Course Title: Genomics and Epigenetics of the Brain

Instructors: Andreas Pfenning

Course Number: 03-360/03-760   Cross Listing: 02-319/02-719

Prerequisites/Corequisites: Prerequisite: Genetics (03-220)

Semesters Offered:

- ☑ Fall
- ☑ Spring
- ☐ Summer-All
- ☐ Summer 1
- ☐ Summer 2

Semester Length:

- ☐ Mini 1
- ☐ Mini 2
- ☐ Mini 3
- ☐ Mini 4
- ☑ Full Semester

Location:
- ☑ Pittsburgh
- ☐ Doha

Course Offering Frequency: Every Spring

Suggested Days and Times: MWF 10:30-11:20

Learning Format:
- ☑ In Person
- ☐ Online
- ☐ Combination

Course Evaluation type:
- ☑ Letter Grade
- ☐ Pass/Fail

Course Unit Justification:

- Total Units: 9 Undergraduate, 12 Graduate Level

In Class Hours: 3 hours per week   Recitation Hours: 0

Lab Hours: 0   Out of Class Hours: 6/9 hours per week

Target Population: Advanced undergraduates and 1st-2nd year graduateate students studying biology, psychology, or neuroscience (especially neurobiology concentration) to provide biological depth and an introduction to computational approaches. Also, advanced computational biology undergraduates and 1st-2nd year computational biology masters and PhD students who wish to study applications of
Computational genomics to neurobiology. *Students are expected to have taken* Genetics (03-220). *Experience in statistics or programming is not required.*

**Anticipated Enrollment:** 30

**Rationale for Course (Background):** Computational genomics and epigenetics are becoming a larger part of neuroscience and have provided novel insights into fundamental concepts, such as neural cell type diversity and neuroplasticity. To build upon Carnegie Mellon University’s unique strengths in the areas of neuroscience, computation, and genomics, this course will bridge those disciplines.

In addition to adding a new dimension to interdisciplinary neuroscience at CMU, the course will aim to accomplish several other objectives. 1) It will provide substantially more depth in area of epigenetics, of interest to undergraduate and graduate students in computational biology, biology, neuroscience, and psychology. 2) For the large population of undergrad/grad students in biology without a strong programming background, the course will provide practical instruction on how to go from raw genomic data to biological conclusions. Rather than provide a broad survey of computational biology and genomics like existing courses, the objective is to provide enough depth for students to design genomic experiments and conduct a careful analysis on their own. 3) There are roughly 15-20 undergraduate neuroscience majors (a program joint between Dietrich and MCS) per year. Although roughly half of students have interests in molecular neurobiology, and there is a computational requirement in the major, there aren’t currently any courses that focus on computational techniques in molecular neuroscience.
Note on impact on other courses: the addiction material that will be taught both qualitatively and quantitatively in this class overlaps partially with the strictly qualitative discussion of addiction that used to be taught in 03-260 (Neurobiology of Disease). In anticipation of this, 03-260 has been modified to remove the unit on addiction and replace it with a unit that looks at diseases of neuronal communication (myasthenia gravis, Lambert-Eaton syndrome, multiple sclerosis, and Guillain-Barre syndrome).

Special Facilities Needed: None

Textbooks and/or Other Materials: Review articles and primary literature on each subject, Stephen Eglen's R tutorial

Assessment: Class participation, 2 in-class exams, 10 homeworks, group presentation on literature review, written report on literature review, final examination, course project (graduate version only)

Topics Covered: 1) High-throughput sequencing and transcriptomics. 2) Analysis of high-throughput genomic data. 3) Biological basis of epigenetics. 4) Genetics of neural plasticity. 5) Genetics of neural cell type diversity.

Course Catalog Description: This course will provide an introduction to genomics, epigenetics, and their application to problems in neuroscience. The rapid advances in genomic technology are in the process of revolutionizing how we conduct molecular biology research. These new techniques have given us an appreciation for the role that epigenetics modifications of the genome play in gene regulation, development, and inheritance. In this course, we will cover the biological basis of genomics and epigenetics, the basic computational tools to analyze genomic data,
and the application of those tools to neuroscience. Through programming assignments and reading primary literature, the material will also serve to demonstrate important concepts in neuroscience, including the diversity of neural cell types, neural plasticity, the role that epigenetics plays in behavior, and how the brain is influenced by neurological and psychiatric disorders. Although the course focuses on neuroscience, the material is accessible and applicable to a wide range of topics in biology.

**Learning Objectives**: Students who successfully complete this course will be able to:

1) Genomics - The course will teach basic facts about genomic technology including high-throughput sequencing, transcriptomics, and epigenetics. At the completion of the course, students should be able to read and critically evaluate primary literature that uses these technologies.

2) Computational Analysis - The course will teach the basics of how to conduct a computational analysis of genomic data. The students will learn to use a command line interface to run genomic analysis tools and learn how to adapt existing code in the R programming language for statistical analysis of different types of genomic data. At a broader level, the course will teach students how to approach problems in neuroscience from a quantitative, data-driven perspective. This includes how to use appropriate controls and design experiments to maximize statistical power.

3) Neuroscience - The applications of genomic technology will be used to provide depth into important concepts in neuroscience. Lectures and programming assignments will demonstrate the diversity of cell types in the brain, the role that epigenetics plays in neurodevelopment/plasticity, and affects that neurological disorders can have on the molecular properties of the
brain. Through these examples, students will learn the caveats of drawing
conclusions from data that comes from a heterogeneous mixture of cell types. 4) Major Concepts - Students will develop an understanding of how genomics is being used to ask a biological question. Is the technology being used to test for specific hypotheses, screen for candidate molecules, provide an annotation, or learn the basic rules underlying a biological system.

Departmental Approval Date: Curriculum committee & Full Department: 9/20/2016

Full department: ______

CUA Recommendation Date: Click here to enter text.

College Council Approval Date: Click here to enter text.

Date Sent to Enrollment Services: Click here to enter text.

Comments: Click here to enter text.

* Please attach a copy of the proposed syllabus