Manual for
MICB 471
24W Term 1

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a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Version 1.5

Acknowledgements

This course was first developed in 2001 by Dr. William Ramey. In 2014, Dr. David Oliver adopted to the course and optimized the course operation and updated the learning objectives. Many people have contributed to the continual development of the course including, Drs. Evelyn Sun and Marcia Graves, Craig Kornak, and a host of dedicated graduate level teaching assistants.
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Department of Microbiology and Immunology
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Version 1.5

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Course Operation and Rules

A. Course Overview

Traditional lab courses tend to present students with experimental recipes and supplies, and then ask students to follow the recipes, look at the results and write a report. This approach allows each student to have the same learning experience but it limits the range of available experiments. In addition, even though instructors expect students to understand the work before attempting an experiment the traditional lab approach allows some students to get through the work by following the directions rather than understanding the purpose of the work. In this course teams of students are expected to design experiments and protocols to test their approach to provided categories of observations rather than just following a supplied recipe. In some cases the explanations might require a simple modification of a previous experiment, in other cases the teams might need to invent an entirely new experimental protocol. In either case, once the experiment has been acceptably designed, your team will be expected to prepare the supplies, set up equipment, carry out the experiment, analyze the results and prepare a formal journal style report that describes the experimental purpose, the methods, the results and the conclusions. The course instructors will review this report. The report will then be returned to the team to correct any significant observed problems in style, logic or fact before it is published to the "Undergraduate Journal of Experimental Microbiology and Immunology" (UJEMI) where it will be available on-line. Teams may repeat a previous experiment to ensure that the results were correct but will still be expected to produce and test an original experiment based on the resulting observations and explanations. The experiments will have some constraints imposed by time, equipment and costs.

This approach is intended to provide a more complete and realistic research experience. We also hope that it will be more interesting for you because you will be contributing knowledge and skills to solve real scientific questions instead of working on recipes chosen by the instructor.

B. Assessment and development

As discussed above, your team's goal in MICB 471 is to generate an original research manuscript accepted for publication in UJEMI. To achieve this goal you will complete a number of assignments and quizzes (milestones) that will facilitate project development over the term. You will receive feedback on each assignment but similar to a directed studies or graduate school projects you will not receive a grade for each assignment. The intent is to use this feedback to drive personal and team-based development. In some cases, we will ask you to submit a reflective summary explaining how you have enacted the feedback from an earlier assignment in a subsequent project. Assignment structure will be guided by a rubric which will also be used to deliver feedback (the assignment rubrics are at the end of the manual). At the end of term, each student will compile a portfolio (PDF format) representing all of their work in the form of assignments, quizzes and reflections. Each student will be asked to thoughtfully analyse and document their own performance during the project (effort, accomplishments, learning gains, teamwork, participation) using a list of course learning objectives or specifications. The specifications will be discussed collaboratively in detail in class and posted to Canvas afterwards. The course instructors will perform a grade similar analysis. If the student and instructor grade

for the course are within +/- 3% then a grade within this range will be assigned by the teaching team. If the student and instructor marks differ by more than +/- 3% then a meeting will be called to discuss the final grade (student grade 95%, instructor grade 85% = meeting called to discuss final grade). The instructors reserve the right to assign final grades based on our assessment of individual student learning gains and comparative analyses with other students in the course.

The submitted portfolio (saved as a PDF) must include:

1. Table of contents
2. Project 1 assignment
3. Project 1 feedback
4. Individual proposal submission
5. Individual proposal with feedback
6. Reflection (1-page single spaced maximum) explaining how individual proposal feedback will be used in team proposal preparation
7. Team proposal submission (team-based)
8. Team proposal with feedback
9. Progress report 1 of 2 (team-based)
10. Progress report 2 of 2 (team-based)
11. Oral presentation slides (team-based)
12. Oral presentation feedback
13. Reflection (1-page single spaced maximum) explaining how oral presentation feedback will be used in draft manuscript preparation
14. Draft manuscript submission (team-based)
15. Draft manuscript feedback
16. Revised manuscript (team-based)
17. Response to reviewers (team-based)
18. Draft abstract for URS or transcript from Q&A video (team-based)
19. Lab notebook (team-based)
20. Quiz 1 Answers and Reflections
21. Quiz 2 Answers and Reflections
22. Quiz 3 Answers and Reflections

The final grade assignment will consider the following

- All assignments were submitted on time via Canvas in the proper format
- Assignment criteria were addressed as per supplied rubrics
- Assignments were of high overall quality (proper formatting, citations, style, rigorous data analysis, appropriate data visualizations, well-edited writing).
- Reflections on assignment feedback were completed and suggestions were enacted in future assignments
- Quizzes were completed on time and reflections explaining incorrect answers were submitted
- Individual attended team meetings and participated
- Individual contributed to teamwork effectively
- Individual worked safely
- Individual was generally a good lab citizen (respectful and collaborative)
- Portfolio was complete and submitted on time

C. Course Operation

The class will operate as teams of three or four students.

The majority of the course is concerned with designing and carrying out a research project but Monday we will meet as a class at 3pm to 5pm. During that part of the class we will discuss/review different aspects of project design and advanced molecular, microbiology, and immunology. Towards the end of term we will also talk about the final report and the characteristics of the final report. The actual content of these classes will depend on general needs for the different projects in the class. Individual weekly meetings will be scheduled during the lab periods on Tuesday, Wednesday, and Thursday afternoons to discuss details of projects with each team. By the start of the weekly meeting each team member should have an idea of the work that the team is intending to complete in the following week and how the team will do that work.

An original copy of the team records must be maintained in a lab book (paper-based or electronic format) whenever the team is working in the laboratory. This book must include all important laboratory details such as the working hypotheses, ideas, data, explanations of observations, and conclusions as well as significant discarded ideas, relevant references, equipment names and models, chemical sources and catalogue numbers. The first page of the book must be reserved for an index that is updated each week. Each page in the book must be numbered and dated as it is used so that the important pages can be identified in the index.

