Course Curriculum for the Interdisciplinary Graduate Certificate in Neurogenomics

This list reflects the currently approved course curriculum for the Interdisciplinary Graduate Certificate in Neurogenomics. Students must complete a total of at least 16 units of coursework including at least 4 units from each of three (3) fields; Neurology, Genetics/Genomics, and Bioinformatics/Computational/Data Analysis.

Note: Due to overlapping subject matter, the same course may be listed within multiple fields and may be offered through different departments under a different course number. As students may enter this certificate program via different graduate programs, all such overlapping courses are listed here for completeness.

Neurology-Related Courses

Neuroscience Graduate Courses
M201. Cell, Developmental, and Molecular Neurobiology. (6) Lecture, six hours. Fundamental topics concerning cellular, developmental, and molecular neurobiology, including intracellular signaling, cell-cell communication, neurogenesis and migration, synapse formation and elimination, programmed neuronal death, and neurotropic factors. Letter grading.

M203. Anatomy of Central Nervous System. (4) (Same as Bioengineering M263.) Lecture, 75 minutes; discussion/laboratory, two hours. Prior to first laboratory meeting, students must complete Bloodborne Pathogens training course through UCLA Environment, Health and Safety. Study of anatomical locations of and relationships between ascending and descending sensory and motor systems from spinal cord to cerebral cortex. Covers cranial nerves and brainstem anatomy along with anatomy of ventricular and vascular systems of brain. Subcortical forebrain areas covered in detail. Integrated anatomy laboratory includes brain dissections and overview of tools for MRI analysis. Letter grading.

205. Systems Neuroscience. (4) Lecture/discussion, four hours. Introduction to fundamentals of systems neuroscience, with emphasis on integration of molecular mechanisms, cellular processes, anatomical circuits, and behavioral analysis to understand function of neural systems. Letter grading.

210A-210B-210C. Introduction to Current Literature in Neuroscience. (2-2-2) Discussion, two hours. Critical discussion of current research literature related to topics of the five core courses in neuroscience graduate curriculum. S/U grading.

211A-211B-211C. Evaluation of Research Literature in Neuroscience. (2-2-2) Discussion, two hours. Advanced critical analysis of current research in neuroscience. S/U grading.

215. Variable Topics Research Literature Seminars: Neuroscience. (1) Seminar, two hours. Critical discussion and analysis of current literature for various neuroscience research topics. Only one topic may be taken twice for credit and applied toward neuroscience graduate requirements. S/U grading.

240. Phenotypic Measurement of Complex Traits. (4) Lecture, three hours. Preparation: background in human genetics helpful. Integrative approach to understanding gene to behavior pathways by examination of levels of phenotype expression across systems (cell, brain, organism), across species (invertebrate, fly, mouse, human), and throughout development across varying environmental milieus. Using examples from human disorders such as schizophrenia and Alzheimer's disease, linking of these diverse approaches in genetic research to map out integrative system of understanding basis of complex human behavior. Emphasis on

basic understanding of methods used at each level of phenotype analysis, along with major resources that can be accessed to gain insight to gene-behavioral links. Letter grading.

250. Neural Development and Repair. (4) Lecture, four hours. Specific training in neural development and repair. Each module offers different research topic and provides perspective on its relevance to human diseases, treatments, and unmet needs for future research. Letter grading.

Bioinformatics/Computational/Data Analysis-Related Courses

Bioinformatics Graduate Courses

201. Seminar: Advanced Methods in Computational Biology. (2) (Formerly numbered M252.) Seminar, one hour; discussion, one hour. Designed for advanced graduate students. Examination of computational methodology in bioinformatics and computational biology through presentation of current research literature. How to select and apply methods from computational and mathematical disciplines to problems in bioinformatics and computational biology; development of novel methodologies. S/U or letter grading.

202. Bioinformatics Interdisciplinary Research Seminar. (4) (Formerly numbered M202.) Seminar, two hours; discussion, two hours. Concrete examples of how biological questions about genomics data map to and are solved by methodologies from other disciplines, including statistics, computer science, and mathematics. May be repeated for credit. S/U or letter grading.

M221. Introduction to Bioinformatics. (4) (Formerly numbered M260A.) (Same as Chemistry CM260A, Computer Science CM221, and Human Genetics M260A.) Lecture, four hours; discussion, two hours. Requisites: Computer Science 32 or Program in Computing 10C with grade of C− or better, and one course from Biostatistics 100A, Civil Engineering 110, Electrical Engineering 131A, Mathematics 170A, or Statistics 100A. Prior knowledge of biology not required. Designed for engineering students as well as students from biological sciences and medical school. Introduction to bioinformatics and methodologies, with emphasis on concepts and inventing new computational and statistical techniques to analyze biological data. Focus on sequence analysis and alignment algorithms. S/U or letter grading.

