Cornell courses relevant to Population, Comparative & Evolutionary Genomics

Assembled by the Cornell Center for Comparative and Population Genomics (http://3cpg.cornell.edu)
Available as a PDF downloadable from the 3CPG web site under "For Current Grads & Postdocs"; "For Undergrads", and "For Prospective Grad Students & postdocs")
Please send corrections or updates to Chip Aquadro (CFA1@cornell.edu)

SPRING 2017 COURSES

(check Course Room & Roster for updates)

BIOMG 1290 Personal Genomics and Medicine -- Chip Aquadro
3 credit. Preference given to freshman & sophomores, no prerequisites. Capped at 104
MWF 11:15 am – 12:05 pm (lectures M & W, discussions F)
Charles (Chip) Aquadro (MBG)
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. Prerequisites: BIOEE 1780 or permission of instructor. Letter grades only.
Lecture: MWF 9:05 – 9:55 AM Lab Sections: Th 9:05 – 11:00 AM, F 2:30-4:25 PM
Covers molecular, Mendelian and population genetic principles as they relate to population biology and biodiversity. A laboratory section is devoted to problem solving, computer exercises and case study discussions. We will focus on eukaryotes and cover a broad range of molecular genetic processes including DNA replication, recombination and gene expression before turning to population level processes. Recommended as a preliminary to upper-level ecology, evolution, and natural resource management courses.

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

PLBRG 4093: QTL Analysis: Mapping Genotype to Phenotype in Practice- Ed Buckler & Jean-Luc Jannink
1.5 credits, S/U grading, Time and location TBA (see course and room roster in the spring)
Discussion of mating designs and populations as well as statistical models to identify genetic loci that affect the phenotype and to predict breeding and genotypic value using DNA polymorphisms, with practical application to real datasets.

BTRY 4381/6381 - Bioinformatics Programming – Haiyuan Yu
3 credits. Letter grades only.
Lecture Tues 2:55PM - 04:10PM, Lab Thursday 2:55 – 4:10 pm
Prerequisite: at least one introductory course in computer programming (any language) and one in statistical methods, or permission of the instructor.
A higher level programming course using Perl 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 Perl programming, R and Bioconductor, sequence alignment, MySQL database (DBI), web programming and services (CGI), microarray analysis, and methods for inferring and analyzing regulatory, protein-protein interaction, and metabolite networks.

BIOPL 4470 Molecular Systematics – Jeff Doyle

Lecture, MW 8:40 – 9:55 am, 3 credits, Lec. [offered alternate years, next offered Spr 2018]
Theory and practice of using molecular evidence, particularly DNA sequence data, for addressing diverse systematic and evolutionary questions. Emphasis is on phylogeny reconstruction, particularly in eukaryotic systems. The organization and evolution of nuclear and organellar genomes is described from the standpoint of their suitability for systematic and evolutionary studies.
Prerequisites: BIOEE 1780 or BIOMG 2810 or BIOMG 3300, or BIOMG 3320, or permission of instructor.

BIOEE4530 / BIONB3530 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. [offered Spring 2017]
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.

BIOEE 4640: Macroevolution – Amy McCune
4 credits. Lecture TTh 10:10-11:25, Discussion section to be arranged. Limited to 35 students. Offered alternate springs, next offered spring 2018.
Prerequisite: BIOEE 1780 or permission of instructor.
Advanced course in evolutionary biology centered on large-scale features of evolution. Areas of emphasis include phylogeny reconstruction, using phylogenies, patterns and processes of speciation, the origin of evolutionary novelties, causes of major evolutionary transitions, and patterns of diversification & extinction in the fossil record. Discussion of these topics requires integration of genetics, morphology, systematics, paleobiology, development and ecology.

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.

BIOMG 4610 Development & Evolution – Mariana Wolfner
TR 2:55-4:10; 3 credits, letter grade only. Every other year (odd-number years); offered Spring 2017.
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.

ENT 4700 / BioEE 4800 Ecological Genetics – Brian Lazzaro
4 credits, Offered odd-year spring semesters; Offered Spr 2017
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.
This course focuses on the application of population genetic concepts in ecological or applied contexts. Emphasis is placed on measuring adaptation in natural populations, detecting the effects of population demography, and determining the genetic basis of quantitative traits. Examples are drawn from primary research on animals and plants to illustrate experimental techniques and methods of data analysis on single-gene, multi-locus and genome-wide scales.

BTRY 4820/6820 Statistical Genomics: Coalescent Theory and Human Population Genomics – Alon Keinan

4-credits, Letter grade or S/U. Offered even number years. Next offered Spring 2018 (due to Sabbatical)
Lecture: Tues/Thurs, 10:10-11:25am; Discussion: Thurs, 12:20-1:10 pm
Prerequisite: MATH 1110 or equivalent. At least one previous course in statistical methods and at least one involving programming, or permission of instructor.
Statistical methods of genomic data, emphasizing coalescent theory and molecular population genetics and genomics. Topics include derivation of coalescent theory, tests of natural selection, population structure, and statistical inference, with a focus on the population genomics of human populations.