The final report must be a formal journal article written in the style of the Undergraduate Journal of Experimental Microbiology and Immunology. This style is adapted from the style used in the American Society for Microbiology journals such as J.Bacteriol and J.Immunol. Approximate examples can be seen in recent volumes of the Undergraduate Journal of Experimental Microbiology and Immunology (UJEMI) at:

https://ujemi.microbiology.ubc.ca/

Keep in mind that the ASM style of citing references changes each year or so. Please use the current ASM style:

http://jb.asm.org/site/misc/ifora.xhtml

D. Purpose

The purpose of the course is to carry out a research project involving aspects of molecular biology and microbiology in order to:

1. demonstrate your ability to apply your skills in this area of science
2. expand your background in this area of research
3. learn additional molecular biology skills

E. Broad Learning Objectives

1. To develop your ability to define a research problem.

2. To develop your ability to adapt your knowledge and background to develop protocols to experimentally solve scientific problems.

3. To develop your ability to locate information and background for designing an experimental protocol.

4. To further your understanding of some of the constraints of an experimental protocol or testable question as well as recognition of the common elements in research protocols.

5. To further your ability to quantitatively analyze data and formulate logical and testable mechanistic models that account for the observations.

6. To reinforce your ability to maintain scientific records and communicate scientific results.

7. To further your ability to prepare and present written scientific reports.

8. To further your ability to organize and complete technical projects with finite resources and time.

9. To further your ability to work in scientific teams.

F. Specific Course Resources

Most of the course material is described in the lab manual. Some resources, inventories and assignments for the course are located at the MICB 471 Canvas site. Some of the files in the website can be downloaded and searched.

G. Rules

1. The major part of your lab work each week should be planned to fit your scheduled class time. However, some work will need to be done at other times to allow your projects to proceed in a timely manner. If you are working outside the scheduled class time the **available lab hours are 8:30 AM to 5:00 PM**. Plan to work within those times.

2. There should be two people present when you are working in the lab. One of the people must be the instructor or the teaching assistants if you are starting any work involving heat, gas, compressed air or hazardous chemicals. If you are counting colonies or weighing safe ingredients to prepare media or supplies you do not need supervision but it might be helpful to have supervision in case questions arise as you proceed with the work. Work that requires long periods of supervision should be confined to the scheduled lab times.

3. You must be certified before you use any hazardous or expensive or fragile equipment. Certification means that the operation of the equipment has been demonstrated to you **by the MICB 471 instructor or teaching assistant**. If there is doubt about the

operation of any of this equipment, it is important to clarify your uncertainty **before** you use the equipment.

4. You must be aware of the hazards of any work that you attempt. As part of that awareness you must consult the MSDS site for every chemical that you attempt to use and copy down or print out any significant risks and the corresponding first aid treatments.

5. You must understand the intent of each step in every protocol that you attempt to use because you will make the work safer for everyone in the lab if you understand the intent of each step in each experiment.

6. Each team must maintain complete experimental records in a single notebook that will be submitted to the course at the end of the term. You may keep individual record books but the team record book must be kept up-to-date each week and available at any time the team is working in the lab.

H. General Expectations

We expect you to remember all the general features of basic, safe aseptic work that you have encountered in other classes. These expectations include:

1. Disinfect the top of your desk with Westosan at the beginning and the end of each lab day to minimize the chance of spreading contaminants around. Wash your hands with disinfectant soap before leaving the lab.

2. Do not eat or drink in the laboratory.

3. Do not take cultures out of the laboratory without permission.

4. Inform the instructors if you spill a culture, and then disinfect the area. Use the brush at the discard cart to sweep up any broken glass or hazardous chemicals and discard them to the designated waste containers.

5. Inform the instructors about any accidents such as cuts, burns or abrasions, even if they seem slight.

6. Wear a protective lab coat when working in the laboratory and secure your hair so that it will not swish into any open flames or chemicals involved in your experiment. Wear gloves and eye protection when the hazards warrant the use of gloves and eye protection.

7. Use assigned lockers in the basement of the Biological Sciences Building to store backpacks and other equipment and materials that are not needed in the lab room. Lockers can be signed out by providing a deposit that will be returned when the locker key or lock are returned

8. Drain tubes containing toxic or corrosive chemicals to the appropriate discards then rinse the tubes with cold water before they are discarded.

9. Cultures and other solutions that are contaminated with microbes should be discarded in closed flasks or tubes so they can be autoclaved before they are dumped out. Adequate closure is achieved by covering the top of a flask with a cotton bung or a layer of aluminum foil when the flasks are discarded to the trays in the lab room.

10. Discard standard calibrated pipettes into the tall discard jars at the bench. Discard disinfected Pasteur pipettes into glass waste.

11. Keep your work space tidy and organized so it is safe and aseptic.

12. **Put away your supplies between lab days and return communal chemicals and other supplies to the appropriate storage places**.

Project 1

Prepare a batch of competent *E. coli* Molecular Microbiology Project

Purpose:

The intent of this project is to provide an opportunity for your team to begin working independently in the laboratory setting. Your team's goal is to determine the transformation efficiency of a batch of competent *Escherichia coli*. To do this you will need to prepare aliquots of competent *E. coli* and a stock of purified plasmid. You have course weeks 2, 3, and 4 to conduct literature research, design an experiment, plan, execute and document your experiment(s). You will need to source protocols, plan your experimental steps, and prepare the requisite reagents such as growth media, chemical solutions, sterile equipment and glassware. You should include appropriate controls to demonstrate that your experiment worked as expected. You should also think about replicates to gather statistical support. You may choose any (non-pathogenic) *E. coli* strain available in the lab strain collection (e.g HB101, DH5α, BL21, B). It is suggested that you think ahead to Project 2 in order to produce competent *E. coli* that may be useful to your team later in the course (Note: competent cells stored in cryoprotectant can be stable for years at -80˚C). Similarly, you may select any plasmid(s) available in our collection (e.g. pUC19, pGlo) to test transformation efficiency.

