BIMM 121 Letter Grade by Practicum

Student Information Sheet

BIMM 121 Laboratory in Microbiology is a course that combines intensive training in microbiology and physiology content with training and practice in basic and course specific lab techniques. In addition, students graduating this course are expected to have a firm foundation in critical thinking, data analysis using spreadsheet programs such as Excel, scientific literacy, and the scientific method.

This practicum is based on the outcomes expected by the end of the course and is therefore a comprehensive test of the concepts, skills, and competencies learned and practiced in the Laboratory in Microbiology course (BIMM 121). This practicum will be conducted with the same rigor as that experienced by students in the course and will be graded for a letter grade only and on the same expectations. Before you decide whether or not to attempt credit by practicum, it is highly recommended that you carefully examine the course learning goals and expected outcomes included in these instructions. These outcomes are based on actual student skill levels at the end of the course. It might also be useful to examine the lab manual to get an idea of the actual content.

This practicum will be a combination of hands-on microbiological work, associated critical thinking, computer work, and a written analytical exam. The practicum will be divided into two parts.

1. Wet-lab: 3.5 hours consisting of bench work and written analytical work

2. Computer and written exam: 2.5 hours consisting of tasks that will require critical thinking and writing. The lab may provide a computer but it is advisable to confirm this before the day of the exam.

Prior to the exam you will be required to complete the standard safety training administered to all students in the lab. This training should take about 75-90 minutes and is mandatory regardless of whether you have had safety training elsewhere. Please let us know in advance if you have any health conditions that would be impacted by working in a microbiology lab. These include but are not restricted to recent injury, allergies, pregnancy, and health conditions that involve suppressed or reduced immune function. Your safety is our concern.

On the day of the lab, you should bring a lab coat, safety glasses or goggles, a scientific calculator, and pens/pencils. If you require a lab coat or safety glasses, please inform the instructor well in advance. Gloves will be provided in the lab and are required for all bench work. These gloves are the standard latex powdered gloves. You will need to provide your own gloves if you have any special glove requirements.
Grade distribution is based on the following scale:

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Grade range</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 - 90</td>
<td>A</td>
</tr>
<tr>
<td>89 - 80</td>
<td>B</td>
</tr>
<tr>
<td>79 – 70</td>
<td>C</td>
</tr>
<tr>
<td>69 – 60</td>
<td>D</td>
</tr>
<tr>
<td>&lt; 60</td>
<td>F</td>
</tr>
</tbody>
</table>

**Expected Proficiencies Upon Entering BIMM 121**

1. Knowledge of cell biology equivalent to the successful completion of BILD1
   - Cell structure and the difference between Prokaryotes and Eukaryotes
   - The Central Dogma of Molecular Biology

2. Knowledge of metabolic biochemistry equivalent to the successful completion of BIBC 102 or its chemistry department equivalent Chem 114B

3. Competency in writing English

4. Basic math and calculator skills

5. Some knowledge of how to access and read scientific literature
List of Topics Covered in BIMM 121 (organized by category)

Basic lab skills
1. Pipetting
2. Dilutions and how to make mixed solutions and cultures
3. Spectrophotometry
4. Accurate observations and note taking
5. Scientific method
6. CRITICAL THINKING
7. **Scientific literacy skills**
   a. Literature searches
   b. Sound understanding of Results and Discussion sections
      i. Data analysis
      ii. Graphing
      iii. Analysis

Microbiology lab skills
1. Sterile technique
2. Microscopy
3. Staining
4. Quantitating microbes (*See Microbial quantitation)

Microbial physiology
1. Structure of cell wall – Gram stain, MacC, Sticky test
2. Endospore
3. Fermentation
4. Respiration
5. Use of macronutrients and other organic compounds
6. Motility
7. Nitrogen metabolism
8. Hydrogen sulfide production
9. Selective and differential media
10. Critical analysis of microbial physiology and environment

Applied microbiology
1. Microbial quantitation
2. Health and safety – coliforms, antibiotics
3. Growth curve
4. Food microbiology – yogurt
5. Antibiotics – antibiotic producer and Kirby Bauer (*see Health and Safety)
6. Environment
   a. Nitrogen fixation (*see Nitrogen metabolism)
   b. Extremophiles
   c. Enrichment and enumeration
7. **Bioinformatics or metagenomics**
8. **Transposon mutagenesis**
BIMM 121 Learning Goals and Expected Learning Outcomes
(Italics)