M222. Algorithms in Bioinformatics. (4) (Formerly numbered M260B.) (Same as Chemistry CM260B and Computer Science CM222.) Lecture, four hours; discussion, two hours. Requisites: Computer Science 32 or Program in Computing 10C with grade of C− or better, and one course from Biostatistics 100A, Civil Engineering 110, Electrical Engineering 131A, Mathematics 170A, or Statistics 100A. Course M221 is not requisite to M222. Designed for engineering students as well as students from biological sciences and medical school. Development and application of computational approaches to biological questions, with focus on formulating interdisciplinary problems as computational problems and then solving these problems using algorithmic techniques. Computational techniques include those from statistics and computer science. Letter grading.

M223. Statistical Methods in Computational Biology. (4) (Formerly numbered M271.) (Same as Biomathematics M271 and Statistics M254.) Lecture, three hours; discussion, one hour. Preparation: elementary probability concepts. Requisite: course M221 or Statistics 100A or 200A. Introduction to statistical methods developed and widely applied in several branches of computational biology, such as gene expression, sequence alignment, motif discovery, comparative genomics, and biological networks, with emphasis on understanding of basic statistical concepts and use of statistical inference to solve biological problems. Letter grading.

M224. Computational Genetics. (4) (Same as Computer Science CM224 and Human Genetics CM224.) Lecture, four hours; discussion, two hours; outside study, six hours. Requisites:

Computer Science 32 or Program in Computing 10C with grade of C− or better, Mathematics 33A, and one course from Civil Engineering 110, Electrical and Computer Engineering 131A, Mathematics 170A, or Statistics 100A. Designed for engineering students as well as students from biological sciences and medical school. Introduction to computational analysis of genetic variation and computational interdisciplinary research in genetics. Topics include introduction to genetics, identification of genes involved in disease, inferring human population history, technologies for obtaining genetic information, and genetic sequencing. Focus on formulating interdisciplinary problems as computational problems and then solving those problems using computational techniques from statistics and computer science. Letter grading.

M226. Machine Learning in Bioinformatics. (4) Course description: (Same as Computer Science M226 and Human Genetics M226.) Lecture, four hours; outside study, eight hours. Enforced requisite: Computer Science 32 or Program in Computing 10C with grade of C- or better. Recommended: one course from Biostatistics 100A, 110A, Civil Engineering 110, Electrical Engineering 131A, Mathematics 170A, or Statistics 100A. Familiarity with probability, statistics, linear algebra, and algorithms expected. Designed for engineering students as well as students from biological sciences and medical school. Biology has become data-intensive science. Bottleneck in being able to make sense of biological processes has shifted from data generation to statistical models and inference algorithms that can analyze these datasets. Statistical machine learning provides important toolkit in this endeavor. Biological datasets offer new challenges to field of machine learning. Examination of statistical and computational aspects of machine learning techniques and their application to key biological questions. Letter grading.

M225. Computational Methods in Genomics. (4) (Formerly numbered M265.) (Same as Computer Science M225 and Human Genetics M265.) Lecture, two and one half hours; discussion, two and one half hours; outside study, seven hours. Introduction to computational approaches in bioinformatics, genomics, and computational genetics and preparation for computational interdisciplinary research in genetics and genomics. Topics include genome analysis, regulatory genomics, association analysis, association study design, isolated and admixed populations, population substructure, human structural variation, model organisms, and genomic technologies. Computational techniques and methods include those from statistics and computer science. Letter grading.

275A. Applied Bioinformatics Lab for Biologists: Fundamentals. (2) Laboratory, six hours (five weeks). Introduction to contemporary methods and techniques in bioinformatics that are used to analyze high-throughput genomic data. Topics include introduction to UNIX, Next Generation Sequence (NGS) data analysis, ChIP-seq, BS-seq and RNA-seq, and others. S/U grading.

275B. Applied Bioinformatics Lab for Biologists: Intermediate. (2) Laboratory, six hours (five weeks). Requisite: course 275A. Contemporary methods and techniques in bioinformatics that are used to analyze high-throughput genomic data. Topics include Galaxy server, R, MATLAB, Python, and variant calling. S/U grading.

Biomathematics Graduate Courses
M207A. Theoretical Genetic Modeling. (4) (Same as Biostatistics M272 and Human Genetics M207A.) Lecture, three hours; discussion, one hour. Requisites: Mathematics 115A, 131A, Statistics 100B. Mathematical models in statistical genetics. Topics include population genetics, genetic epidemiology, gene mapping, design of genetics experiments, DNA sequence analysis, and molecular phylogeny. S/U or letter grading.