Instructions:

Your team is responsible for planning, execution, and documentation of your experiment. Lab notebook guidelines provided should be followed. The Instructor and TAs will be available throughout the scheduled lab period to provide guidance, technical demonstrations (e.g making media and pouring plates), and training on equipment such as the centrifuge, shakers, and autoclave. We can also introduce you to reference manuals and online sources of protocols.

The sections of the course manual describing proper aseptic technique, bench organization, pipetting, and safety should be carefully reviewed before beginning your work.

Portfolio deliverable:

Document Project 1 as experiments in your team's lab notebook. Relevant pages of your team's lab notebook can be submitted to MICB 471 Canvas as a word document or as a scanned PDF of the lab notebook pages (scanning can be done using the photocopier). The **deadline for Project 1 submission is noted in the course schedule**. The submitted notebook pages will be evaluated for **formatting and scientific rigor**. The results themselves will not specifically be graded, rather we will comment on qualities of the report. We will look for an effective title, a well written and referenced Introduction section, a complete Materials and Methods section, a Results section containing appropriate observations and interpretations, well presented data with appropriate statistical backing and noted limitations, objective conclusion(s), and a reasonable future directions section.

Project 2 - Research Project

Purpose:

The intent is to reinforce your understanding of the constraints of the scientific process by designing an experiment to test a proposed explanation, preparing your supplies, identifying required equipment, doing your experiments and communicating your results as an article for a scientific journal. The specific experimental objectives will depend on the observation that your team chooses to explain and the manner in which your team chooses to test the explanation.

Please visit the Projects module on the MICB 471 Canvas web site for descriptions of our 23WT2 projects. Ideas for projects have been provided, however, you are certainly not limited to these ideas. You may propose novel ideas or adaptations based on your own interpretations and reading of the literature. If you are thinking of pursuing a project well outside of these topic areas please contact Dr. Oliver to discuss feasibility.

References

Barker, K. 1998. "Chapter 4, How to setup an experiment", At the Bench, a laboratory navigator, p 69-87 Cold Spring Harbour Laboratory Press, New York, New York.

Barker, K. 1998. "Chapter 5, Laboratory notebooks", At the Bench, a laboratory navigator, p 89-99 Cold Spring Harbour Laboratory Press, New York, New York.

Instructions:

1. The project will be done by teams consisting of three or four students.

2. The general requirement is to review previous course projects to identify a research question, then to devise protocols to address your approach to the observations or problems, prepare the supplies, carry out the tests and analyze the results. A list of the titles and a list of general references are included after the materials and methods section in this project outline.

3. The proposed project may not be an exact duplicate of any other posted experiment but you may repeat an experiment in the Undergraduate Journal of Experimental Microbiology and Immunology (UJEMI) in order to confirm the results before proceeding with your own experiment. You may develop and use a modification of a published experiment if the modification provides a better solution or better insight into the problem and your explanation.

4. The number of teams choosing a particular approach or methodology might be restricted. Each proposal must be different. Proposals that assess similar ideas by different approaches or methods are still acceptable.

5. Each team is encouraged to develop the details of their proposed project. However, if you have a good idea but are unsure how to develop the idea into a testable explanation or develop a suitable protocol you should discuss the idea with the instructor or the teaching assistant to see if they have worthwhile advice. Similarly, if you are having trouble choosing an experiment or you think that you have a suitable experiment but are uncertain whether particular protocols could be attempted with the available equipment or supplies then you should discuss those concerns with the instructors or teaching assistants to get their advice. **The MICB 471 teaching lab is not equipped to deal with pathogens**.

6. Teams proposing projects involving a lot of samples or sampling should do a pretest with a few samples to ensure that the strain(s) have the correct phenotypes, the results are falling in the expected assay ranges and that the methods will work and give reproducible results.

7. The results will be presented as a research article suitable for publication in UJEMI. Any major problems or technical errors in the submitted report will need to be corrected before the manuscript is accepted for publication. The article must be accepted for publication before the mark for the project is added to your grade.

8. The instructor or the teaching assistant must approve proposals before you start significant technical preparation. Some basic preparation of media or buffers or glassware can be done in advance. Ask if you are in doubt about what could be done in advance.

9. The lab will normally be open between 8:30 AM and 5:00 PM to allow you to work on the project outside the scheduled lab periods if that work is necessary or helpful. However, we expect some of the work to be scheduled for your registered lab period when assistance will be available. Your team's lab book may be checked each week by the instructor or the teaching assistant during your registered lab period. If you work in the lab outside your registered class there must be at least one other person present if the work involves any potentially hazardous procedures or equipment.

10. **Weeks I and II.**

Each student must **individually** propose a project based on an observation or suggested follow up experiment described in a UJEMI or UJEMI+ paper that they would like to investigate and prepare a 1-page proposal of approximately 300 – 500 words. **An electronic copy (Word doc only) of your individual proposal must be submitted to the MICB 471 Canvas assignment upload portal on the due date (see schedule).** Other copies should be shared with your team mates for discussion at your team meeting.

