

# Science Research Projects

## Final Report Guidelines

(2010-2011)

The following has been adapted from *Writing Lab Reports and Scientific Papers* by Warren D. Dolphin, Iowa State University. His work can be found at [www.mhhe.com/biosci/genbio/maderinquiry/writing.html](http://www.mhhe.com/biosci/genbio/maderinquiry/writing.html)

---

Communicating scientific findings requires a particular format and writing style to be useful to the larger scientific community. After experiments are completed and duplicated, researchers attempt to persuade others to accept or reject their hypotheses by presenting the data and their interpretations. The scientific paper is the primary vehicle of persuasion; when it is published, it is available to other scientists for review. If the results stand up to criticism, they become part of the accepted body of scientific knowledge unless later disproved.

In some cases, a report may not be persuasive in nature but instead is an archival record for future generations. For example, testing of well water for arsenic occurring over a period of time may, in the future, be useful in deciding whether arsenic concentration varies with time. Regardless of whether a report is persuasive or archival, the following guidelines apply. There is general agreement among scientists that each section of the report should contain specific types of information.

Part of the goal in this project is to allow others (from CV classes or outside researchers) to utilize your work and build from it. To insure this, you need to convey your information in a certain manner. Use the guidelines listed below when completing your final paper that summarizes your work over the course of the year. Please include the headings for each section in your paper.

---

### Title

The title should be less than ten words and should reflect the factual content of the paper. Scientific titles are not designed to catch the reader's fancy. A good title is straightforward and uses keywords that researchers in a particular field will recognize. When considering a good title, consider key words that someone doing an abstract search might use that might bring up your paper as they do a search.

### Abstract

This should be a summary of *all* of the sections below. It should be one paragraph of around 100 - 200 words. Usually, this is indented or otherwise set off in some fashion from the rest of the text of the report. In this section, you want to include a brief statement of your findings and conclusions. You want to "give away" the important stuff to the reader. Most readers will first look at the abstract to determine if reading the rest of the paper is necessary for their own purposes.

### Introduction

In this section, state what your research question is. The first sentence is often a brief, concise description of your question (for example, "The goal of this study is to characterize the arsenic concentration of soil along Ames Creek Road in Sweet Home, Oregon"). This should be followed with supporting sentences that add details (for example, "The goals were to map out existing distributions from past studies; identify additional sampling sites needed, collect additional samples, and analyze these samples using neutron activation analysis at the OSU reactor. The data was entered into a GIS database that will allow further studies to improve the characterization of arsenic over time").

This section should include background information – several paragraphs that answer the questions "what scientific research has already been done regarding this study and why is this study worthwhile"? Think about the following questions when writing your background information. A complete introduction will answer all of these:

- *Why is the study being performed in the first place?*
- *What can existing scientific research tell you about the factors you are studying? What knowledge already exists about your subject?*
- *What isn't already known about your subject and how does your research attempt to fill holes in our understanding?*
- *What justifies the procedure and methodology you used during your research? Has anyone else done an investigation in a similar fashion? What, from your background research, has led you to the procedure you use in your project?*
- *Why might the answer to your question be valuable to scientists and others? For example, would city planners, neighborhood associations, other schools, or youth groups be interested in the information you find? Don't get carried away here however. This should be a minor portion of this section of your paper.*

It is common for students to miss the point of this section of a paper. The purpose of this section is NOT to discuss the history and development of solar panels (if you are doing research associated with solar panels). Rather, in this section you are presenting a case for your investigation – the way you intend to use the panels, how the way you are testing them is valid, why your methodology is sound, why your study is needed, etc . . . .

Your background information should include citations, properly formatted, from other researchers and publications that you have obtained information from during your background research phase of your project. If done well, this part of your introduction will be at least 2 pages long.

Finally, this section should include a hypothesis. Your hypothesis should explain *what* you expect to see and *why*; for example, "... a direct correlation between arsenic concentration in bedrock and in adjacent soil is expected. Past studies have shown a strong correlation in other regions (Kirsch, 1997)". Your statements should be backed by citations from your background research as was done here.

## Methods

As the name implies, the materials and methods used should be reported in this section. The difficulty in writing this section is to provide enough detail for the reader to understand the experiment without overwhelming him or her. When procedures from a lab book or another report are followed exactly, simply cite the work, noting that details can be found in that particular source. However, it is still necessary to describe special pieces of equipment and a general description of the process used. This can usually be done in a short paragraph, possibly along with a drawing of the experimental apparatus. Pictures are often a critical component here. **You should include enough information that someone from another class or another school could duplicate all important aspects of your project** without needing to ask you questions, but you should take care not to include details that would not make a significant difference in the results someone else would expect to get. For example, it might be critical to note mounting angles and total area of a solar panel – but it would not be important to specify the brand of multimeter that was used to measure electrical output.

