OXFORD
INTERNATIONAL AQA EXAMINATIONS

INTERNATIONAL A-LEVEL BIOLOGY

(9610) BL05

Report on the examination

June 2022

REPORT ON EXAMINATION: INTERNATIONAL A-LEVEL BIOLOGY 9610 UNIT 5 BL05 JUNE 2022

General

There were many good answers to each question, with many students demonstrating a high level of understanding of material from the Specification. This included some aspects of osmosis, the design of an investigation on the effect of caffeine on heart rate, and speciation by natural selection.

Areas causing difficulties were drawing from a photograph, graph plotting, the use of appropriate data when analysing experimental results, understanding of logarithms, application of the Hardy-Weinberg equation and striking an appropriate balance between depth and breadth of coverage in an extended prose answer.

Students should be encouraged to read carefully through information given in the stem of a question as this is provided specifically for their guidance and sets the scene for making a reasoned response: time would be well spent in assimilating the information provided and in making sure it is well understood before attempting to answer any questions based upon it. Students would also find it helpful to read through the entire question in order to avoid the inclusion of irrelevant material in their answers to a particular section – this was particularly noticeable in question **3**, the structure of which separated experimental method from results presentation and from statistical analysis of the results.

It is also vital to take note of any particular requirement of a question, for example, in the presentation of data in a table or in a calculation, where an answer requires either an appropriate number of decimal places or a specified number of significant figures.

QUESTION 01

This question was about blood cells as seen in a photograph of a blood smear viewed through a light microscope.

01.1 Relatively few drawings of the white blood cell in **Figure 1** were accurate representations of the cell in the photograph. Some included details that would have been visible only in the electron microscope; some were drawings of a red blood cell. Students must attempt to draw precisely what they can see. Despite the instruction to label the drawing, some students did not.

01.2 Calculations of the magnification of **Figure 1**, given that the real diameter of cell **A** was 10.5 μm, were generally successful. The main problem arose from measuring the diameter in centimetres rather than millimetres and using an incorrect factor for conversion to micrometres.

01.3 Almost all students were able to describe how the phagocyte could engulf a microorganism (weaker students referred to engulfing the ‘disease’). However, only a quarter could then describe intracellular digestion within a vesicle / vacuole / phagosome which fused with a lysosome. It was clear that some even thought that digestion was extracellular.

01.4 Over two-thirds of students understood that the red blood cells labelled **B** in **Figure 1** were a different shape from the others as they had lost water by osmosis. Although most understood the concept of water potential, some were clearly confused by the negative values.

01.5 Only one-tenth of students understood the concept of dynamic equilibrium as applied to osmosis. Most thought that water movement ‘did not occur’ in the normal red blood cells rather than water entering and leaving at the same rate. A significant proportion used the phrase ‘no osmotic gain or loss’ but this was regarded as inadequate as it did not convey there was no *net* gain or loss.

QUESTION 02

This question was about the effect of pH on the action of the enzyme trypsin.

02.1 The table of results was completed successfully by only half of the students, the main error being an incorrect number of decimal places for the rate calculated for pH4 – this should have been given to 3 decimal places, like the example given for pH2, ie 0.050 rather than just 0.05.

02.2 Only around 30 percent of students plotted an error-free graph of the data. A significant proportion of students either failed to label the y-axis or omitted the units. There were very few plotting errors but the line should have been either a smooth curve of best fit or a series of lines ruled point-to-point; some attempted a combination of these while others omitted the line. There were a few bar charts – inappropriate for two continuous variables.

02.3 Just under half the students added the standard deviation bars correctly to their graphs. There were some plotting errors and around 1 in 9 students made no attempt.

02.4 Most knew that the overlap of standard deviations indicated no significant difference between the rates of reaction at pH4 and pH6. However, those who stated 'overlap of *standard error* bars' were penalised as standard errors had *not* been given in **Table 1**.

02.5 Suggested improvements to the method for finding a more accurate value for the optimum pH generally included the use of more pHs at smaller intervals either side of pH8 and close to it. Since **Figure 3** had shown the reaction mixture in a test tube, one mark was available for suggesting the tube might be put in a water bath to maintain a constant temperature, or that the density of the image on the photographic negative could have been better determined using a colorimeter. Only 1 in 10 students gained this third mark.