Here is the link to UJEMI:

https://ujemi.microbiology.ubc.ca/

i. Your written report should be a maximum size of 1 page in single spaced TNR size 10 font. The written individual proposal must be uploaded to Canvas on the due date (see course schedule)**. Reports must be submitted as Word doc or docx as electronic feedback is used. Do not submit files in PDF format.**

The written proposal must include specific labeled sections for:

- **Identification**: your name and email address at the top right corner of the page.
- **Background**: the background necessary to understand / explain the relationship between the problem and the proposed explanation. (This section is not expected to be a full review of the topic but it needs enough detail for the reviewer to understand the logic for your subsequent explanation(s) and proposed experiment. In most cases this would take approximately 300 or 400 words.)
- **Observation**: a brief description of the observation / problem.
- **Hypothesis**: a preliminary potential hypothesis (a prediction supported with an explanation) that might account for the observation that you will work on.
- **Experimental question(s)**: state the actual scientific question that will test the explanation. Include an explanation of how answering the question would assess the validity of the explanation.
- **Approach**: the general experimental approach for testing your hypothesis by answering each experimental question. (What methods or combinations of feasible methods would be the key way of getting data to test your explanation? What would the results from that approach show if the explanation was correct or incorrect?)
- **Feasibility**: the feasibility and outcomes of the proposed approach. (What are the main technical difficulties? What are the main details that need to be worked out to know whether it would work? What are the limitations imposed on the analysis by these methods?)
- **References**: should support your background and any specializaed techniques or experiments. Three key references should be annotated. The reference list can be supplied on a second page.

Each student should think about additional project details and requirements and why they wanted to work on their particular proposal. This additional level of detail is not expected in the individual proposal but the information might be helpful when the team chooses the topic for the project they will develop for the rest of the term.

ii. By Week II you should have selected teammates and been assigned a lab day and bench space.

iii. Teams will choose a time for weekly meetings. Each person should be prepared to discuss their outline. Only 5 minutes will be allotted to each team members' presentation so please be prepared. The Instructor and TA may provide guidance and ask a few questions for clarification.

11. **Week III**

i. To choose a project, compare and discuss the merits of the potential projects proposed by the different team members. Consider the pros and cons of different projects, the general interest of the team and alternative explanations that might account for the observation.

ii. If your team is sure about the intended project then one choice is sufficient. If the team is less certain it is better to choose two. For each of these projects the team should identify the major **specific information** or general background relevant to understanding the observations or the preliminary explanations. When the members draw up this list they should consider what they already know about the topic and how well they recall details. They should also consider whether their knowledge is superficial or detailed, whether the knowledge is dated or current *et cetera*. For example:

a. What is known about the process that formed the original experiment? Would knowing more about that process be beneficial? Is it known whether related processes would work? Is anything known about those processes?
b. Are there known mechanisms involved in the molecular genetics for any of the components involved in the project. Would a more detailed understanding of these mechanisms give more insight into potential explanations and processes? *et cetera.*

iii. Each team member should take responsibility for researching / checking some of the various sets of information that are necessary or helpful for choosing one project and refining the preliminary hypothesis that is going to be presented at the scheduled meeting with the TA and the instructor on Week III.

iv. The team should also consider whether anyone already has a source for some of the background. The web can sometimes provide some ideas and details but the quality of information is inconsistent. More reliable sources can be found by doing library searches for journal articles and compendiums of research facts and methods. The libraries provide workshops on the use of electronic indexes for finding relevant journal articles and searching for relevant key words. Some indexes that might be useful include PubMed, Medline, Biosis and Summons. These options will be discussed further in lecture.

PubMed http://www.ncbi.nlm.nih.gov/pubmed/

UBC library provides links to many of these sites: http://www.library.ubc.ca/

Google Scholar can also be helpful but is less complete than the dedicated research indexes. In addition, by accessing articles through the UBC library, you go through the library subscriptions so more prepaid journal access is available for you.

v. At this stage you can still consider other projects if the initial choices seem less suitable when you consider the details.

vi. After considering the additional information reported by each team member, the team should decide which problem and which hypothesis or approach will be investigated. **This will be your team project for the rest of the term**. When that choice is made each person on the team should consider the known facts and logic that support the proposed explanation. Each person should also bear in mind that the eventual evaluation of the project will consider:

a. Whether the experiment is testing an explanation/model of the observations or at least setting up the potential to test an explanation/model rather than dabbling with experimental variables.

b. Whether the proposal is practical. Can it be done within the constraints of time, expertise and available equipment and supplies?

c. Whether the experiment is worth doing. Some experiments are exciting and interesting. Some experiments are bland but the results are important to further understanding. Some experiments are not worth doing because the answers are either obvious or insignificant. For some experiments the distinctions are most obvious in retrospect.

vii. During the scheduled meeting with the TA and / or the instructor during the lab class the team should be able to:

a. State the observation they intend to investigate
b. Give preliminary explanation(s) of the problem and present testable models
c. Explain what information was sought and discovered by each team member and how it applies to the potential projects.
d. Discuss the general feasibility of your project with the instructors.

viii. Consider any major additional details that the team will need to look up or work out in order to finish refining and designing the experiment. Examples of these details could include relevant strains, chemical requirements, potential hazards, necessary assays, potential equipment, recipes, scheduling *et cetera*.

ix. Assign particular team members specific duties to sort out by the following class.

12. **Weeks IV and V**

During the scheduled meeting with the TA and / or the instructor during the lab class the team should be able to:

a. State the problem that has been approved in principle by the instructors
b. Provide the potential explanation(s) of the problem
c. Explain the evidence or logic for the explanation

d. State the experimental question that will be specifically addressed and how that question relates to the original hypothesis or explanation concerning the original observation.
e. Explain the experimental approach for testing the stated question and the probable outcomes if the hypothesis is true and the probable outcomes if the hypothesis is false.
f. Summarize any outstanding issues or changes to the original questions posed in the preceding week that that need to be addressed.
g. Explain your progress over the preceding week.

