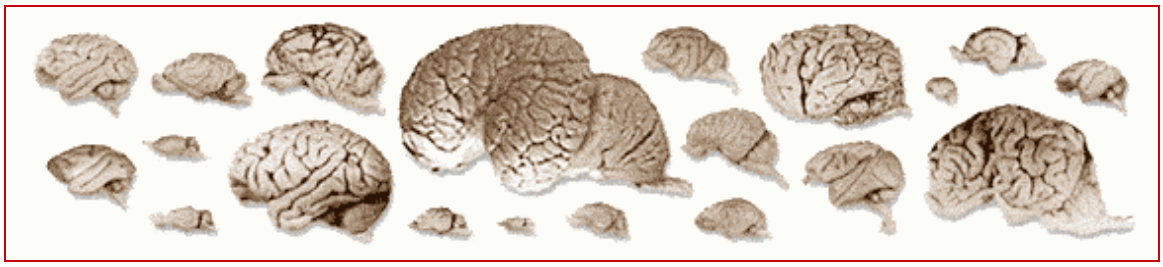

MCB129 The Brain: Development, Plasticity and Decline

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An interactive course about the brain, MCB129 covers select topics in brain development, neural plasticity, memory systems and disorders such as Autism and Alzheimer's Disease. The course is experiment and technology-focused; it is based on experiment and data. Course assignments emphasize critical reading of the literature, experimental design and technology, and a cogent approach to scientific writing.

Course Objectives

- Understand how the neural circuitry of the brain develops
- Understand the basis for synaptic plasticity and aspects of memory storage.
- Apply this knowledge to developmental abnormalities such as Autism and pathologies such as Alzheimer's Disease.
- Gain familiarity with technological innovations applied to brain studies
- Appreciate the requirements and creative aspect of experimental design
- Learn to develop your own ideas and express them in a hypothesis and experimental proposal.

Course Format

- The course will meet once per week to hear a live lecture (Monday **or** Wednesday, 10:30-11:45AM EST). Recordings will be available for those unable to attend.
- The professor will additionally meet each week with students in small "group meetings" or in individual meetings (depending on course enrollment; times TBA according to student's availabilities).

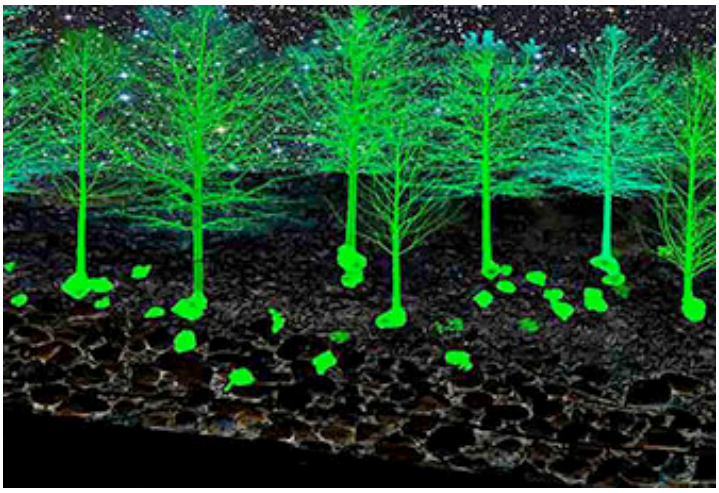
- Groups or individuals will have the opportunity to tune the curriculum to pursue their own interests through their choice of reading material, discussion groups and topics for course assignments.

Course Assignments

- Two essay assignments:
  1) a six-page (double-spaced) review of recent research on a narrow topic of your choice (due Oct 30th; topic must be approved by the professor). You will tie together two or three research articles that illuminate a specific question and from which you derive your own hypothesis.
  2) an eight-page (double-spaced) research proposal based on a different topic (than above), in which you will derive an hypothesis and then propose experiments to test your hypothesis. Here you will describe the experiments and what results might prove or disprove your hypothesis.
- Discussion Participation and Assignment: Bring 4 questions for each research article.

Grading:

250 pts.	First essay (Due Friday, Oct. 30th)
250 pts.	Discussion participation
200 pts.	Problem Solving (problems and in class assignments)
300 pts.	Second Essay (Due last day of Reading Period –Dec. 9th)
1000 pts.	



Course Topics and Schedule (preliminary**)

*** [Lectures involve live class meeting once per week or by video. Other meetings will be group or individual at times that fit student's schedules]*

I. Cell lineage and Cell Fate: Stem Cells, Cortex, New Neurons in Old Brains

The nervous system is composed of functional and structural units with different numbers and types of neurons. Building up this cellular diversity depends on local patterns of cell division and signals that determine cell identity. Neurons continue to be generated in the brain beyond birth in two areas, where they have important roles in olfaction, memory and affect.

