Engineering Faculty Document No. 01-22
April 22, 2021

TO: The Faculty of the College of Engineering

FROM: The Faculty of the School of Biomedical Engineering

RE: Change to Undergraduate-Level Course BME 20500 requisites and structure

The faculty of the School of Biomedical Engineering has approved the change in requisites and structure of the course listed below. This action is now submitted to the Engineering Faculty with a recommendation for fast-track approval.

FROM: **BME 20500 Biomolecular and Cellular Systems Laboratory**
Term offered: Fall, Laboratory, Cr. 1, 16 weeks
Prerequisites: BIOL 23000 (may be taken concurrently) and (BME 20100 (may be taken concurrently) or CHM 26300 (may be taken concurrently) or BCHM 30700 (may be taken concurrently))

Introductory laboratory experience focused on engineering concepts and practices in the analysis of biomolecules and cells. Topics include fundamental quantitative techniques of analysis, methods of isolation, identification, and quantification of biomolecules and cells, and analysis of integrated biosystems. Concludes with student-driven design project. Typically offered Fall.

TO: **BME 20500 Biomolecular and Cellular Systems Laboratory**
Term offered: Fall or Summer, Laboratory, Cr. 1, 16 weeks or 8 weeks
Concurrent Prerequisite: BIOL 23000

Introductory laboratory experience focused on engineering concepts and practices in the analysis of biomolecules and cells. Topics include fundamental quantitative techniques of analysis, methods of isolation, identification, and quantification of biomolecules and cells, and analysis of integrated biosystems. Concludes with student-driven design project. Typically offered Fall.

REASON: Changes made to the course provide more curricular flexibility. The course schedule has been redesigned so that this course can be delivered as either a 16-week course or an 8-week course; similar to consolidating courses for delivery in summer. The 8-week course has been piloted under a temporary BME 29500 course number twice in Fall 2020. This change will now allow this course to be offered as an 8-week course in the summer as well as in the fall. Pre-requisites also now accurately reflect knowledge needed for the course.

George R. Wodicka

George Wodicka
Professor and Head
Weldon School of Biomedical Engineering

BME 205
Analytical Methods for Biomolecular and Cellular Systems

Course Manual
Version 10
Fall 2019

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Acknowledgements

This work represents the collaborative efforts of:

- Jennifer A. McCann-Brown, Ph.D., Former Undergraduate Laboratory Coordinator for the Weldon School of Biomedical Engineering.
- Sherry L. Voytik-Harbin, Ph.D., Professor for the Weldon School of Biomedical Engineering and department of Basic Medical Sciences.
- Aaron Lottes, Ph.D., M.B.A., Former Teaching and Research Assistant for the Weldon School of Biomedical Engineering.
- Ann E. Rundell, Ph.D., Professor for the Weldon School of Biomedical Engineering.
- Allison L. Sieving, Ph.D., Former Lab and Assessment Coordinator for the Weldon School of Biomedical Engineering.
- Lester J. Smith, Ph.D., Former Lab and Assessment Coordinator for the Weldon School of Biomedical Engineering.
- Rucha Joshi, Ph.D., Former Post-Doctoral Research Assistant for the Weldon School of Biomedical Engineering.
- Aya Saleh, Ph.D., Graduate Teaching and Research Assistant for the Weldon School of Biomedical Engineering.

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- Albena Ivanisevic, Ph.D., Former Assistant Professor for the Weldon School of Biomedical Engineering and department of Chemistry.
- Jim Jones, Former Research Manager for the Weldon School of Biomedical Engineering.
- Beverly Waisner, Former Laboratory Technician for the department of Basic Medical Sciences.
- Joanne Kuske, Former Research Associate for the Weldon School of Biomedical Engineering.

BME 205 Course Syllabus
Fall 2018

Course Instructor: Dr. Sherry Harbin — Office: MJIS 3033
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Lab Coordinator: Asem Aboelzahab — Office: MJIS 1055
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Mr. Mrugesh Parasa
Email: mparasa@purdue.edu

Ms. Dana Moryl
Email: moryl@purdue.edu

Class Location: MJIS 1053

Hours:

Tuesday:	11:30 AM – 2:20 PM
Wednesday:	8:30 AM - 11:20 AM
Wednesday:	1:30 PM – 4:20 PM
Thursday:	11:30 AM – 2:20 PM
Friday:	1:30 PM – 4:20 PM

Office Hours: See Blackboard

Co-requisites: BME 201 "Biomolecules"
BIOL 230 "Biology of the Living Cell"

Course Description:

Introductory laboratory experience focused on engineering concepts and practices in the analysis of biomolecules and cells. Topics include fundamental quantitative techniques of analysis, methods of isolation, identification, and quantification of biomolecules and cells, and analysis of integrated bio-systems. This course concludes with a student driven design project.

Course Outcomes:

Upon completion of the course, each student will be able to:

1. Independently describe the theoretical basis of, and put into practice, fundamental analytical tools and techniques used in the isolation, characterization, and quantification of biomolecules and cells

2. Collect, record, process, statistically analyze, and report experimental data related to the analysis of biomolecules and cells in an accurate and understandable manner
3. Conceptually design a simple analytical method and/or tool for solving a medically' relevant problem based upon detection/analysis of a specific biomolecular or cellular related abnormality.

