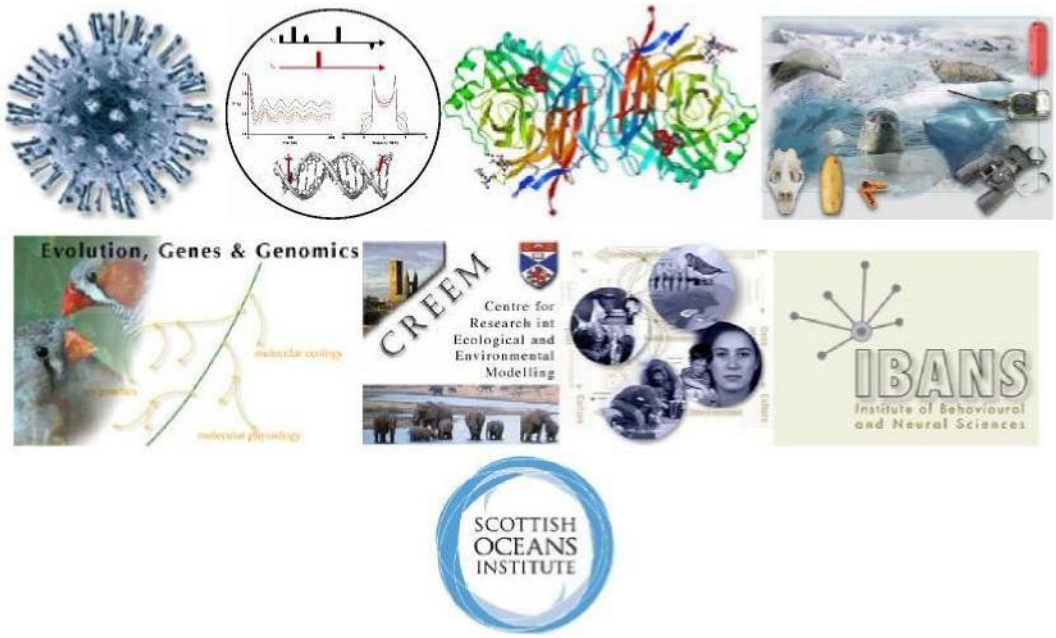
Senior Honours
Experimental Research Project
BL4201



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Module Coordinator: Professor Sue Healy

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The procedures and regulations followed by the School of Biology are outlined in the University Handbook and in the School of Biology Undergraduate Handbook.

Specific School regulations relating to absence reporting, penalties and rules for late submission of work, extensions for coursework, return of coursework, S-coding, Good Academic Practice and Academic Alert are stated in the School of Biology Undergraduate Handbook and students are required to carefully read these regulations.

Students are also referred to the University Handbook, available at: http://www.st-andrews.ac.uk/studenthandbook/

Introduction to the Experimental Research Project

The BL4201 module comprises the research projects (60 credit projects) that fall into 3 broad categories: laboratory-based projects, field-based projects, meta-analysis and data-based analytical projects. All types involve analysis of data, but in the first two types you collect your own data for analysis, while in the others you might be analysing data you have collected from a number of previous published studies or data collected by other scientists but not yet published. It is important to note that although there are important differences between the two groups, **the amount of work necessary to carry them out successfully is the same because**:

- **Laboratory- or field-based projects** require that you collect your own data and carry out the appropriate analyses. In this case, the statistical analyses are unlikely to be very sophisticated because you have invested much time in the production of data.
- **Meta-analysis and data-based projects** use already existing datasets and carry out novel analyses to answer interesting questions. In this case, you **are expected** to carry out sophisticated and cutting-edge statistical analyses. Moreover, you **are expected to have a very thorough understanding of their subject area and to be able to explain the details of the statistical methods and also justify their use. This will be checked during the oral examination.**

If you are carrying out a data-based project and notice that a classmate working on a laboratory- or field based project seems to be working much harder, then you are not doing your best and you are likely to obtain a low mark in your written report and oral examination.

Learning outcomes

A student completing this module will be able to

- Research a defined field of Biology using primary sources and clearly define a key research hypothesis
- Write a critical and analytical evaluation of the current literature in a chosen field
- Write in a defined style appropriate to a lay audience or an expert in the field
- Acquire an in-depth and detailed understanding of a chosen field in Biology
- Plan, propose and conduct a scientific investigation using research techniques appropriate to a chosen field of Biology
- Perform research to a professional standard, keeping accurate and detailed records and producing reliable, repeatable results
- Analyse, present and interpret data in a format and standard suitable for publication
- Report on a research investigation, critically evaluating and analysing the results in the context of current knowledge
- Communicate verbally scientific information accurately and succinctly

Acquired Skills

Examples of Acquired Skills (both practical skills and transferable skills):

Practical skills

- A range of laboratory or field techniques relevant to biological research (dependent on the individual project undertaken)
- Generating scientific hypotheses, designing experiments and problem solving
- Data organisation, analysis and numerical skills
- Data interpretation, critical thinking and reading.
- Presenting scientific information, data and ideas in both written and oral format.
- Working in a professional research laboratory environment, which involves both independent and team work.

Transferable Skills

- Working independently, organisation and time management.
- Working as part of a team
- Quantitative skills, data collection, data analysis, computing
- Written communication; report writing.
- Oral communication; preparation and delivery of short individual presentation, viva
- Information literacy; sourcing relevant literature
- Problem solving

Assessment

Literature Review	10% (6 credits)
Research performance	10% (6 credits)
Research report	70% (42 credits)
Oral examination	10% (6 credits)

The major part of assessment of your project is based on the research component of your activity, i.e. your research investigation and the written report that results from this.