QUESTION 03

In this question, students had to design an investigation to find the effect of caffeine on human heart rate.

03.1 This question was generally well answered with most students suggesting that different concentrations of caffeine / coffee should be given to different groups of people, normalised for age / gender / ethnicity / BMI / 'health', and that their pulse rates should be measured after drinking coffee either at set intervals or after a set time. The most common omissions included the measurement of resting pulse rates before ingesting caffeine, the inclusion of a control given, say, decaffeinated coffee, and the use of a large number of people in each test group (5 being accepted as an arbitrary minimum).

03.2 Most suggested a suitable graphical method for presentation of the results of the investigation which could have been a line graph of pulse rate against caffeine concentration (or against time with separate lines for different caffeine concentrations) or a bar graph for a final pulse rate for each category of people. Although groups of people had been used in part **03.1**, many students did not state that mean values should be plotted and that standard deviation bars should be added to the graph. Many forgot to give the reason for their choice of graph – eg a line graph to represent two continuous variables or a bar graph to show the results for different categories of treatment. The simplest, and probably clearest, way to describe a graph would have been to draw an annotated sketch graph but very few students opted for this.

03.3 The choice of statistical test depended on what had been investigated in answering question **03.1** – eg standard error and 95% confidence limits (or a t-test) to test the significance of differences between the results, or Spearman rank to see if there was a correlation between heart rate and caffeine concentration. Around two-thirds of students chose an appropriate test but only two-thirds of these could give an adequate explanation for their choice.

QUESTION 04

Tay-Sachs disease was the subject of this question, including the effect of the disease on neurones in the brain and a case study of its occurrence in an isolated population in Brazil.

04.1 This section asked how myelin affected the speed of impulse conduction along a neurone. Most students knew that myelin increased the speed of impulse transmission due to saltatory conduction. The question asked for an explanation in terms of the movement of sodium and potassium ions but many answers included the description of myelin simply as an 'insulator' rather than explaining that it prevented the passage of sodium and potassium ions. Most knew that ion movement (or 'depolarisation') occurred only at the nodes of Ranvier. However, only one in 10 students was able to give a complete explanation of the phenomenon.

04.2 Given that a scientist estimated that, in one isolated community, 1 in every 29 people would be a carrier of Tay-Sachs disease, students had to suggest how the use of the Hardy-Weinberg equation could have produced this estimate. Most students could recite the Hardy-Weinberg equation but few realised that the only observable phenotype of Tay-Sachs was the frequency of babies born with the disease and that this equalled q^2, hence q, hence p = 1 – q, hence 2pq. Almost half did realise that 2pq was equal to 1 in 29 but were unable to relate this to the real-life situation of observable phenomena.

04.3 Two-thirds of students were able to give a reason why the Hardy-Weinberg relationship might not be applicable in the given situation, such as the selective disadvantage of being homozygous for the recessive allele, or mutation, non-random mating, being a small community, immigration or emigration.

QUESTION 05

This question was about the association between the use of the selective herbicide 2,4-D and the incidence of prostate cancer.

05.1 Over half the students were able to suggest why scientists could not be sure that 2,4-D was the actual cause of prostate cancer, citing the conflicting evidence between results for the USA and those from Australia and New Zealand, and the inevitable involvement of 'other factors' or the fact that 'correlation does not necessarily indicate causation'.

05.2 Although over two-thirds could suggest one feature of a suitable control for the scientists' investigation (usually the omission of the two agents, 2,4-D and DHT), only a quarter made the point that all other conditions should remain the same as in the experimental flasks.

05.3 Half the students understood that the scientists presented their results using a logarithmic scale for concentrations of 2,4-D and DHT because of the large range of values investigated. Weaker students suggested it was because the concentrations were 'too small' or, alternatively, 'too large'.

