PSY 620 - SEMINAR- NEUROBIOLOGY OF LEARNING AND MEMORY -
SPRING 2017
Department of Psychology, College of Arts & Sciences, Stony Brook University
Tuesday & Thursday 11:30 AM - 12:50 PM
Psychology A, Room 256

INSTRUCTOR: Dr. Ryan Parsons
OFFICE: Psych B, Rm. 320
OFFICE HOURS: By appointment

COURSE MATERIALS: Readings for each topic will be distributed

COURSE DESCRIPTION:

Learning and memory result in long-term changes in behavior, which are supported by molecular and cellular changes in the brain. This seminar will cover background on the basics of molecular and cellular neurobiology. Students will read and discuss works on topics including: intrinsic and synaptic plasticity, neural mechanisms of memory consolidation, *in vivo* models of plasticity, and memory systems. Special focus will also be given to state-of-the-art techniques currently being used to probe brain function as they relate to learning and memory.

COURSE REQUIREMENTS:

Attendance:

Regular attendance is mandatory. If you anticipate having to miss a class for a legitimate reason (e.g. attending a conference), please let me know at the beginning of the semester.

Weekly Readings:

There is no textbook for the course. Weekly readings are listed below. Articles to be discussed for each class period will be available on "blackboard" for download (http://blackboard.stonybrook.edu/).

Weekly presentation and discussion:

Each week, a class member will give a presentation and lead the discussion on the assigned readings. (Presentations should be done in PowerPoint format.) Presentations should last 1 hour and discuss the pertinent literature background, highlight the research question addressed in the article, review the methodology used to answer the question, and discuss the results and their interpretation in relation to the general topic under investigation. Each student will be responsible for leading the discussion 3 times over the semester.

Weekly questions/comments on the readings:

Class members who are not presenting are expected to submit short reaction papers (no longer than 1 page) for each article. You are recommended to first write a brief summary of the article (a few sentences should be sufficient) and then make comments related to (1) the significance and potential impact of the paper, (2) the authors theoretical arguments and empirical approach, and (3) make suggestions for further analyses/experiments. The purpose of the reaction papers is to show that you've read the papers and to further develop critical thinking.

GRADING:

Grading will be based on the quality of the presentations, participation in class, and submission of questions/reaction papers for each class topic.

DESCRIPTION AND SCHEDULE OF THE REQUIRED READINGS AND TOPICS:

Class Schedule

Week/Date	***Discussion Topic***
Week 1	
Jan. 24	Class organization – Lecture: Introduction to the Biology of Memory

Background Readings:
Kandel, E. R. (2009). "The biology of memory: a forty-year perspective." The Journal of Neuroscience 29(41): 12748-12756.
Dudai, Y. (2009). "Predicting not to predict too much: how the cellular machinery of memory anticipates the uncertain future." Philos Trans R Soc Lond B Biol Sci 364(1521): 1255-1262.

Jan. 26 Lecture: Cell Biology of learning and memory
Background Readings:
Johansen, J. P., et al. (2011). "Molecular mechanisms of fear learning and memory." Cell 147(3): 509-524.

Week 2

Jan. 31 Memory Systems: The Hippocampus
Background Readings:
Milner, B., et al. (1998). "Cognitive neuroscience and the study of memory." Neuron 20(3): 445-468.
Research articles:
Zola-Morgan, S. M. and L. R. Squire (1990). "The primate hippocampal formation: evidence for a time-limited role in memory storage." Science 250(4978): 288-290.
Kim, J. J. and M. S. Fanselow (1992). "Modality-specific retrograde amnesia of fear." Science 256(5057): 675-677.

Feb. 2 Memory Systems: The amygdala and cerebellum
Background Readings:
LeDoux, J. E. (2000). "Emotion circuits in the brain." Annual review of neuroscience 23: 155-184.
Kim, J. J. and R. F. Thompson (1997). "Cerebellar circuits and synaptic mechanisms involved in classical eyeblink conditioning." Trends Neurosci 20(4): 177-181.
Research articles:
LaBar, K. S., et al. (1998). "Human amygdala activation during conditioned fear acquisition and extinction: a mixed-trial fMRI study." Neuron 20(5): 937-945.
Krupa, D. J., et al. (1993). "Localization of a memory trace in the mammalian brain." Science 260(5110): 989-991.

