# HOW TO WRITE LAB REPORTS

## LAB REPORT OVERVIEW

The formal lab report is similar to a research report. It should be written as if you were going to submit it to a scientific journal for publication. Therefore, it should follow the specific format outlined below and should be written for a general audience. Assume the reader is familiar with basic biological concepts but does not know anything about the specific lab/experiment you have done. The report should focus on three things: the question you are asking, your prediction(s) based on the background information available, and the answer you found by evaluating the evidence gathered in your investigation. All parts of the report should serve to clarify, add to, evaluate, and explain the question and conclusions addressed by your report. The lab report should only be as long as it needs to be to convey all of the information, but it should be as concise and as well-edited as possible, however, your report should not exceed **6** pages.

## GENERAL REQUIREMENTS

Double-spaced in 12-point, Times New Roman (like this document, or similar font), with 1 inch (2.5 cm) margins. Reports should be free from typographical, grammatical, and spelling errors.

## PARTS OF A SCIENTIFIC PAPER

Scientific papers are made up of three sections, (1) title and abstract, (2) the body of the paper, and (3) literature cited.

## TITLE & ABSTRACT

First, you need a **title and identifying information**. It should be easy to read and include,

1. The title of the report

2. The people who worked on the lab in alphabetical order

3. The date

4. Class, lab section, and group number (if applicable)

*For example:*

Biodiversity of San Francisco Bay

Rachel Carson and Carol Christ

September 13, 2012, Bio 1B Section 480, Group Oxford

Second, you need to have an **abstract**. *Abstracts provide a brief synopsis of your goals, methods, and major findings.* The abstract is a short summary (1 paragraph, limited to 250 words) of the experiment or study. When someone reads your abstract, they should have a good idea of what your paper is about, how you did it, what you found, and what implications it may have. A good way to write an abstract is to try to summarize the main point from each of the main sections of your paper in one to two sentences each. Abstracts are **often the last thing you write**, because by then, you know what the paper is about and what you did. Abstracts **do not include any citations**. Abstracts include, in the following order:

* Topic of study and its significance.
* Your specific system and the question you set out to answer.
* Your hypotheses or predictions about outcomes of the experiments.
* The general methods and statistical tests used to collect and analyze your data.
* Your major findings (including why relevant, if applicable).
* How your findings support or refute your hypotheses.

## BODY OF THE PAPER

The body of the paper is made up of the following sections: (1) Introduction, (2) Methods, (3) Results, and (4) Discussion. Each section should begin with a heading.

### INTRODUCTION – What did we study?

The first part of the introduction should **set the context for your experiment by briefly providing background information**. You should present what information is known from previous studies, and then state what additional information your experiment may provide. Be sure to give proper citations when you state facts or ideas from outside sources (see Literature Cited section for more). Within each paragraph, start with a strong topic sentence as a general statement and become more specific as the paragraph progresses.

In the last paragraph of the introduction, **you should state the objectives, hypotheses, or particular questions you investigated**. State what you did in a general way, such as, “We investigated two populations of flying fish to determine (1) the life history (2) mating behaviors…” Focus on your hypothesis and predictions in this section. Details about the experiment belong in the Methods section.

### METHODS – How did we study the problem?

In this section you provide specific information on what experiments you did and how they were done. The purpose of this section is to allow other experimenters to duplicate the methods you used, so it should be **detailed enough so that someone else could read your report and repeat the experiment** using only minimal additional reference material. Each technique should be a heading with description after it. For specific details that are contained in other literature (e.g., your lab manual), you may refer the reader to the methods described there by using a proper citation; you do not need to reiterate these details in your report.

The methods section should also include descriptions of any formulae, calculations, used in the study such as those used to calculate the metrics. Be sure to include all of the units of measurement. **Always use the metric system.** Sometimes it is helpful to include a figure of your experimental setup. The methods should also indicate the type of statistical tests used.

In terms of writing, the experiment has been completed by the time you write your report, so use **past tense** when describing it. Additionally, please use the **active voice** ratherthanthe **passive voice** for Bio 1B lab reports. See the examples below to distinguish these two writing styles.

*Active voice example*

**We placed** pollen from a dicot flower on a glass microscope slide with 1 drop of 2% sucrose solution, followed by a cover slip. **We incubated the sample** at room temperature, **and inspected it** at 400X power at 15-minute intervals.

*Passive voice example*

Pollen from a dicot **flower was placed** on a glass microscope slide with 1 drop of 2%

sucrose solution. A **cover slip was placed** over the sample, which was incubated at room temperature. At 15-minute intervals the slide **was inspected** at 400X power.

