Lab Report Tutorial

Biology 231/233 Lab Reports

1. What is an Introduction Section?

- **Establishes the framework for the entire report**
- **Brief synopsis of what you know**
- **Introduces the problem you are addressing**

What do you put into an Introduction Section?

- **Present the problem/question under investigation**
  - Use a couple of sentences to introduce the topic you are investigating, to state the specific problem you are interested in and to define any specialized terminology
- **Summarize what you know to date about this problem**
  - Use your knowledge about the topic to highlight the important concepts that you have learned and relate them to the problem
  - Use citations from primary, secondary or textbook sources to present info
- **State your hypothesis and predictions**
  - The background info you presented should lead in to the hypothesis that you developed
  - Never set out to prove, verify or demonstrate the truth of something
- **Put your work in context**
  - Suggest how your work will benefit society or contribute to the scientific community
- **Be Brief**
  - Write for the study you carried out and don't present irrelevant info
  - Be concise and as direct as possible
- **Every topic that appears in later sections of your report should be anticipated clearly in the Introduction**

2. What is a Methods and Materials Section?

- **List of all materials, procedures and analyses performed**
- **Allows the reader to replicate your work to verify your results**

What do you put into a Material and Methods Section?

- **Experimental Design**
  - Include a description of the steps you followed to carry out the experiment – refer to your design worksheet whenever possible
  - Note any changes that you made to your experiment that were not on the original design worksheet
- **Procedures Used**
  - Provide a sentence to refer to your lab manual to describe all procedures used to carry out your experiment – note any changes you may have made to the published procedure
- **Materials Used**
  - Mention all important equipment, chemicals and tools you used when you carried out the experiment as you discuss the experimental design and procedures
  - Note any materials you did/did not use if they differ from the lab manual
- **Statistical Analysis**
  - How did you summarize your data? Are you reporting the averages of many trials? Did you calculate SEM?
  - Refer to a source describing how you performed your analysis

3. What is a Results Section?

- **It is the most important and informative section!**
- **In this section, you should summarize data and show trends using tables, graphs and words**

What do you put into a Results Section?

- **Includes all figures**
  - **Organize your data to reveal important trends:**
    - You need to summarize data with means (averages) and SEMs and hand in graphs or tables that illustrate the trends in your results.
    - Do not limit yourself to the question or hypothesis posed at the start of your study – a more interesting trend may present itself when you analyze the data.
- **Includes a written summary**
  - In this section, you should draw the reader's attention to the major observations and key trends in the data
  - In writing your results section, think of trying to describe your figures to a blind person; you wouldn't mention every data point, but rather try to give an overall impression of trends in the data.

Graphs:

- **Do not automatically assume that your data must be graphed – if it is clearer to present you data in a table, a graph may be superfluous**

When Should You Use a Bar Graph?

- **Independent variable is non-numerical or discontinuous**

  E.g. types of antibiotics, colors of light, males versus females

When Should You Use a Line Graph?

- **Independent variable is numerical and continuous**

  E.g. temperature, wavelengths of light, time of reaction

- **When should you connect the dots? When should you use a best-fit line (curve)?**
  - For the experiments done in this course, a best-fit line will usually show trends better than connecting the dots, since there will be a lot of variability in the data.
- **Your graphs must show what experiment was performed and the results obtained:**
  - This means that the graph should be self-contained: someone reading the report will understand the experiment, without having to read the written results section.
- **Title is informative**
  - It needs to mention the name of any organism, chemical or molecule involved and the treatment to which it was exposed.
- **Title goes below figure and is labeled as: "figure 1"**
- **Use graph or computer paper**
- **Label axes and give units**
  - Independent variable is on x-axis; dependent variable is on y-axis. Axes should start at 0, and scale should be continuous and appropriate, so that there isn't a lot of empty space.
- **Provide a legend if you have more than 1 data set (treatment)**

Written Results

Do:

- **Describe key points, trends, relationships shown in figures & tables**

  I.e. what is the optimum, max, min?

- **Refer specifically to figures (and tables) by number**

  E.g. "Figure 1/Table 1 illustrates the trends in the data we collected."

- **Compare values to a baseline or control**

  E.g. normal swimming behavior of brine shrimp before adding sugar

- **Quantitatively describe by how much a value changes**
  - Don't just say: "activity increased dramatically with temperature"
  - Give the reader a quantitative measure of the changes in the dependent variable
    - Five-fold? Ten times? Half?

- **Show all measurements that you made**
  - Even ones that don't fit the trends or your expectations

Don't:

- **Discuss why you did the experiment**
  - **This belongs in the Introduction section**

- **Explain how you did the experiment**
  - **This belongs in the Material and Methods section**

- **Interpret the results**
  - **Interpretation goes in the Discussion section**

- **Use raw data or list every data point**
  - **Just describe the trends using means and SEMs**

- **Use the term "significant" unless you actually did a statistical test**
  - **For BIOL 231, you will only have to find means and SEMs**

4. What is a Discussion Section?

- **You should Interpret your results by:**
  - **Comparing the results of your experiment to those reported in the literature**
  - **Comparing the results of your experiment to your hypothesis**
  - **Drawing conclusions and stating future studies and applications**

What do you put into a Discussion Section?

