FALL SEMESTER 2008 – BIOM 380
BME INTEGRATIVE DESIGN AND EXPERIMENTAL ANALYSIS (IDEAS) LAB

Instructor: Dr. Timothy Allen
Co-Instructors: Dr. Brett Blackman, Dr. Edward Botchwey, Dr. Brent French, and Dr. William Guilford
TAs: Robert Amanfu, Bryan Piras, and Scott Smith

Credit Hours: 4.0
Prerequisite: APMA 212, 213, BIOM 201, 204, 322 (or instructor permission)
Co-require: BIOM 310, APMA 311
Lecture: Mondays, 11:00 – 11:50 am, MR5 Room 1041
Lab Section 1: Tuesdays, 2:00 – 6:00 pm, MR5 Room 2208
Lab Section 2: Wednesdays, 2:00 – 6:00 pm, MR5 Room 2208
Lab Section 3: Thursdays, 2:00 – 6:00 pm, MR5 Room 2208

Course Overview: First half of a year-long course to integrate concepts and skills from prior courses in order to formulate and solve problems in biomedical systems, including experimental design, performance, and analysis. Lab modules include testing in tissues/cells and manipulation of molecular constituents of living systems to determine their structural and functional characteristics for design of therapeutic or measurement systems. Methods include biochemical, physiological, cell biology, mechanical, electrical and computer, systems, chemical, imaging, and other approaches.

Reading material: Handouts from class

Grading: Quizzes (15%), Lab reports & proficiency (40%), Group participation (10%), Lab notebook (10%), Final exam (25%)

INSTRUCTOR
(TAs)
Allen
(No lab Week 10/13 ➔ Mon-Tues are Reading Days)
Introduction to IDEAS: Fundamental Skills in BME Laboratories
Week 8/26 Introduction to basic laboratory techniques (no report due; no Monday lecture on 8/25)

Allen/Blackman
Module 1. Techniques in Cell Culture - Getting to know your cells.
Week 9/1 Working with Cells in Culture: Analyzing Cell Adhesion and Growth
Week 9/8 Stimulating Intracellular Activity: Isolation of Protein and Total RNA from Animal Cells

Blackman/Piras
Module 2. Quantification & Manipulation of Proteins - What's in the bag?
Week 9/15 Protein Quantification and Analysis: Western Blots
Week 9/22 Immunofluorescence Detection of Cellular Proteins

French/Piras
Module 3. Molecular Evaluation of the Genome - What's controlling us?
Week 9/29 Genes part I: Reverse Transcription: RNA to cDNA
Week 10/6 Genes part II: Real-Time RT-PCR to Quantify Gene Regulation

Guilford
Week 10/20 Fundamentals of Microscopy, Cellular Imaging, and Analysis (Report due Week 11/3)

Botchwey
Module 5. Nano-Systems for Cellular & Molecular Evaluation - Biology, one molecule at a time.
Week 10/27 Biomolecular Energetics: Actin-Myosin Motility Assay
Week 11/3 Quantitative Analysis of Bio-Molecular Movement (Module 4 lab report due!)

Botchwey
Module 6. Principles in Tissue Engineering & Biomaterials - Who needs spare body parts?
Week 11/10 Better Living through Polymer Chemistry
Week 11/17 Modeling Wound Repair (Reports/notebooks due Week 12/1 at 2:00pm on your usual lab day.)

No lab Week 11/24 ➔ Thanksgiving Recess; No lab week 12/1 ➔ Turn in Module 6 report, review for final exam on Mon. 12/1)

FINAL EXAM: Saturday, December 13th, 9:00am-noon
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COURSE EXPECTATIONS

The BME Integrated Design and Experimental Analysis (IDEAS) Lab is a year-long course sequence that is a core requirement of the undergraduate major in Biomedical Engineering.

To become a new kind of engineer, a biomedical engineer for the 21st Century, you must be skilled and well versed in both engineering and biomedical sciences. The IDEAS Lab will expose you to fundamental, new, and exciting tools, skills, analyses, and experiences that you will use in your careers as researchers, clinicians, and engineers. The course is organized into separate 1- to 2-week experimental modules, each covering a specific theme. These modules, which span over 2 semesters, have been developed to instruct you in practical and analytical methods commonly used in cell and molecular biology & engineering, cellular microscopy, cell and tissue mechanics, clinical physiological measurements, and imaging & signal processing/analysis. During the final exam each semester and the final IDEAS Project spanning the last 4 weeks in the 2nd semester, you will be tasked with synthesizing and applying the knowledge you have gained from the previous modules as you design and conduct experiments to test hypotheses encountered every day by biomedical engineers.

It is important to us that every student in our undergraduate program learns from this lab experience. There will be 5 Professors and 3 TAs available to help you get the most out of the BME IDEAS lab. Please do not hesitate to ask questions or to seek advice, whether in lecture, in lab, or on off days.

