Lab 1: Introduction to Biotechnology Lab

From your very first day on the job, whether it's in a lab or on the manufacturing floor, you will be expected to follow standard operating procedures (SOPs). These SOPs includes following written and oral instructions, working in a safe manner, keeping detailed records of all your work, and using all equipment accurately and correctly.

Activities from this lab manual will be carried out each week in lab. Before each class, you are expected to consult the course schedule at the front of the lab manual, see which activities we will be doing, and prepare your pre-lab for each assigned activity in your lab notebook (please refer to the Laboratory Notebook activity for more details on what information should be included in your pre-labs).

The purpose of reading the lab protocols and doing your pre-lab in advance of the lab is so that you are able to use the limited time available in lab to do your lab work. You should walk into lab with a pretty clear idea of what you will be doing that day, awaiting specific instructions from me at the beginning of class with respect to where you can find the materials and equipment you need in order to get started. If you are not prepared in this way, you will likely find that you run out of time and are unable to complete the assigned lab activities. This will slow the rest of your lab group down, and will likely be reflected in your grade. On the other hand, if you come to class prepared, you will find that you are able to learn a great deal, and most students find that they have a lot of fun once they get the hang of it.

Activity 1a
Laboratory Notebooks

In this class, you will each keep a lab notebook. Lab notebooks are bound notebooks with sewn, numbered pages (not spiral notebooks). Keeping a lab notebook is a very important part of the biotechnology curriculum, and an essential professional skill. For a professional scientist, the lab notebook is a legal document. In fact, you will find that on the job, you will be required to sign and date every page of your lab notebook. Many millions of patent decisions come down to whether the scientist has properly documented their work. Often companies have to prove that they were the first to develop a specific procedure or product, and their proof is their laboratory documentation!

When you write your lab notebook, you must use only waterproof, unerasable ink. Before the lab, you will complete a pre-lab in your notebook. During lab, data is written directly into the notebook. The purpose of all of this is so that data is not accidentally lost or purposely faked after the experiment. All data is labeled descriptively, so that anyone else who reads the notebook knows how the experiment was done and what each piece of data refers to. Calculations and conclusions from the data are done in the lab notebook. At the front of your lab notebook, you will make a table of contents so that you can easily locate each experiment. You may run out of room for a lab activity and need to finish recording information on a later page. If so, write "go to page [number]" in the bottom corner of the page. On the page you "go to," write, "from page [number]" in the top corner of the page. This way, you will be able to find all the information you need for a particular lab activity.

Let's review the criteria for keeping a proper laboratory notebook:

1) Bound notebook with sewn, numbered pages
2) Permanent, uneraseable ink
3) Table of Contents located at front of lab notebook
4) Each activity has pre-lab completed before lab begins
5) All data is written directly into lab notebook
6) Calculations, amounts, equipment used, etc. are recorded directly into lab notebook
7) Use "go to page…" and "from page…" statements to link segments of a lab activity

Effective preparation of your lab notebook is a critical time management skill during lab work. If you read the labs in advance and prepare your pre-lab properly, you will know exactly what to do once you are in lab, and you will be able to focus on completing the lab activities during lab instead of working on your notebook in class. This will greatly increase your efficiency during lab and enable you to finish all the activities in the time available.

To encourage you to develop the skill of keeping a lab notebook, I will be checking each person's lab notebook at the beginning of each class and before you leave class for the day. This

is very important, since this is how you receive your notebook points. You need to come to class prepared with your notebook written out before class starts to earn the pre-lab points (6 points per lab), and then show me that you have completed the lab for the post-lab points (6 points per lab). There will be an automatic 1 point deduction from your pre-lab for every 10 minutes you are late to class.

- **Pre-lab notebook requirements:**
  1. Title and reference
  2. Purpose of lab activity
  3. Overview of procedure
  4. Data table(s) and/or diagrams, when indicated or appropriate

- **Post-lab notebook requirements:**
  5. Data recording
  6. Observations and procedural notes
  7. (occasionally) Graph of data

Below is a detailed explanation of each of these sections.

