Principal Assessor Report 2005

Assessment Panel:	**Biology**

Qualification area

Subject(s) and Level(s) Included in this report	**Biology Advanced Higher**

Statistical information: update

Number of resulted entries in 2004	1,571

Number of resulted entries in 2005	1,692

General comments re resulted entry numbers

There has been an increase in entry again this year of just over 8% from the 2004 number. This year's entry is the highest so far, being about 3% up on the previous high (in 2003).

Statistical Information: Performance of candidates

Distribution of awards including grade boundaries

Distribution of awards	%	Cum %	Number of candidates	Lowest mark
Maximum Mark- **125**	-	-	-	-
A	16.0	16.0	277	81
B	26.0	43.0	446	67
C	28.0	71.0	478	53
D	13.0	84.0	213	46
No award	16.0	100.0	278	-

General commentary on passmarks and grade boundaries

- While SQA aims to set examinations and create mark schemes which will allow a competent candidate to score a minimum 50% of the available marks (notional passmark) and a very well-prepared, very competent candidate to score at least 70%, it is almost impossible to get the standard absolutely on target every year, in every subject and level
- Each year we therefore hold a passmark meeting for each subject at each level where we bring together all the information available (statistical and judgmental). The Principal Assessor and SQA Qualifications Manager meet with the relevant SQA Business Manager and Statistician to discuss the evidence and make decisions. The meetings are chaired by members of the senior management team at SQA
- We adjust the passmark downwards if there is evidence that we have set a slightly more demanding exam than usual, allowing the pass rate to be unaffected by this circumstance
- We adjust the passmark upwards if there is evidence that we have set a slightly less demanding exam than usual, allowing the pass rate to be unaffected by this circumstance
- Where the standard appears to be very similar to previous years, we maintain similar grade boundaries
- An exam paper at a particular level in a subject in one year tends to have a marginally different set of grade boundaries from exam papers in that subject at that level in other years. This is because the particular questions are different. This is also the case for exams set in centres. And just because SQA has altered a boundary in a particular year in say Higher Chemistry does not mean that centres should necessarily alter boundaries in their prelim exam in Higher Chemistry. The two are not that closely related as they do not contain identical questions
- Our main aim is to be fair to candidates across all subjects and all levels and maintain standards across the years, even as arrangements evolve and change.

Comments on any significant changes in distribution of awards/grade boundaries

The grade boundaries were decreased by two marks from last year for A and B boundaries and by three for the C boundary. The effect was to leave the percentage distribution of candidates almost identical to last year's values.

The background to this decision came from two directions. Firstly, there was evidence from the pretested objective test questions used in Section A, and statistics on the performance of the cohort as a whole, that suggested the quality of candidates was similar to last year. Independently, data from analysing the performance of individual parts of the exam were consistent with this conclusion.

Secondly, the overall assessment experience in 2005 was felt to be a little more challenging for candidates than

previously. Part of the challenge might be associated with the complex changes made this year to the exam format.

The change in format had several purposes:

- to reduce the literacy demand evident in the previous format
- to reduce time pressures on candidates created by the long questions
- to extend the range of question styles so that there could be more assessment of understanding
- to produce more, shorter questions that test the syllabus more widely
- to provide a better balance of marks to represent the Options more equitably
- to improve the quality of assessment of the Options by introducing problem solving marks and by reflecting the format changes in the mandatory units.

Staff in Centres and candidates will be more familiar with the new format next year and the benefits expected to arise this year from the shorter format questions should emerge.

Comments on candidate performance

General comments

Over the last few years markers often reported that candidates were not completing all the questions in the time available: comments of this type were rare this year. The change in format, from this perspective, achieved its aim. Compared to CSYS, Advanced Higher represented a serious increase in assessment demand. In CSYS, candidates had 210 minutes to score 80 marks, ie 2.7 minutes per mark whereas AH candidates have 150 minutes to tackle 100 marks, ie 1.5 minutes per mark. The introduction of shorter questions this year did not alter the intellectual demand overall but it seems to have helped candidates to access the marks.

Along with positive comments about timing, markers this year commonly remarked on how the new questions were more discriminating. Although candidates had time to tackle the questions, they were losing marks by getting them wrong. The new questions, even very simple ones, showed that candidates do not have a clear understanding of many of the topics. Probably many would have been able to set out essays they had rehearsed but they found it difficult to see the same concepts within contexts. (Specific concepts causing problems are discussed below.) Nevertheless, in Section B candidates scored better in the new format questions when their average scores in these were compared with their performance in the questions common to the old format (long data handling and long essay).