05.4 This question required the analysis of quite complex data from two graphs (**Figure 4** and **Figure 5**) to support the two given conclusions from the investigation. It was not a question about evaluation, although some students treated it as such. The question also contained the instruction to *use data* from the graphs. The first conclusion that 2,4-D on its own had no effect on the multiplication of prostate cancer cells was supported by **Figure 4** which showed that, over the range of concentrations of 2,4-D used, the number of cells remained at approximately the same value as the control. The second conclusion that 2,4-D increased the effect of DHT was shown by both graphs as the effect of DHT on its own was displayed on both, just with a larger scale on **Figure 4**. Data concerning the enhanced effect of 2,4-D on the effect of DHT was evident in **Figure 5** which showed an increase in the number of cells up to a value of 205% of the control number (or an enhancement of about 100% compared to the control, or by 58% of the DHT value, or 75 cells more than the DHT value). The final point required was that enhancement was particularly marked at concentrations between 10^{-9} and 10^{-7} mol dm^{-3}. Nearly all students showed that they did not understand the logarithmic scale on the graph by quoting concentrations as, for example '-8 mol dm^{-3}' which is clearly nonsense, although '-8 log_{10} mol dm^{-3}' was given credit as it quoted the units in the format given on the graph. Only 1 in 4 students was able to give a completely satisfactory answer to this data analysis question.

05.5 This question was concerned with the difficulties of applying the findings of laboratory-based investigations to the situation in the human body. Nearly two-thirds of students made the point that ‘other factors’ – or an example, such as exposure to other chemicals, to UV or other ionising radiation – might impinge on the human body as well as 2,4-D. Some students also pointed out that it would be unethical to experiment on the human body using a chemical suspected of being carcinogenic. Other suggestions, such as the effect of 2,4-D on cancer cells possibly not being applicable to non-cancerous cells, were acceptable but very rarely given.

QUESTION 06

This question was about factors that affected the growth and evolution of plants. Two marks were available for the quality of written communication: the correct use of a range of technical terms in a clear, logically-presented account.

06.1 This question asked for a description of why abiotic factors affected plant growth. Most students scored only 2 or 3 marks out of the 7 marks available. The main problem was that a great deal of detail was often included for very few factors – much greater breadth of coverage was required. The factors suggested related mainly to photosynthesis and enzyme action, which was appropriate but some students devoted up to a third of their answers to details of the light-dependent reaction at the expense of covering more factors. Some mentioned that factors such as carbon dioxide concentration, light and temperature could be rate limiting but did not include any detail to describe how – such as carbon dioxide being needed to combine with RuBP to make GP and TP, or light being used to excite electrons in chlorophyll to drive the synthesis of ATP and reduced NADP, or temperature affecting the speed of molecular movements and hence reaction rates but too high a temperature denaturing the active sites of enzymes. The pH of the soil was given quite frequently (as a factor that might cause denaturation of enzymes), as was water (for use in photolysis or for maintaining turgor in cells) – but other factors, such as inorganic ions in the soil and oxygen, were rarely mentioned.

06.2 Most students gained 2 or 3 marks out of the 4 available for describing an experiment to find if the leaves of two related species of plant needed different light intensities for optimum photosynthesis. Many students did not notice that these were woody plants and hence immersing each plant in a test tube of water would not be an appropriate experimental procedure. Some suggested, more appropriately, that a section of leaf from each plant could be immersed in either water or dilute sodium hydrogencarbonate solution and the volume of oxygen released measured, or bubbles counted, the plant material being subjected to light from a lamp placed at different distances to vary the light intensity. Control variables (such as the temperature) were sometimes given but few students stated that measurements should be repeated, means calculated and then a comparison made between the results for the two species of plant.

06.3 Accounts of speciation initiated by geographical isolation were often very good, including variation due to mutation, different phenotypes having a selective advantage in the different environments, survival and reproduction to pass on the favourable alleles, finally resulting in two groups of plants that could not reproduce together to produce fertile offspring. One point that was very rarely given was the use of the information in the stem that it was 600 000 years since the two modern species had a common ancestor – hence there was plenty of time for more mutations to occur leading to increasing genetic differences between the two populations. Information about the two species growing on different islands off the coast of Asia (given in question **06.2**) was sometimes forgotten – hence ‘sympatric speciation’, mentioned by a considerable proportion of students, was not likely.

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