# Cornell courses relevant to Population, Comparative & Evolutionary Genomics

Assembled by the Cornell Center for Comparative and Population Genomics (<u>http://3cpg.cornell.edu</u>) *Please send corrections or updates to Chip Aquadro* (<u>*CFA1@cornell.edu*</u>)

3CPG serves as a key source of communication and collaboration to faculty, staff, students and postdocs across campus, and also hosts an outstanding 3CPG Seminar Series each year. To receive emails regarding seminars, workshops, resources, and news relevant to comparative and population genomics at Cornell (including those in other seminar series on campus), email <u>Evolgen Seminars-L-request@cornell.edu</u> with a blank subject line and the single word "join" in the body of the message.

# **SPRING 2024 COURSES**

(check Class Roster and Courses of Study for updates and especially class times)

BIOMG 1290 Personal Genomics and Medicine - Chip Aquadro

3 credit. No prerequisites. Capped at 130

MW 11:20 am - 12:10 pm lectures plus weekly disc sections F 11:20-12:10pm.

Are you curious about your family ancestry? How, and why, might your genetic ancestry have influenced the diseases to which you are susceptible? Do you have allergies to milk or wheat? Does a relative suffer from a genetic disease, and you wonder if you might also be at risk? How will medicine and insurance be impacted by DNA testing? How will your own future, your quality of life, your decisions regarding children be impacted with this information available to anyone with as little as \$99 and a saliva sample? What are the scientific, ethical, legal and social challenges obtaining and using this information? This course will introduce you to the challenges and opportunities of DNA testing that is rapidly becoming part of our future.

NTRES 2830 DNA, Genes, and Genetic Diversity - Matt Hare

4 credits. No prerequisites. Letter grades only.

Lecture: MWF 9:05 – 9:55 AM Lab Sections: Th 10:10am – 12:05pm, F 2:30-4:25 PM

Do genes make us who we are? What are the rules of inheritance and when don't they apply? How does a genome carry enough information to code for a complex organism? Can we keep an endangered species from going extinct based on information in its genome? This introductory genetics course is distinct from others at Cornell by devoting 1/3 of the semester to population-level topics including heritability, population connectivity, genetic rescue, evolutionary capacity and the factors determining levels of genetic diversity. These topics build upon a foundation of Mendelian transmission genetics (rules of inheritance) and molecular genetics (processes leading from genes to phenotype). Lab activities include use of DNA databases, bioinformatic tools, simulations, model construction, debate and role play. Useful for advanced courses in conservation biology and evolution.

BIOEE/MATH 3620 - Dynamic Models in Biology – Steve Ellner, Alexander Vladimirsky, and Andrew Hein 4 credits. Prerequisite: two majors-level biology courses and completion of mathematics requirements for biological sciences major or equivalent, or consent of the instructor.

Lecture TR 1:25 – 2:40 pm, computer lab F 12:20 - 2:15pm

Introduction to the development, computer implementation, and applications of dynamic models in biology. Case-study format covering a broad range of application areas such as gene regulatory networks, neurobiology, infectious disease management, and conservation of endangered species. Students also learn how to study dynamic model of biological systems on the computer using the R scripting and graphics environment.

(NOTE – this course will be reconfigured as BioCB3620/6620 and taught by Andrew Hein in Spring 2025 and henceforth).

PLBIO 4000 / 6000 Concepts and Techniques in Computational Biology - Gaurav Moghe

Spring. 4 credits. Letter grades only. TR 9:05-11:00am

Since a significant amount of learning for this class occurs outside the class, auditing this class is not permitted.

Prerequisites (may be waived with the permission of the instructor)

- Biology courses: BIOMG 2800, BIOMG 3320, BIOMG 3350, PLBRG 2250 or equivalent
- Computational courses: CS1110 (Introduction to computing using Python) or equivalent
- Statistics courses: BTRY 3010, STSCI 2150, BTRY 6010 or equivalent

This course is geared towards graduate students and advanced biology undergraduates seeking a better understanding of computational biology. Lectures will be a combination of presentations, paper discussions and hands-on sessions. Labs and paper discussions will have a significant component of plant science, but students from non-plant fields are also encouraged to register. Students will learn to work in a Unix environment, code using Python/R, and deploy tools for genome assembly,

RNA-seq data analysis, local and global sequence alignment, protein domain searching using Hidden Markov Models, phylogenetic reconstruction, metabolomic analysis, and machine learning. Lectures will cover the algorithmic concepts underlying popular tools. The students will also learn practical aspects of implementing these tools in their own research using facilities available at Cornell.

