Examiners' Report
Principal Examiner Feedback

November 2021

Pearson Edexcel Level 3 GCE
Biology B
Paper 3: General and Practical Principles in Biology

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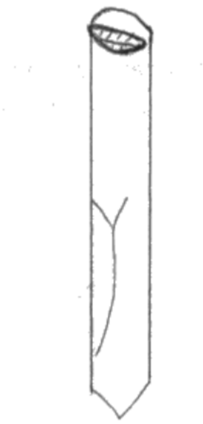
General comments

To do well in this paper, students need detailed knowledge of all areas of the specification and must be able to link concepts together to answer synoptic questions. There are a large number of marks linked to core practicals, and to analysis and interpretation of novel data; students need to be able to apply their biological knowledge to these unfamiliar situations and data. There were some strong, well-structured answers, suggesting that schools are giving students practice in these complex skills.

Question 1

1(a)(i)

Students were provided with a photomicrograph of a longitudinal section through phloem tissue and asked to draw the cell labelled X. This proved surprisingly challenging for almost all students taking this paper, and suggests that more practice is needed in biological drawing – this is Core Practical 2.
The expectation was that the single cell to be drawn would be of the right shape and proportion, with any features included and no shading. Labels were not required.
The drawing in the centre illustrates most of these points. The majority of students drew a stylised diagram which bore no resemblance to the photograph; the drawing on the right is a typical example.



1(a)(ii)

Students were asked to explain how phloem tissue is adapted for its function. In order to answer this successfully, three elements needed to be included:

- the types of cells present in phloem tissue
- the functions of these cells
- the adaptations which enable the cells to carry out these functions.

The best answers included reference to sieve tubes transporting organic molecules, and having no organelles so there are fewer barriers to this process; while companion cells provide ATP, since energy is needed for transport.

1(b)

Many students realised that in microscopy, stains are used to make organelles clearly visible. However some made vague statements about improving contrast or providing colour, which gained no credit.

Question 2

2(b)(i)

This proved difficult for many students, although the style of question is commonly seen. It required them to identify and clearly state similarities and differences between the central nervous system and peripheral nervous system. While some clearly had this knowledge, marks were lost through answers which included information about only one of the systems with no reference to the other, eg. the peripheral nervous system contains sympathetic and parasympathetic systems.

2(b)

Students were given the context of a soldier with a brain injury, and the impact this had on movement of his arm. Many knew the functions of the cerebellum and cerebrum, but some were unable to explain how, following the injury, the soldier used the cerebrum to carry out movements which were previously automatic.

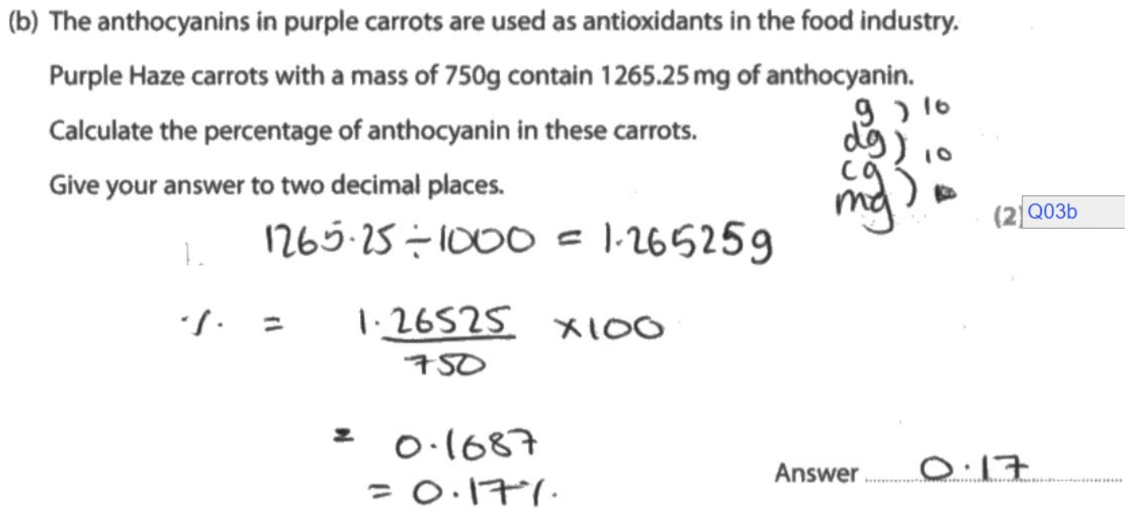
Question 3

3(a)

