York University
BPHS 4090 / PHYS 5800: Biophysics II (4 credits)
Fall 2015

Labs/Projects

A major component of 4090/5800 is the laboratory component. The goal of the labs is to be student-centric, in that you are ultimately encouraged identify, develop, and test your own hypotheses. Thereby, you will gain a deeper experience with experimental-design, data analysis, presentation (both oral and written), lab practice (e.g., lab book etiquette), and comfort with receiving/providing/making use of critical feedback. In addition to time spent in the lab, students will have to:

- Keep a detailed lab book
- Write up lab report (preferably using LaTeX)
- Prepare a "poster" and present such via an oral presentation

Additionally, students will be required to provide/implement peer feedback in some fashion that will also contribute to assigned grades.

There will be three labs altogether, as outlined below. There are a choice of different lab topics (see next section). The first two labs are designed to be semi-structured (i.e., there will be some form of lab manual in place), while the third lab is more student-driven and open-ended. Logistical aspects are as follows:

1. **Lab 1** (9/23, 9/30; lab book due date = 10/2) – First lab will stem from a topic listed below. Students can work in pairs. Focus will be to get comfortable with the setup, take detailed lab notes, and collect (and partially analyze) some data. Another focus here (and of 2nd round) is for students to get comfortable with equipment around the lab and what it is capable of. Grading will stem from assessment of the student's lab book.

2. **Lab 2** (10/7,10/14; report due date = 10/21) – Same as first, except students identify a new setup and no longer work in the same pairs. This lab explicitly must have some clear quantitative* aspect to it, and some statistical analysis of the collected data will be required, which must be clearly and completely explained). This lab will require a short (3–6 page) written report.

3. **Lab 3** (10/21 10/28, 11/4, 11/11, 11/18, 11/25, 12/2; proposal due date = 11/4, poster presentation = 12/2) – Third lab has students independently identifying an experimental approach, get together the setup they need to explore such, identify a central hypothesis, then rigorously proceed to test such. This round will culminate the creation of a poster based upon their approach/findings, which will then

*By 'quantitative', we mean that data collection must explicitly quantify (i.e., put numbers to) the measures made, as well as the associated uncertainty.

be presented at the end of the semester. It is expected that students take a strong and clear quantitative approach. Identifying 4090 research project topic will be challenging, so there will be several sequential steps (i.e., iterative process with feedback from instructors and peers)[†]

Potential lab topics

Projects that can be used for **Labs 1 and 2**:

- light microscopy
- optical tweezers
- in-vivo spectroscopy
- coaxial cable[‡]
- Johnson noise

Potential ideas for **Lab 3** are (but not limited to):

- electric circuit model of a chaotic system (and synchronization)
- Brownian motion & particle tracking
- electrophysiology (e.g., measuring action potentials, evoked potentials)
- identify/quantify biological patterns (e.g., fractal nature of leaf morphology)
- characterize swimming patterns of microscopic organisms
- microfluidics & diffusion

If so inclined (but not required), students may have the opportunity to develop their own measurement system using platforms such as Arduino or Raspberry Pi.

Lab Grading

Assigned grades for the labs will depend several criteria:

- Detailed/clear lab book
- Required assignments (report, poster & oral presentation)
- Attendance[§]

[†]If students are totally at a loss in this regard, let the instructors know and a suitable topic will be chosen for you.

[‡]This is relevant regarding a course topic later in the semester dealing with cochlear mechanics.

[§]You will need to be present for each lab session, unless rescheduling is pre-arranged with the instructor and/or TA.

- ◇ Clarity/completeness of quantitative approach
- ◇ Providing useful critical feedback to peers

A bit more specifically:

- ◇ *Lab Notebooks* – As good lab book skills are essential in physics, you will be expected to keep a dedicated lab book for the course. You should outline the lab ahead of time (e.g., overview, hypotheses, methods, etc...), taking detailed notes during the actual lab. Then afterwards, analyze any collected data and write up a (brief) discussion and summary. Be sure to answer any questions posed in the lab guide and point out any difficulties encountered. Two days following the lab, you will be expected to turn in your lab book to be graded based upon completeness and clarity.
- ◇ *Lab Report* – There are several labs throughout the course, the second of which you will be expected to write up into a formal report and hand in separately from your lab book. The report should consist of an introduction, methods, discussion, and a summary, as well as clear figures detailing salient results. Be sure to weave into the narrative answers to all questions in the lab guide.
- ◇ *Proposal* – Students are required to submit a one page summary detailing the nature of their project they aim to pursue. The summary should consist of an overview of the topic, the nature of the problem, several background references, and a detailed outline as to how the student aims to pursue the final two stages. Critical feedback will be provided as needed to help focus the project. This summary will be **due on Nov. 4**.
- ◇ *Poster presentation* – Students will give a 12 minute presentation on their topic[¶]. These presentations will take place during the lab session on **12/2**. While not required, it is *highly encouraged* that students prepare their talk well ahead of time and submit the slides for review well beforehand so to receive helpful/critical feedback from the instructor. You will also be expected to critically assess your peer's presentations and your input will form some fraction of their grade.

→ It is strongly recommended that students get an early start on the labs/project and not wait until the last minute! It can not be overemphasized that success with regard to the labs require a significant amount of dedicated time and focus. Also, students will be required to make a clear connection between their chosen lab projects and the associated underlying biology and physics (e.g., how does the Johnson noise lab relate to a biological problem?). Searching research literature (e.g., via Google Scholar, PubMed, Web of Knowledge) and incorporating such into the project's narrative can help significantly towards this end.

[¶]Note that 12 min. is not a lot of time, though in the scientific community (e.g., at conferences), it is. So you need to plan very carefully and budget your time. One key strategy in this regard is *practice, practice, practice*!

"Journal club Presentation"

Students will pick a paper from a scientific journal (preferably related to their Lab 3 topic) and lead an in-class discussion critically reviewing the paper (i.e., similar to a journal club). Students will be expected to explain the science underlying the behavior, critically assess its strengths & weaknesses, and get other members of the class engaged in a discussion. These discussions will take place in class in mid-November.