



Advanced Higher
Coursework
Assessment Task



Advanced Higher Biology

Project

Assessment task

This document provides information for teachers and lecturers about the coursework component of this course in terms of the skills, knowledge and understanding that are assessed. It **must** be read in conjunction with the course specification.

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Introduction

This document contains instructions for teachers and lecturers, marking instructions and instructions for candidates for the Advanced Higher Biology project. You must read it in conjunction with the course specification.

This project is worth 30 marks (scaled to 40). This contributes 25% to the overall marks for the course assessment.

This is one of two course assessment components. The other component is a question paper.

Instructions for teachers and lecturers

General information

This information applies to the project for Advanced Higher Biology.

The project assesses the application of skills of scientific inquiry and related biology knowledge and understanding.

The project gives candidates an opportunity to demonstrate the following skills, knowledge and understanding:

- ◆ extending and applying knowledge of biology to new situations, interpreting and analysing information to solve complex problems
- ◆ planning and designing biological experiments/investigations, using reference material and including risk assessments, to test a hypothesis or to illustrate particular effects
- ◆ carrying out complex experiments in biology safely, recording systematic detailed observations and collecting data
- ◆ selecting information from a variety of sources and presenting detailed information, appropriately, in a variety of forms
- ◆ processing and analysing biological information/data (using calculations, significant figures and units, where appropriate)
- ◆ making reasoned predictions and generalisations from a range of evidence/information
- ◆ drawing valid conclusions and giving explanations supported by evidence/justification
- ◆ critically evaluating experimental procedures by identifying sources of error and suggesting and implementing improvements
- ◆ drawing on knowledge and understanding of biology to make accurate statements, describe complex information, provide detailed explanations and integrate knowledge
- ◆ communicating biological findings/information fully and effectively
- ◆ analysing and evaluating scientific publications and media reports

The project offers challenge by requiring candidates to apply skills, knowledge and understanding in a context that is one or more of the following:

- ◆ unfamiliar
- ◆ familiar but investigated in greater depth
- ◆ integrating a number of familiar contexts

Candidates research and report on a topic that allows them to apply skills and knowledge in biology at a level appropriate to Advanced Higher.

The topic must be chosen with guidance from teachers and/or lecturers.

The project has two stages:

- ◆ research
- ◆ report

In the research stage candidates must plan and carry out their experimental work, and collect and analyse their experimental data. Candidates must also gather information from books, journals and/or the internet to support their understanding of the biology underlying their project.

Candidates must produce a report on their research.

Candidates should keep a lab book, recording their work, which forms the basis of their report.

The lab book is not assessed and is not submitted to SQA.

Conditions of assessment

Setting, conducting and marking the project

Setting

The project is set:

- ◆ by centres within SQA guidelines
- ◆ at a time appropriate to the candidate's needs
- ◆ within teaching and learning and includes experimental work at a level appropriate to Advanced Higher

Conducting

The project is conducted:

- ◆ under some supervision and control
- ◆ in time to meet a submission date set by SQA
- ◆ individually by the candidate

Marking

The project report is submitted to SQA for external marking.

All marking is quality assured by SQA.

Assessment conditions

Controlled assessment is designed to:

- ◆ prevent third parties from providing inappropriate levels of guidance and input
- ◆ mitigate concerns about plagiarism and improve the reliability and validity of SQA awards
- ◆ allow centres a reasonable degree of freedom and control
- ◆ allow candidates to produce an original piece of work

Both stages of the project are conducted under some supervision and control.

This means that:

- ◆ candidates do not need to be directly supervised at all times
- ◆ the use of resources, including the internet, is not tightly prescribed
- ◆ the work an individual candidate submits for assessment is their own
- ◆ teachers and/or lecturers can provide reasonable assistance

The term ‘reasonable assistance’ is used to try to balance the need for support with the need to avoid giving too much assistance. However, the teacher and/or lecturer must not adopt a directive role or provide specific advice on how to re-phrase or improve responses. Teachers and lecturers must not provide model answers.

Teachers and lecturers must be careful that the integrity of the assessment is not compromised.

The project may involve candidates undertaking a large amount of autonomous work, without close supervision. Although candidates may complete part of the work outwith the learning and teaching setting, the teacher or lecturer must put processes in place for monitoring progress and ensuring that the work is the candidate’s own and that plagiarism has not taken place. For example:

- ◆ having regular progress meetings with candidates
- ◆ conducting spot-check interviews with candidates
- ◆ reviewing candidates’ lab books regularly
- ◆ completing checklists to record candidates’ progress

Teachers and lecturers must exercise their professional responsibility to ensure that the report submitted is the candidate’s own work.