Each component of the project is assessed independently by at least 2 markers. These two markers mark independently and record their initial grade and, if the grade differs, they then discuss the assessment and arrive at an agreed final grade. In the event of a continued disagreement or uncertainty, a third marker will be asked to arbitrate. An external examiner might also be asked to adjudicate to ensure fairness to all students. **The external examiner oversees all the projects and grades, which are reported on MMS. Please, note that these are not final until after the module boards and once the grades are released onto the student record.**

Preparation for your Project

You will already have chosen your project at the end of your Junior Honours year and by now might have met your project supervisor. You should arrange an initial meeting with your supervisor, who will discuss the general area with you, and provide a framework for you to formulate a specific question that you will address. You will probably also be pointed at a few

research papers or may be given 'starter pack' (hard copy and/or eversion) to read to get you started in developing background knowledge in the project area.

The project spans both semesters 1 and 2, and the time that you allocate to the project during each of the semesters depends on the number of modules you have chosen across each semester. For example, if you have chosen four taught modules in Semester 1 you will do almost all of your work in Semester 2.

Collect from the Teaching Office your laboratory/field notebook in which you should record your progress with your project.

PLEASE inform your supervisor of any special needs; disabilities, or health problems that you have that may affect your safety or progress during the project.

Project Timeline

Appropriate milestone dates will vary between projects, and should be discussed with your supervisor. You should agree a date by which you will give your supervisor the draft of your Materials and Methods and Results section, you cannot expect them to read and feedback adequately if you give too little time.

Timing of laboratory/fieldwork

It would normally be expected to conduct your research for your thesis over Semester 1 and Semester 2 of the academic year. However some laboratories are set up to expect students during Semester 2 and some projects due to the seasonal nature of some activities demand that fieldwork is conducted over the summer. You should agree with your supervisor a schedule for your project work early in the process so that there is clear understanding on both sides when the research is going to be conducted. In total your entire project from beginning to end should be the result of 600 hours of student effort including all reading, research, data analysis and writing up. The balance of how and when these hours are spent depends very much on the field of your research project.

Workshops and training sessions

- **Introduction to the research project**, Prof. Sue Healy
- **Introduction to writing** a **literature review**, Prof. Sue Healy
- **Good experimental design**, Prof. Greame Ruxton.
- **Self-editing workshop**, Dr Anne Smith.

The timetable is available from the **online** module handbook.

Statistical analysis support will be available in Semester 1 and 2 through CAPOD. Details on how to obtain this support can be found here https://www.st-andrews.ac.uk/students/academic/advice/studyskillsandadvice/mathsandstatisticssupport/.

Literature review 10%

You are expected to carry out a **systematic literature review**, which presents the most novel and interesting findings in a research field in a synthetic way and highlights knowledge gaps and new avenues of research. It is much more than a simple essay and requires a substantial amount of work. The main steps that you should follow to produce a quality review are:

- Identify all relevant published and unpublished evidence
- Select studies for inclusion
- Assess the quality of each study or report
- Synthesise the findings from individual studies or reports in an unbiased way
- Interpret the findings and write a balanced and impartial summary of the findings with due consideration of any flaws in the evidence
- Prepare an outline with subtitles and only then write the literature review.

The Literature Review should be preceded by a 500-word 'lay summary' which summarises the essay in non-scientific laymen's terms.

The maximum length of the Literature Review is 1800 words. This includes **everything EXCEPT** the lay summary, figures and/or tables, and the reference list at the end. **Note, however, that the 10% leeway rule applies for all word limits.** Thus, the length of the main text should be between 1620-1980 words and the length of the lay summary should be between 450-550 words. The citation style of the essay has to be uniform throughout and should follow the **Vancouver reference system**.

It is quite acceptable that there may be *some* duplication (but not word for word) in the description of the background literature between your Literature Review and the Introduction section of the research paper. However, remember that the background information in the Introduction of the research paper should be focused specifically on material relevant to the contents of the paper and the Literature Review should be considerably broader providing information on the wider field. Furthermore, the Introduction performs several additional functions beyond providing background information, and so the overlap should not be great.

If the project, for whatever reason, moves away from the area outlined in your Literature Review there with be no penalty incurred.

The project supervisor should be consulted during the preparation of the review. You can discuss the review, but supervisor(s) (including other members of their lab such as Postdocs) are not allowed to comment on any written material. The writing must be your own (see below for permitted peer support). It is always helpful to search for published reviews to get a good idea of what constitutes a good review paper. Your supervisor or members of her/his research group should be able to suggest good examples.

Please note that you are required to declare any peer-input you received on the written essay (i.e. any proof reading) including any language assistance (i.e. style, idiom, grammar, syntax or spelling). See the undergraduate handbook for further information and the declaration to be included. You should not solicit any external help outside simple language or grammar based proof reading.

You must be mindful of the rules regarding academic misconduct and plagiarism. If in doubt speak to the Module Coordinator. Plagiarism, even if unintentional, can have serious consequences *per se*.

Guidelines for researching the literature

All Senior Honours projects require you to become familiar with the research published in your area of study. The initial references provided by your supervisor form a useful starting point, but **you will be expected to expand your knowledge greatly through your own research into the literature**. More references can be found in the lists at the end of these initial papers, or by consulting the electronic Library resources, or by web searching with Web of Science or Google Scholar. Textbooks may also be a useful source of background material, but they are not usually sufficiently advanced or up-to-date to provide you with all of the information that you need for a project. You should be reading original scientific papers and review articles as your primary source material.

When you read a paper, make careful notes on its content (e.g. in your study notebook), including the exact bibliographic reference, and specific examples and numerical facts mentioned in the paper. You will probably want to photocopy or download e-versions of key papers to which you will be referring repeatedly. Specialist books, or articles in journals that are not kept by the library in St Andrews, can be obtained by inter-library loan with the approval of your supervisor (who will help with the cost of this process).

