct method but with the diameter instead of the radius.

05.3

This question discriminated reasonably well.

There was generally a proficient level of understanding on how to provide adequate control tests for this investigation, although using the context of "positive" and "negative" controls did distract quite a lot of students, including some with high ability.

Acceptable positive controls were given more often than acceptable negative controls. "Doing nothing to the well" for a negative control was a frequent incorrect answer; "adding bacteria to the well" was also invalid and demonstrated those students had not fully comprehended the design of this investigation.

A mark was not achieved for suggestions that "using antibodies" could be a positive control.

Occasionally, answers made correct suggestions but for the wrong types of control; for example, using water for the positive control and an antimicrobial for the negative control.

05.4

84% of answers achieved 1 mark. An incorrect median figure for the positive control was often the reason why the mark was not achieved.

In the marking guidance, the correct mean values are given to the same number of significant figures used with other data presented in the Table. This was designed to reinforce the expectation that processed data have an appropriate number of significant figures when given in tabulated form. On this occasion, examiners eased the demand of the mark scheme by also accepting correct answers given to 3 significant figures.

05.5

Less than 5% of answers achieved both marks.

Very few students noted that the information given on the bottom line of Table 1 represented only one standard deviation. Consequently, the calculations rarely used 2 × SD and so missed a mark. Some students did use the correct approach but then made a mistake with basic arithmetic.

Examiners looked for answers which represented the full range of data associated with 2 mean values (ie 4 figures), but rarely observed it.

Regardless of the calculated answers given, it was disappointing that so many students still gave explanations that involved the “results” being due to chance, or “results” are not significant, rather than explaining that the “difference” is due to chance, or the “difference” is not significant. In addition, some correctly referred to a context of “differences in mean values” but then did not link this to an overlap of the standard deviations (or overlapping distributions), so missed the mark.

Examiners eased the demand of the mark scheme by awarding mark point 2 independently from mark point 1; ie when correct calculations to support a valid explanation were absent.

06.1

This question discriminated well, with 70% of the cohort knowing at least one of the definitions. More students gave a suitable definition of genome than of proteome.

Poor expression restricted the marks for some students who otherwise had something of a good feel for these definitions. References to all the “genetic information” or to “the genetic code” or to “the genetic constitution” of a cell gained no marks for the genome definition.

Many answers lacked precision in the detail given about the proteome. For example, answers giving “all the proteins a cell codes for” lacked precision by not referring to DNA or to the genome. Others omitted reference to the proteins a cell “can produce”, relying instead on a vague mention of “all the proteins in a cell”. In addition, the term “expression” was used incorrectly by some students; for example, the “proteome is the expression of all proteins in a cell”.

Examiners also noted incorrect answers where the genome was referred to as “all the DNA in a population or species” and likewise, for the proteome, with “all the proteins produced by a species”.

06.2

This question differentiated reasonably well with a quarter of students gaining full marks and over 80% achieving at least one mark. It was an accessible test of the AO3 assessment objective.

The command word in this question was “consider”. It proved to be an effective trigger and encouraged many students to evaluate the technique fully.

Some students demonstrated their secure comprehension of details given in the question when they explained how separate species would be indistinguishable because they possessed an identical number of flagella or flagella of identical shapes. Many answers made clear references to ideas of the “low resolution of (optical) microscopes”, to “broken flagella” and to the consequence of “the difficulty in staining flagella”, so achieved the maximum 3 marks.

Examiners noted only a few occasions when students confused the idea of “resolution” with “magnification” and some occasions when mention of “resolution” was omitted in the context of optical microscopes.

06.3

This question was answered most successfully by students at the top end of the ability range.

Many answers were no more specific than to refer vaguely to using “new technology” or “scientists are now better at classification” or “the early method was inaccurate”. Often, students thought that the organisms had evolved into new species, or they had mutated so needed to be renamed. Many answers referred to the need to move away from techniques that relied upon identifications using observable, physical features, but did not go on to suggest what those new techniques could be. If alternative microscopes were mentioned, either the type of microscope or its resolution were usually omitted.