Many students were now on much more familiar ground with a question linked to Core Practical 5, relating to the effect of temperature on membrane permeability. There were excellent examples of control of variables, eg. size and surface area of carrot tissue, volume of water; and most students were able to explain how to use the colorimeter to give quantitative results. Many stopped at this point and did not go on to explain how to analyse the results through drawing a graph or use of a stats test. A few were confused about whch core practical was being tested, and wrote about leaving the carrots in water and measuring the change in mass when water entered by osmosis.

3(b)

Many students were able to carry out the calculation to find the percentage of anthocyanin in carrots. Common errors included incorrect conversion of mg to g, so the final answer was to the wrong power of ten, or not giving the final answer to two decimal places as required. This student set out the working clearly and gained two marks.


(b) The anthocyanins in purple carrots are used as antioxidants in the food industry.

Purple Haze carrots with a mass of 750g contain 1265.25 mg of anthocyanin.

Calculate the percentage of anthocyanin in these carrots.

Give your answer to two decimal places.

(2) Q03b

$1265.25 \div 1000 = 1.26525g$

$\% = \frac{1.26525}{750} \times 100$

$= 0.1687$

$= 0.17\%$

g) 10
dg) 10
cg) 10
mg)

Answer 0.17

3(c)(i)

This question was about cauliflowers which could be dark purple, light purple or white in colour, due to differing levels of anthocyanin.
Almost all correctly gave the genotype of the F1 generation (which were light purple) as Prpr.

3(c)(ii)

Despite getting the genotype of the F1 generation right in part (i), many students found it very difficult to give the ratio of phenotypes in the F2 generation when the F1 generation was crossed (this would be a 1:2:1 ratio), and to use this to give the expected numbers of each colour. Answers ranged from a 9:3:3:1 ratio to all being the same colour.

3(c)(iii)

Students used their expected numbers to obtain a Chi-squared value. A surprising number did not realise that if there were three phenotypes (dark purple, light purple and white) there must be three values for $\frac{(O - E)^2}{E}$ and that these must be added together.

3(c)(iv)

Students used the Chi-squared value they had calculated in 3(c)(iii) to assess whether the conclusion that the colour was controlled by a single gene with two co-dominant alleles was valid. Many confidently obtained a critical value and compared this to their calculated value, although reference to probability of 0.05 was rare. Some were unsure how to determine the value for degrees of freedom, and were therefore unable to obtain the correct critical value.

Question 4

4(a)(i)

Most students could explain why biodiversity in the playing field was low, relating this to trampling and disturbance. A few also used the photograph and realised that the area was mown.

4(a)(ii)

Students were provided with the formula and asked to calculate the biodiversity index for a woodland reserve. Many completed this successfully, but it proved difficult for some, as they were unsure what the symbols N and n referred to.

4(a)(iii)

The method used to survey the woodland reserve was outlined and students were asked to criticise it. Whilst the command word "criticise" can require students to look at the merits and faults of the information provided; they were told here that the biodiversity index calculated in part 4(a)(ii) may be an underestimate, so they were looking for faults.
This question was well answered by many, who were able to identify several ways that the investigation could have been improved, including

- lack of bias in placing quadrats;
- more effective sampling of animals;
- better coverage of all areas of the woodland, not just the area near the path;
- sampling at different times of the day or year, to record animals which may not have been present if the survey was carried out only once.

4(b)

Students were provided with some background information and asked to explain how the increase in honeybees in towns and cities would affect biodiversity. Many thought that increased numbers of honeybees would increase pollination, which would lead to increased plant biodiversity, with some wrongly stating it would give rise to new species of plants.
Very few considered the effect of increased competition from honeybees on the other pollinators, and realised that this was likely to decrease biodiversity.