A large amount of information is often available from a simple Google Scholar search on the Internet however many papers will only be available by going through the University Library search engines. Google Scholar can be extremely useful as a scene-setting starting point, but **you must be aware of its limitations.** Scientific literature that is published in reputable journals is almost always reviewed and verified by acknowledged experts in the field, but this is not the case for the vast majority of information on web pages. Mistakes easily creep in (due to a typographic error, one Harvard university tutorial website confused mRNA and rRNA, much to the embarrassment of the author when this was pointed out), and so you cannot accept website information as being absolutely reliable, even when it comes from a reputable source. **Also, you must be very careful NOT to just copy and paste material from the Web - this is plagiarism, it will be detected and the penalties are severe**.

Literature Review format

Literature Reviews should adhere to the following format (e.g. include these headings):

A Title Page including

- **Title**
- **Contact details** (For the purpose of this assignment please provide your matriculation number –not your name).

Lay Summary

Provide a summary of the Literature Review in plain English, explaining the context of the research, its aims and objectives, its potential applications and benefits. The summary should be written in a style that is accessible to a variety of readers, including the general public. The lay summary should not exceed 500 words and should be in a

separate page. Note that the 10% leeway rule applies (i.e. length between 450-550 words).

Literature Review

The maximum length is 1,800 words but the 10% leeway rule applies (i.e. length between 1620-1980 words). The literature review should be structured into sections that are preceded by an appropriate subtitle. The first section corresponds to the introduction, which explains the importance of the subject, provides the necessary background, and explains the aims and objectives of the literature review. The last section is the conclusions, which summarises the main take-home messages and highlights knowledge gaps that should be the subject of future research efforts. The total number of sections/subtitles depends on the particular subject you are reviewing. You should keep in mind that you are writing for an audience of peers and, therefore, you need to make every possible effort to facilitate the readers understanding of the subject you are reviewing. Thus, **the use of subtitles, tables and figures is essential**. You can include up to **6 figures** (each can include several panels) and **tables** (inclusive) in your paper.

References

The citation style of the essay has to be uniform throughout and should follow the **Vancouver reference system**. When using the Vancouver style, the reference list should be in numerical order and each number matches and refers to the one in the text. DO NOT include DOIs.

The reference list should be at the end of your work.

Literature Review submission

- Upload a digital copy in **pdf format** only to MMS.
- Digital submissions must meet the deadline.
- Late submissions will be penalised.
- The assessment should only have your MATRICULATION NUMBER, not your name, on the front cover, nor should your name appear anywhere within the text.

Research Performance 10%

Most of your time during the project will be spent actually carrying out your research, and your supervisor will assess your aptitude and application during this period. The marking descriptors for your research performance grade can be found at the end of this handbook and on MMS.

Guidance and Feedback

You should discuss the project plan and experimental programme with your supervisor. Your supervisor should organize any training required for the use of specialist apparatus etc., and also keep you informed of any Health and Safety issues such as the handling of chemicals. You can expect to have ready access to assistance with daily routine matters so that trivial problems can be resolved as quickly as possible.

You should have regular meetings (normally at least once a week) on a more formal basis in which your progress and plans are discussed, and in which you receive feedback on any areas where your performance is causing concern.

You should show your supervisor your study notebook at some or all of these meetings. You can expect to receive guidance on the analytical methods appropriate for your project. However, note that your supervisor may not be able to provide technical advice concerning R or some advanced statistical methods. If this is the case, you should contact CAPOD to seek expert guidance.

As the project progresses, you should present your analysed data at the regular meetings with your supervisor. These will then be used as the basis for discussion about what to do next.

You are likely to receive a higher score in your research performance assessment if you come to these meetings having already thought about what your results mean, and with some ideas about what to do next!

Study/laboratory/field notebooks

You should maintain and submit a study/laboratory/fieldwork notebook.

Student study notebooks contribute directly to the assessment through the research performance mark and the assessment criteria can be found in the appendix of this document.

In professional scientific research the laboratory notebook is also a document that can be used as evidence in disputes such as patent claims, or accusations of plagiarism or fraud. In the context of your Honours project, the notebook is the evidence that you actually did the research that you write about in your Report and also may be used by the external examiner in the event of a discussion about your grade.

The Teaching Office will provide you with a suitable bound notebook at the start of your project. You should show the notebook to your supervisor periodically to make sure that you are fulfilling the expectations with regard to note keeping.

The exact nature of this will vary between projects, but essentially it is a combination of a reflective diary and a laboratory or fieldwork notebook, in which you keep a record of your activities, thoughts and ideas relating to the project.

You should record in note-form with dates and times:

- papers that you have read and your reflections on the papers
- details of your activities each day you work on your project.
- details of experiments/observations that you plan and/or have completed and the results
- questions that you want to ask your supervisor each time you meet
- notes on your meetings with your supervisor and what you discussed and agreed.
- your analyses and the results from them
- your own reflections on your results and your thoughts about what to try next

Oral Examination 10%

For most people, an oral examination is an unfamiliar and perhaps rather worrying prospect. However, be assured that the assessors are expected to be professionally supportive, and are not out to trick or trap you – they simply want to allow you to do the best that you can.

The time allocated for each oral examination is 20 minutes in total.

The purpose of the oral examination

The oral examination gives you the opportunity to talk about your research project with two interested academics who are keen to learn about your project. The examiners want to learn how well you understand your project, your engagement with the topic and your critical, analytical and synthetic skills with respect to your research area.

The constitution of the oral examination panel

The panel will consist of the second marker of your report and a member of the teaching committee. The teaching committee member is there to ensure consistency and fairness across the degree programme. Both members of the panel will have read your report.

How the oral examination will be conducted

Two members of staff will attend the oral examination. You will have 5 minutes to give a summary of your project, highlighting any key findings. You can, if you wish, bring copies of relevant figures or tables from your project to illustrate your key points (Data projection will not be available but you can bring a (fully charged laptop if what you want to show cannot be easily printed).

