GCSE
BIOLOGY

8461/2H

Report on the Examination

8461

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General

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

Particular problems which occurred quite frequently included:

- confusion of certain terms, eg a control and a control variable or neurone and nerve
- inappropriate use of the terms accurate, precise, reproducible, repeatable and valid and not realising that the term 'fair' is always inadequate unless suitably qualified
- not paying enough attention to information provided in the stem of a question in order to guide the response and avoid misconceptions
- repeating information given in the question, for which no marks are available, wasting valuable time
- lack of precision in the reading of data from a graph, for example reading a small square as '0.1' unit instead of 0.2
- 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 is not
- the concept of energy transfer, for example in respiration energy is not 'produced' but is released from glucose. The idea of energy being produced, made or created is not credited.

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 Students had to select two examples of reflex actions from a list of five different actions. 42% of students recognised that both releasing saliva when food entered the mouth and withdrawing the hand from a sharp object were reflexes, with withdrawal from a sharp object being the more common option.

01.2 655 of students understood that a **bright** light, or **increase** in light intensity, would cause constriction of the pupil of the eye, but many gave 'light' or 'light intensity' as an insufficient answer.

01.3 72% of students knew that the structure labelled on the diagram of a frontal view of the eye was the iris. Incorrect answers included the 'retina', the 'cornea' and the 'lens'.

01.4 64% of students gave insufficient answers to this question, as they did not state that muscle contraction in structure Q (the iris) caused the decrease in size of the pupil.

Incorrect references to radial and circular muscles were still allowed as knowledge of these went beyond the requirements of the specification. Some students made incorrect references to 'ciliary muscles' or stating that muscles 'contract and expand' (muscle 'relaxation' was ignored by examiners). Other incorrect answers seen referred to 'enlargement' of the iris or to muscles 'constricting'.

01.5 This 'extended response' question required an answer in extended prose and was marked using a 'level of response' mark scheme. An answer at level 2 (4–6 marks) would make reference to three key features of the given diagram of the reflex arc: the receptor, the neurones and the effector, in terms of their functioning and given in the correct sequence. The inclusion of further details, such as the conduction of impulses (rather than 'messages' or 'signals'), the mechanism of transmission at the synapses, the nature of the effector (muscle or gland) and how it responded (contraction or secretion) determined the mark awarded.

Answers at level 1 (1–3 marks) would typically:

- omit essential features, such as one of the neurones
- state that the effector carried out an 'action'
- include an incorrect detail, typically the involvement of the brain
- might give the neurones in an incorrect sequence.

63% of students gave level 2 responses.

Question 2 (standard demand)

02.1 In this question, students had to decide whether the trend in carbon dioxide concentration and air temperature, as shown in the graph, was to stay constant, to decrease or to increase during each of three given date ranges. 75% of students were completely successful, the main errors being in deciding which trend was applicable to the air temperature.

02.2 49% of students were able to explain how an increase in carbon dioxide concentration might cause an increase in temperature in terms of reducing the loss of heat / long-wavelength radiation / infra-red radiation from the earth or acting as an 'insulator'.

Errors included the mention of ultra-violet radiation, the ozone layer and the fact that heat was released in the process of combustion which was also the process that released carbon dioxide. There were also many references to 'global warming' offered as an explanation rather than as a phenomenon in need of explanation.

02.3 This 'extended response' question was marked using a 'level of response' mark scheme. An answer at level 2 (3–4 marks) required students to give evidence both **for** and **against** the proposition that an increase in carbon dioxide in the atmosphere was the cause of an increase in air temperature, together with the inclusion of numerical data (as stated in the question) to back up their argument.

One approach was to make use of the trends already worked out in answer to question **02.1**, possibly adding on numerical values from the graph to illustrate the point being made. For example, between 1960–1977 the concentration of carbon dioxide rose by about 20 ppm (from 320–340 ppm) while the temperature decreased by around 0.4 ºC.

Since there was no grid on the graph, approximate numerical values were allowed. However, some students misread or misunderstood the scales on the graph and stated, for the given example, that carbon dioxide concentration rose from 0.1–0.3 (ppm or °C), or that the temperature changed from 0 ºC to −0.4 ºC or even from 320–280°C. 61% of students gave level 2 answers.

Some students did not follow the instruction to use data from the graph and / or only gave evidence for one side of the argument, usually in favour of the proposition.

02.4 79% of students were able to give the burning of some sort of fuel (eg a fossil fuel or wood) as a human activity that would cause higher concentrations of carbon dioxide in the atmosphere in the winter than in the summer. In some instances this was described indirectly in terms of examples such as driving cars or the use of home heating systems.

