GCSE
BIOLOGY

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

8461
June 2022

Version: 1.0

General Comments

Nearly all questions were attempted by all students and there were some very good answers.

Particular problems which occurred quite frequently included:

- 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 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 pages;
- 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 numerical data from a graph, or presenting evidence both for and against an hypothesis when only evidence in favour is asked for, or not following instructions in multiple-choice items, such as to tick the correct number of boxes;
- careless reading of data from a graph;
- poor handwriting, for example with numerals – especially the distinction between the numbers 1 and 2;
- mis-spelling of certain terms, eg glycogen (easily confused with glucagon with hybrid spellings), tropism/trophism, and confusion of certain terms like biotic/abiotic;
- 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 is not;
- the concept of energy transfer: for example in respiration, energy is not 'produced' but is *released* from glucose and energy is not needed 'for' respiration;
- not checking whether the answer to a calculation is sensible – for example, it is unlikely that a person could produce 3 200 000 dm^3 of sweat in a day – or not checking that the correct number of significant figures, as asked in the question, has been given in the final answer;
- striking an incorrect balance between depth and breadth of coverage in an extended prose answer.

Question 1

This was the first of three questions common to both the Foundation and Higher Tier papers. The topic was reproduction and meiosis.

01.1 Three-quarters of students correctly selected whether each of the three statements applied to sexual and/or asexual reproduction. The most common error was not knowing that in *both* types of reproduction genes are passed from parents to offspring.

01.2 Almost the same proportion knew that pollen is the male gamete formed in flowering plants. Incorrect answers included 'anther', 'stamen, 'stem', 'stigma', 'sperm' and even 'testis'.

01.3 -01.6 Interpretation of the graph in **Figure 4**, which showed changing amounts of DNA in a cell before, during and after meiosis, was good in questions **01.3** and **01.4** where, respectively, the correct period of DNA synthesis and the correct times of cell divisions were selected. However, only half the students chose the correct values for the amount of DNA expected in a sperm cell and in an embryo in **01.5** and **01.6**.

Question 2

This was the second of three questions common to both the Foundation and Higher Tier papers. The topic was biotic and abiotic factors that affected the populations of earthworms in two habitats.

02.1 It was evident that many students did not understand the difference between the two types of factors, with fewer than half scoring full marks for suggesting two abiotic and two biotic factors that could affect the size of an earthworm population. Appropriate answers for abiotic factors included water, oxygen, pH and temperature and, for biotic factors, food availability, predators and pathogens.

02.2 This was a 6-mark extended response question on planning an investigation to compare the number of earthworms per m^2 in two areas: a grass lawn and a farmer's field. Most students answered this very well, with almost a half scoring full marks. Answers typically included the use of the given chemical **X** to bring the worms to the surface, the use of a quadrat (sometimes of stated dimensions) placed randomly, with a suitable method for selection of random coordinates, counting the worms, repeating the procedure a large number of times, calculation of a mean and a comparison between the two areas. Points less frequently given included standardisation of the concentration and volume of the chemical, waiting a standard amount of time for the worms to come to the surface and collecting for a standard time period. Inappropriate points included the use of a transect or attempts at randomisation by throwing the quadrat.

Question 3

This was the final common question on the topic of insulin and blood glucose, and the relationship between obesity and Type 2 diabetes.

03.1 Around three-quarters of students were able to state a time on the graph in **Figure 2** at which the concentration of insulin in the blood would be high – i.e. corresponding to a high blood glucose concentration. The most common error was to select a time when blood glucose was low, at 2.5 hours.

03.2 While the vast majority knew that insulin would lower the concentration of glucose in the blood, explanations of how this was achieved varied in detail. Some referred to the glucose being taken out of the blood without stating that it went into the body cells, or into organs such as the liver or muscles. Some correctly included the conversion of glucose to glycogen. Full marks were awarded to around half of the students.

03.3 and **03.4** These questions involved interpretation of the height – body mass graph in **Figure 3**. Over 90 percent of students correctly deduced that person **A** was underweight, but fewer than three-quarters could give sufficiently precise values for the range of healthy weights for person **B**, given a height of 1.9m, even though this fell on a major gridline.

