Course Announcement – Spring 2014

FUNCTIONAL NEUROANATOMY - An introduction to the vertebrate nervous system– rat brain for the future neuroscientist
Course 26 112 501

Professor: J.I. Morrell, CMBN
Class times: Twice a week Tues and Friday 3-5 pm
Place: Aidekman Seminar Room (103B)(back)

Narrative Overview of the Course

The course provides a high level of information on the functional anatomy of the brains of laboratory rodents, with emphasis on rat, but including mouse. Specific topics include information on gross and cellular components of all key motor, sensory, emotion, cognitive, and autonomic systems and their connections. A strong detailed knowledge of the functional neuroanatomy of mammals is the objective. To attain this the rodent brain is used as the exemplar, but the level of knowledge readily generalizes to all mammals, and includes routine reference to specific comparisons in the human.

Course Objectives:

To train future neuroscientists in the most frequently used fundamental laboratory rodent models. Students will attain a practitioner's level of knowledge with the functional neuroanatomy of the rodent brain. Such a level of knowledge is important regardless of the specific experimental focus of the neuroscientist.

Pre- and Co-requisite courses:

This course will be open to graduate students as well as advanced undergraduate students who have taken the "Foundations in Neuroscience" course: 26:112:565 and 26:112:565 . A limited number of other students may enroll by Special Permission of the Instructor. The course will be limited to 15 students.

Scientific Computing in Matlab

(26:112:611)

Instructor: Bart Krekelberg
T: 973 353 3602
Office: Aidekman 220.
E: bart@vision.rutgers.edu

Narrative/Catalogue Description: Matlab has become one of the main tools for the analysis of scientific data. This course will introduce the student to scientific computing, data analysis, and modeling in Matlab. While general programming techniques will be taught, specific examples will be drawn from the field of Neuroscience; including the analysis of behavioral data, functional imaging, and spike and local field recordings.

Almost all research projects in Neuroscience involve a considerable amount of ever more sophisticated data analysis. In the absence of a formal course in these methods students learn these techniques while doing research. This training, however, often does not lend itself well to generalization, as the student only learns a small subset of techniques that are directly relevant to their research project. The goal of the course is to provide more general training in structured programming and thereby provide a broader basis for their current and future research.

Course Objectives: To learn structured, efficient, and robust programming in the Matlab language for the analysis of data obtained in Neuroscience experiments.

Pre-requisites: Two successfully completed semesters of graduate study, or by special permission of the instructor.

Learning outcomes

On completion of this course, the student will be able to read in data in a variety of common Neuroscience formats, develop structured programs to analyze them, and present the results in a graphical manner. Additionally, the student will have learned a number of recurring analysis methods with wide applicability in systems neuroscience and beyond.

Reading List: Matlab for Neuroscientists, Wallisch et al., Academic Press, Handout (TUT), Introduction to Matlab (Handout, B. Krekelberg), Matlab Style Guide (Handout, R. Johnson)

Evaluation Criteria: Students will be judged on the correctness, efficiency, correct code-documentation, and robustness of the implementation of homework (30%) and a final project (70%). The final project will be developed in the second half of the course, but finalized at home. Project topics can be drawn from the student's own research, or proposed by the instructor.

Time slots: One three hour time slot per week.
Enrollment Cap : 30
Credits: 3

Topics by Week

Fundamentals

1. Matlab Development Environment, Variables, Matrices, Vectors,
2. Indexing, Algebra
3. Program Flow, Sparse Matrices, Structures
4. String Manipulation, Graphics, File I/O

Data Analysis

5. Behavior: Statistics, Anova, Bootstrap, Curve fitting, Signal detection
6. Spikes: Rasters, Histograms, Cross-correlation, Spike-triggered averaging
7. Spikes: Spike density, clustering,
8. Local Fields: Fourier Analysis, Spectrograms,
9. Local Fields: Coherence, Wavelets, Principal Components
10. Imaging: General Linear Model, Support Vector Machines,
11. Imaging: Functional Connectivity

Special Topics

12. Interfacing with external programs
13. Graphical User Interfaces

Neural Bases of Cognitive Development, Fall, 2013

(26:112:630:01)

Wednesdays 1:30 pm to 3:30 pm

A. A. Benasich: 973-353-3598

Infancy Studies Lab (214, 216, 205), x3593

NARRATIVE OVERVIEW OF THE COURSE:

A broad overview of the emerging field of developmental cognitive neuroscience will be presented. Behavioral as well as biological approaches to the study of relations between early brain development and developing language and cognition will be included. The major focus will be on the neural bases of cognition in children (i.e. links between brain development & cognitive development). Pertinent supporting research in the cellular and animal literatures will provide a framework for understanding the links between the biological processes occurring during CNS development and the behavioral capacities exhibited in the mature organism. The contributions of processes intrinsic to the CNS relative to the contributions of influences from extrinsic sources, such as behavioral experience, trauma, nutrition, hormonal states, etc will also be addressed. Topics include: historical and theoretical background for the study of the developing brain, embryonic and fetal brain development, perceptual development, language and cognitive development, brain plasticity, and brain-based disorders of language and cognition.