Week 3

Feb. 7 Long-Term Potentiation as the cellular correlate of learning
Background Readings:
Morris RG (2003): Long-term potentiation and memory. Philos Trans R Soc Lond B Biol Sci. 358:643-647.
Research articles:
Whitlock, J. R., et al. (2006). "Learning induces long-term potentiation in the hippocampus." Science 313(5790): 1093-1097
Nabavi S, Fox R, Proulx CD, Lin JY, Tsien RY, Malinow R (2014): Engineering a memory with LTD and LTP. Nature. 511:348-352.

Feb. 9 Neurobiology Seminar
Michael Hasselmo – Boston University
12:00-1:00
Life Sciences Bldg - Room 038

Week 4

Feb. 14 Metaplasticity and learning

Background Readings:

Sehgal M, Song C, Ehlers VL, Moyer JR, Jr. (2013): Learning to learn - intrinsic plasticity as a metaplasticity mechanism for memory formation. Neurobiol Learn Mem. 105:186-199.

Research articles:

Moyer, J. R., Jr., et al. (1996). "Trace eyeblink conditioning increases CA1 excitability in a transient and learning-specific manner." J Neurosci 16(17): 5536-5546.

Clem RL, Celikel T, Barth AL (2008): Ongoing in vivo experience triggers synaptic metaplasticity in the neocortex. Science. 319:101-104.

Feb. 16 Neurobiology Seminar

Andre Fenton – New York University
12:00-1:00
Life Sciences Bldg - Room 038

Week 5

Feb. 21 Synaptic Tagging and memory

Background Readings:

Redondo RL, Morris RG (2011): Making memories last: the synaptic tagging and capture hypothesis. Nat Rev Neurosci. 12:17-30.

Research articles:

Frey U, Morris RG (1997): Synaptic tagging and long-term potentiation. Nature. 385:533-536.

Ballarini F, Moncada D, Martinez MC, Alen N, Viola H (2009): Behavioral tagging is a general mechanism of long-term memory formation. Proc Natl Acad Sci U S A. 106:14599-14604.

Feb. 23 Glutamate Receptors and Learning

Research articles:

Miserendino, M. J., et al. (1990). "Blocking of acquisition but not expression of conditioned fear-potentiated startle by NMDA antagonists in the amygdala 117." Nature 345(6277): 716-718.

Rumpel, S., et al. (2005). "Postsynaptic receptor trafficking underlying a form of associative learning." Science 308(5718): 83-88.

Week 6

Feb. 28 Protein Kinase Signaling

Background Readings:

Giese KP, Mizuno K (2013): The roles of protein kinases in learning and memory. Learn Mem. 20:540-552.

Research articles:

Atkins, C. M., et al. (1998). "The MAPK cascade is required for mammalian associative learning." Nat Neurosci 1(7): 602-609.

Kelleher, R. J., III, et al. (2004). "Translational control by MAPK signaling in long-term synaptic plasticity and memory." Cell 116(3): 467-479.

Mar. 2 Protein synthesis and memory

Background Readings:

Hernandez PJ, Abel T (2008): The role of protein synthesis in memory consolidation: progress amid decades of debate. Neurobiol Learn Mem. 89:293-311.

Research articles:

Schafe, G. E. and J. E. LeDoux (2000). "Memory consolidation of auditory pavlovian fear conditioning requires protein synthesis and protein kinase A in the amygdala." The Journal of neuroscience: the official journal of the Society for Neuroscience 20(18): RC96.

Canal, C. E., et al. (2007). "Amnesia produced by altered release of neurotransmitters after intraamygdala injections of a protein synthesis inhibitor." Proc Natl Acad Sci U S A 104(30): 12500-12505.

Week 7

Mar. 7 CREB and memory

Background Readings:

Research articles:

Josselyn, S. A., et al. (2001). "Long-term memory is facilitated by cAMP response element-binding protein overexpression in the amygdala." J.Neurosci. 21(7): 2404-2412.

Han, J. H., et al. (2009). "Selective erasure of a fear memory." Science 323(5920): 1492-1496.12505.

Mar. 9 Epigenetic Regulation of Memory

Background Readings:

Day JJ, Sweatt JD (2011): Epigenetic mechanisms in cognition. Neuron. 70:813-829.