Question 5

5(a)

Students were given data on the density of stomata on the upper and lower surface of leaves in eight species of plant, and asked to analyse the data and photographs to explain the distribution of stomata. Although they were told in the stem of the question that this data had been collected in an investigation into transpiration, many ignored water loss as a factor and focused entirely on the role of stomata in gas exchange.

It was clear that some students were unsure how to manage the data provided and simply described it, rather than making an attempt to use it in an explanation. Better answers recognised that the plants fell into three groups: those with more stomata on the lower surface, those with more stomata on the upper surface and those with a roughly equal distribution of stomata. They then went on to consider the features of the leaf (eg whether it was flat, floating on water or upright), and used these to explain the effect on water loss or gas exchange.

5(b)(i)

This required analysis of a graph showing transpiration rate for maize seedlings in dim light and when extra illumination was added. They were asked to calculate the approximate percentage increase in transpiration rate.
The rate in dim light was relatively stable and most could determine a reasonable value. The rate in bright light fluctuated much more, and most attempted to determine a mean rate. From these two values most could calculate the percentage increase. The most common error was to divide the increase by the rate in bright light, rather than by the original rate.

5(b)(ii)

This should have been a straightforward question after the challenges of 5(a) and 5(b)(i), but many students ignored the command word to explain, and simply stated two factors that should have been controlled in this investigation. Whilst the factors were usually correct, there was no credit unless there was an explanation.

Question 6

6(a)(i)

Students were given information about the enzyme acetyl CoA carboxylase and asked to analyse the information to explain how the activity of this enzyme is controlled. This proved very challenging for most students, because they did not use the information given in an effective way.
Despite being told that citrate activates the enzyme by binding to a site which is not the active site, several described this as non-competitive inhibition. Very few realised that fatty acyl CoA molecules are likely to be similar in structure to acetyl CoA, and that this would result in competitive inhibition.

6(a)(ii)

Many realised that inhibiting an enzyme that converts acetyl CoA into fatty acids will result in fewer fatty acids being produced, and that this will result in less fat being stored in the body.

6(b)

Most understood that enzymes are specific, and that an inhibitor of the bacterial enzyme would not affect the human enzyme. Stronger answers went on to explain how bacteria would be affected if the enzyme was inhibited, ie. they could not make fatty acids and so respiration may be reduced.

Question 7

7(a)

The command words here were to “analyse the data to comment on” the effect of the concentration of sodium chloride solution on the blood. Where students realised that the data

provided related to osmosis, and could be explained by water moving in or out of the red blood cells, there were some organised and well-structured answers. However some simply converted the table of data into prose form, gaining no credit. The terminology used was often imprecise and not of A-level standard.
Very few realised that 0.7% sodium chloride solution was closest to the water potential of the erythrocyte cytoplasm.

7(b)

Some achieved one mark for stating that glucose is a monsaccharide and sucrose is a disaccharide, but very few realised that twice the concentration of sucrose is needed to have the same effect as the glucose. None linked this to molecular mass or its effect on osmotic potential.

7(c)(i) and (ii)

Almost all knew that the hypothalamus is responsible for osmoregulation.
Part (ii) required an explanation of how the brain ensures that the water potential of the blood remains constant on a hot day. There were some clear, well-structured answers to this question. However although some students understood the mechanisms involved, lack of precision in the answer prevented them from scoring more highly. For example most did not link sweating to a fall in the water potential of the blood (despite the stem of the question relating to water potential of the blood); many referred to the role of the hypothalamus, but did not mention osmoreceptors; some knew that ADH was involved, but not that it came from the pituitary gland; some did not know how ADH affected the permeability of the collecting ducts.