COURSE OBJECTIVES:

The Neural Bases of Cognitive Development will provide graduate students an advanced understanding of how the brain is built during the fetal and infant periods, the interplay between nature and nurture, the influence of early experiences, plasticity, and the role of timing in language acquisition and cognitive development, and the tools available to study the interface between neural substrate and observed behavior.

PRE- AND CO-REQUISITE COURSES:

This course will be open to graduate students as well as advanced undergraduate students who have taken the "Foundations in Neuroscience" course: 26:112:565 and 26:112:565. A limited number of other students may enroll by Special Permission of the Instructor. The course will be limited to 15 students.

EXPECTED LEARNING OUTCOMES OR COMPETENCIES:

a.) Understand neuromotor and neurosensory maturation across fetal and infant development (i.e. in terms of proliferation, migration, differentiation, and growth of neurons and their axonal and dendritic processes) and the progressive development of the human central nervous system (CNS).

b.) Appreciate the contribution experience makes to the maturation of the nervous system and to subsequent cognition.

c.) Become familiar with the techniques available to examine brain-behavior relationships.
d.) Understand the development of cognition as related to behaviorally observable information-processing abilities (whether they be perceptual, language, or performance-based) and the neural bases of cognition in children (i.e. links between brain development & cognitive development).
e.) Consider the role of brain plasticity on the developing brain in both normally developing and abnormally developing and brain-damaged populations.

READINGS:

We will read selections from several textbooks as well as current readings as this is an emerging field and no one text covers all the material. Copies of the chapters assigned will be provided, although you may want to buy the main textbook.

Main Text*: Mark H. Johnson, Developmental Cognitive Neuroscience, 3rd Edition, Oxford: Wiley-Blackwell Publishing, 2010.*

We will also read selections from *Charles A. Nelson and Monica Luciana (Eds). Handbook of Developmental Cognitive Neuroscience, 2nd Edition, London: The MIT Press, 2008*; *Michelle de Haan and Mark H. Johnson (Eds.). The Cognitive Neuroscience of Development, New York: Psychology Press, 2003* and from *Donna Coch, Kurt W. Fischer and Geraldine Dawson (Eds). Human Behavior, Learning and the Developing Brain, New York: The Guilford Press, 2007*. I will give you copies of those chapters. In addition, there will be handouts for some of the lectures and a number of suggested readings from the original literature. I will supply copies of the required readings.

EVALUATION CRITERIA:

General:

- Attendance and active participation is required at all classes.
- Required Readings must be done prior to each week's class.
- The course format will include a mixture of lectures and seminar-style discussions.
- Two exams, a midterm and a final exam will be given. In addition, each student will give a class presentation on an assigned reading and lead the discussion. A short synopsis should be submitted.

Grading:

Class presentations/synopsis = 15%
Midterm Exam = 35%
Final Exam = 50%

WEEK-BY-WEEK LIST OF TOPICS, READINGS AND ASSIGNMENTS

The course format will be a combination of lecture (most given by the professor with a few guest lecturers on specific topics), student presentations of original research papers, and seminar-style discussions. The goal is to cover the relevant knowledge in the field of developmental neuroscience and the relations of brain to behavior. All participants will be given examinations (one midterm and one final) and will be required to present and lead discussion on one to two assigned papers on topics from the course curriculum.

COURSE TITLE: Neural Bases of Cognitive Development

(CMBN/RU: 26:546:630:01; UMDNJ: NEUR R630)

Professor: April A. Benasich, Ph.D., CMBN

Fall 2010 Wednesdays 1:30 pm to 3:30 pm

Texts:

1. Johnson, M. H. Developmental Cognitive Neuroscience, 3ed Edition, Oxford: Wiley-Blackwell Publishing, 2010.

2. Michelle de Haan and Mark H. Johnson (Eds.) The Cognitive Neuroscience of Development, New York: Psychology Press, 2003

3. Donna Coch, Kurt W. Fischer and Geraldine Dawson (Eds.) Human Behavior, Learning and the Developing Brain, New York: The Guilford Press, 2007.

Copies of required Chapters will be provided. Additional readings for this course are indicated in the syllabus as "Readings" and will also be provided.

INTRODUCTION/THEORETICAL OVERVIEW

Johnson, Chapter 1: The biology of change. pp. 1-18.

Readings:

Chugani, H., Phelps, M.E. and Mazziotta, J.C. (1987). Positron emission tomography study of human brain functional development. Annals of Neurology. 22, 487-97. In *Johnson, Munakata, & Gilmore (Eds). Brain Development and Cognition: A Reader, 2nd Edition, 2002,* Chapter 7, pp. 101-116.

Markham JA, Greenough WT. (2004). Experience-driven brain plasticity: beyond the synapse. Neuron Glia Biol. 1(4):351-363.

EMBRYONIC AND FETAL BRAIN DEVELOPMENT/

POSTNATAL SHAPING: ADDITIVE AND SUBTRACTIVE EVENTS

Johnson, Chapter 2: Building a brain. pp. 19-52

Readings:

Huttenlocher, P.R. (1990). Morphometric study of human cerebral cortex. Neuropsychologia. 517-527.