Lab Manual: Analytical Methods for Biomolecular and Cellular Systems

Supplies: Laboratory Notebook with duplicate pages (required)
Examples:
- Roaring Springs, Edison Lab Notebook # 7097277644
- National Brand, Laboratory Research Notebook # 7333343649

Safety Goggles (optional: student choice)

Laboratory Attire: Safety regulations require that you wear long pants (or equivalent) and closed-toe shoes while working in the laboratory

Academic Conduct: You are expected to behave in a professional and ethical manner. Only through rigor and practice does one become a competent engineer that contributes to society. Plagiarism and cheating undermine that process. Plagiarism or cheating will result in a zero for that particular assignment. If an individual behaves unethically during the semester, the instructor reserves the right to fail the student. For more information, see Purdue University Student Conduct Code at:

http://www.purdue.edu/odos/administration/codeconduct.htm.

The student is also expected to respect course instructors and contribute to a positive atmosphere in the class. Undermining or disruptive behavior will be reflected in your participation grade.

Class Attendance: 100% attendance is required to pass. In the case class is missed due to extenuating circumstances (e.g., death in family, illness), the course instructor should be contacted immediately (prior to class, if possible) and written documentation will be required. Makeup work will be considered and assigned on a case by case basis.

Campus Emergency Policy: In the event of a campus wide emergency the class outline and course requirements may be subject to change. The course instructor will provide information in regards to changes in the course requirements or course schedule as a result of a campus wide emergency.

Grading Scheme:

Standard Labs (8)	**70%**
Break down of standard laboratory grading	
Pre4Lab	*15%*
Notebook	*15%*
Participation	*10%*
Post4Lab Analysis	*30%*
Formal Labs (2)	**10%**
Break down of formal lab grading	
Prelab	*2%*
Notebook	*2%*
Lab Report	*6%*
Design Project (1)	**10%**
Break down of design project grading	
Assignment 1	*5%*
Assignment 2	*2.5 %*
Assignment 3	*2.5%*
Lab Practical*	**10%**
Total:	**100%**

**Note: You will receive a zero on your lab practical unless you bring a copy of completion of the end of course evaluation. Time will be set4aside in class for you to complete this requirement.*

Grade Scale: The following grading scale is guaranteed; however, based upon student performance, final grades may be curved by the instructor.

A+	**100%**	**A**	**100 – 93%**	**A-**	**90-93%**
B+	**89 - 87%**	**B**	**86 – 83%**	**B-**	**82-80%**
C+	**79 - 77%**	**C**	**76 – 73%**	**C-**	**72 - 70%**
D+	**69 - 67%**	**D**	**66 – 63%**	**D-**	**62 - 60%**
F	**59% and below**				

For this class you can use Blackboard Vista to view your grades and obtain useful support information. To access Blackboard Vista use the following link:

https://**mycourses.purdue.edu**

Regrade Policy: Students have the right to contest any grades throughout the semester. In the event that a student feels an assignment has been inappropriately graded, the student must submit one typed page indicating the source of the problem and an

explanation for the regrade submission. Along with this document, the original assignment must be returned. Students have 1 week to protest a grade; after this time, grade disputes will not be accepted. Papers submitted for a regrade will be completely reevaluated (i.e., the entire paper will be regraded, not only the portion under protest), which means that students may lose additional points for mistakes missed during the first grading process. Please note that all regrade requests will be evaluated at the end of the term and will only be considered for those students with a borderline grade (i.e., between an A and B).

Assignments:

- ***Pre Lab**:* Prior to each laboratory session, students are expected to read over the laboratory material. Pre Lab questions and exercises are designed to prepare you with the appropriate knowledge to be successful in the laboratory and for working with equipment and data analyses associated with biomolecular and cellular systems. Some Pre Lab activities will require the reading and researching of resources other than the laboratory manual (e.g., internet; relevant books). All Pre Lab assignments are to be completed online through Blackboard Learn. Prelab assignments must be completed on Blackboard Learn prior to the start of your assigned laboratory. Late completion of a Pre Lab will result in a grade of zero. Refer to the Lab Guide section for additional details.
- ***Notebook:*** During Lab, students will be expected to record appropriate data; Students will turn in the carbon copy pages of their notebook for grading the following week with the Post Lab Analysis or Formal Lab Report. Refer to the Lab Guide section for additional details.
- ***Post Lab Analysis:*** After Lab, students will be expected to process and analyze data as specified for each laboratory activity. Post Lab analyses associated with each week's session are due at the start of the following laboratory session unless specified otherwise. Refer to the Lab Guide section for additional details.
- ***Formal Lab Report:*** Students will prepare two formal laboratory reports (Lab 3 and a combined report for Labs 5, 6, & 7). These detailed reports should be no more than 12 double-spaced pages in length and written following the IEEE format (see blackboard for IEEE formatting styles).
- ***Design Project:*** In this course you will explore the first stages of engineering design: information gathering, problem definition, idea generation, and evaluation and decision making. There are three assignments associated with these concepts due at various times in the semester. Refer to the design project section of lab manual for specific details on the design project assignments and due dates.
- ***Lab Practical:*** This Lab has a comprehensive final lab practical that evaluates your knowledge of laboratory equipment, data analysis, and application of experimental methods. This lab practical is a closed booked/note written exam.

