A-Level
Biology
7402-1

Report on the examination

Version: 0.1
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General comments

This paper produced a marks' distribution with almost identical mean and standard deviation to that obtained in 2024. The spread of marks was very slightly wider because some questions in 2025 achieved better discrimination in the ability range. The assessments used to test knowledge and understanding (AO1) proved to be a little more challenging this year and some of the maths assessments were slightly more accessible.

01.1

This question showed very good discrimination, and almost all students attempted it. Less than 15% of students obtained all four marks. Approximately a third of the students obtained at least three marks, over 50% at least two marks and almost 80% at least one mark.

Most responses obtained 1 mark for noting that emulsification increases the surface area of lipid droplets, but few clearly explained how this increased lipase activity or hydrolysis. Simply stating that lipase digests or hydrolyses lipid did not gain credit. Many answers reflected only basic understanding or included errors like suggesting triglyceride formation. There was also confusion between the roles of micelles and emulsification, and some mistakenly claimed emulsification alone causes lipid hydrolysis, ignoring the role of lipases.

Explanations were better when they described micelles increasing solubility and transporting specific molecules to ileum cells. Some answers missed marks by referencing only the lumen, not the cells. Many understood a role for diffusion but often did not name the molecule, losing credit. Frequently, responses ended with 'fatty acids being absorbed' without mentioning diffusion.

01.2

Approximately 80% of students achieved at least 1 mark, usually for identifying the (phospholipid) bilayer. Approximately 30% of answers went further to explain membrane formation is caused by molecular interactions with water. Marks were not achieved when students explained effects on membrane permeability (e.g. number of carriers) instead of giving a reason for the bilayer structure. Common errors included misidentifying phosphate groups as hydrophobic and fatty acids as hydrophilic. Diagrams suggesting a bilayer rarely gained credit as they were often unlabelled and did not indicate water's location.

02.1

This question discriminated reasonably well. Most students accurately explained mRNA production from pre-mRNA, mentioning intron removal or the elimination of non-coding DNA. Many answers also noted that exons remain in the final mRNA after splicing. Some responses were less specific, simply stating that "pre-mRNA is spliced" without detailing the process.

02.2

This question was a good discriminator. Examiners encountered detailed and relevant descriptions of bond formation between ribose and phosphate in adjacent nucleotides or in RNA's sugar-phosphate backbone. Many students did not identify phosphodiester bonds correctly, sometimes describing bond formation between bases or between RNA and DNA. While most answers identified 'condensation' as the reaction type, some confused phosphodiester bonds with hydrogen bonds. Additionally, a few responses included descriptions of the transcription process that, while accurate, were not relevant.

02.3

Approximately 75% of students correctly identified D – C as the expression representing activation energy. The most common incorrect answer was the distractor, A – C.

02.4

This question required students to relate their knowledge of the induced-fit model of enzyme action to an earlier model, so appreciating how science theory has changed over time. While many responded adequately, less than 10% obtained the maximum four marks. This was often due to imprecise references to changes in the shape of the active site. Often, responses only referred to changes in the tertiary structure. Examiners frequently saw creditworthy mention of enzyme-substrate complexes, but many students simply copied from the passage without demonstrating real understanding. Vague answers like "both cause reactions," did not gain a mark. Some also incorrectly described the induced-fit model as enzymes binding with 'substances' rather than substrates. Far greater success was had in describing similarities between the models of enzyme activity. For these reasons, the question was accessible up to a point but was not a good discriminator. Approximately 40% of students obtained at least three marks, approximately 80% at least two marks and approximately 95% at least one mark

03.1

This question assessing AO1 skills was an effective discriminator. Approximately 45% of students were able to correctly identify the features of all three biological molecules. Approximately 75% of students obtained at least two marks and approximately 95% obtained at least one mark.

03.2

Almost 90% of students calculated a correct volume of galactose. So, this test of using maths skills was very accessible; however, it was not a good discriminator. This might suggest some students with otherwise good maths skills had not experienced practical assignments of the type shown in this context.

Some errors included rounding 4.736 (cm^3) to 4.73, leading to an incorrect answer of 14.19 cm^3. A frequent mistake was arriving at '15' by either adding the ratio to 18 instead of 19, resulting in the calculation $(90 \div 18) \times 3 = 15$ or $90 \div 6 = 15$.

03.3

This question required students to critically analyse data generated from a laboratory procedure and apply their understanding of enzyme activity to explain outcomes. Approximately 15% of students obtained all four marks. Approximately 45% obtained at least three marks, approximately 75% at least two marks and approximately 90% at least one mark.