Week V continued

i. The team must submit a detailed written team proposal (see course schedule). The report must provide:

- **Identification**: the team alpha-numeric and the names of the team members
- **Title**: a relevant working title for your experiment (It might change by the final report).
- **Introduction and Background**: sufficient background to understand the explanation of the observation, the chosen approach to testing the question and the outcomes.
- **Hypothesis**: the experimental observation and the proposed explanation that the project is addressing.
- **Experimental Aims**: the experimental question(s) that you are aiming to answer that will test your explanation / hypothesis of the observation. Include the potential outcomes if the explanation is correct or incorrect.
- **Protocol**: description of the project that **explains what will be done** and how the tests fit together. It would include details of sampling, number of samples, timing of sampling, types of assays for the different types of proposed measurements, controls, growth requirements. It is recommended that his be arranged in a table.
- **Methods**: description of **how the assays and tests will be done**. It would include recipes or step by step explanations and details to make measurements, grow the cultures, and actually assay the samples. Include quantities and control conditions *et cetera*. It must be detailed enough to allow the team to make the supplies in appropriate quantities.
- **Supplies and Equipment**: provides quantities, and condition of the chemicals, equipment and strains. Any required chemicals or kits or strains that are not available in the inventories for the class must be clearly identified.
- **Weekly Time Frame**: the detailed schedule of the project work that will be done by the team each week in order to finish the project on time. Some work can be overlapped to allow testing of unfamiliar procedures, testing of strains, taking preliminary measurements to assess response ranges *et cetera* before the final experiment is attempted. A Gantt chart may be useful.
- **Potential Pitfalls**: potential problems that might arise to put the work behind schedule.
- **Known Hazards**: any **significant unusual** hazards associated with the work and your means of controlling those hazards so the work is safe.

ii. This report should be submitted as a Word doc or docx (only) on the MICB 471 Canvas assignment portal. There should only be one submission for each team.

iii. The report will be graded for completeness, relevance and readability for each of the expected sections.

iv. **Submit requests for required strains, kits or chemicals** via the survey link on Canvas.

v. During the scheduled meeting with the TA and / or the instructor during the lab class for Week V the team should be able to explain the timeframe, the required amounts of supplies and equipment, the strains and the sources of strains that will be needed for the project.

vi. The team can start to prepare basic supplies that will be needed for the project.

Weeks VI-through XIII.

i. Over this time the team must finish preparing the required supplies (if they are not already available). Carry out the experiment. Examine the results. Then use the observations from your first experiment to re-design or refine the first experiment to improve or confirm the initial results. Sometimes the second experiment should use the same general approach with a better sampling strategy, additional controls or different input. Sometimes the second experiment should use a different approach to the initial hypothesis. In either version of the second experiment the intent is to refine your understanding of the initial observation and your proposed explanation of that observation. In all cases the second experiment must continue to test the idea or an explanation of the problem or observation made in the first round of testing.

ii. **On Weeks IX, XI, XIII**, prior to the scheduled meeting with the TA and / or the instructor during the lab class the team should submit a Weekly Summary by email any time during the week it is due (note: end of week is Sunday at 11:59pm).

Weekly Summaries should include:

a. The team name and submission date.
b. Project title (once defined).
c. A summary of the week's activities as bullet points.
   - max 1/2 page in single spaced TNR size 10 font.
   - Each point should <u>concisely</u> explain:

     - experimental reference numbers from your lab notebook
     - the rationale for work performed
     - results, key observations, conclusions
     - any decisions made and major changes to project
     - any technical challenges and difficulties
     - any remaining work with respect to timeline

13. **Weeks XII and XIII**. ***Continued***.

- During the scheduled lecture time, each team will present a summary of their project, including background, results, analysis, conclusions and future directions. Presentations may be delivered by one or more members of the team. Presentations should be no longer than 10 minutes maximum (points will be deducted for presentations exceeding 10 minutes in length). The audience is expected to compose questions for each presentation. Each team should choose one question to submit to the presenting team via Canvas. Each presenting team can choose to respond to 3 questions submitted by their peers via video.

- All team members must attend the lab during their normal scheduled class time to **clean up** supplies and work places unless the clean-up was done the week earlier.

Completing the project

i. Each team must submit a formal journal article that documents their hypothesis, their experiment, their results and their conclusions (see course schedule for due date). The article must be written in the style outlined by ASM Instructions to Authors.

https://jb.asm.org/content/scope

ii. If the journal article is started in the last week of class it could be a large amount of work. However, much of the effort can be dispersed if the team coordinator assigns tasks that initiate the article by early - to- mid-November (MICB 471 term 1) or mid-March (MICB 471 term 2). For example, even though the final draft might require revisions to include the final results it is possible to make a draft version of the introduction as well as the materials and methods section. It is also possible to prepare preliminary graphs and tables that portray the preliminary results from the first round of the experiment before doing the second round. It is also possible to develop a written list of the major thoughts and provisional conclusions suggested by that data. Even though the final tables and figures need to be embedded at the end of the word document as pictures pasted into text boxes the preliminary tables and figures can be prepared in Excel (or an analogous spread sheet program) and saved so they are easy to update and use when the final experiments are completed.

iii. The final report is expected to include **at least** 6 journal article references aside from UJEMI articles that are relevant to the explanation of the ideas being tested. To meet this requirement, it would be useful to continue the library searches and develop a provisional reference list well before the article is due. An early search might be helpful for interpreting the observations from the first experiment and designing the second experiment.

iv. **Streaked plates of all relevant bacterial strains, clones, constructs and plasmids used in your project must be prepared and submitted to the instructor so the strains can be preserved and accessible for any future students that wish to continue your project**. **Strains information must be emailed to the Instructor.**

18. The submitted draft reports will be reviewed in the order that they are received and the reviewer's comments will be returned to the team that submitted the report within a few days.

The team must complete any required revisions and corrections then resubmit the report in Word doc or docx electronic by due date for revised papers.

Materials and Equipment:

- Lists of inventories of the available equipment, strains and chemicals are available in the laboratory and on MICB 471 Canvas.