Instructions

This assessment is carried out over a period of time. Candidates should start at an appropriate point in the course.

The instructions for candidates outline the requirements for the project and teachers and lecturers must give these to candidates at the outset. Teachers and lecturers must ensure that candidates understand the requirements of the task.

Teachers and lecturers should encourage candidates to keep a lab book to maintain a record of their planning, research, experimental measurements, and analysis. It is important that the teacher and/or lecturer check each candidate's lab book regularly to monitor progress and give advice.

Teachers and lecturers must not, at any stage, provide candidates with a template or model answers.

Research stage

The research stage is conducted under some supervision and control. See 'Conditions of assessment' section.

Choosing the topic

At the start of the research stage, the teacher or lecturer must agree the choice of topic with the candidate to ensure that it:

- ◆ is appropriate for Advanced Higher Biology
- ◆ has associated experimental work that can generate numerical data suitable for graphical analysis
- ◆ allows the candidate the opportunity to access all of the available marks

The teacher or lecturer should discourage candidates from embarking on over-ambitious plans. Well-controlled investigations, with a limited number of input variables, are likely to score higher marks than overly complex investigations, which often do not allow candidates to draw valid conclusions.

Candidates from the same centre should investigate different topics. They must have different aims.

Once candidates have agreed their topic with their teacher or lecturer, they must formulate their aim.

Formulating the aim

To ensure the candidate's aim is achievable, the teacher or lecturer must provide advice on its suitability, taking into account:

- ◆ health and safety considerations
- ◆ the availability of resources

Teachers and lecturers must not provide candidates with an aim.

After the candidate has formulated an aim, they can progress through the research stage.

Experimental research

Candidates must plan experimental work and collect data from this experimental work. It is expected that they will spend a minimum of 15 hours on this.

Teachers and lecturers are responsible for ensuring that appropriate risk assessment has been carried out and that candidates have guidance on the safe and correct use of equipment.

Candidates must plan their own experimental work.

Teachers and lecturers must not provide candidates with experimental data.

Teachers and lecturers must not provide a blank or pre-populated table for experimental results.

Candidates must carry out the experimental work individually. Group work is not allowed.

Internet/literature research

Candidates must gather information from internet/literature sources to support their understanding of the underlying biology.

As with experimental research, internet/literature research must be the work of the individual candidate. Teachers and lecturers should advise candidates to avoid using sources with little scientific rigour. Candidates are unlikely to produce a high-quality project using such sources.

Report stage

The report stage is conducted under some supervision and control. See 'Conditions of assessment' section.

Evidence to be gathered

The following candidate evidence is required for this assessment:

- ◆ a project report

The project report is submitted to SQA, within a given timeframe, for marking.

The same project report cannot be submitted for more than one subject.

Volume

The project report should be between 3000 and 3600 words in length, excluding the title page, contents page, tables of data, graphs, diagrams, calculations, references, acknowledgements and any appropriate appendices.

Candidates must include their word count on the project report flyleaf.

If the word count exceeds the maximum by more than 10%, a penalty is applied.

Marking instructions

In line with SQA's normal practice, the following marking instructions for the Advanced Higher Biology project are addressed to the marker. They will also be helpful for those preparing candidates for course assessment.

Candidates' evidence is submitted to SQA for external marking.

General marking principles

Always apply these general principles. Use them in conjunction with the detailed marking instructions, which identify the key features required in candidates' responses.

Always use positive marking. This means candidates accumulate marks for the demonstration of relevant skills, knowledge and understanding; marks are not deducted for errors or omissions.

Detailed marking instructions

Read the whole report before you assign any marks.

Section	Max mark	Expected response and marking instructions
1 Abstract (1 mark)		
	1	<p>A brief abstract stating the main aim(s) and overall findings/conclusion(s)</p> <p>A brief abstract must be immediately before or after the contents page and must be under a separate heading.</p> <p>The abstract must contain a clear statement of the main aim(s) and overall findings/conclusion(s) of the investigation and must be separate from the introduction.</p> <p>The overall findings must be consistent with the conclusion(s) given in the discussion and should relate to the aim(s).</p>
2 Introduction (5 marks)		
2 a	1	<p>A clear statement of the aim(s) together with relevant hypotheses</p> <p>The aim(s) and hypotheses must be explicitly stated.</p>
2 b	4	<p>An account of the underlying biology, with justification of the biological importance of the project</p> <p>Mark this section in a holistic way. Professional judgement must be used when awarding marks.</p> <ul style="list-style-type: none"> ◆ The account of underlying biology is relevant. This information must link clearly to the aim(s). Candidates should not be rewarded for irrelevant information.