Mark point 1 was not often achieved, mainly owing to unclear language. Many referred to galactose inhibition or binding, but often did not specify the location, mentioning only a binding site or allosteric site but not the active site. Others simply restated that galactose inhibits lactose action without detail. Some incorrectly described non-competitive inhibition or suggested galactose binds to lactose.

Mark points 2 and 3 were also commonly missed, largely because students did not use correct terminology or express themselves clearly. They mentioned enzyme-substrate complexes and glucose formation but omitted hydrolysis/breakdown or digestion, so did not offer a full explanation. In mark point 3, students referenced enzyme-substrate complexes but often did not state it would lead to more glucose production or increased lactose breakdown.

Reasons for using tube Z as a control was understood correctly by the vast majority.

03.4

This question assessed whether students could modify a practical procedure to determine if lipase is competitively inhibited. Approximately 25% of students obtained both marks and approximately 40% at least one mark.

To confirm competitive inhibition, increasing substrate should increase product formation, unlike with non-competitive inhibition. While many students understood this, some only altered galactose or lactose concentrations which simply changed the degree of inhibition rather than confirming its type. Other suggestions, such as staining galactose to see it located in the active site or replacing enzymes with water received no marks.

04.1

Approximately 40% of students obtained both marks for this question, and approximately 75% at least one mark.

The correct answers given commonly were ‘flagella’, ‘plasmid’, and ‘capsule’. Weaker responses mentioned viral structures like ‘capsid’ or referred to ‘capsid/capsule’. ‘Pili’ was common but often misspelled, and ‘70S ribosomes’ was a frequent error. Many responses listed the organelles found only in eukaryotes.

04.2

This proved to be a very accessible question. Approximately 55% of students obtained the maximum four marks and approximately 85% obtained at least three marks.

Most students correctly identified optical microscopes to use in the first scenario and gave two valid reasons for their choice. More commonly, students mixed up the uses of SEM and TEM with the second scenario, stating, for example, TEM produced 3-D images. A frequent error involved misunderstanding resolution, with some stating optical microscopes had higher resolution when they meant a larger minimum resolvable length. Similarly, some claimed electron microscopes had lower resolution appropriate for smaller lengths. Comments about ease of use or specimen preparation did not gain marks.

05.1

This question required students to apply their understanding of co-transport in the context of pear ripening. Students had to link cellular changes in fructose concentration to water movement via osmosis. This question was a good discriminator. Less than 10% of students obtained all four marks. Approximately 30% obtained at least three marks, approximately 60% at least two marks and approximately 80% at least one mark.

Many students incorrectly stated that energy is "produced" instead of "released" which negated mark point 1. Some confused the movement of "hydrogen" with movement of H^+, omitted the direction of ion movement, or did not note that active transport requires energy. Additionally, some mistakenly described H^+ movement into vacuoles as facilitated diffusion despite evidence in **Figure 2** to the contrary.

The 'co-transport' idea was challenging. Some answers clearly explained that H^+ movement down the concentration gradient out of vacuoles enabled fructose co-transport in. However, many responses incorrectly described fructose entering via active transport or by facilitated diffusion, despite no evidence of this in **Figure 2**.

The most difficult marking point was explaining why vacuole volume increased. While students often correctly linked this to water potential and osmosis, they frequently incorrectly suggested that fructose accumulation alone increases pressure or volume owing to its molecular size compared to H^+.

05.2

This question required students to apply the principle that ATP is produced in respiration to explain H^+ movement in pear cells. Many answered well, though some omitted stating that a respiratory inhibitor would reduce ATP production. Students generally understood the effects of inhibitors on ATP hydrolase activity and on energy release, as well as the relationship between H^+ concentration and pH.

Since the question asked students to use information in **Figure 2**, they were not required to give biochemical details of respiration (Specification topic 3.5.2). Examiners noted very few cases where answers had ignored this requirement. Where this did occur, for example referring to chemiosmosis, students were not penalised.

The question was another good discriminator. Approximately 20% of students obtained three marks, approximately 50% at least two marks and approximately 70% at least one mark.

05.3

In this answer, students were asked to apply an understanding of how changes in the number of carrier proteins can affect the rate of movement of substances across membranes (Specification topic 3.2.3). The context required a consideration of changes in gene expression which might affect the movement of H^+ and/or fructose. Examiners looked for answers in which ‘increased’ gene expression would produce ‘more’ carrier (proteins). It did not ask students to reason ‘how’ gene expression had changed (for example, with ideas on methylation or acetylation). This would have included the knowledge covered in Specification topic 3.8.2.2. Examiners noted very few answers made references to methylation or to acetylation and ensured students who did refer to them were not disadvantaged.

