A-LEVEL
BIOLOGY

7402/1 Paper 1
Report on the Examination

7402
June 2022

Version: 1.0

General comments

On the whole the questions on this paper discriminated very well. 24 of the questions achieved discrimination indices greater than 0.4. (The discrimination index is a measure of correlation and indicates the extent to which an item discriminates between high-attaining and low-attaining students.) The mean mark and standard deviation were both higher than those achieved in 2019.

Students demonstrated they had good knowledge of subject areas such as nucleus structure and function, carbohydrate transport in plants, and starch digestion. They made comprehensive comparisons between the structure of starch and the structure of cellulose. This suggests they had made good use of the advance information distributed to all centres.

In addition, good success was observed in the answer using an understanding of the osmosis practical (Required Practical Activity 3). Less success was seen with the understanding gained from the practical on growing microbes (RPA 6). One aspect of weaker responses was how best to prepare suitable controls to use in an enzyme investigation.

Question 1

01.1 Students knew the structure and function of nuclei well, with over 90% of students achieving at least 1 mark and many answers scoring 3 or 4 marks. Examiners noted the full range of marking points across all answers. A noticeable number of students thought that the nucleolus contains all the DNA of the cell.

The function of the nucleus was less well understood. Very few referred to genetic information coding for polypeptides/proteins, with expressions such as ‘holding genetic material to control cell activities’ often seen; this is low-level GCSE standard and achieved no mark. Long and well-described answers often did not achieve full marks because they only included a single function of nuclei.

01.2 The correct answer featured in around two-thirds of all responses. Most answers referred to cellulose. A common misconception has murein or peptidoglycan as a component of fungal cell walls.

01.3 Many answers made invalid references to biomass representing the size and number of organisms, in much the same way a pyramid of biomass is an improvement on using a pyramid of numbers.

Relatively few students appreciated that the question was testing their understanding of using a practical technique to measure the abundance of a single species. Consequently, they often referred to biomass as a measure of energy flow or to a method to exclude water from an analysis. Many referred to counting being difficult to do accurately, but few explained that it is large numbers of organisms or their small individual sizes that will make the count subjective.

01.4 Over 90% of answers gained at least one mark, showing that there is a strong ability in this cohort of students of being able to accurately use a formula, like the index of diversity formula given in the specification. Almost all students achieved one mark for calculating the total shoot biomass from the information in the table. More than a few ignored the stated formula and went on to use the formula they had learnt in the specification and so failed to gain a mark.

01.5 About 30% of answers achieved no marks on this question. Many who did score marks gave a valid suggestion that farming practices reduced the index of diversity of plants. Often these were accompanied by lengthy explanations based on students' knowledge of farming effects, such as pesticide or herbicide use, as well as descriptions of monoculture.

Few students achieved both marks because they did not use information on fungi taken from Figure 1. The best answers made precise links between farming practices, and a reduction in fungal biodiversity leading to a reduction in plant biodiversity. In some responses, a description of the trend shown in the Figure was given without further mention of farming and these achieved no marks.

Question 2

02.1 This question produced answers that discriminated well, with 80% of students scoring at least 1 mark. Examiners marked detailed explanations which focused on changes in the frequency of alleles for resistance in a population of bacteria present in a hospital context. This reflected a very good understanding of natural selection principles applied to a novel context.

Fewer mentioned the use of more antibiotics in hospitals or the effect of weakened immune responses in patients as reasons for the stronger selection pressure in hospitals. Some incorrectly referred to the over-prescription of antibiotics or to people not completing a course of medicine as reasons for the selection pressure, when, in fact, antibiotic use is carefully controlled in hospitals.

A common misconception, seen also in previous exams, makes antibiotic use the cause of mutations. Another misconception has bacteria showing an immune response to antibiotics, often with the involvement of white blood cells and antibodies.

02.2 The mark was achieved in 85% of answers.

02.3 Two-thirds of answers gained 2 or 3 marks, showing there is good understanding of the principles used in aseptic technique. In a minority of cases, the descriptions included using tweezers to transfer paper discs onto agar plates or a loop to transfer a precise volume of liquid, which are not suitable techniques in the context of this question. Many students were vague when they covered marking point (MP) 4, suggesting they reduced the time that the lid was off the plate rather than holding the lid at an angle. Few students gave a valid explanation of why work is done close to a lit Bunsen burner.

02.4 This question discriminated well. Many students identified the difference in growth rate shown in Figure 2 and linked it to faster production of cells. On the other hand, answers which referred only to changes in the number of bacteria did not achieve the mark. Many students developed their evaluation by accurately considering the absence of statistical testing on the observed differences. Examiners noted that this student cohort did a better job of doing this fully compared with performance in previous examinations.