# NS 4300 - Proteins, Transcripts, and Metabolism: Big Data in Molecular Nutrition - Nathaniel Vacanti Spring semesters

Tues/Thurs 1:00PM - 2:15PM EST/EDT

This course will cover fundamental concepts of big data analysis at an introductory level in the context of gene expression at the mRNA and protein levels with a focus on metabolic regulatory networks. Programming in Python and R will be used, but no prior experience is necessary. Programming in this course will focus methods to parse large data sets and perform informatics analyses.

Prerequisite: one semester introductory biology lecture (BIOMG 1350, BIOG 1440, or equivalent), biochemistry (NS 3200, BIOMG 3300, or equivalent), and introductory statistics (STSCI 2150, PAM 2100, AEM 2100, or equivalent). Enrollment limited to: senior, junior, and graduate students. Sophomores by permission during the ADD period. Students are required to bring their own laptop to class.

# BIOMG 4390 - The Molecular Basis of Disease -Hojoong Kwak

3 credits. Student option grading.

Lecture Tues/Thurs 2:45-4:00 pm.

## Prerequisites: BioMG3300, or BioMG3310 and BioMG 3320, or BioMG 3350, and BioMG2800

This course will examine how changes in the normal expression, structure, and activity of gene products caused by genetic mutations and environmental agents lead to disease in humans and other animals. The material will focus on how proteins with modified structures and biochemical activities cause alterations in normal cellular processes, as well as the physiological consequences of these changes. Topics will be selected from hormone insensitivity syndromes, gene fusions resulting in hybrid proteins, gene amplification, gene inactivation, disruption of signaling pathways, genetic variation in non-coding transcriptional regulatory elements, and the molecular actions of environmental poisons and toxins. The methods used to identify the underlying biochemical and genetic basis of diseases, as well as possible pharmaceutical and genetic therapies for treating the diseases, will be presented.

## BIOPL 4400 / ENTOM 4400 Phylogenetic Systematics – Kevin Nixon

4 cr, Tu/Th 10.10-11 am and a biweekly computer lab, for a total of 5 lab hours per week (lab times TBA) This course covers basic and advanced theory and methods of phylogenetic analysis. Introduces students to phylogenetic analysis using parsimony, maximum likelihood and Bayesian analysis methods. Allows students to gain hands-on experience with computer programs which analyze both morphological and molecular data. Topics also include applications of phylogenetic methods to biogeography and evolutionary studies. Provides the fundamentals of understanding and interpreting phylogenetic analyses to any student using phylogenetic trees in their current or future research.

## BIOEE 4530 / BIONB4530 Speciation: Genetics, Ecology, and Behavior – Kerry Shaw

Spring. 4 credits. Limited to 40 students. Prerequisites: BIOEE 1780 and BIOMG 2810 or equivalents, or permission of instructor. S-U or letter grades.

TR 10:10 – 11:25 am; Offered alternate years.

Advanced course in evolutionary biology focusing on the pattern and process of speciation and the nature and origin of behavioral, morphological, physiological and ecological traits that form the intrinsic barriers to gene exchange. Lecture topics include species concepts and definitions, the history of ideas about speciation, the biological basis of intrinsic barriers to gene exchange, current models for the origin of such barriers, genetic architecture of speciation, rates of speciation. Emphasis is on developing a rigorous conceptual framework for discussing speciation and on detailed analysis of a series of case histories.

BIOMG 4610/6610 Development & Evolution – Mariana Wolfner

TR ~2:30-4:00; 3 credits, letter grade only. Every other year (odd-number years);.

Prerequisites: genetics, molecular biology and evolution (e.g. BioMG2810, BioMG3320 (or 3300 or 3330), BioEE1780 or their equivalents).

Have you ever wondered what makes animals develop to look so different? Amazingly, the same fundamental pathways regulate many aspects of development across the animal kingdom, but over the course of evolution they have been modified in different lineages to cause striking variation in form and function. This course addresses the ways in which these fundamental pathways have changed during evolution, and how this results in the dazzling diversity seen in the animal kingdom. Class meets twice a week to explore the fascinating, new and current field of "EvoDevo" through readings of

papers in the current scientific literature, and lecture and in-class discussion. The course material requires background in Genetics, Evolution and Molecular Biology - usually acquired through the prereq courses.