This will be followed by a period of discussion with the panel that will be an opportunity for the panel to find out more about what you have done and for you to talk some more about your project. Also, it will be used to test the extent or depth to which you understand the topic that you have researched, and the methods and analysis that you have undertaken. Do not be scared to show an awareness of the limitations of your project. It can also be used by you to clarify or expand on information in your paper that perhaps the examiners themselves have not understood or appreciated properly, or to raise any issues that you feel may have prevented you from achieving your full potential in terms of your project outcome.

After 20 minutes in total the examination will be announced as over and if time allows an informal conversation may turn to less exacting topics; the degree controllers are keen to learn at first hand about your project experience. This will not be part of the mark.

When and where the oral examination will be held

You will receive an e-mail explaining where and when your oral examination will be held; please check and double check the time and venue. The current plan is to hold the oral examinations on the first two days of the examination diet.

If you have any queries please contact the Teaching Office in the first instance.

Please contact the Teaching Office immediately as soon as you become aware that you are unable to attend for any reason.

Non-attendance without good reason will result in the grade 0 being awarded.

Writing the research report 70%

Length

The final written report on your research activity takes the style of a research paper. After the title page, you have to include an Abstract of up to 250 words, which do not count towards the **7000-word limit** (figures, tables, and references **are also excluded**). **Note, however, that the 10% leeway rule applies for all word limits**. This means that the length should be between 6300-7700 words. You can include up to 8 **figures** (each can include several panels) and **tables** (inclusive) in your paper.

You MAY need to include an Appendix, for example of complex data listings, additional figures, or detailed statistical analysis, as in many modern research papers, and this is not included in the word limit. But DO NOT use an Appendix as a sneaky way to exceed the word count!! The report must be fully comprehensible *without* any detail given in an Appendix.

The text of the paper should form a well structured "package" that tells a coherent story. This may well mean that not all the experiments/observations that you performed will be included in this final report. However, if you encountered a scientific problem and tried several ways to solve it, and you have the feeling that the experiments are scientifically valuable and/or interesting, we want to read about them even if you were in the end not able to solve the problem. But please distinguish between experiments that did not work because you made an error and those that 'worked' but gave a negative result.

The Research report is the assessed outcome of your research project.

Layout

The layout for a **research-based project** should include the following sections:

Title page

Declaration of Authorship (Your chance to acknowledge specific help given)

Contents list: (With page numbers)

Abstract: (Single page summary)

Introduction: (Statement of aims of project and issues being addressed)

Materials and Methods (A full description of your methodology)

Results (Description of the results)

Discussion (What it all means in the broader scheme of things)

References: (In alphabetical order and in standard format)

Appendices: (Where appropriate)

Title

This should be concise, giving a clear indication about the topic, and not containing abbreviations.

Title, Matriculation No., Degree Course, date, word count

Declaration of Authorship (Acknowledgements)

The Declaration of Authorship is important for all students as it is for all scientists to acknowledge the support they have had in their research. It is essential that your examiners have a clear understanding of precisely what was your own effort, and what was due to the input of others, before they start to read and assess your report. Your declaration of authorship will achieve this in part, at the very beginning of your report; providing a brief summary of the routine and non-routine support that you received (from your supervisor, research students, technicians, postdoctoral researchers, etc) during your research. Here you identify for yourself the efforts and inputs of others that have enabled you to achieve the academic goals, learning objectives and achievements presented in your report. You should not view the acknowledgement of this assistance as being in any way detrimental to your training, or your research achievements and the assessment thereof. Inform readers in this section about who helped you with what. It will help examiners in judging what you did by yourself. It should include a clear statement about any data that were given to you rather than being collected by you.

It may be, for example, that you were provided with sets of aerial photographs of seal colonies and your project concerned your individual gleaning of information and data from those photographs. In this case, you need simply acknowledge the provision of the photographic material and the personnel involved. If, however, important levels of support and assistance were given on the acquisition of the actual data from the photographs then this must be acknowledged. You must also offer a clear appraisal of the extent to which the data had been processed before you obtained them. For example, you may have had a project concerning the analysis of photosynthesis of marine algae in relation to Sea Surface Temperature anomalies. You may have been provided with the raw satellite data, which you yourself then processed to identify the anomalies. This is very different to being provided with SST data already processed from their original state into anomalies.

Here are some examples of what might constitute a simple Declaration of Authorship.
Statement:

The work reported in this Report is all my own. Other than the typical input, advice, discussion and support of my supervisor, I received no individual or special assistance or training from other staff or students.

Matriculation number..... Date

This is a minimal statement, appropriate if you genuinely had received no assistance beyond that provided routinely by your supervisor. However, it is quite likely that other people did provide specific expertise, assistance or training (beyond the typical) in one or more aspects of your work. These should be acknowledged as in the following illustrative examples.

Statement:

Except where duly acknowledged (here, and under Acknowledgements), the work reported in this Report is my own. My supervisor provided the typical input, advice, discussion and support but numerous individuals provided specific assistance and laboratory support.

Dr B. Smith (Postdoctoral Fellow) provided training and advice on statistical analyses and data processing.

For extensive discussions concerning the interpretation and further analysis of my results I am grateful to Mr. D. Jones and Ms J. Chisolm (Research Students).

Logistical and safety support in the field was kindly provided by Messrs I. Johnston and F. Danvers. Their skill in boat handling under often difficult weather conditions was especially important to the successful conclusion of the field sampling trips.

For assistance in trouble-shooting the complexities of micro-array analysis I am grateful for the particular guidance offered by members of the Molecular Biology Group (BMS), and especially Dr. V. Helpful.

Matriculation number..... Date

It is important to reiterate that the key objective here is to encourage and require you to carefully consider what your own effort was and what is due to others' input. In order for your examiners to assess your specific skills and achievements it is essential that they have a clear impression of these facets of your project work before the assessment procedures commence.

In putting your Matriculation number under the Declaration of Authorship and submitting the work electronically you are signing to attest that the declaration is correct.