03.5 This question involved the selection of appropriate data from a simple table that compared blood concentratons of cholesterol, glucose and insulin in an obese person with mean values for people who did not have Type 2 diabetes. Around half the students were able to point out that person **C** had *higher* concentrations of both glucose and insulin. Simply quoting figures from the table, without a comparison, was inadequate, as was the use of a non-comparative term such as 'high' concentration. Any mention of cholesterol was deemed inappropriate – the question tested the selection of *relevant* data.

03.6 Nearly all students knew that exercise was a means of reducing the chance of developing Type 2 diabetes. Most also knew that 'diet' was relevant but many answers, such as 'a heathy diet' or 'a balanced diet' were inadequate; it was necessary to state that the diet contained less sugar / carbohydrate / fat or involved weight loss.

Question 4

This question was about air and water pollution.

04.1 Almost 90 percent of students were able to name a substance that would cause air pollution, carbon dioxide and methane being the most common correct answers, but sulfur dioxide, carbon monoxide and particulates / smoke were also acceptable.

04.2 This was more demanding than the previous section as *three* substances that could cause water pollution had to be named. The most common correct answers included fertilisers, sewage and toxic chemicals (or a named example), followed by various types of pesticide and even nuclear waste. Some answers were rather vague – e.g. 'industrial waste' might well constitute mainly water and, as such, was not rewarded. Only a fifth of students were able to give three suitable examples with just over a half able to name at least one.

04.3 This was a 6-mark extended response question on how air and water pollution could be harmful to living organisms. To enter Level 2 (4 to 6 marks), students had to link specific effects to several phenomena related to named pollutants of both air and water. These could include, for example, melting of ice caps and loss of habitat linked to global warming caused by increasing concentrations of carbon dioxide in the air, and organisms in water being unable to respire due to bacteria multiplying and using up the oxygen in their own respiration, when raw sewage entered the water. Such linkages of cause and effect were, unfortunately, rarely given and only one in forty students attained Level 2.

Major problems included a lack of specific biological detail coupled with insufficient breadth of coverage for a variety of named pollutants. Many answers referred to 'pollutants' or 'harmful substances' which might be 'dangerous' or could 'harm / kill / cause illness'. A prevalent, incorrect belief was that rising carbon dioxide concentrations in the air would reduce the availability of oxygen and make it harder for us to breathe.

Question 5

The topic of this question was the inheritance of a human disease and the specific effects of this condition on the body.

05.1 Evidence from the pedigree diagram given in **Figure 4** that maple syrup urine disease (MSUD) was a recessive condition was provided by the fact that unaffected parents could produce a child with MSUD. Incorrect answers related to one of the parents having the condition but none of her children having it, or to the low frequency of MSUD in this family. Fewer than half of the students gave a correct answer.

05.2 Three-quarters of students were able to draw a correct Punnett square diagram to show that heterozygous parents had a 25 percent chance of producing a child with MSUD.

However, fewer than half of these gained all 4 marks, mainly because they did not follow the instruction in the question to *identify the phenotype of each offspring genotype*.

Questions **05.3** to **05.6** were based on **Figure 5** which gave a metabolic pathway showing the breakdown of some types of amino acids and included the production and breakdown of a toxic substance, **P**.

05.3 The majority of students incorrectly selected the *kidney* as the organ in which the reactions were most likely to occur, with the correct answer, the *liver*, in second place.

05.4 Given that MSUD was caused by an inability to make the enzyme that broke down substance **P** into harmless products, students had to explain why the blood of a person with MSUD would contain a high concentration of substance **P**. Around three-quarters of students understood that substance **P** would not be broken down but only around 1 in 100 could fully explain that therefore the concentraton of **P** would build up in the cells that made it *and* that **P** would then move from the cells into the blood. Some thought, incorrectly, that **P** could not be excreted by the kidney and would therefore build up in the blood – although the subsequent question would have given evidence against this idea.

05.5 Some details of how the kidneys function were required to answer this question about why substance **P** would be found in the urine, namely that it would be filtered out of the blood by the kidneys and not reabsorbed. Despite urine being mentioned in the question, a surprisingly large proportion failed to mention the kidneys in their answers. Filtration was a better-understood concept than reabsorption. Fewer than one-third of students scored any marks for this question.

05.6 Since toxic substance **P** was derived from certain amino acids, the majority of students understood that a person with MSUD should have a low-protein diet because proteins were made of amino acids. However, fewer than one third of these could go on to explain that amino acids would need to be kept in small amounts to avoid a build-up of **P** which would harm the body cells / tissues / organs.

