Math 563: Modeling cell-scale biology
September – December 2016

Topics and textbook:

We will investigate mathematical models of cellular processes. We will start by examining the motion and chemical interactions of biomolecules at the scale of tens of nanometers to micrometers. We will consider cases where there are many such molecules, and we can apply the diffusion equation, as well as cases where there are few molecules and we should take a stochastic (probabilistic) approach. We will also look at applications of stochastic processes to the kinetics of ion channels, polymer growth and molecular motor behavior, and to stochastic modeling of gene expression and regulatory networks.

The mathematical parts (and some of the biological parts) of the core topics are found in the text by Paul Bressloff: *Stochastic Processes in Cell Biology* (Springer, 2014). The book can be downloaded from the UBC library (you will need to be on campus or attached via the library proxy). We will also refer to additional papers and notes, related to simulating cellular processes via reaction-diffusion master equation (RDME) and particle-based methods (e.g. smoldyn by Steve Andrews), and when we need to discuss experimental techniques.

Background:

This course will focus on useful tools for modeling and simulation and it is definitely not a course on the theory of stochastic processes. Even though the main examples will be cell-scale, most or all of the modeling techniques that will be studied are in broad use at the tissue/organismal/ecological levels as well.

I intend this course to be accessible to students from diverse backgrounds, given a reasonable background in undergraduate applied mathematics. If you are not sure about your preparation, please contact me to discuss. A major part of the assessment will be via a medium-size project (individually or in small groups). Project topics will be based on student interests and won't necessarily have to be at the cell scale provided they are interesting.

Assessment:

Homework (every two weeks) 40%
Presentation of a paper from the reading list and critical write-up 20%
Project proposal (individual or group) 5%
Project presentation (oral and written) 30%
Participation in class 5%