CLASS OUTLINE

WEEK OF	WEEK	LAB ACTIVITY	ASSIGNMENT DUE
MODULE 1: FUNDAMENTAL QUANTITATIVE TECHNIQUES			
8/19	1	Lab 1: Fundamental Laboratory Safety and Practices	Pre lab 1
8/26	2	Lab 2: Principles of Microscopy	Post lab 1; NB 1; Pre lab 2
9/2	3	Lab 3: Protein Analysis	Post lab 2; NB 2; Pre lab 3
9/9	4	Lab 4: Chromatography	Lab Report (Lab 3); NB 3; Pre lab 4
MODULE 2: FROM BIOMOLECULES TO CELLS: ISOLATION, IDENTIFICATION AND QUANTIFICATION			
9/16	5	Lab 5: Centrifugation and Cell Fractionation	Post Lab 4; NB 4; Pre lab 5
9/23	6	Lab 6: PCR	Pre lab 6
9/30	7	Lab 7: DNA Analysis	Pre lab 7
MODULE 3: ANALYSIS OF INTEGRATED BIOSYSTEMS			
10/7	8	Lab 8: Cell Cycle	Lab Report (lab 5, 6, and 7); NB 5, 6, 7; Pre lab 8
10/14	9	Lab 9: Antibodies and ELISA	Post lab 8; NB 8; Pre lab 9
10/21	10	Lab 10: Enzyme Kinetics	Post lab 9; NB 9; Pre lab 10
MODULE 4: APPLICATION AND DESIGN OF BIOMEDICAL PLATFORMS			
10/28	11	Lab 11A: Molecular Engineering	Post lab 10; NB 10; Pre lab 11
11/4	12	Lab 11B: Molecular Engineering	**Assignment 1: Design Project Paper**
11/11	13	Lab 12: Biosensors, Ligand Attachment	Post lab 11; NB 11; Pre lab 12
11/18	13	Lab Practical Review, complete Lab 12, and **Design Project: Team Analysis (Assignment 3)**	**Assignment 2: Design Project Ideas**
11/25	13	Thanksgiving Break	
12/2	15	Lab Practical (night exam Wed 12/4; 6:30 – 7:30 pm PHYS 112)	Post lab 12; NB 12
12/9	16	Finals week – No class	

Table of Contents

This guide is intended to inform you of your responsibilities in managing the cleanliness and organization of the lab station you will be using for the next two semesters. For effective and safe use of your lab time, it is vital that you take care of your lab station. Further, maintenance of the lab station by each lab section will ensure that you do not have to spend your lab time cleaning after the previous lab section.

Lab Station Assignments

Each station has been assigned a number and each section has been assigned a color to improve workflow efficiency and identify team projects. Please use the microcentrifuge tubes and microcentrifuge racks assigned to your section. If the rack is in use from a previous section, please inform your TA or instructor.

Clean and Organize All Equipment

At the end of each lab session, be sure to wash all equipment with either soap and water or 70% ethanol, where appropriate, and place the equipment into the appropriate location.

Clean the Computer, Too

If you are using the computer during the lab session, clean the keyboard and mouse before you leave by spraying a paper towel with 70% ethanol and wiping down the equipment. Do not spray ethanol or apply any liquid solutions directly onto the computer equipment.

Autoclave Bags

There are translucent autoclave bags in orange standing bag holders on your lab station. Use these bags for pipet tips and small refuse unless otherwise specified. Do not discard gloves, plates, or tissue culture dishes into these bags. Once full, close and place the bags into the large “look alike” waste boxes. Refill the bag holders with new autoclave bags.

This is Part of Your Participation Grade

Per your syllabus, there will be points deducted from your post lab grade if your lab station is not cleaned and organized since this is part of your participation effort.
This means that a perfect post lab submission can result in a B if your station is unkempt.

Also, keep in mind that this is a team effort so each of you is responsible for lab station upkeep. The points lost will apply to the entire team unless otherwise specified.

Lab Station Organization

The lab stations are organized such that most equipment and items you need are available to you for each lab session. Please become familiar with this organization and return equipment/items to their proper places at the end of your lab session.

- Station countertop (Top Level)
  - Autoclave bags in standing bag holders
  - Computer workstation
  - Microcentrifuge
  - LTS Pipettors
    - LQ1000
    - LQ200
    - LQ20
  - Pipettor holders
- Station countertop (Low Level)
  - 2 light microscopes
  - Drying rack
  - 10% Bleach
  - Hand soap
  - Dish soap
  - MilliQ water
  - 70% ethanol
  - Paper towels
- North side drawers
  - Drawer A
    - Sophomore Teaching Lab Station Guide
    - Autoclave bags
    - Nitrile gloves (XS, S, M)
    - Hemocytometer
    - Cover slips
    - Timer
    - Counter
    - Markers
    - Scissors
  - Drawer B
    - Microcentrifuge tubes
    - Microcentrifuge tube racks
  - Drawer C
    - Gauze
    - Test Tubes
    - Test Tube Racks
  - Drawer D
    - Safety Goggles
- Southside drawer
  - Drawer A
    - Pipette tips – 1000 microliters
    - Pipette tips – 200 microliters
  - Drawer B
    - Pipette tips – 20 microliters
  - Drawer C
    - Gauze
  - Drawer D
    - TestResources items
- Northwest cabinet
  - Stirring hot plate
  - Vortexer
  - Pipette Aid
- Northeast cabinet (dry glass wear)
  - Aluminum Foil
  - Solution Reservoirs
  - 1000, 600, 200, and 150 ml beakers
- Southwest cabinet
  - Stirring hot plate
  - Vortexer
  - Pipette Aid
- Southeast cabinet
  - Short term room temperature storage
- Cabinet under west sink
  - Paper towel surplus
  - Lab Mat Surplus

Lab Guide

For each lab, you will be required to complete a pre5lab assignment and either a post5lab assignment or a formal lab report. In addition, you are expected to maintain a laboratory notebook throughout the course of the semester. Following is a description of what is expected for each.