Few students noted that only a single concentration of trehalose was used in the investigation or that this was a laboratory-based investigation rather than tested on people. Statements observed in many poorly expressed evaluations included generic comments such as 'correlation does not mean causation' or 'other factors may be involved' and did not score marks.

Question 3

03.1 This question did not discriminate well because many students misinterpreted the question to be: 'give two **differences** between prokaryotic cells and eukaryotic cells.' Only about a fifth of students achieved the mark.

Many students listed structures that are found only in some prokaryotes and so failed to achieve the mark. These structures included plasmid, capsule and flagellum. Others correctly identified 70S or smaller ribosomes as structures present in all prokaryotes without appreciating that eukaryotic cells also contain the same structures; again no mark was given.

03.2 The mark was achieved in 85% of answers.

03.3 Half of all answers achieved 1 or 2 marks. Generally, there is a good level of understanding of hydrophilic and hydrophobic properties of substances in membrane structure. However, students often found it challenging to describe how the two different sides of the AP, and their different properties, enabled the AP to orientate itself within the phospholipid bilayer. The clearest answers contained a description of APs sitting across a membrane. Many other answers referred to helices sitting outside or on top of membranes, which made it harder to accurately describe channel formation. Examiners noted a significant number of answers that confused hydrophilic with hydrophobic; these achieved no marks.

03.4 Half of all answers contained the correct calculation. In a further quarter of papers, the correct formula for determining the area of a circle was recalled and used, but it was either based on incorrect dimensions taken from the Figure of a channel or the answer was rounded incorrectly.

03.5 Over 60% of all answers achieved at least 1 mark. Many students successfully applied their understanding of cholesterol's role in the fluid-mosaic model of membrane structure to explain why APs do not damage eukaryotic cell-surface membranes. Misconceptions included in some answers had cholesterol strengthening membranes and others had cholesterol resisting the pressure caused by turgidity. Some failed to gain a mark by not suggesting precisely how APs affected membranes, relying instead on a vague reference to 'they damage membranes'.

03.6 This question discriminated well. In many answers, students applied what they knew about the action of monoclonal antibodies to successfully explain how the techniques identified membrane-bound protein. 'Antibody binding' and the 'high resolution' of TEMs are well known principles. Examiners observed less evidence of precise understanding of the complementary nature of antibody binding. References made to ELISA testing as the technique that the scientists used were simply ignored unless they suggested, incorrectly, that antibodies had an active site.

Question 4

04.1 This question produced a high discrimination index, but examiners noted there is generally limited knowledge of virus replication for many students. Around a third of all students scored zero. Misconceptions included: suggesting a role for binary fission and mitosis in virus replication; that mRNA is injected into cells; virus replication happens inside nuclei.

When attachment proteins were included, the answers often did not link them to receptors on the host cells. Low-level details, such as 'viruses inject genetic information', were insufficient for a mark. Many ended their descriptions without including viral assembly before new particles are released from host cells.

04.2 Almost 90% of students achieved at least 1 mark, demonstrating that there is good knowledge of these cell division topics.

04.3 Over 60% of answers achieved at least 1 mark and the question discriminated well. Many students successfully described the movement of chromosomes in a non-disjunction event. They also understood that meiosis halves the number of chromosomes by separating (sister) chromatids. Those who achieved only 1 mark usually did so because they successfully applied the principles of chromosome movement in a normal meiotic cell division. Not separating chromatids was a common way in which students failed to gain a mark.

Many students did not discriminate clearly in their diagrams between long and short chromatids, but examiners on this occasion decided that they would not be penalised for this. Some students thought that non-disjunction of one chromosome would leave a daughter cell with no chromosomes.

04.4 Many students successfully obtained accurate information from the Figure to determine the total frequency of childbirths which had a non-disjunction error and used the appropriate population size in the calculation. A significant number failed to include 0.01 in the total frequency of MM1 errors, or they incorrectly referred to it as 0.1.

Examiners noted many answers where 82.8 was incorrectly rounded to 82 for the outcome of MM2 errors. Other students failed to use population sizes in the calculation, leaving their answers as a total frequency. Some students made no attempt to do any calculations and just stated that the conclusion was not valid.

Question 5

05.1 Three-quarters of all students correctly defined ‘quaternary structure’.

05.2 Many answers achieved no marks. A common misconception was suggesting the sequence of amino acids is a degenerate code or that it determines the order of bases.

Many answered a question on how two enzymes are produced rather than the actual question, so they included irrelevant details on mutations and base sequences. Those who did consider active site shapes, often failed to mention tertiary structure, or gave lengthy details of the induced-fit hypothesis. Some identified tertiary structure using ‘3^{o}’ which is not a recognised abbreviation in the specification.