Research articles:

Levenson JM, O'Riordan KJ, Brown KD, Trinh MA, Molfese DL, Sweatt JD (2004): Regulation of histone acetylation during memory formation in the hippocampus. The Journal of biological chemistry. 279:40545-40559.

Miller CA, Gavin CF, White JA, Parrish RR, Honasoge A, Yancey CR, et al. (2010): Cortical DNA methylation maintains remote memory. Nat Neurosci. 13:664-666.

Mar. 14 SPRING BREAK

Mar. 16 SPRING BREAK

Week 8

Mar. 21 Protein kinase M-Zeta and memory maintenance

Background Readings:

Kwapis JL, Helmstetter FJ (2014): Does PKM(zeta) maintain memory? Brain research bulletin. 105:36-45.

Research articles:

Pastalkova, E., et al. (2006). "Storage of spatial information by the maintenance mechanism of LTP." Science 313(5790): 1141-1144.

Volk, L. J., et al. (2013). "PKM-zeta is not required for hippocampal synaptic plasticity, learning and memory." Nature 493(7432): 420-423.

Mar. 23 Reconsolidation of memory after retrieval

Background Readings:

Alberini CM, Ledoux JE (2013): Memory reconsolidation. Current biology: CB. 23:R746-750.

Research articles:

Nader, K., et al. (2000). "Fear memories require protein synthesis in the amygdala for reconsolidation after retrieval." Nature 406(6797): 722-726.
Lattal, K. M. and T. Abel (2004). "Behavioral impairments caused by injections of the protein synthesis inhibitor anisomycin after contextual retrieval reverse with time."

Week 9

Mar. 28 Extinction learning

Background Readings:

Milad MR, Quirk GJ (2012): Fear extinction as a model for translational neuroscience: ten years of progress. Annu Rev Psychol. 63:129-151.

Research articles:

Milad, M. R. and G. J. Quirk (2002). "Neurons in medial prefrontal cortex signal memory for fear extinction." Nature 420(6911): 70-74.
Likhtik E, Popa D, Apergis-Schoute J, Fidacaro GA, Pare D (2008): Amygdala intercalated neurons are required for expression of fear extinction. Nature. 454:642-645.

Mar. 30 Extinction of memory following retrieval

Background Readings:

Hutton-Bedbrook K, McNally GP (2013): The promises and pitfalls of retrieval-extinction procedures in preventing relapse to drug seeking. Frontiers in psychiatry. 4:14.

Research articles:

Monfils, M. H., et al. (2009). "Extinction-reconsolidation boundaries: key to persistent attenuation of fear memories." Science 324(5929): 951-955.
Xue YX, Luo YX, Wu P, Shi HS, Xue LF, Chen C, et al. (2012): A memory retrieval-extinction procedure to prevent drug craving and relapse. Science. 336:241-245.

Week 10

Apr. 4 From the lab to the clinic: D-cycloserine

Research articles:

Walker, D. L., et al. (2002). "Facilitation of conditioned fear extinction by systemic administration or intra-amygdala infusions of D-cycloserine as assessed with fear-potentiated startle in rats." The Journal of neuroscience: the official journal of the Society for Neuroscience 22(6): 2343-2351.
Ressler, K. J., et al. (2004). "Cognitive enhancers as adjuncts to psychotherapy: use of D-cycloserine in phobic individuals to facilitate extinction of fear." Arch Gen Psychiatry 61(11): 1136-1144.

Apr. 6 Stress effects on memory

Background Readings:

McGaugh JL (2004): The amygdala modulates the consolidation of memories of emotionally arousing experiences. Annu Rev Neurosci. 27:1-28.

Research articles:

Wood, G. E. and T. J. Shors (1998). "Stress facilitates classical conditioning in males, but impairs classical conditioning in females through activational effects of ovarian hormones." Proc Natl Acad Sci U S A 95(7): 4066-4071.
Baratta MV, Kodandaramaiah SB, Monahan PE, Yao J, Weber MD, Lin PA, et al. (2016): Stress Enables Reinforcement-Elicited Serotonergic Consolidation of Fear Memor y. Biol Psychiatry. 79:814-822.

Week 11

Apr. 11 The role of neurogenesis in memory

Background Readings:

Deng W, Aimone JB, Gage FH (2010): New neurons and new memories: how does adult hippocampal neurogenesis affect learning and memory? Nat Rev Neurosci. 11:339-350.

