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Examiners' Report/ Principal Examiner Feedback

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IAL Biology

Unit: WBI06_01

Practical Biology and Investigative Skills

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Grade Boundaries

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General comments

As has been noted previously, the majority of students appear to be well prepared for this paper and are able to describe core practical's and apply them in the planning of an investigation. A full range of marks was observed for this paper and there was little evidence of incomplete answers suggesting that students had sufficient time to complete the paper. When students recognised the context in which the question was set, they generally found question 1 and 3 accessible and many good answers were seen. However, a number of students are still trying to apply 'generic' answers to these questions. This will often result in little credit. Many students continue to score highly with question 2. This is particularly the case for those parts of the question in which students are expected to tabulate, present and analyse data provided for them.

In preparing for this paper students should make sure they understand the underlying biological principles being explored as well as the practical techniques employed. When planning their answers to questions students should ensure they understand the context in which the question is set and must apply their answers to this context. It is particularly important to bear this in mind when using mark schemes with previous papers in preparing for this exam.

Question 1

A pleasing number of students were able to describe the process used to carry out amplification of DNA in a polymerase chain reaction. However, students often struggled to demonstrate their understanding of the science behind the application of the technique.

In 1(a) any students scored 4 or 5 marks for this question with mark points 4, 5 and 6 being seen most frequently. Few students referred to appropriate times for the reaction steps (MP 7) and the need for magnesium or buffer was rarely suggested (MP3). Many students stated that the reaction needs to be carried out for many or several cycles but did not give a clear indication of a sensible number of cycles and did not gain mark point 8.

(a) Describe how to amplify a strand of DNA using the polymerase chain reaction (PCR).

(5) Q01a

A sample of the DNA strand that is needed to be amplified is taken into a test-tube along with taq polymerase, abundance of small free nucleotide and primers. They are then placed into the thermostat cycle. The temperature is then raised to 94°C, and this causes the hydrogen bond between the double strand to break, and form a single strand. The temperature is then brought down to 54°C, so that the primers joins to the DNA strand. The temperature is raised to 75°C which is the optimum temperature for taq polymerase. The free nucleotide allignes beside the DNA strand, according to the complementary base pairing, and binded together by the enzyme. This cycle is repeated many times, to get an abundant DNA sample. 35 repeated cycles produces around 34 million copies of the DNA

In this example the student gained the maximum of five marks for MP 2, 4, 5, 6 and 8.

In part 1(b) students were asked about the specific properties of the DNA polymerase used. Many students recognised that the enzyme is thermostable and does not denature at high temperatures (MP1) and that the enzyme has an optimum temperature for polymerase activity of around 75°C (MP2). Answers gaining mark points 3, 4 and 5 were rarely seen. A disappointing number of students simply stated that enzymes have an active site and are specific for a particular substrate without providing any detail.

(b) An enzyme is used in the amplification process. Describe **two** properties of this enzyme that are relevant to its biological activity in this process.

(2) Q01b

Enzyme have an active sites to which its substrate binds to form enzyme substrate complexes. It works best at an optimum temperature, which is the maximum temperature. After that, the enzyme denatures

This answer does not relate to the particular properties of DNA polymerase and gained no marks.

In 1(c) students were asked to explain how changing the temperature for one of the steps in the PCR reaction could lead to reduced production of DNA. A pleasing number of students gained both marks often for a description of the effect of temperature on denaturation or primer annealing. Students attempting to explain the effect of temperature on the extension step often only gained one mark. This was because they generally suggested that a temperature below 70°C would result in the synthesis of less DNA. However, the question asks them to explain why there would be less DNA. To gain the second mark they needed to suggest that at temperatures below the optimum/75°C new strands of DNA will not be completed.

Step The mixtures are heated up to 95°c

Explanation If the ~~ter~~ temperature is lower than 90°c, the hydrogen bond between DNA strand cannot be broken up and so there is no template strand for the formation of new DNA.

In this response the student clearly identified that a temperature below 90°C will result in reduced denaturation of the DNA and so less template strand will be produced. Both marks awarded.
In 1(d) (i) students often struggled to apply their knowledge and understanding of biology. To gain both marks students needed to explain that the DNA sequences of individuals within a species are different. Testing several individuals allows for this variability to be controlled. A number of students gained this second mark by referring to the idea of improving the reliability of the study.

(i) The scientists collected and analysed samples from more than one individual of each species.

(2)

Each individual has their own set of different alleles and mutations in their genes. ~~They~~ Collected samples from more than one individual will make the results more reliable and anamolies may be discovered.

In this response the student recognises that individuals have different DNA sequences (alleles) and that by looking at several individuals differences within the species can be identified improving the reliability of the study. Both marks awarded.

In 1(d)(ii) students needed to explain that the sequence variability in different part of the genome will be different. Therefore by looking at several genes scientists will gain a better determination of how closely related the different species are. A number of students gained a mark for

suggesting that comparing 5 genes allows a better determination of how closely related the species are. However, relatively few students recognised that different genes/loci will show different degrees of genetic variation between species and did not gain the first mark point. A large number of students repeated their answer to 1(d)(i).

(ii) For each sample, the scientists examined the DNA sequence of **five** different genes.

(2)

The more ~~the~~ the genes analysed are, the more evidence the scientists have to show that 2 species are closely related. A match in the microsatellites in one gene may not ~~indicate~~ mean the microsatellites in other genes will also match. A Matches in several microsatellites would indicate a close relationship between 2 species.

