



## **Biology (revised) Advanced Higher**

### **Biology Investigation**

#### **Teacher/Lecturer Guidance (for use from Session 2012 -2013)**

##### **Introduction**

The investigation seeks to develop the candidate's investigative skills and to provide opportunities for self-motivation, independent learning and the planning and designing of appropriate experiments. It also provides the candidate with an opportunity to write in a scientific manner. The report produced should show the significance of the findings of the investigation through critical and scientific analysis of the results and demonstrate knowledge and understanding of the biological basis of the investigation.

The investigation is assessed internally through the Unit assessment and externally through the Course assessment.

The investigation forms part of the Advanced Higher Biology (revised) Unit *Investigative Biology*. This Unit provides candidates with the opportunity to acquire knowledge and understanding of the principles of biological research and experimental design and to develop the ability to analyse and evaluate scientific reports of biological research. It is these skills that candidates will apply when carrying out their own investigation.

The notional length of the Unit *Investigative Biology* is 40 hours. The theoretical part of the Unit could be delivered early in the Course as a self-contained study, or could be integrated into the practical work of the other two Units of the Course, or be delivered in conjunction with the investigation as the candidate progresses. The assessment of the theoretical part of the Unit by the analysis and evaluation of a scientific report allows candidates to be assessed when they are ready for assessment rather than necessarily at the end of the Unit.

Although there are no recommendations for the allocation of times to the Unit, it is anticipated that the planning stage of the investigation and the experimental work should take around 20 hours. The preparation of the report for Course assessment is likely to take a further 5–10 hours from the 40 hours of additional programmed Course time.

## Choice of an investigation topic

A number of points to consider:

- (a) Topics for investigation do not require prior approval by the Scottish Qualifications Authority.
- (b) Candidates must not submit the same investigation for another SQA qualification.
- (c) Group work and joint investigations are not permitted.
- (d) While the topic for investigation may be outwith the biology covered in the Advanced Higher Biology Course it must consist of a biology topic commensurate with the demands of Advanced Higher Biology. It must allow candidates to meet the Performance Criteria of the Unit Outcome — Carry out a biological investigation and to meet the Course assessment requirements for the investigation report.
- (e) The investigation must involve planning, collection and analysis of information through experimental work carried out by the candidate. Both laboratory and fieldwork topics are suitable for investigation. Simulations or data handling exercises on their own are not suitable.
- (f) Time constraints (including the ‘turn around’ time for experiments and seasonal constraints), laboratory facilities, availability of equipment and costs are all factors that need to be considered when candidates choose investigation topics.
- (g) While not wishing to stifle enthusiasm, the teacher/lecturer must sound a note of realism and discourage candidates from embarking on over-ambitious plans. Focused investigations completed in the time available are likely to be the most successful. Candidates with well-controlled investigations employing a limited number of input variables are likely to score higher marks than those with over-complex investigations from which valid conclusions cannot be drawn.
- (h) In consultation with the teacher/lecturer, candidates should try to select topics that genuinely interest them.

The teacher/lecturer should encourage candidates to consult a wide variety of up to date sources in selecting topics for investigation. The sources could include:

- ◆ textbooks of a suitable level of demand
- ◆ journals and periodicals, eg *School Science Review*, *New Scientist*, *Scientific American*
- ◆ medical or government reports
- ◆ newspapers
- ◆ internet websites

## Supporting the candidate with their investigation

A number of points to consider:

- (a) Teachers/lecturers must ensure that the investigation is the candidate's own work and that any help received is acknowledged and is not excessive. Where candidates carry out their investigation outwith the centre or have access to external specialist advice the teacher/lecturer must ensure that the investigation is the individual work of the candidate. Each candidate must sign the flyleaf accompanying the investigation report as a declaration that the report and the data in it have been produced by the candidate.
- (b) The teacher/lecturer should maintain regular scheduled dialogue with the candidate throughout their investigation to assess their progress and to give advice, support and encouragement. Excessive direction to candidates can be avoided by referring the candidate to the *Biology (revised) Advanced Higher - Biology Investigation — Candidate Guidance* and to the learning acquired in the Unit and by directing the candidate to reflect on these.
- (c) Teachers/lecturers should encourage the candidate to be creative and innovative; the investigation does not require to be a piece of original research but should be new to the candidate. Candidates should be discouraged from having a similar investigation to a class mate, this makes ensuring originality difficult.
- (d) Teachers/lecturers must make candidates aware of the assessment requirements at an early stage. Candidates should be thoroughly familiar with the SQA document *Biology (revised) Advanced Higher — Biology Investigation — Candidate Guidance*. This document gives candidates advice on conducting their investigation and gives a summary of the assessment scheme and mark allocation for the investigation. This is vital information for candidates.
- (e) Candidates should be encouraged to maintain a laboratory record in which they note preliminary thoughts, plans and designs at the start of their investigation as well as their methods and results as these notes will form the basis of the investigation report for Course assessment. They should maintain a brief record of their discussions and dialogue with their teacher/lecturer. The laboratory record could include:
  - ◆ a record of discussion with teachers/lecturers and other scientists as appropriate
  - ◆ background research
  - ◆ references
  - ◆ details of procedures
  - ◆ results recorded
  - ◆ analysis and presentation of results in appropriate forms, eg tables, graphs
  - ◆ statement of findings/conclusions
  - ◆ modifications and suggestions for further research.

