GCSE
BIOLOGY

8461/2H: Paper 2 - Higher
Report on the Examination

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General

Particular points which occurred quite frequently included:

- confusion of certain terms, such as:
  - phenotype and genotype
  - dominant and recessive
  - a control and a control variable
  - reabsorption, absorption and filtration
  - diffusion and osmosis
- inappropriate use of the terms 'accurate', 'precise', 'reproducible', 'repeatable' and 'valid', and not realising that the term 'fair' is always inadequate unless suitably qualified
- paying insufficient attention to information provided in the stem of a question in order to guide a reasoned response and avoid misconceptions and the inclusion of irrelevant information
- repeating, rather than using, information given in the question, for which no marks are available, and which wastes both time and space (there being adequate space provided for relevant material without recourse to additional answer sheets)
- careless reading of the question resulting in an inappropriate answer, for example failure to give a comparative answer to a comparative question, or failure to use the information given in a table or a graph, or not presenting both sides of an argument when the instruction in the question is to 'evaluate', or not following instructions in multiple-choice items, such as to tick the correct number of boxes
- imprecise reading of data from a graph or other numerical scale
- poor handwriting, for example with numerals – especially the distinction between the numbers 1 and 2
- although chemical formulae are generally acceptable as alternatives to the names of substances, they need to be correct, for example CO_2 is an acceptable alternative to carbon dioxide but CO^2 and CO2 are not
- the concept of energy transfer: for example, in respiration, energy is not 'produced' but is *released* or *transferred* from glucose
- not checking whether the answer to a calculation is sensible – for example, the concept of 0.014 of a water flea in a cubic metre of pond water, or the idea that a sperm cell could contain ¼ of 46 chromosomes (ie 11½ chromosomes).

Levels of demand

Questions are set at three levels of demand for this paper:

- **standard demand** questions are designed to broadly target grades 4–5
- **standard/high demand** questions are designed to broadly target grades 6–7
- **high demand** questions are designed to broadly target grades 8–9.

A student's final grade, however, is based on their attainment across the qualification as a whole, not just on questions that may have been targeted at the level at which they are working.

Question 1 (standard demand)

01.1 Nearly all students correctly selected 'primary consumer' as the term to describe the Daphnia.

01.2 Around 91% of all students were able to draw and correctly label a pyramid of biomass for the food chain. Some drew the pyramid upside down, which was acceptable if the levels were appropriately labelled. Others inverted the labels and so did not gain the mark. Many added multiple labels which was acceptable provided **every** form of labelling was completely correct – for example, the Daphnia could be called by its name or be called a 'primary consumer', '1st-order consumer', 'herbivore' or 'trophic level 2'; some students did not gain the mark due to a labelling error.

01.3 About 40% of the students answered correctly. There were vague answers given by some students - 'because biomass is lost between trophic levels' or 'because there were fewer Daphnia than algae' were not sufficient to gain credit.

The mechanism of loss of biomass was required – eg non-digestible material/used in respiration/the algae being eaten by other organisms.

01.4 In this question, students had to calculate the mean of five counts of Daphnia, each from a 1 dm^3 sample of pond water and, given that 1 m^3 = 1000 dm^3, scale the value up to a mean number in 1 m^3 of pond water. The actual mean of the five samples was 14 and so an answer of 14 000 in 1 m^3 should have been calculated.

Errors were prevalent: some divided by 1000 and so obtained an impossible value of 0.014 Daphnia per m^3. Others omitted the value of zero given in the table and so calculated a value of 17 500 per m^3. There were also various arithmetic errors among those who first multiplied each of the five values in the table by 1000 before finding the mean.

Half of the students gave a fully correct final answer.

01.5 Given the dimensions of the pond, students had to use the value obtained in question 01.4 to calculate the estimated number of Daphnia in the whole pond, with their final answer in standard form. Since the dimensions of the pond were given in metres, there was no need for any conversion of units, although this did not prevent some students trying to do so. The actual calculation was: answer from question 01.4 $\times$ volume of pond

However, some miscalculated the volume of the pond, dividing rather than multiplying and many did not present their final answer in standard form. More than half of the students gained full credit in this question.

01.6 The data in Figure 2 showed that a large number of Daphnia were found at the given concentration of fertiliser in the pond water. To account for this, students had to understand that the fertiliser would have been used by the algae and therefore the number of algae would have increased, thus providing more food for the Daphnia. Many students thought that the Daphnia fed directly on fertiliser or that the fertiliser provided ‘optimum conditions’ for the Daphnia. Around 41% of students scored any marks for this question.