Abstract

Take particular care with your abstract; everyone will read it first, and first impressions matter. Keep it snappy and informative, giving a well-balanced and accurate summary of the main content of your Report. There should be a clear description of the aims and the hypothesis, and a brief statement of main results and conclusions. You should respect the 250-word limit.

Introduction

Normally, it is advisable to engage the reader's attention as soon as possible by explaining the problem to be investigated and why it is of interest. Make very clear the hypothesis and the aims of the study. Then move on to describe the historical and/or theoretical background of the subject. State briefly what your methodological approach was (and why, if appropriate). Finally, you may wish to preview the most significant result(s) you obtained: the reader is then able to judge the evidence supporting the main findings as they read through the rest of the paper.

It is quite acceptable that there may be *some* duplication (but not word for word) in the description of the background literature between your Literature Review and the Introduction section of the research paper. However, remember that the background information in the Introduction should be focused specifically on material relevant to the contents of your report and the Literature Review should be considerably broader providing information on the wider field. Furthermore, the Introduction performs several additional functions beyond providing background information, and so the overlap should not be great.

Materials and Methods

The concept of repeatability is at the very heart of the scientific method, and the purpose of the Materials and Methods section is to give enough information about the technical aspects of what you did and how you did it to enable another scientist to repeat your experiments in as similar manner as possible.

Details of all non-standard techniques that you employed. Where a standard method was used (e.g. protein determination, ATPase assay) merely give a reference in the text, but do indicate precisely what metering equipment was used (make and model). If a method has been modified, give the original reference and spell out your modifications.

Details of protocol. Where the experimental protocol was standard but an essential part of the work, you may describe it in brief as well as giving the reference. But do not give a numbered list of steps like a cookery book, as seen in laboratory manuals. Where the protocol was of your own devising, as in many field-based projects, describe the method in detail including dates and times of collections and any environmental variables that were measured (again with details of all equipment and suppliers)

Details of any statistical analysis methods that you applied. This is particularly important for projects based on data analysis, in which the methodology is likely to comprise an important component of the overall project design. It is essential that you demonstrate a clear understanding of the method used and why it was appropriate. If the methodology is complex and involves many steps, it may be necessary to include this information in the appendix and only provide an overview of the method in the main text.

NOTE: if you designed your own analytical methodology and verified it with tests on known data, then you should describe these tests in the opening part of your Results section.

Results

The Results section consists of a body of text, with figures and tables embedded in it. The text should be a cohesive piece of writing that describes the major features of your results, and which can be read on its own without the figures. You can state key numerical findings within the flow of the text, but do not include full numerical details of experimental findings; these should be placed in figures or tables. The figures and tables thus serve as evidence for, and illustrations of, the results described in the text. They enable the reader to verify that the statements of findings within the text are actually substantiated by the experimental data.

Excluded material. It is very likely that not all of the work you do will be included in your final written report. This does NOT mean that you wasted your time on this other material. Experiments that failed through no fault of your own, or experiments that succeeded but which do not fit into the focused theme of the report, will still contribute

positively to the assessment of your research performance, and you may want to mention them in an appendix.

In general, you should not attempt detailed explanation or interpretation of the meaning of your findings with the Results section; leave that for the Discussion. However, it can sometimes be difficult to banish all explanations of data from the Results section. The Results may describe a series of experiments, and the purpose of a later experiment can often only be understood in the context of the explanation of the findings of a previous experiment. So one has to use common sense in deciding what level of explanation needs to go into the Results section, and what should be postponed until the Discussion section.

Discussion

The Discussion section is where you round off your paper, explain what your findings mean, and place them in the overall context of the field. You will usually include a summary of your main findings near the start of your Discussion, but you should go well beyond this. When writing your discussion you should think back to the aims that you stated in your Introduction, and possibly explicitly (but briefly) re-state them, and then show to what extent your experiments have actually accomplished those aims. You must consider any shortcomings in your data or methodology, and, if possible, argue that these do not detract from your main conclusions. If your data are open to several different interpretations, you should consider these in turn, and then suggest which you think is the most plausible. You can discuss what further work could be performed to take the project to a more advanced stage, or to decide between possible alternative interpretations of your data. You can speculate on interpretations of your data that go beyond what you have actually demonstrated, as long as you make it clear that this is indeed speculation. You may want to end your Discussion with a succinct and pithy statement of how; hopefully, your findings have advanced knowledge in the field of your research.

Figures, Tables and Legends

Figures and tables provide the evidence that backs up statements made in the main text, but they do NOT substitute for the text itself. In other words, the main text should make logical sense to the reader without him or her having to actually look at any of the figures or legends.

All figures and tables must be numbered. Maintain separate lists for each (i.e. the first figure is Fig. 1, and the first table is Table 1). Maintain one number sequence throughout the Report: do not restart numbers in each chapter or section.

All figures and tables must be referred to by number in the text, following the order in which they are cited for the first time.. You can use a text style that either refers to figures explicitly, such as “The experiments illustrated in Fig. 13 show that many birds like to eat pretzels.”, or implicitly, such as “… many birds like to eat pretzels (Fig. 13).” Note that the latter uses fewer words! You should settle on one style and use it consistently, rather than swapping between styles. Make sure that the numbering of figures and tables reflects their order of appearance in the text.

Figures and tables should, if possible, be placed in-line in the text (rather than on a separate page) near to the place where they are first mentioned.

All figures and tables should have a legend associated with them. The legend is a short paragraph (maybe a single sentence) that allows the reader to understand

what the figure/table shows without reference back to the main text. The legend should include the key to any symbols shown in the figure (unless they are defined as part of the figure itself). If you are not sure about what goes into a legend, look at range of textbooks or research papers for examples.

A set of figures that are closely related (e.g. a series of graphs showing the effects of different concentrations of the same chemical) can be grouped into a single figure, with sub-section labels such as A, B, C etc. You can even have sub-sub-section labels (Ai, Aii, Bi etc) within the single figure. Avoid the redundancy of replicating between graphs and tables.