In this response the student explains that different loci (microsatellites) will differ in their degree of relatedness and that looking at several loci will give a better indication of the closeness of the relationship. Both marks awarded.

Question 2

A large number of comprehensive and high scoring responses were seen for question 2. Most students appeared to understand the context of the study and gave appropriate responses. However, in several places students did not follow the instructions given in the question.

2(a)

In general the ability of students to write a null hypothesis is improving. One mark is given for the use fo the correct significance term. Many students correctly recognised that in this case the hypothesis involves a significant difference. Some students continue to give multiple answers e.g. a significant difference or significant correlation. Others avoid using either term and refer to a significant effect. These approaches do not gain credit. The second mark is for a clear description of the dependent and independent variable. In this case, reaction times and consumption of coffee with or without caffeine. Many students failed to include one or other.

(a) Write a suitable null hypothesis for this investigation.

(2)

There is no significant difference between the reaction time of student who drink coffee containing caffeine and student who drink coffee containing no caffein.

Both marks awarded as the correct significance term is used and the correct reference is made to reaction times and coffee with and without caffeine.

In 2(b) many students ignored the instruction to tabulate just, sample size and mean values. On this occasion, they were not penalised for including raw data in the table.

In 2(c) bar graphs were usually plotted accurately. However, students frequently ignored the instruction to show variability of the data or used an axes scale that prevented accurate plotting of the range bar.

In 2(d) many students gained 2 or 3 marks for this question, most often from mark points 3, 4 and 5. Although the question directed students to use their graph and the data in the table, few students used the information from their graph (mark points 1 and 2).

In 2(e) students are asked to comment on the validity of the investigation. Many students obtained two marks for the identification of two variables or factors that were not controlled in the investigation. Very few students suggested that only students that regularly consumed caffeine were tested or that the investigation was only carried out at one time of day (MP3 or 4). Many students suggested unequal sample sizes and overlapping range bars. However, these have been dealt with by the statistical test – which shows a significant difference – so no marks were awarded for these suggestions.

Question 3

To gain maximum credit in question 3 students need to put their answers into the context of the investigation. Students will generally not gain credit for verbatim reproduction of statements seen in previous mark schemes.
In 3(a) many students gained one or two marks. In the context of this investigation, the main ethical issue revolve around using animals (frogs) and the main safety issues are that the frogs are poisonous and that students will be growing bacterial cultures. Frequently, marks were awarded for sensible ethical considerations such as suggesting that no harm should come to the frogs or that the frogs should be released after collecting the secretions. From a safety perspective marks were often awarded for the idea that frogs are poisonous and contact should be avoided e.g. wear gloves or wash hands after contact. Less frequently marks were awarded for the idea of preventing exposure to harmful bacteria. Simple statements about using aseptic technique are not enough. Aseptic technique is about protecting the culture from contamination, not the investigator. Acceptable answers here would be: culture agar plates at temperatures below 37^{o}C to prevent the growth of potential pathogens, leave an air gap to ensure conditions not favourable to anaerobic bacteria, autoclave plates at the end of the experiment.

In 3(b) students are asked to describe preliminary practical work. To gain credit students need to suggest what practical work they would do to determine the best 'set up' for their investigation. Most students recognise that they need to practice the method to see if it works (MP1). However, it is disappointing that many students do not recognise that preliminary work is about finding something out. They will often say something like, "find the optimum temperature for incubation of the bacterial plates, that is 30^{o}C". By adding on "that is 30^{o}C" they change their answer from a description of

finding something out, to a statement that they will use a particular temperature. This stops them gaining credit. Another common mistake is to make general statements with no link to the investigation. Many students will simply say they will find out which variables will affect the investigation. This will not gain any credit. They need to link their answer to the proposed investigation and to particular aspects of the method they will use in their investigation.

(b) A description of preliminary practical work that you might undertake to ensure your proposed method would provide meaningful data.

(3) Q03b

Practise the propose method before to ensure that the process works. Determine a suitable timescale, ~~to determine~~ to carry out the experiment. Determine a suitable dependent variable. Determine what other variable are needed to be controlled to give a valid data.

This response was awarded 1 mark (mark point 1). The remaining statements did not link to the context of the investigation and did not gain any credit. If the student had linked one to the actual investigation e.g., to determine a suitable time scale to measure inhibition of bacterial growth, then marking point 6 would have been awarded.

In 3(c) comprehensive well written answers were frequently seen and many gained full marks. Some students identified the frogs as being the independent variables rather than the (antibiotic) secretions and did not get making point two. When describing the need for repeats, students need to make clear it is repeats of the whole experiment or repeats for each type of secretion to gain marking point 11.

In 3(d) many students gained all four available marks. A table with suitable headings and clear indication that mean values will be calculated, together with an appropriate sketch graph can gain mark points 1, 2 and 3.
In 3(e) students are asked to identify limitations of the proposed method. As with the rest of question 3 answers need to be in context of the investigation. In this case this means that most of the available marks are going to be for limitations associated with the frogs, their secretions and the assay used to measure antibiotic properties.

Hints for revision and answering questions

- Read each question stem with great care to make sure you are attempting to answer the question asked.

- The answers you provide will often need to be linked to the context of the question. Useful information can be found in the stem of the question to help you to answer it. It may sometimes be helpful to highlight such information before answering a particular question.

- Use past papers to ensure you get practice with the types of questions asked and to become familiar with what is expected.

- Make sure you are familiar with all the core practical's. Question 1 and 3 will require you to be able to describe and apply your understanding of practical methods.

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