Section	Max mark	Expected response and marking instructions
		<ul style="list-style-type: none"> ◆ Biological terms/ideas are explained clearly and accurately. The candidate must show an understanding of the terms/ideas used at Advanced Higher level. Where the terms/ideas used are from outwith the course content, these must be at Advanced Higher level or beyond. ◆ Biological terms/ideas are at an appropriate depth. The candidate should provide enough information in this section to allow an appropriate level of analysis, interpretation, or discussion of results. ◆ The biological importance is justified. The candidate must explain why the investigation is worth doing. They do not have to justify their investigation in terms of an immediate benefit to humans or to the environment. <p>An introduction weak in all four components could still attain marks. For example, if only two points are covered and done well, then 2 marks should be awarded. If all four points are covered, but not fully or with inaccuracies, then some marks could still be awarded. Where only a few minor errors are present, 4 marks could still be awarded.</p> <p>The candidate must use their own words.</p> <p>Do not award marks if a candidate copies lengthy sections of original text, even with acknowledgment. Copying directly from the internet, books or journals suggests that the candidate does not understand the biology involved.</p> <p>The candidate can copy and paste complicated diagrams from an internet source. However, if they acknowledge their source, this does not count as a cited reference.</p>

Section	Max mark	Expected response and marking instructions
3 Procedures (9 marks)		
3 a	1	<p>Procedure(s) are appropriate to the aim(s)</p> <p>The procedure(s) used should allow the aim(s) to be achieved. If they do not state an aim, award this mark if the aim is obvious elsewhere in the report.</p>
3 b	2	<p>Procedure(s) described in sufficient detail to allow the investigation to be repeated</p> <p>The candidate must clearly describe at least one procedure. If more than one procedure is carried out, then the major one used in the investigation must be described. The procedure should be described in sufficient detail for it to be repeated from the description.</p> <p>Award 2 marks for a full and clear description of all stages in the procedure(s). Award 1 mark if the candidate omits some minor details, but not if they omit an essential part of the procedure.</p> <p>The procedures should be written in the past tense and impersonal voice. Ignore the use of first person on a small number of occasions. If written as a set of instructions in the imperative voice, award a maximum of 1 mark for the description.</p> <p>Bulleted or numbered points are only acceptable if the statements are sentences, and are still meaningful and coherent if the bulleted or numbered points are removed.</p>
3 c	1	<p>Appropriate controls are identified</p> <p>The candidate must identify appropriate negative controls, or if controls were not used (for example if they have compared the relative effect of two treatments), then justification must be given. Positive controls do not need to be considered.</p>

Section	Max mark	Expected response and marking instructions
3 d	1	<p>Control of confounding variables is described</p> <p>The candidate has controlled confounding variables.</p> <p>Where it has not been practical for the candidate to control these variables, it must be clear that they have taken steps to monitor them and/or minimise their impact.</p>
3 e	1	<p>Sample size is appropriate</p> <p>There must be evidence of repeat measurements within the report. Simple duplication is the minimum requirement.</p>
3 f	1	<p>Independent replication is described and a separate data set(s) is provided</p> <p>Within the report, there must be a description of how independent replication was carried out. A separate data set or sets must also be included.</p>
3 g	1	<p>Justification of how the pilot study informed the final procedure(s)</p> <p>The candidate must provide justification of how their pilot study informed the final procedures. They do not need to include a full description of the pilot study.</p>
3 h	1	<p>Procedures show complexity, creativity or accuracy</p> <p>Award this mark for any one of the following:</p> <ul style="list-style-type: none"> ◆ use of a complex protocol ◆ use of difficult or unfamiliar techniques ◆ evidence of originality or creativity in the design of the investigation