GROUPS. For each lab section, there will be a maximum of 5 groups and maximum of 4 students in each group (with exception). Group membership will be assigned randomly within each lab section, and these groups will remain together for the duration of the semester. However, the Instructors reserve the right to alter group composition at any time, for any reason. Lab members must rotate responsibilities each week in order to get full exposure to all aspects of the lab experience. The TAs and Professors will make sure this is put into practice. Be aware that you will each receive Instructor assessments at the middle and end of the semester. These group participation evaluations will contribute toward 10% of your final grade.

QUIZZES. Because there are many details to cover in a limited amount of time, it is absolutely essential to read and understand each week’s written materials before coming to class, in addition to attending lecture each Monday. To this end, quizzes will be given at the beginning of each lab session. These quizzes will test both your knowledge of the written materials accompanying that day’s lab and your understanding of the concepts/material covered in lecture. Please be prepared. Quizzes will be graded out of 10 points each and count will 15% of the final grade.

LAB NOTEBOOK. An essential skill in laboratory management is the ability to document the details of daily experimental events. These include methods used to set up, run, or analyze an experiment, the raw data collected, the processed (i.e. analyzed) data, and the results obtained. You should also include any comments along the way. The function of the notebook is manifold: it serves as a written legal document of the work that YOU complete, as your own, in the lab; it also allows you and others who read your notebook to go back and perform those experiments and be able to get the same results; and it is a hardcopy of all of your data. Each lab group will be responsible for maintaining one lab notebook throughout the entire semester, and the TAs must sign off on your notebook before you leave lab on any given day. The notebook will be handed in with the last report. Each group will receive a maximum of 10 points (10% of the final grade) for the quality and completeness of the notebook.

LAB REPORTS. BIOM 380 consists of 6 individual lab “modules,” and there are two weeks in most modules. A Lab Report will be due for each module (i.e. not each week), and these reports will be due the next lab session (not lecture) after the end of the module, with the exception of Module 4. (Since the Module 4 report requires significant post-lab analysis, this report will be due the 2nd week of Module 5.) Points will be deducted from reports handed in late. One Lab Report will be handed in by each group, and each of you must sign the honor pledge for every report. Only students in the same group can work together on the report. Reports must be typed, all pages stapled together, well organized, and readable. Use 12-point font (Arial or Times), 1.5-spaced, and minimum 0.75” margins all around. After the first page, your Group Number should appear in the header (right side) along with the page number. The page/word limits below must be adhered to, or point deductions will result. Follow the format below:

Abstract (5-points) LIMIT to 250 words
The abstract needs to provide an overview of the lab Module. It should answer the following questions: What is the module about? What is the importance of this module? What did you do in the module? What were the highlights of your results? What are the conclusion(s) from the results?
Results (60pts) LIMIT to 4-pages total text and figures

The results section is the most important section in any primary research paper in the biomedical sciences and engineering. In IDEAS, the results will include what you observed, measured, analyzed, calculated, etc. in the module. Include brief AND concise methods used for (1) generating and (2) analyzing the data. (Summarize what was done to achieve each result – do not merely restate the detailed methods and protocols provided in your lab handout.) The results must be supported with Figures and/or Tables. In some modules, the instructor may give you explicit directions on specific figures/tables that must be included. In all modules, you want to include the figures/tables (data, graph, images, etc.) that best convey your results (even if not asked for explicitly). However, note that an excess of figures/tables is not acceptable and will cause you to exceed the page limit. Figures/Tables can be integrated within the body of the text or all together at the end of the Results section. Convey the results in an unbiased manner as an independent observer of the results. Be sure to explain what you did and why you perform certain experiments. Use Subtitles for each distinct Results subsection, when applicable. You will be graded on the quality of your data generation/collection and your data analysis/presentation/reporting.

Inquiry-Based Questions (IBQs) (35pts) LIMIT to 2-pages (unless instructed otherwise)

Each Module will include “Inquiry-Based Questions” that are to be answered and submitted as part of your Lab Report. These are questions we encourage you to think about more deeply and discuss amongst your group members. The first question in every module will always be the same: You will be asked to summarize your conclusions from the module by encapsulating the key findings from your results. (Given the results/data/figures/etc. that you presented in the previous section, what did you learn? Do the results support the initial hypotheses set forward at the outset of the lab module? If not, what is the most likely reason(s)?) Please number the responses corresponding to this question and the subsequent module-specific IBQs. Do not restate the question. Please make sure you document/cite any references/sources you look up and use in answering these questions. These should be listed under a section titled “References” at the end of the IBQs section. (Note that references cited do not count toward your page limits.)