About 70% of candidates answered the *Physiology, Health and Exercise* questions; the other 30% were divided roughly equally between the other two options. Candidates found the new format testing the option topics slightly more difficult than before; average performance was slightly down in *Animal Behaviour* and *Physiology* units, ie for a total of 85% of candidates, and marginally up in *Biotechnology*.

In questions testing the mandatory units, candidates performed to the same standard as last year in Section A, the objective test questions, whereas in Section B, the new-style questions, were answered better than the old style. In Section B, average performance was almost the same in the two units.

Average performance in Investigations was slightly lower this year than last. Many projects were of fairly minimal quality: they were poorly designed, poorly executed and frequently would have only taken minutes to perform. In others, the science had not gone much past Standard Grade. Also, there was evidence that candidates are not following the instructions given in the *Guidance to Candidates* document when preparing the report for submission.

There were, however, many excellent pieces of work, genuinely able to command high marks for the quality of thought, the sophistication of the procedures and the quality of the Report. This level of submission is increasing in frequency. The last contribution from SQA to clarifying standards in this area was issued to Centres at the start of the summer term of 2005 (*Suggestions for Investigations*). It is hoped that this document will help to raise standards overall by outlining some of the pitfalls that cost candidates marks. The Appendix from 2004 dealing in detail with Investigations is attached again (Appendix 1).

Areas of external assessment in which candidates performed well

Numerical questions were generally done well and there is an increasing awareness of the role of error measurements in determining the reliability of data. Given that standard deviation is taught in Standard Grade Credit Mathematics there may well be scope at some point in the future for extending the syllabus to incorporate the statistical treatment of data.

There were fewer complaints by markers about the quality of written English this year. Although there were fewer long pieces of extended writing for candidates to construct, the improvement in standard is commendable.

There were some excellent Investigations and many where candidates had clearly thought about what they were trying to achieve. Most Reports were word processed and included material taken from the Internet. The majority of candidates seem to have excellent IT skills. More graphs were drawn by hand this year and these did not contain the usual problems we see with graphs generated by Excel - incorrect X axis, inappropriate use of 3-D, inappropriate graph selection.

There were many good performances in data handling parts of questions, although it was not uncommon for the same candidates to go on to score very few marks in the knowledge components of the questions.

Candidates did well with the extended response on eutrophication (section B Q4) but there were also some misconceptions in this question, as mentioned below. More able candidates did well with question 6 on the 'melting ' of DNA and many scored well in the restriction mapping question. There was also good understanding of the cell cycle and checkpoints.

There were some excellent answers to all the questions in the Physiology option. In the Behaviour option, candidates had good understanding of the role of display by male capercaillies and of coloration in the females.

Areas of external assessment in which candidates had difficulty

Just about every question revealed misconceptions or simple lack of knowledge. Many marks were lost by not reading the questions properly or by not using what was given.

Terminology/technical vocabulary that caused problems included vector, obligate, consequential dormancy, poikilothermic, facilitation, eutrophication, proximate and ultimate cause, sexual dimorphism, Hamilton's Rule, the idea of risk factors, niche, plasmids, protoplasts, transgenic.

Conceptual confusion included the following: lipoprotein taken to be cholesterol; activation energy meaning the same as enzyme activation; active site as part of substrate; modulation of enzyme activity linked to competitive inhibition; switching on a gene meaning the same as enzyme activation; sequence of events in making transgenic plants and the roles of enzymes employed. One or two points are teased out below to clarify what the exam required.

In the question where the food intake of two bird species is shown, understanding of the niche concept is being tested. Niche refers to the role of an organism in its community together with its use of resources, and an organism can only occupy its fundamental niche when there is no competition. The question asks for evidence that neither species can be occupying a fundamental niche. The answer is that both species take food of the same size so they are competing. Poor answers talked about *overlapping graphs* and did not mention that the graphs were about prey size.

Question B4 is asking for *facilitation* to be explained as communities causing habitat changes that then disadvantage the current community and favour colonisation by new species. Understanding of this idea is then checked by asking candidates to recognise in the loch diagrams some changes that apply to all autogenic

successions. In this question, many candidates were unfamiliar with the term *facilitation* and were unable to recognise the general issues shown. Some did not know the term facilitation but went on to describe in the next question exactly the answer required for the previous question. They had not been able to distinguish the general process involved from the examples of changes it generates.