Question 8

8(a)

Students were required to modify Core Practical 1 – investigate a factor affecting the initial rate of an enzyme-controlled reaction. The factor was temperature and the enzyme was a protease, digesting the protein in fat-free skimmed milk. Most students realised that a colorimeter was an effective way to obtain quantitative results (of absorbance or transmission), but some did not consider the need to determine initial rate, and instead measured the time for all the protein to be digested, ie. the milk to become clear. Variables were generally well controlled, but some did not realise that juice would have to be extracted from the pineapple, and instead cut same-sized blocks of pineapple to add to the milk. Very few used the results to plot a graph.

8(b)(i)

This was a straightforward question requiring two differences between Gram positive and Gram negative bacteria, and there were some excellent answers. The most common errors were to describe only one type of bacteria, not both (eg. Gram positive bacteria contain teichoic acid), or to give similarities and differences, as in a compare and contrast question.

8(b)(ii)

The majority of students were able to correctly calculate the swimming speed of the bacterium in mm s-1. Where there were errors, they were usually in the conversion of micrometers to millimeters.

8(b)(iii)

There were some clear explanations of how BvB kill Gram negative bacteria without affecting humans, and how they could be used to kill bacteria which have become resistant to antibiotics. Weaker answers repeated the information in the stem of the question eg. that BvB prey on Gram negative bacteria, without attempting to explain it.

Question 9

This question was about Gilbert's potoroo, one of the most critically endangered species in the world; its role in the ecosystem, the problems involved with captive breeding programmes and culling predator species to maintain numbers of potoroos.

9(a)

Although most realised that fungal spores being spread in the faeces of potoroos allowed the fungi to colonise new areas, few understood the role of fungi (other than as a food source for potoroos). There were very few references to decomposition or recycling of mineral ions.

9(b)(i)

When the number of individuals of a species declines so catastrophically, there are challenges in setting up a successful captive breeding programme. It was encouraging that so many students understood the reasons for this, and some were able to explain this complex concept clearly.

9(b)(ii)

This was the levels-based question which required students to consider the evidence provided, and discuss whether the plan to poison feral cats in order to protect the population of Gilbert's potoroos was justified. The command word "discuss" requires students to explore all aspects of an issue.

In general this question was well answered, with the majority of students putting forward points both in favour of, and against, poisoning the feral cats. Weaker answers focused on the idea that it is wrong to kill cats without exploring the reasons why. The strongest answers developed the arguments for and against the cull, bringing in the information in the stem and their biological knowledge. They also considered the wider effects on the ecosystem, eg. the effect on the food web of killing up to 2 million feral cats in one area, or the possible development of resistance to the poison in feral cats. This question was accessible to almost all students and most achieved level 2 or 3.

This student laid out the arguments clearly and gained full marks.

Discuss whether the plan to poison feral cats is justified.

(9)

For:

- feral cats are predators of potorous; so their existence is rapidly increasing the already dwindling population and threatening extinction of potorous. Potorous are of the most critically endangered species and already thought to be extinct once; miracle that some were found. feral cats not endangered species so less of threat of extinction.

Against:

· Feral cats not only predators of potoroos; foxes also predators so unjust to only kill off feral cats.

- Feral cats and foxes both introduced into Australia by settlers; so it is not their fault that they grew and took to Australia (adapted to) as their habitat; so unjust punishment. Killing off large amounts of feral cats could eventually cause them to become extinct; decreasing biodiversity, cause to be naturally at disadvantage to other species.

- Idea that not 100% certain that all native wildlife proved resistance to poison; some undiscovered precious species might be succumb to effects of poison before discovery. Killing off a large fraction of one species could give rise imbalance to the food chain and bring about negative effects. ~~Some~~ Expensive and harmful to kangaroo species to be used as bait for feral cats to be poisoned. Amount of foxes could increase as competition for potoroos would have decreased if feral cats were to be killed off. Alternative methods not harmful to feral cats could be exploited in protecting endangered species of potoroo; unfair to feral cats if all other alternative methods not exhausted. Ethical reasons could also lead to the fact that it is not the fault of feral cats whom their prey is, this has all been the result of natural selection and should be left as is.