Our expectation is that all lab reports will be error-free, not only with respect to data presentation (e.g. properly-labeled axes, appropriate significant figures, etc.), but also with respect to written English (spelling, grammar, punctuation, etc.). This careful attention to detail to your lab reports is the minimum that you can do to show respect for your audience (not just in this course, but to your future coworkers, supervisors, and colleagues), and will be expected in all formal scientific writing and technical literature you write in the future.

ALL Lab Reports will be graded on the following merits:

- Technical execution, analysis, interpretation of data/results, and well-thought out answers to the IBQs
- Readability – including language, correct spelling and conciseness, quality of presentation

A note regarding the Lab Reports: While your write-ups are called “lab reports” in this course, they are very likely different from any report that you have had to write to date in your studies at U.Va. (e.g. your intro chemistry or physics labs). There is no “cookbook” recipe to follow in writing these reports, and we intentionally do not tell you precisely what figures, results, tables, etc. to include for each module. In other words, we largely leave the content up to you. One of the key educational objectives in IDEAS is for you to learn how to think critically about your results and to present them in a way that is accurate, clear, and concise. This critical thinking also requires that you understand the purpose and context of each experiment. In particular, as you outline the Results section for each module, think about the following: “What was the point of the lab? What did we learn from the results we generated? Are the results conclusive, or are there potential sources of error? If there are sources of error, what might they be?” This sort of in-depth analysis will help you immensely as you craft each report.

Final Exam. The will be no midterm exam. The Final Exam will be in the style of a written practicum and will test your individual knowledge of background material and concepts, techniques, and procedures you used in the labs.

Extended Time to Work on Labs. There will be no time to make up labs. If there are special or unexpected circumstances, please discuss your situation with Dr. Allen or one of the Instructors responsible for that week’s Module. Some labs will require groups to perform tasks on non-lab days. We know this may be an inconvenience in your schedule, but is essential to the full laboratory experience. In such cases, posted “windows of opportunity” to do these tasks will accompany each lab. No after-hours work will be allowed (that is, after 6pm).
LAB SAFETY

Please read and understand all instructions prior to each lab session. Some chemicals and reagents are harmful, so please protect yourself by wearing safety glasses, lab coats, and gloves when necessary, and use the chemical hood when specified. If you are unsure of any step, please ask for assistance from the TA or Professor. Also, please make sure you wash your hands before and after (i.e. before leaving) the lab – even if you wear gloves.

Lab Dress Code. You MUST wear shoes which fully enclose your feet. Absolutely NO open-toed or backless shoes/sandals can be worn in the lab. If you accidentally wear the wrong shoes, you will have to go back and change. You will not be allowed to perform the lab module until you are wearing the correct shoes. This is purely a safety issue. You must also wear a knee-length lab coat. (We recommend coats that have elastic cuffs on the sleeves, but this is not required.) Coats can be purchased from the lab supplies section of the UVA Bookstore.

Chemicals. Some of the chemicals used in the laboratory are hazardous. All manufacturers of hazardous materials are required by law to supply the user with pertinent information on any hazards associated with their chemicals. This information is supplied in the form of Material Safety Data Sheets or MSDS. MSDS contains the chemical name, CAS#, health hazard data, including first aid treatment, physical data, fire and explosion hazard data, reactivity data, spill or leak procedures, and any special precautions needed when handling this chemical. MSDS information can be accessed on World Wide Web. You are strongly urged to make use of this information prior to using a new chemical and certainly in the case of any accidental exposure or spill. NOTIFY the instructor or TA immediately in the case of an accident involving any potentially hazardous reagents.

The following chemicals are particularly noteworthy:

- Phenol - can cause severe burns
- Acrylamide - potential neurotoxin
- Ethidium bromide - carcinogen

These chemicals are not harmful if used properly: always wear gloves when using potentially hazardous chemicals and never mouth-pipette them. If you accidentally splash any of these chemicals on your skin, immediately rinse the area thoroughly with water and inform the instructor. Discard the waste in appropriate containers.

Ultraviolet Light. Exposure to ultraviolet light can cause acute eye irritation. Since the retina cannot detect UV light, you can have serious eye damage and not realize it until 30 min to 24 hours after exposure. Therefore, always wear appropriate eye protection when using UV lamps.

Electricity. The voltages used for electrophoresis are sufficient to cause electrocution. Cover the buffer reservoirs during electrophoresis. Always turn off the power supply and unplug the leads before removing a gel.

General Housekeeping. All common areas should be kept clean and free of waste. You have only a limited amount of space to call your own, so it is to your advantage to keep your own area clean. Since you will use common equipment and facilities, please restore it to the way it was prior to you using it (that is, keep it clean and any parts stored as they were). All products produced from each module including solutions, cell culture dishes, samples, etc, for example, should be clearly labeled by each group and dates. Please label items with your group name and Module number if applicable. Unlabeled material found in the incubators, refrigerators or freezers may be destroyed. Always mark the backs of the plates with your initials, the date, and relevant experimental data, and be sure to record this information in your lab notebook.