Lab Reports

Lab reports and all scientific writing are generally written in the past tense. The information is objective and written in a way that is short and concise. Personal pronouns should be avoided in most cases unless the teacher specifies that they do not mind them. The entire experiment should be repeatable from the information given and unless there were errors, the results should be the same. All of the conclusions should be supported with data from the results. All teachers have specific methods that they like their students to follow and this is usually handed out, explained in lab, or on the course web site. Most teachers divide a lab into the following categories: Title, Introduction, Results, Discussion, and References. But again, everyone has their own preferences.

Title

A title is important to any lab report and it must be clear and specific. It summarizes the purpose of the lab. It is never a good idea to use the title from the lab manual. An example title might be "Finding an Unknown Dilution by Measuring Optical Density of Serial Dilutions."

Abstract

The abstract clearly and concisely summarizes information presented in the lab report. Generally no more than 250 words, it consists of a sentence or two from each section of the report. Although it should be concise, it is important to include enough transitions to create a logical thread that the reader can easily follow. It should include a brief description of the purpose of the study, what question is being addressed, and enough methods to simply outline the approach. Results can include numerical data if desired (although must be limited) in order to support statements of the overarching conclusions. Keep in mind that the abstract should be able to stand alone. It is also often written last, after the rest of the report is complete.

Introduction

The introduction includes the purpose of doing the experiment, background information needed to understand the experiment or procedures, and at least one hypothesis that makes an educated guess from the background information. Any important definitions that are needed to understand the experiment should be found in the introduction.

Method and Materials

This section is a summary of the procedure that includes all measurements and equipment used. The experiment should be repeatable from the information given. The method of how data was analyzed should also be explained. The information should all be in past tense and written in paragraph form instead of lists or bulleted items.
**Results**
The results include all data found, observations made, figures, tables, charts, and graphs. All charts, graphs, figures, and tables are kept separate and referred to in the results when they are being explained. The results are explained in this section, but they are not interpreted.

**Discussion**
This is the most significant section of the lab report. The results are analyzed and related to the hypothesis and purpose. They are compared to what was expected and any differences should be explained. The writer should go in deeper and explain what these findings have to do with the bigger picture of life as a whole. All weaknesses or errors in the experiment, including human error, are mentioned and it is explained how they had an impact on the results. Even if the experiment failed, the lab report can be saved by explaining the errors, showing what they did to the results, and explaining what should be done differently next time to prevent this failure. Further questions on the subject or improvements in the lab should be mentioned in this section.

**References**
Any sources used in the lab report should be cited in the report and then documented in the references. These sources might include the lab manual, textbook, or some other source used to write the background information in the introduction. Any information that is not common knowledge should be cited. Generally, students use APA format for citations and references and teachers do not usually have any preference as long as you’re consistent.

**How to Approach Writing a Lab Report**

1. Begin with the Materials and Methods section. This is a good section to begin with because it just involves detailing the steps that were taken in doing the experiment. Some things to remember when writing this section are that subheadings should be used for easy reference and that you should state the reason for doing something if it is not obvious.

2. After the Materials and Methods section the Results section can be written. By writing the Materials and Methods section first, it is easier to order the Results section based on when data was collected. When writing the Results section keep in mind that the goal is to summarize the data. Therefore, things like how and why the experiment was formed and a discussion of the quality of the results and what they mean should not be present in the Results section. Any verbalization of the results should be a summary that draws attention to key points in figures. Therefore, it is best to create the figures first and then go back and verbalize the results.

3. After writing the Results section the Discussion section can be written. Considering the fact that the Discussion section is an examination of the results in relation to expectations about how the experiment would turn out, it makes sense that this section can only be written after the Results section. In this section the expectations should be stated with supporting references and then the results of the experiment should be analyzed in relation to the expectations. Reasons for unexpected results should also be offered.
4. After the bulk of the lab report has been written the student can go back and write the Introduction section. It is best to save this section for the end because the introduction gives an outline for the entire lab report in addition to giving background information about the topic. In other words, the introduction outlines the issues that will be examined in the rest of the lab report and, because of this, it is easiest to save this section for near the end. While writing the introduction keep in mind that you should state the problem or question and then include factual details that are supported by references.

