

Experimental Design Project Description.

Objectives

- perform the full experiment and collect the necessary data
- analyze data using the planned statistical tests
- draw conclusions based on the outcome of the statistical tests
- write up results in an appropriate format, based loosely on the format of a scientific paper

Project timeline

<u>Week</u>	<u>Task</u>
2. Sep 1-5	Read abstracts and introductions of three papers on the effectiveness of antibacterial soap.
3. Sep 8-12	Read methods and results sections of the three papers. Examine protocol of former soap experiment and think about its design and flaws. You can begin writing the introduction to your paper this week (due in two weeks)
4. Sep 15-19	Discuss the design of your experiment. Decide on number and types of treatments, data collection methods, and sample size. Write methods (protocol) as a group by end of period and turn in. Homework: finish writing your introduction to the paper to be turned in the following week.
5. Sep 22-26	Receive copies of another group's methods and write a review.
6. Sep 29-Oct 3	One copy of review returned to group, another to the grading TA. Group revises methods in light of comments in reviews.
7. Oct 6-10	Conduct experiment.
8. Oct 13-17	Collect and analyze data. Major group assignment: write up results (including statistical analysis) to be turned in before leaving lab.
9. Oct 27-31	Receive analysis back from grader with comments.
10. Nov 3-7	Submit final draft to TA for grading. Since most parts of the paper have already been graded, the final draft will be graded mostly on the abstract, conclusions, and adherence to overall format of a scientific paper.

The lab printers will be turned off at the starting time of lab (10 after the hour) on the due date of the final draft. Do not be burned by procrastination and technological disaster!

General notes about the project

Group vs. individual work

You will be conducting this project as a part of a group consisting of 6 to 8 students corresponding roughly to one side of your bench. Your bench TA will serve as your mentor for the project. Some components of the project will be done and turned in by the group. For these parts, all members of the group will receive a group grade. Those parts are:

- write-up of methods section (experimental protocol)
- conducting the experiment itself
- data collection and analysis
- write-up of results section, including statistical analysis

Obviously for these parts of the project, it is acceptable under the Honor Code to collaborate and turn in group assignments. Other aspects of the Honor Code, such as appropriate citation of the work of others, remain in force.

Some parts of the project will be done on an individual basis. You will receive an individual grade for those components. For those parts of the project your work must be your own. Normal BSCI 111 Honor Code expectations apply, i.e. you can discuss with others, but the work and words must be your own unless you quote and cite appropriately. Those parts are:

- write-up of introduction

- written critique (peer review)
- abstract and conclusions in final draft

Scope of the project and limitations of materials

It is intended that this project be a redesign of the protocol of the past BSCI 111a experiment described in this section of the lab manual. You should seek to address the flaws of this design and protocol, rather than coming up with a completely different experiment (e.g. swabbing bathroom doorknobs).

The materials that each group can use in their experiment can include the following:

- standard tools for microbiological manipulations, e.g. spreaders, loops, pipettes, microfuge tubes, colony counters, incubating ovens, gloves, etc.
- sterile nutrient broth and buffers.
- regular soap (SoftSoap)
- antibacterial soap (Dial)
- solution of antibacterial agent (triclosan) at the concentration commonly used in soap
- 16 nutrient agar plates. Because of the labor-intensive nature of pouring these plates, do not ask for more than this number. The lab staff will be available to take plates out of the incubating oven on the following day.

It is possible that groups may decide that there is a reason to use spectrophotometry in their protocol. If this is the case, spectrophotometers and cuvettes would be available. If there are other specialized materials that are needed, then you must discuss why you think you need them with Dr. Baskauf, who will determine if it is feasible to acquire them. You will need to submit a materials list at the end of class during the week of Sep 15-19 indicating the number and kinds of items you will need.

The protocol should be designed to be able to be completed in one class period (along with the DNA structure lab). There will also be time available the following week (during the long wait times of the PCR lab) to collect and analyze data.

About the paper.

