Lab Report “How To”

Lab reports are different than things like term papers and book reports that you might write for useless and unimportant classes like English or Social Studies. Before we grind away at the details, here is a list of some COMMON MISTAKES:

1. Inadequate title. For example, “Osmosis Lab” offers little info about the content of the report.
2. Use of a table of contents at the beginning; not appropriate for a lab report.
3. Beginning each separate section (Introduction, Discussion, etc.) on a new page. Save paper; skip two lines and start the next section.
4. Writing in the style of a lab manual. For example, “First pour 1 mi. of water in a small beaker, then add 2g. of potassium chloride.” A lab report does not give instructions, it reports on what was done.
5. Beginning the Methods and Materials section with a list of equipment. This is also something you will see in a lab manual, but not a lab report.
6. Information is placed in wrong sections of the report. For example, Results are often put in the Methods and Materials section (We took the solution’s temperature and it was 80° C).
7. The Results section includes only a table and/or a graph with no accompanying text.
8. There are no references in the text to the accompanying tables and figures. (Figure 1 shows...).
9. Tables and figures are not numbered consecutively.
10. There are no literature citations in the text, or footnotes (like in a term paper) are used instead.
11. Listing references that are not actually used in the report.
12. Improper English such as misspellings, incomplete sentences, punctuation errors are present.
13. Handwritten. LAB REPORTS MUST BE WORD-PROCESSED!!

Now let’s get down to the nitty gritty.

Always keep this in mind – you are writing this report to tell other people what you did in your experiment or research; a big part of the process of science is sharing your findings with others so we can build on each other’s work. These people aren’t in this class, so they didn’t do this lab you are reporting on, so everything you write needs to be understandable to them (not to you or me – we know what the lab was about). Your report needs to be SELF-explanatory; in other words, it can stand alone so they don’t have to hunt you down and pester you with text messages to find out what you meant by the solution (“a 0.2M sucrose solution” is self explanatory, the word “the” isn't).

You need to use proper English; spelling, punctuation and grammar count. I don’t want anyone to read your report and wonder “who was this kid’s teacher; why do they keep writing “preformed” when they mean “performed”?”.

PROOFREAD. Don’t rely on spellcheck; it can’t tell “weigh” from “way”. Read it and listen to see that it says what you want it to say. Better yet, listen with the ears of a person who wasn’t in the lab and see if it sounds self-explanatory.

Write plainly and clearly; get to the point and don’t try to impress the reader with your latest vocab words from AP English (don’t use “plethora” for example). While it has already been stated that you should be reporting what you did and not telling someone what to do (like a lab manual would), your writing should be clear enough for them to be able to repeat the experiment if they wanted to.
Your report will be arranged in the following standardized format:

- Title
- Introduction
- Methods and Materials
- Results
- Discussion
- Conclusions
- Literature Cited

The section headings are always centered on their respective pages (except for Title; you won’t put the heading Title, just put the Title to the paper). DO NOT begin each section on a new page, but, DO NOT have a section heading as the last line of a page with the body of the section starting on the next page. Note, too, that a research report DOES NOT have a table of contents. Now let’s look at each section in more detail.

**Title**

The most important thing about a title is that it must be SELF-EXPLANATORY; the reader should be able to tell, just by reading the title, what you have done without having to read the paper itself. This helps them decide whether or not the paper is of interest to whatever it is they are researching; and saves them a lot of fruitless searching. A title such as A Biology Lab Report, for example, tells the reader nothing. They have no idea whether your study involved a plant or an animal, or what you were measuring or testing. Effects of Environmental Factors on Organisms is a little better, but still not SELF-EXPLANATORY. What effects, what factors and what organisms would be the three questions that this title falls short of identifying. Effects of Environmental Factors on Growth of Rana pipiens would tell the reader what effect was being measured (growth) and what organism was being tested (Rana pipiens), but not which factors were being tested. A title such as The Effects of Light and Temperature on the Growth of Rana pipiens would answer ALL those questions and would therefore be SELF-EXPLANATORY.