Pre Lab Questions. Each pre5lab assignment is designed to assist you in preparing for the associated laboratory activities. A significant part of the pre5lab assignment involves thoroughly reading over the laboratory exercise (and any supplementary material provided to you). The pre5lab assignments are administered through blackboard learn. Prelab assignments must be completed by the start of your assigned laboratory period. Pre labs not completed prior to the start of the lab will not receive credit.

Notebook. Notebooks should include the following information: you name, date, partner's name, laboratory title, and the objective, observations, and results for each laboratory part (see Figure 1). Data such as calculations and numerical information used or obtained in the experiment must be written down (this includes reagent weights, solution concentrations, dilution calculations, absorbance readings, etc.). Any thoughts or observations about a particular procedure should also be recorded. For instance, if you mix two solutions and a new color results, write down that observation. These observations/thoughts may be important in the post5lab analysis. Finally, any data printouts or computer generated graphs or plots should be taped into the notebook. All entries in the lab notebook are to be done in black ink. If you make a mistake, simply cross out the mistake by making an X through the area and make the correction next to it. It is expected that all work is well organized. An example of a well5kept lab page is provided at the end of the lab guide. A carbon copy of your notebook pages is to be turned into a laboratory instructor at the end of each laboratory session. Figure 1 shows an example of what a notebook should look like.

Notebooks will be graded on a 0 – 3 point scale in which your notebook will be assessed using the scale in Table 1.

Table 1. Laboratory Notebook Assessment

Score	Assessment
3	All information is included in a clear and complete manner
2	Information is clearly presented in an organized manner, but missing minor information (printout, data, objectives, observations, etc); Lack of figure and table labels.
1	Information is presented unclearly (information is not organized, lack of use of tables and figures when appropriate) or significant information is missing (missing 2 or more components of the notebook)
0	Notebook was not turned in

<table>
<tr><td>BME 205

Lab No. 1</td><td>Title: Fundamental Laboratory Safety and Practices

Date: 08/ 24/ 2006</td><td></td></tr>
<tr><td></td><td>Name: Josh Sinker Group Members: Jill Lake</td><td>Page No. 1</td></tr>
<tr><td></td><td>Part #: 1

Objective: Determine the accuracy and precision of a L1000 and L200 micropipette using an analytical balance

Observations: Sometimes the balance would show a weight (~0.005g) after it had been tared.

Results:
Table 1.1: Weight of a specified aliquot of water that from an L1000 or L200 micropipette
<table>
<tr><td>Micropipette</td><td>Volume (mL)</td><td>1st Reading (g)</td><td>2nd Reading (g)</td><td>3rd Reading (g)</td></tr>
<tr><td>L1000</td><td>1.0</td><td></td><td></td><td></td></tr>
<tr><td>L200</td><td>0.2</td><td></td><td></td><td></td></tr>
</table>
Part # 2

Objective: Preformed a 2 point calibration using pH buffers 7.0 and 4.0

Observations: pH meters took a while to record a reading.

Results: A 97% slope was acquired from the 2 point calibration.

Part #3 ……

Josh Sinker 08/ 24/ 2006</td><td></td></tr>
</table>

Figure 1. Example of a Notebook page for a standard report.

Post Lab Analysis. For most labs, you will be expected to turn in a post5lab analysis. Post5lab analyses will involve the analysis and interpretation of the data obtained during the laboratory exercises. You will also be expected to answer questions involving application and integration of the relevant concepts covered in that lab. These assignments must be typed. The post5lab analysis is to be handed in at the beginning of the following lab period. Each person in the class is to complete and turn in their own post5lab assignment.

Formal Lab Report. During the semester, you will be expected to complete two formal lab reports (see syllabus). These reports are to be completed with your lab teammates; each group will turn in one report. The formal lab reports must be typed. Teammates are expected to contribute equally to

the assignment. A proper lab report is well thought out and well organized. The lab report will consist of the following components: lab title, brief abstract, introduction, materials and methods, results, discussion and conclusions, and any references.

The title page will include the title of the report, the group member names, the class number, and the date.

The abstract provides a summary of the entire lab report. It should contain a brief introduction, materials and methods, results, and discussion and conclusions. The abstract should not exceed 250 words. The goal of the abstract is to catch a reader's attention or interest.

The introduction should include background information on, and the rationale for, the problem investigated in the experiment. In some instances, it may be necessary to use information outside of that provided in the lab. In addition, the overall goal of the study should be identified (i.e., what hypothesis is being tested?) and a brief explanation of what you want to accomplish and how you will do this should follow. However, the reader should not be able to read the introduction and know the specific procedures and outcomes of the experiment.

The methods section provides the details of the protocol used in the experiment. Another person with the same background should be able to read through the materials and methods section and repeat your work, but this section is not to be copied directly from the lab manual. Furthermore, this section should only include information relevant to the materials and methods utilized, not results. For instance, if you are reading absorbance values for samples to determine the DNA concentration, you provide information on how you did this, but do not provide the absorbance readings.

The results section should be a descriptive summary of what you found experimentally. While this section will include things such as pictures, figures, graphs, and tables, these items should be accompanied by explanations that relate the findings to the overall goal of the lab. Any figures, graphs, etc. used in the results must be properly labeled; that is, different samples must be identified, different time points must be noted, specific structures in an image must be identified, etc.