Many students proposed the ‘change in the expression of genes’ to be ‘a mutation in one gene’. Consequently, lengthy descriptions of changes made to the tertiary structure of one or more carrier proteins achieved no mark. For this reason, the mean mark achieved on this question was lower than expected and the question did not discriminate that well.

Students more often successfully connected the context of the question to how increasing carrier proteins in membranes affected transport outcomes. They often correctly noted 'increased H^+ movement' or 'more fructose co-transport' to gain marks. Approximately 15% of students obtained both marks for this question, and approximately 60% at least one mark.

06.1

Less than 10% of students obtained both marks on this question and approximately 40% at least one mark. This demonstrated that those who successfully achieved at least one mark tended to be students with higher levels of understanding on the Specification topic 3.3.4.1.

Many struggled to identify where the pO_2 for gills and other tissues would be on **Figure 3.** While some gave appropriate changes in haemocyanin’s oxygen affinity, most did not apply this to the data shown. For example, no marks were given for stating that lower oxygen affinity at high temperatures helps haemocyanin load more oxygen in gills, since low oxygen concentrations do not occur in gills. Few students correctly identified that a change in temperatures made no difference to oxygen loading in the gills. Many of these responses concentrated on pO_2 below 7 kPa in **Figure 3**, which was not the relevant part of the curve.

06.2

This answer required knowledge and understanding of using a colorimeter gained in a required practical to obtain measurements and construct a calibration curve. The question was accessible, and it discriminated well. Approximately 20% of students obtained all three marks, approximately 50% at least two marks and approximately 70% at least one mark.

Errors such as plotting (light) absorbance or transmission on the x-axis of the calibration curve were frequently observed. Many students began by preparing a dilution series, indicating they did not recognize that ready-made blood samples had been provided. Identifying appropriate control variables was also difficult. Incorrect references to using the same crab, identical carbon dioxide concentrations, and pH indicated some misunderstanding of the context in which the blood samples were supplied. Some recommended using the same colorimeter. However, the mark scheme required answers at a higher level, such as the recognition of using one filter or maintaining consistent light wavelengths inside the equipment.

06.3

Students were required to accurately determine the mean running time from the trend line and y axis, convert hours to seconds, and use correct arithmetic. Approximately 55% of students obtained both marks for this multi-step calculation.

Examiners observed many students had not read the curve carefully; for example, many incorrectly used 1.6 h (not 1.8 h), resulting in an answer of 302.4 m. These responses received an error carried forward mark for applying the right method to an incorrect value. Inaccurate readings taken from **Figure 5** was a main reason why the mean mark for this question was slightly lower than expected. It appears that this kind of error was made by students with an otherwise good understanding of using appropriate maths skills.

06.4

This question required students to assess the validity of the method used to present the data obtained from a practical procedure. Examiners noted that students often pointed out the limited running speeds (only three) and small sample size (20 crabs). However, few mentioned that the number of crabs varied widely at each speed or that each speed covered different data ranges.

Many overlooked that on **Figure 5** the y-axis used 'mean' values, leading to mistaken comments about using median values or concerns over presenting means. Additionally, suggestions like adding error bars were misplaced, as the data ranges for the running speeds did not overlap, making mean values in **Figure 5** clearly distinct. References to anomalous data or outliers were also unfounded, as **Figure 6** contained no such data.

Overall, students found this question challenging. Less than 5% of students obtained three marks, approximately 20% at least two marks and approximately 50% at least one mark. Evidence from marking suggested many had limited awareness of how the nature of the outcomes of a practical procedure can affect the best way to present data.

07.1

This proved to be the most challenging assessment of maths skills on the paper.

Most students correctly noted that 6 mitotic divisions from one parent cell yield 2^6 or 64 cells, obtaining at least one mark. It seems some confused the reference in the figure to 'one meiotic division' to mean only the 'first meiotic division' had occurred: giving 2 daughter cells from a PS cell instead of 4 daughter cells. So, common errors included using 2^7 or 128 instead of 2^8 or 256. Additionally, some answers were not presented in standard form or rounded 5.859375×10^4 incorrectly: for example, as 5.8×10^4.

07.2

This discriminated well. Approximately 10% of students obtained three marks, approximately 60% at least two marks and approximately 80% at least one mark.

Mark point 1 assessed students' ability to label bar chart axes accurately and use separated bars. Few succeeded, mainly due to incomplete y-axis labels: lacking one or more of 'DNA mass', 'per cell', or 'units (au)'. A common mistake presented bars without spaces, making the chart resemble a histogram. Most x-axis labels were correct.