01.7 The situation here paralleled that in the previous question except that a decrease in the population of the Hydra had to be explained. Since the specified concentration of fertiliser had resulted in a low number of Daphnia, students needed to deduce that the Hydra would not have enough to feed on and hence their numbers would decline. Some students thought incorrectly in terms of absolutes: ‘the hydra would have no daphnia to eat.’ An alternative explanation in terms of the high concentration of fertiliser possibly being toxic to the Hydra was also accepted.

Question 2 (standard demand)

02.1 Around 85% of students knew that the structures in the nucleus of a human cell that contain DNA are the chromosomes, or genes. Incorrect suggestions included:

- nucleus
- cell membrane
- mitochondria
- ribosomes
- cytoplasm
- chloroplasts.

02.2 There was some confusion over the selection of labels for the three parts of the DNA molecule, with around 65% of students knowing that structure X was sugar, Y a nucleotide and Z a base.

02.3 The vast majority knew that the correct scientific term to describe the structure of the DNA molecule was a double helix. Other terms were seen which were not creditworthy and these were generally based on ‘twisted’ (as given in the question) or ‘coiled’.

02.4 The section of DNA shown in Figure 3 consisted of a single strand of nine nucleotides. Two-thirds of students knew that three nucleotides coded for one amino acid. ‘9’ was given by approximately a quarter of the students.

02.5 Benefits of understanding the human genome were not well known; although 69% of students knew at least one benefit, only half of these knew two. Answers were often expressed imprecisely – eg the detection and treatment of ‘disease’ rather than an inherited disease. The most common correct answers related to detection and treatment of inherited conditions, or to tracing ancestry or human migration patterns.

Question 3 (standard demand)

03.1 Having been given a definition of phototropism, three-quarters of students were able to name a second tropism. The most common correct answer was gravitropism or geotropism, although hydrotropism was given by a few. Most of these students were then able to name the corresponding stimulus. Some students described a response rather than just giving the stimulus.

03.2 In this question, students had to design an investigation to show the effect of light from one direction on the growth of plant seedlings. Figure 4 showed equipment that could be used in the investigation.

This extended response question was marked on the basis of a 'level of response' mark scheme. An answer at Level 2 (3–4 marks) had a minimum requirement of seedlings being set up in different light conditions so that the effect of these could be compared. Level 3 requires students to describe an investigation that would give valid results and therefore a Level 3 answer (5–6 marks) required comparison of the effect of light from one direction (in terms of height change and/or direction of growth) with that of either all-round light or no light (ie darkness) together with at least one control variable.

The bulk of the answers were in Levels 1 and 2, with around 15% of students attaining Level 3.

A common error was to shine light onto the seedlings from different directions, possibly through variously-positioned holes cut into the sides and/or top of cardboard boxes. However, each of these still constituted light from one direction, so each group of seedlings was essentially treated in the same way (a Level 1 answer). Had an extra box with no holes been included, this would have given a control with the potential for entering a higher level. Some set up lamps at different distances, hence giving different light intensities; this was represented 'different light conditions' which made the answer potentially Level 2.

Many answers did not include any control variables, such as temperature and the amount of water given, the inclusion of which was a pre-requisite for entering Level 3.

Overall, attainment in this question was less than anticipated, especially considering that it tested knowledge and understanding of RPA 8 from the specification.

03.3 The key point of the phototropic response is that it enables a plant to absorb **more** light and thus perform photosynthesis **more** efficiently thereby producing **more** organic substances such as glucose.

About 27% of students scored no marks in this question. A major cause of this was a failure to give a comparative answer. If a plant did not respond to the direction of light in this way, it would still receive some light and would still photosynthesise, but it would do so less well.

Other students included irrelevant details in their answers, attempting to explain the way redistribution of auxin could cause the phototropic effect rather than focusing on the advantages of it in terms of the plant's survival.

Question 4 (standard/high & high demand)

04.1 This question differentiated between students very well. Given an unlabelled diagram of the formation of an image of a distant object by the eye (Figure 5), students had to describe how the eye would adjust to form an image of a nearer object. Although many knew that the ciliary muscles would contract (rather than 'constrict'/'tighten'), some had forgotten the name of the muscles and others thought the muscles would relax. Only a small minority realised that this would give a smaller diameter to the circle of muscle tissue.