PRE-LAB:

1. **Title & reference** for the experiment. This should be a descriptive title, not just an experiment number. Sometimes the title I use will be sufficient, and sometimes you may need to add a little information to make the title more descriptive. The reference for the lab activity procedure is simply the page numbers from the lab manual. This allows you to quickly refer to your lab manual when doing an experiment or review your data later.

2. **Purpose of lab activity**. This is a brief statement that describes **why** you are doing this activity or experiment. Since you are learning most of these procedures for the first time, the purpose of doing the lab activities is frequently to learn a new skill or procedure. For example, "To learn how to use micropipettes accurately," or "To learn how to introduce plasmid DNA into bacterial cells."

3. **Overview of procedure**. This is a general description of **what** you will be doing in the lab activity or experiment. Read the experiment, and write a summary (about one paragraph long) in your own words of what you plan to accomplish and how. Be complete without going into too much detail. Example: "In this activity, we will continue learning about assay development by learning how to assay activity for the enzyme peroxidase. We will test plant and animal materials for peroxidase activity, isolate the peroxidase enzyme from horseradish root, and test for peroxidase activity using the chemical TMB." You should NOT list all of the procedure's steps in this section. Do NOT copy the laboratory manual into your notebook! By the time you have read the lab activity and written this overview, you should have a good idea of what you will be doing when you get to lab.

4. **Data tables**. In many lab activities, you will prepare blank data tables. Read through the procedure of the lab to see what measurements you will be making and what data you will be recording. In your notebook, write down in order a brief description of the data you will be

taking, including units, and leave space for the actual data. Organize this information into a neat table. Occasionally, a data table will be designed for you in your lab manual, but you will often need to make your own data table based upon the data you will be collecting during your lab activity. Here is an example of a data table from your lab manual:

Table 3.1 $CuSO_4$ Mass/Volume Solution Preparation

Tube #	$CuSO_4$ solution	Total Volume	Concentrat'n (mg/mL)	Calculation of Mass Needed (g)
1	5.0 mL of 300 mg/mL			
2	4.5 mL of 150 mg/mL			
3	4.0 mL of 75 mg/mL			
4	3.5 mL of 37.5 mg/mL			
5	3.0 mL of 18.75 mg/mL			

POST-LAB:

5. **Data recording**. During lab, you will enter data into tables; all units should be clearly labeled. Data includes all calculations, measurements, and results obtained during the lab activity or experiment.

6. **Observations and procedural notes**. Here, you describe exactly what was done during the lab. This is not a copy of the lab manual procedure. Rather, it is a description of what your lab group did. If everything was done exactly as described in the lab manual, then you can simply write a brief summary of when certain steps were done and other relevant information. Often, you will need to deviate from the procedure in the lab manual, or you will make a mistake. This is the area to write down how you did the experiment, start and stop times for any incubations, whether there were any deviations from the lab protocol, and whether something occurred that was unexpected. This is very meaningful information that will help you interpret your data.

7. (occasionally) **Graph of data**. A few times during the semester, you will collect data that needs to be graphed. On these occasions, the graph will be a part of your post-lab.

Activity 1b
Laboratory Safety & Etiquette

A biotechnology laboratory, like most laboratories, can pose a number of different safety hazards. In order to protect yourself and your labmates, it is very important to be aware of safety concerns in our biotechnology lab, as well as in any future laboratory workplace in which you may be employed. In addition, you must know and follow the basic lab safety rules and always work to reduce potential risks in the lab. Should an accident occur, each student must know what to do to minimize the damage that might occur. This includes knowing the location of emergency equipment and how to use it.