Lenroot, R.H. & Giedd, J.N. (2007) The structural development of the human brain as measured longitudinally with Magnetic Resonance Imaging. I*n Coch, Fischer & Dawson (Eds) Human Behavior, Learning and the Developing Brain, 2007*, Chapter 3, pp. 50-73.

MYELINATION; CEREBRAL LATERALIZATION; PLASTICITY

Readings:

Zhou, X, and Merzenich, M.M. (2007). Intensive training in adults refines A1 representations degraded in an early postnatal critical period. Proc Natl Acad Sci U S A., 104(40):15935-40.

Froemke ,R.C & Jones, B.J. Development of auditory cortical synaptic receptive fields, Neuroscience & Biobehavioral Reviews, Volume 35, Issue 10, November 2011, Pages 2105–2113.

Greenough, W.T., Black, J.E. and Wallace, C.S. (2002). Experience and brain development. Child Development. 58, 539-59. Reprinted in: M. Johnson, Brain development and cognition: A reader. Oxford: Blackwell, pp. 186-216.

COGNITIVE DEVELOPMENT I: THEORIES

Johnson, Chapter 6: Memory and learning, pp. 119-129.

Johnson, Chapter 8: Frontal Cortex, object permanence, and planning, pp. 146-157

Readings:

Diamond, A. (1991). Neuropsychological insights into the meaning of object concept development, In: S. Carey and R. Gelman, The epigenesis of mind: Essays on biology and cognition, (pp. 67-119). New York: Erlbaum Associates

COGNITIVE DEVELOPMENT II: VISUAL PERCEPTION, ATTENTION & MEMORY

Human Behavior, Learning and the Developing Brain, Chapter 6: Webb, S.J. Recognition Memory, pp. 138--182

Readings:

TO BE ANNOUNCED

EARLY LANGUAGE DEVELOPMENT: BRAIN & LANGUAGE

Johnson, Chapter 7: Language, pp. 130-145

and

The Cognitive Neuroscience of Development, Chapter 6: Leonard, C.M. Neural substrate of speech and language development, pp. 127-155

MIDTERM EXAMINATION

SFN Meetings—No CLASS

COGNITIVE DEVELOPMENT III /DEVELOPMENTAL/ DISABILITIES:

AUTISM and SLI

Guest Speaker TBA

Johnson, Chapter 4: Perceiving and acting on the physical world, pp. 78-91

Readings:

TO BE ANNOUNCED

DISORDERS OF DEVELOPMENT/THEORY OF MIND: AUTISM, SPECIFIC

LANGUAGE IMPAIRMENT

Johnson, Chapter 4: Face recognition and social cognition, pp. 98-125.

Readings:

Volkmar FR, State M, Klin A. (2009). Autism and autism spectrum disorders: diagnostic issues for the coming decade. J Child Psychol Psychiatry, 50(1-2):108-15. Review.

ADDITIONAL READINGS TO BE ANNOUNCED

COGNITIVE DEVELOPMENT AFTER EARLY BRAIN INSULT

Readings:

Lenneberg, E (1967). Toward a biological theory of language development. In E., Lenneberg, Biological Foundations of Language, Chapter 9, 371-380:

Stiles, J. and Thal, D (1993). Linguistic and spatial cognitive development following early focal brain injury: Patterns of deficit and recovery. In M. Johnson, Brain development and cognition: A reader. Oxford: Blackwell. Chapter 27, 643-664.

November 18[th]**:** HORMONAL INFLUENCES ON EARLY BRAIN

DEVELOPMENT/NEUROPHYSIOLOGY OF LANGUAGE DISORDERS

Guest Speaker: Dr. Holly Fitch

The Cognitive Neuroscience of Development, Chapter 9: Berenbaum, S. A., Moffat, S., Wisniewski, A. & Resnick, S. Neuroendocrinology: Cognitive effects of sex hormones, pp. 207--235

Readings:

Galaburda, A.M. (1993). Neuroanatomic basis of developmental dyslexia. Neurological Clinics, 11(1), pp, 161-173

Herman A., Galaburda A.M., Fitch R.H., Carter, A.R., & Rosen G.D. (1997). Cerebral microgyria, thalamic cell size, cell number, and auditory temporal processing in male and female rats. Cerebral Cortex, 7, 453-464.

Threlkeld SW, Hill CA, Rosen GD, Fitch RH. (2009). Early acoustic discrimination experience ameliorates auditory processing deficits in male rats with cortical developmental disruption. Int J Dev Neurosci. (4), 321-8.

Thanksgiving Recess

ELECTROPHYSIOLOGICAL INDICATORS OF FUNCTION/

INFANTS AT HIGH RISK FOR DELAYS

Guest Speaker TBA

"EEG/ERPS in the developing infant"

Human Behavior, Learning and the Developing Brain, Chapter 7: Mills, D.L. & Sheehan, E.A. Experience and developmental changes in the organization of language-relevant brain activity, pp. 183—218.