“Genome sequencing” was seen more frequently in answers than those mentioning molecular sequencing. Students often failed to include the word “base” in their responses referring to DNA, mRNA or RNA sequencing.

06.4

This question discriminated well. Approximately half of the students achieved both marks. They had successfully measured the length of the cell, used the units appropriately and made magnification the subject of an equation that they had recalled. The answer of × 20 000 was the most frequent correct answer.

An incorrect conversion of mm to µm was observed in a good proportion of calculations. A frequent reason for achieving only 1 mark was observed when students measured the image size in mm, then converted it incorrectly to µm; for example, 46 mm converted to 4600 µm. Those students who correctly converted 2.3 µm to 0.0023 mm and used this as the denominator were able to score at least one mark.

A small number of students used an incorrect formula; they divided the real size by the image size and scored no marks unless, of course, they had successfully converted the units.

07.1

This question proved to be difficult for many students, with 40% getting no marks.

It tested students’ ability to apply an understanding of oxygen dissociation curves to an unfamiliar context and to interpret scientific information. Unfortunately, many answers showed only a recall of knowledge associated with a general oxygen dissociation curve. For example, answers stating that the COHb “would load more readily at low pO_2” are correct in a general sense, but incorrect as an effect of carbon monoxide poisoning, where the haemoglobin would not load oxygen at these low oxygen partial pressures. Instead, COHb would unload less oxygen in the given context. Consequently, very few students achieved mark point 3.

Students were more successful in using the Figure to recognise that the COHb had a higher oxygen affinity as well as for correctly noting 50% (oxygen) saturation was the maximum for this type of haemoglobin. Examiners observed that almost as many students had referred to COHb with a lower oxygen affinity as had referred to COHb with a higher oxygen affinity.

The Bohr shift and the effects of changing (blood) pH were irrelevant to the answer required, but many students made references to them.

07.2

This question discriminated well, however not many students (only 5%) achieved full marks.

In the best answers, students stated clearly whether the scientists’ conclusion was correct or incorrect and then went on to provide appropriate supporting evidence using information from the table. This represented impressive evaluative skills because the context used for this question was designed to offer significant challenge. Unfortunately, many got lost in the detail of the question because it required them to make comparisons using maths inequalities suggested in WHO recommendations against the predictions obtained from a mathematical model. Consequently, many students gave lengthy evaluations which lacked logical flow and made contradictory statements.

Comments made about the nature of the investigation's design often achieved some marks. Many correctly identified that the mathematical model was based on theory, not on real life, and others noted the absence of statistical tests (although, once again, students missed a mark by failing to refer to statistics measuring 'differences' between results). Some correctly noticed there was a lack of attention given in the design to people varying in size or age etc, and some also noticed the data were generated only for people at rest.

08.1

This question was accessible to most students; 80% achieved at least one mark.

Many (42%) achieved both marking points, usually for stating "2 nuclei (per cell)" and "cytokinesis is inhibited". Fewer identified telophase as the stage to which mitosis had reached.

Some students identified the nuclei shown in diagram A as being separate cells but surrounded by a single cell-surface membrane. They, clearly, had failed to identify nuclei in the Figure.

08.2

This question was very well answered by most students, with over 50% achieving full marks.

Mark point 1 was achieved most often for stating that either the inhibitor binds at a site that is not the active site or it binds to an allosteric site. Occasionally, students described an inhibitor bound to a substrate and a few incorrectly described this enzyme-inhibitor interaction as competitive inhibition.

Examiners observed many good descriptions of how the inhibitor interaction changed bonding in tertiary structure leading to a changed shape of active site.

When mark point 3 was not achieved, it was usually for either omitting a reference to the complementary relationship between the enzyme and its substrate or for not specifying that the loss of the complementary relationship meant the substrate could no longer "bind" to the enzyme. Some students referred to a 'loss of specificity' between the enzyme and its substrate, which did not convey enough of the idea of them losing the complementary relationship.

08.3

Students tended to score no marks or 1 mark for their answer.

Many achieved mark point 2 because they correctly identified a trend in which increased MiTMAB concentrations produced "more inactive enzymes" or caused "more cell death" or "less cytokinesis". Many missed this mark because they referred to "increased drug concentrations had caused cell death or stopped cytokinesis", so they had not described a trend in the data.

