DEVELOPMENTAL NEUROSCIENCE, FALL 2022

NEUR 601 / BIOL 691 / PSYC 592

Dr. Karl J. Fryxell
School of Systems Biology, and the
Interdisciplinary Program in Neuroscience

Introduction. In theory, our genes encode the structure and function of the nervous system. In practice, in order to build a nervous system from genetic instructions, there are many steps of embryological signaling, gene regulation, directed cellular migration, axonal pathfinding, and finally the formation and remodeling of specific synaptic connections. During this process, the patterns of neuronal activity and behavioral experience are used to refine the numbers and types of neurons and their synaptic connections. This course will provide an introduction to all of these processes, as well as the molecular and genetic methods that are used to explore neuronal development.

Prerequisites. The formal prerequisites for this class are PSYC 372 (Physiological Psychology), or BIOL 213 (Cell Structure and Function) and BIOL 303 (Animal Biology), or equivalent. On the other hand, the primary goal of this course is to serve as part of the required core sequence for the Neuroscience Ph.D. program, in which students have usually completed 1-2 undergraduate-level courses in neurobiology, as well as in chemistry (often including biochemistry), and in cell and molecular biology. Therefore, this background is assumed, and will not be recapitulated in the lectures or assigned reading.

Contact Information

Course meets: Wednesdays, 4:30 - 7:10 pm, Krasnow 229.

Office hours: Fridays, 11:00 am – 12:00 noon online via Zoom
https://gmu.zoom.us/j/7931936280?pwd=RWV1OC9oVmRpQUNQb3Y5czhURG91UT09#success

E-mail: kfryxell@gmu.edu *(Please label your e-mails with the subject line "NEUR 601")*

Telephone: 703-993-1069 *(Please leave a detailed message including your name, class number callback phone number, and dates/times when you are available for me to call you back.*

Course web site: GMU Blackboard web site, includes lecture notes, study questions, and other materials.

Readings. There is one required text for this course, *Development of the Nervous System* by Sanes, Reh, Harris and Landgraf (4th edition, 2019). Copies of this book were ordered for the GMU Fairfax bookstore, where they may be shelved under any of the course numbers listed at the top of this page. Textbooks may also be purchased remotely (over the internet), either from the GMU bookstore or from Amazon.com. The assigned reading also includes a few articles from the scientific literature. These are available in electronic form through the GMU library web site (click on "journals" and then search for the journal title, then volume, issue, etc).

Grading summary: 45% midterm exam, 45% final exam, 10% participation. The participation grade is based on both attendance and participation during class (relevant questions, answers, and comments).

Exams: Midterm and final exams are closed book, in a short-answer and short-essay format that covers the assigned reading and lecture notes. Each exam will cover one half of the course. Exam questions are patterned after the study questions posted each week on Blackboard.

Exam rules: Collaboration and cell phone use of any kind (including texting) is not allowed during examinations. These and other Honor Code violations will result in a grade of zero for the exam. Excused absences from exams require permission from (two-way conversation with) the instructor prior to the exam. Makeup examinations are not given in this course.

Class Schedule & Reading List

Wednesday, August 24 – Introduction, and neural induction (lecture 1)
Text, chapter 1.

Wednesday, August 31 – Embronic polarity and regional identity (lecture 2)
Text, chapter 2.

Wednesday, September 7 – Neurogenesis and cell migration (lecture 3)
Text, chapter 3.

Wednesday, September 14 – The generation of neural diversity (lecture 4)
Text, chapter 4.

Wednesday, September 21 – Axon growth and axon guidance (lecture 5)
Text, chapter 5.

Wednesday, September 28 – Selection of synaptic targets (lecture 6)
Text, chapter 6.

Wednesday, October 5 – Midterm Exam (covers lectures 1-6)
Midterm exam will be held in class, 4:30 pm to 7:10 pm.

Wednesday, October 12 – Naturally-occurring neuronal cell death (lecture 7)
Text, chapter 7

Wednesday, October 19 – Synapse formation and synapse maturation (lecture 8)
Text, pp. 227-255.

Wednesday, October 26 – Synaptic plasticity and synapse elimination (lecture 9)
Text, pp. 255-277.

Wednesday, November 2 – Refinement of synaptic connections and developmental critical periods (lecture 10). Text, pp. 277-303.

Wednesday, November 9 – Sex-specific brain development and imprinting (lecture 11)
Text, pp. 335-342.
Cornil, C. A., G. F. Ball and J. Balthazart (2015) The dual action of estrogens hypothesis. *Trends Neurosci*. **38**, 408-416.
McCarthy, M. M., B. M. Nugent and K. M. Lenz (2017) Neuroimmunology and neuroepigenetics in the establishment of sex differences in the brain. *Nat. Rev. Neurosci*. **18**, 471-484.

Wednesday, November 16 – Behavioral development in newborns and children (lecture 12)
Text, pp. 311-335; 342-356.

Wednesday, November 23 (University closed for Thanksgiving holiday)

Wednesday, November 30 – Cognitive and behavioral development in adolescents (lecture 13)
Galvan, A. (2010) Adolescent development of the reward system. *Front. Hum. Neurosci*. **4**, 6.
Petanjek, Z. et al. (2011) Extraordinary neoteny of synaptic spines in the human prefrontal cortex. *Proc. Natl. Acad. Sci. U.S.A*. **108**, 13281-13286.
Crone, E. A. and R. E. Dahl (2012) Understanding adolescence as a period of social-affective engagement and goal flexibility. *Nat. Rev. Neurosci*. **13**, 636-650.

Wednesday, December 7 – Final Exam (covers lectures 7-13)
Final exam will be held in class, 4:30 pm to 7:10 pm.