TEACHING PHILOSOPHY

As information becomes increasingly available from numerous angles, citizens must be able to read a large number of sources with a critical mindset. A fundamental knowledge of certain scientific topics can facilitate learning across disciplines. All branches of science are intertwined, and often the same information is presented in different ways. A few key principles underlie many branches of knowledge: probability and statistics; basic physiology at the organism and cellular level; and the basics of modern physics. All of these are accessible to undergraduate students and should form a part of any liberal arts education.

Learning new subjects involves not only their vocabulary, but also understanding on a practical level what is difficult, what is easy, and thus from what angles technological or conceptual breakthroughs might arise. As just one example, the development of the COVID vaccine led to a great deal of press about mRNA vaccines and the history of their development. How hard was it really to develop a COVID vaccine? What was it based on? Can we expect cancer vaccines in the near future?

A great way to appreciate the relative difficulty of different techniques is with hands-on experience. Thus, one goal of my teaching career has been to discover the most effective ways to allow students to perform practical experiments within the time and budgetary constraints of the term. Most of the techniques of modern molecular biology can be presented to students in three or four weeks, so a semester or summer term is sufficient to allow those with no previous biology background to perform basic experiments in gene cloning, transfection, and protein purification.

One of my first goals at McGill was to create a course to do just that. BMDE506, "Methods in Molecular Biology for Physical Scientists," later given as Biophysics at PSU, has helped students in physics, chemical engineering, and medicine begin research with a biological element. The course is almost entirely practical, with lectures providing only the bare definitions and students discovering what these definitions mean by touching and manipulating the reagents and instruments. Because the laboratory course suffered from lack of a coherent textbook, I submitted a proposal to Taylor & Francis to write a full-length text intended for biophysics students and instructors. *Introduction to Molecular Biophysics* came out in September 2011 and met with significant success; a Second Edition appeared in 2017. This course may be given with or without a laboratory component, as I discovered in 2021 during the quarantine.

Whether in lecture or in lab, bacteria present wonderful test systems for a tremendous array of subjects. Students can understand ecosystems and extreme environments by studying bacterial communities, genetics by cloning using *E. coli*, and exponential growth using simple growth curves. Learning about bacteria can help in understanding of infectious disease, public health, and biotechnology.

Finally, reading and writing skills underlie all fields of knowledge, and practicing them is essential in any course. Most of my courses have involved an active-learning component where students pick a topic to present and prepare a lecture and/or final report. The topic may be one listed in the course outline or one of the student's choosing. This approach has proven to be popular and fun and has led to the addition of several new topics to the syllabus of most of my courses.

TEACHING EXPERIENCE

Courses Taught at PSU (2017-2025)

PH 624: Classical Mechanics
Level: Graduate
Years offered: Fall 2022-2024
Topics: Lagrangian and Hamiltonian mechanics, Kepler's laws, secular perturbation theory
Type of content: lecture
Evaluation: problem sets and exams.

PH212: Introductory Physics With Calculus II
Level: Undergraduate
Years offered: Winter 2018, Summer 2018
Topics: introduction to electricity and magnetism.
Type of content: lecture
Evaluation: problem sets and exams.

PH664/665: Statistical Mechanics
Level: Graduate
Years offered: Spring 2018-2025
Topics: Statistical mechanics of particles.
Type of content: lecture
Evaluation: problem sets and exams.

Ph 378U or Sci 355U: Learning Science through Sci-Fi
Level: Undergraduate
Years offered: Fall 2018
Topics: Writing-intensive course on the science of science fiction.
Type of content: lecture and discussion.
Evaluation: Essays.

PH490/590: Biophysics
Level: Upper division and graduate
Years offered: Spring 2019/Winter 2021
Topics: Introduction to topics in biophysics.
Type of content: lecture
Evaluation: problem sets and exams.

At OHSU (Oregon Health and Sciences University)
MP531: Radiophysics (Fall 2019)
Graduate-level course in foundations of radiation physics for Master's students in the Medical Physics program.

Courses Created at PSU
Physics 412/512: Quantum Mechanics II (submitted for approval 07/2018, offered each Spring since)
PH665: Statistical Mechanics II
WR 510: Summer Technology Training (Coding Bootcamp) (with Sarah Read of English)
Physics 410/510: Mathematics for Quantum Sciences (given as Special Topics in Fall 2021)

Courses Taught in Medical School, McGill University (2004-2015)
Medical School Unit 7: Microbiology, Spring 2008
Problem-based learning (PBL) small group sessions focusing on case histories in microbiology.

Medical School Unit 8: Pharmacology
Years offered: Fall 2008, Fall 2009, Fall 2010, Fall 2012, Fall 2013
Problem-based learning (PBL) small group sessions focusing on case histories in pharmacology.

Courses Created in the Department of Biomedical Engineering, McGill
BMDE 510: Astrobiology
Level: Post-graduate
Time: 39 hours/ term
Years offered: Winter 2014
Topics: origin and evolution of life on Earth; solar system missions and the search for life on Mars; the
search for exoplanets; planetary protection.
Type of content: lecture
Evaluation: quantitative problem sets (1/2 weeks) and final paper.

BMDE 509: Mathematical Cellular Physiology
Level: Post-graduate
Time: 39 hours/ term
Years offered: Fall 2010, Fall 2012, Fall 2013
Topics: Mathematical methods and models in biology from a mathematical standpoint, including transport and homeostasis, cellular excitability, and networks.
Type of content: lecture
Evaluation: quantitative problem sets (1/ week) and final quantitative project (solution to a problem or creation of a computer program).

BMDE 506: Methods in Molecular Biology
Level: Post-graduate and medical school
Time: 39 hours/ term
Years offered: Summer 2005, 2006, 2007, 2008
Topics: A laboratory course designed to introduce students with a math/ physics background to molecular biology.
Type of content: laboratory