Lecture: CHE2118, M 1:00-3:30 PM

Target Audience: Upper level undergraduates, M.S. students and Ph.D. students with some mathematical background [multi-variable calculus, basic concepts in differential equations] and an interest in cell physiology. This course complements BIOE603 (Electrophysiology), and addresses several topics covered in BIOE340 (Physiological Systems) in greater depth.

Summary: Students will be introduced to neuromuscular and cardiovascular physiology from a quantitative perspective, emphasizing modern experimental and theoretical research strategies. The focus of the lectures will be on cell physiology, with some exposure to tissue-level physiological systems. Students will also apply principles acquired from course material to the presentation and critical discussion of journal articles examining current research.

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Office Hours: M 3:30-4:30 or by appointment (this may change)

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Schedule of Topics Covered: The basic themes are physiological/biophysical, but the approaches used to study these topics and the syntheses of these topics into theoretical models are quantitative.

Week 1 (J28 - Shah): Introduction to the Cell and the Neuron (Stereology, Sampling, Statistical Analysis)
Week 2 (F4 – Bradberry): Action Potentials and Ion Conductances (MATLAB Simulations of Hodgkin-Huxley, Cable Equation, Rall Model)

PROBLEM SET #1 DUE F11
Week 3 (F11 - Shah): Cell Polarity and Neuronal Growth (Adhesive Forces, Symmetry Breaking)
Week 4 (F18 - Shah): Neuronal Growth and Polarity, Axonal Transport (Imaging and Quantitative Biochemical Approaches, System Modeling)

PROBLEM SET #2 DUE F25
Week 5 (F25 – Aranda/Jiang): Guest Lecture, Bioengineering Seminar
Week 6 (M3 – Shah): Axonal Transport and Molecular Motors (Imaging, In Vitro Motility Assays, Optical Trapping)
Week 7 (M10): Presentations – Session 1

TAKE HOME QUIZ #1 DUE M14
Week 8: (M17): Spring Break

LITERATURE REVIEW DUE March 24
Week 9 (M24 – Shah): Intro to Skeletal Muscle and the Cross-Bridge Cycle (X-Ray Diffraction Studies, Theoretical Modeling)
Week 10 (M31 – Kyrtos): Neuromuscular Circuits (Transfer Functions, Muscle Spindle Activity)

PROBLEM SET #3 DUE April 7
Week 11 (A7 – Shah): Cardiovascular System (Architecture and Design as they relate to Function)
Week 12 (A14 – Shah): Vascular Modeling (Continuum and Lumped-parameter Models)

PROBLEM SET #4 DUE April 21
Week 13 (A21 – Shah): Ventricular-Vascular Coupling (Quantitative Methods of Assessment)
Week 14 (A28 – Shah): Gas Transport/Exchange (Diffusion-Permeation-Reaction Models)

TAKE HOME QUIZ #2 DUE May 5
Week 15 (May5 – Shah): Ethics in Data Collection and Analysis
Week 16 (May12): Presentations – Session 2

RESEARCH PROPOSAL DUE AT FINAL EXAM PERIOD
**Reading:** Course readings will be given out 1-2 weeks preceding lectures. The following textbooks are on reserve for optional background reading. Appropriate chapters will be suggested during class.


**Grading:**

*Philosophy and learning objectives:* Comprehension and application of the reading and lecture material will be essential for the completion of each assignment. Problem sets and quizzes will include questions designed to test the student’s knowledge of course material and more open-ended questions requiring the student to apply this knowledge towards the development of experimental and theoretical research approaches. Students will also be required to integrate knowledge from modern experimental and theoretical literature with course material to complete writing and presentation assignments.

The ability to understand fundamental scientific principles and critically analyze the work of other researchers is critical for both upper level undergraduate and graduate students pursuing a research career in either industry or academia. However, the learning objectives and expectations for undergraduate and graduate students are slightly different. In general, graduate students have more experience in independent research and interpreting scientific literature compared to undergraduate students. Also, graduate students have generally completed more presentations and writing assignments than their undergraduate counterparts. Consequently, in grading the assignments of undergraduates and in defining their final grade distribution (below), more emphasis is given to the direct comprehension and application of lecture and reading material to homework, quizzes, presentation, and writing assignments.

**Undergraduate Students:** Homework/Quizzes (30%), Paper Presentation (15%), Paper Summaries (15%), Literature Review (17.5%), Research Proposal (17.5%), Participation/Attendance (5%)

**Graduate Students:** Homework/Quizzes (25%), Paper Presentation (15%), Paper Summaries (15%), Literature Review (20%), Research Proposal (20%), Participation/Attendance (5%)

**Paper Presentation:** Each student (or a small group of students, depending on class size) will present a recent research paper from a peer-reviewed journal once during the semester. Papers should be relevant to course material and should be selected following consultation with the instructor at least 2 weeks before the presentation. The presentation should be in PowerPoint format and may be informal, but must include: brief introduction and background, key experimental approaches, figures from the paper, interpretation and critique, and a list of suggested follow-up studies. During the presentation, questions about the paper posed by classmates and the instructor must also be addressed.

**Paper summaries:** For each presented research paper (except his/her own), each student will complete a short (1-2 paragraphs) summary, including: a brief summary of problem statement and major results, questions that the authors answered convincingly, questions that the authors failed to answer convincingly, and at least one question for the person presenting the paper.

**Homework/Quizzes:** Homework will be regularly assigned based on reading and lecture. Quizzes will be given periodically through the semester. Homework and quizzes will include both fact-based questions and open-ended design questions.

**Literature Review:** Each student will write a three-page (1-1.5 spaced, 11-12 point Times or Arial font) summary of at least 4-6 research articles on a focused topic relevant to course content. The review topic should be discussed with the instructor at least three weeks before the review deadline. Content should
include details on why the audience should care about the summarized topic, major advances in the field, and unanswered questions in the field. Additionally, references should be compared and contrasted with each other. Summary should include 2-3 relevant figures (both student-generated and cited from the literature are OK) and appropriately formatted references. At least two references should be from journals published in the last two years. References may be on an additional page, but all figures, tables, etc. must be included within the three pages. Points will be deducted for submitted papers not conforming to the required formatting.

Research Proposal: Write a three-page (1-1.5 spaced, 1-1.5 spaced, 11-12 point Times or Arial font) research proposal based on the background provided by the literature review, and research methods detailed in the course material and literature. The proposal should address a topic using a combination of experiment and theory. The proposal must include: background/motivation, specific aims (assessment of unanswered questions identified in the literature review should help to define these aims), and proposed experiments that will address each aim. Up to three figures may be included if they help the proposal’s clarity. References may be on an additional page, but all figures, tables, etc. must be included within the three pages. Points will be deducted for submitted papers not conforming to the required formatting.