Generally, this section attempts to answer the following questions:

- *What materials were used? How much of each?*
- *How were they used?*
- *What equipment was needed?*
- *Where and when was the work done? (This question is most important in field studs.)*
- *How many trials were carried out?*
- *What was the reasoning behind the methods used in your project?*

Remember, your findings will need to be verified by others if it is to become a part of our larger body of accepted knowledge. **Again, it is essential that this section contain enough information so that others can repeat your investigation in every detail without needing to ask you about it.**

## Results

The results section should summarize the data from the experiments *without discussing their implications*. Many authors organize and write the results section before the rest of the report. This section should include a verbal and numeric summary of your data. This section of your report should concentrate on general trends and differences and not on trivial details. The data should be organized into tables, figures, graphs, photographs, and so on. But data included in a table should not be duplicated in a figure or graph. Most of you are looking at correlations. Correlations are best shown via a linear regression as illustrated in class using Microsoft Excel with appropriate measures of scatter. This section should include any existing correlation as well as the statistical characteristics to indicate the degree to which the two variables correlate. In this section the fitted line as well as the  $R^2$  value should be provided.

All figures and tables should have descriptive titles and should include a legend explaining any symbols, abbreviations, or special methods used. Figures and tables should be numbered separately and should be referred to in the text by number, for example:

Figure 1 shows that the activity decreased after five minutes.  
The activity decreased after five minutes (fig. 1).

**Figures and tables should be self-explanatory**; that is, the reader should be able to understand them without referring to the text. All columns and rows in tables and axes in figures should be labeled.

DO NOT SIMPLY LIST DATA WITHIN THE TEXT OF YOUR PAPER. Your data should take the form of both RAW data (the original measurements and calculations you wrote down on your data sheets) and COMPILED data (smaller spreadsheets that show only average values and other calculations).

Along with your data tables, this section should include a detailed description of your results. Include a narrative of your activities (on a day to day basis, if necessary) along with periodical observations. DO NOT DISCUSS ANY CONCLUSIONS IN THIS SECTION – THIS IS FOR THE NEXT SECTION. DO NOT DISCUSS WHAT THE  $R^2$  VALUE MEANS OR COMMENT ON THE RESULTS OF A T-TEST IN THIS SECTION.

## Discussion

This section is the most important part of your report. You should draw conclusions and generalizations from your study, point out any errors or exceptions that you have observed, and discuss any practical and theoretical implications of your work. In general, any experiments you have done will not *prove* anything; they will simply provide evidence for a position. In fact, DO NOT use the word “prove”, or any altered form of this word in your paper. In science, when dealing with the real world, you can never “prove” anything. As such, **all of your statements should be backed by statistical evidence** wherever possible. For example, instead of saying “...the results show that non-native plants require more nutrients than native plants”, write “...the results suggest that non-native plants require more nutrients than native plants ( $p=0.03$ ).

In your discussion, make sure that you address the following questions:

- *What, according to your data, was the answer to your question?* In other words, was your hypothesis correct?
- *Why did you get the results you did?* This question should be answered through additional research. *What else might explain your results?* Your goal is to explain the scientific causes that might generate the results you saw. You cannot be certain about the reasons you propose when answering this question; instead, each reason you suggest might be the basis for a future scientific experiment. You should list at least two possible explanations that explain why you obtained the results you did THAT ARE OTHER THAN THE VARIABLES YOU PURPOSEFULLY ALTERED AND CONTROLLED. Each reason should be backed by scientific research. THIS IS AN IMPORTANT PART OF THE DISCUSSION – SPEND SOME TIME HERE.

- *What other factors might have been responsible for the results you obtained as opposed to the independent variable you controlled? What other conclusions, beyond testing your original hypothesis, are you able to make given your data and your experiences?*
- *How can the study be improved? In other words, what advice would you give to future groups if they wanted to duplicate or extend your study?*
- *What are the next logical steps in your study if it were to be continued? What are you still uncertain about?*

## Literature cited

This section lists all articles, books, or other sources cited in your report. It is not the same as a bibliography, which simply lists references regardless of whether they were cited in the paper. The listing should be alphabetized by the last names of the authors. Use the APA citation format as described on the link on the CV Library's web page. Your paper is to have, at minimum, citations from five different peer-reviewed articles that you either obtained during your original background research or later.

---

## General Comments on Style

- **Avoid using the first person, I or we, in writing.** Keep your writing impersonal, in the third person. Instead of saying, "We weighed the frogs and put them in a glass jar," write, "The frogs were weighed and put in a glass jar."
- It is better to be concise and to the point rather than wordy and colorful. Readers will be interested in your paper for its *content*, not for your creative writing skills.
- Minimize text whenever possible. However, you must clearly communicate your information and be complete at the same time.
- All scientific names (genus and species) must be italicized.
- Use the metric system of measurements. Abbreviations of units are used without a following period.
- Numbers should be written as numerals when they are greater than ten or when they are associated with measurements; for example, 6 mm or 2 g but two explanations of six factors. When one list includes numbers over and under ten, all numbers in the list may be expressed as numerals; for example, 17 sunfish, 13 bass, and 2 trout. Never start a sentence with numerals. Spell all numbers beginning sentences.
- Be sure to divide paragraphs correctly and to use starting and ending sentences that indicate the purpose of the paragraph. A report or a section of a report should not be one long paragraph.
- Every sentence must have a subject and a verb.
- Avoid the use of slang and the overuse of contractions.
- Be consistent in the use of tense throughout a paragraph--do not switch between past and present. It is best to use past tense. Use active voice where possible.
- Be sure that pronouns refer to antecedents. For example, in the statement, "Sometimes cecropia caterpillars are in cherry trees but they are hard to find," does "they" refer to caterpillars or trees?
- YOU MUST WORD-PROCESS YOUR REPORT.
- PROOFREAD!!! Have someone else (your parent) check it. THIS IS IMPORTANT!