Many students achieved their only mark for knowledge of enzyme-substrate complexes, but some then lost this mark by incorrectly describing the substrate as being the location of the active site. Students should be aware that the abbreviation E-S is not listed in the specification and so in isolation it is not acceptable unless the full label is given at least once elsewhere in the answer.

05.3 Only 2% of answers scored either 2 or 3 marks, suggesting that the principle of preparing controls in the context of this enzyme investigation was not well-understood. Examiners noted many misconceptions in answers on the nature of a control and the practical steps required to make a control. Very few students achieved more than a single mark. Usually, it was awarded for successfully controlling the concentration of substrate.

Many answers contained instructions to change the independent variable, such as using a different enzyme (‘to show what a normal reaction looks like’), changing the pH, adding an inhibitor, and using a different substrate. References to using a denatured enzyme were rarely seen. Students invariably mentioned using ‘the same pH’, rather than using a buffer or a **solution** of known pH, so lacking the detail expected at A-level. The control of temperature was another frequently given incorrect answer and often this was in a context where using the wrong temperature would denature the enzyme in the control, which completely missed the essential point.

05.4 Very few students achieved full marks. Many found it difficult to interpret the graphs and did not realise that a reduction in substrate concentration was indicative of a reaction taking place. This could mean that they misinterpreted when an enzyme was denatured, linking this with a drop in substrate concentration. In addition, many students wrote that an enzyme “worked well”, which was insufficient at this level for an indication of enzyme activity. Students most often achieved MP 2, by stating whether an enzyme was or was not affected by pH changes.

Question 6

06.1 This question discriminated well, although only two-thirds of answers achieved at least one mark. Many answers included long descriptions of patterns shown in the Figure, that did not include the required explanations. Consequently, they achieved no marks.

The role of increased temperature or increased light intensity were the usual ways the explanation mark was achieved. Few answers went on to state precisely why these factors affected transpiration. Frequently answers lacked precision, for example by referring to ‘the sun’ rather than to ‘light intensity’.

A misconception observed in some answers had stomata opening to allow water loss instead of opening to allow gas exchange, with water loss being a consequence of this. Many incorrectly included changes in the rate of photosynthesis in the explanation of the trend shown in the Figure. Some answers referred to the sun coming out to imply that the temperature will therefore increase, but this imprecise link gained no mark. Examiners noted that, in the best explained answers, students had often drawn lines onto the Figure, which identified the time range addressed in the question.

06.2 About half of all answers achieved full marks on this calculation, with a further 30% gaining one mark for showing an understanding of how to calculate the percentage increase from information taken from a Figure. Using the correct denominator (0.75) was the most common partially correct answer for 1 mark, but many students incorrectly used 0.8 so had not calculated the percentage change.

06.3 This question discriminated well, with a third of answers gaining full marks. Most students described an investigation that involved the change in mass of mangrove root sections, left for a period in seawater. Marks were not gained due to a lack of specific detail, particularly by omitting a method to dry root tissue. Students were confident to weigh before and after the investigation and to dry the root samples before re-weighing.

Good understanding and use of water potential terminology was used, although some incorrectly referred to the movement of seawater by osmosis rather than to movement of water (from seawater). There was no need for a series dilution to be used by the students although this was an approach followed by many. Only a small number of students chose to make a microscope slide of a sample of cells, to add sea water and then observe any changes. This technique enabled some students to gain full marks and was well described and explained.

More than a few referred to using a potometer, but this incorrect method to measure the change in water volume between cells and the external solution achieved no marks.

Question 7

07.1 The accurate recall of information on DNA and tRNA structures was a feature in many answers, with 90% of responses achieving at least 1 mark. Differences in aspects of nucleotide structures were often given correctly, along with references to double helix and clover-leaf structures.

Marks were not awarded for answers using only letters (T and U) rather than naming thymine and uracil. They were also not awarded for answers that referred to a helix without identifying it is a double helix. Many who mentioned an anticodon in tRNA failed then to adequately describe a 'lack of exposed bases' in DNA.

The use of an outline table made this question more accessible for students to produce comparative statements. Even this, however, was not sufficient for a few students who simply gave lists of unconnected factual details.

07.2 Many answers contained detailed descriptions, demonstrating a good understanding of ultra-centrifugation principles. To achieve MP 1, answers needed to make a reference to the idea of a low centrifuge speed or a gradually increasing centrifuge speed. Some students just described the faster speeds of ultracentrifugation which would occur after dense organelles are removed.

MP 2 was more easily achieved, particularly if students used the terms 'pellet' or 'supernatant'. Other common reasons for not achieving full marks included not specifying where the 'large organelles' are located in the centrifuge tube and incorrectly describing a pellet 'forming at the top of the tube'. Some answers scored no marks because they contained only a description of filtration.

