DEVELOPMENTAL NEUROSCIENCE, FALL 2020 (rev. 6/20)

NEUR 601 / BIOL 691 / PSYC 592

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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

(All registered students will receive e-mailed instructions for how to access lectures & office hours).
Course meets: Thursdays, 4:30 - 7:10 pm online (Blackboard Collaborate website).
Office hours: Fridays, 2 pm – 3 pm online (http://gmu.webex.com/meet/kfryxell).
E-mail: kfryxell@gmu.edu *(please identify your e-mails with the subject line "NEUR 601")*
Telephone: 703-993-1069 (I am currently able to check voice mail about twice per week).
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 are available in the GMU Fairfax bookstore. Some copies of these books might be shelved under any of the course numbers listed at the top of this page, so if you don't find it, try looking under another cross-listed course number. The assigned reading also includes a few articles from the scientific literature, which are available in electronic form through the GMU library web site (click on "journals" and then search for the journal title).

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 examinations will require that students have a quiet, private space with a computer, webcam and a reliable internet connection. Students will also be required to install the Respondus Lockdown Browser, which is freely available on the Blackboard Courses webpage. 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

Thursday, August 27 – Introduction, and neural induction (lecture 1)
Text, chapter 1.

Thursday, September 3 – Embronic polarity and regional identity (lecture 2)
Text, chapter 2.

Thursday, September 10 – Neurogenesis and cell migration (lecture 3)
Text, chapter 3.

Thursday, September 17 – The generation of neural diversity (lecture 4)
Text, chapter 4.

Thursday, September 24 – Axon growth and axon guidance (lecture 5)
Text, chapter 5.

Thursday, October 1 – Selection of synaptic targets (lecture 6)
Text, chapter 6.

Thursday, October 8 – Midterm Exam (covers lectures 1-6)
Midterm exam will be held online, 4:30 pm to 7:10 pm.

Thursday, October 15 – Naturally-occurring neuronal death (lecture 7)
Text, chapter 7

Thursday, October 22 – Synapse formation and synapse maturation (lecture 8)
Text, pp. 209-239

Thursday, October 29 – Synaptic plasticity and synapse elimination (lecture 9)
Text, pp. 239-261

Thursday, November 5 – Synapse refinement and developmental critical periods (lecture 10)
Text, pp. 261-281

Thursday, November 12 – Sex-specific brain development and imprinting (lecture 11)
Text, pp. 309-314.
Rudolph, L. M. et al. (2016) Actions of steroids: new neurotransmitters. *J. Neurosci.* **36**, 11449-11458.
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.

Thursday, November 19 – Behavioral development in childhood (lecture 12)
Text, pp. 287-308; 315-325.

Thursday, November 26 (Thanksgiving holiday)

Thursday, December 3 – Cognitive and behavioral development in adolescents (lecture 13)
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.

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