References

When you give a piece of information, or describe an idea in your Report, it will either be a result of your own work, or of someone else's. In the latter case, you need to decide whether you should give a reference for it. Some ideas or information come into the category of "general knowledge", and these do not need to be referenced. However, others are more specific, novel or detailed, and these should be referenced. If in doubt, reference! Direct quotations should *always* be referenced and included in quotation marks or, for longer sections, indented, to give a clear indication of what text is included in the quote. The point of referencing is to give credit where it is due (and thus avoid any accusation of plagiarism), and to allow the reader to follow up or verify the information that you give.

References come in two parts; a citation in the text placed at the point where the information or idea is first presented and a citation in the Reference List at the end of the Report where full bibliographic information is delivered.

Make sure there are no orphans: all citations in the text should also occur in the reference list, and *vice versa*.

You should use the **Vancouver referencing system** for your final report. A reasonably full description of this is found in the core textbook 'Practical Skills in Biology', or on many academic websites. A brief description follows.

Citation within the text

Within the text you only give the surname(s), date, and, if necessary, a letter qualifier for the date for each reference.

There are two styles; explicit and implicit - e.g. "As Smith (1999) proved, blue is better than red" (explicit), or "Blue is better than red (Smith, 1999)" (implicit). Either style is acceptable.

If you quote two or more references for the same topic, put them in **chronological** order: e.g. "Blue is better than red (Bloggs, 1879; Smith, 1999)", or "As shown by Bloggs (1879) and Smith (1999), blue is better than red".

If an author published two separate articles in the same year and you need to reference them both, use a letter qualifier with the date - e.g. "Blue is better than red (Smith, 1999a) but yellow is better than green (Smith, 1999b)". This letter qualifier is also used in the reference list at the end of the Report. However, make sure that you don't blindly copy the letter qualifier from a reference list given in a paper that you read, if you yourself only refer to one of the articles.

For a multi-author article, if there are two authors, give both names, e.g. "Smith and Jones (1999) showed ...", but if there are more than two, use *et al.*, e.g. "Smith *et al.* (1999) showed ...". In the reference list give the full list of all the names in multi-author papers.

If you are referencing work that you have not read personally, but have found referred to in a paper that you *have* read, use the format "(Smith 1988, cited by Jones 1990)". Put both references in the reference list. Don't do this more than you can help - it looks amateurish or lazy, and the author of the paper that you have read may be misquoting the paper that you have not read - this is a way that errors and misconceptions spread through the scientific literature. If the paper is a key paper, than you should definitely read it yourself, if necessary getting it translated from a foreign language (you should approach your supervisor if you think this is required).

Reference List

The reference list occurs near the end of the Report, and contains the full bibliographic information about the references. It must contain enough information for the readers to be able find and read the references for themselves.

There are standard formats that are used in the reference list by the Harvard system, depending on whether you are citing a journal article, book, book chapter *etc*. The most common of these are shown below.

Reference to a journal article:

Moon LDF, Asher RA, Rhodes KE and Fawcett JW. (2001). Regeneration of CNS axons back to their target following treatment of adult rat brain with chondroitinase ABC. Nature Neuroscience 4:465-466. (Note: journal names have standard abbreviations: e.g. the Journal of Experimental Biology is J. exp. Biol. You can use either the abbreviated form or the full form of journal titles, but be consistent throughout your reference list. If you are unsure as to the correct abbreviation for the title, then check at:
http://images.webofknowledge.com/WOK46/help/WOS/A abrvjt.html

Reference to a book:

Jones A., Reed R and Weyers J. (2003). Practical Skills in Biology. Third Edition. Pearson Education Limited. pp 41-46.

Reference to an article in a book:

Chalmers DJ. (1999). The Puzzle of Conscious Experience. In: The Scientific American Book of the Brain. Lyons Press. pp287-296.

Reference to a website:

Gilbert S.F. (1997). The embryological origins of the gene theory. http://zygote.swarthmore.edu/gene1.html. Accessed 15/06/04.

There are a large number of more obscure reference formats, and many of these are shown on the quoted website, but those above are the most common. If in doubt, look at the website, or ask your supervisor.

General Advice

Back up, back up, back up. IT has a horrible habit of letting us down at the most inconvenient time – always keep several copies of your work in different places.

Be as concise and clear as possible. Write in a formal scientific style, and avoid colloquialisms. Write the main body of the text in essay style, using proper sentences and paragraphs. Make the sense of the text flow, so that ideas follow each other in a logical sequence.

All abbreviations should be defined in full when first used, *e.g.* deoxyribonucleic acid (DNA).

Use sub-headings to clarify the organisation of the topic, but do not take this to extremes. Looking for section 2.1.3.a.iv is no fun at all!

Presentation does matter. The project mark depends in part on the overall quality of the presentation, including grammar, spelling and layout, and the aesthetic quality of figures.

If in doubt about a style issue, study a suitable published paper to see how a professional publisher has tackled it. Check with your supervisor about which journals to use as models. Be careful about copying the style of a previous Honours Report, which may not have scored highly on presentation quality!

Make sure that every sentence you write makes sense! This means that before you start to write the sentence, you have to be exactly clear in your own mind what it is that you are trying to say. This may sound obvious, but it is surprisingly easy to have a vague and ill-defined thought, that ends up as a vague and nonsensical sentence. Waffle and excessive verbosity will certainly not attract extra marks, and are more liable to irritate than impress the marker.

Proof read your work carefully before submitting it to eliminate typographical errors.

Help and Feedback on Writing your Report

Your supervisor can give you guidance and feedback on the materials and method and results sections, the introduction and discussion should be written without assistance. You should plan the overall structure, method of data presentation, scientific content and balance before you start writing, and you would normally do this in consultation with your supervisor.