Readings:

TO BE ANNOUNCED

ROLE OF CORTEX IN EMOTION/STRESS DURING

DEVELOPMENT

The Cognitive Neuroscience of Development, Chapter 8: Davis, E.P., Parker S.W., Tottenham, N. & Gunnar, M.R., Emotion, cognition, and the hypothalamic-pituitary-adrenocortical axis: A developmental perspective, pp. 181-206

Readings:

McEwen, B.S. (1995). "Stressful experience, Brain and emotions: Developmental, genetic and hormonal influences", In: M.S. Gazzaniga, (Ed.). The Cognitive Neurosciences, 1st Edition, (pp.1117-1135), Cambridge, MA: The MIT Press.

SUMMARY OF NEURODEVELOPMENTAL COGNITIVE

PROCESSES ---REVIEW

FINAL EXAM

CELLULAR NEUROPHYSIOLOGY
BNS 26 112-532

Instructor: Dr. J.M. Tepper x3151 CMBN Seminar Room

Tuesdays, Thursdays, 2:00-3:30 pm

Learning Goals

This is an advanced course in Cellular Neurophysiology designed for BNS graduate students who have already completed Foundations of Neuroscience. The course aims to teach students how to interpret raw voltage and current clamp data, as well as some anatomy in the form of light and electron micrographs in the form of figures from the literature. The goal is that at the completion of the course students will be able to read the literature and decide for themselves if what the authors claim to have demonstrated has actually been shown to be true.

Students will also learn to create and deliver short slide talks on a neurophysiological topic of their choosing to gain experience with scientific presentation and use of appropriate neurophysiological terminology.

There are no assigned texts for the class. There will be handouts for many of the lectures, and there will be a number of suggested readings from the original literature, listed at the back of this handout. Copies of the readings will be available for downloading from the course web site (http://garcia.rutgers.edu) at least one week ahead of time. Images from the Keynote presentations will be available for download as pdf files a week *after* the lectures.

There will be two exams and a student presentation. Final class grade will be based on the two exams (35% each), the presentation (20%), and class participation (10%).

Syllabus

Week 1 **September 7, 9 2010**

Topics: *Historical Introduction*

No class on Sept. 9th-Rosh Hashannah

Week 2 **September 14, 16, 2010**

Topics: *Overview of Neurophysiological Methods*

Basic Concepts in Electrical Circuitry

Week 3 **September 21, 23, 2010**

Topics: *Ionic Bases of Cellular Potentials*

Dendritic Electrotonus

Week 4 **September 28, 30, 2010**

Topics: *Action Potentials, Hodgkin-Huxley Models*

Week 5 **October 5, 7, 2010**

Topics: *Synaptic Transmission I*

Week 6 **October 12, 16, 2010**

Topics: *Synaptic Transmission II*

Week 7 **October 19, 21, 2010**

Topics: *Review*

Midterm Exam Oct. 21

Week 8 ***October 26, 28, 2010***

Topics: *Synaptic Transmission III*

Week 9 **November 2,4, 2010**

Topics: *Presynaptic Modulation and Neuromodulators*

Optogenetics - Dan English

Student Presentation Topics Due

Week 10 **November 9, 11, 2010**

Topics: *No class on Nov. 9th*

Week 11 **November 16, 18, 2006**

No Class on Nov. 16th - SFN Meeting

Neuronal Integration and Interaction

Week 12 **November 23, 25, 2010**

Topics: *Neurophysiology of Monoamine Neurons*

No class on Nov. 25 - Thanksgiving

Week 13 **November 30, December 2, 2010**

Neurophysiology of Basal Ganglia

Week 14 **December 7, 9, 2010**

Topics: *Student Presentations*

Week 14 **December 14, 16 22010**

Topics: *Review*

Final Exam Dec. 16

READINGS AND SOURCE MATERIAL

Although there are **no assigned texts**, there are a number of good books on the market that you may find informative. Many of the readings are drawn from these texts. The rest come from the original literature. Readings will be available on the course web site.

For an excellent, general, non-quantitative introductory neuroscience/neurophysiology text that covers a broad range of material

1) ***From Neuron to Brain, 5th Ed***., J.G. Nicholls et al. Sinauer Associates Inc., Sunderland, 2011, IBSN# 0-878-93609-2

For more quantitative cellular biophysics:

2) ***Foundations of Cellular Neurophysiology***, D. Johnston and S. Wu, MIT Press, Cambridge, 1995 IBSN# 0-262-10053-3

3) ***Biophysics of Computation***, C. Koch, Oxford University Press, New York, 1999, IBSN#0-19-510491-9

4) **Ion Channels of Excitable Membranes**, 3rd Edition B. Hille, Sinauer Associates Inc., Sunderland, 2001, IBSN# 0-87893-321-2

For the best coverage of systems neurophysiology every written, with each chapter written in the same format by the best experimental neuroscientists in their field. A really amazing book. If you only buy one book on neurophysiology, it should be this one.

5) ***The Synaptic Organization of the Brain***, 5th *Ed*., G. Shepherd, Oxford University Press, New York, 2003, IBSN# 0-195-15956-X

(Strongly suggested readings are marked with an asterisk. Unmarked items are source and reference materials that may be of use to you at some later point, or for more in-depth information.)