The discussion and conclusion section should provide a brief summary of all results and how they relate to the overall goal of the experiment. To do this properly, you will likely have to refer to the figures and graphs that were generated in the results section; you cannot assume that the reader will just know what you are talking about. In addition, you should discuss the overall significance and relevance of your results in terms of "the big picture".

The reference section is to include any sources used while writing the lab report. This means any information gathered to provide a well5rounded introduction should be cited, etc.

A productive method for working through a lab report is as follows:

1. Write out the Methods.
2. Analyze your data and determine the best format for its presentation; create figures, tables, etc.; write up your Results section.
3. Write an Introduction that provides a relevant "backdrop" for your work.
4. Write a Discussion and Conclusions section that explains the observations/results you obtained during the experiment. Make sure to reiterate the most important findings as well as discuss their relationship to the overall experimental goal and their relevance to BME applications.
5. Write the Abstract, a brief summary of the entire lab.

General Tips on writing an Excellent Formal Lab Report

General –

- Never use "I". Try to avoid statements in which you have to indicate someone doing something. When necessary use "we" instead of "I".
- Figures should have a label, title, and a caption below it.
- Tables should have a label and title above it.
- Tables and figures should always be referenced in the main body of your paper.
- Labels to figures and tables should always be on the same page as that figure or table.
- Avoid using contractions or symbols in your document as words (i.e., in the text of your document you should not use % or #, write out the word); exceptions include in tables in which you are indicating a unit or when you are listing a specific percentage (i.e., 89%). Then %, in place of "percent" is acceptable.
- When using abbreviations be sure to describe to the reader what the abbreviation is prior to using (i.e., phosphate buffered saline (PBS), fetal bovine serum (FBS), etc.)
- Scientific writing never uses the word "proves" (or any other derivative of that word); there is always room for it to not be true. Use less powerful words such as "the data suggests" or "the data indicates".
- Avoid using a lead in such as, "in part 2 of the lab" or "in the next section of the lab". Just state exactly what you are doing. It will flow just fine without that lead in. Scientific writing is concise. Get to the point! Avoid losing your readers in "writing fluff".

Abstract –

- Should contain the following:
    - General statement about why you are doing this experiment (global picture)
    - Summary of materials and methods (2 53 sentences)
    - Summary of results (include analyzed data such as statistical differences or measured values). Give a reason for the reader to want to read the rest of the article.
    - Discussion/conclusions. Include specifics as well as global. (i.e., this experiment indicates….which means that….)

Introduction –

- Why are you doing this? What is the big picture?
- Background detail. What is already known? We are not looking for a book. Use the information provided in the background to the lab.
- Summary of what you are going to do to answer the problem that you have posed. No specifics! Keep it generalized! I should not know how to do the experiment; I should just know what you did.
- Hypothesis on this experiment. Can be very general.
- Be sure to reference correctly! All information presented that is not common knowledge needs to be referenced (i.e., population statistics, new findings on a disease, unique gene markers, etc.). If you are unsure about referencing contact an instructor. Referencing should be in IEEE format. If you do not know what that is go and look it up.

Methods –

- Should not be written as directions.
- Can be helpful to break it into subsections (i.e., Lab 3: Protein Analysis):
    - Protein gel
    - BCA Assay
- If you happen to complete statistical analysis for data analysis you may create a separate statistics section in which you would list what type of test was done (including post hoc) and the significance level that you choose as a cut off (Typically $p \leq 0.05$). If a software statistical analysis program was used that should be mentioned as well (SAS, SPSS, NCSS, MiniTab, etc.).

Results –

- Organize your data. Use tables and graphs to emphasize the results.
- Every table or figure needs to have supporting text in the main body of the results section. Supporting text can be used to describe the figure or use the figure to help clarify your text.
- Conclusions that you draw from the results should never be presented in the results section.
- Raw data should not be presented. For example, absorbance readings and step by step calculations from standard equations are considered raw data.
- Observations should be included in the results section.
- How to present statistical information:
    - Data suggests there is a significant difference between group A and B ($p \leq 0.05$).
    - There is no statistical difference between groups A and B.

Discussion & Conclusions –

- Big opening sentence or two discussing the importance of this project (lab).
- Summary of all results. Good time to reiterate significant differences between test groups.
- Discuss your interpretations of the results (goes hand in hand with summary of results. Two sections should be interwoven). What does the data mean? Yes it is significantly different but is that good, bad, does it really matter?
- Big closing. What can come from your results? What is the next step in understanding or solving the problem?

Safety in the Laboratory

The purpose of this guide is to provide you with basic knowledge, which will ensure a safe working environment for you and your classmates. For a lab environment to be safe, everyone in the class must be aware of their surroundings and work cautiously. More so, most accidents can be avoided by simply using common sense.

This handout provides some general safety precautions and guidelines that apply to all laboratory activities associated with this course. In addition, each lab will spell out specific safety issues that apply to that week's lab activities. For more complete information on laboratory safety items, you may also contact a lab instructor, or call REM directly (4C0121). REM is the Radiological and Environmental Management agency on Purdue's campus; they oversee lab safety practices on campus.