Mark points 2 and 3 focused on correct understanding of the DNA mass changes expected before and during meiosis and focused on bar plotting skills. Many students performed well, while others used non-linear y-axis scales, incorrect numerical values for DNA mass or inaccurate plotting. Some partial credit was given when students showed that DNA mass halved during meiotic divisions.

07.3

Approximately 50% of students obtained the mark for this question.

It assessed students' understanding of a first meiotic division's outcome based on knowledge of the chromosomes in a parent cell. Common errors included diagrams showing 6 chromatids (mitosis result), 6 chromosomes with sister chromatids (no reduction), or 3 chromatids (second meiotic division). Many also drew 3 chromosomes but did not indicate a single representative from each homologous pair.

07.4

This question was a good discriminator but very few achieved mark point 3. Consequently, approximately 5% of students obtained all three marks. Approximately a third of the students obtained at least two marks, and two thirds at least one mark.

For mark point 1, most students chose non-disjunction; some answered aneuploidy, and 'addition' was the most frequent mistake. ‘Non-disfunction’ was also a common error. Mark point 2 was often achieved, but those who missed it lacked clarity. Many did not specify that chromatids/ ‘homologous’ chromosomes had failed ‘to separate’. Very few succeeded with mark point 3. Many only restated that a cell ends up with an extra chromosome which was given in the question. They did not explain that both chromosomes or both chromatids are ‘moved’ to ‘one side’ (of a cell) or the consequence of inadequate spindle fibre activity.

08.1

This question discriminated well. Approximately 15% of students obtained three marks, approximately 45% at least two marks and approximately 75% at least one mark.

Patterns in answers suggested that good lessons were learned from errors and omissions made in similar questions set on this topic in previous examinations. Some students did give broad responses that missed crucial details about reproduction and 'passing on alleles.' A few mixed up 'gene' and 'allele', or mistakenly talked about vaccines rather than antibiotics, which impacted their scores.

08.2

This question assessed students' competence in substituting numerical values into an unfamiliar algebraic equation to calculate a correlation coefficient. Prior knowledge of the Spearman rank correlation equation was not required; the question did not test for this knowledge.

This question was accessible, with approximately 70% of students gaining both marks and approximately 85% at least one mark. Very few students did not attempt it. Some did not appreciate d^2 had already been calculated, so they were often squaring numbers given in the final column of the table. A common incorrect answer was -71.2, produced using 6 x 38^2 in the numerator, rather than 6 x 38. Some moved '1 –' into the numerator, as (1 – (6 x d^2)) to obtain (-)227 in the numerator. Inaccuracies with the denominator included answers with 25(25^2 – 1) or 5(5 -1) or 16(16^2 – 1), where '16' is the plasmid E, d^2 value taken from Table 5.

By far the error observed most often was the correct substitution of appropriate figures into the equation but incorrect calculations and not showing any working. These students missed opportunities to obtain the 1-mark alternatives.

08.3

This question did not discriminate well. Approximately a third of students achieved a mark, suggesting there is limited understanding of how to use a correlation coefficient from a statistical test (Specification maths skill reference, MS1.9).

08.4

This straight-forward maths question was answered correctly by approximately 70% of students; it did not discriminate well.

Those who did not gain 2 marks often calculated the correct answer but then went further, to multiply by 11 (the number of different plasmid types).

08.5

This question required students to analyse information given in a graph showing two dependent variables. The context asked students to link a knowledge of binary fission to increased cell number or increased cloudiness in a bacterial culture. To make the answer more accessible, students could also gain marks by referring to changes in plasmid copy number caused by plasmid replication (a straightforward context).

It proved to challenge many students. Less than 10% of students obtained three marks, approximately 30% at least two marks and approximately 70% at least one mark. The mean mark for the question was close to 1 out of 3 marks; the question did not discriminate very well.

Students scoring zero often only described the data, not relating changes in plasmid copy number or changes in cloudiness to plasmid replication or binary fission. So, comments like, 'plasmid copy number increased' or 'cloudiness plateaued' achieved no marks. Others failed to gain marks by not referring clearly to the phases shown on the graph. Mark point 2 was achieved most frequently.

09.1

Approximately half of all answers achieved the mark for correctly identifying tissue and organ.

Errors included acellular/unicellular, genus and organ for the answer to 'cells of one type'; multicellular, phylum and organ system for 'cells of more than one type'.

09.2

This question required knowledge of chloroplast structure. Approximately 20% of students achieved the mark.

Many identified structure **Q** as being a component of a cell, such as a vacuole or a nucleus, reflecting some basic misconceptions about organelle structure. Some referred to **Q** as being a thylakoid or granum, although the image clearly identified structure **Q** as a round structure. It was separate and clearly different from the obvious grana shown elsewhere in the chloroplast image. Structure **R** was identified correctly by most; some answers incorrectly mentioned stoma (incorrect spelling of stroma?), cytoplasm or thylakoid/granum.