General References that might be Useful to find Project Background

1. Books

Molecular Cloning: A Laboratory Manual, Green and Sambrook 2014.
At the Bench ; a Laboratory Navigator, Barker K.. 1998. A guide to many basic laboratory research skills and functions.
Difco & BBL Manual , Manual of Microbiological Culture Media , Zimbro MJ, Power DA., (eds.). 2003. A manual discussing the history, properties and uses of the Difco and BBL media that are commonly used in microbiological work.
Molecular Cloning, 2nd ed., Sambrook J, Fritsch EF, Maniatis T. 1989. A manual molecular biological techniques.
Molecular Biology of Bacteriophage T4, Karam, J.D. and J.W. Drake (eds.) (1994) Reference text concerning T4 properties
Principles and Techniques of Practical Biochemistry, 5th ed., Wilson K. Walker J. 1999. Theory and application of biochemical techniques.
Short Protocols in Molecular Biology, 4th ed., Ausubel FM et al. 1999. A manual of molecular biological techniques.

2. Catalogues

Bio-Rad Life Science Research Products Information on molecular biology reagents and methods
Fisher Biotech Collection Information on molecular biology reagents and methods
Invitrogen Information on molecular biology reagents and methods
New England Biolabs Information on molecular biology reagents and methods
Promega (Fisher Scientific) Information on molecular biology reagents and methods
Roche Molecular Biochemicals Information on molecular biology reagents and methods
Sigma Catalogue Information on chemicals

3. Websites

UBC Library at http://www.library.ubc.ca

Search for journal articles related to topics by using
Biosis
Medline
PubMed
Web of Science.

These are good places to find journal articles in the topics and to search whether published authors have published more recent studies.

Google Scholar at http://scholar.google.ca/schhp?sourceid=navclient&ie=UTF-8
Search for research articles and scholarly books
Google at www.google.com
General information search site
EcoCyc and **MetaCyc** at http://ecocyc.org and http://metacyc.org

Information on metabolic pathways and enzymes in hundreds of different organisms including *Escherichia coli* and *Bacillus subtilus*.

Coli Genetic Stock Center at http://cgsc.biology.yale.edu/

Data base and source for mutant strains of *Escherichia coli* including the single gene knockout strains in the Keio Collection.

Hancock Laboratory Methods at http://cmdr.ubc.ca/bobh/methodsall.html

Extensive collection of common assays for molecular and cellular work.

Data Presentation and Analysis:

The final report for this project must be written as a journal article in a modified form of the general style used by the American Society for Microbiology. Examples of this style include the Journal of Bacteriology, the Journal of Immunology, the Journal of Clinical Microbiology and the Journal of Virology.

When the initial draft of the manuscript has been submitted and reviewed by the editors it will be returned to the authors for any required corrections or revisions. The manuscript should be submitted as a word document and the entire portfolio should be submitted as a PDF. All accepted articles will be published and available for other students in other classes to read and study.

Schedules, Performance, Marks

Schedule

The course goal is complete the assignments, reflections, and quizzes to assemble a portfolio. You will need to work concurrently on some assignments during the course. Material may be submitted in advance of the due date.

Schedule Overview (MICB 471 24WT1)

Week	Date	Lecture	Phase	Assignment/Reflection/Quiz	Due Date	Team Meetings
1	3 – 6 Sept	No lecture	P2 Individual Proposal	Lab safety tours, Wed/Thurs/Fri		none
	9 – 13 Sept	1		Project 2 Individual Proposal	15 Sept	yes
2	16 – 20 Sept	2				yes
3	23 – 27 Sept	3	P2 Team Proposal / P1 Project	Canvas Quiz 1 / Project 1	29 Sept	yes
4	30 Sept – 4 Oct	No lecture		Project 2 Team Proposal / Indiv Prop Reflection	6 Oct	yes
5	17 – 11 Oct	4				yes
6	14 – 18 Oct	No lecture	P2 Research			none
7	21 – 25 Oct	5				yes
8	28 Oct – 1 Nov	6		Canvas Quiz 2	3 Nov	yes
9	4 – 8 Nov	7				yes**
10	11 – 15 Nov	No lecture		Canvas Quiz 3	17 Nov	yes
11	18 - 22 Nov	8				yes
12	25 – 29 Nov	9		Presentation and Questions #1	25 Nov	yes**
13	2 -6 Dec	10	P2 - Writing	Presentation and Questions #2	2 Dec	yes
Exam Period						By request
UBC Exam Period (note: there is no exam during this period for MICB 471)				Project 2 Draft Paper / Oral Pres Reflection	13 Dec	By request
				Portfolio and Revised Paper	23 Dec	By request

Team meetings may be optional on some weeks depending on lab activity. Visit MICB 471 Canvas for updates on a week to week basis.

** Weekly Summaries are submitted on Weeks 9, 12 only. These assignments can be submitted anytime during the week before Sunday at 11:59am.

* Quiz 1 - WHMIS and Introductory Lab Quiz Canvas-based

Effort and Etiquette

Other research courses such as directed studies expect approximately 20 hours of lab work per week. The weekly workload for your team should be similar. Some weeks it might be higher.

Your lab work affects other people in the department that either share the same equipment, clean equipment, prepare media or instruct. There are seven rules that you will be expected to follow in order to minimize problems with other people.

1. Clean up balances, centrifuges, and spectrophotometers each time you use them.

2. Clean up your working area including the sinks and balances before leaving the lab. Put the capped tubes that need to be autoclaved and the uncapped tubes in separate discard racks. Remove tape labels and felt pen labels from flasks and beakers. Use cold water to rinse out all flasks and tubes that contained dangerous chemicals before you put the flasks on the discard cart for washing.

3. Place working equipment back in the storage areas when you finish.

4. Tell the instructors about malfunctioning equipment so that it can be repaired.

5. Tell the instructor if any particular bottles of chemicals are running low so that the chemicals can be ordered before there is a shortage.

6. Discard your cultures from the incubator and the refrigerator when the lab work is completed.

7. Prepare your own project supplies unless you have made formal arrangements to borrow supplies from another team. Respect other student's spaces and supplies.