Following is a list of safety guidelines:

1. **Personal protection.** You may never eat, drink, smoke, or apply makeup in the laboratory, as any spills or airborne particles may interfere with sensitive chemicals or devices. Shoes must be worn at all times. Open toe shoes or sandals are not acceptable footwear in the lab. You should avoid wearing loose clothing on lab days, as this may be a hazard. Long, loose hair should be pulled back. Lab coats may be worn to protect clothing if desired (these are not supplied in lab). Long pants, or an equivalent, must be worn in the lab at all times, unless you have a lab coat, which protects your legs. Safety goggles must be worn whenever you are handling lab equipment or observing someone handle lab equipment. In addition, it is recommended that contact lenses not be worn to class. Nitrile gloves will be supplied in the lab and must be worn when handling lab equipment or supplies.

2. **Safe lab practices.** Never work alone in the lab. Perform only the experiments assigned to you by the instructor. A lab instructor should always be in the lab while you are performing an experiment; this way if anything goes wrong there is someone to help you or answer questions.

3. **Safety equipment.** You should know where all safety equipment (e.g., eye wash station, shower, fire alarm, fire blanket, fire extinguisher, etc.) is located in the lab, and you should know how to properly operate each piece of equipment. In addition, you should know where the phone is located, emergency numbers are posted near the phone. Finally, be aware of any posted emergency procedures. A lab instructor will point out and explain these items during the first lab period; if you have questions about these items it is your responsibility to contact a lab instructor and he/she will go over the information with you again.

4. **Excess materials.** Any extra items you bring to lab (including book bags, purses, sweaters, scarves, etc.) must be placed in the designated storage area. These items should not be placed on the lab bench as they will serve as clutter and potential hazards.

5. **Waste.** All waste must be disposed of as indicated by the lab instructors. All chemical waste will be put into labeled waste containers; containers should only be filled with the chemicals listed on the container, otherwise an adverse reaction may occur. All other biohazard waste will have a designated area for its disposal as well. REM will be called to pick up all hazardous waste.

6. **Chemicals.** Always read the label on each chemical that you use and be aware of the location of the materials safety data sheets (MSDS). Only use chemicals as specified in the laboratory exercises. Replace all chemicals to their proper storage area; chemicals are stored in designated places (and away from other chemicals) to avoid adverse reactions. All chemical containers should be tightly sealed for storage purposes. All containers must be properly labeled. Old, or used, chemicals must be disposed of properly (REM will pick up chemical waste). Finally, never taste or smell a chemical, and avoid direct contact with all chemicals.

When working with a chemical (e.g., creating a solution), always label the container with the container contents, your initials, and the date.

7. **Cells and cell products.** At different times in this class, you will be asked to work with various animal products (e.g., your own cheek cells, animal blood). Always wear gloves when working with these products. Follow the safe handling instructions outlined in the individual labs when dealing with these products.

8. **Empty containers.** All empty chemical containers must be triple rinsed (in some cases the rinsate may have to be discarded as a biohazard) and labeled with a "Safe for Disposal" tag. Rinsed empty containers must be placed in the designated area for pick up.

9. **Common sense.** When working in the lab, use common sense and good judgment. Read the lab exercise before coming to class. Do not touch hot objects. Never use mouth suction to fill a pipet. Do not use glassware that is broken or chipped. Handle broken glassware very carefully. Avoid inhaling any fumes in the lab. Always clean used glassware promptly. Never take a community reagent back to your desk. Only use the designated amount of each chemical. Avoid any behavior that may confuse, startle, or distract other students. Beware of your body and your surroundings so as to avoid knocking over lab equipment or others. Practice good hygiene; wash your hands thoroughly with soap and water upon completion of lab work.

Emergencies. If an emergency situation or an accident should occur, **immediately** stop your work and report it to a lab instructor. Emergencies include high hazard situations, low hazard situations, fires, and mercury spills.

In general, if you spill a small amount of chemical on your body, rinse it with cold water immediately and notify a lab instructor. If a chemical splashes on your safety goggles, do not remove your goggles. Notify an instructor, ask for assistance to reach the eye wash or shower station, and drench your face and goggles in water.

REM has categorized situations which are immediately dangerous to life and health, involve a large area, an infectious agent, a highly toxic substance, or a major injury to personnel as high hazard emergencies. In these circumstances, isolate and evacuate the area, immediately call the emergency number (911), and ask that an ambulance be sent to Biomedical engineering building. Identify 2 individuals to meet the emergency personnel. These individuals should be posted at the east main entrance (between rooms 1061 and 1081), and west main entrance of the building (by Room 1001). Identify a 3rd individual to contact the academic offices about the accident. For chemical spills in the eye or on the skin, rinse the affected area for at least 15 minutes or until emergency staff arrive at an eye wash station or in a shower. Remove all contaminated clothing and jewelry.

Low hazard emergencies include small emergency situations which do not involve fire, involves low to moderately toxic materials in small amounts, or a readily treatable injury. For a minor injury, report to Purdue University Student Health Services (PUSH) or a local emergency room; an uninjured party must accompany the injured. For a small spill, use an absorbent material that will neutralize the spill, if available. A dustpan, brush, and protective clothing should be used. The area should then be decontaminated with soap and water. Any residue should be placed in a proper waste disposal container.

Fire emergencies include abnormal heating of material, hazardous gas leaks, hazardous/flammable liquid spills, smoke, or odor of burning. In these situations, the building's fire alarm system should be activated, the fire department must be notified (911), and the area must be isolated and evacuated (this may require shutting off equipment and closing doors). A fire extinguisher may be used to assist in evacuation or to treat a small fire.

If a mercury spill occurs, evacuate the area and notify an instructor. REM must be contacted for mercury clean up (4C0121).

