Biomath 203: Stochastic Models in Biology
Instructor: T. Chou
Location & Time: M-W 12:00-1:50
Location: Slichter 2834 (tentative)

BIOMATH 203 is a graduate course that will cover canonical stochastic models typically used to describe biological systems. Prerequisites include proficiency solving basic linear ordinary differential equations and linear algebra. Familiarity with complex variables and integration will be useful. Emphasis will be placed on constructing physical models, limits of validity of models, and assumptions/approximations used in modeling biological phenomena. Topics covered vary from year to year, but roughly include:

I. Preliminaries - review

- Probability, distributions, expectations, moments

II. Discrete state models

- Markov processes
- Random processes on integers, random walks, Master equations, generating functions, detailed balance vs. NESS, backward equations, first passage times, large system size expansion,
- Numerical methods: Gillespie/BKL
- Models: random sequential adsorption, birth-death processes, branching processes, extinction, models for transcription, ASEP models, transcription-translation coupling model, molecular motors, Brownian ratchets, Wright-Fisher/Moran model, kinetic proofreading, receptor signaling

III. Continuous state models

- Brownian motion, SDEs, Ito, Stratonovich calculus, jump processes
- Numerical methods: Euler, Milstein
- Feynman-Kac formula
- Evolution of probability densities, Fokker Planck Eq., Chapman-Kolmogorov eq., Kramers eq., O-U process, kinetic theories, anomalous diffusion, CTRW/Montroll-Weiss
- Backward equations and first passage times
- Models: target search, exit, stochastic structured populations.

You can anticipate 1-2 homework sets, perhaps one midterm quiz, and either a final exam **or** a final project consisting of an oral presentation and a short write-up (to be determined). Grading will be based on performance on the homeworks, exams, and on the novelty an depth of the oral presentation and accompanying written report, if applicable. No specific textbook will be used.