02.5 77% of students knew that 'photosynthesis' was the biological process that lowered the concentration of carbon dioxide in the summer. Some attempted to answer in terms of human activities.

02.6 Loss of habitat, usually in terms of polar bears in the Arctic, changes in migration patterns and extinction were the main examples given as effects of rising global temperatures on living organisms. 80% of students were able to give at least one of these. Quite commonly, answers were too vague, such as 'organisms dying'.

Question 3 (standard demand)

03.1 84% of students were able to calculate that the missing column on the bar graph for water loss in faeces was 120 cm^3.

03.2 77% of students correctly selected 'respiration of glucose' as the metabolic process that produced water.

03.3 98% of students suggested correctly that sweating was the process by which more water was lost through the skin in a person running a 10-kilometre race. 74% of students were able explain that this was in order to cool the body.

03.4 In order to explain why more water was lost during the race by breathing, it was necessary to give a comparative answer. 85% of students were able to explain that the person would breathe more heavily and / or more frequently during the race. 33% of students explained that the rate of respiration would have increased. And 8% were able to explain that this was because of the extra energy needed to run.

Many who did mention respiration **did not** gain credit as they did not emphasise the increased respiration rate during exercise. The terms respiration and breathing were also frequently confused.

Question 4 (standard & standard / high demand)

04.1 57% of students understood that the purpose of placing quadrats at random was to:

- allow for the uneven distribution of the dandelion plants
- get a more representative or valid result
- avoid bias
- obtain a more accurate or precise mean value from the 10 samples.

Many others stated that it was to make the results accurate, precise, reproducible, repeatable or fair and such statements were ignored by examiners.

04.2 Calculation of the dandelion population in the L-shaped field was a 5-step process, with each step worth a mark:

1 calculation of the mean number of dandelions in 1 m^2 from the 10 results in the table (6 / m^2)

2 calculation of the area of the field (55 000 m^2)

3 multiplying the mean by the area (6 $\times$ 55 000)

4 getting the correct answer from step 3 (330 000)

5 converting the answer from step 4 to a number in standard form (3.3×10^5).

Errors made at each step were allowed for in subsequent steps to avoid excessive loss of marks when students clearly understood the method they had to employ. Many students set out their working in a somewhat disorganised way which was difficult for examiners to follow.

44% of students achieved full marks, with 29% gaining four out of the five marks, primarily because they forgot to convert their final answer to a number in standard form.

04.3 Many students produced excellent answers to this question. But a large proportion of the remainder did not achieve any marks at all as they chose an inappropriate investigation: sowing dandelion seeds in pots and seeing how well they grew with lights of different intensities shining on them.

Higher-attaining students described how they would run a line transect from the shady woodland across the field, placing the quadrat at regular intervals along this and counting the dandelion plants in each quadrat. They anticipated that the density of dandelions would increase further away from the woodland.

The highest-attaining students stated that a light reading should be taken with a light meter within each quadrat, that the transect should be repeated at several other similar locations, means being calculated for set distances from the woodland, and that a graph should be plotted of the number of dandelions against light intensity, hoping to find a positive correlation. A suitable alternative to this method was to place a large number of random quadrats in a shady area and in a brightly-lit area and determining the mean number of dandelions for each area which could then be compared.

Answers were marked using a level of response mark scheme with:

- level 3 (5–6 marks) being awarded if the method described would give a valid outcome and the key steps were logically sequenced
- level 2 (3–4 marks) for a sensible method which would not necessarily produce a valid outcome as one or two key steps had been omitted.
- level 1 (1–2 marks) giving an answer that would definitely not give a valid outcome, although some relevant material had been included.

Overall, 33% of students achieved level 3.

04.4 Suitable suggestions of two other environmental factors that might have determined how well the dandelions grew included water, mineral ions and the pH of the soil, as well as biotic factors such as herbivores or trampling. 97% of students were able to give at least one factor with 44% managing to provide two.

Factors considered inappropriate included the concentration of carbon dioxide or oxygen in the air, as they were unlikely to be limiting in an open field, but these were often stated by students.

Question 5 (standard / high & high demand)

05.1 63% of students knew that genetically-identical cells were only produced in mitosis, that haploid cells were produced in meiosis and that DNA replication was necessary for both processes.

05.2 The advantages of asexual reproduction for bluebell plants most commonly cited by students were that it was a faster process than sexual reproduction and that it required less energy. Many stated that 'identical' plants were produced, but this required qualification in terms of the offspring being **genetically** identical.

50% of students achieved the two marks available.