You are advised to give your supervisor a full draft of these sections of your report at least two weeks before the submission deadline to allow adequate time for revisions. But do note that when supervisors make their assessment of the project, they will take into account how much assistance and revision was required. It is therefore advisable to submit drafts from which trivial errors have been eliminated. In particular, you yourself should make full use of spelling and grammar checkers within your word processor before giving the draft to your supervisor. Supervisors do not like acting as your unpaid proof readers!

Note: some supervisors may want to receive elements of your work at defined times in semester 2. So, be prepared.

Your supervisor should NOT be expected to completely re-write your Report. Instead, the supervisor will highlight examples of poor or good practice. They may provide a detailed critique of one page to serve as a benchmark for the remainder of the Report.

Remember the supervisor **should not be asked to comment on the Introduction or Discussion section** at all, as this should be all your own work. Your supervisor will give you general guidance on the lay-out, but it is *your* Report, so the intellectual input, particularly to the interpretation of data and the discussion, must be yours.

Technical Aspects of Report Production

Reports should be word-processed using a word processor that has a file format compatible with Microsoft Word (Word itself is the most likely program).

You should use double-spaced text (except for the Abstract and Legends, which can be single spaced if desired), and you should set left and right margins of no less than 25mm, to allow for

the binding spine and for markers comments. Text should be Arial or Times New Roman font. The main text should be 12-point size, although legends and appendices (if any) could be 10 point.

You may want to use the Style formatting facility within Word (you can define your own styles if you do not like the pre-defined styles). This ensures that text style is consistent throughout the Report, and it allows you to make rapid and global changes to style if you decide that a change is needed.

You are especially recommended to use Styles for your **headings** and **sub-headings**. This has two advantages. First, you can automatically generate a Contents page without having to worry about counting pages, and you can easily keep it up to date if you make changes to the text. Second, you can make use of the Outline View facility within Word, which greatly aids organising and re-organising the text. As with any computer-based activity, it is ESSENTIAL to keep proper back-up copies of material as you produce it. Computers can and do break, and they *always* do so at the most inconvenient times.

Printing and binding

Your report should be printed single-sided and bound using either the Unibind or Fabric soft spine method or something similar.

The University's Print & Design Unit is ideally set up to print and/or bind your report. You can send your material in PDF format (with a note of pages to be printed in colour etc) to: printanddesign@st-andrews.ac.uk and then they will be in touch when your job is ready. Price lists and further information from: www.st-andrews.ac.uk/printanddesign/

Please note that the Report will be bound in the exact page order in which it is handed in. It is your responsibility to check that all the pages are in the correct order and facing in the right direction.

Research report submission

You must also supply a DIGITAL version of your Report in **pdf format**, which you must upload this to MMS by the electronic submission deadline. This digital version will be analysed by Urkund. Once you have the final version of your report ready for submission, **save it as a pdf file** and upload it to MMS.

Two bound IDENTICAL PAPER copies of your project must be submitted by the hard copy submission deadline. One will be returned to you after the results are released, your supervisor keeps the other. Submit both to the TEACHING OFFICE (now in the BMS Building).

In addition, you should submit your study notebook to the TEACHING OFFICE with your Report.

Please note that your Report must be anonymised. This requires that you use your student ID number in place of your name on the front.

Guidance for supervisors

The following is not an exhaustive list, but it gives some of the key responsibilities of project supervisors.

The supervisor should have an initial meeting with the student to agree working practices, to outline the project and point to suitable initial background reading material or advice. Where

project work needs to be performed during the summer, such contact should be made at the earliest opportunity mutually acceptable for student and supervisor after project allocations have been made.

The supervisor is directly responsible for strategic aspects of planning, conduct, safety and guidance relating to the project. The supervisor must comply with any relevant risk assessment procedures.

At the start of the project the teaching office will provide each student with a standard bound study notebook, in which the student records and makes notes about their project planning, results and general progress. The supervisor should give guidance on appropriate record keeping, and periodically review the contents of the study notebook.

Early in the project the supervisor should discuss with the student a title for the Literature Review, and suggest an initial set of references. The supervisor should give the student reasonable guidance regarding the choice of submission type, the depth and breadth of coverage expected.

A student may expect to have ready access to assistance with daily routine matters, so that trivial problems can be resolved as quickly as possible. In addition, there should be regular supervisor-student contact, with a normal minimum of one discussion meeting per week. In the event that the supervisor is away for more than a very short period, a stand-in supervisor should be designated, and the Teaching Office informed (in addition to the normal procedures for authorizing absence from St Andrews).

Each student is responsible for the collection and/or analysis of their own data. Where practical work is involved, no two students should be sharing the experimental data they collect. In projects where students are required to work with preexisting data sets, they should not co-operate with others in such a way that these collaborations would generate similar sets of derived data.

The total number of hours that a student devotes to the project should reflect the fact that it accounts for one complete normal semester workload. The proportion of time devoted to the practical and analytical components of the project may vary considerably between projects and is at the discretion of the supervisor. Supervisors should bear in mind that students may have commitments to taught courses running at the same time as the project, and should manage the project accordingly.

The supervisor should take care to inform the student of any areas in which his/her performance is deemed unsatisfactory

Time commitments

The total number of hours that a student should devote to their research project should reflect the fact that it accounts for ~50% of the 'year' workload. Remember that students will also be enrolled on 4 x 15- credit taught modules some of which involve travel in the field. Moreover, since there is flexibility in when students undertake these taught modules, this will have a knock-on effect in how they plan their project.

Supervisors should therefore meet with their project students early in semester 1: to discuss working practices and a plan for the year, to provide a 'starter pack' of suitable initial references at this point or shortly thereafter.

At the start of the project the Teaching Office will provide each student with a standard bound study notebook, in which the student records and makes notes about their project planning, results and general progress. The notebook is used to record both positive and negative

aspects of the project e.g. they may record particularly interesting observations or thoughts, or technical problems/critiques.

