Advanced Higher Biology Candidate Investigation Guidance
(for use from session 2008-2009)

Candidate information

The investigation is an individual project undertaken to show that you can:

- research a biology topic using various sources to include textbooks, journals and internet websites;
- plan and design experiments;
- make observations and carry out experiments safely;
- collect data accurately;
- process, present and analyse data in appropriate formats;
- evaluate procedures and results;
- produce a scientific report.

Your investigation should be based on a topic that is appropriate to the demands of Advanced Higher Biology. It cannot also be submitted as an investigation for any other Advanced Higher Course such as Advanced Higher Chemistry or Advanced Higher Physics. It must include experimental or survey work and must not be a technical exercise in statistics or computing. Group work and joint investigations are not permitted.

A successful investigation is likely to be in an area in which you have a genuine interest. Early discussions with your teacher should take place to ensure that your proposals are practical, realistic and take account of the time and resources available to you.

Your investigation will be assessed both **internally** and **externally**.

Internal assessment

The investigation is a component Unit of the Advanced Higher Biology Course and, as such, is assessed internally using a NAB. The NAB has two outcomes, each with Performance Criteria that must be met for you to reach the standard for a pass:

Outcome 1: Develop a plan for an investigation

Performance Criteria

PC (a)	A record is maintained in a regular manner.
PC (b)	The aims of the investigation are clearly stated.
PC (c)	Hypotheses or questions relevant to the aims of the investigation are formulated.
PC (d)	Experimental, observational and sampling procedures, techniques and apparatus devised are appropriate for the investigation.
PC (e)	The need for controls and replicate treatments or survey samples is considered.
PC (f)	Relevant problems associated with the use of living materials or natural habitats are considered.

Outcome 2: Collect and analyse information obtained from the investigation

Performance Criteria

PC (a) The collection of experimental information is carried out with due accuracy.
PC (b) Relevant measurements and observations are recorded in an appropriate format.
PC (c) Recorded experimental information is analysed and presented in an appropriate format.

To provide satisfactory evidence of your achievement of these outcomes you will be asked to submit a **record** of your investigation planning and practical work. This laboratory record must be in the form of a laboratory notebook, a loose leaf folder or some other suitable format.

Your laboratory record must be checked regularly by your teacher during the investigation and handed in by you once you have completed your investigation report.

Like any other Unit assessment, you can either pass or fail. If you fail, you cannot receive a Course award.

External assessment

For external assessment purposes, you are required to produce an investigation **report** based on your laboratory record. This report is submitted to SQA for external marking. A total of 25 marks (20% of the total marks) are allocated to the investigation report.

If you follow the guidelines given below, you should be able to score a high mark for this part of the Course.

The investigation process

The three important stages in the investigation are planning, collecting data and producing the investigation report. The key to success is good forward planning: you should set realistic deadlines and stick to them. Keeping a good record of your work on a regular basis will help you to produce a good report.

The main stages in the investigation are shown in the table below. You should have regular discussions with your teacher to ensure that procedures, safety, resources and timescales are appropriate.

Phase	***Tasks***	***Deadline***	***Completed***
Planning	Select an investigation topic that interests you. Discuss ideas with your teacher.		
	Research the biological background to your topic (books, journals, websites etc.)		
	Develop outline plan for the investigation.		
	Record aims, hypotheses and questions.		
	Outline experimental methods and procedures.		
Collecting Data	Complete the experimental work in the time allocated. Allow time for replication.		
Producing Report	Hand in first draft		
	Hand in final draft		

Maintaining your laboratory record

Your laboratory record should be brought to every laboratory session and should contain a complete record of the work undertaken.

The laboratory record must include:

- discussions with your teacher and other scientists
- background research
- references
- details of procedures
- results presented in appropriate forms, eg tables, graphs
- analysis of results
- conclusions/findings
- next steps
- modifications

Producing the investigation report

The investigation report submitted to SQA must have a logical structure and must be clear, concise and easy to read.