5. After all the other sections have been written it is possible to write an Abstract. If an abstract is to be included it should be saved for last because an abstract summarizes in a single paragraph the content of the entire lab report. Therefore, it is easiest to write this section last after you know what the lab report contains. Keep in mind that abstracts are typically written in the passive voice and that they should be informative enough so that a reader can decide if it would be in their best interest to read the report after reading the abstract.

6. After all the other sections have been written, a Reference section can be included based on what sources were used throughout the lab and a Title should be included. The specific format for references depends on the TA. Therefore, students should consult their TA for specific formatting instructions. Titles should be descriptive and give some insight into what your experiment was about specifically.

**Guidelines for Lab Reports**

- Instructions for lab reports will vary slightly according to your professor and TA; make sure to follow the guidelines specific to your lab.
- Lab reports are traditionally written in the third person; however, many biology courses today require that you use the first person for the sake of clarity. For example, “We measured the diameter of the pellet” as opposed to the passive 'The diameter of the pellet was measured.” Always check with your professor or TA for his/her preference.

**Title**

- Should be a succinct, specific description that summarizes the experiment.

**Abstract**

- Single paragraph
- Summarizes five key points, which are representative of the parts of a lab report:
  - why the experiment was conducted (introduction)
  - the problem being addressed (introduction)
  - what methods were used to solve the problem (materials/methods)
  - the major results obtained (results)
  - the overall conclusion from the experiment as a whole (discussion)
• **Tips:** The abstract is brief, it is comprehensive but as efficient as possible. Five or six sentences should suffice. Write it last, using the rest of your report as a base from which you can condense the salient points into an extremely concise summary of the entire lab report.

**Introduction**

- Outlines the purpose of the experiment
- Asks the question: why is the study important?
- Uses background information to validate and expand on the importance

**Tips:** Depending on the course level, the introduction can be rather lengthy. There is often an extensive amount of background research involved; one of the main purposes of the introduction is to really show your TA/professor that you understand the implications and consequences of the experiment, and you're expected to do this through your background research. *See Works Cited.*

**Method and Materials**

- Detailed step-by-step account of the procedure

**Tips:** This part of the report is often hard to gauge; a general rule of thumb is to include enough detail so that a fellow biologist could exactly replicate the experiment. There should be no extraneous or subjective detail. Depending on your guidelines, the materials/methods section can often be presented as a bulleted list.

**Results**

- Systematic presentation of data; includes all relevant findings that contribute to the final conclusion
- Data is presented in whatever form is most appropriate, such as graphs, figures, tables, etc.
- Each set of data is numbered (Figure 1, etc.), labeled, and followed by a short explanatory paragraph

**Tips:** This is not a discussion of the experiment; it is an objective layout of your data. There should be no analysis of the results.

**Discussion**

- Interpretation of results: What did the experiment demonstrate?
- Compare and contrast expected findings with actual findings
- Explanation of unexpected results
**Tips:** Your results never "prove" anything; they only ever "support" the hypothesis. Be careful with scientific vocabulary. The discussion section, like the introduction, is another crucial place to demonstrate your grasp of the material; it's important to be thorough, but equally important to avoid excessive or irrelevant information.

**References/Works Cited**

- Alphabetical list of sources used

**Tips:** Whether or not you even have a works cited/references section depends, once again, on the level of the biology course. In upper level courses you are often required to have several outside sources, which provide the background information found in the introduction. These sources are usually from scientific journals; see below for two sample citations.


—Kristen McClaran

**Terminology**

**Terms and Language often used in Biology Lab Reports**

Affect vs. Effect: affect is a verb; to produce a change in or impact results. Effect is a noun; describes the observed change or impact on test groups or results.