BTRY 4830 (& BTRY 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.

NTRES 4940 Molecular tools for ecology, conservation, and natural resource management – Nina Overgaard Therkildsen

3 credits, Lectures Tues, Thurs 10:10-11:00, Lab Fri 10:10-12:35
Prerequisites: BIOEE 1780, and an introductory genetics course (e.g. NTRES 2830, BIOMG 2800/2801, ANSC 2210, PLBR 2250) or permission of the instructor.
Target audience is sophomores and Juniors in the EES and Biology majors, though others are welcome.
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. Students will learn to identify the major types of genetic variation, their function in the genome, and their utility for molecular ecological analyses; to explain and perform basic molecular biology laboratory techniques such as DNA extraction, polymerase chain reaction (PCR), and gel electrophoresis; to analyze raw molecular sequence and genotyping data and interpret the results in an applied context; to summarize the strengths and limitations of molecular ecological methods and identify scientific questions in ecology, conservation, and natural resource management that can be addressed with a molecular approach.

VTPMD 6250, Evolutionary Genomics of Bacteria – Michael Stanhope

Credits: 1; Letter or S/U, Meets: Tuesday and Thursday, 1:00 – 2:15 pm
An overview of comparative evolutionary genomics of bacteria, with an emphasis on pathogens. Principles and concepts will be stressed, although methodology and bioinformatics tools will also be addressed. The course involves a combination of lectures and discussion of primary scientific literature. There will be three classes devoted to bioinformatics tools for studying bacterial genomics, including a lecture, an open tutorial session, and a group presentation of the assigned bioinformatics exercises.

BTRY 6890: Current Topics in Population Genetics – Philipp Messer

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.

BTRY 7200: Statistical and Computational Genomics – Amy Williams

1 credit. S/U only. Prerequisites/Corequisites Prerequisite: BTRY 4840/BTRY 6840 or permission of instructor.
Tuesdays 1:25 - 2:50 pm

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.

BTRY 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.

NTRES 7283 Molecular Genetic Approaches to Study of Ecology & Evolution -- Matt Hare
1 credit Seminar, S/U. In this seminar we will cross traditional disciplinary lines to examine discoveries in natural history, ecology and evolution made through the innovative assay and analysis of molecular genetic polymorphisms. Readings will relate to theory and methods applied in population genetics, quantitative genetics, evolutionary genetics, and conservation genetics research, with a continued focus in on genomic and transcriptomic studies utilizing next-generation sequencing to study non-model species. The weekly workload will usually consist of preparing for discussion by reading 1-2 articles of which one will be discussed in detail. On a rotating basis each student will organize a week's discussion by (1) working with me to choose articles, (2) prepare questions for discussion and (3) lead discussion.

BIOEE 7600 - Introduction to Modeling in Ecology and Evolutionary Biology - Steve Ellner
3 Credits, S/U Only, Even numbered years, next offered Spring 2018
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" ecological and evolutionary models and identify the underlying assumptions; build their own process-based models; simulate models on the computer using R; and use computational methods to analyze the behavior of simple models. There are no exams and no homework turned in for grading - instead, students will lead discussions of problems assigned for the computer labs, and different ways of solving them. The course grade (S/U only) is based on participation in discussions, and a term project in which students develop and simulate a simple model related to their research interests. Previous knowledge of R is not essential.

BIOMG 8340 - Quantitative Biology for Molecular Biology & Genetics – Jeff Pleiss
2 credits. Limited to 1st year Ph.D students in the grad fields of BMCB and GD. We will examine topics in modern molecular biology and genetics focusing on the quantitative tools necessary for analyzing experimental data. Classes will be both lecture- and discussion-based including critical readings of current literature. Students will use computational statistical packages to individually and collaboratively re-evaluate data from the primary literature.

FALL 2017 COURSES (check Course Room & Roster for updates)

NS 2750 Human Biology and Evolution (also ANTHR 2750) -- Zhenglong Gu
3 credits. Prerequisite: college biology. Lec MW 10:10-11:00, Disc selected times R or F. S–U or letter grades. Offered alt. years; next offered Fall 2017.
Examines the theories and mechanisms of modern evolutionary biology as they apply to present-day humans and their hominid ancestors. Lectures and discussions of molecular and paleontological evidence of human evolution, the causes and consequences of contemporary human biological diversity, and biological and behavioral modes of human adaptation to past and present natural and cultural environments.