The report should be around 2,000-2,500 words in length excluding the title page, contents page, tables, graphs, diagrams, calculations, references, acknowledgements and any appendices. It should be written in the past tense and the impersonal voice should be used.

The report must include the following sections:

- title page
- contents page
- abstract/summary
- introduction
- procedures
- results
- discussion
- list of references

Title page

This page must include an appropriate and informative title for the investigation, your name and candidate number and the name and number of the centre you attend.

Contents page

The contents page must list the sections within the investigation along with their corresponding page numbers for the purposes of cross-referencing. It is essential that all pages throughout the report are numbered.

Abstract/summary

In your brief abstract you must state the aims and findings of the investigation. The abstract should immediately follow the contents page.

Introduction

Your introduction must include a clear statement of the aims of the investigation (despite the fact that you have already stated these in the abstract) together with relevant hypotheses or questions. The aims need to be clear and explicit since these are key to the overall report.

In this section you must include a concise account of the relevant background theory to the investigation at a level appropriate to Advanced Higher. Take care to use terms accurately and explain ideas clearly. You must also justify the biological importance of the investigation.

Diagrams, formulae and equations should be included as appropriate.

References

A **reference** is any piece of material to which a writer '**refers**' in the text. Each reference must be listed at the end of the report to provide information about the source of the material '**referred to**'. This allows the reader of the report to consult the original work if necessary and is also an acknowledgement of the work of other authors.

Each reference must also be cited in the appropriate part of the text using the author's surname and the year of publication as in the exemplar below:

There are many different starches whose different properties make them suitable for different uses. Recently, transgenic plants have been used to produce 'designer starches' for use in specific commercial applications (Bowsher, 2007).

When you are citing websites, it is sometimes difficult to attribute the information used to specific authors; in such cases, the citation should use the organisation responsible for the output published on the web pages consulted, as in the exemplar below:

Until the results of badger culling trials are known, it may not be possible to judge whether killing badgers will have a significant impact on the incidence of tuberculosis in cattle (The Mammal Society, 2006).

Within the report, there must be a minimum of three references from different sources, at least two of which must be from books or journals (published or online). References should be listed in alphabetical order and must be written in standard form as follows:

Books

Author(s), (surname followed by initials) (Year of publication) *Title*, Publisher, Place of publication, Page number(s).

eg: Wright, R (2005) *Environmental Science: toward a sustainable future*, Pearson Prentice Hall, New Jersey, p.446

Journals/periodicals

Author(s), (surname followed by initials) (Year of publication) Title of article, *Name of Journal*, **Volume number** (Part number if appropriate), Page number(s).

eg: Bowsher, C (2007) Designer starches, *Biological Sciences Review*, **19** (3), pp18-20.

Websites

As many of the following items as are available must be given: author, date, title, publisher, the URL and the **date you accessed the material** (because the 'site' may be updated between the time the writer uses it and the point at which a reader refers to it).

eg: The Mammal Society (2006) Position statement: badgers and bovine tuberculosis.
URL: http://www.abdn.ac.uk/mammal/badgers_tb.shtml
Visited: August, 2007

Procedures

The procedures you use must be appropriate to the aims of the investigation.

The procedures must be clearly described in sufficient detail to allow the investigation to be repeated.

The experimental procedures that you use in your investigation must be at an appropriate level of demand for Advanced Higher Biology. Assessment of this section will include consideration of the following questions:

- have you included necessary controls in your plans?
- have you controlled factors that should be kept constant?
- are your replicates and sample sizes adequate?
- how complex is the design of your experiments?
- how creative and original have you been?
- how accurate are your measurements?
- did you modify your procedures when this was necessary?

The procedures should be presented in a meaningful and coherent way and not as a set of instructions. It would be appropriate in this section to include labelled diagrams or photographs of assembled apparatus. There must be evidence that you have been involved in the planning of the investigation and have not simply followed a given set of instructions.

Results

The results must be relevant to the aims of your investigation.