Research articles:

Shors, T. J., et al. (2001). "Neurogenesis in the adult is involved in the formation of trace memories." Nature 410(6826): 372-376.

Akers, K. G., et al. (2014). "Hippocampal neurogenesis regulates forgetting during adulthood and infancy." Science 344(6184): 598-602.

Apr. 13 Sleep and memory

Background Readings:

Diekelmann S, Born J (2010): The memory function of sleep. Nat Rev Neurosci. 11:114-126.

Research articles:

Rasch B, Buchel C, Gais S, Born J (2007): Odor cues during slow-wave sleep prompt declarative memory consolidation. Science. 315:1426-1429.

Euston DR, Tatsuno M, McNaughton BL (2007): Fast-forward playback of recent memory sequences in prefrontal cortex during sleep. Science. 318:1147-1150.

Week 12

Apr. 18 Optogenetic manipulation of memory

Background Readings:

Goshen I (2014): The optogenetic revolution in memory research. Trends Neurosci. 37:511-522.

Research articles:

Ramirez, S., et al. (2013). "Creating a false memory in the hippocampus." Science 341(6144): 387-391

Apr. 20 'DREADD' manipulation of memory

Background Readings:

Urban DJ, Roth BL (2015): DREADDs (designer receptors exclusively activated by designer drugs): chemogenetic tools with therapeutic utility. Annu Rev Pharmacol Toxicol. 55:399-417.

Research articles:

Garner AR, Rowland DC, Hwang SY, Baumgaertel K, Roth BL, Kentros C, et al. (2012): Generation of a synthetic memory trace. Science. 335:1513-1516.

Week 13

Apr. 25 Using CRISPR/Cas9 to manipulate memory

Background Readings:

Doudna JA, Charpentier E (2014): Genome editing. The new frontier of genome engineering with CRISPR-Cas9. Science. 346:1258096.

Research articles:

Awata H, Watanabe T, Hamanaka Y, Mito T, Noji S, Mizunami M (2015): Knockout crickets for the study of learning and memory: Dopamine receptor Dop1 mediates aversive but not appetitive reinforcement in crickets. Sci Rep. 5:15885.

Apr. 27 Experimenter effects on behavior

Sorge, R. E., et al. (2014). "Olfactory exposure to males, including men, causes stress and related analgesia in rodents." Nat Methods 11(6): 629-632.

Week 14

May. 2 Preventing age-related memory decline

Villeda, S. A., et al. (2014). "Young blood reverses age-related impairments in cognitive function and synaptic plasticity in mice." Nat Med 20(6): 659-663

May. 4 The Nature of Amnesia

Chen S, Cai D, Pearce K, Sun PY, Roberts AC, Glanzman DL (2014): Reinstatement of long-term memory following erasure of its behavioral and synaptic expression in Aplysia. Elife. 3:e03896.
Ryan TJ, Roy DS, Pignatelli M, Arons A, Tonegawa S (2015): Memory. Engram cells retain memory under retrograde amnesia. Science. 348:1007-1013.

ACADEMIC INTEGRITY STATEMENT:

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, and Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at

CRITICAL INCIDENT MANAGEMENT:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

Blackboard and electronic communication:

In addition to classroom communications, announcement posted on blackboard and email sent via Blackboard are ways we will officially communicate with you for this course. It is your responsibility to check blackboard announcements and read your email in your official University email account. For most students that is Google Apps for Education (***http://www.stonybrook.edu/mycloud***) but you may verify your official Electronic Post Office (EPO) address at: ***http://it.stonybrook.edu/help/kb/checking-or-changing-your-mail-forwarding-address-in-the-epo***

If you are not familiar with using blackboard, read the following information.

You can access class information on-line at: http://blackboard.stonybrook.edu

In order to log into this website, you will need your blackboard user name and password. If you have used Blackboard in the past, your login information (Username and Password) has not changed. If you have never used Stony Brook's Blackboard system, your initial password is your SOLAR ID# and your username is the same as your Stony Brook (sparky) username, which is generally your first initial and the first 7 letters of your last name. ***For help or more information see:***

https://tlt.stonybrook.edu/StudentServices/BbStudents/Pages/default.aspx

For problems logging in, go to the helpdesk in the Main Library SINC Site or the Union SINC Site, you can also call: 631-632-9602 or e-mail: helpme@stonybrook.edu