Laboratory Safety Rules

1. No eating or drinking in the lab. Budget your time as necessary in order to take short breaks for water and food.
2. Wear gloves and goggles when necessary. Tie long hair back when working with chemicals, bacterial cultures, or open flames.
3. Know the locations of the fire extinguisher, safety shower, and eye wash.
4. Dispose of broken glass safely and properly in the cardboard glass disposal bin—not in the trash can. If you break any glassware, let me know so that I can help you clean it up safely.
5. Always be aware of any potential danger from a substance used in a lab activity. Some chemicals are hazardous to touch or breathe and should be used with extra caution. Also, some chemicals may be flammable or very reactive in the presence of specific other chemicals. Special care must also be used when handling these chemicals.
6. When working with bacterial cultures, all instruments and lab materials that have been contaminated with microorganisms must be disposed of properly. I will give you specific instructions for disposal of these materials when appropriate.
7. When using laboratory instruments and equipment, always follow instructions correctly. If the instructions seem unclear in any way, please ask me to clarify them. This will prevent potential injury and damage to laboratory equipment.
8. Report spills and accidents to your instructor immediately.

Laboratory Etiquette

1. Keep your lab area neat while you are working.
2. When using a chemical or material that is to be shared by the whole class, make sure to return the chemical or material to the common area so that it is available to other groups. If a piece of equipment needs to be shared by the whole class, be efficient so that other groups do not have to wait excessively.
3. Make sure that all lab instruments and equipment are clean and stored in the correct place after you have finished using them.
4. If you are going to go on a break and leave the lab for more than a couple of minutes, let your lab group members know so that the group can make sure that experiments can be completed within the lab period.
5. Lab work should be shared equitably among all members of a lab group. Everyone should do their part, and everyone should have the opportunity to practice important lab skills.
6. Make sure to leave 10 – 15 minutes at the end of the lab period in order to clean up, wash glassware, and restore your lab bench to its original condition.

Activity 1c
Laboratory Reports

You will turn in a total of 2 lab reports worth 50 points each. We will have done 8 different sets of experiments that were investigative labs by the end of the semester. You can choose which 2 you wish to write up and turn in. Please refer to the list of experiments at the end of this handout when choosing experiments to write up for a lab report.

Due dates:

The first lab report will be due at the midpoint of the semester, and the second lab report will be due the last week of class, just before Exam 2. Please refer to your syllabus for the exact due dates. You can turn lab reports in early or by the due date. No late work will be accepted.

Your lab reports must include the following sections:

NOTE: These sections should be separate sections, with headings so that they can be easily identified.

- ***Purpose***: Why are you doing the lab? This should be summed up in 1-2 sentences.
- ***Procedure***: Summarize the procedure that you wrote down in your lab notebook. This won't be as detailed as your lab notebook, but should be sufficient to allow another person to understand how you did your experiments.
- ***Results***: What happened during your experiment? You should have this information in your notebook. Summarize and describe your data and the outcome of your experiments here.
- ***Discussion***: This is the fun part—the data analysis! Why did your results come out the way they did? Did the experiment give you the outcome that you expected? What may have gone wrong?

If you've never written a lab report before, or if you are unsure about the format, please ask me before you start—I am happy to help!

Writing:

Writing quality, grammar, sentence structure, and spelling are an important part of your grade. If you need assistance with your writing, please go to the Writing Center on campus (room E-257, phone: 510-464-3426). Your lab report must be individual work in your own words. You may not do lab reports with your lab group together and turn in copies of your group lab report. This will be considered cheating, and will result in zero credit for the assignment.

Note all of the lab activities that we will do are experiment-based; therefore, only some of the lab activities are appropriate for writing a lab report. On the following page, you will find a table listing each lab topic and the associated activities that should be covered for a complete lab report. If you have any questions about which activities can be used to write your lab report, please ask me.

You will also find a grading rubric on the next page. When I hand back your graded lab report, you will have a rubric like this one stapled to your report, with points assigned and comments written by me. When preparing your lab report, you may find it helpful to consult this grading rubric so you know exactly what is expected in a complete lab report.