Readings (raw data) must be recorded and be within the limits of accuracy of measurement. Ensure that average results do not have an excessive number of decimal places.

All your raw and processed results must be presented in a clear and concise manner with appropriate use of tables, graphs, diagrams and calculations. It is essential that you summarise results adequately. Where results are presented graphically, a table containing the relevant processed data must support each graph. Extensive raw data may be presented in an appendix. Where Excel or other software packages are used to present graphs, it is important that axes are adapted to suit the data so that the results are presented in a scientific manner.

You must include a statement of results from tables and/or graphs to show the main trends and patterns observed.

In descriptive components of the work, observations must be detailed and suitably recorded and, where appropriate, quantitative.

Discussion

The discussion section is the most important part of the investigation report and in it you must discuss your findings in a critical and scientific manner. It provides you with an opportunity to show off the depth of your knowledge and understanding relevant to the biology in your investigation. It would be appropriate in this section to include a discussion of experiments that you carried out and which did not produce results or for which results were not presented.

In your discussion section you must include a clear statement of the **overall** conclusion(s) and a critical evaluation of the investigation **as a whole**.

The overall conclusions must relate to the aims of the investigation and they must be valid for the results obtained.

The discussion section requires you to review your work in a critical manner.

Your evaluation of **procedures** considers as appropriate:

- accuracy of measurement
- adequacy of replication
- adequacy of sampling
- adequacy of controls
- sources of error in relation to measurements
- the ways in which problems encountered in the investigation were resolved
- ways in which procedures might have been modified to improve the investigation.

In this section it is also appropriate to emphasise positive aspects relating to the procedures.

Your evaluation of **results** must include as appropriate:

- analysis and interpretation of the results
- account taken of the errors described
- consideration of the effect of error on the outcome(s)
- suggestions for further work
- critical and scientific discussion of the significance of the findings
- demonstration of a reasonable depth of biological knowledge and understanding.

List of references

References should be listed alphabetically and must be in the format described on pages 4 and 5.

Advanced Higher Biology Investigation — summary of assessment scheme and mark allocation for the Course report

Assessment category and criteria	Mark	Check
Presentation		
◆ appropriate and informative title	**1**	
◆ contents page and page numbers		
◆ brief summary/abstract stating aims and findings		
◆ references cited in text and listed in standard form	**1**	
◆ report is clear and concise (2,000 – 2,500 words)	**1**	
Introduction		
◆ clear statement of aims together with hypotheses/questions	**1**	
◆ account of underlying biology relevant to aims	**3**	
◆ biological terms/ideas are clear and at an appropriate depth		
◆ biological importance is explained/justified		
Procedures		
◆ appropriate to aims	**1**	
◆ clear description with enough detail to allow repetition	**1**	
◆ include appropriate controls and adequate control of variables	**1**	
◆ adequate replicates and sample size	**1**	
◆ appropriate complexity of methods/inputs/outputs	**2**	
◆ creativity and originality		
◆ appropriate accuracy or modifications to improve accuracy		
Results		
◆ relevant to aims	**1**	
◆ data recorded within limits of accuracy of measurement	**1**	
◆ data presented summarise overall results	**1**	
◆ adequate quality, including headings/units/scales/labels/clarity	**1**	
◆ brief description of trends and patterns in tables or graphs	**1**	
Discussion		
◆ conclusions relate to aims	**1**	
◆ conclusions are valid for results obtained	**1**	
evaluation of procedures includes comment as appropriate on:	**2**	
◆ accuracy/sources of error in measurement		
◆ adequacy of replication/sampling		
◆ adequacy of controls		
◆ solutions to problems and modifications to procedures		
evaluation of results includes as appropriate:	**3**	
◆ analysis and interpretation of results		
◆ account taken of error/variation in replicates		
◆ meaningful suggestions for further work		
◆ critical and scientific discussion of significance of findings		
◆ appropriate depth of biological knowledge and understanding		
Total marks	**(25)**	