Analysis: study and examination of results and what they mean

Calculations: processing of raw data to show patterns or summary statistics

Control: test group that is not treated with any variable

Consistent: describes data or results that show little variation or align with an explanation

Correlates: describes a relationship between variables that change or occur together

Data: (plural) information, qualitative or quantitative, gathered for experiment; process of gathering discussed in methods section

Experimental Error: addressed in discussion section; possible explanations for unexpected results; areas where inaccurate measurements or observations may have been made
Factors: often used in discussion to describe things that might affect some result or observation

Observations: notes or record of events that may have occurred during experimental process

Procedure: series of steps or methods used throughout experiment to collect and process data or observations

Purpose: what did you hope to achieve from this experiment? more general than hypothesis

Significant: description of results that are relevant to hypothesis; can either support or refute. Statistically, significant values have a p-value less than 0.05.

Support/Refute: terms used to state whether or not results would be expected if the hypothesis were true; CANNOT prove or disprove hypothesis (never 100% sure)

Trial(s): number of times the experimental procedure was repeated to produce more results

Variables: experimental elements that are being observed; often expected to see some difference between control and variable groups

Sample Lab Report

Sample Lab Report:

“Assessment of Natural Selection Acting Upon Individual Characteristics of the Precis coenia Butterfly” is a lab report written for BCOR 012 Exploring Biology. This lab report received a grade of an A-. The assignment was to write a full-length laboratory report on an experiment that was done in class. It was to include all the necessary components of a laboratory report: title, abstract, introduction, methods and materials, results, discussion, and works cited. The report includes all necessary methods to recreate the experiment, all results and conclusions drawn from these results, two figures, and the use and citations of outside sources. In a laboratory report the sections are usually separated. In the lab report you may see sentences that are deleted and replaced with ellipses (...). This is to discourage plagiarism.

Sample Lab Report:

“The effect of intraspecific competition on Paramecium micronucleatrum population growth,” a lab “The effect of intraspecific competition on Paramecium micronucleatrum population growth” is a report written for BCOR 012 lab in 2014 that is based on a similar experiment to that of the second Sample Lab Report. It received an A-. The experiment was conducted during lab time and required a full report (worth 50 points) with an extensive list of requirements provided by the TA (found at the end of the sample). Although similar to the second report, it illustrates the range of variability in approaches to lab reports. It includes all of the standard sections, formatting,
Sample Lab Report:

“Impact of Sodium Chloride on Yeast Fermentation” is a lab report written for BIO 001 in 2015. The assignment received a grade of A- (93). All expected lab report sections are included except an abstract, as this is typically not required in BIO 001. The report also includes a supplemental data section, as it was required for the report. Comments have been made in each section and on critical points in order to best explain the intent behind how each section was completed. This report is not perfect, and is meant to be used as a general example. A grade of A- was given rather than an A because of a lack of detailed explanation in the results section. Expanding on and adding to the key points in this report using your professor’s or TA’s guidelines and suggestions is recommended.

Using the Lab Manual

Your lab manual itself can be very helpful in writing each section of your lab report.

The Introduction and Conclusion

The lab manual can contain a lot of background information that relates to your experiment. Use this to your advantage. Though you should avoid directly taking information from the lab manual, you can highlight relevant or important information from the lab manual text that you could use in your introduction or conclusion sections. You can then look in online journal databases for relevant journal articles that describe that information. Often citations for possible sources are listed in the lab manual itself, so it is best to look here first.

The Methods Section

Lab manuals are the best reference sources for writing the methods section in a lab report, often containing step by step instructions for how to perform your experiment. When writing the methods section, you can follow along the lab manual’s instructions, but instead of simply copying the bulleted or number steps into paragraph form, you should try to synthesize information. Try to paraphrase or combine several steps into one sentence and sift through whether information in the lab manual is relevant for an actual lab report (hint, not all of it is!).