- **State you expectations explicitly**
  - Use background information and references to tell the reader what you expected to find in your results. This information should expand the ideas you presented in the Introduction
  - Reiterate your hypothesis to remind the reader of your initial thoughts for the experiment
- **Discuss the results you obtained**
  - **Do your results support your hypothesis?**
    - Results support but **do not prove** a hypothesis
  - **Interpret the results:**
    - Compare hypothesis to results; restate **major** findings only
    - Cite data that led you to conclude that your results did or did not support your hypothesis
- **Explain unexpected results**
  - **Go beyond human error**
    - Suggest some possible reasons, including but not restricted to sources of error
    - Critique your experimental design and make suggestions for changes in the future

- **Do your results & interpretation agree or contrast with previously published work?**
  - **Relate to information in the literature and explain differences**
  - **Cite references but *use your own words***
    - Plagiarism (from published work or other students) is a serious offense
    - Don't use quotations: to demonstrate that you really understand the material, summarize it in your own words
- **What do your results mean? What are the practical applications, or principles demonstrated by your results?**
  - What conclusions can be drawn from your results?
  - What further experiments would you suggest that would contribute to further understanding of this topic?

5. What is a Literature Cited Section?

- **Acknowledgement of information you have gained from the scientific community**

How do you acknowledge information correctly?

- **In Text Citations**
  - **Cite sources of all information that is NOT common knowledge or from your own results**
  - **Cite sources each time you use them, as you use them (not at end of paragraph) for each topic – Do not footnote or *ibid***
  - **Paraphrase information into your own words (Don't use quotations)**
  - **Use (author, year) or author (year) format**
    - E.g. Enzymes are biological catalysts (Campbell and Reece, 2002).
    - E.g. According to Campbell and Reece (2002), enzymes are biological catalysts.
      - 1 author – Surname, year
      - 2 authors – Surname and Surname, year
      - >2 authors – Surname *et al.*, year
- **Literature Cited Section**
  - **Different disciplines use different methods; this doesn't mean that approaches learned in other classes are wrong, only that for Biology 231 we will follow a standard approach**
  - **Cite only those articles that you actually used in the text of your report**
  - **List citations alphabetically by first authors last name**
  - **For journals, you must include surnames and initials of all authors, year of publication, full title of article, name of journal, volume and issue used, and pages of the article**
    - Zoolander, J.J. 1997. Sleeping is Good for the Memory. Canadian Journal of Fatigue Science 15 (6): 121-151.

- **For textbooks and lab manuals, you must include surnames and initials of all authors, year of publication, name of book, edition, publisher, place of publication, and pages referred to**
  - Purves, W.K., G.H. Orians, and H.C. Heller. 1992. Life: The Science of Biology. 3rd edition. W.H. Freeman, Salt Lake City, Utah, pp. 123-130.
  - Addy, H.D., W.R. Huddleston, C.A. McRae. 2004. Biology 231 Lab Manual 2004-2005 edition. University of Calgary, Calgary, pp. 14 - 15.
- **For web pages, you must include surnames and initials of all authors, date posted, title of page, URL, and the date you accessed the information**
  - Smirnoff, A.A., Aug 16, 2003. Home Page of the Official Drinkers Discussion Forum. http://www.nobraincells.com. Accessed Sept. 22, 2004.

Sample Literature Cited section

Addy, H.D., W.R. Huddleston, C.A. McRae. 2004. Biology 231 Lab Manual 2004-2005 edition. University of Calgary, pp. 14 - 15.

Purves, W.K., G.H. Orians, and H.C. Heller. 1992. Life: The Science of Biology. 3rd edition. W.H. Freeman, Salt Lake City, Utah, pp. 123-130.

Smirnoff, A.A., Aug 16, 2003. Home Page of the Official Drinkers Discussion Forum. http://www.nobraincells.com. Accessed Sept. 22, 2004.

Zoolander, J.J. 1997. Sleeping is Good for the Memory. Canadian Journal of Fatigue Science 15 (6): 121-151.

6. Critical Steps (Pechenik Chapter 5, inside back cover)

- **Good, clear writing will earn students' better grades. Strong verbal and written communication skills are essential in biology. Biologists *must* be able to present their results to their colleagues, for grant proposals etc.**
- **Write as if you were explaining the material to another student**
    - Read your work aloud: does it make sense?
    - Read it after putting it down for a while; read it out loud; swap with a friend
- **Be concise in your use of words**
    - Are all the words necessary?
    - Are you saying what you mean to say?
- **Revise! For content and clarity**
    - Students should spend 30% of available time writing first draft and researching it; 70% of time should be spent on revising, editing and proofreading.
    - Don't make the reader guess what you are trying to say
- **Proofread!**
    - Don't count on spellchecker to get all errors
    - Keep good will of TA
    - Sloppy presentation could indicate sloppy thinking
- **Back up computer files as you work**
    - Print off an extra copy
    - Printing problems not excused