Experiments appropriate for a lab report write-up:
(Note: You must cover <u>all</u> parts of the lab on which you choose to write in one cohesive report)

Topic	**Includes lab activities:**
DNA Fingerprinting	5a, 5b, 5c
Assaying for sugar, starch & amylase	6a, 6b, 7a
Testing plant substances for antibacterial activity	6c, 7b
Testing different enzymes on apple juice production	7c
Testing for peroxidase activity; isolation of HRP, testing for HRP w/TMB	8a, 8b, 8c
Bacterial transformation	9a, 10a
GFP purification & determination of concentration	11a, 12a, 12b
SDS-PAGE, gel staining, Western blot	13a, 13b, 14a, 14b

Tips for a successful lab report

• Writing should be in the <u>past</u> <u>tense</u>, since you are describing work that has already happened.
• If you choose a topic that has multiple activities, make sure you address all the activities in your report, but do so in a cohesive way. In other words, you should write <u>one</u> purpose, <u>one</u> procedure, <u>one</u> results section, and <u>one</u> discussion section that covers all the activities. Do not write multiple sections for each activity.
Your results section <u>must</u> have some type of figure (the procedure section might also have one as well). It might be a drawing of a gel or a plate, or a graph of some kind; this will depend on which topic is chosen. It's a very good idea to consult with me *before* you start working on your lab report to discuss which type of figure is appropriate for the lab topic you have chosen.
• Don't confuse the results and discussion sections. The results section is where you present your data and all details associated with the data, with *no interpretation*. All interpretation of the data, discussion of whether the outcome was expected or not, and consideration of error and experimental difficulties should be done in the discussion section.
• Make sure you spend a <u>lot</u> of time on your results and discussion sections. This is where you demonstrate that you really understood the data that you obtained and present your thoughts and interpretations of the data. Go over the components I'm looking for in the rubric on the next page and make sure you have covered each one thoroughly.
• You don't need to include background information about your topic. This is not a research paper, so you can just focus your report on the sections required.
• If you are unsure about anything regarding your lab report assignment, please ask me—I'm here to help!

Grading Rubric for Bio 75 Lab Report

Purpose _____ (6 pts)
- clearly and accurately stated
- thorough (includes all information relevant to the purpose of the experiment)
- succinct (does not include information that is unrelated to the purpose)

Procedure _____ (9 pts)
- experimental procedure is summarized in student's own words (not a list of steps)
- procedure is clear and easy to understand
- all critical aspects of the procedure are described

Results _____ (12 pts)
- experimental data and observations (both quantitative and qualitative) are clearly described
- data tables, diagrams and/or graphs are presented clearly, logically, and neatly
- results are complete; all data pertaining to the experiment are presented and discussed

Discussion _____ (12 pts)
- clear understanding of experiment and what was expected for data/results
- thoughtful, deep discussion of quality and significance of results
- possible sources of error in the experiment are described
- discussion of future experiments: improvements, further areas to explore

Writing quality _____ (11 pts)
- logical progression of sentence structure and paragraph structure
- grammar, punctuation, and spelling are correct
- scientific words are spelled, labeled, and abbreviated correctly

Activity 1d
Metric Units and Conversions in Biotechnology Lab

Base units used in the metric system
To measure length, use ***meter***.
To measure volume, use ***liter***.
To measure mass, use ***gram***.

Prefixes used in the metric system*
(*Those that you will use most commonly in biotechnology are boldfaced.)

Prefix	Symbol	Meaning	Exponential Notation
kilo	**k**	**1,000**	**1×10^{3}**
base unit (no prefix)		**1**	**1×10^{0}**
centi	**c**	**.01**	**1×10^{-2}**
milli	**m**	**.001**	**1×10^{-3}**
micro	μ	**.000001**	**1×10^{-6}**
nano	n	.000000001	1×10^{-9}

The latin prefixes used in the metric system literally mean the number they represent.
Example #1: **1 kilo**gram = **1000** grams Example #2: **1 milli**meter = **0.001** meters

Why Metric?

A. The metric system is <u>much</u> easier. All metric units are related by factors of 10. This means fewer mistakes, less confusion and a greater understanding of scientific principles and concepts!
B. Nearly the entire world (95%), except the U.S., now uses the metric system. (see map) U.S. economic competitiveness would be strengthened by converting to the metric system.
C. Metric is used exclusively in science -- therefore, understanding of scientific and technical issues by non-scientists will be enhanced if the metric system is universally adopted.