There should be regular weekly supervisor-student contact. In the event that the supervisor is away for more than a minimal period, a stand-in supervisor should be designated, and the Teaching Office informed (in addition to the normal procedures for authorising absence from St Andrews).

Students must be made VERY AWARE of the importance of the submission deadlines. Extensions will not be given lightly.

Guidance on Assessed Tasks

Supervisors should help the students with planning the contents of their **Literature Review**, but neither supervisors nor any members of their research group should read or comment on any draft versions of this assessment.

The supervisor should give **feedback on the Literature Review** after it has been marked. The feedback form must therefore be completed by BOTH markers in a way that can be shared with the student as well as with the External Examiners. The aim of this feedback is to help improve the performance of the student in writing the research paper.

Supervisors should discuss the content and theme of the final **research report** with students before they start writing it.

You should discuss the overall theme, plan and layout of your research paper with your supervisor. You should discuss which sets of experiments should be included or excluded, and you should confirm that you are in agreement as to what the final "take-home message" of the paper should be. Such discussions may well result in the production of mind-maps, bulleted lists, outlines etc.

Your supervisor will provide feedback on ONE draft of the Materials and Methods and the Results section. You should NOT ask your supervisor or any other member of the research group to comment on any draft of the Introduction or Discussion sections of your paper.

All papers will be checked for any evidence of plagiarism, and any such evidence could result in disciplinary action

Supervisors should read and comment on the Materials and Methods and Results sections only. The supervisor should not completely re-write any section of the Report. Instead, the supervisor should highlight examples of poor or good practice. They may wish to provide a detailed critique of one page to serve as a benchmark for the remainder of the Report. The supervisor will point out any generic errors in style or content, giving specific examples to illustrate. The student is then expected to apply this advice in re-drafting their work and generating their final submission

Once the student has uploaded to MMS the electronic version of their report, **the supervisor should use Urkund to detect plagiarism**. She/he is responsible of scrutinising the Urkund reports (as opposed to just the scores) and certifying that this has been done using the Assessment form. If plagiarism is an issue, then the supervisor should notify the module organiser (oeg) immediately.

Supervisors can help students prepare for their **oral examination**, both by advising on the planning of the presentation section and by discussing any questions that might arise in the examination.

Finance

Where appropriate, the School will, through your supervisor, bear costs that are essential to your project. This may include such costs as obtaining articles by interlibrary loans, and photography intrinsic to the project, or essential travel costs. It will NOT include the costs of Report preparation and binding. Discuss possible expenses with your supervisor well before you spend the money, to make sure that your supervisor agrees that the cost is reasonable.

Travel expenses can be claimed through the Main School Office; next to the Teaching Office.

What to do if things go wrong!

First and foremost, don't panic! All research suffers set-backs at one point or another. Your supervisor is the first port of call: be honest about your concerns. Your Honours Adviser/Degree Controller is the main person to contact with general questions not related to your project but relating to your overall performance and progress and your future plans. If for any reason you are not happy talking to your Adviser or your supervisors, then any other member of staff will be happy to help.

If you experience any problems with your project that you feel are not being adequately addressed by your supervisor you should consult your Advisor of Studies and/or the Module Coordinator. The Director of Teaching will always be informed through the Module Coordinator of any major problems.

Extensions

Extensions to the deadlines are only granted in EXCEPTIONAL CIRCUMSTANCES. In general, you MUST meet the deadline, even if it means handing in a piece of work that is not finished to as high a standard as you would wish. Do not let the best be the enemy of the good (or even the adequate) if it means risking missing the deadline!

ONLY the Module Coordinator can authorise an extension to the project deadline.

If you think that you have a legitimate reason why you cannot complete the project in time, you must apply for an extension BEFORE the deadline. To apply for an extension, you must (a) discuss with your supervisor how long an extension you will need, AND (b) arrange a meeting with the Module Coordinator to explain the situation and get authorisation for the extension.

Ethical Statement

All projects involving humans or vertebrates and cephalopods require ethical approval http://biology.st-andrews.ac.uk/committeepageset.aspx?gc=BIOETHICSCOMMITTEE

Unless your project is part of previously approved ongoing research you will need to complete an application as soon as you know how your project is going to be run. It can take up to 2 months to get ethical approval so you should do this early in the process.

Health and Safety guidance

A booklet, containing the Health and Safety Policy of the School, is available http://biology.st-and.ac.uk/documents/HealthandSafetyPolicy Manual 11 2013 all.pdf

It is the duty of the Academic Supervisor, as well as your own, to ensure that you are aware of its contents, especially in so far as they affect your work activities, and that you work safely at all times. You may obtain a copy of this Policy from the School Safety Officer Donna Pierz-Fennell.

ALWAYS ASK IF YOU ARE IN ANY DOUBT ABOUT THE HEALTH AND SAFETY POLICY OF THE SCHOOL.

PLEASE inform your supervisor of any special needs, disabilities, or health problems that you have that may affect your safety during the project. It is important that both you and your supervisor are aware of any possible problem to avoid adding to the range of hazards that exist in research work and to avoid creating risks for others.

Out-of-hours laboratory work by undergraduates is not normally allowed unless performed under the on-site supervision of a member of academic staff. Under some circumstances the supervisor may nominate a postdoctoral worker, postgraduate student or technician to provide supervision. In such cases, the nominee should be given a thorough briefing on all aspects of safety relating to the work. Before out-of-hours working begins the nominee should be given a copy of a nomination form and a duplicate sent to the director of teaching.

It is your duty to make sure that you follow the Health and Safety Policy of the School and any Health and Safety instructions given to you by your Academic Supervisor/Laboratory Manager/Laboratory Demonstrator.

References :

https://workspace.imperial.ac.uk/lifesciences/Public/teaching/ug/biology/life sciences marking criteria 2013 2014.p df

http://www2.ph.ed.ac.uk/~muheim/teaching/sh-projects/SH-Grade-Descriptors.pdf