05.3 Most students concentrated on just two points that related to sexual reproduction in general and did not amplify further in terms of the context of the question, ie sexual reproduction in a plant. Thus, variation in the offspring was given together with an attempt to describe some sort of selective advantage in terms of survival. The latter point was frequently made inadequately as students' answers implied that all would survive rather than just some which had the selective advantage.

Only a minority of students explained that sexual reproduction in plants involved seed production. And that seeds could be dispersed over a far wider area than bulbs, hence leading to potential colonisation of new areas giving a higher probability of survival should some unfortunate event overtake the original habitat.

32% of students scored no marks in this question, with 65% achieving one or two marks and 2% achieving three or four.

Question 6 (standard, standard / high & high demand)

06.1 In the stem of the question students were told that both sets of apparatus were placed in a dark cupboard. However, many students thought that the purpose of the damp blotting paper in each set of apparatus was to prevent light affecting the direction of root growth.

57% of students selected the correct reason which was to prevent water affecting the direction of root growth.

06.2 24% of students were able to explain that apparatus B acted as a control because it allowed gravity to act evenly on all sides or cancelled the effect of gravity.

Many students attempted to explain why a control was needed rather than how apparatus B acted as a control in the given situation. Many also misused the terms 'geotropism' or 'gravitropism' when they in fact meant gravity.

06.3 Lack of precision was an issue for many students here: while most realised there was an anomalous result for apparatus B, many did not point out that this was for seedling 4 whose increase in length was less than 10% of that of the other seedlings.

06.4 Two omissions were evident in the answers of most students. As in question **06.3**, many forgot to mention seedling 4. Plus, although most thought the anomalous result should have been ignored or that the experiment should have been repeated, they did not state that the mean should have been recalculated. 31% of students achieved the mark.

06.5 Although the drawing of the root of a seedling from apparatus A showed a right-angle bend with the tip pointing vertically downwards, many students stated that the effect was due to a response to light.

34% of students gained partial credit and 13% achieved all three marks for stating that gravity had caused the hormone to be unevenly distributed in the root of seedling A resulting in more growth on the upper side. While in seedling B the hormone was evenly distributed.

06.6 61% of students were able to link each of the plant hormones, auxin, ethene and gibberellin, to a correct example of its use in horticulture.

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

07.1 Students were required to draw a pyramid of biomass on the graph paper, to scale, using figures given in the food chain. 32% of students were completely successful, but the following errors were common among the remainder:

- Forgetting to label the *x*-axis as 'Biomass in g/m^{2}'.
- A scale ranging from 0 to 900 in both directions from the mid-point. Consequently, the plotted bars that were twice the width they should have been (eg 840 units for the algae was plotted as 1680). Thus all the plotted bars were incorrect as none of them matched the student's chosen scale.

07.2 There were two possible routes for the calculation of the percentage of biomass lost between the algae and the large fish, given that their biomasses were 840 and 10 g/m^2 respectively.

Allowance was made for arithmetic errors in that one mark was available for an answer given to two significant figures, correctly derived from an incorrect answer to the calculation. Many students did not give their answer correct to two significant figures eg '98.8' was a common answer. This scored two of the three marks available, provided it was evident that an appropriate method had been used to produce this figure. 51% of students achieved full marks, with a further 13% achieving two marks.

07.3 63% of students knew a method by which biomass could be lost between trophic levels in a food chain, such as inedible or indigestible material, or by the process of respiration. Many students suggested 'movement' but this was ignored unless respiration was also mentioned.

07.4 Students had to be able to link concepts from various sections of the specification: 4.7.3.2 (pollution of water by sewage), 4.7.2.3 (the decay of biological material, including the use of oxygen), 4.2.2.1 (digestion) and 4.4.2.1 (aerobic respiration). Students were also prompted by the sentence in the stem of the question: 'Untreated sewage contains organic matter and bacteria.'

Most students did not link the decay of organic matter by bacteria, involving digestion and aerobic respiration, to depletion of oxygen dissolved in the river water, leaving insufficient oxygen for the fish to respire, and hence the fish being deprived of the energy necessary to sustain life.

The vast majority of students associated bacteria with disease in the fish which was insufficient at this level and for which no marks were awarded. Some suggested toxins in the sewage might kill the fish, which was allowed as an alternative to lack of energy as a cause of the fishes' death.

42% of students achieved any marks and 0.2% students achieved full marks in this high demand question.

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

08.1 77% of students understood the term mode and hence correctly chose the value '3.7' from the graph.

08.2 There was evidently some confusion about the meaning of the terms phenotype and genotype. While 51% of students correctly chose '2' as the number of phenotypes possible for a feature controlled by one dominant and one recessive allele, the option '3' was a very strong distracter.

