**Psych 5603. Stem cells and the brain (Graduate-level)**

Instructor: Elizabeth Kirby

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Office hours: TBD

**Meeting location and time**: TBD

**Lecture** for 2.75 h/week

**Description**: Stems cells are an integral part of the brain from its embryonic beginnings through adulthood. However, what stems can do and how they can influence behavior varies depending on age, location, environment and disease. Stem cells hold great promise as therapies for many brain diseases but how do their changing characteristics in different places and at different ages affect their usefulness? This course will explore the biology, function and relevance of stem cells for brain and behavior from development through aging. Through lectures and primary research literature, we will discuss what it means to be a neural stem cell, how stem cells shape the brain and what the role of stem cells might be in brain disorders and mental health.

**Learning objectives**: In the course, you will learn the basics of stem cell biology and how it applies specifically to the brain. You will acquire the vocabulary and background needed to discuss primary literature in the neural stem cell field. You will read and/or present landmark papers in neural stem cell research and become able to identify key findings that shaped one of the most dynamic and cutting edge fields of neuroscience today through in depth discussions in class. You will also learn about the ethical challenges that face neural stem field, some of which are unique to stem cell biology and some of which apply across many fields of medical research.

**Course materials**: Instructor notes and primary research literature

**Pre-requisites:** consent of instructor

**Grade basis**:

25% Presentation of primary research article

Within the first 4 weeks of class, graduate students will select a recent empirical paper related to neural stem cells and the brain for approval by the instructor. They will present this article in a journal club format and lead a discussion of the article’s merits and shortcomings. Graduate students will present for 45 min-1hr with 10-15 min for discussion. Presentations will be graded on equal parts worth 5 points each: 1) presentation of article background, context or motivation; 2) presentation of experimental methods; 3) presentation of experimental data; 4) summary of major conclusions and 5) proposed questions to stimulate further discussion of the article’s findings/relevance to stem cells or neuroscience

25% Written proposal of followup experiment

Graduate students will create a follow-up experiment or additional control experiment related to the paper they presented (1-2 pages in length). Proposals will be graded out of 25 points based on 3 criteria: 1) Appropriate background, context or motivation for follow-up experiment (10 points). 2) Experimental design (10 points). 3) Predicted findings and justification for predictions (5 points).

30% Attendance and participation

A major part of the class is participating in discussion and analysis of primary experimental literature. In addition, attendance is essential for lecture portions because there is no text book and material will be largely covered in class by the instructor. Students will receive full attendance credit for every class in which they attend (1/2 credit) and participate with a substantive comment (1/2 credit). Students may drop their lowest 4 attendance scores (for unexcused absences, for example).

20% Quizzes

There will be 13 short quizzes (15 min each) in weeks 2-14, focusing on the material from the previous week. Students may drop their lowest 2 quiz scores.

**Scale**: Letter grade, standard OSU scale

**Attendance**: Mandatory and part of grading basis. Students are allowed up to 2 dropped quiz scores and 4 dropped attendance scores to compensate for any unexcused absences. Make-up work for missed classes/quizzes beyond this will require a University-approved rationale with appropriate documentation (letter from the Department of Athletics, doctor’s note).

**Due dates**: Students will begin presenting primary literature in the 3rd week of the course. Students will sign up for preferred presentation slots at the beginning of the course. Quizzes will happen at the start of Weeks 2-14 (13 total). Graduate student written proposals will be due by the last day of class.

**Week 1: What is a stem cell?**

-Defining stemness

-Defining potency (pluripotent versus totipotent versus multipotent)

-Where can we find stem cells?

-What are the differences between different kinds of stem cells (embryonic, neural, etc.)

-What are classical stem cell signaling cascades?

Homework: short readings on stem cells for background (< 1hr)

**Week 2: How is the brain built?**

-Phases of brain development and various stem cell populations involved

-Where do neural stem cells come from?

-What happens to stem cells as development proceeds?

-Conservation of mechanisms across species

Homework: readings on developmental neurobiology for background (1-2 hr)

Quiz: 15 min on previous week’s topic

**Week 3: Regulation of brain development: environment, genetics and disorders**

-Role of the neurogenic niche in development

-How can neural stem cells be disrupted during development? What are the consequences for development of brain and behavior?

-How do neural stem cell dynamics (due to genes or environment) participate in developmental disorders such as autism, mental retardation, microcephaly, etc.