### RESULTS – What did we find?

In this section you report the results of your experiments or study, often accompanied by tables or figures.

The results section **always starts with text**, NOT with tables or figures. The content will include: general observations made during the experiments; quantitative results, which may appear in figures and/or tables unless there are only a few numbers that can be mentioned in the text; and a summary of the results of statistical analyses. Data are reported in 3 ways: (1) text, if there are just a few numbers to report; (2) figures, such as a graph, picture, map, or diagram; or (3) tables, which contain only rows and columns of numbers or names.

**Do NOT discuss the implications of the results in this section, nor attempt to explain why various results occurred.** It is more appropriate for these interpretations to be discussed in the conclusions section.

*Figures and tables*

* Never include a table or figure that you don’t reference in the text. A figure is useless unless you tell the reader when to look at it and why.
* Each table or figure should be accompanied by a brief **descriptive title** that is detailed enough that the figure can be understood apart from the text. Details of the figure are found in the results section.
* Tables/figures must be numbered as independent lists (you may have both a Fig. 1 and a Table 1).
* Tables have a title above, and figure titles are located below.
* Put all of the figures and tables at the end of the paper, after the literature cited, with all of the tables together in order and all of the figures together in order. Figure 1 should be labeled and should be followed by Figure 2. The figure captions should follow all of the figures and tables and be ordered sequentially.

### DISCUSSION – What do the findings mean?

The discussion is usually the most important part of the paper. Although the results section explains detail of each figure or table, the discussion section interprets the entire work as a whole. In a research publication this section is used to place your work in the context of previously published work and discuss the significance. It is also the section where possible future experiments are discussed.

The discussion is your chance to be original, cleverly interpret the results you obtained, and draw general conclusions. Information in the discussion should start with your specific results and move toward the more general themes or theory. Begin the discussion by briefly stating the major conclusions from the results. Explain what the results mean. **Discuss whether the results SUPPORT or do NOT support your original hypothesis(es)**. Did you find what you were expecting? Be careful not to extrapolate too liberally from your data, i.e., don’t tell stories! If your findings are inconclusive, do not try to stretch them to unreasonable ends. Sometimes in this section you also include possible sources of experimental error and what affect you would expect these to have on your results.

*The discussion should be co-written by each group member.* Do not assign the discussion section to one or a couple members of the group. As with the entire report the discussion must also be edited in its entirety by each group member and each member should ensure that the information there is in agreement with each other part of the report (abstract, introduction, methods, results).

### LITERATURE CITED

You must cite all references that you used in your lab report. We will use the format used in the journal, *Bioscience*, summarized below. **Your citation list should be listed in alphabetical order by last name.** Only include references you cite in the paper. Make sure to check your paper over closely for the correct format and congruence between the body of your paper and the literature cited. It is likely you will cite the Campbell Textbook and your Lab Instructions, **but do not cite internet sources.** Citations are typically “ex-dented”—see examples below.

Journal *Bioscience* formatting guidelines:

<http://www.aibs.org/bioscience/resources/BioScience_Style_Guide.pdf>

**In text citations**

**One author:** Horses evolved a long time ago (MacFadden 2005) or According to

MacFadden (2005), horses evolved a long time ago **Two authors:** (MacFadden and Williams 2002) **Three or more authors:** (MacFadden et al. 1999)

**Literature cited list**

*Journal article*

Include the author(s), year, title of the article (with only the first word capitalized), name and volume of the journal, and pages for the article.

Vitousek PM. 1994. Beyond global warming: ecology and global change. Ecology 75: 1861-1876.

Post WM, Emanuel WR, Zinke PJ, and Stangenberger AG. 1982. Soil carbon pools and world life zones. Nature 298: 156-159.

*Specific selection from a book*

Last Name First and middle initials. Year. Title of Selection. Pages XX - XX in: Last

Name First, and middle initials eds. Title of Book. Publisher.

Mock DW. 1997. Infanticide, siblicide, and avian nestling mortality. Pages 3-30 in: Hausfater G, and Hardy SB, eds. Infanticide: comparative and evolutionary perspectives. Academic Press.

*Bio1B Documents*

Bio. 1B. 2014. Phylogenetics Lab Instructions. Department of Integrative Biology, UC Berkeley.