Many took eutrophication to be algal bloom and the ensuing oxygen depletion rather than nutrient enrichment.

There were a number of issues in the essay in Question 8. Both essays exposed weak knowledge but performance was poorer in the one on prokaryotic cells and the use of plasmids to make transgenic plants. Candidates commonly spent too long on the first part, which was only asking for differences in nuclear organisation between pro- and eukaryotic cells. They discussed membranes and organelles and did not stick to the question or state the obvious. They would achieve three of the four marks available for stating that prokaryotic cells have a single circular molecule DNA in a nucleoid and have small extra rings of DNA called plasmids.

There was almost complete lack of understanding of transgenic plants. The idea being tested is that if *Agrobacterium* plasmids are used, they can incorporate genes into the plant's genome. The new genes are not in the plant cell cytoplasm as plasmids, they are incorporated into plant chromosomes and get passed on by plant sexual reproduction. Knowledge of a few technologies is needed to grasp the whole story: bacterial culture, plasmid modification, protoplast production and plant tissue culture.

The essay on enzymes highlighted that candidates find this subject area challenging.

Many candidates discussed cell signalling as a way of switching on enzyme production. Many others described very well how the *lac* operon works in switching enzyme production on for those enzymes that are not constitutive. Others talked about how the sodium-potassium pump works. In this, some of the vocabulary fits covalent modification of enzymes: the pump is a protein, its configuration is changed to do a job and it gets phosphorylated by a kinase enzyme.

Candidates had difficulty with the meaning of *activity* and *activation* in relation to enzyme reactions. It is important when teaching this theme to be clear about what is being discussed. Activity refers to the rate or amount of reaction in a process, and it would be affected by conditions such as concentrations of substances and pH. It does not refer to how individual enzyme molecules are behaving at the structural level. Although *activation* of enzyme molecules has an impact on rates of reaction, the focus is more on what is happening at the structural level. Commonly, activation refers to the subtle control of substrate binding through alterations to the active site, and it applies exclusively to the enzymes that are regulatory in pathways. Negative modulators that are inhibitory in this context are not doing the same thing as they do with non-regulatory enzymes.

In general, activation does not mean the regulatory enzyme molecules are altered so that they are switched on and off, or made active and inactive. Activation refers to speeding up or slowing down of catalysis that is happening at a particular rate in the absence of modulators. (See Nelson DL and Cox MM (2000), *Lehninger:Principles of Biochemistry* 3rd Edition, Worth).

Recommendations

Feedback to centres

Visit the SQA website regularly (www.SQA.org.uk). All the documents mentioned in this feedback are available from the website.

Use the current versions of documents: content statements in Arrangements (5th edition), *Advanced Higher Biology Investigation Guidance (August 2004)*, the specimen paper which exemplifies exam format, information regarding the internal assessment of the Biology Investigation (AH) unit contained within the current NAB, and Marking Instructions which are published on the SQA website. Share the appropriate documents with candidates.

Ensure that you have copies of:

- *Exemplification of Standards: Advanced Higher Biology Investigations*. This contains an A and a C graded Investigation and information on how they were marked.
- *Suggestions for Investigations*.

Check that your text and class resources are in line with current Arrangements.

Read appendix 1, reprinted from last year's PA Report, listing issues with Investigations.

It is recommended that candidates receive the full allocation of teaching time needed to fulfil the demands of the Advanced Higher course. This is needed for proper supervision of the Investigation; for discussing content with candidates so that they can pick up the subtleties and understand the depth required; for going beyond the syllabus to look at social issues created and solved by biology; for developing skills in working in the laboratory and for preparing presentations.

Appendix 1: reprinted from 2004 Report

Investigations

Some Reports are models of the format specified, and describe how good scientific principles were applied in a context relatively new to the candidates. Most, however, lack some or many of the following: informative title, page numbers, contents page, summary of aims and findings, references in the specified format, discussion of biology indicated by results obtained; rigorous evaluation.

Centres should support candidates in the planning and execution of the Investigation. Staff should be aware at an early stage when replicates and controls are not adequate, when procedures are inappropriate for the aims, and when candidates are failing to get results because of poor skills or faulty equipment and should provide constructive feedback at this stage.