Section	Max mark	Expected response and marking instructions
		<ul style="list-style-type: none"> ◆ a novel use of a simple procedure ◆ procedures or apparatus used deliver an appropriate level of accuracy to test the aim(s)
4 Results (6 marks)		
4 a	1	Data is relevant to the aim(s)
4 b	1	<p>Raw data is recorded and within the limits of accuracy of measurement</p> <p>The raw data must be measured within the limits of accuracy of the measuring instrument. Raw data may be recorded in an appendix.</p>
4 c	1	<p>Results presented appropriately</p> <p>The formats used to present data in this section (tables/graphs/charts) must be appropriate.</p> <p>Data in the appendices is not taken into account for this mark.</p>
4 d	1	<p>Overall results calculated and presented</p> <p>The candidate must calculate overall mean or average values to summarise the data from replicate experiments. These must be presented as a graph that is supported by an appropriate table in this section.</p> <p>Data from repeats can be used if replicates were not carried out.</p> <p>The accuracy of the calculations and the presentation of the graph and table are not considered for this mark.</p>

Section	Max mark	Expected response and marking instructions
4 e	2	<p>Presentation of tables and graphs is correct and accurate</p> <p>Award 1 mark for tables:</p> <ul style="list-style-type: none"> ◆ Data in this section must be tabulated. ◆ Column headings must be appropriate and have correct units. ◆ Mean or average values must be calculated correctly and tabulated. Mean or average results must not have an excessive number of decimal places or a claimed degree of accuracy greater than that of the raw data. <p>Award 1 mark for graphs:</p> <ul style="list-style-type: none"> ◆ Axes must have suitable scales, labels, and units. ◆ Graphs must be clear enough to allow any trend(s) to be observed, and plotting must be accurate. ◆ Mark computer-generated graphs in the same way as hand-drawn graphs. Where major and/or minor gridlines are absent, check the accuracy of plotting against the values in the supporting table.
5 Discussion (conclusion(s) and evaluation) (7 marks)		
5 a	1	<p>Conclusion(s) relevant to the aim(s) and supported by data in the report</p> <p>The conclusion(s) must be relevant to the aim(s) and supported by data in the report.</p> <p>Where the candidate has used an indirect measurement, they must make reference to the dependent variable and not only to the indirect measurement.</p>

Section	Max mark	Expected response and marking instructions
5 b	1	<p>Conclusion(s) is valid</p> <p>A valid conclusion(s) is stated. Validity depends on an appropriate method, adequate control of variables, and evidence of repeatable results from sufficient replication and sample size.</p>
5 c	2	<p>Evaluation of procedures with justification</p> <p>Mark this section in a holistic way.</p> <p>Award 2 marks for an evaluative discussion supported by appropriate justification of any four of the following areas:</p> <ul style="list-style-type: none"> ◆ means by which accurate measurements were achieved/sources of error in measurement and their impact on the results ◆ why the sample size was appropriate and how independent replication was achieved ◆ how the controls contributed to the overall validity of the investigation ◆ how confounding variables were controlled or monitored and their impact on the validity of results ◆ solutions to problems and reasoning behind modifications to procedures in light of the pilot study <p>A detailed discussion of any two areas, or a weaker discussion of at least four areas, should be awarded 1 mark, provided they are supported by some justification.</p>

Section	Max mark	Expected response and marking instructions
5 d	3	<p>Results analysed and interpreted, and findings discussed critically and scientifically</p> <p>Evaluation of results should include each of the following:</p> <ul style="list-style-type: none"> ◆ analysis of results The candidate should discuss variation in results obtained from repeats and replicates, and the degree of accuracy of results. They can use statistical analysis to support this discussion, but this is not essential. Calculation(s) used in the analysis of the results must be correct. ◆ interpretation of results The candidate should discuss the meaning of trends or differences observed in relation to the aim(s) and hypotheses. This discussion should consider the appropriateness of the procedure, the accuracy of the measurement, and the reliability of data. ◆ critical and scientific discussion of the findings The candidate should discuss the findings in relation to the biology discussed in the introduction and/or findings of other published research. <p>Award 3 marks for a good critical discussion of all three areas.</p> <p>Award 2 marks for a good critical discussion of two areas, or for a good critical discussion of one area with a weaker discussion of the other two.</p> <p>Award 1 mark for a good critical discussion of only one area.</p>

Section	Max mark	Expected response and marking instructions
6 Presentation (2 marks)		
6 a	1	<p>Appropriate structure, with informative title, contents page and page numbers</p> <p>The project report structure should be easy to follow.</p> <p>The title must include two from:</p> <ul style="list-style-type: none"> ◆ an input ◆ an outcome ◆ a process/context/organism <p>For example, ‘Effect of garlic on lipase activity’ is acceptable; ‘Pollution and plants’ would not be acceptable.</p> <p>A contents page with page numbers is essential. Pages throughout the project report must be numbered. Do not penalise occasional missing page numbers, for example on hand-drawn graphs.</p>
6 b	1	<p>References cited in the text and listed using Harvard or Vancouver referencing systems</p> <p>Harvard or Vancouver systems of referencing must be used. References may include books, journals/periodicals and websites.</p> <p>The candidate must cite at least three references correctly in the main body of the report (not including diagrams), and list the same references correctly at the end of the report.</p> <p>The candidate must cite at least three different sources. Note that it must not be the same book/website referred to on more than one occasion even if the reference is to different page numbers.</p> <p>Ignore additional references cited or listed incorrectly.</p>
Total	30	

Instructions for candidates

This assessment applies to the project for Advanced Higher Biology.