A very common error was to state that the suspensory ligaments would then 'relax' rather than slackening or loosening. Most knew that the lens would then bulge or become 'fatter', that it would become more convergent (or refract the light rays more, but not 'more light is refracted' and certainly not 'light is reflected more') and the image would then be in focus on the retina. The idea of light simply 'hitting' the retina was not creditworthy.

04.2 Half of the students scored any marks on this question. Around 13% of students understood completely that a person who is long-sighted cannot form a clear image of a near object either because the eyeball is too short or the lens cannot be thickened sufficiently and so the image would have been 'focused' behind the retina.

Many students were clearly confused about the nature of long-sightedness and short-sightedness and told the wrong story. Many others confused accommodation with adjustment to a change in light intensity and wrote about the action of the iris.

04.3 Many students had difficulty explaining how spectacles could correct long-sightedness. Some were confused over whether a converging or diverging lens was required (usually described, respectively, as convex or concave), although most knew that the light rays from the near object would need to be refracted (inwards) more. Many stated that the light from the near object could then be brought to a focus 'on the back of the eye' rather than specifying the 'retina' and did not gain credit.

This question differentiated very well across the ability range with around 12% of students scoring full marks.

Question 5 (standard, standard/high & high demand)

05.1 Given a table showing the complete classification of four flowering plants, most students had no difficulty on deciding that species 1 and 3 were the most closely related because they belonged to the same order (the other two only sharing taxonomic groupings down to class level).

05.2 and **5.3**
Figure 6 showed how a red-flowered pea plant crossed with a white-flowered pea plant produced offspring (F_1) plants which all had red flowers, whereas a similar cross between red-flowered and white-flowered snapdragon plants produced offspring with only pink flowers.

Using the given symbols for alleles, students then had to give the genotype of an F_1 red-flowered pea plant and of a white-flowered snapdragon plant. 74% of students successfully gave Rr for the pea plant, and 54% managed C^WC^W for the snapdragon plant.

Although the format of the given allele symbols C^R and C^W may have appeared unusual to most students in this application question (AO2), all they had to do was select and copy them. Errors included 'C^W', 'C^R C^W', 'rr', 'C^{WW}' and 'C^{RW}'.

05.4 Students had to draw a Punnett square diagram to show how a cross between pink-flowered snapdragon plants produced only *some* plants with pink flowers in the next generation. Around 46% of students were completely successful. Many did not gain the mark for assigning phenotypes to the offspring genotypes as they did not do so, despite the instruction in the question to do so.

A few students decided to use their own symbols for alleles rather than the ones given in the question – this would have been legitimate and creditworthy if they had first been defined, but generally they were not and thus a mark could not be gained.

05.5 The percentage of offspring with pink flowers given in answer to this question had to match that predicted by the student's answer to question 05.4. Had the answer to 05.4 been completely correct, then this would have been 50%. About 83% of students got this right.

05.6 This question examined practical techniques involved in the cloning of pink-flowered snapdragon plants, as outlined in Figure 7.

Most students were unable to give reasons for the first three techniques:

- why several groups of cells were used (ie to produce several new plants)
- why nutrients were added to the agar jelly (ie for making a named organic substance – eg protein or chlorophyll – or to provide energy for growth)
- why hormones were added to the jelly (ie to stimulate differentiation or the growth of roots or shoots). Most students thought 'to encourage growth' was sufficient.

Many students, however, understood that sterile conditions were necessary to prevent the growth of microorganisms or to prevent disease, and that a temperature of 20°C would encourage optimum or good growth or provide a temperature at which enzymes worked well. The 'prevention of growth of pathogens' was an inappropriate concept here as, unlike a human, a plant does not have a body temperature of 37°C.

05.7 To explain why the technique shown in Figure 7 produced only pink-flowered plants, many students stated correctly that the offspring were 'clones' or that all would have been 'genetically identical'. The idea that asexual reproduction or cells produced by mitosis was involved was given far less often. 81% of students scored at least one mark.

Question 6 (standard/high & high demand)

06.1 About 71% of students correctly selected the pituitary gland as the hormone-producing gland for the control of water loss from the body.

06.2 Around 85% of students knew that the hormone that helps the kidneys control water loss was called ADH.

06.3 How the hormone stimulated the kidneys to reduce water loss was fully understood by about 3% of students and less than a half gained any credit in this question.