The final product of this project is a paper in the format of a scientific journal article. However, we will be constructing the various sections of the paper over the course of the semester, so it will not involve large amounts of time at any particular time during the semester. You should maintain a word processing document to which you will add the various sections as you complete them. As mentioned above, some of the parts will be written as a group and others will be written by you individually.

In particular, your paper should have the following features.

1. **Sections of the paper.** The paper should begin with the title and author (you). If you want to make it look more like a real paper, you can list all of the other group members as co-authors. However, if you do that, you should list your name first so that we know that you wrote it. The paper should contain the following sections with explicitly labeled headings: abstract, introduction, methods, results, discussion, and references. It is not necessary to include keywords, author affiliations, or acknowledgements. It is not necessary to subdivide the methods and results sections, but you may use subheadings if they would improve the clarity and organization of the material.

2. **Tables and figures.** Tables and figures should be included at the appropriate point in the text (not at the end as is common practice when submitting papers for publication). Figures and tables should be numbered sequentially and have a descriptive caption beginning with "Fig. X. ..." or "Table X. ...". References to figures and tables in the text should be by type and number (e.g. "Fig. 5"). "Figure" should

always be abbreviated by "Fig." and never written out as the full word. Graphs are always considered figures.

3. **Formatting.** Pages should be numbered. It is not necessary to have a running head at the top of the page. Text may be single-spaced. Although it is common practice in journals to place text in two columns per page, that is neither necessary nor recommended in this assignment.

4. **Reporting of results of statistical tests.** Use the guidelines for the reporting of statistical tests which will be discussed later. Simple results may be reported in the text, while the results of multiple tests may be reported in a table if that increases clarity. It is not necessary to provide a citation for a simple *t*-test of means, paired *t*-test, or linear regression. If you use other tests, you should cite the text or reference you followed to do the test. In your materials and methods section, you should report how you did the test (e.g. using JMP-IN).

5. **Citations.** Citations should be in the form of (author, date) rather than as numbered footnotes. If the author name is used in the text, the date in parentheses should follow the name. Citations should be used any time reference is made to specific ideas, procedures, or data that are associated with specific published works. **Do not cite Internet URLs.** If you obtain an article from the Internet, it should have a bona fide journal name, volume, and page number. If it does not, then it is not primary scientific literature and cannot justifiably be cited.

6. **References.** Your reference listing should include all references cited in the text and should not include any other references that are not cited. They should be listed alphabetically by last name of the first author. There is variation among journals in the exact formatting of references, but please use the format described in this manual. The name of journal **articles** is not italicized. The **titles** of journals are typically abbreviated in a standardized way and may or may not be italicized depending on the journal. For this paper you can italicize. You can look up journal abbreviations at <http://library.caltech.edu/reference/abbreviations/> or list the entire journal title. Following the journal title is the volume number, a colon, and the range of page numbers that include the article. The volume and pages are given without abbreviations (e.g. 23:57-89 **not** "vol. 23, pg. 57-89"). The issue number is often omitted.

General comments on the paper. The paper, including all graphs and tables must be done electronically (i.e. typed and graphs produced using software). No part should be handwritten. There is no specific page requirement for the paper. You should use the number of pages required to present and analyze the results and no more. In fact, papers that are too wordy or which contain material that is irrelevant to the experiment will be criticized and will have point deductions. Although writing in the passive voice is considered poor practice in general writing, it is the norm in scientific papers. Thus you would not generally say, "I counted the colonies on one quarter of each plate and multiplied the resulting counts by four." but rather "One quarter of the colonies on each plate were counted and the resulting counts were multiplied by four."

The abstract should be written last. It should briefly summarize the important results and conclusions of the experiment. It should not contain background information or citations.

It is not appropriate to engage in speculation or to make conclusions that are unsupported by data collected in the paper. It is appropriate in the conclusions section to comment briefly on the broader implications of the results and to suggest further research that might follow the experiment.

Late work will not be accepted. You know the schedule and deadlines, so plan accordingly.

The word "data" is plural. Say "the data were ..." not "the data was ...".