NTRES 3100 -- Applied Population Biology (every Fall). 3 credits. Tu/Th 1:25-2:40 -- Evan Cooch
Prerequisite: calculus (MATH 1106 or MATH 1110). Recommended prerequisite: Background in Ecology or Biology. Enrollment preference given to NTRES, SNES and ESS majors.
An in-depth analysis of the ecological factors influencing the natural fluctuation and regulation of animal population numbers. The course examines models of single- and multi-species population dynamics, with emphasis on understanding the relationship between ecological processes operating at the individual level and subsequent dynamics a the population level. Significant emphasis placed on principles as applied to conservation and management. Computer and field-based exercises are used to reinforce concepts presented in lecture. An in-depth analysis of the ecological factors influencing the natural fluctuation and regulation of animal population numbers. The course examines models of single- and multi-species population dynamics, with emphasis on understanding the relationship between ecological processes operating at the individual level and subsequent dynamics a the population level. Significant emphasis placed on principles as applied to

conservation and management. Computer and field-based exercises are used to reinforce concepts presented in lecture.

ENTOM 3310/3311 - Insect Diversity and Evolution — Bryan Danforth
Fall. 3 credits. Offered alternate years (next offered Fall 2017)
Prerequisite: ENTOM 2120. Co-requisite: ENTOM 3311.
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 4100 Advanced Conservation Biology: Concepts and Techniques – Evan Cooch & Matt Hare
4 credits. Lecture: Tu/Th 10:10-11:25, Computer Lab: Wed 10:10-12:05
Prerequisites: CALS math requirement; NTRES 2830, NTRES 3100 or equivalent or permission of instructors.
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.

BTRY 4810 / BIOMG 4810: Population Genetics -- Philipp Messer
4 credits. Prereq: BIOMG 2810, BIOEE 1780, or equiv., Lec MWF 10:10 – 11:00am, plus disc.
Population genetics is the study of the transmission of genetic variation through time and space. This course explores what the patterns and dynamics of genetic variation in populations can teach us about the processes that underlie evolution. Topics include the quantification of genetic variation, mutation, selection and fitness, genetic drift, migration, population structure, multilocus models, quantitative traits, and adaptation at the molecular level. We will also discuss efforts to connect genotype with phenotype and ultimately fitness. Emphasis is placed on the interplay between theory, computer simulations, and data from natural as well as experimental populations. Specific case studies include the evolution of drug resistance, experimental evolution of microbes and insects, breeding techniques in plants and animals, the evolution of cancer, and the genetic structure and evolution of human populations.

BTRY 4840: Computational Genetics and Genomics – Amy Williams
4 credits. Prerequisite: BTRY 3010 and CS 2110 or equivalents.
Lecture TR 10:10am – 11:25 pm plus discussion F 12:2 – 1:10pm.
Computational methods for analyzing genetic and genomic data. Topics include sequence alignment, hidden Markov Models for discovering sequence features, inferring haplotypes and local ancestry, genotype imputation, gene and motif finding, and phylogenetic tree reconstruction. Prior knowledge of biology is not necessary to complete this course.

BIOMG 4870: Human Genomics -- Andy Clark
3 credits. Prerequisite: BIOMG 2810. Lec.Tues/Thurs 8:40-9:55 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.

NTRES 6940: Current Topics in Non-Model Genomics – Nina Therkildsen and David Toews
1 credit, S/U
This graduate seminar will take the form of a journal club that meets weekly to discuss the burgeoning literature on non-model genomics, focusing on applications of next-gen sequencing to address ecological and evolutionary questions in non-model organisms (i.e. without the benefit of a high-quality well-annotated reference genome). The topics covered will be determined based on student interest and will include both novel results and methodological questions.

BioMG 7800 / BTRY 6890 (Topics in Population Genetics and Genomics) – Alon Keinan
1 credit, S/U [next offered Spr 2018 (due to sabbatical)]
This is a graduate seminar on population genomics. It takes the form of a Journal Club, where each week students, postdocs and faculty meet to discuss research papers. This semester will focus mostly on human population genomics.

BIOEE 7600: Special Topics in Evolution and Ecology, Comparative Functional Genomics – Bob Reed
1 credit, S/U; Tues 12:00 – 1:30 pm

PHYS 7682: Computational Methods for Nonlinear Systems – Chris Myers
3 credits. Prerequisite: None. No prior programming experience necessary. Enrollment may be limited.
Mon/Fri 1:30 – 3:30 pm
Hands on graduate computer laboratory, focusing on tools for computation, simulation, and analysis of complex, nonlinear systems arising in a broad range of fields. Course is self-paced, and can accommodate a wide range of experiences, from novice to expert. Topics are drawn from physics, biology, engineering, applied mathematics and computer science, addressing problems including dynamical systems, pattern formation, complex networks, chemical kinetics and statistical physics.