Many answers described what the Figure showed, with no explanation given. For example, "as MiTMAB concentration increased, proportion of control growth decreased" or "there is a negative correlation". Some demonstrated they had a clear understanding that the dependent variable measured the number of cells in drug-treated cultures compared with the number of cells in untreated cultures; however, most students showed little comprehension for the meaning of the dependent variable.

Mark point 1 and mark point 3 were not often awarded. These marking points tested students' ability to read accurately from the logarithmic scale in the Figure. Few students did this successfully, with common incorrect references made to 80 rather than 70μg dm^{-3}, 1100 rather than 2000 μg dm^{-3}, etc. Examiners also noted many incorrect answers which referred to MiTMAB concentration < 100 μg dm^{-3} when the correct range taken from the Figure is between 30 μg dm^{-3} and 70 μg dm^{-3}.

Examiners eased the mark scheme and allowed references to "lowest" or to "highest" MiTMAB concentrations to remove the need to take numerical information from the Figure, but very few answers referred even to lowest or highest.

08.4

This question was answered correctly by very few students; 7% achieved 2 marks. 32% of all students left the question unanswered, and an equal number scored zero marks.

Some students successfully identified 2000 as the concentration of MiTMAB giving cell growth at 0.0 of the control; however very few correctly used values of MiTMAB between 30 and 70 to successfully calculate the increase in mass. Very few students used the logarithmic scale correctly; for example, many answers referred to 20 rather than 30, or 1100 rather than 2000.

Some answers contained evidence of the correct use of the dilution factor (0.01), so achieved 1 mark. Evidence of other types of acceptable 1-mark answers were almost never observed.

09.1

Half of all students got a single mark for this answer, almost invariably for correct references to enzymes and substrates; fewer (about 8%) identified antigens at line T.

Examiners noted many examples of well written answers that demonstrated good knowledge of the ELISA technique set in a lateral flow test context. These answers made it clear that the test detected dengue antibodies in blood samples, leading to an enzyme catalysed reaction with a substrate and a colour change. Unfortunately, many students referred instead to detection of viruses or to detection of antigens present in blood, which demonstrated that they had not fully comprehended all the details given in the question.

It was often difficult for examiners to decipher from the convoluted wording in some answers, exactly what was immobilised on the T line.

Some answers referred to antigen-antibody complexes and described these reacting with a substrate. They did not achieve a mark because they had not involved enzymes; similarly, other answers referred only to a coloured dye or to beads that changed colour.

09.2

This question did not differentiate well, but a fifth of all students got the mark.

Examiners looked for an understanding that the control line showed that the blood sample had moved through line T to reach line C. So, a result at line C (whether positive or negative) would be questioned without unambiguous evidence that the sample had passed through line T.

Most incorrect answers focused on why a coloured line could develop at C; for example, “it showed anti-human antibody with enzyme and its substrate had reacted at C”.

09.3

This question differentiated well.

Most students correctly referred to the rapid or uncontrolled replication of the “cancer cell” part of fused cells.

Fewer achieved mark point 2, often because either the answers did not mention B cells, or they did not mention antibody production. Examiners eased the demand of the mark scheme by accepting reference to plasma cells or memory cells as alternatives to B cells. Those who gave accurate (often lengthy) descriptions of a humoral response achieved mark point 2 by this route even though, in the hybridoma context, such a response would not occur. Other irrelevant details included references to interleukin, the involvement of T cells and to an immune response in rabbits by assuming these animals were exposed to cancer cells.

09.4

Few students correctly answered this question.

The command word “evaluate” was almost invariably missed when students tried to comprehend the question. Consequently, a very large majority of answers gave only one side of the argument; they focussed only on the harm done to rabbits.

09.5

60% of all students achieved at least 1 mark but few scored full marks.

The command word “discuss” did encourage some students to write at length on trends shown in the data. Some provided logical comparisons of the tests and went further to consider at least one aspect of the investigation’s design (often by referring to the cost-effectiveness of the new test or to the speed of obtaining results).