08.3 40% of students were able to explain that the large number of categories for the milk fat percentages gave evidence that this was a feature controlled by several genes.

08.4 Students were required to demonstrate their understanding of the relationship between a gene and the structure of the protein for which it coded. Thus, if a mutation resulted in the change of one amino acid in an enzyme molecule, this could stop the enzyme working because the shape of the enzyme, and in particular its active site, would be altered so that the substrate would no longer fit. 19% of students fully understood this.

Many students digressed into details of base changes in the DNA. Others used the correct terminology but demonstrated a lack of understanding of it with many appearing to think the active site was part of the substrate molecule rather than part of the enzyme.

08.5 The evidence in Figure 11 (a pedigree diagram showing the inheritance of milk fat content in cattle) that cow number 7 was heterozygous should have come from consideration of this animal's offspring, some of which produced low-fat milk and some high-fat milk.

- Many students considered that the animal's ancestors were important but the animal in question had undergone mutation, thus rendering consideration of its ancestors irrelevant.
- Other students thought that 'evidence' was provided by animals inheriting the mutation rather than by the phenotypes produced by the presence or absence of the mutation.

34% of students were able to cite appropriate evidence.

08.6 The main reason for using IVF and embryo transfer into 11 other cows was to produce 11 offspring quickly, rather than waiting many years for the parents to produce them naturally. Alternative reasons, such as allowing embryo screening or the prevention of injury to the female due to repeatedly giving birth, were also allowed.

35% of students gained credit in this question.

08.7 This question required students to construct a Punnett square genetic diagram to show how animals 7 and 8 in Figure 11 could produce some offspring that made low-fat milk and others that made high-fat milk. While the vast majority of students had some degree of success, full marks were achieved by 28% of them.

Although some students opted for incorrect genotypes of the parents, these were still able to score a mark for correct derivation of the offspring genotypes. Most errors were due to omission:

- not identifying which gametes came from which parent (ie D + d from cow 7 and d + d from bull 8)
- not identifying the phenotypes of the offspring.

Many simply stated that 50% of the offspring would produce high-fat milk and 50% low-fat milk without stating which did which.

08.8 In this high demand question 60% of students scored none of the four marks available. The task was to describe how selective breeding of some of the animals in Figure 11 could produce a type of cattle that made large quantities of low-fat milk. Many students did not mention the quantity of milk and just concentrated on the fat content. Others did not make it clear that the scientists should mate animals of opposite gender. So 'cows' were crossed with 'cows' or with animals that produced low-fat milk (female) or with animals that produced a large volume of milk (female), rather than with males whose female offspring produced low-fat milk or produced a large volume of milk.

The most success was achieved by suggesting mating of animal 13 from Figure 11 (ie the female with the lowest fat content in her milk) with a bull whose previous female offspring produced large quantities of milk. Only 4% of students got any further than this by suggesting that the best male and female offspring (for both features) should be selected repeatedly for breeding in subsequent generations.

Question 9 (standard, standard / high & high demand)

09.1 37% of students knew that the four missing taxa in the hierarchy were class, order, family and species. Some demonstrated the use of mnemonics to enable them to recall these technical terms. Unfortunately, some could only remember the mnemonic, not what it represented.

09.2 48% of students knew the binomial name of an organism was composed of the genus plus species: here, *Lemur catta*. Many incorrect answers included the family name from the table, '*Lemuroidea*'. Many gave a single word for the binomial name.

09.3 Most students appeared not to make use of the scale given on the map. Therefore, did not realise that the ancestral lemur would have had to swim 400 kilometres to get to Madagascar.

Others did not seem to appreciate how long ago 60 million years was and stated that the ancestral lemurs might have been stowaways on boats. 3% of students described how lemurs would have likely been carried on rafts of vegetation (or tree trunks) which would have floated and been propelled by the favourable water currents.

09.4 The ideas required to answer this question were that several populations of ancestral lemurs would have been isolated from one another, perhaps by mountains, deserts or rivers, and found themselves in different types of habitat. Genetic variation, or mutation, within each population then led to the better adapted surviving long enough to reproduce and pass on their beneficial alleles to their offspring, eventually producing different groups of lemurs that could not reproduce with members of another group to produce fertile offspring. Such a complete explanation was given by 4% of students. Although 53% of students were able to achieve at least two of the five available marks, usually for the first two marking points given above.

Weaker explanations gave ideas such as 'the lemurs were in different parts of Madagascar', 'the lemurs survived and passed on their characteristics', 'the lemurs could no longer reproduce together'.

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.