Question 6

This question was about the water cycle and the efficiency of energy transfer in a simple food chain.

06.1 Process **X** in **Figure 6** was successfully identified as *evaporation* by the vast majority.

06.2 Only around half knew that plant roots absorb water by *osmosis*, or by *diffusion*.

06.3 Although most could give at least one use of water to a plant, such as photosynthesis, support or for transport, only around a quarter could give two uses.

06.4 In this question, students were given an equation for energy conversion efficiency and had to select data from the food chain in **Figure 7** to calculate how many more times efficient the cow was at converting energy (given as 4.098%) than the grass it ate. Around 60 percent of students were completely successful and scored all 5 marks. The most common errors were to calculate the reciprocal of the comparative efficiency and not to round the answer to 3 significant figures correctly – i.e. 3.196... to 3 significant figures is 3.20, not 3.2, nor 3.19.

06.5 Reasons for the greater energy efficiency of raising cows indoors were often expressed inadequately. Many failed to explain that less energy would be *lost* as heat and *lost* in movement indoors compared with outdoors. Thus fewer than half scored any marks.

06.6 Disadvantages of raising cattle indoors were not well known with only a little over a third having any correct ideas, such as the increased spread of disease, extra costs of heating / lighting / supplying food and potentially aggressive behaviour of the animals in confined conditions resulting in harm to each other. Inadequate answers referred to 'cruelty' or to unqualified extra costs, and the unexpected idea that the grass would not grow so well indoors.

Question 7

This question was about the calculation of the population density of a microscopic unicellular alga and problems that might be encountered in the method of doing so.

07.1 Since the unusual colour of the alga had been caused by a mutation, students had to define the term *mutation*. Just under two-thirds understood that a mutation was a change in the genetic material, such as DNA, a base, a gene or a chromosome.

07.2 A description was given in the question of how a scientist set up a special slide with a counting grid in order to count the algal cells in a given volume of a suitably diluted sample of pond water. Section and plan diagrams of the special slide were given in **Figures 8** and **9**. Students then had to score the number of cells in a 0.2 mm × 0.2 mm square in **Figure 9**, observing the given rules for inclusion or exclusion of cells on the boundaries. Around three-quarters of students arrived at the correct answer of 16.

07.3 This question was a 6-mark calculation to find the number of algal cells in 1 mm^3 of undiluted pond water from a count of 14 cells in the 0.2 mm × 0.2 mm square. Many students presented their working in a manner that was very difficult to follow, with a series of mathematical operations that were clearly not equalities yet that were all interconnected with 'equals' signs. A large proportion of students regarded the volume of the sample on the special slide as being equal to 0.2 × 0.2 = 0.04, forgetting to multiply by the depth of 0.1 mm to obtain an actual volume of 0.004 mm^3. Some misinterpreted the scientist's dilution factor: 2.5 cm^3 made up to 10 cm^3 is a 4-fold dilution, not 5-fold as many thought. Many did not consider the dilution and ended up with an answer of 3500 (or 350 with the incorrect volume) instead of the correct value of 14 000.

The correct calculation was simply:

$$\frac{14 \times 4}{0.004} = 14\,000$$

but only around 1 in 8 students arrived at this answer.

07.4 To understand this question required thinking about the experimental situation and the results shown in **Figure 9**. If the pond water had not been diluted, there would have been 4 times the number of cells shown in **Figure 9** which would have made them impossible to count. Just over a quarter of students made any reference to the ease of counting. Some thought the algae would have been easier to see as the murky pond water had been diluted. Some answers were close – stating that dilution reduced the likelihood of cells overlapping – but did not then go on to state that they would thus be easier to count.

07.5 The original information about the scientist's investigation included mention of a thick coverslip over the sample. In this question, information was given about a student trying to repeat the investigation but with a thin coverslip that was pulled downwards slightly, and asking for an explanation of what difference this would make to the cell count. Fewer than half scored any marks and only one in six scored both marks for stating that the volume would be reduced and the cell count therefore also reduced. There were various, highly inventive but incorrect, ideas such as a thinner cover slip allowing light to pass through more easily so more cells would be counted, or that the curved coverslip would somehow refract the light and alter the count as a result. Many stated that the cell count would be 'altered' without being more specific about the direction of this alteration.

Question 8

This question compared temperature regulation in a primitive mammal, the echidna, with that of a human.

