

Psychology W2480 - The Developing Brain - Fall 2016

W2480 The Developing Brain

Fall 2016: 3 pts. F. Champagne MW 10:10-11:25 AM. Room 614 Schermerhorn Hall

Prerequisite: Psychology W1001 or W1010 or the instructor's permission.

Brain development across the life span, with emphasis on fetal and postnatal periods. How the environment shapes brain development and hence adult patterns of behavior.

Course Description

This course is designed to provide students with an understanding of the process of brain development from embryogenesis through adulthood with emphasis on the role of the environment in directing this process. In the first 7 weeks of lectures, the origins of the central nervous system will be discussed. Topics will include the regional organization of the brain, neurogenesis, cellular differentiation, migration and targeting of neurons, synapse formation and refinement of the nervous system. In the second half of the course, lectures will focus on the infant brain and the role of experiences during infancy in modifying brain function. Topics will also include recent advances in our understanding of the role of gene-environment interactions and epigenetic programming and shaping brain development. Finally, the adaptive vs. maladaptive outcomes of environmental modifications to the nervous system will be discussed. Throughout the course, students will be guided through examples of how changes in the developing nervous system lead to behavioral patterns both in infancy and adulthood.

Course Evaluation

Grading: Midterm exam (30%), final exam (40%), and a short (6 pages) term paper (30%).

Textbook & Readings

Textbook:

Sanes, D.H., Reh, T.A. and Harris, W.A. (2011). *Development of the Nervous System*. San Diego: Academic Press.

The required readings will consist of: (1) chapters from a textbook on brain development and (2) additional chapters/papers that provide literature reviews on specific topics (these will be posted on Courseworks)

Schedule of Topics**WEEK 1****Course introduction, overview of brain development****WEEK 2****Basic principles of neuroscience****READINGS:**

Introduction to Neurons, Brains, and Biological Psychology, Chapter 1 (page 1-54)

Influence of environment on brain development prior to fertilization**READINGS:**

Hales BF, Robaire B. (2001) Paternal exposure to drugs and environmental chemicals: effects on progeny outcome. *J Androl.* 22(6):927-36.

Jenkins TG, Carrell DT. (2012) The sperm epigenome and potential implications for the developing embryo. *Reproduction.* 143(6):727-34.

Ledig M, Misslin R, Vogel E, Holownia A, Copin JC, Tholey G (1998) Paternal alcohol exposure: developmental and behavioral effects on the offspring of rats. *Neuropharm.* 37(1):57-66.

Abel E (2004) Paternal contribution to fetal alcohol syndrome. *Addiction Biology* 9(2):127-33.

WEEK 3**Maternal regulation of early embryonic development****READINGS:**

Nothias JY, Majumder S, Kaneko KJ, DePamphilis ML. (1995) Regulation of gene expression at the beginning of mammalian development. *J Biol Chem.* 270(38):22077-80.

Pauli A, Rinn JL, Schier AF. (2011) Non-coding RNAs as regulators of embryogenesis. *Nat Rev Genet.* 12(2):136-49.

Tadros W, Lipshitz HD. (2009) The maternal-to-zygotic transition: a play in two acts. *Development.* 136(18):3033-42.

Walker SK, Hartwich KM, Robinson JS. (2000) Long-term effects on offspring of exposure of oocytes and embryos to chemical and physical agents. *Hum Reprod Update.* 6(6):564-77.

WEEK 4

Regional organization of the embryo & segmentation in the central nervous system

READINGS:

Development of the Nervous System Chapters 1 - 2

Generation of neurons

READINGS:

Development of the Nervous System Chapter 3

WEEK 5

Cellular differentiation

READINGS:

Development of the Nervous System Chapter 4

Guidance and growth of axons

READINGS:

Development of the Nervous System Chapter 5

WEEK 6

Selecting targets for neural connection

READINGS:

Development of the Nervous System Chapter 6

Death & survival of neurons

READINGS:

Development of the Nervous System Chapter 7

WEEK 7

Synapse formation

READINGS:

Development of the Nervous System Chapter 8

Midterm review

WEEK 8

MIDTERM EXAM

Refinement of the nervous system

READINGS:

Development of the Nervous System Chapter 9

WEEK 9**Behavioral development****READINGS:**

Development of the Nervous System Chapter 10

WEEK 10**Prenatal programming of the infant brain****READINGS:**

Monk C, Spicer J, Champagne FA. (2012) Linking prenatal maternal adversity to developmental outcomes in infants: the role of epigenetic pathways. *Dev Psychopathol.* 24(4):1361-76.