How to convert within the metric system using the B—S rule (METHOD #1)

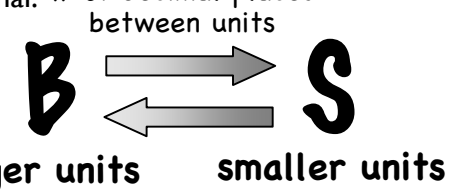
1. First, learn where the metric prefixes are along the metric scale. Each notch on the metric scale represents one power of 10. This means you would either multiply or divide by 10 when moving one notch on the metric scale.

nano *n* | **micro** *μ* | **milli** *m* | centi *c* | **base** | **kilo** *k*

[smaller size units] [bigger units]

2. Determine the number of notches between the unit you have and the unit you want. This is the number of places that you will move the decimal point when converting between the two units. Moving the decimal one place to the right is the same as multiplying by 10. Moving the decimal point one place to the left is the same as dividing by 10.

3. Use the B ← → S rule to determine which way to move the decimal. You move the decimal to the right (multiply) if converting from bigger units to smaller units, or to the left (divide) if converting from small units to bigger units.



4. Double-check: think about your answer and ask yourself if it makes sense!

Metric system conversions using dimensional analysis (METHOD #2)

Dimensional analysis is a method of converting between different units of measurement. This method is used in chemistry and physics courses. While it requires a bit more set-up on paper, it has the advantage of built-in checks and balances. In other words, you can tell if you set up a problem correctly by whether the units cancel.

To start, consider that all measurements consist of a numerical value and a unit. You should always include the units when writing any number in your lab notebook; without the units, the number is often meaningless. Once you memorize the metric prefixes, these can then be used as conversion factors. For example, looking at the metric scale, you can see that there are 1000 millimeters in a meter. This can then be written as $\frac{1000\ mm}{1\ m}$ or as $\frac{1\ m}{1000\ mm}$

These are conversion factors. Another common conversion that you will do in biotech lab is to convert between milliliters (ml) and microliters (μm). Since the "milli" and "micro" metrix prefixes are three notches from one another on the metric scale, you can say that there are 1000 microliters (the smaller sized unit) in 1 millileter (the relatively bigger sized unit). Now you can use this information as a conversion factor: $\frac{1000\ \mu l}{1\ ml}$ or as $\frac{1\ ml}{1000\ \mu l}$

To convert from one unit to another, you simply take the measurement you have, and multiply it by the conversion factor that will convert the units you have to the units you want. You do this in your day to day life without thinking about it. For example, if you are going to watch a movie that is 90 minutes in length, you mentally calculate that this movie is 1.5 hours long. To do this, you used a conversion factor along the way:

$$(90\ \cancel{min}) \times \left(\frac{1\ hour}{60\ \cancel{min}}\right) = 1.5\ hours$$

conversion factor, set up so minutes cancel & hours remain

So, to convert 530 milligrams (mg) to grams (g), you would set up the following:

$$(530\ \cancel{mg}) \times \left(\frac{1\ g}{1000\ \cancel{mg}}\right) = 0.53\ g$$

conversion factor, set up so milligrams cancel & grams remain

Lab 1 Homework

Name: _____

1. You want to know how many mm are in 62.9 m.
   a) First, how many places will you be moving the decimal? (How many notches on the metric scale is milli from the base unit)? _____.
   b) Next, are you going from a bigger sized unit to a smaller sized unit (B→S) or a smaller sized unit to a bigger sized unit (B←S)? _____.
   c) So, you will move the decimal point _____ places to the _____.
   d) Finally, 62.9 m = _____ mm.

2. 7.2 mL = _____ L

3. 0.045 mL = _____ μL

4. 0.037 m = _____ km

5. 6309 g = _____ kg

6. 2300 μL = _____ L

Do the following metric conversion problems using method #2 (dimensional analysis).

7. How many L are in 650 mL?
   a) First, what are your starting units? _____.
   b) Next, what units to you want to convert to? _____.
   c) What conversion factor will you use? _____.
   d) Set up and solve the problem:

8. 0.257 L = _____ mL
   Set up and show your work here:

9. 4.13 mL = _____ μL
   Set up and show your work here:

10. 0.088 g = _____ μg
    Set up and show your work here: