

Molecular Genetics Graduate Topic Course (2025 Winter Term)

Course Title: MMG1315H S (Gene and Protein Evolution)

Course Coordinator: Zhaolei Zhang

Course Location: TBD

Course Time and Date: Wednesdays 1-3 pm, March 19 to April 23, 2025 (6 weeks)

Course Overview:

This course will survey the genetic and biophysical forces that have shaped the evolutionary history of genes and proteins. The first lecture will review basic concepts in molecular evolution and mutational processes, while the latter lectures will discuss recent theoretical and experimental advances. Topics to be covered include mutational processes, positive and negative selection, neutral theory of protein evolution, predicting deleterious protein mutations, biophysical models of protein evolution, protein sequence and structure spaces, mutational robustness and evolvability, epistasis and co-evolution of interacting amino acid residues, protein interactions and networks, evolution of gene expression and gene regulation. Student grades will be based on participation in discussions, paper presentation, and a written CIHR grant LOI.

Course Objectives:

- Understand important concepts and techniques in molecular evolution
- Understand how to determine whether a gene or protein is under selection
- Understand protein domains and motifs and how they evolve
- Understand biophysical models that govern evolution of protein sequence and structure
- Explore methods to predict deleterious mutations in gene or protein
- Explore how new genes arise and get retained during evolution
- Evolution and variation of gene expression and gene regulation
- Understand protein and gene evolution from a network perspective

Marking Scheme:

- 15% for class participation
- 25% for paper presentation
- 60% for a final project: a five-page CIHR operating grant letter of intent (LOI)

If you anticipate missing a class you must let the instructor know in advance, given the weight on participation and the fact that there are only six classes. Providing that you had a legitimate reason for missing the class, you will be provided with an assignment based on the reading for that week that you can use to make up for the lost class.

The basic outline for what will be covered in the six weeks is below. Assigned reading will be sent out the week in advance. In addition to the research articles, a review article may be distributed that is meant to provide a bit of context for the lecture for those students with less background and will not be a specific point of discussion.