(Total for Question 9 = 14 marks)

Question 10

10(a)

Many students could explain the key points of succession that occur when lichens colonise bare rock. There were some clearly structured answers describing lichens as pioneer species, their role in developing simple soil, and how this supports the establishment of other plant species leading to a climax community.

10(b)

Students were required to use aspects of Core Practicals 15 and 16 to devise an investigation to show how lichen distribution is affected by a named abiotic factor.
Most could name a suitable abiotic factor, although a few wanted to set up a lab-based investigation rather than surveying lichens in the field. Where this was done it was clear that students did not understand the growth rate of lichens, as they suggested leaving them for a week or two to colonise rocks in different conditions.
Most correctly used a quadrat to sample lichens on rocks (either as a transect or placed randomly in sample sites with environmental differences), and measured either presence or absence of lichens, or percentage cover. A few remembered to measure the abiotic factor they were finding the effect of, and to measure, or to try to control, other abiotic factors which may affect lichen distribution. For example, if distance from the sea was being investigated, light intensity should have been controlled if possible, by choosing sampling sites with similar light intensity. Very few described the analysis of results once they had been collected, eg. by using a suitable stats test.

Question 11

11(a)

Students were required to devise an investigation to show whether the presence of clover plants affects the concentration of chlorophyll in grass plants growing near to them. Almost all gained one mark for comparing grass grown close to clover with grass grown without clover; a few did this by setting up a lab-based investigastion and growing the grass and clover. Some realised that a colorimeter could be used to compare the concentration of chlorophyll, and that it would be necessary to extract the chlorophyll using a solvent before this could be done. This required them to modify aspects of Core Practical 11. Some gained marks for controlling variables eg. light intensity or mineral ion concentration where the clover was growing initially, by collecting a known mass of grass and using a known volume of solvent.
Once again, hardly any used a stats test to analyse the data they had collected.

11(b)(i)

Almost all students were able to name an organic molecule containing nitrogen atoms found in plant cells. Most common answers were proteins and amino acids, although nucleic acids and chlorophyll were also given.The few who lost marks here named inorganic molecules.

11(b)(ii)

Students found this question very challenging. They were given the equation for the conversion of atmospheric nitrogen to ammonia, catalysed by the enzyme nitrogenase, and asked to analyse the information to explain how nitrogenase is involved in the energy changes required for the reaction. Many gained one mark for stating that the enzyme lowered the activation energy needed for the reaction, but did not use the information provided in the stem of the question to link this to the large number of ATP molecules still required, or the unreactive nature of nitrogen gas.

Paper Summary

Based on their performance on this paper, students are offered the following advice:

- practise making accurate biological drawings of specimens (from photographs or from biological material). These should be of the correct shape and proportion, show all key features and lines should be clear with no shading.
- ensure that you are familiar with the command words and recognise the different types of answers they require.
- in "compare and contrast" questions, each point must be either a clear similarity (eg. they both….) or a difference involving both of the things you are describing (eg. PNS contains sympathetic and parasympathetic systems but CNS does not).
- when the command is to "analyse the data to explain", simply describing the data will not score highly. The key is to recognise the patterns in the data, and to use any information given, and your biological knowledge, to explain the cause.
- make sure you are familiar with how to carry out common calculations
- eg. working out a biodiversity index, finding the test values in the stats tests required in the specification. When carrying out stats tests it is vital to know how to find the critical value from the table provided, and how to use this to draw conclusions from the data.
- showing working in calculations will enable you to access marks for the intermediate stages, even if the final answer is incorrect.
- read the information given in the stem of the question carefully and use it to inform your answer.
- when a question asks you to "devise an investigation" it will normally require you to use aspects of at least one of the core practicals, but will not be exactly the same as the practical you have done. It is important to use the information given in the stem, including any photographs, to decide on the key features of the investigation. These will include identifying the independent variable, dependent variable, and controlled variables, and giving details of how to carry out practical procedures eg. use of filters when measuring absorbance with a colorimeter.
- when describing a practical investigation, do not stop at the point where you collect your results. Suggest how these could be analysed, eg. by plotting a graph or using an appropriate stats test.

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