Here, then, is what a SELF-EXPLANATORY title includes:

1. The independent variable
2. The dependent variable
3. The subjects

You will see that the title of a Table or Figure is also going to include these three things, so try to let them sink into the long term memory. This way of writing titles actually makes them easy to compose – you simply need to correctly identify the two variables and the subjects and then use your language skills to work them into something that sounds like a title. Notice that such titles are not short like a book title, but don’t make them too long either; they should not be a full sentence such as This Experiment Shows How Light and Temperature Effect the Growth of Rana pipiens. This is a descriptive sentence, not a title. One exception to the above is if there are so many variables that naming them all would make the title so long that it was awkward. For example, if testing the effect of 12 different chemicals on plant growth, it would be acceptable for the title to be something like The Effects of Various Chemicals on the Growth of Zea mays. The same would apply if you were testing several types of subjects. Use your judgment, but always remember the golden rule – titles must be SELF-EXPLANATORY.
Introduction

The Introduction is the statement of the problem and contains some background information concerning the problem. If appropriate, a hypothesis is also stated in the Introduction. If this was your Nobel Prize attempt, the Introduction would have an extensive literature review, but we are going to keep it short and sweet. State the purpose of your lab, that is, state what specific question you are trying to answer. “What should this statement include?”, you ask. Interestingly enough, it should include the independent variable, the dependent variable and the subjects. Sound familiar? It can actually be a lot like the title of your paper if you made the title into a question. Add just a few more descriptive statements, then attempt a hypothesis. Your hypothesis must be testable, and should predict the outcome of the experiment, but it should not be a guess off the top of your head. It needs to include a legitimate reason for the prediction, based hopefully on some scientific principle, but at the very least on observation and logic. If at all possible, it should also include a quantitative prediction, but this must also be based on a scientific principle. For example, “As temperature increases, so will the rate of photosynthesis” is a hypothesis. It is testable (all hypotheses must be), but it lacks a reason and is not quantitative. Here is an improvement: “Since photosynthesis involves chemical reactions, every 10 degree Celsius increase in temperature will double the rate of photosynthesis as predicted by the ‘Chemical Rule of 10’”. Now, I made up that ‘Chemical Rule of 10’ thing because I forget what it is called (it is legitimate) and don’t feel like looking it up, but you get the idea. This hypothesis is testable and quantitative and is based on a scientific reason. Finally, you should give a reference to your reason unless you were the one that discovered it. Your textbook will usually do for this, but you need to cite it correctly.

Methods and Materials

In this section, you explain how and sometimes when you did your work. You describe your experimental apparatus, your design, method of gathering data and the type of control, if any, that you used. The rule to keep in mind is this: the Methods and Materials section should be detailed and clear enough so that any reader would be able to duplicate the experiment if they wished to do so. It is an important part of the process of science that something must be repeated several times before anyone should believe it; it is the same reason why your design includes repeated trials and/or many subjects.

While we are at it, if you are designing this experiment yourself, FIVE is the minimum number of subjects per group or trials per subject to achieve the proper level of repetition. MORE is BETTER. Also, a design should have several levels of the independent variable to be a valid high school experiment (in other words, for you to get a good grade). For example, instead of testing at “hot” and “cold” temperatures, you might test at 10, 20, 30, 40 and 50 degrees. This would show a true measure of the effect of temperature on what you were testing.

Keep in mind that this is a report on what you did, therefore should be written in the past tense. The entire lab report should read like a narrative in which you tell the story of what you did and what the results were. It SHOULD NOT be written like a lab manual. For example, instead of “First pour agar into 10 petri dishes”, you should write “I poured agar into 10 petri dishes” (1st person), or “Ten petri dishes were filled with agar” (passive voice). Most Methods and Materials sections are written in the passive voice.

Also, DO NOT make a list of the materials and equipment; this is also something you would do if you were writing a lab manual, but not if you are writing a lab report. The materials used are simply mentioned in the narrative as the experimental procedure is explained in detail.
When describing variables that were controlled, make sure to describe **HOW** you controlled them, don’t just say that they were controlled. For example, something like “Temperature was controlled by constantly checking the thermometer in the flasks and adding ice to maintain a 10 degree reading” tells **how** you controlled temperature.

Reminder: **DON'T** put results in this section. For example, don’t write “We recorded the temperature of the solution after one minute and it was 24 degrees.” Leave out the 24 degrees part; it is a result, and goes in the next section.

**Results**

Here you present your data for inspection by the reader. Do it in a straightforward manner; this is not a flowery English essay, so don’t try to impress with vocabulary. Present your data, but **DON’T** make any conclusions or value judgments in this section; they belong in the next section. Usually this section will contain tables and/or graphs to organize the data and make it clear, but this is up to your judgment; don’t include a table if only a couple of numbers are involved (rare, but possible). If you do use a table or graph, remember that they **MUST** be accompanied by some text. The text would describe the results that are presented in the table or graph and calls attention to what you consider to be significant about it (most, least, increasing, decreasing, correlations, etc.). Here is an example:

The results of the temperature experiment are shown in Figure 1. The number of bacterial colonies increased up to 40 degrees centigrade but decreased at higher temperatures (here the author is specifically calling attention to the significant results so the reader can easily see the important data in the graph). The greatest amount of growth occurred between 35 and 40 degrees.