This project is worth 30 marks. This contributes 25% to the overall marks for the course assessment.

It assesses the following skills, knowledge and understanding:

- ◆ extending and applying knowledge of biology to new situations, interpreting and analysing information to solve complex problems
- ◆ planning and designing biological experiments/investigations, using reference material and including risk assessments to test a hypothesis or to illustrate particular effects
- ◆ carrying out complex experiments in biology safely, recording systematic detailed observations and collecting data
- ◆ selecting information from a variety of sources and presenting detailed information, appropriately, in a variety of forms
- ◆ processing and analysing biological information/data (using calculations, significant figures and units, where appropriate)
- ◆ making reasoned predictions and generalisations from a range of evidence/information
- ◆ drawing valid conclusions and giving explanations supported by evidence/justification
- ◆ critically evaluating experimental procedures by identifying sources of error and suggesting and implementing improvements
- ◆ drawing on knowledge and understanding of biology to make accurate statements, describe complex information, provide detailed explanations and integrate knowledge
- ◆ communicating biological findings/information fully and effectively
- ◆ analysing and evaluating scientific publications and media reports

This project has two stages:

- ◆ research
- ◆ report

Your teacher or lecturer will let you know if there are any specific conditions for doing this assessment.

In this project, you have to investigate a topic in biology by doing research. You will work individually to gather data/information from your own experiments and from internet/literature research. This may involve you carrying out a significant part of the work without supervision.

Your experimental research will involve planning experiments and gathering data. You should plan to spend a minimum of 15 hours doing this.

You will gather information from internet/literature sources to support your understanding of the underlying biology.

From the start of your project, you should maintain a record of your work in a lab book.

You must produce a report on your project.

Your teacher or lecturer will not mark your report at any point. It is sent to SQA for marking.

Research stage

At the start of your project, you should set up a timescale with start dates and deadlines for each phase of your project. Practical work usually takes longer than you anticipate.

Phase	Start date	Tasks	Deadline dates	Completed
Research – planning		Read the ‘Instructions for candidates’.		
		Discuss your choice of topic with your teacher or lecturer.		
		Research the biology underlying your chosen topic.		
		Decide on the aim for your project and discuss its suitability with your teacher or lecturer.		
		Record your hypothesis.		
		Research potential experiments and show your teacher or lecturer a detailed plan of your experimental procedures.		
		Prepare a risk assessment for your procedures and have this checked by your teacher or lecturer.		
Research – experimental		Check and organise when the apparatus will be available.		
		Complete the experimental work in the time allocated by your teacher or lecturer. Allow time to make modifications and carry out replicate experiments.		
		Analyse your experimental results and consider your conclusions.		
		Evaluate your experimental procedures and results.		
Report		Complete a draft of your report.		
		Finalise your report.		

Keeping a lab book

It is important that you ask your teacher or lecturer to check your lab book regularly, and take their advice.

Your lab book should contain a complete record of the work undertaken each time you work on your project.

It should include:

- ◆ notes of any discussions with your teacher or lecturer and any other scientists
- ◆ background research
- ◆ references
- ◆ details of procedures
- ◆ tables of results
- ◆ analysis of results
- ◆ modifications
- ◆ next steps
- ◆ findings and/or conclusions

It is important that you write your entries into your lab book in such a way that you will find it easy to follow and understand when you use it to produce your report.

Choosing your topic

- ◆ You need to choose a topic in biology to investigate.
- ◆ Think about the biological importance of your investigation. Why is it worth doing?
- ◆ You must agree your topic with your teacher or lecturer.

Deciding your aim

- ◆ Once you have chosen your topic, you need to decide what the aim of your project is.
- ◆ Remember that you need to plan, carry out and collect data from experiments.
- ◆ Your teacher or lecturer will provide advice on the suitability of your aim.

Constructing your hypothesis

- ◆ You must construct a hypothesis that you will test using your experimental research.