The scenario was a man walking in a desert without any drinking water, hence he would need to conserve water. Thus, his blood would have become more concentrated which would have stimulated ADH release by the pituitary to increase the permeability of the walls of the kidney tubules so that more water would have been reabsorbed. Some students referred to 'how much' water was in the blood rather than mentioning concentration (or water potential) or wrote about the 'body' having a reduced water content, rather than the blood.

Some students thought that the rate of 'filtration' of the blood would have been reduced while others thought that less water would be 'absorbed' from the blood into the kidney tubules. It was evident that many students had limited knowledge of how the kidneys work in this challenging question.

06.4 Explanations of two reasons why a kidney transplant was preferable to treatment by dialysis were required by this question, with the proviso that cost and convenience should not be included. This meant that biological explanations had to be given. Many students still answered just in terms of cost and convenience.

Higher-attaining students understood that concentrations of urea and salts, and the volume of water, would increase between dialysis sessions and hence had the potential for causing damage to body cells. A second reason was that the skin would be repeatedly punctured with needles with dialysis treatment, thus increasing the chance of infection or blood clots. A very small minority of students scored three or four marks in this question.

Question 7 (standard, standard/high & high demand)

07.1 This extended response question related to RPA 9: Measure the population size of a common species in a habitat. The species here was the weed, ragwort, growing in a field on a farm.

The mark scheme was divided into two levels and the requirement for entering Level 2 was that the method would lead to the production of a valid outcome with all key steps being identified and logically sequenced. In relation to the topic of the question, this meant that:

- a suitable number of quadrats should be placed (a minimum value of ten)
- a method for placing the quadrats randomly should be described

- the number of ragwort plants within the quadrat should be counted
- the mean value for unit area (say, 1 m^2) should be scaled up to the area of the field.

This meant that the placing of ‘several quadrats’/‘a few quadrats’/‘five quadrats’ was insufficient to enter Level 2, as did ‘throwing the quadrat randomly’. Ideally, each quadrat should have been placed at a pair of coordinates selected randomly from a table of random numbers or using the random number button on a calculator or even by pulling numbers randomly out of a hat. Examiners did allow throwing the quadrat if it was done ‘with eyes shut’ or ‘over the shoulder’ but such a practice is not to be recommended and is not considered to be a valid method of achieving randomness.

Some students decided to place quadrats at intervals along a transect line which was not really appropriate for estimating a population size; others determined percentage cover which, again, would not give a population size. Three-quarters of students did not give answers above Level 1.

07.2 This question asked for an explanation of why the rate of reproduction of the bacteria increased between two times on the graph (in the exponential phase of growth). A quarter of students were able to explain that since there were more bacteria with the passage of time, so there would be more bacteria to reproduce at the later time.

07.3 As in most typical growth curves, the rate of growth began to slow down after a certain time. Suggestions made by students for how a high bacterial reproduction rate could be maintained included:

- adding more nutrients (or named examples)
- adding more oxygen
- increasing the temperature
- removing any toxic waste products
- simply stirring the culture.

Most students were able to give at least one of these with around 10% of students able to give the three asked for.

07.4 Two rates of reproduction of the bacteria had to be compared in this question. The rate at 7 hours was quite straightforward as the graph was a straight line at this time. To determine the rate at 12 hours, students had to draw a tangent to the curve (specification WS 3.3).

Many students successfully determined the rate at each of the two specified times and then divided the rate at 7 hours by the rate at 12 hours. Since there was reasonable variation between tangents drawn by different students, examiners accepted answers for the rates and for the final quotient within certain ranges, as well as ascertaining that tangent(s) were drawn on the graph.

This question differentiated well between students of differing abilities, with approximately 11% gaining full marks and over half gaining partial credit. The greatest success was shown by those who drew their tangents over the full extent of the graph paper – thus any small errors in reading the scales had a smaller proportional effect.

Some students did not draw tangents but divided the number of bacteria at 7 hours by 7 and that at 12 hours by 12 to find the two rates and, undeterred by the outcome of the rate at 12 hours appearing to be greater than the rate at 7 hours, simply divided the larger number by the smaller.

07.5 The most obvious advantage of genetic modification of crop plants to make them resistant to a herbicide, was that weeds could be killed without harming the crop. Almost three quarters of students realised this and gained credit. Some students went on to explain that this would result in a higher yield of crop due to reduced competition with weeds for some named factor eg water, light or mineral ions. Around 7% of students gained full marks.