It is acknowledged that the time-scale for Investigations and the level of demand are a challenge. However candidates citing 'lack of time' in the Evaluation section of the Report for failing even to consider replicates and controls cannot expect credit for their retrospective awareness. This design flaw should have been spotted early in the planning recorded in the Daybook; if it is not amended after early discussion, then the candidate should not pass the Unit.

Many Centres are criticised for presenting sets of Investigations so similar that candidates could not possibly have had to plan anything; background and protocols are virtually identical except for minor amendments eg the organism, antiseptic or enzyme being tested.

Specific areas to consider

1. Is the depth of knowledge and level of demand sufficient for AH level? Routine and low level work will only score the low level and routine marks.

2. Are several of your candidates doing the same Investigation? The challenge of the Investigation is lost if all the candidates in a Centre are doing essentially the same protocol - background research is common to them all and there is no scope for creativity and discussion. Try to have all candidates doing different investigative work.

3. Is the work a Chemistry project masquerading as Biology? It may not be adequately biological; check with other departments that the same/similar work is not being submitted for another Advanced Higher course.

4. Make sure enough time is devoted to the work: it is pretty obvious to markers when someone has only spent a few minutes repeating a simple procedure; the work cannot possibly add up to 20 hours. Should these candidates pass the Unit?

5. Check very early on that a procedure and equipment will be adequate; markers find it difficult to believe, for example, that anyone can use a tally counter to record invertebrate heart rates of 300 per minute.

6. Safety is not an SQA matter but it should figure in the planning recorded in the Daybook. It is to be hoped that staff are aware of the local health and safety regulations, eg. on incubation of skin micro-organisms, incubation at 37^0 C, use of pesticides and on use of human blood samples.

7. When preparing candidates for Investigations, discuss the role of replicates in experiment design. Move on from the Higher LO3 point that mean values are more reliable than individual values, to discuss the idea that replicated treatments should produce identical results. If the results are not identical, which is likely in biological work, then there needs to be some discussion about the cause of the variance.

8. Could other factors, not controlled for, be causing the results obtained? Encourage candidates to think the problem through so that the plan anticipates these factors. For example, rate of diffusion affects the spread of materials from wells cut in agar; if bacteriocidal molecules have different size or shape or concentration, whatever their toxicity, killing zones will vary in diameter. Or, if different concentrations of nutrients/growth substances are being added to water culture solutions then there will be osmotic effects; will they affect the growth measurement separately from the substance effect? Or, when monitoring the effect on recovery time of energy drinks in schoolchildren, what other factors have an influence and how many of them cannot be controlled; how are the results to be compared?

9. Conclusions usually focus on trends in mean results but Evaluation discussions should examine the validity and reliability of the conclusions in the light of variation evident in replicates. The more replicate values differ, the more unreliable trends will be. Advise candidates not to reel off routine measurement/systematic errors as the cause of variance.

10. If there are no replicates and controls, should the candidate be passing the Unit? Validity and reliability are compromised without them and Conclusions will be dubious. Results from both replicates and controls need to be discussed with awareness. This is partly what distinguishes A Grade candidates.

11. Procedures may not deliver results in the end. Be sure that candidates can talk sensibly about modifying procedures and are not left lamely having to propose that they would improve their methods by having replicates and controls.

12. Is the accuracy of instruments noted, and in derived values, eg averages, is the implicit accuracy beyond what the instrument could generate?

13. Have mean values been calculated from replicates and plotted? Check that the replicates have not all been plotted – this reveals a lack of understanding of the purpose of the replicates.

14. Are treatments results grouped into a single graph representing the investigation results? Candidates should not plot time course results if only the final values are relevant.

15. Are X axes of graphs drawn by Excel software scaled correctly; do they have grids and plotted points for checking values; are graphs too small to read values?

16. Have too many graph varieties been generated from the same data; is 3-D really needed?

17. Are graphs/results described in the results section; are they analysed for trends and errors in the Discussion section?

18. Does the Discussion make very clear links between the biological background, presented as relevant in the Introduction, and the results obtained by the study? This is partly what distinguishes A Grade candidates.

19. Check for poor quality references, failure to acknowledge sources and plagiarism. It is inappropriate in the Introduction of the Report for a candidate to assemble a series of extracts from sources and claim they are original thoughts.