

Microbiology Research Project

Introduction

You are going to have an opportunity this semester to have some fun with science by designing and carrying out your own experimental research project. The project will be directed toward answering a question by comparing numbers of bacteria in two sources (usually food). What would you like to find out in your experiment? Perhaps you would like to check the number of bacteria in plain hamburger vs. hamburger mixed with garlic; or compare the concentration of microbes in fresh milk vs. milk after its expiration date. You might want to compare different types of food: hot salsa vs. mild salsa, or home-made salsa vs. taco bar salsa. Maybe single dipping vs. double dipping at a party. The possibilities are only limited by your imagination.

To count the microbes in your food sources you will use the serial dilution technique, which you learned previously in Ex. 8 Counting Microbial Populations. You can make modifications on this procedure to fit the design of your experiment. For example, in that experiment we were counting microbes in a urine sample that had purposely been inoculated with bacteria. If you would expect your food source to have less microbes than that inoculated urine, then you should make adjustments to your dilution series to make sure you have enough colonies to count. Also, if your food source is a solid food, it will need to be liquified before making serial dilutions. This could be accomplished in a blender by blending one gram of solid food into ninety-nine milliliters of sterile water (or 2 grams in 198 milliliters). This would count for the first 1:100 dilution.

Be certain that your experiment is designed to count bacteria and compare their numbers. Only the condition you are testing should vary between the food samples you count. All other variables should remain constant. For example, if you were enumerating the number of bacteria in hamburger after different cooking times, you would want to insure that all the hamburger came from the same package, was thawed for the same amount of time, was cooked at the same temperature, etc.

We are going to work as teams of 2-4 students on the research project. After forming a team and deciding on an experiment, the next step will be to turn in a Pre-Experiment Write-up of your project. I will collect these, evaluate them, and give you feedback. Then we will have a lab day to actually perform the experiments in class. Finally your team will turn in the final project with the data from your experiment. The due dates for all of these steps are listed in your syllabus.

The project is worth 50 points per student and the grading procedure is described later in this handout. The grading criteria are listed in the Research Project Grading Rubric. Pay very close attention to each item listed in this rubric to make sure you achieve the highest score possible for your work.

Pre-Experiment Write-up

Before we actually perform your experiment in lab, you need to write up a protocol describing the experiment you plan to do. The writeup will include the Title Page, Introduction, Materials, Methods, Results (Table and Graph setup) and Bibliography sections of your report. See the description of individual sections below. Your report should be clearly typed in APA format with proper grammar and spelling. Also turn in copies of all the original research articles listed in your bibliography

The Experiment

Plan ahead for the actual in class experiment. For example if you are counting microbes in expired milk, you would need to buy the milk far enough in advance for it to be expired when you perform the experiment.

Final Report

The final report will include the entire project with the components in the following order: Title Page, Abstract, Introduction, Materials, Methods, Results (with tables & graphs), Discussion, and Bibliography. Also turn in again the original Pre-Experiment Write-up with my comments. You will also turn in a digital (computer) copy of the final project, preferably in PDF format. Also include a copy of the Delegation of Teamwork Form for grading purposes.

Your report should be organized in the general format of a research publication with the following sections:

- a. A **Title Page** can help create a professional look to your report and should include the title of the project, the list of investigators' names, the date, and name of the course.
- b. The **Abstract** provides a short (one paragraph) summary of your research question, findings and conclusions. A person reading the abstract should be able to acquire a general idea of what your project is about. Since the Abstract summarizes results, it will only be included in the Final Project Report. It will NOT be included in the Pre-Experiment Writeup.
- c. An **Introduction** section should describe the background of the project and the question or hypothesis that the research hopes to answer. Literature research from libraries or Internet will also be included. Do not copy from your references. Write the introduction in your own words. **Citations:** any direct quotes, opinions, or specific data from references should be followed by the author, date, and page numbers in parentheses (Smith 1982, p. 23). All of your sources should then be listed in a bibliography (see below).
- d. A **Materials** list should be included in the report. See the exercises in this manual for examples.

- e. A **Methods** section will describe the steps of your experiment with enough detail that another scientist (i.e. another member of the class) could reproduce the experiment without asking you for further clarification.
- f. The **Results** section of the write-up will show the actual data you obtained. The data should be organized in a table and a graph so that a reader can easily see whether the hypothesis is supported or nullified. See Appendix G Graphing for help with tables and graphs.
- g. The **Discussion** should include an explanation of your results. What are your conclusions? Did the results support or nullify your hypothesis? Are there any alternative explanations for the results and any suggestions for further experimentation? The Discussion will only be included in the Final Project Report, not in the Pre-Experiment Writeup.
- h. An alphabetical **Bibliography** using APA format should be included for any references in your report. Single-space within a reference and double-space between them. Also turn in copies of your library and Internet source materials. Here are directions for formatting your bibliography

Directions for Journal Articles

- Author. (Year). Title of article. *Title of Journal in Italics, Volume of Journal in Italics*, Pages.
- Smith, John & Jane Doe. (2002). Identity crisis—a microscopic self inspection. *Psychology Today*, 34, 44-59.

Directions for Books

- Author. (Year). *Title of book in italics*. Location: Publishing Company.
- Roast, Chuck. (2007). *Gourmet guide to procaryotic protein*. New York, NY: Food for Thought Publishing Co.