ENTOM 4610 - Model-Based Phylogenetics and Hypothesis Testing – Leland Graber and Corrie Moreau 3 credits. Student option grading. (offered alternate even years; offered Spring 2024)

Prerequisite: BIOEE 1780 or BIOMG 2800 or equivalent, or permission of instructor.

This course is an introduction to the "tree of life" (phylogeny): its conceptual origins, methods for discovering its structure, how phylogenies are used in macroevolution, and its importance in evolutionary biology and other areas of science. Topics include historical context and concepts, sources of data, methods of phylogenetic analysis, and the use of phylogenies to study systematics and classification, the tempo and mode of lineage diversification, coevolution, biogeography, conservation, molecular biology, development, and epidemiology.

## ENTOM 4700 / BIOEE 4800 – Ecological Genetics – Brian Lazzaro

4 credits, Offered odd-year spring semesters

*Prereq:* BioEE 1780 or permission of instructor. Familiarity with genetics and basic statistics is recommended. Satisfies major requirements in Entomology and Ecology and Evolutionary Biology.

Ecological Genetics focuses on the application of population genetic concepts in ecological contexts, with emphases on measuring adaptation in natural populations, detecting the effects of population demography, and determining the genetic basis of quantitative traits. Illustrative examples will be drawn from the primary research literature to demonstrate experimental techniques and methods of data analysis on single-gene, multi-locus and genome-wide scales. Learning Outcome 1: Students will be able to apply and test basic models of genetic evolution to real biological scenarios, guided by case examples from the primary scientific literature as well as lecture-based presentation of abstract concepts. Learning Outcome 2: Students will be able to apply analytical tests to empirical data sets and draw statistically robust conclusions. Learning Outcome 3: Students will be able to interpret data and results in broader context to reach plausible biological conclusions. Students will employ "scientific thinking" to solve problems that mirror real-life experimental scenarios.

## BioCB 4830 / BioCB 6830 Quantitative Genomics and Genetics - Jason Mezey

4 credits, Lecture: Tues, Thurs 8:40 - 9:55 am, plus computer Friday lab (time varies from year to year) Available via Video-conferencing between at both Ithaca and Weill Medical College campuses.

Prerequisites: BTRY 3080 and Introductory Statistics or equivalent

A rigorous treatment of analysis techniques used to understand complex genetic systems. This course will cover the fundamentals of statistical methodology with applications to the identification of genetic loci responsible for disease, agriculturally relevant, and evolutionarily important phenotypes. Data focus will be genome-wide data collected for association, inbred, and pedigree experimental designs. Analysis techniques will focus on the central importance of generalized linear models in quantitative genomics with an emphasis on both frequentist and Bayesian computational approaches to inference.

BioCB 4910 / 6910. Advanced Population Genetics - April Wei

3 credits. Lecture Tentatively Tue/Thu 2:55-4:10 pm

**Prerequisites**: BIOCB4810/BIOCB6810 or have basic knowledge of Genetics and Probability, or pending lecturer approval.

Course Description: This class covers the latest development and cutting-edge research topics in population genetics, aiming to enable students to perform research in population genetics. The first part will cover coalescent theory and inference involving complex demography. The second part will discuss natural selection and methods for inferring selection. We will allude to the complexity of demographic history and natural selection and their importance in explaining genomic patterns. The third part will introduce new data types and the challenges and opportunities with these data. We will dive into genotype likelihood and will emphasize the importance of simulation in population genetics. The class will be mostly delivered through lecturing, each interspersed with short conversations about reading assignments. Coursework involves reading literature, solving problem sets, and a course project.

BIOEE 4940, Ecological and Evolutionary Statistics – Andres Lopez Sepulcre \*\* NEW COURSE\*\* 3 credits. Lecture: TWTh 11:15-2:15 PM

Offered Spring 2023

The Ecology and Evolutionary Biology department uses this course number for "trial" courses that are offered once and rotate. In Spring 2024, the focus is on statistical methods in ecological and evolutionary biology.

NTRES 6100, Collaborative and Reproducible Data Science in R – Nina Overgaard Therkildsen 2 or 3 credit options. Lecture: Tue/Thurs 9:40am - 10:55am, Lab: Thurs OR Fri 12:25pm - 2:20pm NOT offered Spring 2024

As datasets grow larger and more complex across all areas of science, computational skills are increasingly in high demand. This course introduces a series of practical tools that enable researchers to spend less time wrestling with software or repeating error-prone manual data processing and more time getting research done in efficient and transparent ways that facilitate collaboration and reproducibility. We will work in R/RStudio. Topics covered include 1) tidy data formatting, 2) rearrangement, filtering, exploration, and visualization of complex datasets, 3) basic programming, 4) version control with Git and GitHub, and 5) using R Markdown to combine text, code, tables, and figures into reports, websites, and presentations. The course emphasizes practical skill development and is structured around hands-on (the keyboard) learning.

## BTRY 6020 - Statistical Methods II - J. Guinness

4 credits. Spring. Prerequisite: BTRY 6010 or equivalent. Enrollment limited to graduate students or permission of instructor

Continuation of BTRY 6010. Emphasizes the use of multiple regression analysis, analysis of variance, and related techniques to analyze data in a variety of situations. Topics include an introduction to data collection techniques; least squares estimation; multiple regression; model selection techniques; detection of influential points, goodness-of-fit criteria; principles of experimental design; analysis of variance for a number of designs, including multi-way factorial, nested, and split plot designs; comparing two or more regression lines; and analysis of covariance. Emphasizes appropriate design of studies before data collection, and the appropriate application and interpretation of statistical techniques. Practical applications are implemented using a modern, widely available statistical package.

*NTRES* 6300: *Current Topics in Molecular Ecology and Population Genomics – Nina Overgaard Therkildsen* 1 credit, SX option only

Not offered 2023-2024 academic year

This graduate seminar will take the form of a journal club that meets weekly to discuss the burgeoning literature on genomic approaches used to address ecological and evolutionary questions in non-model organisms (i.e. organisms that have not been selected by large research communities for extensive study). The class time is used for discussion of recent primary research articles. Paper topics will be determined based on student interest and will include both novel results and methodological advances, primarily in evolutionary and ecological genomics or molecular ecology.

# BioMG 6870, Genetic analysis of biological pathways: Tricks of the trade: how to use genetics to dissect cell, molecular, and developmental pathways – Mariana Wolfner

Spring. Offered alternate (even) years. Next offered Spring 2024

3 credits. Letter or S/U grade options are both available.

Tues/Thurs. 2:55-4:10pm

Prerequisites: Prior courses in Genetics & Genomics (BioMG2800 or equivalent) and in Molecular Biology (BioMG 3300, 3320, 3330, 3350, or equivalent). Prior course exposure to Developmental Biology and/or Cell Biology is helpful but not required.

The explosion of new genetic/genomic methods, including the availability of genome sequences and CRISPR-based genome editing, provides new elegant tools and approaches with which to discover and dissect the pathways that mediate cell function, development, and other biological processes. This course presents and examines these approaches, with examples showing their use to determine the time/place/partners/actions of important genes. We focus primarily on multicellular organisms, including (but not only) model systems like fruit flies, nematodes, and mice. Lectures, class discussion, and problem sets are based on important papers in the current scientific literature, and some older "classics" where relevant.

BioCB 6890: Current Topics in Population Genetics - Philipp Messer

1 credit. S/U only. Prerequisite: BIOMG 4810, BTRY 4810 or permission of instructor.

Graduate seminar on current topics in population genetics. Readings are chosen primarily from current scientific literature. Participation in discussion and presentation of at least one paper required for course credit.

BIOEE 6900 /ENTOM 6900 Seminar in Ecology and Evolution of Infectious Diseases - M. Greischar and C. Murdock 1 credit (S/U). Thursdays 1:25 – 2:15pm

Graduate-level discussion of the ecology, epidemiology, genetics, and evolution of infectious disease in animal and plant systems. Weekly discussion of research papers published in the primary scientific literature. Participation in discussion and presentation of at least one paper required for course credit.

PLBRG 7170 - Quantitative Genetics in Plant Breeding – Kelly Robbins & Jean-Luc Jannink Spring. 4 credits. Letter grades only.

Prerequisite: PLBRG 4030 and BTRY 6010 or equivalent.

This course will provide students with a solid foundation in quantitative genetics theory, as applied to the field of plant breeding, and introduce students to modern day applications in genomic selection and genome-wide association mapping. While the methodologies of plant and animal breeding are distinct in many ways, the core principles are the same and this course will attempt to cover topics in a way that is inclusive of animal breeding applications. Although this course will cover a wide range of topics it is by no means an exhaustive coverage quantitative genetics, and students are strongly encouraged to compliment the principles learned in the class with introductory courses in statistical methods and experimental design.

BioCB 7200 Statistical and Computational Genetics – Jaehee Kim Weekly seminar series on recent advances in computational genomics. A selection of the latest papers in the field are read and discussed. Methods are stressed, but biological results and their significance are also addressed. Prerequisites/Corequisites Prerequisite: BTRY4840/BTRY6840/CS4775 or equivalent. Open to undergrads as well.

BioCB 7210: Topics in Quantitative Genomics - Jason Mezey

1 credit. S/U only. Prerequisites: BTRY 4830/BTRY 6830 or permission of instructor. Weekly seminar series on recent advances in quantitative genomics. A selection of the latest papers in the field is read and discussed. Methods are stressed, but biological results and their significance are also addressed.

BIOEE 7600 - Introduction to Modeling in Ecology and Evolutionary Biology - Steve Ellner

3 Credits, S/U Only, Offered alternate (even numbered) years. Next Spring 2024 (most classes during January 2024) This course is aimed at grad students in E&EB and related fields with no prior exposure to modeling. Students taking the course will learn to "read" dynamic models and identify the underlying assumptions; build their own process-based models; simulate models on the computer using R; and use computational methods to study the behavior of simple models. The class is in "bootcamp" format (75 min lecture and 3 hr computer lab each day, for about 3 weeks). Most class meetings will occur prior to the start of the semester, in January 2022. Students interested in enrolling should contact Patty Jordan (pj17) by midway through fall semester. Grades are based on computer exercises that will be completed in-lab, and a term project involving a modest extension of published research using an ecological or evolutionary model. Prior knowledge of R is not required. The course is especially suitable for early (1st and 2nd year) grad students wishing to acquire modeling skills that can be used in their thesis research.

# FALL 2024 COURSES (below is from Fall 2023 so check for updates)

(check Class Roster and Courses of Study for updates)

BIOCB 2010/6010 Introduction to Computational Biology

Team taught by Andy Clark, Amy Kuceyeski, Andrew Hein, April Wei, Charles Danko, Haiyuan Yu, Jaehee Kim, Jason Mezey, Philipp Messer, and Will Lai.

3 credits. No prerequisites.

MWF 10:10 am - 11:00 pm , 224 Weill Hall

This class is designed to inspire students to see the power of Computational Biology in advancing fundamental research in the life sciences. The course is team-taught by experts in diverse applications of Computational Biology, with each sharing the excitement of showing how computational approaches have been transformative in their field. The course will also teach many fundamental skills in manipulating large data sets, including genome sequences, functional genomic data, images, protein structures, etc. The course will consist of two lectures each week and one practical exercise session each week. In the practicals, students will learn the use of many of the latest software tools, and will develop basic programming skills. Students will learn essential problem solving skills in several aspects of genome analysis and modeling in neurobiology, ecology, physiology and evolution. This will prepare them for future courses in these more focused biological areas covering specific applications of computer programming as well as use of specialized software tools. Students will be able to explore their own specific interests in greater depth on a term project.

ENTOM 3310/3311 - Insect Diversity and Evolution - Bryan Danforth

Fall. 3 credits. TR 10:1-11:25am.

Prerequisite: ENTOM 2120. Co-requisite: ENTOM 3311 Insect Diversity Laboratory (T 1:25-4:25pm).

Insects are the dominant terrestrial organisms on planet earth both in terms of the number of species as well as in biomass. This course will provide a detailed look at insect diversity, phylogeny, natural history, and the insect fossil record. We will examine what is known about insect higher level relationships based on morphology and DNA sequence data and explore how phylogenies can be used to examine the evolution of behavior, life history, ecology, and natural history. Students will come away from the class with a deeper understanding of insect biodiversity, evolution, natural history, and phylogeny.

NTRES 3400: Molecular Tools for Ecology, Conservation, and Natural Resource Management – Nina Overgaard Therkildsen – NOT OFFERED FALL 2023

Fall. 3 credits. Lec MW 9.05-9.55am, Lab W 11.20am-1.50pm

Molecular genetics has become one of the fastest growing fields in the life sciences, and application of molecular methods has spread to virtually all fields of modern biology. In this course, we will examine how DNA analysis and modern 'omics' technologies can be used to address important issues in ecology, conservation, and natural resource management such as identification of species, populations, and individuals, reconstruction of phylogenetic and kinship relationships, and inference of migration patterns, behavior, and abundance. The focus will be on practical applications, and students will develop both a theoretical understanding of the methods and hands-on experience with all steps from sample collection, molecular biology laboratory techniques, data analysis, and communication of results.

# BIOMG 4000/6000 Genomics - John Schimenti

# Fall. 3 credits. Lec MW 2:55-4:10pm

Introduction to principles underlying the organization of genomes and the methods of studying them, emphasizing genomewide approaches to research. Covers the application of genomics methodologies for addressing issues including gene regulation, evolution, complex systems, genetics, and gene: phenotype relationships. Landmark and timely genomics papers and other research developments will be discussed. Basic bioinformatics tools will be incorporated.

NTRES 4100 Advanced Conservation Biology: Concepts and Techniques – Evan Cooch & Matt Hare 4 credits. Lecture: Tu/Th 10:10-11:25, Computer Lab: Wed 12:20-2:15

Prerequisites: CALS math requirement; introductory genetics; ideal precursor courses are NTRES 2830, NTRES 3100. Satisfies major requirements for EEB concentration in Biology and EBAE concentration in Environment & Sustainability. Decision making in conservation biology requires measurement and analysis of variation at the genetic, population, and landscape or system levels. Emphasis in this course is on quantitative tools for the formal analysis of variation at all three levels and principles guiding maintenance and management of biological and genetic diversity to promote population persistence.

# BIONB 4200:001 Genomics and Social Evolution – Michael Sheehan

2 credit seminar. Students will read, present and discuss the current and historical primary literature at the interface of genomics and social evolution. In the first part of the semester, we will read papers dealing with the genomic changes that accompany the origin and elaboration of sociality, focusing mainly on comparative genomic approaches. In the second part of the semester, we will read papers examining the effects of social behavior on genetic variation within populations.

# PLBIO 4220/6220 Comparative Plant Development: Evo-Devo - Adrienne Roeder and Michael Scanlon Offered odd years (next offered Fall 2025)

2 credits. Student option grading. Tuesday Thursday 11:15 AM to 12:105 PM

Prerequisites/Corequisites: BIOMG 2800 or PLBRG 2250, and PLBRG 2410 or permission of instructor. A comparative analysis of the developmental-genetic mechanisms contributing to the evolution of plant morphological structure and diversity.

ANSC 4310/5310 Animal Genomics and Epigenetics - Ellie Duan

3 credits. Tues/Thurs 11:40am -12:55pm (lecture Tues, disc Thurs)

Prerequisite/corequisite: ANSC 2210 or equivalent genetics class.

Animal Genomics and Epigenomics provides a foundation in functional genomics, epigenomics, and basic bioinformatics. It is designed to facilitate mastery of advanced techniques in genomics and their applications to animal biology, health, and production. The course consists of weekly lectures covering basic concepts and weekly workshops (computer labs or journal discussion). Workshops consist of exercises and discussions to provide students with hands-on experience performing basic genomic analyses. Students will become familiar with the UCSC genome browser, databases, and basic bioinformatic tools. Students will work in groups on a final project and develop research goals to study function(s) of a specific gene of interest.

BioCB 4381 / BioCB 6381 – Biomedical Data Mining and Modeling – Haiyuan Yu

Fall. 3 credits. Letter grades only. Lec T 2:55-4:10pm, Lab R 2:55-4:10pm

Prerequisite: at least one introductory course in computer programming (any language) and one in statistical methods, or permission of the instructor. Co-meets with BTRY 6381.

A biomedical data science course using Python and available bioinformatics tools and techniques for the analysis of molecular biological data, including biosequences, microarrays, and networks. This course emphasizes practical skills rather than theory. Topics include advanced Python programing, R and Bioconductor, sequence alignment, MySQL

database (DBI), web programing and services (CGI), genomics and proteomics data mining and analysis, machine learning, and methods for inferring and analyzing regulatory, protein-protein interaction, and metabolite networks.

#### BIOCB/BIOMG 4810/6810 Population Genetics - Philipp Messer.

4 credits. Prereq: BIOMG 2810, BIOEE 1780, or equiv.

## MWF: 10:10-11:00, Fernow Hall G24

Discussion sections: Mondays: 2:30 pm – 3:20 pm, Ives Hall 109, or Tuesdays: 1:25 pm – 2:15 pm, Comstock Hall B106 Population genetics is the study of the transmission of genetic variation through time and space. This course will provide a comprehensive introduction to the fundamental concepts and methods in population genetics, with a focus on exploring how patterns of genetic variation are connected to the underlying evolutionary processes. Topics include genetic drift, mutation, coalescence theory, demography, population structure, selection, fitness, quantitative traits, selective sweeps, and adaptation at the molecular level. Emphasis is placed on the interplay between theory, computer simulations, and the analysis of genetic data from natural as well as experimental populations. We will also discuss efforts to connect genotype with phenotype and ultimately fitness. Specific case studies will include the evolution of drug resistance, genetic ancestry mapping, experimental evolution, and the genetic structure and demographic history of human populations. *Note Advanced Population Genetics BIOCB 4910 / 6910, a follow-up course to BIOCB 4810/6810 Population Genetics, is now offered starting Spr semesters by April Wei.* 

## BioCB 4840/6840: Computational Genetics and Genomics – Jaehee Kim

4 credits. Prerequisite: BTRY 3010 (Biol Stats I; Fall) and CS 2110 (Object-Oriented Programming & Data Structures; Fall, Spr, Summer) or equivalents.

Lecture TR 10:10am - 11:25 pm plus discussion F 12:25 - 1:15pm.

Computational methods for analyzing genetic and genomic data. Topics include sequence alignment, hidden Markov Models for discovering sequence features, motif finding using Gibbs sampling, phylogenetic tree reconstruction, inferring haplotypes, and local and global ancestry inference. Prior knowledge of biology is not necessary to complete this course.

#### BIOMG 4870/6871: Human Genomics – Andy Clark

3 credits. Prerequisite: BIOMG 2810. Lec Tues/Thurs 10:10-11:25 am.

Applies fundamental concepts of transmission, population, and molecular genetics to the problem of determining the degree to which familial clustering of diseases in humans has a genetic basis. Emphasizes the role of full genome knowledge in expediting this process of gene discovery. Stresses the role of statistical inference in interpreting genomic information. Population genetics, and the central role of understanding variation in the human genome in mediating variation in disease risk, are explored in depth. Methods such as homozygosity mapping, linkage disequilibrium mapping, and admixture mapping are examined. The format is a series of lectures with classroom discussion. Assignments include a series of problem sets and a term paper.

## BTRY 6010 Statistical Methods - David Kent

4 credits. Fall. Limited to graduate students or permission of the instructor

Develops and uses statistical methods to analyze data arising from a wide variety of applications. Topics include descriptive statistics, point and interval estimation, hypothesis testing, inference for a single population, comparisons between two populations, one- and two-way analysis of variance, comparisons among population means, analysis of categorical data, and correlation and regression analysis. Introduces interactive computing through statistical software. Emphasizes basic principles and criteria for selection of statistical techniques.

## BIOCB 6890. Current Topics in Population Genomics - April Wei

1 credit (S/U). W 2:30-3:20 pm

Prerequisite: BIOMG 4810, BIOCB 4810 or permission of instructor.

Graduate seminar on current topics in population genetics. Readings are chosen primarily from current scientific literature. Participation in discussion and presentation of at least one paper required for course credit.

# BIOEE 6900 /ENTOM 6900 Seminar in Ecology and Evolution of Infectious Diseases - M. Greischar & C. Murdock 1 credit (S/U). Thursdays 9:05-9:55 am (offered spring and fall semesters)

Graduate-level discussion of the ecology, epidemiology, genetics, and evolution of infectious disease in animal and plant systems. Weekly discussion of research papers published in the primary scientific literature. Participation in discussion and presentation of at least one paper required for course credit.

# BIOEE7600: Special Topics in Evolution and Ecology- Robert Reed fall

1 credit (S/U). TBA time and day

Lectures and intensive study of special topics in the field of Ecology & Evolutionary Biology. Content varies each semester.