Student presentations: Primary articles relevant to the week’s topic.

Homework: readings on environmental impact on neural development for background (1-2 hr); reading primary articles

Quiz: 15 min on previous week’s topic

**Week 4**: **Adult neural stem cells in the subventricular zone**

-Review of adult neurogenesis and stem cells in the adult subventricular zone

-Role of SVZ stem cells in brain function and behavior

Student presentations: Primary articles relevant to the week’s topic.

Homework: readings on adult SVZ neurogenesis for background (1-2 hr); reading primary articles

Quiz: 15 min on previous week’s topic

**Week 5**: **Adult neural stem cells in the hippocampus**

-Review of adult neurogenesis and stem cells in the adult hippocampus

-Role of hippocampal stem cells in brain function

Student presentations: Primary articles relevant to the week’s topic.

Homework: readings on adult hippocampal neurogenesis for background (1-2 hr); reading primary articles

Quiz: 15 min on previous week’s topic

**Week 6: Regulation of adult neural stem cells by the environment**

-Role of the neurogenic niche, relevance to behavior and mental health

-How do adult neural stem cells respond to aging, disease, injury?

-How do adult neural stem cells respond to positive stimuli like exercise?

Student presentations: Primary articles relevant to the week’s topic.

Homework: readings on environmental impact on neural stem cells for background (1-2 hr); reading primary articles

Quiz: 15 min on previous week’s topic

**Week 7: Stem cells as therapy: neurodegenerative disease**

-Review of current and past approaches to using stem cells to treat nervous system degeneration (Alzheimer’s, Parkinson’s, ALS).

Student presentations: Primary article relevant to the week’s topic.

Homework: reading primary articles

Quiz: 15 min on previous week’s topic

**Week 8: Stem cells as therapy: trauma, spinal injury**

-Review of current and past approaches to using stem cells to treat nervous system trauma (spinal injury, TBI)

Student presentations: Primary articles relevant to the week’s topic.

Homework: reading primary articles

Quiz: 15 min on previous week’s topic

**Week 9: Stem cells and society: medical ethics**

-Stem cell clinics and their ethical challenges

-Balances between inherent risk and benefit for patients

-Discussion of several prominent uses of stem cell therapy for brain injury (and why they never came to fruition or were abandoned)

Student presentations: Primary articles relevant to the week’s topic.

Homework: reading primary articles

Quiz: 15 min on previous week’s topic

**Week 10:** **Neural stem cells and society: research ethics**

-Discussion of prominent example of research misconduct in the stem cell field and its implications for science and society

Student presentations: Primary articles relevant to the week’s topic.

Homework: reading primary articles

Quiz: 15 min on previous week’s topic

**Week 11: Induced pluripotent stem cells**

-Discussion of what iPSCs are, what they may be useful for, their limitations

-Discussion of applicability of iPSCs to the brain and neurodegeneration **specifically**

Student presentations: Primary articles relevant to the week’s topic

Homework: reading primary articles

Quiz: 15 min on previous week’s topic

**Week 12:** **Stem cell interactions with other cell types in the niche**

-Discussion of how neural stem cells communicate with other cells in their niche

-Control of differentiation, function and clinical application by healthy and diseased neighboring cells

Student presentations: Primary articles relevant to the week’s topic

Homework: reading primary articles

Quiz: 15 min on previous week’s topic

**Week 13: Aging and stem cells**

-Discussion of how aging affects stem cells in the brain

-How aging impacts clinical potential of stem cells in the brain

Student presentations: Primary articles relevant to the week’s topic

Homework: reading primary articles

Quiz: 15 min on previous week’s topic

**Week 14:** **Neurogenesis in cortex of primate adult brain (controversy in the early 1990s)**

-Discussion of a controversy centering on 2 research groups in the early 1990s about whether primates show adult neurogenesis in the cortex

-Discussion of evidence for both sides, final resolution, implications for stem cell research

Student presentations: Primary articles relevant to the week’s topic

Homework: reading primary articles

Quiz: 15 min on previous week’s topic

Academic misconduct statement: “It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term “academic misconduct” includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct at <http://studentlife.osu.edu/csc/>."

Disability statement: “Students with disabilities that have been certified by the Office of Student Life Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office of Student Life Disability Services is located in 098 Baker Hall. 113 W. 12th Ave.; telephone 292-3307, TDD 292-0901; <http://www.ods.ohio-state.edu/>.”