M207B. Applied Genetic Modeling. (4) (Same as Biostatistics M237 and Human Genetics M207B.) Lecture, three hours; laboratory, one hour. Requisites: Biostatistics 200B, 202B (may be taken concurrently) or equivalent coursework or consent of instructor. Covers basic genetic concepts (prior knowledge of human genetics not required). Topics include statistical

methodology underlying genetic analysis of both quantitative and qualitative complex traits. Laboratory for hands-on computer analysis of genetic data; laboratory reports required. Course complements M207A; students may take either and are encouraged to take both. S/U or letter grading.

M271. Statistical Methods in Computational Biology. (4) (Same as Bioinformatics M223 and Statistics M254.) Lecture, three hours; discussion, one hour. Preparation: elementary probability concepts. Requisite: Bioinformatics M221 or Statistics 100A or 200A. Introduction to statistical methods developed and widely applied in several branches of computational biology, such as gene expression, sequence alignment, motif discovery, comparative genomics, and biological networks, with emphasis on understanding of basic statistical concepts and use of statistical inference to solve biological problems. Letter grading.

285. Introduction to High-Throughput Data Analysis. (4) Seminar, three hours. Requisites: courses M260A, M260B. Introduction to high-throughput data analysis, including DNA microarray technologies and next-generation sequencing technology. Presentation of statistical methods and software for handling complex data produced by experiments using these technologies. Some hands-on training on data analysis provided. S/U or letter grading.

Human Genetics Graduate Courses
M207A. Theoretical Genetic Modeling. (4) (Same as Biomathematics M207A and Biostatistics M272.) Lecture, three hours; discussion, one hour. Requisites: Mathematics 115A, 131A, Statistics 100B. Mathematical models in statistical genetics. Topics include population genetics, genetic epidemiology, gene mapping, design of genetics experiments, DNA sequence analysis, and molecular phylogeny. S/U or letter grading.

M207B. Applied Genetic Modeling. (4) (Same as Biomathematics M207B and Biostatistics M237.) Lecture, three hours; laboratory, one hour. Requisites: Biostatistics 200B, 202B (may be taken concurrently) or equivalent coursework or consent of instructor. Covers basic genetic concepts (prior knowledge of human genetics not required). Topics include statistical methodology underlying genetic analysis of both quantitative and qualitative complex traits. Laboratory for hands-on computer analysis of genetic data; laboratory reports required. Course complements M207A; students may take either and are encouraged to take both. S/U or letter grading.

CM224. Computational Genetics. (4) (Same as Bioinformatics M224 and Computer Science CM224.) Lecture, four hours; discussion, two hours; outside study, six hours. Requisites: Computer Science 32 or Program in Computing 10C with grade of C− or better, Mathematics 33A, and one course from Civil Engineering 110, Electrical and Computer Engineering 131A, Mathematics 170A, or Statistics 100A. Designed for engineering students as well as students from biological sciences and medical school. Introduction to computational analysis of genetic variation and computational interdisciplinary research in genetics. Topics include introduction to genetics, identification of genes involved in disease, inferring human population history, technologies for obtaining genetic information, and genetic sequencing. Focus on formulating interdisciplinary problems as computational problems and then solving those problems using computational techniques from statistics and computer science. Concurrently scheduled with course CM124. Letter grading.

M229S. Seminar: Current Topics in Bioinformatics. (4) (Same as Biological Chemistry M229S and Computer Science M229S.) Seminar, four hours; outside study, eight hours. Designed for graduate engineering students as well as students from biological sciences and medical school. Introduction to current topics in bioinformatics, genomics, and computational genetics and preparation for computational interdisciplinary research in genetics and genomics. Topics include genome analysis, regulatory genomics, association analysis, association study design,

isolated and admixed populations, population substructure, human structural variation, model organisms, and genomic technologies. Computational techniques include those from statistics and computer science. May be repeated for credit with topic change. Letter grading.

M265. Computational Methods in Genomics. (4) (Same as Bioinformatics M225 and Computer Science M225.) Lecture, two and one half hours; discussion, two and one half hours; outside study, seven hours. Introduction to computational approaches in bioinformatics, genomics, and computational genetics and preparation for computational interdisciplinary research in genetics and genomics. Topics include genome analysis, regulatory genomics, association analysis, association study design, isolated and admixed populations, population substructure, human structural variation, model organisms, and genomic technologies. Computational techniques and methods include those from statistics and computer science. Letter grading.