Example:
The lab manual states:

4. Add 2 ml of the bacterium culture into the test tube with a Pasteur pipette.

5. Centrifuge the test tube for five minutes. Then remove the test tube and place it in an ice bath for three minutes.

6. At the end of 3 minutes, pipette the supernatant into a separate test tube and record the color in Table 2.

This could be summarized in the following manner:

Two milliliters of the bacterium culture were added to a test tube and then centrifuged for five minutes before being placed in an ice bath for three minutes. The resulting supernatant was then pipetted into a separate test tube and its color was recorded.

**Using Tables**

If the methods section in the lab manual describes a series of trials using varying amounts of different chemicals or solutions, consider creating a table in your lab report with this information, especially if the lab manual itself presents it in a table. This will make your methods section flow much more smoothly. If you do end up creating a table, be sure to reference it in your writing.

**Example:** Three trials were performed with varying quantities of Solution A, Compound B, and Mixture C (Table 1).

**The Discussion Section**

The discussion section is where you typically expand upon your results, interpreting them and relating them back to your hypothesis, and then describing how they connect to the greater scientific field. The post lab questions, if available in the lab manual, are good guidelines for topics to explore in the discussion section. These questions will help guide your analysis of your results towards specific topics or overarching ideas that your TA (and professor) are expecting you to explore at the end of your lab report. Often they will be required! These questions can
also give you a good sense of how to relate your results to the broader scientific community (and a potential theme for a possible required outside resource).

Professor Tips

Here are a few comments about scientific writing according to Lisa Emerson, a Fulbright Scholar who studies the role of scientists as writers.

- While scientific writing is most often referred to as written in the passive voice, a lot of the literature in most scientific disciplines is written in the active voice. The only part of a lab or research report where it is absolutely necessary to write in the passive voice is in the materials and methods section, because what matters is not who did the procedure but rather how it is done. Students should check whether to use active or passive voice in the rest of their report with their professor.

- One of the most important aspects of scientific writing is conciseness. Although it might be tempting to construct beautiful, flowing paragraphs, brevity is of the utmost importance while writing a lab or research report. In addition, the structure relies on a compressed frame of diagrams, graphs, and tables, indicating the need for providing a myriad of information in a concise manner.

- A scientific lab or research report is written in deductive paragraphs within an inductive structure. Contrary to numerous scholarly works that state a clear thesis in the beginning, lab or research reports usually start with a situation and end with the significance after the details are accurately presented.

- Writing a lab or research report is more like writing a detective story than one would think. In a sense, the introduction outlines a dilemma and poses a question, the body observes the clues, and the conclusion presents the answer, much like solving the mystery. A lab or research report holds a sense of persuasion, starting from the hook in the introduction. The details within must present enough evidence to support those details in the results and inference in the discussion.

- All scientific writing must tell a story from the introduction to the discussion. This story is not about the scientists themselves. Instead, a lab or research report tells a story about science, outlining the relationship between the scientists’ story and a bigger scientific phenomenon. When beginning to write a lab or research report, it is often helpful to ask, “What is the story and what is the evidence that will construct that story?”

Interviewer: Shannon Lozito
General Tips for Writing in Biology
(from BCOR 102 TA, Judith Keller)

• Biological writing does not have to be lengthy to get a point across. Often a straightforward, concise statement is more well-received than an entire paragraph elaborating on the same thing with superfluous sentences.

• When writing numbers in a lab report, always include zeros before the decimal point (for example, 0.05 instead of .05). As a general rule, when you start a sentence with a number, the number should be written out, whereas if it is used within a sentence, it is okay to use the numerical format (for example: “Seven galls were dissected and analyzed.” “There were 12 different kinds of insects found.”)

• Read a journal article in your specific subject area to learn more about writing in that field. For example, if you are writing a report about moose populations in Vermont, look up an article in the journal Ecology. All journals have a “to the authors” section on their websites which give specific instructions on what to include in sections and in what order things are usually presented. This can be helpful in organizing your thoughts and getting you used to a particular writing style. This section can also provide helpful hints on how to make tables and figures visually pleasing.

• If you want to become a good writer in your field, read, read, read! The more subject appropriate literature you read, the more apt you become at adopting scientific writing styles.