Focused Topics: Cell lineage, cell migration, cell type identity, development of the hippocampus and cortex.

Lecture and Discussion of readings from the 1st Paper Set
(Wed 9/02, Wed 9/09, Mon 9/14)

II. Lateral Inhibition and Intrinsic Clocks: Neuro-Ectoderm, A Community of Individuals

Signaling underlies the ability of stem cells to make all the necessary cells of the nervous system. One mechanism, known as *lateral inhibition*, involves a cell surface receptor, Notch and its ligands (Delta, Serrate, and more). This pathway is pleiotropic – it has roles well beyond neural development to include memory, adult stem cell maintenance and, when aberrant, cancer. On the flip side, stem cells use internal clock-like mechanisms to count their cell divisions, to vary the types of neurons they produce over time, a mechanism underlying the development of the mammalian cortex. We will compare and contrast these extrinsic and intrinsic mechanisms.

Lecture and Discussion of 2nd paper set
(Wed 9/16, Mon 9/21, Wed 9/23)

III. Wiring up the Nervous System – Cell and Molecular Biology of Axon Guidance and Synaptic Specificity

Understanding how the complex and specific patterns of connections form between neurons requires observing it as a temporal systems process, from the earliest steps onward. At the level of individual neurons, it is a cell biological process, wherein the exploratory tips (growth cones) of axons follow stereotyped mechanisms of connecting one neuron to another. Recent years have seen the identification of molecules that guide axons to their target sites. What are these molecules, and how does *guidance information* steer the growth cone?

Lecture and Discussion of 3rd paper set
(Mon 9/28, Wed 9/30, Mon 10/05, Wed 10/07)

IV. The Finishing Touches –– Plasticity and Refinement of Neural Circuits

The pattern of synaptic connections is, especially in vertebrates, begun crudely and modified on the basis of optimizing circuit function. Synaptic connections change accordingly. For example, visual input and experience is required to achieve the normative resolution of visual perception. We indeed learn to see. At the heart of this process are mechanisms that regulate where synapses are formed and which are maintained during critical periods after birth.

Lecture and Discussion of 4th paper set
(Wed 10/14, Mon 10/19, Wed 10/21)

[Friday 10/30 – First Essay due]

V. On the Molecular Basis of Autism

Autism Spectrum Disorders (ASDs) display an onset early in postnatal life, coincident with neural circuit refinement. Here we consider Autism's causes and possible treatments.

Lecture and Discussion of 5th paper set
(Mon 10/26, Wed 10/28, Mon 11/02)

VI. Memory

Learning, memory and recall are central capabilities of the brain and form the basis for our personal identity. Here we will study memory systems, from the circuit to the molecular level.

Lecture and Discussion of 6th paper set
(Wed 11/04, Mon 11/09, Wed 11/11, Mon 11/16, Wed 11/18)

VII. Alzheimer's, a Memory Disease

Alzheimer's Disease (AD) is a quickly progressing dementia that includes loss of memory and cognitive ability. There is currently no effective treatment. The most widely accepted explanation for the cause of AD is the *Amyloid Cascade Hypothesis*, but drugs designed on the basis of this hypothesis have failed to help patients. We will consider molecular mechanisms that might cause AD.

Lecture and Discussion of 7th paper set
(Mon 11/23, Mon 11/30, Wed 12/02)

[Wednesday December 09th, Final Paper Due]

Collaboration Policy Note (taken from the OUE website

Collaboration Permitted

a. Written Assignments

Discussion and the exchange of ideas are essential to academic work. For assignments in this course, you are encouraged to consult with your classmates on the choice of paper topics and to share sources. You may find it useful to discuss your chosen topic with your peers, particularly if you are working on the same topic as a classmate. However, you should ensure that any written work you submit for evaluation is the result of your own research and writing and that it reflects your own approach to the topic. You must also adhere to standard citation practices in this discipline and properly cite any books, articles, websites, lectures, etc. that have helped you with your work. If you received any help with your writing (feedback on drafts, etc), you must also acknowledge this assistance.

b. Problem Sets

Discussion and the exchange of ideas are essential to doing academic work. For assignments in this course, you are encouraged to consult with your classmates as you work on problem sets. However, after discussions with peers, make sure that you can work through the problem yourself and ensure that any answers you submit for evaluation are the result of your own efforts. In addition, you must cite any books, articles, websites, lectures, etc that have helped you with your work using appropriate citation practices. Similarly, you must list the names of students with whom you have collaborated on problem sets.