Genetics/Genomics-Related Courses

Human Genetics Graduate Courses
M207A. Theoretical Genetic Modeling. (4) (Same as Biomathematics M207A and Biostatistics M272.) Lecture, three hours; discussion, one hour. Requisites: Mathematics 115A, 131A, Statistics 100B. Mathematical models in statistical genetics. Topics include population genetics, genetic epidemiology, gene mapping, design of genetics experiments, DNA sequence analysis, and molecular phylogeny. S/U or letter grading.

M207B. Applied Genetic Modeling. (4) (Same as Biomathematics M207B and Biostatistics M237.) Lecture, three hours; laboratory, one hour. Requisites: Biostatistics 200B, 202B (may be taken concurrently) or equivalent coursework or consent of instructor. Covers basic genetic concepts (prior knowledge of human genetics not required). Topics include statistical methodology underlying genetic analysis of both quantitative and qualitative complex traits. Laboratory for hands-on computer analysis of genetic data; laboratory reports required. Course complements M207A; students may take either and are encouraged to take both. S/U or letter grading.

210. Topics in Genomics. (2) Seminar, two hours. Survey of current biological theory and technology used in genomic research. Topics include genomic technologies, functional genomics, proteomics, statistical genetics, bioinformatics, and ethical issues in human genetics. S/U grading.

CM224. Computational Genetics. (4) (Same as Bioinformatics M224 and Computer Science CM224.) Lecture, four hours; discussion, two hours; outside study, six hours. Requisites: Computer Science 32 or Program in Computing 10C with grade of C− or better, Mathematics 33A, and one course from Civil Engineering 110, Electrical and Computer Engineering 131A, Mathematics 170A, or Statistics 100A. Designed for engineering students as well as students from biological sciences and medical school. Introduction to computational analysis of genetic variation and computational interdisciplinary research in genetics. Topics include introduction to genetics, identification of genes involved in disease, inferring human population history, technologies for obtaining genetic information, and genetic sequencing. Focus on formulating interdisciplinary problems as computational problems and then solving those problems using computational techniques from statistics and computer science. Concurrently scheduled with course CM124. Letter grading.

M226. Machine Learning in Bioinformatics. (4) Course description: (Same as Computer Science M226 and Bioinformatics M226.) Lecture, four hours; outside study, eight hours. Enforced requisite: Computer Science 32 or Program in Computing 10C with grade of C- or better. Recommended: one course from Biostatistics 100A, 110A, Civil Engineering 110, Electrical Engineering 131A, Mathematics 170A, or Statistics 100A. Familiarity with probability, statistics,

linear algebra, and algorithms expected. Designed for engineering students as well as students from biological sciences and medical school. Biology has become data-intensive science. Bottleneck in being able to make sense of biological processes has shifted from data generation to statistical models and inference algorithms that can analyze these datasets. Statistical machine learning provides important toolkit in this endeavor. Biological datasets offer new challenges to field of machine learning. Examination of statistical and computational aspects of machine learning techniques and their application to key biological questions. Letter grading.

M229S. Seminar: Current Topics in Bioinformatics. (4) (Same as Biological Chemistry M229S and Computer Science M229S.) Seminar, four hours; outside study, eight hours. Designed for graduate engineering students as well as students from biological sciences and medical school. Introduction to current topics in bioinformatics, genomics, and computational genetics and preparation for computational interdisciplinary research in genetics and genomics. Topics include genome analysis, regulatory genomics, association analysis, association study design, isolated and admixed populations, population substructure, human structural variation, model organisms, and genomic technologies. Computational techniques include those from statistics and computer science. May be repeated for credit with topic change. Letter grading.

236A. Advanced Human Genetics A: Molecular Aspects. (4) Lecture, three hours. Recommended preparation: prior knowledge of basic concepts in molecular biology and genetics. Advanced topics in human genetics related to molecular genetics and relevant technologies. Topics include genomic technologies, human genome, mapping and identification of disease-causing mutations, transcriptomics, proteomics, functional genomics, epigenetics, and stem cells. Reading materials include original research articles and reviews or book chapters. Letter grading.

236B. Advanced Human Genetics B: Statistical Aspects. (4) Lecture, three hours; computer laboratory, one hour. Recommended preparation: introductory statistics knowledge equivalent to Biostatistics 100A or Statistics 13 and general genetics knowledge equivalent to Ecology and Evolutionary Biology 121, Human Genetics 236A, or Molecular, Cell, and Developmental Biology 144. Statistical and population genetics related to analysis of complex human genetic traits. Reading materials include original research papers and reviews. Letter grading.