- (f) Teachers/lecturers should offer advice and encouragement to candidates but avoid direction and excessive support. While candidates may need advice in the early stages of their investigation in identifying a suitable topic for investigation and in selecting an appropriate experimental design as the investigation progresses teachers/lecturers should allow candidates to make more independent decisions, particularly in the evaluation of procedures and the analysis and evaluation of their results.
- (g) It is likely that the supervising teacher/lecturer will want to ensure an early focus on choosing a topic and give clear direction as to the suitability of the topic chosen. While candidates will be involved in initial reading and research, it is important that this aspect of the investigation does not absorb too much time and delay preliminary practical work. Early discussion with candidates is essential to establish feasible timescales and deadlines. A timetable such as the one in the candidate guidance may be a useful way to ensure that all stages of the investigation are well-managed.
- (h) In selecting an appropriate experimental design teachers/lecturers should support candidates by using open questions and refer to the principles of investigation learned in the Unit and to the candidate guidance to assist candidates to reflect and review on their own experimental designs. A consideration of the mark scheme shows that poorly designed investigations will not only produce a low score in the procedures section they will also make a number of the marks in the discussion section inaccessible to the candidate.
- (i) Preliminary work such as developing techniques or apparatus and devising observational, experimental or sampling procedures are all suitable as part of the investigation should be recorded, as credit can be gained by referring to these in the investigation report for Course assessment, even if they were not pursued in the main body of the investigation. Topics for investigation should allow for the opportunity to modify procedures or to develop further investigative work based on experimental results. Investigation topics should have sufficient variables to investigate and where possible lead to results (whether qualitative or quantitative) that allow appropriate analysis.

## Unit Assessment

The biological investigation has one Unit Outcome and all Performance Criteria must be met to achieve the Outcome.

### Outcome 3

Carry out a biological investigation.

### Performance Criteria

- (a) The experimental design is appropriate to the aim of the investigation.
- (b) Ethical considerations in the use of living materials, human subjects and the conservation of natural habitats have been taken into account as appropriate.
- (c) Potential hazards have been identified, associated risks assessed and appropriate control measures applied.
- (d) Initial results are used to develop or confirm procedures in the experimental design.
- (e) Consideration is given to collecting data with precision and accuracy.

The teacher/lecturer must confirm that the candidate has met all the Performance Criteria for Outcome 3 in carrying out a biological investigation. Through discussion and dialogue with the candidate and by observation and supervision of their practical work the teacher/lecturer will be able to gather evidence to assess the Performance Criteria for Outcome 3. This evidence must be recorded in a checklist such as the one shown in Appendix 1.

The checklist contains suggestions to aid the teacher/lecturer's professional judgment in assessing the Performance Criteria. In the evidence for Outcome 3 PC (a) the experimental design must include the aim of the investigation and formulate questions or hypotheses to be investigated. The experimental, observational and/or sampling procedures devised must include techniques and apparatus appropriate to the investigation and consider the need for controls and replicate treatments or samples.

A candidate who successfully achieves the Unit Outcome should be able to access all the marks in the Course assessment.

## Course Assessment

For the Course assessment each candidate is required to submit a final investigation report.

A total of 25 marks, representing approximately 20% of the total marks for the Course, are awarded for the investigation report. The report is entirely externally marked; no marks are awarded by the centre for Course assessment.

The investigation report will be marked using the following categories:

- ◆ Presentation (3 marks)
- ◆ Introduction (4 marks)
- ◆ Procedures (8 marks)
- ◆ Results (4 marks)
- ◆ Discussion (6 marks)

The centre will be supplied with a flyleaf and a clear-faced bag for the submission of each candidate's report. The use of ring binders or other bulky folders must be avoided to ensure the report fits into the supplied stationery.