Week #1 - Introduction, Methods Overview

1..Kita, S.T. & Park, M.R. (1990) Intracellular Electrophysiological Techniques, in A.A. Boulton, G.B. Baker & C.H. Vanderwolf (Eds.) Neuromethods Vol. 14 Neurophysiological Techniques-Basic Methods and Concepts, Humana Press, Clifton, pp. 1-34.

Week #2 - Basics of Circuit Analysis, Ionic Bases of Cellular Potentials

*1. Nicholls et al. (1992) Appendix A., Chapter 3

*2. Hille (2001), Chapter 1

3. Shepherd (1988) *Neurobiology, 2nd Edition*, Oxford University Press, New York, Chapter 6.

Week #3 - Dendritic Electrotonus, Passive Electrical Properties and Action Potentials

*1. Nicholls et al., (1992), Chapters 4, 5.

*2. Koch,1999, Chapter 6

3. Shepherd (1990), "*The Synaptic Organization of the Brain, 3rd Edition*", Chapter 13 (Appendix).

Week #4 - Voltage-gated Ion Channels

*1. Hille (2001) Chapters 2, 3, 4, 5

2. Song, W.-J. (2002) Genes responsible for native depolarization-activated K+ currents in neurons. *Neuroscience Research 42*:7-14.

3. Rudy, B. and McBain, C.J (2001) Kv3 channels: voltage-gated K+ channels designed for high-frequency repetitive firing *Trend Neurosci. 24*:517-526.

4. Ogata, N., and Ohishi, Y. (2002) Molecular structure and function of the voltage-gated Na+ channels. *Jpn. J. Pharmacol. 88*:365-377.

5. Sah, P., and Faber, E.S.L. (2002) Channels underlying neuronal calcium-activated potassium currents. *Prog. Neurobiol. 66:*345-353.

Week #5 - Synaptic Transmission I

*1. Nicholls et al., (1992), Chapter 7.

*2. Korn et al. (1982) Transmission at a central inhibitory synapse. II. Quantal description of release, with a physical correlate for binomial n. *J. Neurophys. 48*:679-707.

3. Neale et al. (1983) Synaptic interactions between mammalian central neurons in cell culture. III. Morphological correlates of quantal synaptic transmission. *J. Neurophysiol. 49*:1459-1468.

4. Dudek et al., (1983) Recent evidence for and possible significance of gap junctions and electrotonic synapses in the mammalian brain. In: *Basic Mechanisms of the Epilepsies*, A.R. Liss, New York, pp31-73.

5. Gulledge, A.T. and Stuart, G.J. (2003) Excitatory actions of GABA in the cortex. *Neuron 37*:299-309.

6. Auger, C. et al., (1998) Multivesicular release at single functional synaptic sites in cerebellar stellate and basket cells. *J. Neurosci. 18:*4532-4547.

Weeks #6 and #7 - Synaptic Transmission II and III

*1. Nicholls et al., Chapters 8-10.

2. Baxter and Bittner (1981) Intracellular recordings from crustacean motor axons during presynaptic inhibition. *Brain Res. 223*:422-428.

3. Park (1987) Monosynaptic inhibitory postsynaptic potentials from lateral habenula recorded in dorsal raphé neurons. *Brain Res. Bull 19*:581-586.

4. Tepper, J.M. & Groves, P.M. (1990) In vivo electrophysiology of central nervous system terminal autoreceptors. In: S. Kalsner and T.C. Westfall, (Eds.) *Presynaptic Autoreceptors and the Question of the Autoregulation of Neurotransmitter Release*. *Ann. New York Acad. Sci. 604*:470-487.

5. Tsukahara (1981) Synaptic plasticity in the mammalian central nervous system. *Ann. Rev. Neurosci. 4*:351-380.

6. Fanardjian and Gorodnov (1983) Electrophysiological properties of cortical synaptic inputs of rubrospinal neurons. *Neurosci. Lett. 40*:269-283.

*7. Surmeier, D.J., & Kitai, S.T. (1993) D1 and D2 dopamine receptor modulation of sodium and potassium currents in rat neostriatal neurons. *Prog. Brain Res. 99*:309-325.

*8 Iribe et al., (1999) Subthalamic stimulation-induced synaptic responses in nigral dopaminergic neurons *in vitro. J. Neurophysiol. 82:*925-933.

***Week #8* – Presynaptic Modulation and Neuromodulators and Optogenetics**

*1. Thomson, A. (2000) Facilitation, augmentation and potentiation at central synapses. TINS 23:305-312.

*2. Fenno L, Yizhar O, & Deisseroth K. (2011) The development and application of optogenetics**.** Ann. Rev. Neurosci. 34:389-412. doi: 10.1146/annurev-neuro-061010-113817.

3. Boyden ES. (2011) A history of optogenetics: the development of tools for controlling brain circuits with light. F1000 Biol Rep. 3:11. doi: 10.3410/B3-11. Epub 2011 May 3.

Week # 9 - Neuronal Integration, Neurophysiology of Monoamine Neurons

*1. Shepherd (1990), Chapter 13 (Appendix).

*2. Wilson (1988) Cellular mechanisms controlling the strength of synapses. *J. Electron Microscop. Tech., 10*:293-313.

3. Llinas and Jahnsen (1982) Electrophysiology of mammalian thalamic neurons in vitro. *Nature 297*:406-408.

4. Waterhouse et al. (1981a) Alpha-receptor-mediated facilitation of somatosensory cortical neuronal responses to excitatory inputs and iontophoretically applied acetylcholine. *Neuropharmacology 20*:907-920.

5.   Andrade and Aghajanian (1984) Locus coeruleus activity in vitro: regulation by a calcium-dependent potassium conductance but not by α_2 adrenoceptors. *J. Neurosci. 4:*161-170.

6. Diana, M., & Tepper, J.M. (2002) Electrophysiological Pharmacology Of Mesencephalic Dopaminergic Neurons. In: G. Di Chiara (Ed.), *Handbook of Experimental Pharmacology Vol. 154/II*, *Dopamine in the CNS II -* Springer-Verlag, *pp. 1-61.*

Week # 10 - Basal Ganglia

*1 Tepper, J.M., Abercrombie, E.D., and Bolam, J.P. (2007) Basal ganglia macrocircuits, in: Tepper, J.M. et al., *GABA and the Basal Ganglia: From Molecules to Systems, Progress in Brain Research, Vol. 160, Elsevier, pp 3-7*.

*2. Wilson, C.J. Basal Ganglia in Shepherd (2003), Chapter 9.

*3. Gerfen, C.R. (1989) The neostriatal mosaic: Striatal patch-matrix organization is related to cortical lamination. *Science 246*:385-388.

*4. Penney and Young (1983) Speculations on the functional anatomy of basal ganglia disorders. *Ann. Rev. Neurosci. 6*:73-94.

5. Wichman, T. & DeLong, M.R. (1998) Models of basal ganglia function and pathophysiology of movement disorders. Neurosurg. Clin. N. Am. 9:223-236.

CRITICAL THINKING (26:112:651)

Denis Pare

1. Narrative overview of the course

The ability to read and analyze research papers and seminars is critical to the development of a researcher in neuroscience. This course provides training in these skills, with specific focus on recent "breakthrough papers." Each week, students will read and critically assess recent scientific papers or attend a scientific seminar. The papers and seminars will be the object of group discussions. In the case of seminars, the students will also have the opportunity to discuss with the speakers.

2. Objectives of the course

The goals of this to course are (1) to improve the student's analytical and critical thinking abilities and (2) to improve their ability to clearly formulate their arguments in writing. Students will develop skills to rigorously analyze and evaluate scientific data and arguments and to formulate their own arguments.

3. Pre- and co-requisite courses

Foundations in Neuroscience I or equivalent courses.

4. List of learning outcomes and competencies

Through this course, students are expected to improve their ability:
-to evaluate various forms of scientific arguments;
-to evaluate inductive and deductive logic, including familiarity with common fallacies;
-to recognize, and if appropriate, challenge assumptions;
-to draw on other sources to back up arguments;
-to take into account accepted standards of judgment used in Neuroscience;
-to recognize the importance of positive and negative controls in scientific experiments;
-to present their own arguments in a clear, synthetic, and coherent manner.

5. Evaluation criteria

Fifty percent of the grade will be based on student participation to group discussions and the quality of their presentations. Fifty percent of the grade will be based on the quality of the written assignments, as described below.

(1) From January 30 to March 6, for each paper we will discuss, students will write a brief essay (font arial, font size 11, one inch margins, 1-3 double-space pages excluding references). There are two possible formats for these papers: perspective article or review (as in peer-review). These papers are

writing exercises. They should feature your best writing. Write clear and simple sentences. Eliminate superfluous words. Use adverbs sparingly. Avoid science lingo and colloquial English. Assume that your audience has no specific knowledge of the paper's topic, but good general knowledge of Neuroscience. I will provide feedback on the content and form of these papers to each student individually.

(2) In addition, each student will write a brief review in the format of the "Journal club" articles found in the Journal of Neuroscience. The deadline for this paper will be May 1. If appropriate, the best paper(s) will be submitted for publication to the *Journal of Neuroscience*. As explained in the "Instruction to Authors" of the Journal of Neuroscience, "Journal club" articles are short, critical reviews of recent papers that appeared in the Journal of Neuroscience. They are written exclusively by graduate students or post-doctoral fellows. They summarize the important findings of the paper and provide additional insight and commentary. Your paper should conform *exactly* to the format described in the "Instruction to Authors" of the Journal of Neuroscience for "Journal club" articles.

6. Week-by-week list of topics, readings and assignments

January 23, 2013 Brief orientation meeting where students will be assigned specific papers to present from the list below. Note that for the dates in blue, instead of the regular "in classroom" meeting, students will read and discuss papers suggested by colloquium speakers (on Tuesdays at 1:00 PM). The seminar will take place the next day at 11:00 in the seminar room. Right after the seminar, the students will have the opportunity to discuss with the speaker.

January 30, 2013
Logothetis et al. (2012) Hippocampal-cortical interaction during periods of subcortical silence. *Nature* 491:547-553.

February 6, 2013
Dugladze et al. (2012) Segregation of axonal and somatic activity during fast network oscillations.. *Science* 336:1458-1461.