Directions for Web Sites

- Author or place of publication or publisher. (Date the web site was last updated). Title of article. Location: Publisher. The exact character-by-character URL address (In addition give your **ranking** for the reliability of internet sources on a 1-10 scale with 10 being the most reliable).
- Hacker, G. K. (2001) Viruses without cures. Washington, DC: National Center for Safe Computing. Retrieved September 20, 2004, from the World Wide Web: <http://ur.nvr.safe.org> (1).

Research Project

Grading Rubric

Components of Scientific Paper (0-10 points)

- Includes Title page, Abstract, Introduction, Materials, Methods, Results, Discussion and Bibliography
- Title page includes title, author(s), date, and course
- Abstract accurately summarizes significance of paper
- Introduction provides accurate background information and hypothesis of experiment
- Materials list is complete
- Digital (computer) copy of paper complete
- Copy of Graded Proposal and Source Materials turned in with Final Project

Experimental Design & Depth of Research (0-15 points)

- Level of rigor (difficulty) of experiment
- Extent of background information in Introduction
- Extensiveness of data collection
- Good testable hypothesis is clearly stated
- Logic of experiment is clear and easy to follow in Methods section
- Appropriate controls are used
- Scientific references are researched and cited

Presentation and Interpretation of Results (0-15 points)

- Tables and graphs used to present results clearly (the presentation should provide an obvious answer to the question posed in the hypothesis)
- Calculations for number of microbes per milliliter are performed correctly.
- Presentation focuses on the appropriate results (e.g. number of bacteria per milliliter rather than number of colonies per dilution)
- Graphs should be clearly and completely labeled including title, both axes and units
- Appropriate form of graph (line, bar, etc.) is used
- Conclusions made in Discussion should be supported by results
- Unexpected results and problems should be discussed in Discussion
- Alternative or follow-up hypotheses are provided, if appropriate

Writing Style and Presentation of Paper (0-10 points)

- Communicates effectively (points are clearly stated, flow of ideas is easy to follow)
- Interesting and informative
- APA format is followed
- Correct spelling & grammar used
- Typed and neat (Including tables & graphs); consistent fonts throughout
- Follows proper rules of nomenclature for scientific names
- References are cited properly in paper
- Bibliography is complete and in proper format

✓ Indicates a component of project that was exceptional

✗ Indicates an area that could be improved

Teamwork

Workplace supervisors and employers have said that one of the primary skills they would like to see in today's graduates is the ability to work together. They want their employees to be able to work together on projects as a team. They want team members to be able to speak up for themselves, listen to others, keep focused on task, share their ideas, and share the work. Effective collaboration requires that individuals learn to work with others to resolve conflicts and develop creative solutions to problems. A good team can produce a project together that is better than any individual could have developed alone.

To practice team-building skills, we will complete the Research Project in teams of 2-4 students. Each team will turn in one joint Final Report for the research project.

Grading

Each research project will be graded based on the attached grading rubric. This rubric includes a break down of how many points are earned for different components of the project and the final report. The entire team is responsible for the entire project. To get the best score for your project, it is a good idea to review and edit each others work. Fill in a blank Delegation of Team Work Form listing the work done by each team member and what percentage of the work each student contributed to the project. See sample below.

	Major Contributions	% of Total Work
Partner 1 Name U. R. Heer	Helped with idea for experiment & control Helped with library/internet research (2 references) Designed title page and bibliography Edited first draft of proposal and typed second draft Helped perform first run of experiment Designed Results table Helped with design of Results graph Present for all team meetings Expressed ideas and listened to others during meetings	30%
Partner 2 Name Betty Kan	Helped with idea for experiment & control Helped with library/internet research (1 reference) Wrote up Materials list Did shopping for materials Helped perform second run of experiment Helped with design of Results graph Organized team meetings (even made cookies) Present for all team meetings Good diplomat and leader during discussions	30%
Partner 3 Name Sue Perstudent	Synthesized idea for experiment & control Helped with library/internet research (2 references) Wrote majority (Introduction & Methods) of research proposal Helped perform first run of experiment Helped perform second run of experiment Wrote Abstract & Discussion of research final report Helped with design of Results graph Present for all team meetings Good creative problem solver	35%
Partner 4 Name Will B. Sorry	Watched others perform experiment Present for half of team meetings. Difficult time staying focused during meetings Ate all the cookies at meetings	5%
TOTAL (Must add to 100%)		100%

Once the project has been graded, each individual student's grade will be determined based on the percentage contribution they made to the project. For example, suppose the research project for the above group earned a score of 30 points out of 50 points possible. Since there were four member in the team, we would first multiply 30 points times 4 (= 120 points). Each student's score would be calculated as their percentage of 120 points. U. R. Heer and Betty Kan would both receive 36 points (30% of 120 points), Sue Perstudent would have earned 42 points (35% x 120) and Will B. Sorry would receive 6 points (5% of 120). However, the highest possible score is still only 50 points.

Delegation of Team Work Form

	Major Contributions	% of Total Work
Partner 1 Name		
Partner 2 Name		
Partner 3 Name		
Partner 4 Name		
TOTAL (Must add to 100%)		100%

Group Dynamics

Briefly describe the group dynamics of your research team. Were you able to work well as a team? Do you feel the team produced a better project than you could have created individually? Were there any personality conflicts or communication problems? Were you able to resolve the problems?