# GCSE
# BIOLOGY

## 8461/2F: Paper 2 – Foundation
## Report on the Examination

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## General

Nearly all questions were attempted by the vast majority students and there were some very successful answers. Questions seven, eight and nine were common with the Higher tier paper.

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. No marks are available for this and it 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:

- **low demand** questions are designed to broadly target grades 1–3
- **standard demand** questions are designed to broadly target grades 4–5.

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 (low demand)**

**01.1** Nearly all students understood that chemicals were detected by the tongue and light by the eye and were therefore able to link each stimulus correctly to the appropriate sense organ.

**01.2** Definitions of a reflex action were frequently weak with very few stating that the action was a response or a reaction. Many knew that a reflex action was automatic or not under conscious control. Often, the definition centred around the action being fast or for protecting the body from danger which, being general descriptions, were allowed, whereas just 'moving away from heat' (as in the question) was not.

A number of students appeared to believe that reflexes are not coordinated by the brain and although this is incorrect, it was ignored by examiners as at this level the distinction between this and 'not coordinated by the conscious part of the brain' is subtle. Repetition of 'action' from the question was insufficient to gain a mark, however a small addition to reaction would have gained credit. A number of students attempted to describe a reflex arc and rarely gained credit.

**01.3** Around 92% of students correctly selected the option 'the muscle contracts' as the means by which an arm muscle removes the hand away from a hot object.

**01.4** Given the example in the stem of the question, most students were able to read the three sample results correctly as 8, 11 and 13 centimetres for the distance the ruler fell before being caught. Errors included reading the position of the lower edge of the thumb instead of the top edge and reading the position of the forefinger.

**01.5** About 31% of students were able to give a description of the evidence for the proposition that drinking coffee speeds up reactions. Some simply stated that the reaction was faster after drinking the coffee, which made no advance on the question.

Examiners were looking for evidence from the results table, as had been asked: thus, a reference to the reduced time to catch the rule, or to the rule falling less far before being caught, after drinking the coffee was required. A significant number of students referred to only one or two of the five tests but this was not sufficient as individual results do not imply a trend. Only very few calculated the mean values but, when they did, they were usually correct.

**01.6** Many suitable suggestions were made by students for how the method could have been improved. These included carrying out more repetitions, testing more people, using a ruler with a millimetre scale (rather than one having just centimetres as in the question), ensuring the ruler was dropped from the same height. Students should have completed Required Practical Activity (RPA) 7 on the topic of reactions but may not have done it using this technique, thus examiners allowed reference to an alternative method such as a computer program for one mark.

Those students who suggested altering the independent variable, such as 'try the investigation with different drinks' or '…with different strengths of coffee' had not answered the question, which was about drinking coffee, as opposed to not drinking coffee, so could not gain credit. A number of students suggested that using a stopwatch to measure reaction time would be an improvement on the given method and it seemed likely that these students did not understand the impact of an additional reaction on the results.

Around 65% of students were able to suggest at least one improvement, with 17% being able to suggest two.

**Question 2 (low demand)**

**02.1** About 53% of the students knew that a dominant allele was one that was expressed even if a person had only one copy of the allele. The second most commonly selected option was that two copies of the allele were needed.

**02.2** Around 89% of students completed the Punnett square correctly by entering the three missing genotypes of the offspring. Those who did not could gain one of the marks for correctly identifying just one of the offspring genotypes.

**02.3** The answer here, giving the probability that one of the children would have attached earlobes, was linked to the answer given in question 02.2. Three-quarters of students were successful, with '0.5' usually being appropriately selected, although '0.25' or '0.75' were allowed if such an answer matched the Punnett square in question 02.2.

**02.4** This question required completion of another Punnett square, but this time the sex chromosomes in the missing gametes had to be entered. About 70% of students entered these correctly.

Errors included putting the Y chromosome in the wrong position and the inclusion of diploid rather than haploid gametes. About 14% of students did not attempt to answer this question.

**02.5** Students were given an equation to help them find the probability of the offspring being a girl with attached earlobes, using their answer to question 02.3 and the information given in **Figure 5**. Two-thirds of students were successful, with a variety of formats being acceptable.