February 13, 2013
Livneh and Paz (2012) Amygdala-prefrontal synchronization underlies resistance to extinction of aversive memories. *Neuron* 75: 133-42.

February 20, 2013 Colloquium: "Heterogeneous Composition of Dopamine Neurons of the Rat A10 Region: Molecular Evidence for Diverse Signaling Properties". Speaker: Marisela Morales.

February 27, 2013
Garner et al. (2012) Generation of a Synthetic Memory Trace. *Science* 335:1513-6.

Liu et al. (2012) Optogenetic stimulation of a hippocampal engram activates fear memory recall. *Nature* 484:381-385

March 6, 2013, 2013

Mesgarani and Chang (2012) Selective cortical representation of attended speaker in multi-talker speech perception. *Nature* 485:233-236.

March 13, 2013 Colloquium: "Mesolimbic Dopamine System Activity Correlated with Cocaine Levels in the Satiety Model of Self-Administration". Speaker: Mark West.

March 20, 2013 No Class ("Spring recess")

March 27, 2013 Colloquium: "EEG in Prematurely Born Infants: Makers of Developmental Processes and Nurture Intervention". Speaker: Michael M. Myers.

April 3, 2013
Lim et al. (2012) Anhedonia requires MC4R-mediated
synaptic adaptations in nucleus accumbens. *Nature* 487:183-189.

April 10, 2013
Churchland et al. (2012) Neural population dynamics during
Reaching. *Nature* 487: 51-56.

April 17, 2013 Colloquium: "Synaptic Autophagy and its Possible Role in Causing Autism". Speaker: David Sulzer.

April 24, 2013
-Hubel (2009) The Way Biomedical Research Is Organized Has Dramatically Changed Over the Past Half-Century: Are the Changes for the Better? *Neuron* 64:161-3.
-Crafting a revision. *Nature Neuroscience* (2011) 14:941
-Nieuwenhius et al. (2011) Erroneous analyses of interactions in neuroscience: a problem of significance. *Nature Neuroscience* 14:1105-7.

May 1, 2013
Huber et al. (2012) Multiple dynamic representations in the Motorcortex during sensorimotor learning. *Nature* 484: 473-8.

May 8, 2013
Students will engage in a constructive critique of each other's "Journal club" papers.

Neurobiology of Emotions (26:54:618)

Denis Paré

1. Narrative overview of the course

This course will review research and concepts on the nature, functions and neural basis of emotions. In turn, evolutionary, psychological and neurological approaches to the study of emotions will be considered. Then, the neural basis of an emotion with a clear evolutionary significance (fear) will be discussed in detail. Here, the structure and function of the amygdala, orbitofrontal and medial prefrontal cortices will be reviewed. In the process, the relationship between emotion and memory will also be discussed. This will lead to a consideration of the role of normal fear learning processes in human anxiety disorders. Finally, evidence that much emotional processing goes on unconsciously will be reviewed.

The course will take the form of twelve 3-hour classes, most including a ≈2-hour lecture by myself and a ≈1-hour presentation of critical papers by students.

2. Objectives of the course

The goal of this to course is (1) to increase knowledge about the neural substrates of emotions, and their adaptive role from an evolutionary perspective, (2) to provide students with current knowledge about the anatomy and physiology of the amygdala as well as its involvement in the learning and expression of fear, (3) to increase knowledge about the role of medial prefrontal and orbitofrontal cortices in the regulation of behavior and emotion, (4) to provide students with knowledge about the mechanisms underlying the facilitation of memory consolidation by emotions.

3. Pre- and co-requisite courses

Foundations in Neuroscience I and II or equivalent courses.

4. List of learning outcomes and competencies

At the end of this course, the students are expected to acquire knowledge about:

-The arguments for and against the view that emotions have an evolutionary origin.

-The history of psychological concepts regarding emotions.

-The history of neurological models of emotions.

-The structure and connections of the amygdala.

-The various cell types present in the amygdala and their physiological properties.
-The evidence implicating the amygdala in Pavlovian fear conditioning.
-The processes regulating the extinction of classically conditioned fear responses.
-The structure, connections and role of the medial prefrontal cortex.
-The structure, connections and role of the orbitofrontal cortex.
-The involvement of normal emotion learning mechanisms in anxiety disorders.
-The evidence indicating that much emotional processing goes on unconsciously.

5. Evaluation criteria

Two take-home exams (25% each) where students will be required to write a short "commentary" paper on a specific aspect of the course. These papers will each be 10 pages or more in length (excluding references and figures), with 1 inch margins, 12 characters per horizontal inch and four lines per vertical inch. These papers are expected to provide a critical review of a particular aspect of the course. Students should consult with me when selecting a topic. Fifty percent of the grade will be based on student participation to group discussions and the quality of their short oral presentations.

6. Week-by-week list of topics, readings and assignments

During the first class, students will chose (or will be assigned) papers or topics to present in the five following classes. Students will also be invited to think about the theme of their first "Commentary". They will have until class 3 to reach a decision, in consultation with me. A similar approach will be used during the second half of the course (i.e. assignment of papers during class 7 and choice of theme for second commentary by class 9). The deadlines for the first and second paper are March 11 and April 29, respectively.