C236C. Societal and Medical Issues in Human Genetics. (5) Lecture, three hours; discussion, two hours. Sequence of entire human genome is now known. Consideration of how this knowledge impacts concepts of ourselves as individuals and of our place in biological universe, concepts of race/ethnicity and gender, ability of DNA-based forensics to identify specific individuals, ownership and commodification of genes, issues of privacy and confidentiality, issues of genetic discrimination, issues of predictive genetic testing. Discussion of human cloning for reproductive and therapeutic purposes. Exposure to medical genetics cases. Discussion of role of whole genome sequencing in clinical setting. Human Genome Project influence on medicine and on our concepts of self and identity. Concurrently scheduled with course CM136C. Letter grading.

C244. Genomic Technology. (4) Lecture, three hours; discussion, one hour. Requisite: Life Sciences 4. Survey of key technologies that have led to successful application of genomics to biology, with focus on theory behind specific genome-wide technologies and their current applications. Concurrently scheduled with course C144. S/U or letter grading.

M255. Mapping and Mining Human Genome. (3) (Same as Pathology M255.) Lecture, three hours. Basic molecular genetic and cytogenetic techniques of gene mapping. Selected regions of human genomic map scrutinized in detail, particularly gene families and clusters of genes that have remained linked from mouse to human. Discussion of localizations of disease genes. S/U or letter grading.

M265. Computational Methods in Genomics. (4) (Same as Bioinformatics M225 and Computer Science M225.) Lecture, two and one half hours; discussion, two and one half hours; outside study, seven hours. Introduction to computational approaches in bioinformatics, genomics, and computational genetics and preparation for computational interdisciplinary research in genetics and genomics. Topics include genome analysis, regulatory genomics, association analysis, association study design, isolated and admixed populations, population substructure, human structural variation, model organisms, and genomic technologies. Computational techniques and methods include those from statistics and computer science. Letter grading.

Bioinformatic Graduate Courses
M224. Computational Genetics. (4) (Same as Computer Science CM224 and Human Genetics CM224.) Lecture, four hours; discussion, two hours; outside study, six hours. Requisites: Computer Science 32 or Program in Computing 10C with grade of C− or better, Mathematics 33A, and one course from Civil Engineering 110, Electrical and Computer Engineering 131A, Mathematics 170A, or Statistics 100A. Designed for engineering students as well as students from biological sciences and medical school. Introduction to computational analysis of genetic variation and computational interdisciplinary research in genetics. Topics include introduction to genetics, identification of genes involved in disease, inferring human population history, technologies for obtaining genetic information, and genetic sequencing. Focus on formulating interdisciplinary problems as computational problems and then solving those problems using computational techniques from statistics and computer science. Letter grading.

M225. Computational Methods in Genomics. (4) (Formerly numbered M265.) (Same as Computer Science M225 and Human Genetics M265.) Lecture, two and one half hours; discussion, two and one half hours; outside study, seven hours. Introduction to computational approaches in bioinformatics, genomics, and computational genetics and preparation for computational interdisciplinary research in genetics and genomics. Topics include genome analysis, regulatory genomics, association analysis, association study design, isolated and admixed populations, population substructure, human structural variation, model organisms, and genomic technologies. Computational techniques and methods include those from statistics and computer science. Letter grading.

Biomathematics Graduate Courses
M207A. Theoretical Genetic Modeling. (4) (Same as Biostatistics M272 and Human Genetics M207A.) Lecture, three hours; discussion, one hour. Requisites: Mathematics 115A, 131A, Statistics 100B. Mathematical models in statistical genetics. Topics include population genetics, genetic epidemiology, gene mapping, design of genetics experiments, DNA sequence analysis, and molecular phylogeny. S/U or letter grading.

M207B. Applied Genetic Modeling. (4) (Same as Biostatistics M237 and Human Genetics M207B.) Lecture, three hours; laboratory, one hour. Requisites: Biostatistics 200B, 202B (may be taken concurrently) or equivalent coursework or consent of instructor. Covers basic genetic concepts (prior knowledge of human genetics not required). Topics include statistical methodology underlying genetic analysis of both quantitative and qualitative complex traits. Laboratory for hands-on computer analysis of genetic data; laboratory reports required. Course complements M207A; students may take either and are encouraged to take both. S/U or letter grading.

Psychology Graduate Courses
205G. Behavior Genetics. (2) Lecture, three hours. Designed for graduate students. In-depth analysis of field of behavior genetics, including methods for determining genetic and environmental influences and for locating and characterizing genes impacting these traits, as

well as current knowledge of genetic contributions to cognition and behavior and disorders thereof. Letter grading.