**Question 3 (low & standard demand)**

**03.1** Almost two-thirds of students correctly selected '46' as the number of chromosomes in cell A of Figure 6. A further one-third of students opted for '23'.

**03.2** This question produced the rare outcome of an incorrect option being more commonly selected than the correct answer. Thus, over two-thirds opted for a quarter of the mass of cell A's DNA in the sperm cell rather the correct answer of one half.

This was probably due to not reading the description of the first step in Figure 6, 'cell growth and *copying* of the DNA'. Students who did this just used the information that there were two rounds of cell division however, reviewing their answers may have corrected this as 46 × ½ × ½ would have resulted in 11½ chromosomes in each sperm cell, which would have been impossible (as would 23 × ½ × ½, giving 5¾ chromosomes per sperm cell).

**03.3** About 69% of students correctly selected 'meiosis' as the type of cell division that produces sperm cells. The remainder were equally divided between 'binary fission' and 'differentiation'.

**03.4** Around 86% of students recognised that the correct term for describing an error in the genetic material was 'mutation'.

**03.5** This question proved t difficult for most students. Many thought the three children would not be genetically identical because 'they had different genes' or because they were 'born at different times' or because 'this is sexual reproduction'. None of these answers were considered creditworthy.

To gain credit, it was necessary to state either that a different egg or sperm was involved each time, that the genes they inherited came from two parents or that there was different genetic information in each gamete. More than a quarter of students were able to make one of these points, with around 4% making two.

**03.6** Almost a third of students correctly selected '8' as the number of cells in the embryo after three cell divisions and almost as many opted for '6'.

**03.7** Measurement of the diameter of the embryo, distance X in the photograph in Figure 7, was done successfully by around 80% of students. The anticipated answer was 40 mm (although an answer in the range 39–41 was acceptable).

Some students measured in centimetres and gave the answer '4', while others took this value and converted it to millimetres incorrectly, leading to answers such as '400', '4000' and '0.04'.

**03.8** Students had to substitute their answer to question 03.7 into the given equation in order to calculate the real length of the embryo. They then had to convert their answer to micrometres using the information that 1 mm = 1000 µm. The anticipated answer of 80 µm (or the value corresponding to the answer from question 03.7) was given by around 57% of the students.

Errors included incorrect substitution in the given equation (eg multiplying rather than dividing), failure to use the conversion factor of 1000, or dividing by it instead of multiplying. Thus, answers ranged from 0.0008 µm to 40 000 000 µm, the latter corresponding to a 40-metre embryo.

**03.9** Students were asked why an embryo, the size of which they had just calculated, might be lost from the woman's body without her noticing. Many correctly identified that the embryo

would have been very small and that, as such, it could not be seen or felt, or that it might be lost in the next menstrual period without being noticed.

At least one of these points was given by around 57% of students; around 17% of students gave two correct points. Although many students referred to the menstrual cycle, they did not identify the correct part of it, thus 'she is on her menstrual cycle' was insufficient. A number of students appeared to believe that the embryo would be lost during urination.

**Question 4 (low & standard demand)**

**04.1** Just under half the students correctly selected 'bacteria' and 'fungi', with a further one-third including just 'bacteria' and another fifth including just 'fungi' as the organisms that cause decay.

Some ticked only one box instead of the two required. 'Insects' and/or 'worms' were quite common incorrect choices.

**04.2** This question asked how the rate of decay in the compost heap would be affected by both an increase in oxygen concentration and an increase in temperature from 5 °C to 25 °C. Just under half of the students scored any marks.

A common error was to write solely about just one of the conditions (usually temperature). The concept of an increase in the rate of chemical reactions did not occur to most students, although an increase in enzyme activity was allowed. Similarly, the connection between oxygen and respiration was rarely given, with many thinking that decay organisms thrived in 'anaerobic' conditions. Some thought that bacteria would 'work' faster at 25 °C while others thought, incorrectly, that this temperature would denature their enzymes.

**04.3** About 36% of students knew that dampness, or water, was needed for decay, while others thought that 'light', 'darkness', 'carbon dioxide' or 'worms' were needed.

**04.4** About 46% of students recognised that methane was the main fuel gas in the biogas. 'Nitrogen' and 'hydrogen' were the two most commonly-selected distracters.