Basic Lab Skills:

A. Proficiency in measuring accurate volumes with pipettors and serological pipets
   a. Able to accurately measure and deliver small volumes with pipettors
      (formative only)
   b. Able to accurately combine measurement of small and large volumes
      with serological pipets (formative)

B. Advanced proficiency in the calculations and techniques required to make dilutions of mixed and single chemical solutions and mixed and pure microbial cultures
   a. Able to accurately calculate the stock and diluent volumes for solutions with one or more components and to make these solutions/suspensions
   b. Able to accurately calculate stock concentrations from information on dilutions

C. Comprehensive, logical, and systematic observations and note taking ability
   a. Maintain well organized and detailed notes with appropriate diagrams, tables, and calculations where necessary
   b. Observations on experiments are comprehensive and contain indication of critical analysis and forward thinking

D. Clear understanding of the scientific method and its application to experimental design
   a. Students will demonstrate a clear understanding of the principles and progression of the scientific method
   b. Students will be able to define and provide examples of the following: dependent, independent, and controlled variables and the importance and execution of control conditions.
   c. Students will be able to apply scientific method in designing a rigorous scientific experiment.

E. Demonstrated critical, quantitative, and analytical thinking skills
   a. Able to understand, demonstrate, and explain the connections between different scientific concepts
   b. Able to apply scientific and mathematical concepts to analyze novel questions
   c. Where necessary, able to apply appropriate mathematical and statistical analyses to demonstrate and support the outcome of experiments
F. Demonstrated scientific literacy skills including but not limited to the following areas:
   a. Conduct effective searches for primary literature using UCSD library and other search engines
   b. Understand the structure of a standard journal article and the purpose of each section
   c. Demonstrate ability to produce the Results and Discussion section
      i. Conduct effective analyses of large data sets
      ii. Construct appropriately organized and formatted tables, graphs, and figures to illustrate the results
      iii. Outline logical conclusions and support with the data

Microbiology lab skills

A. Master aseptic technique
   a. Demonstrate ability to transfer cells from one medium to another w/o contamination
   b. Demonstrate (show your TA) the CORRECT technique for aseptic transfer
   c. Isolate desired bacterial strain from mixture using T-streak or spread plate

B. Master the use of a phase contrast binocular microscope
   a. Rapidly and efficiently focus slides using both bright field and phase contrast microscopy
   b. Identify shape, size and cell arrangement of an unknown organism
   c. Calibrate the microscope and measure the size of a microorganism
   d. Distinguish between prokaryotes and eukaryotes
   e. Prepare good smears, wet mounts, and stains

C. Understand cell membranes/cell wall structures, their relationship to cell function, and the methods to study them
   a. Describe the structural and functional differences between cell wall/cell membrane in Gram positive and Gram negative bacteria
   b. Perform a well executed Gram stain and accurately identify the Gram characteristic of an unknown organism
   c. Relate the results to the MacConkey medium and the sticky test
   d. Describe the identification and importance of acid-fast bacteria

D. Understand the structure, function, and importance of endospores
   a. Describe the structural modifications of an endospore and their function in its survival
   b. Describe the importance of endospores and toxin production in disease

E. Demonstrate understanding of biochemical principles of energy production through respiration and fermentation
   a. Distinguish between fermentation and respiration in energy release from organic compounds
b. Describe the relationship between diagnostic tests and fermentation/respiration

c. Relate oxygen requirements respiration and fermentation capabilities

d. Explain the concept of gradients with respect to oxygen and other chemicals

F. Understand the diversity of carbon and energy sources that microbes can use
   a. Explain the diversity of methods by which organisms make or obtain carbon and energy sources, and the associated diagnostic value
   b. Identify the role of extracellular enzymes in macronutrient degradation and how the enzyme activity is detected
   c. Describe the role of macronutrient degradation in energy and nutrient cycling in ecosystems
   d. Demonstrate understanding of the diagnostic value of testing for the use of small organic compounds such as citrate and amino acids