07.3 Many students realised that the 'bound ribosomes' are bound to the rough endoplasmic reticulum and would therefore create structures with a greater mass. These heavier structures would, therefore, travel further down the tube and end up in the pellet. The idea that the detergent would break down the membrane of the rough endoplasmic reticulum was not well explained, with many writing that the detergent broke down lipids (which is information given in the stem of the question) rather than extrapolating to the idea of phospholipids or the membrane. A few referred to dissolving the cell-surface membrane, which was incorrect.

Question 8

08.1 This question had good discrimination, with 80% of answers gaining at least one mark. It tested the ability of students to apply their understanding of cell structures in the context of a counter-staining technique. Those who knew that the red blood cells of fish contain a nucleus/DNA often correctly used the counter-stain technique to identify cells with haemoglobin and achieved full marks.

The most common way to gain full marks was when students assumed the red blood cells of fish did not possess a nucleus, which is the situation found in mammalian red blood cells and covered in the specification. More than a few students incorrectly gave iron/Fe^{2+} as a molecule, or incorrectly referred to needing to use a stain because red blood cells are 'too small to view without it' or the 'resolution of an optical microscope is too low'.

08.2 Three-quarters of all answers scored at least 1 mark, demonstrating that, generally, there is a good understanding of how to accurately calculate a ratio and how to change the subject of an equation. Common errors were in dividing volume by surface area to get the surface area to volume ratio and failing to give the answer to 2 significant figures, as the question required. For example, 84 615 was frequently incorrectly rounded to 84 000.

08.3 This question discriminated well. Many students successfully identified that the uncontrolled cell division created a longer diffusion pathway, and many went on to link this to reduced diffusion rates. Reference to 'less' diffusion, rather than 'slower' diffusion did not score a mark.

The requirement to link uncontrolled cell division to changes in the structure of the gas exchange surface was less frequently observed in answers. Although some students were able to describe a difference between the two images, many gave vague answers; for example 'gills are thicker', or the 'gills are bent'. Better answers were more specific in which parts of the gill were thicker, identifying the gill filaments or gill lamellae and so achieved the mark.

08.4 This question had good discrimination, with many students identifying relevant differences between the circulatory systems, frequently referring to relevant heart structures or to the oxygenation state of the blood flowing through the heart. Reference to counter-current flow versus unidirectional flow in the circulatory systems was a common misconception. In addition, many mentioned the oxygenation of blood in gills versus oxygenation of blood in lungs as a circulatory difference, for which no marks were given.

Question 9

09.1 This question discriminated very well. A third of students achieved 4 or 5 marks. Sucrose was given as the carbohydrate transported in phloem cells only by those who tended to achieve at least three marks. Precise details of sucrose movement into phloem tubes by co-transport was not well known and answers often contained inaccurate descriptions of H^+ movement into and out of leaf cells. The use of the term 'mass flow' to describe movement inside phloem tubes was not often used, with many answers describing the diffusion of substances along phloem tubes. Often this diffusion occurred 'along a pressure gradient'.

Knowledge of osmosis leading to increased pressure in phloem tubes was known by most students, often leading to the only mark achieved. Many students failed to state where the transported sugar reached, using vague statements such as 'the sugar is respired at the sink' and did not mention 'cells'. Examiners reported another misconception observed in references to the *diffusion* of sugar as a transport mechanism into the sink from the phloem, rather than facilitated diffusion or active transport.

09.2 This question discriminated very well. A quarter of all answers achieved 5 or 6 marks and 85% scored at least 1 mark. Many answers contained detailed and accurate knowledge of cellulose structure and starch structure and included concise and valid contrasts and comparisons. Unfortunately, more than a few made lists of the relevant structures without linking them into comparisons; they achieved no marks. A common misconception occurred when myofibrils were given as a structure of cellulose (confusing this structure with muscle fibres).

Many answers contained long explanations of how the structures of polysaccharides are related to their function, which did not address the question and scored no marks.

09.3 This question discriminated very well. A quarter of answers achieved full marks and three-quarters achieved at least 1 mark. Few students referred to membrane-bound enzymes. Some detailed responses were spoiled by not naming maltose as the product of starch digestion, instead using the less specific term “disaccharide”. Some weaker answers contained a description of a one-stage digestion of starch straight to glucose. Examiners reported seeing more than a few answers describing starch digestion at no more than GCSE level, with references to ‘breakdown’, and the ‘production of sugar’.

The action of bile salts was frequently mentioned incorrectly in the context of starch digestion. Lengthy descriptions of co-transport also achieved no marks. References to glycosidic bonds were seen less frequently than those to hydrolysis.

Mark Ranges and Award of Grades

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