## A NOTE ABOUT PLAGIARISM

Every idea, method, or piece of information included in your report that is not your own should have a reference associated with it (unless it is very common knowledge). **Not properly giving credit for the work of others is considered to be plagiarism and is considered academic misconduct.** Please read over the information at [http://www.plagiarism.org](http://www.plagiarism.org/) and [UCB Library](http://guides.lib.berkeley.edu/c.php?g=4374&p=15427) for examples and clarification on intentional and accidental plagiarism.

## YOUR ASSIGNMENT FOR THE BIOINDICATORS LAB

**With your group, report your findings in a full lab report as described above.** In addition, make sure you follow the specific instructions below for your Results and Discussion/Conclusions sections. All members are responsible for the entire report and should edit the report to be sure that all of the information in each section of the report is in agreement. All members should work on the Discussion/Conclusion section collaboratively.

**Begin your *Results* section with your observations of the graphed data from your Jupyter Notebook. and address the first three questions below.** This will familiarize you with the data.

**Then, use the Jupyter Notebook to perform a resampling test for each metric to compare each measure between Forks.** Each group member should complete at least one of the tests. Be sure to indicate which group member performed each test. To complete your results section, follow the instructions in the Results section of the guidelines above for how to write lab reports. Your results must include your answers to the four questions below. \*

1. Using visual inspection of the graphed data, identify the metrics for which the North Fork appears to have better water quality than the South Fork. For which measures does the South Fork appear to have better water quality than the North Fork?
2. For which metrics is there overlap between the measurements of the North Fork and the South Fork?
3. How does the value your group calculated for each metric compare to the mean for each metric calculated by the class? How do you explain any differences?
4. According to the statistical results, which metrics were significantly different between the North Fork and South Fork?

**In your *conclusions,* you must address each of the following questions.\***

1. Do your results support your group’s hypothesis about the relative water quality of the two forks? Explain.
2. Based on your results which fork has lower water quality? Be sure to discuss your results for each measure and any relevant observations you made.
3. Why might it be beneficial to use several metrics in a biomonitoring program? Use examples from this lab to compare the specific kinds of information that different metrics provide.
4. Is it possible that the observed differences between the North and South Forks are due to differences in the habitats at each sampling location? Design a new field study to assess whether differences between the two sites are due to water quality conditions (e.g., pollutants) or habitat differences. If you could sample from additional sites, how would you try to assess differences in benthic macroinvertebrate communities?
5. The samples in this lab were collected in April. How do you think the invertebrate community would change if you sampled at different times of year?

**\* Address each of the questions listed here in the text of your results and conclusions sections. These questions are to guide your content; do not include these points as a numbered**

**or bulleted list.**

Reports are submitted to bCourses. Please follow this report file naming convention:

**GroupLastNames\_Section#\_Bioindicators\_Semester (Fa/Sp)Year (20xx)**

e.g.,) CarsonChrist\_480\_Bioindicators\_Sp2020

**See next page for your lab report checklist.**

**Lab Report Checklist**

**General:**

Double-spaced

Typo free and edited so that the lab report reads as if one person wrote it.

Title and author info (date, group, etc.) completed.

**Abstract:**

250 words or fewer.

Contains purpose of experiment and brief description of methods.

Contains hypotheses or predictions about outcome of the experiments.

Contains major findings and conclusions

**Introduction:**

Contains background information from the literature (primary references).

Citations are paraphrased. Direct quotations are not used.

Objectives of experiment (or hypotheses) are clearly stated.

**Methods:**

Contains all relevant information to enable the reader to repeat the experiment.

Written in past tense and active voice.

No preview of how the data will be organized or interpreted.

**Results:**

The results, including resampling results for each metric, are described in words and contain no interpretation.

Answers to each of the 4 questions on previous page (also pg. 5 of data sheets.) are included.

Reference is made to each table/figure.

Figure/table titles are informative and can be understood apart from the text.

Figure titles are below the figure and table titles are above the table.

Figure axes (with units), table columns, data sets, etc. are clearly labeled.

Order is parallel to methods section.

**Discussion/Conclusions:**

Results are briefly summarized and interpreted in relation to group’s hypotheses

Explanations for results are given, larger implications of results are considered.

Answers to each of the 5 questions on previous pg. (also page 5 of the data sheets).

Errors and inconsistencies, limitations to the experimental design, and improvements to the study are addressed.

**Literature Cited:**

In text and works cited list citations are properly formatted.

All references have been cited in the text. All citations in the text are in Literature Cited.

**Appendix:**

Figures are labeled and present in order.

Figure captions follow all figures and tables.

Each group member’s calculated t-test is included with work shown and individual names.