

Quantitative Genomics and Genetics
BIOCB 4830/6830; PBSB.5021.03
Spring 2024 – Cornell / Weill Cornell

Time: Tuesday, Thursday 8:40 am – 9:55 am (Lectures)
Thursday **or** Friday (Labs)

Professor Jason Mezey
Department of Computational Biology (Cornell)
Department of Genetic Medicine (Weill Cornell)

Cornell TA: Beulah Agyemang-Barimah
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Weill Cornell Med TA: Samuel (Sam) Terkper Ahuno
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Course Times and Locations

Lectures: T/Th 8:40-9:55AM

Cornell, Ithaca: Weill Hall 224 (Tues) Weill Hall 226 (Thurs)

Weill Cornell: Belfer Building (BB200's-300's classrooms) as listed on the classroom schedule

All Lectures will be lead by Professor Mezey (see schedule)

Computer lab:

Cornell, Ithaca Computer Lab 1: Th 3:35-4:25PM (Mann Library B30A)

Cornell, Ithaca Computer Lab 2: Fri 9:05-9:55AM (Mann Library B30A)

WCM, NYC Computer Lab: Fri 9-10AM (A-950, 1300 York Ave, 9th floor)

All Computer Labs will be lead by Beulah Agyemang-Barimah (Cornell, Ithaca) or by Samuel Terkper Ahuno (WCM, NYC) and supervised by Professor Mezey. Labs will consist of R coding discussions and assignments that complement the lecture topics each week (see schedule)

***Work Requirements for BTRY 4830 (Undergraduate)
vs BTRY 6830 / PBSB.5021.03 (Graduate)***

Additional work for graduate students (required to register for BIOCB 6830 or PBSB.5021.03) compared to undergraduates (BIOCB 4830) will include answering additional questions and content delivery requirements for the final class project.

Note that graduate and undergraduate students will be graded separately.

Help Sessions

Jason's Office Hours: TBA

Note that individual help sessions with Jason (Cornell or WCM), may be set up by appointment.

Suggested Prerequisites (Not Required)

Introductory genetics. Introductory probability and statistics.

Course Work/Grading Policy

Exams: A single mid-term and a final exam. The final exam will be cumulative. Both of these will be take-home exams.

Problem Sets: There will be a short problem set handed out on Tues. or Thurs. approximately every week.

Class Project: A single class project, involving analysis of real data, will be assigned during the second half of the semester (~4 weeks).

Grades: your grades will depend on the course work listed above with the following weights: Mid-Term (20%), Final (30%), Problem Sets (20%), Project (25%), Computer Lab (5% - attendance). A letter grade will be determined from these components. For S/U grading, a letter grade of C- or above is required for an "S".

Lecture and Lab Schedule

Date	Topic / Assignments	Lecture	Lab
Jan 23	INTRODUCTION	<i>Logistics / Intro. to Quant Gen</i>	
Jan 25	PROBABILITY AND STATISTICS	<i>Intro. to probability</i>	Intro to R and Latex
Jan 30		<i>Intro. to conditional probability</i>	
Feb. 1	HW #1 – Assigned	<i>Intro. to random variables and random vectors</i>	R Basics and Rmarkdown
Feb. 6		<i>Expectations, variances, covariances, and probability models</i>	
Feb. 8	HW #1 – Due HW #2 – Assigned	<i>Introduction to inference</i>	Into to plotting
Feb 13		<i>Introduction to estimation</i>	
Feb 15	HW #2 – Due	<i>Maximum likelihood estimators</i>	R functions
Feb 20		<i>Introduction to hypothesis testing I</i>	
Feb 22	HW #3 – Assigned	<i>Introduction to hypothesis testing II</i>	Data handling

Feb 27		<i>No Class!!</i>	
Feb 29	QUANTITATIVE GENOMICS	<i>Introduction to hypothesis testing III</i>	Review
March 5	HW #3 - Due	<i>Introduction to genetic modeling</i>	
March 7		<i>Introduction to genetic inference I: genetic linear regression model</i>	Linear regression
March 12	HW #4 - Assigned	<i>Introduction to genetic inference II: MLE</i>	
March 14		<i>Introduction to genetic inference III: calculating p-values</i>	GWAS
March 19	MAPPING: GWAS	<i>Genome-Wide Association Studies (GWAS) I: Introduction</i>	
March 21	HW #4 - Due	<i>Genome-Wide Association Studies (GWAS) II: Linkage Disequilibrium</i>	Review
March 26	Midterm Assigned	<i>Genome-Wide Association Studies (GWAS) III: statistical and experimental issues</i>	
March 28	Midterm Due	<i>Genome-Wide Association Studies (GWAS) VII: Covariates and QQ plots</i>	
April 2		<i>No Class!!</i>	

April 4		<i>No Class!!</i>	
April 9	Project Assigned	<i>Genome-Wide Association Studies (GWAS) VI: Minimum GWAS analysis and PCA</i>	
April 11		<i>Genome-Wide Association Studies (GWAS): logistic regression I</i>	Covariates
April 16		<i>Genome-Wide Association Studies (GWAS): logistic regression II</i>	
April 18		<i>Genome-Wide Association Studies (GWAS): logistic regression III (IRLS algorithm)</i>	Logistic regression
April 23		<i>Mixed Models</i>	
April 25	BAYESIAN STATISTICS	<i>Bayesian inference I: introduction & inference basics and linear models</i>	Review
April 30		<i>Bayesian inference II: MCMC algorithms</i>	
May 2	PEDIGREE AND INBRED LINE DESIGNS	<i>Basics of linkage analysis & Inbred line analysis</i>	EM and MCMC
May 7	CLASSIC QUANTITATIVE GENOMICS Project Due	<i>Additive genetic variance and heritability</i>	