Participation

1. Students are expected to show enthusiasm for their projects and commitment to doing the best possible job. This commitment includes demonstrating concern for other team members as well as their individual part of the projects.

2. On average over the term, each member in the team is expected to participate in the planning, lab work, analysis and writing phases of all the projects.

3. Participation will be assessed by using the weekly summary, the draft report and the final, peer comments with regard to the participation, and observed effective participation in the class work throughout the term.

4. The average weekly amount of work for each team member over the term is expected to be 5 or 6 hours per week. Some weeks might be shorter than the average if other weeks are longer as long as the overall participation balances out every two or three weeks.

5. Individual students can meet with the instructors if they feel that there is a problem in the way the workload or effort is distributed. If a member of the team is consistently not participating in the assignments or blocking participation of others then the other members of the team should discuss the problem with the instructors.

Laboratory Notebook

The lab notebook must be brought to each lab to keep it up to date and be a record of all raw experimental details. **It is your responsibility** to ensure that it is maintained throughout the term**. The TAs and Instructor may check lab notebooks from time to time throughout the term to provide feedback and to assess progress.** Refer to lab notebook formatting guidelines.

Project Proposals and Papers

The requirements for the reports will be discussed in lecture and provided as a handout.

Each report must be submitted by the due date and time. Reports will not be accepted once the material is covered in class or any submitted reports are returned to the class. Missing reports will be marked as zero when the final grade is calculated. Each marked report will be returned with written comments and suggestions on how to improve future reports. If you feel that the mark is less than you expected and you do not understand the comments in the report, please discuss your concerns about the mark with the instructor.

Project Presentation, Questions

The goal of the project presentations is to give each time an opportunity to share their research with their peers. We recognize that projects will be underway and that data will represent a work-in-progress. Teams should follow the presentation guidelines described in lecture. Conclusions should be derived from the presented evidence only (i.e. avoid speculation or extrapolation). During each presentation, each audience member should think of / compose 1 or 2 questions. These questions can be asked at the end of the presentation or can be discussed after class with your team. Each team must submit 1 question for every other team via Canvas by 5pm the day after the presentation.

Theory Assessment

Quiz questions could include:

- any concepts presented or encountered in the lectures.
- application of any general type of calculation encountered in lab work such as growth rate, growth yield, unit conversions, dilutions and data transformations
- principles for establishing or designing experiments.
- the theory covered hand-outs.
- the safety concepts and hazards discussed in Appendix B of the lab manual such as the WHMIS symbols, aerosols and containment.

Some questions might require calculators. Graph paper will be provided with the exam if it might be useful or necessary to answer particular questions.

Assignment Guides

The following pages have guides outlining criteria for the various reports that will be submitted over the term.

- Weekly Summaries – Project 2
- Project 1
- Lab Notebooks – Projects 1 and 2
- Individual Project Proposal – Project 2
- Team Project Proposal – Project 2
- Draft Paper – Project 2
- Team Oral Presentation – Project 2
- Questions – Project 2
- Video Response – Project 2

Project 1

Proposal detail	Criteria
Identification	Lab notebook is labelled with team name and names of individual team members.
Title	Experiment is given a descriptive title.
Purpose	States the goal of the project and the context of the work with respect to previous and future work.
Materials and Methods	All materials and methods are documented. Relevant literature is referenced.
Experimental Design	Experimental question and hypothesis are stated clearly. Experiment is well controlled and practical (e.g. performs sufficient replicates but does not consume unnecessary amount of materials)
Results	All observations are recorded. Data is presented as stand-alone tables or figures and is also clearly described in the text. Intepretations of data are stated. In general, results are written in past tense.
Figures and Tables	Formatted as per ASM 2013 guidelines for paper submission. Appendix F.
Conclusions	Bullet point summary of main findings and points of interest.
Future Directions	Comment on the potential outcomes and technical problems that need to be addressed.
Overall impression	Demonstrates care and critical understanding throughout the report. Correct language,

	tenses, and terms. Correct and appropriate citations.

Individual Project Proposal

Proposal detail	Criteria
Identification	Identifies your submission with your name
Background	Clearly written background to understand / explain the relationship of the explanation to the problem and the approach.
Observation / problem	Clearly written description of the selected observation or problem
Explanation / hypothesis	Clearly articulated explanation of the cause of the observation / problem that you will work on.
Experimental Aims	Clearly stated experimental question(s) that will test the explanation / hypothesis. Includes a brief explanation of how knowing the answer to the question testing the hypothesis.
Approach	Clearly written description of the general technical approach you would use to test the experimental question. Mention the specific type of methods (PCR, mutagenesis *et cetera*).
Feasibility / potential outcomes	Comment on the potential outcomes and technical problems that need to be addressed.
Overall impression	Demonstrates care and critical understanding throughout the report. Correct language, tenses, and terms. Correct and appropriate citations.

Team Project Proposal

Expected Detail	Criteria
Proposed Title	Suitable and relevant to proposal. Sufficient detail to be unique and complete with regard to the objectives.
Introduction and Background	Clearly written. Addresses details needed to understand the explanation, approach and outcomes for your proposal.
Observation and Explanation	Clearly articulated explanation for the observation. Suitable relevance. Builds on an idea instead of dabbling with a method.
Experimental Aims	Clearly written question (or part of a question) that will test the explanation. Relates to explanation and provides outcome.
Overview Chart (Concept Map)	<Optional> Brief overview that shows a diagrammatic relationship of the tests within the context of the experimental question.
Protocol	Explains what will be done. An overview of the work and how the methods fit together to address the objectives
Methods	Explains how the parts / tests will be done. Choice of suitable methods for the protocol and objective. Can be referenced but should give operational details.
Supplies and Equipment	List of supplies and chemicals needed. Include quantities and details of preparation of solutions such as solvation conditions for your actual experiment. <Primer design and analysis should be included as well as diagram of cloning steps>

Weekly Time Frame for Completing the Work	Week by week staging of the work. Allow time to test/work with unfamiliar procedures or equipment, testing strains, determining preliminary values to assess ranges before attempting the main experiment.
Potential Pitfalls	Description of the main obstacles or difficulty that might be encountered in the protocol.
Known Hazards	Identifies **unusual** and **significant** hazards (if any). Marginal if reasonable unusual problems missed. Inadequate if deadly problems are missed. Distinguishes routine, minor risks from real hazards.
References	At least four background references supporting the proposed explanation and protocol. Proper ASM style.
Participation Report	Includes a meaningful section describing how each team member contributed to the work and the report.
Overall	Demonstrates care and critical understanding throughout the proposal. Has been checked to eliminate most spelling, grammar and syntax problems. Clearly and concisely presented. Complete. Readily understood.

