

Systems Biomedicine: Molecules, Cells and Networks

Overview:

General course description: This is a core course for entering PhD, MD/PhD and master's students that introduces the student to integrated approaches to understanding physiological functions and the underlying biochemical, cell biological and molecular biological mechanisms. Elements of genetics and epidemiology are also included. The emphasis is 'top-down', beginning with a patho-physiological condition studied from a clinical perspective going down to exploration of the biochemistry and molecular biology underlying the disease and normal state. The course uses a combination of experimental and computational approaches, including methodologies for handling large data sets and for generating different kinds of systems models. An Introductory Module introduces an array of basic concepts and computational tools that will be used throughout the four disease-focused modules that follow. Those four modules are focused on: Diabetes, Cancer, Renal Disease and Drug Abuse.

Classroom time (typically 2-hour sessions) includes didactic presentations but class discussions and question-answer formats are employed extensively. Students are guided to relevant textbook material as needed, although an aim of the course is to use primary literature as a way of studying scientific method as well as conclusions; Journal Club-type sessions are thus built into the schedule of all modules and students are asked to lead the presentation and discussions.

Each module includes 2 problem sets. Collaborative work among students is encouraged for the first problem set; the students are asked to include a list of their collaborators when they submit their individual answers. For the second problem set of each module, students are asked to work individually. Evaluation of student participation in class, including general class discussion as well as journal club-type sessions are also part of the performance evaluation.

Integration among and within modules of the course: The faculty presenters in this course bring "domain expertise" that spans basic sciences of multiple disciplines as well as clinical sciences and patient-involved research. Integration of concepts across classes within a module is optimized by the active engagement of the course director(s), module directors and TAs who participate in class discussions and/or in blog discussions or TA sessions outside of class to build bridges between material from different classes and modules and from different domains of science.

Major course goals: A goal of the course, as a core introductory course, is to guide students toward mastery of core principles of mechanistic molecular sciences. The methodology of the course is to present cell, molecular and biochemical principles in a context that will enable students to fit the burgeoning information from mechanistic, structural and genomic studies into schema of physiological and patho-physiological networks and systems that underpin normal physiology and disease states. This entails integration of computational approaches and systems biological reasoning throughout the course, with specific emphasis on the importance of systems approaches to identification of potential therapeutic targets and to development of network models that produce testable hypotheses about patho-physiological phenomena.

Two Sample Modules - Module 2, Diabetes; Module 3, Cancer:

For each of the two modules shown, there follows:

- (1) Module overview including an introductory overview, class-by-class module flow, including placement of Journal Clubs, and points of integration with other modules and within the module.
- (2) PowerPoint slide set, assignments/hand-outs for each session and links to relevant chapters in standard texts that are on NIH Bookshelf
- (3) Problem sets