Experimental research

When carrying out your experiments, you must work on your own. Your experimental research must allow you to achieve your aim and to test your hypothesis. This should be suitably complex or creative for work at this level.

Conclusions can only be valid if you address all of the issues relating to validity in the procedures you use.

Considering the following questions will help you to address issues relating to validity and reliability when planning and carrying out your experiments:

- ◆ Have you considered if controls are necessary? Have you included negative controls when appropriate?
- ◆ Have you controlled confounding variables? Where it is not practical to control confounding variables, have you taken steps, such as randomisation of treatments, to minimise their impact?
- ◆ Are your sample sizes appropriate?
- ◆ Are your replicates adequate and have you carried them out independently of each other, so that you have obtained at least one separate data set?
- ◆ Do your procedures allow you to make accurate measurements?
- ◆ If necessary, have you modified procedures based on the results of a pilot study?

Internet/literature research

- ◆ You must research the biology underlying your chosen topic. You can use information from books, journals and/or websites to help you, but you should avoid using sources with little scientific rigour.
- ◆ It is important that you record your sources of information. You need to cite and reference at least three of these sources in your report using either Harvard or Vancouver referencing systems.

Report stage

Producing the report

The report must be all your own work.

Resources

The information you recorded in your lab book should form the basis of your report. You can access any resources you need to write your report.

Guidance on producing your report

The following table shows the marks allocated to each section in your report.

Sections	Mark allocation
Abstract	1
Introduction	5
Procedures	9
Results	6
Discussion (conclusion(s) and evaluation)	7
Presentation	2
Total	30

You should use a structure for your report that flows logically. Using headings will help to make your report clear.

Title page

This page must have a title that clearly indicates the subject matter of the project. It should indicate the dependent and independent variables. You might start out with a working title and then consider revising the wording of the title as the project nears completion. The title page must have your name and candidate number and the name and number of the centre presenting you.

Contents page

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

Abstract

Although it appears early in the report, as the abstract summarises the project, it may be one of the last things you write.

You must state the aim and overall findings and/or conclusion(s) of the project in your abstract. It must be brief, should be immediately after the contents page, and it must be separate from the introduction. Your overall findings must be consistent with the conclusion(s) given in the discussion, and must relate to the aim.

Introduction

Your introduction must include a clear statement of the aim (although you have already stated this in the abstract) and relevant hypotheses. The aim needs to be clear and explicit since this is key to the project report.

You must include an account of the biology underlying your chosen topic. It must link clearly to the aim and be at a level appropriate to Advanced Higher Biology. The information you present can include theory studied during the Advanced Higher Biology course, but this is not essential. Take care to use terms accurately and to explain ideas clearly.

You must justify the biological importance of your investigation. You must explain why the investigation is worth doing.

Unless you are directly quoting from a source, you must put things into your own words. Copying directly from the internet or books or journals suggests that you do not understand the biology involved.

Copying sections of text from any source, without acknowledgement, is plagiarism.

Procedures

You must write your description of the procedures in the past tense and using the impersonal voice.

You must present the procedures in a meaningful and coherent way, and not as a set of instructions. Bulleted or numbered points are only acceptable if the statements are sentences, and are still meaningful and coherent if the bulleted or numbered points are removed.

You must describe the procedures you used clearly and in sufficient detail to allow someone else to repeat the investigation. You must include an adequate description of how you addressed issues relating to validity and reliability. Considering the following questions will help you do this:

- ◆ Have you described any controls?
- ◆ If no control was necessary, have you justified this?
- ◆ Have you described how you controlled confounding variables?
- ◆ Where it was not practical to control confounding variables, have you described the steps you took to minimise their impact?
- ◆ Have you clearly indicated the sample size?
- ◆ Have you described how many replicates you carried out and how you achieved independent replication?
- ◆ Have you explained how your pilot study informed your final procedure?

It may be appropriate to include labelled diagrams or photographs of assembled apparatus.

You can place non-essential information, such as recipes for standard culture media, in an appendix. You must not include essential information, needed to repeat the procedures, in an appendix.

Results

The results must be relevant to the aim of your project.

You must provide all raw data (the measurements you actually recorded) as well as processed or derived data. The raw data must be within the limits of accuracy of the equipment you use to make your measurements.

You can present raw data in an appendix. If you include data from your pilot study this can also be in an appendix.

You must present your data in appropriate formats.

You must summarise your results adequately. You must use the data from replicate experiments to calculate overall mean or average values. You must present the overall means or averages as a graph and support this with an appropriate table in this section.