08.1 Since a comparison of temperature variation in the echidna and the human was required, using data from the graphs in **Figures 11** and **12**, it was essential to quote or manipulate numbers from the graphs and to state which variation was the greater. Fewer than a quarter of students were completely successful. Some misread the figures on one or both graphs, others selected the cold-weather data for the echidna whereas warm weather had been asked for, and others did not state which organism's variation was the greater.

08.2 Many students struggled to understand why a low body temperature for hibernation in cold weather would benefit the echidna. Although just over half appreciated the animal would lose less energy, or heat, from its body, few could go on to explain that this was because of the lower temperature gradient between the echidna and its environment or explain that its body energy stores would last longer as a result.

08.3 Two different approaches to answering this question were given credit: to explain how activity could cause an increase in body temperature or to explain why an increase in body temperature would enable the animal to be more active. Either of these hinged on the vital point that energy was released by *respiration*, which was not mentioned by many students and thus only one-third scored any marks.

08.4 Explanations of how dilation of blood vessels in the skin could result in a decrease in body temperature were generally deficient in two respects: a misunderstanding of vasodilation and the omission of how cooling the blood in the skin resulted in a lowering of the temperature of the rest of the body. Some just stated that more blood flowed through dilated vessels or stated incorrectly that the vessels rose up through the skin. Hardly any students could explain that blood cooled at the skin would flow round the rest of the body and so remove heat from the other parts of the body. The one point generally scored was that more heat would be lost from the blood through the skin.

08.5 This proved to be a straightforward calculation for three-quarters of students, who scored full marks. A common error was the failure to convert correctly an answer in cm^3 to dm^3, even with the fact, given in the question, that 1000 cm^3 equalled 1 dm^3. Some left their answers as 3200 cm^3 of sweat lost by the athlete per day, others incorrectly coverted this to the somewhat improbable answer of 3 200 000 dm^3 per day.

08.6 The need to take salt tablets was related to replenishment of the salt lost in sweat by fewer than half of the students. Many thought that the extra salt in the blood would help to retain water in the body.

Question 9

This question was about investigations involving phototropism and the redistribution of auxin.

09.1 The amount of water given, the temperature and the type of plant were common correct answers for control variables in the investigation shown in **Figure 13**. 'Light' was an inappropriate suggestion as this was different in each of the three experiments. 'Time' was not rewarded as this was given as 12 hours in the diagram. More than three-quarters of students were able to suggest at least one correct control variable, with almost one third giving two.

09.2 Most responses to this question were very weak, with only one in eight scoring any marks. Most answers simply described experiments **B** (in the dark) and **C** (with all-round light) rather than stating these could be compared with experiment **A** (one-sided light) to show that light caused the effect in experiment **A** and that this light had to come from one side.

09.3 Careful inspection of **Figure 13** was necessary to answer this question – which showed the ink marks just behind the tip of the shoot were further apart in all three seedlings after 12 hours and that this region was also the part that bent towards the light in experiment **A**. Hence growth and response/bending occurred in this region. Both points were evident to only one in 20 students.

09.4 Nearly three-quarters of students knew that the response shown by seedling **A** was called *phototropism*. There was the inevitable confusion with the term 'phototropism', and 'tropism' unqualified was considered inadequate. Some correctly used the term 'positive phototropism' but the qualification 'negative' cancelled what would otherwise have been worth the mark.

09.5 This question, and the next, examined the ability to select appropriate information from **Figure 14** about the distribution of auxin in shoot tips under different light regimes. Most answers (two-thirds of students) correctly referred to shoot tip **F** which showed that a higher amount of auxin had moved into the agar beneath the side receiving less light. Far fewer students chose to compare this with the situation in shoot tip **G** where auxin was prevented from moving sideways through the shoot by the thin sheet of glass and thus resulted in equal amounts of auxin in the agar beneath the shaded and the illuminated sides. Many made inappropriate references to the results from the shoot tips kept in the dark (**D** and **E**).

09.6 The hypothesis that light causes the breakdown of auxin was easily refuted by the observation that all four blocks of agar, whether beneath shoot tips in the light or in the dark, contained approximately equal amounts of auxin. Only one fifth of students made relevant observations about the shoot tips in the light compared with those in the dark, while many simply focused on the results for shoot tip **G** and did not gain credit.

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.