Zeisel SH. (2006) The fetal origins of memory: the role of dietary choline in optimal brain development. *J Pediatr.* 149(5 Suppl):S131-6.

Harris A, Seckl J. (2011) Glucocorticoids, prenatal stress and the programming of disease. *Horm Behav.* 59(3):279-89.

Epigenetic influence on brain development**READINGS:**

Meaney MJ. (2010) Epigenetics and the biological definition of gene x environment interactions. *Child Dev.* 81(1):41-79.

Francis DD, Szegda K, Campbell G, Martin WD, Insel TR. (2003) Epigenetic sources of behavioral differences in mice. *Nat Neurosci.* 6(5):445-6.

Fagiolini M, Jensen CL, Champagne FA (2009) Epigenetic influences on brain development and plasticity *Curr Opin Neurobiol.* 19(2):207-12.

WEEK 11**Neurotransmitters and hormones****READINGS:**

Sarter M, Parikh V. (2005) Choline transporters, cholinergic transmission and cognition. *Nat Rev Neurosci.* 6(1):48-56.

Young SN, Leyton M. (2002) The role of serotonin in human mood and social interaction. Insight from altered tryptophan levels. *Pharmacol Biochem Behav.* 71(4):857-65.

Balthazart J, Ball GF. (2006) Is brain estradiol a hormone or a neurotransmitter? *Trends Neurosci.* 29(5):241-9.

Maternal vs. paternal influences on brain development**READINGS:**

Keverne EB, Curley JP (2008) Epigenetics, brain evolution and behaviour. *Front Neuroendocrinol.* 29(3):398-412.

Wilkins JF, Haig D. (2003) What good is genomic imprinting: the function of parent-specific gene expression. *Nat Rev Genet.* 4(5):359-68.

WEEK 12**Sex differences in brain development****READINGS:**

Arnold AP, Rissman EF, De Vries GJ. (2003) Two perspectives on the origin of sex differences in the brain. *Ann N Y Acad Sci.* 1007:176-88.

McCarthy MM, Konkle AT. (2005) When is a sex difference not a sex difference? *Front Neuroendocrinol.* 26(2):85-102.

Reward and the brain**READINGS:**

Berridge KC. (1996) Food reward: brain substrates of wanting and liking. *Neurosci Biobehav Rev.* 20(1):1-25.

Fareri DS, Martin LN, Delgado MR (2008) Reward-related processing in the human brain: developmental considerations. *Dev Psychopathol.* 20(4):1191-211.

WEEK 13**Immune system and the brain****READINGS:**

Maier SF, Watkins LR, Fleshner M (1994) Psychoneuroimmunology. The interface between behavior, brain, and immunity. *Am Psychol.* 49(12):1004-17.

Kemeny ME (2009) Psychobiological responses to social threat: evolution of a psychological model in psychoneuroimmunology. *Brain Behav Immun.* 23(1):1-9.

Gene-environment interactions in the CNS**READINGS:**

Caspi A, Sugden K, Moffitt TE, Taylor A, Craig IW, Harrington H, McClay J, Mill J, Martin J, Braithwaite A, Poulton R. (2003) Influence of life stress

on depression: moderation by a polymorphism in the 5-HTT gene. *Science*. 301(5631):386-9.

Casey BJ et al.(2009) Brain-derived neurotrophic factor as a model system for examining gene by environment interactions across development. *Neuroscience*. 164(1):108-20.

WEEK 14

The adolescent brain

READINGS:

Casey BJ, Jones RM. (2010) Neurobiology of the adolescent brain and behavior: implications for substance use disorders. *J Am Acad Child Adolesc Psychiatry*. 49(12):1189-201

Giedd JN. (2008) The teen brain: insights from neuroimaging. *J Adolesc Health*. 42(4):335-43.

Sisk CL, Zehr JL. (2005) Pubertal hormones organize the adolescent brain and behavior. *Front Neuroendocrinol*. 26(3-4):163-74.

Plasticity in the adult brain

READINGS:

Ming GL, Song H. (2005) Adult neurogenesis in the mammalian central nervous system. *Annu Rev Neurosci*. 28:223-50.

Holtmaat A, Svoboda K. (2009) Experience-dependent structural synaptic plasticity in the mammalian brain. *Nat Rev Neurosci*. 10(9):647-58.

Roth TL, Sweatt JD (2009) Regulation of chromatin structure in memory formation. *Curr Opin Neurobiol*. 19(3):336-42.

WEEK 15

Final review

FINAL EXAM: TBA