Question 8 (standard, standard/high & high demand)

08.1 About 31% of students were able to give a complete account of how insulin and glucagon would control a person's blood glucose concentration after a meal. These students knew that insulin would be released to cause glucose to enter the body cells, that the glucose would be converted into glycogen, that the consequential lowering of the blood glucose level would cause glucagon secretion and that this stimulated the conversion of glycogen back to glucose.

Some students confused the roles of the two hormones and often had problems making themselves understood due to hybrid spellings between the terms glucagon and glycogen. Despite glucose being mentioned in the question three times, many students wrote about 'blood sugar'.

08.2 This question differentiated well between the higher-attaining students. Overall, around 36% scored marks with a very small proportion of this gaining all three. Since the cells of a person with Type 2 diabetes do not respond to insulin, this would result in less glucose entering the cells (not 'no glucose' entering as many students claimed, which would have resulted in the death of the cells). Consequently, much glucose would remain in the blood, raising the blood's glucose concentration which in turn would stimulate the pancreas to keep on releasing insulin, hence the elevated insulin levels.

Answers that did not gain credit often referred to 'amounts' of glucose 'in the body' rather than concentrations of glucose in the blood and the notion that, since insulin was not 'used up' in stimulating the cells, it would therefore remain in the blood leading to the observed high insulin concentration.

08.3 Nearly all students were able to suggest at least one control variable for the investigation, such as:

- the age of the participants
- their gender
- BMI

- severity of diabetes
- the dose of the drug given
- the same meal given to each
- other health conditions
- other drugs being taken.

A third of students gave the required three examples.

08.4 The stem of this question introduced the students to the unfamiliar concept of standard deviation. No prior knowledge of this concept was required as sufficient detail was given to students to allow them to make use of it in answering questions 08.4 and 08.5.

Given that standard deviation was a measure of the spread of results about the mean. Around 72% of students had no problem in selecting the answer ‘mean = 177.2 ± 15.4’ as being the most precise from the four examples given as this had the smallest standard deviation.

08.5 This question was intended for the highest-attaining students and differentiated well at this level. A table of data (Table 3) and a bar graph of more data (Figure 9) had to be used in the evaluation of a student’s statement that the drug metformin worked better when used with other drugs. Students had to decide what was meant by ‘worked better’ and they had to select appropriate data to use in their evaluation as not all of the data was relevant.

The question was marked using a level of response mark scheme, with three levels. The descriptors for Level 2 (3–4 marks) and Level 3 (5–6 marks) required that ‘some logically linked reasons are given’ and, since this was an evaluation, at least one logically linked reason supporting the statement and at least one that did not support the statement were required. Many students did not meet this criterion, and around 84% of students were limited to Level 1 or below.

Both Table 3 and Figure 9 gave the standard deviation (SD) of each result. The bullet points immediately before the actual question explained that an overlap of SDs between two means shows there is no significant difference, whereas non-overlap can be taken to show a significant difference.

Some students concentrated too much on the data in Table 3 and claimed that the blood glucose concentrations in people in the 2-drug trial were much higher than those in the 1-drug trial. Although this was true, it was a result after only 30 minutes (the graph in Figure 9 showed results after 3 hours) and all the SDs overlapped, indicating that the differences were insignificant. Some of these students also thought that the higher blood glucose level was an ‘improvement’ of the patients’ condition.

Figure 9, however, showed clearly that the mean reduction in blood glucose concentration was higher when metformin was used with drug A *and* when used with drug B, which supported the student’s statement. In addition, the SD for metformin + drug A did not overlap with the SD for metformin alone and hence showed a *significant* improvement, thus supporting the student's statement. However, the results for metformin + drug B showed a small overlap of SDs with metformin on its own and hence showed *insignificant* improvement. Consideration of the effects of drug A and drug B on their own were irrelevant (although many students included these in their answers).

Most students did not give any consideration to the scientists' methodology. However, some mentioned the low numbers of people in each drug trial and some mentioned that there were different numbers in each trial, but few developed this further in terms of anomalies having a greater effect on smaller groups. Hardly any students stated that there was no mention of other control variables in the scientists' investigation, despite having themselves suggested such control variables in their answer to question 08.3; had these not been controlled, it might have invalidated the results.

Finally, to attain Level 3, a judgement had to be made on whether the student's statement was correct or incorrect or partially correct. This judgement had to be supported by a discussion of the evidence, as presented above.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

Mark Ranges and Award of Grades

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