Keep this information on record:

Location of the eye wash station: _____
Location of the safety shower: _____
Location of the fire extinguisher: _____
Location of the telephone: _____
Location of ambulance entrances: _____
Location of the academic offices: _____

BME 295: Biomolecular and Cellular Systems Laboratory
Syllabus and Course Manual
Fall 2020

Instructor of Record: Prof. Tamara Kinzer-Ursem — Office: MJIS 3084
Email: tursem@purdue.edu — Office hours: By appointment

Lab Coordinator: Dr. Michael Linnes — Office: MJIS 1055
Email: mlinnes@purdue.edu — Office hours: By appointment

Course TAs:

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TA Office Hours: Monday 6-8 pm, Wednesday 6-8 pm

Class Location: MJIS 1053

Lab:

One of the following:

Monday 8:30 - 11:20 am
Tuesday 11:30 – 2:20 pm , 2:30 – 5:20 pm
Wednesday 8:30 - 11:20 am
Thursday 11:30 – 2:20 pm, 2:30 – 5:20 pm

Pre-requisites (may be taken concurrently):

BIOL 230 Biology of the Living Cell

Course Description:

Introductory laboratory experience focused on engineering concepts and practices in the analysis of biomolecules and cells. Topics include fundamental quantitative techniques of analysis, methods of isolation, identification, and quantification of biomolecules and cells, and analysis of integrated bio-systems. This course concludes with a student driven design project.

Course Outcomes:

Upon completion of the course each student will have the ability to:

1. Independently describe the theoretical basis of, and put into practice, fundamental analytical tools and techniques used in the isolation, characterization, and quantification of biomolecules and cells.
2. Collect, record, process, statistically analyze, and report experimental data related to the analysis of biomolecules and cells in an accurate and understandable manner
3. Conceptually design a simple analytical method and/or tool for solving a medically' relevant problem based upon detection/analysis of a specific biomolecular or cellular related abnormality.

Brightspace (Learning Management System): All information regarding this course (syllabi, assignments, assignment submissions, lab manuals, tutorials, videos, etc) will be distributed and collected via purdue.brightspace.com.

Required Supplies:

- Laboratory Notebook
- Writing Utensil
- Face Mask
- Face Shield
- Goggles (when indicated)

Emergency Policy/Procedures:

Campus Emergency Policy: In the event of a campus wide emergency the class outline and course requirements may be subject to change. The course instructor will provide information in regards to changes in the course requirements or course schedule as a result of a campus wide emergency.

Response Procedures:

http://www.purdue.edu/fire/safety_handbook.pdf

- **Fire Alarm** – Evacuate MJIS 1061 through the south door (nearest the elevator); then, leave the building through the doors which exit to the east side of the building (back of the building near the construction of the Herrick Labs extension). Only gather personal items if it does not jeopardize your safety. Assist those who need help. Proceed to the front lawn Lilly Hall of Life Sciences (corner of State St. and S. Russell Dr.) **Report to a course instructor your name before leaving the emergency assembly area.**

- **All hazards warning** (Tornado, hazardous release, civil unrest, etc.) – When you hear the all hazards alarm immediately seek shelter (**Shelter-In-Place**) in a safe location. For a tornado, proceed to the basement of MJIS, using either the stairwell on the northwest side (by the police station) or the southeast side (across from MJIS 1087).

Campus Emergency Policy: In the event of a major campus emergency, course requirements, deadlines, and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. If an emergency should occur, check Brightspace and your Purdue email accounts to learn about modifications to the course.

Overall Expectations:

Academic Conduct: You are expected to behave in a professional and ethical manner in all aspects of this course. Only through rigor and practice does one become a competent engineer that contributes to society. Plagiarism and cheating undermine that process. Plagiarism or cheating will result in a zero for that particular assignment. Instances of unethical behavior will be reported to the Dean of Students Office and will result in a grade reduction of at least one letter grade. If an individual behaves unethically during the semester, the instructor reserves the right to fail the student. For more information, see Purdue University Student Conduct Code at:

https://www.purdue.edu/odos/osrr/resources/documents/academic_integrity.html

The student is also expected to respect course instructors and contribute to a positive atmosphere in the class. Undermining or disruptive behavior will be reflected in your participation grade.

Protect Purdue Pledge:

By attending Purdue you assume the responsibility of being a part of the Boilermaker community and assume the responsibilities of the Protect Purdue Pledge:

Being a part of the Boilermaker community means that each of us must take extraordinary steps to stay well and persistently protect each other, on campus and in the community. Accountable together, I pledge to take responsibility for my own health, the protection of others and help keep the Purdue community safe from spread of COVID-19 and other infections as identified and instructed by the university.

https://protect.purdue.edu/pledge/

Expectations for Laboratory:

Laboratory Attire: Safety regulations require that you wear a face mask, goggles, gloves, face shield, long pants (or equivalent) and closed-toe shoes while working in the laboratory. You will not be allowed to work in the lab if you are wearing proper personal protective equipment.

Class Attendance: Under normal circumstances 100% attendance is required to pass. We are not in normal circumstances. In the case class is missed due to extenuating circumstances (e.g., death in family, illness), the course instructor should be contacted immediately (prior to class, if possible) and written documentation will be required. Makeup work will be considered and assigned on a case by case basis. *To receive credit for the lab, a student must be in the lab on time, no more than 15 minutes late. A student who is more than 15 minutes late and who does not have an excused reason may receive a zero on the lab.*

Lab Safety: See the lab safety document posted on Brightspace. It provides some general safety precautions and guidelines that apply to all laboratory activities associated with this course. In addition, each lab will spell out specific safety issues that apply to that week's lab activities. For more complete information on laboratory safety items, you may also contact a lab instructor, or call REM directly (4C0121). REM is the Radiological and Environmental Management agency on Purdue's campus; they oversee lab safety practices on campus.