Some did not achieve mark point 1 because they omitted a reference to the current test.

Examiners noted in some excellent answers that students had determined the total number of positive results for each test, and others had calculated correct percentages using those totals. They represented high order analytical skills.

09.6

This question discriminated very well.

Examiners observed a common misconception in many answers when references were made to the return of “tissue fluid” by osmosis, not to the “movement of water” by osmosis. This cost students one mark and was often seen in otherwise good explanations.

Many answers referred incorrectly to the movement of protein causing an increase in the water potential of tissue fluid. Likewise, many did not identify where the water potential had increased or refer to the direction of water movement.

10.1

This question was very well answered. A quarter of students achieved full marks and 90% scored at least 1 mark. It looked for a straightforward description of protein structure, linking the various levels of protein structure to specific types of bonds.

The best descriptions covered all mark points in just a few lines of writing. Many who did not achieve full marks had omitted a description of the primary structure in terms of peptide bond formation “between amino acids” or they did not mention “condensation reaction(s)”.

A sizeable number of students think that a quaternary structure is made of four polypeptides, possibly because of the prefix used in “quaternary”, or because the concept was taught using haemoglobin as an example. Many answers missed mark point 5 because they referred to many “tertiary structures” rather than to “polypeptides”.

Some answers contained a lengthy description of protein synthesis which was irrelevant to the question and gained no additional marks.

10.2

More than half of all students obtained 4 marks on this question and 15% went further to achieve full marks.

The marking points most often observed included references to histones, the complementary relationship between named nitrogenous bases, to named structures in a nucleotide and the double stranded nature of DNA molecules held together by hydrogen bonds. A lot of students made correct references to the number of hydrogen bonds between complementary base pairs, some identified the pyrimidine and the purine bases, and they described the 5’ to 3’ direction of polynucleotide strands: all of which, while being correct, were at a level not expected for A-level. Many students made correct references to phosphodiester bonds without always precisely stating the location of those bonds.

Unfortunately, some students only provided first letters of the base names which, as in previous examinations, was not credited.

The mark point observed less frequently related to DNA being a “polymer of nucleotides”.

10.3

This question differentiated well, although few scored 4 marks.

Most answers began with references to the genetic variation produced in meiosis. Some described the crossing over process in detail; for example, that non-sister chromatids break and re-join. However, details of homologous pairing were often omitted, which prevented many answers from achieving the mark point. Examiners accepted “bivalent” as a description of a homologous pair, but references to “chiasma”, the visible expression of a crossing over event, did not contribute to the award of the mark point.

When students failed to mention homologous pairing, descriptions of independent segregation were often tortuous. It was clearly challenging for students to describe the random mix of chromosomes in gametes, where one chromosome is taken from each homologous pair, without using the word “homologous”. Some achieved it by referring to “separating or using either a maternal or a paternal chromosome from each pair”, but otherwise the mark point eluded many.

Many good answers, that achieved mark point 1 and/or mark point 2, were not finished by using a reference to something like “this produces new allele combinations”. These answers had successfully described some of the key details in meiosis but then did not state the obvious, which is “what the increased genetic variation within a species actually looks like”.

The concept of random fertilisation is well known but, surprisingly, many did not state that random fertilisation involved gametes; for example, “fertilisation is random” did not achieve a mark.

Many wrote at length about the introduction of new alleles (eg migration) increasing genetic variation in a species. Although it would introduce new versions of alleles it is only through events in meiosis or at fertilisation where the genetic variation is increased. Some gave lengthy descriptions about the effects of natural selection in changing allele frequencies but, again, they missed the point; only through meiosis and fertilisation can new combinations of alleles be formed.

Examiners suggested it is good practice to refer to mutation, meiosis, and genetic variation in teaching the inheritance topic and the speciation topic to reinforce the difference between genetic variation (brought about by mutation and meiosis), and changes in allele frequency.

References to non-disjunction events gained no marks because these are types of (chromosomal) mutations, which the rubric of the question excluded. Similarly, a misconception held by some students, that environmental factors caused increased genetic variation, did not score a mark (obviously).

Mark Ranges and Award of Grades

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