**04.5** Around 90% of students were able to calculate from the information in the pie chart that gas X (ie methane) occupied 60% of the biogas.

**04.6** Around 61% of students were able to give any benefit for the spreading of partly decayed organic matter on a farmer's fields. Some of the successful students thought it would make crops grow better and some thought it might release mineral ions (generally referred to as 'nutrients' or 'fertiliser'), but about 12% of students were able to include both ideas in their answers. There were a few other acceptable ideas such as water retention, improved drainage, insulation and the suppression of weed growth – but very few students suggested any of these.

**Question 5 (low & standard demand)**

**05.1** About 46% of students, having been given the binomial name of the dodo (*Raphus cucullatus*) recognised that '*Raphus'* was the name of the genus, and not 'animal' or 'bird'.

**05.2** Suggestions about why the dodo became extinct soon after the arrival of humans in its habitat included:

- being eaten, either by humans or by the animals they brought with them
- its eggs being eaten
- its food being eaten
- its habitat being destroyed
- disease.

About 38% of students were able to suggest two of these.

**05.3** Around 84% of students were able to suggest a possible use of the land after the trees of the forest had been cut down, such as farming or building houses. A few students with more detailed knowledge referred to growing palms for palm oil production.

**05.4** Students were asked to tick two boxes from the list of five optional explanations of why the removal of trees causes an increase in carbon dioxide in the atmosphere. More than a quarter of students selected both 'less photosynthesis' and the 'burning of the trees'. Many students ticked only one box. Overall, three-quarters knew that a reduction in photosynthesis would increase carbon dioxide levels and a third knew that burning of the trees would have this effect.

**05.5** About 88% of students knew that an increased concentration of carbon dioxide in the atmosphere would cause an increase in global air temperature.

**05.6** Students were given a map of the rainforest, which was divided into nine sectors, and the information that it took 30 years to cut down the trees in one sector. About 90% of students were able to use this information to calculate that it would take 270 years to cut down the trees in all of the sectors.

**05.7** This question asked students to explain why the pattern of tree-felling shown in Figure 11, in which non-adjacent sectors of the forest were felled in a cyclical pattern, would stop the biodiversity of the rainforest being reduced.

An answer in extended prose was required and it was marked on the basis of a 'level of response' mark scheme. An answer at Level 2 (3–4 marks) required students to include several linked statements, ie an activity that could occur linked to the consequence of that activity. For example: animals being able to migrate to an adjacent area of the forest and so finding a suitable habitat; plants growing back in a recently deforested area and so providing food or shelter or nest sites for returning animals.

Only a very small minority of students were able to achieve more than Level 1 as they gave just a few isolated, mainly non-linked, ideas in their answers, usually about animals migrating elsewhere and the trees re-growing. Some decided this question was about natural selection and therefore gave largely irrelevant answers. Some misread the question and attempted to explain why biodiversity would be reduced rather than its reduction being prevented.

About 48% of the students either did not attempt an answer or scored zero marks for what they did write; and only slightly more scored just one or two marks. Fewer than 2% attained Level 2. Although tough, this question differentiated well between the ability range of students.

**Question 6 (low & standard demand)**

**06.1** Almost a quarter of the students knew that urea was made from protein and so a lot of urea would be made if the diet contained a lot of protein. Many selected 'lipid' or 'salt' from the distracters.

**06.2** About 41% of students knew that urea had to be excreted from the body because it was a waste product or because it was potentially toxic. Some answers stated the urea might 'harm' the body or might cause 'disease'. Some obviously confused the terms urea and urine and described how it might carry other substances out of the body.

**06.3** The processes that made carbon dioxide and that removed it from the body were frequently confused. However, about 63% did select the correct terms for these processes as 'respiration' and 'breathing', respectively. Occasionally, 'osmosis' or 'digestion' were chosen.

**06.4** This question posed a fairly complex scenario requiring students to assign relative amounts of urine production to differing combinations of air temperature and volume of water consumed. About 59% of students correctly assigned the terms least, medium and most to the appropriate conditions.

**06.5** This question presented students with a schematic diagram (Figure 12) showing various molecules on either side of a partially permeable membrane in a dialysis machine. Although over half of the students correctly selected 'diffusion' as the process by which urea leaves the blood, 'osmosis' was a very close second.