The deadline for submission of the investigation report in Advanced Higher Biology is likely to be late April. SQA Co-ordinators should be able to provide exact dates.

### 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

Detailed advice on the contents of the investigation report is given in *Biology (revised) Advanced Higher — Biology Investigation — Candidate Guidance*. Information on the assessment criteria for each of the above assessment categories, together with the subdivision of marks available within these categories, is provided in Appendix 2.

## Appendix 1: Advanced Higher Biology Investigation — Unit assessment checklist

Checkpoint	Suggestions to aid professional judgement	Check (✓)
Stated the aim of the investigation and formulated questions or hypotheses to be investigated.	The candidate has developed ideas for an investigation by reviewing and discussing previous learning and/or researching appropriate sources of information. The purpose of the investigation is clear and/or questions to be investigated and/or hypotheses to be tested have been formulated.	
Devised appropriate experimental, observational and sampling procedures, techniques and apparatus.	The procedures devised are appropriate to the aim of the investigation. The candidate has selected an appropriate procedure after considering or trying alternatives or becoming proficient in the procedure.	
Considered the need for controls and replicate treatments or samples.	Use of negative and positive controls and the control of potential confounding variables has been considered as appropriate. The need for repeated measurements, replicate treatments or samples and repeated experiments has been considered.	
Taken into account the ethical use of living materials, human subjects and the conservation of natural habitats.	The candidate has developed knowledge of and taken into account any ethical issues relevant to the investigation.	
Identified potential hazards, assessed their associated risks and applied appropriate control measures.	The candidate is aware of any potential hazards and has used the appropriate control measures to control risks in carrying out the investigation.	
Initial results have been used to devise further experiments or to confirm the appropriateness of a procedure for further work.	Experimental findings have been reviewed and further steps identified and carried out if appropriate.	
Made observations and recorded measurements with appropriate precision and accuracy.	Observations and/or measurements are recorded in a planned and organised way. Consideration has been given to the precision and accuracy of results.	

## Appendix 2: Advanced Higher Biology Investigation — Summary of assessment scheme and mark allocation for the Course report

Assessment category and criteria	Mark	Check (✓)
<b>Presentation</b> <ul style="list-style-type: none"> <li>◆ appropriate and informative title</li> <li>◆ contents page and page numbers</li> <li>◆ brief summary/abstract stating aims and findings</li> <li>◆ references cited in text and listed in standard form</li> <li>◆ report is clear and concise (2,000–2,500 words)</li> </ul>	1  1  1 <b>(3)</b>	
<b>Introduction</b> <ul style="list-style-type: none"> <li>◆ clear statement of aims together with hypotheses/questions</li> <li>◆ account of underlying biology relevant to aims</li> <li>◆ biological terms/ideas are clear and at an appropriate depth</li> <li>◆ biological importance is explained/justified</li> </ul>	1  3 <b>(4)</b>	
<b>Procedures</b> <ul style="list-style-type: none"> <li>◆ appropriate to aims</li> <li>◆ clear description with enough detail to allow repetition</li> <li>◆ include appropriate controls and adequate control of variables</li> <li>◆ adequate replicates and sample size</li> <li>◆ appropriate complexity of methods/inputs/outputs</li> <li>◆ creativity and originality</li> <li>◆ pilot study or experiments based on previous findings</li> <li>◆ appropriate accuracy or modifications to improve accuracy</li> </ul>	1  1  1  2  3  <b>(8)</b>	
<b>Results</b> <ul style="list-style-type: none"> <li>◆ relevant to aims</li> <li>◆ data recorded within limits of accuracy of measurement</li> <li>◆ data presented summarise overall results</li> <li>◆ adequate quality, including headings/Units/scales/labels/clarity</li> </ul>	1  1  2  <b>(4)</b>	
<b>Discussion</b> <ul style="list-style-type: none"> <li>◆ conclusions relate to aims</li> <li>◆ conclusions are valid for results obtained</li> <li><b>evaluation of procedures</b> includes comment as appropriate on:               <ul style="list-style-type: none"> <li>◆ accuracy/sources of error in measurement</li> <li>◆ adequacy of replication/sampling</li> <li>◆ adequacy of control</li> <li>◆ solutions to problems and modifications to procedures</li> </ul> </li> <li><b>evaluation of results</b> includes as appropriate:               <ul style="list-style-type: none"> <li>◆ analysis and interpretation of results</li> <li>◆ meaningful suggestions for further work</li> <li>◆ critical and scientific discussion of significance of findings</li> </ul> </li> </ul>	1  1  2    2  <b>(6)</b>	
<b>Total marks</b>	<b>25</b>	