G. Identify motility in bacteria
   a. Distinguish among Brownian motion, swimming, and swarming motility using wet mounts, agar plates, and soft agar deeps
   b. Explore the relationship between motility and oxygen conditions

H. Explain the transformation of nitrogen through the nitrogen cycle
   a. Evaluate the role of nitrogen fixation and nitrate reduction in driving the nitrogen cycle
   b. Elaborate on the effect of oxygen presence on both of the above processes
   c. Describe the effect of the presence or absence of nitrate on community diversity. Evaluate the effects of agricultural and industrial practices on nitrogen cycling

I. Demonstrate understanding of microbial hydrogen sulfide production
   a. Describe the biochemistry of hydrogen sulfide production and its detection
   b. Illustrate the non-exclusivity of fermentation or respiration
   c. Use the Kligler Iron Agar to predict one physiological activity based on another

J. Critical analysis of selective and/or differential media and their use in the identification of bacteria
   a. Identify an unknown organism using the media and physiological tests provided

K. Critical analysis of microbial physiology and the interrelationships among physiological functions, and with the environment.
Applied microbiology

A. Quantitation of microbial cultures
   a. Estimate the density of a culture using direct counts (hemocytometer counts), spectrophotometry, and viable plate counts and demonstrate understanding of units
   b. Create standard curves relating OD and either total count (hemocytometry) or viable counts
   c. Demonstrate clear knowledge of basic dilution terms and methods, calculate culture concentration, and predict colony numbers
   d. Solve dilution problems involving microbes at increasing levels of complexity

B. Health and Safety (Coliforms, Antibiotics)
   Coliforms
      a. Describe the relationship between the spread of food and water borne disease and the occurrence of coliforms and/or E.coli.
      b. Evaluate the utility of E.coli detection as a measure of fecal contamination
   Antibiotics
      c. Describe some cellular mechanisms of antibiotic sensitivity and resistance
      d. Elucidate the differences between antibiotic production, sensitivity, and resistance
      e. Explain the concept of the minimum inhibitory concentration and its use in determining the size of the Zone of Inhibition
      f. Explain how the Kirby Bauer method standardizes the relationship between the sensitivity of an organism and the size of the zone of inhibition.
      g. Design an technique to identify antibiotic producers in environmental samples

C. Growth rates: Measuring the impact of the environment on the growth of organisms
   a. Describe the phases of an ideal growth curve and explain the importance of each phase
   b. Evaluate the effectiveness of selective pressure on growth rates with particular reference to the phases of growth

D. Food microbiology – yogurt
   a. Describe the relationship between the nutrients in milk and the physiology of microbes in the making of yogurt
   b. Use the temperature and pH adaptations of yogurt microbes to predict the formation of yogurt under different incubation conditions
c. Develop a testable hypothesis regarding the formation of yogurt and design an experiment to test it.

E. Environment (Extremophiles, Enrichment and Enumeration)
   Extremophiles
   a. Describe the classification of microorganisms according to their adaptation to different ranges of temperature, pH, and osmolarity
   b. Identify and explain the adaptations in extremophiles in each of the environmental parameters listed above

Enrichment and Enumeration
   c. Demonstrate how the application of a selective pressure affects the diversity of a community
   d. Explain the use of selective and/or differential media in enrichment and enumeration of specific groups of microorganisms in an environment of interest.
   e. Elucidate the concept of enrichment using thermophiles as an example. Contrast this enrichment with one using nutrient limitation as a selective pressure
   f. Calculate the fold enrichment of the target organisms given the colony numbers and plating information under various conditions
   g. Propose an enrichment exercise providing information on the environment sampled, the type of target organisms, media and incubation conditions used, and the control conditions necessary

F. Metagenomics
   a. Describe some ways of measuring diversity in a community. Debate the pros and cons of each method
   b. Describe the selection of an indicator gene and demonstrate the identification of microorganisms in a mixed microbial community from sequence information.

G. Transposon mutagenesis
   a. Distinguish a transposon from a regular insert in a plasmid
   b. Dissect the design of each element of the transposon mutagenesis experiment and demonstrate how this experimental design eliminates all but the transconjugant
   c. The diversity of microbial populations has increased due to mutations and horizontal gene transfer – explain this statement using the transposon mutagenesis experiment as example