09.3

This question assessed understanding of the structure and function of chloroplasts set in a context showing images of chloroplasts taken from healthy and mutant plants. Many responses correctly identified fewer/smaller grana or thylakoids. However, most explanations lacked some of the detail required for mark point 2. This required references to reduced chlorophyll, to decreased light absorption and to lower rates of photosynthesis. Consequently, approximately 15% of students obtained both marks and approximately 70% at least one mark.

09.4

This question tested students' ability to describe trends in data and offer an explanation based on their knowledge of the chloroplast structures shown in **Figure 12**. Approximately 15% of students obtained all three marks, approximately 50% at least two marks and approximately 80% at least one mark.

Most students appreciated that differences in the lamellae shown in the chloroplast structures would suggest that the rate of photosynthesis should be lower in mutant plants and they realised this was not supported in the data. Consequently, mark point 1 was accessible to many students. What proved to be far more challenging was students' understanding of the change in chlorophyll ratio between mutant plants and healthy plants. Many incorrectly described 'more' chlorophyll a in mutant plants compared to healthy plants, despite them also identifying the mutants had (far) less chlorophyll overall. They had focussed on absolute quantities rather than on proportions. For this reason, the question did not discriminate well and produced a marks' total lower than was anticipated.

Many students used the trends they identified to correctly suggest the chlorophyll (a) in mutant plants absorbed more light, or a bigger range of light wavelengths and so achieved mark point 3. This mark was negated when reference was also made to 'more' chlorophyll (a) absorbs more light (wavelengths) because 'more' chlorophyll (a) is not shown in the data.

10.1

This question assessed students' understanding of the translation process and proved to be accessible; it discriminated extremely well. Less than 15% of students obtained the maximum six marks. Approximately 55% of students obtained at least four marks, approximately 70% at least three marks and approximately 90% at least one mark.

Most provided logically sequenced answers, but few mentioned ATP's role in amino acid attachment to tRNA or that the ribosome covers two codons/base triplets. While many identified the start codon correctly, references to codon–anticodon interactions often lacked detail (did not mention 'binding' and the 'complementary' idea). Also, descriptions of ribosome movement on mRNA (producing a polypeptide) were sometimes unclear.

10.2

Approximately 5% of students obtained the maximum four marks for this question. Approximately 20% obtained at least three marks, approximately 45% at least two marks and approximately 75% at least one mark.

Many students achieved marks for recognising there are many stomata and for noting thin leaves presented a 'small diffusion pathway'. Mark point 4 was seldom attained. While students often discussed a large surface area, this was typically considered in relation to the whole leaf rather than individual cells. Mark point 5 was also infrequently reached, as references to a large surface area-to-volume ratio did not consistently include diffusion, instead noting its role in gas exchange.

Because the question focused on gas exchange, achieving the relevant mark points required students to expand beyond simply stating "for gas exchange" by including a comment about diffusion; many did not do so, resulting in missed opportunities to obtain mark points 2, 4, 5, and 6.

Students who obtained few or zero marks generally provided brief responses or misunderstood the question. Sometimes these responses discussed xerophytic adaptations, cohesion-tension theory, or adaptations related to light absorption for photosynthesis. Some responses reflected misconceptions regarding short diffusion pathways, such as attributing them to thin membranes or single-cell thickness. There were also references to the flatness of the leaf providing a short diffusion pathway. Terminology confusions occurred, with "stroma" and "spiracles" sometimes cited instead of "stomata/stoma". While most students mentioned stomata, references often omitted "many" or described their location or role in gas exchange without sufficient detail to achieve mark point 1 or 2. Numerous students mentioned the waxy cuticle and the function of guard cells in opening and closing stomata at different times of day which did not address the question.

10.3

This question was a good discriminator.

Some responses were clear and concise, producing good 4 and 5-mark answers. However, some students did not end blood flow at the coronary arteries or confused pulmonary arteries with pulmonary veins. Several stopped their description at the lungs or misused terms like valves, bicuspid, and tricuspid, often mixing them up or omitting them entirely. Responses scoring zero provided low-level descriptions of heart function and incorrect sequences of blood vessels (often the level was 'at or lower' than Key Stage 4). For these reasons, the mean mark for this question was a little below what was expected. Approximately 15% of students obtained the maximum five marks for this question. Approximately 30% obtained at least four marks, approximately 40% at least three marks and approximately 70% at least one mark.

Mark Ranges and Award of Grades

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