Draft Paper

Report detail	Consideration	Criteria
Title	Clear and Accurate	Concisely conveys intent and outcome of project
	Relevant	Relates to the study purpose
Abstract	Clear and accurate. Appropriate format	Easy to read. Consistent with article. Includes purpose, main observations and main conclusion. No abbreviations or references
	Relevant details	
Introduction	Clear and accurate	Easy to follow. Focused on the purpose of project. Proper coverage of background for the analysis and the discussion. Does not include parts that should be in Methods
	Relevant details. Appropriate content.	
	Appropriate depth	
Materials and Methods	Complete and accurate	Mentions relevant details. Uses paragraph form. **Uses citations where appropriate**. Provides enough detail to follow approach.
	Appropriate format and content. Suitable abbreviations	
Results	Consistent and accurate processing	Consistent interpretation between uses. No processing errors
	Appropriate format. Details are clear and accurate	Tables and figures processed with expected details. Suitable expressed comparable significance.
	Appropriate interpretation of the results	Interpretation of trends and observations is reasonable
	Appropriate observations	Has recognized the major relevant observations
	Appropriate comments	Integrated ideas and wrote about the ideas rather than simple descriptions
Discussion	Clear and accurate	Statements are consistent with the results, help to understand the results and relate the results to the purpose. Statements show insight. Makes use of supporting knowledge. Covers all major observations
	Relevant	
	Reasonable depth of analysis	
Conclusion	Accurate deductive statement	Deductive statement "proved" by the results rather than explanations

	Addresses the experimental question	Conclusion addresses the experimental question
Future Directions	Relevant and feasible	Addresses a significant problem or explanation raised in the discussion. Relevant to original purpose.
	Outcomes	
References	Additional, appropriate and relevant	Four additional references that provide depth to discussion. Helpful. Relevant
	ASM format, accurate and appropriate citation	Cited by number in the manuscript. Correct ASM style in listing.
Participation Report	Explain how each author contributed to the project and the report.	Includes a meaningful section describing how each team member contributed to the work and the report.
Overall	Overall impression	Demonstrates care and critical understanding throughout the report. Correct language, tenses, and terms. Good insight into results.
Lab Citizenry	Weekly lab work assessed by TAs and Instructor.	Demonstrates safe, courteous, and organized work habits in the lab.

Oral Presentation

Presentation detail	Criteria
Title	Effective title. Title is supported by data presented.
Introduction	Effectively explains: research question, significance, observation, hypothesis, and experimental aims.
Experimental concepts	Effectively explains experimental question and key concepts.
Data presentation and interpretation	Effectively explains experimental set-up (including figures and tables), observations, and interpretations.
Conclusions and Future Direction	Conclusions are supported by presented data. Future directions are logical, feasible, extensions of conclusions.
Acknowledgements	Recognize team members, collaborators, contributors, funding.
Visual aids	Appropriate use of presentation technology (e.g. Powerpoint). Slides are well designed and easily interpreted.
Formatting	All Figures and Tables are formatted as per ASM style guidelines. All figures show markers and are labeled clearly.
Delivery	Speaker(s) sets a reasonable pace, displays enthusiasm and confidence (e.g. makes eye contact), and modulates tone for emphasis.
Timing	Presentation meets time constraint of maximum ___ minutes. (Time will depend on number of teams in class)
Question and Answer Period (not included in ___ minute presentation)	Presenters effectively address questions from audience. e.g. openly considers perspectives, provide logical, direct responses.

Overall	Overall quality of presentation. Logical flow. Attention to details such as figure formatting, font size, and references.

Video Response

Proposal detail	**Criteria**
Title and Credits/References	Includes a descriptive presentation title at the beginning. Closes with team names and relevant references.
Summary of Project	Video opens with a brief (1-3 minute) summary of the project outlining key background info, the research question, hypothesis, and approach.
Originality / Creativity	Demonstrates some original thought or presentation style.
Quality of Answers	Answers address the stated question. Evidence is presented clearly. Assumptions and limitations are acknowledged. Each questions will be scored out of 3 points.
Delivery	Video is well paced; vocal tone is enthusiastic or modulated to engage viewer / listener.
Appropriate level of detail	Video explains concepts at a level that suits the target audience.
Timing	Video presentation meets maximum 15 minute time constraint.
Overall Impression	Video presentation demonstrates care and critical understanding. Clearly and concisely presented. Complete. Readily understood.

Progress Reports

Proposal detail	**Criteria**
Identification	Identifies your submission with team alphanumeric and individual names
Working Title	Current working title for project
Major Progress	Explains the goal and what has been accomplished; provide experimental reference numbers from lab notebook
Major Difficulties	Explains any major difficulties that have slowed progress or led to changes in approach
Major Changes	Explains any major changes and the purpose for the changes.
Remaining Work	Description of the remaining work and the week by week staging of the remaining work.
Overall	Demonstrates care and critical understanding throughout report. Has been checked to eliminate most spelling, grammar and syntax problems. Clearly and concisely presented. Complete. Readily understood.