**06.6** Most students had no difficulty in deciding that protein was the substance in the blood that would not enter the dialysis fluid as Figure 12 showed that the protein molecules were larger than the pores in the partially permeable membrane.

**06.7** Figure 13 was a graph showing changing urea concentrations over 14 days in the blood of two patients with kidney disease – one treated by dialysis and one who had a kidney transplant.

Using information from Figure 13, students had to work out how many dialysis sessions had taken place each week. Half the students were able to translate three reductions in urea concentration in each period of seven days as indicating three dialysis sessions per week.

**06.8** In this question students were required to know that urea concentrations in the blood would increase between dialysis sessions, but slightly fewer than half did so. Many stated that the urea concentration went 'up and down'. There also seemed to be an element of guesswork here as 'decreases' appeared almost as often as the correct answer.

**06.9** Reasons given for why a kidney transplant might be preferable to treatment by dialysis were mainly in terms of convenience – the avoidance of multiple visits to a hospital or no restrictions on diet. Only a few used information from Figure 13 which showed a constant and low concentration of urea in the blood of the patient with the transplant.

Suitable alternative reasons given by some students were the avoidance of blood clots or infection as dialysis involved repeated piercing of the skin. Although converse answers were accepted, if clear, a few students reversed the question and described possible advantages of dialysis. A fifth of students were able to give two correct reasons.

**Question 7 (standard demand)**

**07.1** Three-quarters of students correctly selected 'primary consumer' as the term to describe the Daphnia. 'Secondary consumer' was the next most common option.

**07.2** More than half of the 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 called a 'primary consumer','1st-order consumer', 'herbivore' or 'trophic level 2'; some students did not gain the mark due to a labelling error.

**07.3** 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. About 7% of students gave a creditworthy answer.

**07.4** 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 very 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. More than a fifth of students gave the correct final answer.

**07.5** Given the dimensions of the pond, students had to use the value obtained in question 07.4 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 – but this did not prevent many students trying to do so. The actual calculation was: answer from question 07.4 × 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. There was a relatively even split of students across the mark range, with about 15% gaining full credit. This question did differentiate between students very well.

**07.6** The data in Figure 15 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 15% of students scored any marks for this question.

**07.7** 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 were expected to deduce that the Hydra would not have enough to feed on and hence its 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. A significant number of students appeared to believe that Hydra is a plant and that lack of sunlight (caused by a layer of fertiliser or algae) would 'prevent it from photosynthesising'. Students were generally more successful in this question than in question 07.6.

**Question 8 (standard demand)**

**08.1** Half the 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
- different cell types or names of whole organs.

**08.2** There was much confusion over the selection of labels for the three parts of the DNA molecule and about 11% of students demonstrated that structure X was sugar, Y a nucleotide and Z a base.

**08.3** Approximately 46% of students knew that the correct scientific term to describe the structure of the DNA molecule was a 'double helix'. There were various other terms, generally based on 'twisted' (as given in the question) or 'coiled' that were not creditworthy.

**08.4** The section of DNA shown in Figure 16 consisted of a single strand of 9 nucleotides. It was evident that relatively few students knew that 3 nucleotides coded for one amino acid. Hence selection of the answer 3 for the number of amino acids coded for was not the most common option (approximately one-quarter of students); '9' was far more popular (around half the students).

**08.5** Benefits of understanding the human genome were not well known, with about 16% of students knowing just one and around 4% knowing two. Answers were often expressed imprecisely eg the detection and treatment of 'disease' rather than an inherited disease; or 'we need to know more about ourselves'. The most common correct answers related to detection and treatment of inherited conditions, or to tracing ancestry or human migration patterns.

**Question 9 (standard demand)**

**09.1** Having been given a definition of phototropism, less than one-third 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. Two-thirds of these students were able to name the corresponding stimulus. Some students described a response rather than just giving the stimulus.

**09.2** 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 17 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 Level 1 as they contained some relevant points but did not satisfy the criteria described above. About 30% of students gave Level 2 answers and around 2% attained Level 3 in this question that differentiated across the ability range well.

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 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, along with a control set up, 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.

**09.3** 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.

Around 72% of students scored no marks in this question. A major cause of this was due to not giving 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.

**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.