Your tables, graphs, and diagrams must be of a suitable quality:

- ◆ tables must have:
 - appropriate column headings and correct units
 - mean or average values calculated correctly (Mean or average results must not have an excessive number of decimal places, or a claimed degree of accuracy greater than that of the raw data.)
- ◆ graphs must:
 - have suitable scales, axes labels, and units
 - have accurate plotting
 - be clear enough to allow any trend(s) to be observed

If you use software packages to generate graphs, you must format the axes correctly to suit the data, so that the results are presented in a scientific manner.

Discussion (conclusion(s) and evaluation)

You must state a valid conclusion. This must be relevant to the aim(s) and supported by data in the report. Where you have used an indirect measurement, you must refer to the dependent variable and not only to the indirect measurement.

You must discuss your findings in a critical and scientific manner. Your discussion is an evaluation of the investigation as a whole.

Evaluation of procedures

You must support the evaluation of your procedures with appropriate justification. Use the following questions to inform your discussion:

- ◆ How did you achieve accurate measurements?
- ◆ What were the sources of error in measurement and how did they impact on the results?
- ◆ Why was the sample size you used considered appropriate?
- ◆ How did you achieve independent replication?
- ◆ How did the controls contribute to the overall validity of the investigation?
- ◆ How did you control or monitor confounding variables and what was their impact on the validity of your results?
- ◆ What were the solutions to any problems that arose?
- ◆ What was the reasoning behind any modifications you made to procedures in light of the pilot study?

Evaluation of results

Your evaluation of results must include each of the following:

- ◆ an analysis of the results
You must discuss any variation you observe in the repeat measurements and independent data sets, and the degree of accuracy of the results. You can use statistical analysis to support this discussion, but this is not essential.
- ◆ an interpretation of the results
You must discuss the meaning of the trends or differences you observed in relation to your aim(s) and hypotheses. You must also consider the appropriateness of the procedure, the accuracy of the measurement, and the reliability of data in your discussion.
- ◆ a critical and scientific discussion of the findings
In this part of your evaluation, you must discuss the findings of your project in relation to the biology discussed in the introduction and/or the findings of other published research.

Presentation

References

You must include a minimum of three references from different sources in your report. Different pages from the same book or journal counts as only one reference. Similarly, if you refer to the same website several times, this also counts as only one reference.

You must use either Harvard or Vancouver referencing systems. Both systems have two basic components:

Citation

When you use another person's work in your project report, either by referring to their ideas, or by including a direct quotation, you must acknowledge this in the text of your work. This acknowledgement is called a citation.

Reference list

The reference list is placed at the end of the report. It provides full information about every citation and allows the reader to locate each source you use.

Citations

The Harvard system uses bracketed citations that direct the reader to source information in the reference list. Each citation has the author name(s) and the year of publication.

For example:

'These sprays, dusts, and aerosols are now applied almost universally to farms, gardens, forests, and homes – non-selective chemicals that have the power to kill every insect, the "good" and the "bad"...' (Carson, 1962).

If there are more than two authors the citation has the name of the first author followed by the abbreviation 'et al.,' and the year of publication.

For example:

‘This classification system divides proteases into clans based on catalytic mechanism and families on the basis of common ancestry.’ (Rawlings et al., 2006).

The Vancouver system is a numerical system with in-text citations that use numbers, either in brackets or as superscripts. The same number is used for a source that is cited more than once.

For example:

‘Sequencing of mitochondrial DNA has been used to understand how a parasite spreads between different human populations.’³

or

‘Sequencing of mitochondrial DNA has been used to understand how a parasite spreads between different human populations.’ (3)

Reference list

The Harvard system list of references should be organised alphabetically.

For example:

Carson R. (1962), *Silent Spring*, Boston: Houghton Mifflin Company, p. 189.

Daniels, J. W., Molé, P. A., Shaffrath, J. D. and Stebbins, C. L. (1988) Effects of caffeine on blood pressure, heart rate, and forearm blood flow during dynamic leg exercise, *Journal of Applied Physiology*, 85(1), pp. 154-159.

The Vancouver system list of references must be in numerical order, according to the order in which they appear in the text.

For example:

- 1 Standley, C. (2010) Using genetics to fight schistosomiasis. *Biological Sciences Review* (1) pp. 7-11.
- 2 Carson R. (1962), *Silent Spring*, Boston: Houghton Mifflin Company, p. 189.