Follow the guidelines set forth in the handout **The Use of Tables and Figures** when constructing your table or figure.

If calculations such as T tests or Chi Square are involved in the processing of results, it is common to show the set up for such a calculation, but it is not necessary and not preferable to show all the work for every calculation, especially when using math commonly used in experimentation such as finding a mean. If you are using some applied math that is out of the ordinary, it would be appropriate to show a more extensive set up and an example of your methods, but we probably will not do any fancy math in this class. Someday, though,…

**Discussion**

Here you explain what you think your results mean. Describe any patterns that emerged, relationships that you think are meaningful, and any correlations that you could figure out. If the results turned out differently than you hypothesized, you will venture an explanation as to why. List possible sources of error, such as accuracy of measurement, but don’t put a long list of things that may have happened, like “measurements may not have been taken accurately”; only write about things you witnessed and/or could reasonably have happened, and describe them something like this: “On day 2, three of the thermometers were observed to no longer be in the liquid being measured, so those temperature measurements are suspect, they should probably be higher”. Refer to your handout on Errors and Uncertainties. Evaluate processes, use of equipment and time management. Approximate how significant the weaknesses are; this means to **explain the IMPACT** you think the problems had on the results. Do you think they had a great impact? If so, in what direction? If you don’t think they had any impact, then say that.
Here you might compare your results to any previous experiments or information known about the problem, and then make conclusions about the meaning of the data and refer back to the data to help explain why you reached those conclusions. For example, “Since twice as much carbon dioxide was produced at 30 degrees than at 20 degrees, I conclude that increasing the temperature by ten degrees doubles the rate of reaction.” State whether or not the data “supports” or “does not support” your hypothesis, and be sure to use those terms (see Conclusion section below).

**Conclusion**

This section is a partial repeat of the Discussion section in that you are again going to state your conclusion, but this time with only the main reason as to why you reached those conclusions. If this reason hinges on a statistical test like a T test, state the actual “p” value and whether or not it supports your hypothesis. If not a statistical test, your conclusion probably still was driven by numbers of some sort, so refer to the key numbers(s) and state them (don’t just say one group average was “more” than the other, actually state the numbers as well). Always use the term “supports” or “does not support” when referring to your hypothesis. Results never “prove” a hypothesis as being “right” or “wrong” – don’t use this language. This succinct concluding statement enables the reader, if they don’t have time to read the entire paper, to quickly determine what you have discovered so that they can decide whether it is of interest to them. By reading the Introduction and Conclusion sections, a reader should have a pretty good idea of what you did and what the results were, even if they don’t know how you did it. In the Conclusions section you might also suggest further investigations that could be done on the general problem and what contribution you have made to the problem with your present research.

**Literature Cited**

This section lists, in alphabetical order by author, all published information that was referred to anywhere in the text of the paper. It provides the reader with the information they need if they should want to conduct a literature search on the general problem. Note that the Literature Cited section includes only those references that were actually mentioned, or cited, in the paper. Any other books or articles that you might have read but did not mention (cite) in the paper are not included in this section. This is why the section is called Literature Cited instead of References or Bibliography.

Cite the literature in whatever format your English teacher says is the current fad; I can’t keep up with them. Here is an example of a journal article reference:


And an example of a book reference:


**How To Cite References**

Any time you mention any information in your paper that is not information that you actually obtained yourself via your own experiments or observations, you must include a reference to indicate the source of that information. This is referred to as citing the reference.
Remember: scientific papers DO NOT USE FOOTNOTES!!! There are two basic ways to cite a reference; both methods involve naming the authors of the information and the year of the publication. If the reader is interested, they can locate the full reference information in your Literature Cited section. Here are examples of the 2 ways:

1. Some freshmen are so short they can dial in the combination of a lock on a lower locker without bending their knees (Speziale and Johnson 2009).
2. Speziale and Johnson (2009) found that most freshmen still carry a piece of their baby blanket with them in their backpack.

And there you have it – everything you need to know about writing a lab report but were afraid to ask (Woody Allen 1971).