Graded Course Material:

Pre-lab Quizzes & Online Material: It is expected and required that students watch and learn the material presented in the online lectures available through Brightspace. This material is to be learned prior to coming to lab each week it is assigned. The course schedule details when each lecture is assigned. Watching and learning this material is part of the lecture component of the course. This includes the completion of short pre-lab quizzes given in Gradescope that test your retention of the pre-lab material. The pre-lecture quiz is due by 11:59 pm on the Friday before lab. This is the same for all sections.

Post Lab Analysis: Each lab protocol will contain answer boxes that need to be filled out. Some of these will be filled out during lab and others will need some work post-lab to complete. These protocols will need to be scanned in and submitted to gradescope no later than the Monday following your lab week. Most labs you will complete 80-90% of this document in-lab. This due date is the same for all sections.

Laboratory Notebook: Each individual must maintain a laboratory notebook or electronic notebook. A lab notebook is used to document work in a research setting; it details what was done, when it was done, and who did it. Whether your career takes you into an industrial or academic research setting, you will be expected to maintain a proper lab notebook. In these settings, notebooks become important legal documents which can be used to submit a patent claim and credit an original discovery. **Electronic notebooks (via Microsoft Word or similar) are encouraged.** Scanned copies of your hard copy notebooks that are completed in a legible manner in ink will also be accepted for this course. There will be periodic **notebook checks** to make sure that you are documenting your work.

Please visit the lab notebook document on Brightspace for further explanation and examples of what should be included in your lab notebook.

Formal Lab Reports*:* At the conclusion of week 4, your group will write a formal lab report. This will include an abstract, introduction, materials & methods, results, discussion/analysis, and conclusion sections. The ability to integrate ideas will demonstrate that you have fully achieved the objectives of the lab exercises; this is an important part of your lab report. It is up to your team to integrate the concepts from your work in each module; the background and conclusions sections may be excellent choices to tie the experiments and results together. Review the Formal Lab Report Guidelines on Brightspace for more details.

Final Design Project: In this course you will explore the first stages of engineering design: information gathering, problem definition, idea generation, and evaluation and decision making. Refer to the final design project document on Brightspace for specific details on the design project assignment and due date.

Late Submissions: No late pre-lab quiz submissions will be accepted. Late lab reports, notebook checks, formal lab reports, and final design project submissions will lose 25%/day including weekend days. Late work should be submitted to Brightspace or emailed directly to the Lab Coordinator.

Course Reviews

Online Course Evaluations: You must complete all online course evaluations for this class AND submit to the lab coordinator evidence of survey completion before finals week. If no evidence of survey completion is submitted you will receive a zero for the individual participation and rigor part of your grade.

Course Grading:

The following grading scale is a guaranteed minimum; however, based upon student performance, final grades may be curved by the instructor.*

Letter Grade	Percentage	GPA score
A+	≥ 98	4.0
A	≥ 93	4.0
A-	≥ 90	3.7
B+	≥ 87	3.3
B	≥ 83	3.0
B-	≥ 80	2.7
C+	≥ 77	2.3
C	≥ 73	2.0
C-	≥ 70	1.7
D+	≥ 67	1.3
D	≥ 63	1.0
D-	≥ 60	0.7
F	60 >grade>0	0

Grade Breakdown:

Pre-lab Quiz x 6	12 %
Post-lab Scan x 6	36 %
Notebook Check x 2	12 %
Formal Lab Report x 1	15 %
Final Design Project	20 %
Individual Participation and Rigor	5 %*

***** If you do not complete the course evaluation you will not receive a grade for individual participation and rigor.

Re-grade Policy: Students have the right to contest any grade throughout the semester. Once an assignment has been graded and returned, students have **1 week** to protest a grade via gradescope; after this time grade disputes will not be accepted.

Course Schedule and due dates*:

Week	Week of:	Topic:	Prelab video + Quiz Due 11:59 pm on Friday:	Deliverables Post-lab Scan Due 11:59 pm on Monday following lab:	Formal Report + Notebook Checks Due 11:59 pm on Wednesdays:
1	10/19	Lab Introduction: Pipetting, pH meter, making solutions, bacterial growth curve, plasmid DNA isolation	10/16	10/26	
2	10/26	Genetic Engineering I: Measurements, restriction digestion, agarose gel electrophoresis, gel extraction, PCR	10/23	11/02	**Notebook Check 1:** Through Lab 2**:** 11/04
3	11/2	Genetic Engineering II: DNA restriction digest, ligation, transfection, starter culture, sequencing	10/30	11/09	
4	11/9	Synthetic Biology: Transcriptional control, protein expression and isolation	11/06	11/16	**Formal Lab Report** Due: 11/18
5	11/16	Protein Engineering: Antibodies and Protein detection	11/13	11/23	
6	11/23	Protein Engineering II: Enzyme Kinetics (Virtual Lab)	11/20	11/30	**Notebook Check 2:** Through Lab 5 Due: 12/2
7	11/30	Work on Design project			
8	12/7	Design Project Due			**Design Project:** Due: 12/09

*Laboratory topic order and assignment due dates are subject to change, as needed.