

**Genomics and Epigenetics of the Brain**  
**02-319/03-360, 9 units; 02-719/03-760, 12 units**  
**Fall 2018**

**Course 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:

- Describe the technological advances in genomics, different classes of genomic experiments researchers conduct, and how genomics has contributed towards our understanding of biology.
- Critically evaluate primary literature that uses genomic technology to understand the brain.
- Distinguish whether genomic technology is being used to test for specific hypotheses, screen for candidate molecules, provide an annotation, or learn the basic rules underlying a biological system.
- Explain the role that epigenetics plays in gene regulation and inheritance.
- Conduct a computational analysis of genomic data, from raw output to biological conclusions, using existing genomic analysis tools at the command line.
- Conduct a statistical analysis of transcriptomic and epigenetic data using the R programming language.
- Design genomic experiments with sufficient statistical power and controls by approaching problems in biology and neuroscience from a quantitative perspective.
- Describe the molecular and functional difference between neurons, astrocytes, oligodendrocytes, and microglial cells in the brain.
- Describe how epigenetics contributes to the process of neural plasticity.
- Describe the biological basis of neurological and psychiatric disorders and how genomic technology has contributed towards our understanding of them.

**Prerequisites:**

Students are expected to have taken Modern Biology (03-121), Honors Modern Biology (03-151), or equivalent. Introductory genetics (03-220) or permission from the instructor is also required. Introductory programming is required (02-201, 15-110, or 15-112).

**Course Versions:**

Undergraduate Version (9 units) – Lectures, Reading, Programming Assignments, Final Exam

Graduate Version (12 units) – Lectures, Reading, Programming Assignments, Final Exam, Project

**Course Text:** Primary literature

**Class times:** MWF 9:30 – 10:20

**Location:** GHC 4301

**Instructor:** Andreas Pfenning  
[apfenning@cmu.edu](mailto:apfenning@cmu.edu)  
Feel free to email

(<https://medium.com/@lportwoodstacer/how-to-email-your-professor-without-being-annoying-af-cf64ae0e4087-.hp4hv7lio>)

Office Hours: ???, GHC 7711 (**Don't be shy!**)

Office Phone: 412-268-5518

**TA:** ???

**Evaluation:**

900 points undergraduate, 1200 points graduate

Homework Projects: 300 points

Literature Review Report: 100 points

Literature Review Presentation: 100 points

Class participation: 100 points

Exams: 150 points

Final Exam: 150 points

Graduate Project: 300 points

- **Exams.** There will be two exams during the semester which covers the biological background and computational foundations. They will only *explicitly* test material in that unit of the course (they are not explicitly cumulative). However, many of the questions will *assume* a basic understanding of the concepts from earlier units.
- **The final.** The final is cumulative for the entire course. It will be during finals week. There will be some emphasis on the last unit.
- **Exam re-grades.** We are committed to grading as fairly as possible. If you think a mistake was made in grading your exam, you can submit your exam and a written explanation of why you think you deserve more points than you were given and your exam will be re-graded. Re-grades must be submitted **no more than one week** after exams have been returned. The instructors reserve the right to re-grade the entire exam in addition to the disputed question, and add or subtract points.
- **Primary literature paper report/presentation.** Students are advised to read as many of the supplementary scientific literature papers as possible. Each student must choose one primary scientific paper. Students must then write a report on the paper. Students will give short presentations on the literature review the final week of class. More information will be given out during the first week of class.
- **Homeworks.** Homeworks will consist two larger projects, one per quarter, which are broken down into milestones (30 points each) due Monday at the beginning of class most weeks. Assignments turned in late may not receive timely feedback and are subject to a 5pt per day penalty. They may not be turned in more than 2 days late. For the entire course, students have 2

homework grace days they can use at any time. They may not be used for the graduate project, literature review, or exams.

- **Class participation.** Students are expected to participate actively in class discussions. Your participation in small group and class-wide discussions during the semester is required. Extraordinary participation may make up for some lost points on homework assignments.
- **Graduate Project.** Students taking the 700 level of the course are required to complete a graduate project. As a part of the project, the students must process genomic data, perform a multi-faceted analysis of the data, and draw conclusions about the brain.

## Class Policies

### Academic Integrity:

- **Cheating.** Cheating of any sort will not be tolerated. For example, if exam answers are copied from another student, both students will receive zeros; if graded exams or homeworks are altered and resubmitted for a higher score, the revised score will be zero. In addition, these and other forms of cheating may also be referred to the Academic Review Board for more severe penalties. This warning has two purposes: 1) to dissuade a small number of students from even thinking about cheating; and 2) to persuade the large majority that they will get a fair grade based on their individual performance.
- **Plagiarism.** Cheating also includes plagiarism, the presentation of the work of another person as one's own. This applies whether the source of the material is a printed book, a web site, or work of another student from this course or any other course. Lifting even a single sentence without appropriate attribution constitutes plagiarism. Read Promoting Academic Integrity (<http://www.cmu.edu/policies/documents/Cheating.html>) for official university policy on this issue. Any source you reference (aside from the class text book) must be referenced, *even if you only used the source for ideas and did not quote a single word*. This applies to all work at CMU, but is especially relevant in this class on the anatomy presentation and written reports.

### Students with Disabilities:

*If you wish to request an accommodation due to a documented disability, please inform your instructor and contact Disability Resources as soon as possible. They can be reached at [access@andrew.cmu.edu](mailto:access@andrew.cmu.edu) or 412-268-2013.*

### Health approach towards coursework:

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call [412-268-2922](tel:412-268-2922) and visit their website at

<http://www.cmu.edu/counseling/>. Consider reaching out to a friend, faculty or family member you trust for help getting connected to the support that can help.

*If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night:*

**CaPS: [412-268-2922](tel:412-268-2922)**

**Re:solve Crisis Network: [888-796-8226](tel:888-796-8226)**

**If the situation is life threatening, call the police:**

**On campus: CMU Police: [412-268-2323](tel:412-268-2323)**

**Off campus: 911**

*If you have questions about this or your coursework, please let me know.*

## ***Responsibilities***

*The choice to take this course is entirely up to you. If you do choose to take the course, please do your best to be a good course citizen. Although I never take attendance, this means you should make every effort to attend all classes on time and to participate in class discussions and activities.*

*In turn, I will make every effort to build a valuable learning experience for every student. If there is ever any way I can improve your learning, or if any topic doesn't capture your interest, I welcome feedback (either in class, outside of class, or anonymously).*

*Finally, it is everyone's responsibility to be respectful of others during class.*