In both systems, the references in the list must contain the following pieces of information:

Books

Author(s) (surname followed by initials), (year of publication), *title*, place of publication: publisher, page number(s).

For example:

Carson R. (1962), *Silent Spring*, Boston: Houghton Mifflin Company, p. 189.

Online books

The reference for an online book should be the same as a printed text: author(s) (surname followed by initials), (year of publication), *title*, place of publication, publisher, page number(s) should all be given, **not** the website title or URL.

Journals or 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) if available.

For example:

Daniels, J. W., Molé, P. A., Shaffrath, J. D. and Stebbins, C. L. (1988) Effects of caffeine on blood pressure, heart rate, and forearm blood flow during dynamic leg exercise, *Journal of Applied Physiology*, 85(1), pp. 154-159.

Online journals

You must provide the details of the author(s) and journal, **not the host website**.

For example:

On the website 'Springer Link', the page with the URL:

<https://link.springer.com/article/10.1007%2FBF02861686> leads to an abstract of the article that should appear as follows:

Weaver, M. L., Hautala, E. and Reeve, R. M. (1971) Distribution of oxidase enzymes in potato tubers relative to blackspot susceptibility II. Peroxidase and Catalase, *American Journal of Potato Research*, 48(1), pp. 16-20.

Websites

You must give as many of the following items as are available:

Author or organisation, date, title, publisher, the URL, and the date you accessed the material (because the site may be updated between the time you use it and the time a reader refers to it).

For example:

American Liver Foundation (2016) Alcohol-related liver disease.

Available from: liverfoundation.org/for-patients/about-the-liver/diseases-of-the-liver/alcohol-related-liver-disease [Visited: April, 2019]

When you are citing websites, it is sometimes difficult to attribute the information you use to specific authors. In these cases, your citation should include the organisation responsible for the output published on the web pages you consulted. This is known as a 'corporate author'. You can often detect information about the corporate author from the URL.

If you cannot cite a named or corporate author, use 'Anon' as the author name. You should avoid sources like this, as they may not be accurate. It is important to identify sources of information based on genuine scientific research or knowledge.

In this section, you can also acknowledge people who have advised or assisted you in carrying out your project.

Summary

You can use this table to check you have covered all the sections in the report.

Section	Expected response	Marks
Abstract 1 mark	a brief abstract stating main aim(s) and overall findings/conclusion(s)	1
Introduction 5 marks	clear statement of aim(s) together with relevant hypotheses	1
	<ul style="list-style-type: none"> ◆ account of underlying biology relevant to aim(s) ◆ biological terms/ideas explained clearly and accurately ◆ biological terms/ideas at an appropriate depth ◆ biological importance justified 	4
Procedures 9 marks	appropriate to aim(s)	1
	procedures described clearly in sufficient detail to allow the investigation to be repeated	2
	appropriate controls identified	1
	control of confounding variables described	1
	sample size appropriate	1
	independent replication described and separate data set(s) provided	1
	justification of how the pilot study informed the final procedure(s)	1
Results 6 marks	data relevant to the aim(s)	1
	raw data recorded and within limits of accuracy of measurement	1
	results presented appropriately	1
	overall results calculated and presented appropriately	1
	presentation of tables and graphs correct and accurate	2
Discussion (conclusion(s) and evaluation) 7 marks	conclusion(s) relevant to the aim(s) and supported by data in the report	1
	conclusion(s) valid	1
	evaluation of procedures with justification: <ul style="list-style-type: none"> ◆ means by which accurate measurements were achieved/sources of error in measurement and their impact on the results ◆ why the sample size was appropriate and how independent replication was achieved ◆ how controls contribute to the overall validity of the investigation ◆ how confounding variables were controlled or monitored and their impact on the validity of results ◆ solutions to problems and reasoning behind ◆ modifications to procedures in light of the pilot study 	2

Section	Expected response	Marks
	results analysed and interpreted, and findings discussed critically and scientifically: <ul style="list-style-type: none"> ◆ analysis of results ◆ interpretation of results ◆ critical and scientific discussion of significance of finding(s) 	3
Presentation 2 marks	appropriate structure, with informative title, contents page and page numbers	1
	references cited in the text and listed using Harvard or Vancouver referencing systems	1
Total		30

Administrative information

Published: May 2019 (version 1.0)

History of changes

Version	Description of change	Date

Note: you are advised to check SQA's website to ensure you are using the most up-to-date version of this document.

Security and confidentiality

This document can be used by SQA approved centres for the assessment of National Courses and not for any other purpose.

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