Below is a week-by-week list of compulsory readings and student presentations.

Class 1: Defining and studying emotions. Evolutionary perspectives on emotions.

Student presentations:

Facial expression of emotions: are they universal?

Basic emotions

Compulsory readings:

Damasio, A. R. (2000) A second chance for emotion. In Cognitive neuroscience of emotion, eds. R. D. Lane and L. Nadel. 12-23. New York: Oxford University Press.

Damasio, A. (2001) Fundamental feelings. Nature 413: 781.

Class 2: Neural substrates of emotions: historical overview.

Student presentations**:**

James, W. (1884) What is an emotion. Mind 9: 188-205.

Cannon, W. B. (1927) The James-Lange theory of emotions: a critical examination and an alternative theory. Am J Physiol 39: 106-124.

Bard, P. (1928) A diencephalic mechanism for the expression of rage with special reference to the sympathetic nervous system. Am J Physiol 84: 490-515.

Compulsory readings:

James, W. (1884) What is an emotion? Mind 9: 188-205.

Cannon, W. B. (1927) The James-Lange theory of emotions: a critical examination and an alternative theory. Am J Physiol 39: 106-124.

Bard, P. (1928) A diencephalic mechanism for the expression of rage with special reference to the sympathetic nervous system. Am J Physiol 84: 490-515.

Class 3: Psychological perspectives on emotions.

Student presentations**:**

Are different emotions correlated to distinct patterns of autonomic activation?

What are the effects of deafferentation on emotional experience?

Schachter, S., J. E. Singer. (1962) Cognitive, social and physiological determinants of emotional state. Psychological Review 69: 379-399.

Compulsory readings:

Lazarus, R. S.,McCleary, R. A. (1951) Autonomic discrimination without awareness: a study of subception. Psychol Rev 58: 113-122.

Schachter, S., Singer, J. E. (1962) Cognitive, social and physiological determinants of emotional state. Psychological Review 69: 379-399.

Bruner, J. (1992) Another look at New Look 1. American Psychologist 47: 780-783.

Greenwald, A. G. (1992) Unconscious cognition reclaimed. American Psychologist 47: 766-779.

Kihlstrom, J. F., Barnhardt, T. M., Tataryn, D. J. (1992) The psychological unconscious: found, lost and regained. American Psychologist 47: 788-791.

Lazarus, R. S. (1991) Cognition and motivation in emotion. American Psychologist 46: 352-367.

Zajonc, R. B. (1980) Feeling and thinking: preferences need no inferences. American Psychologist 35: 151-175.

Class 4: Amygdala: phylogenesis, nuclei (connections, cell types, transmitters).

Compulsory readings:

Aggleton, J. P. (2000) Chapter 1 of The amygdala: a functional analysis. Second ed., 1-30, Oxford: Oxford University Press.

Paré, D., Royer, S., Smith, Y., Lang, E.J. (2002) Contextual inhibitory gating of impulse traffic in the intra-amygdaloid network.

Class 5: Conflicting views on the role of the amygdala in learning.

Student presentations:

Packard, M. G., Cahill, L., McGaugh, J. L. (1994) Amygdala modulation of hippocampal dependent and caudate nucleus-dependent memory processes. Proc Natl Acad Sci USA 91: 8477-81.

A critical discussion of the concept of "extended amygdala" based on the following paper:
Alheid, G. F., Heimer, L. (1988) New perspectives in basal forebrain organization of special relevance for neuropsychiatric disorders: the sriatopallidal, amygdaloid, and corticopetal components of substantia innominata. Neuroscience 27: 1-39.

Compulsory readings:

McGaugh, J. L. (2002) Memory consolidation and the amygdala: a systems perspective. TINS 25:456-461.

Cahill, L., Weinberger, N. M., Roozendaal, B. McGaugh, J. L. (1999) Is the amygdala a locus of 'conditioned fear'? Some questions and caveats. Neuron 23: 227-228.

Packard, M. G., Cahill, L., McGaugh, J. L. (1994) Amygdala modulation of hippocampal-dependent and caudate nucleus-dependent memory processes. Proc Natl Acad Sci USA, 91: 8477-81.

Class 6: Role of the amygdala in the acquisition of conditioned fear responses.

Student presentations:

Nader K., Schafe, G. E., LeDoux, J. E. (2000) Fear memories require protein synthesis in the amygdala for reconsolidation after retrieval. Nature 406: 722-26.

Debiec, J., LeDoux, J. E., Nader, K. (2002) Cellular and systems reconsolidation in the hippocampus. Neuron 36: 527-538.

Compulsory readings:

Blair, H. T., Schafe, G. E. Bauer, E. P., Rodrigues, S. M., LeDoux, J. E. (2001) Synaptic plasticity in the lateral amygdala: a cellular hypothesis of fear conditioning. Learning and memory 8: 229-242.

Nader K., Schafe, G. E., LeDoux, J. E. (2000) Fear memories require protein synthesis in the amygdala for reconsolidation after retrieval. Nature 406: 722-26.

Debiec, J., LeDoux, J. E., Nader, K. (2002) Cellular and systems reconsolidation in the hippocampus. Neuron 36: 527-538.

Class 7: Extinction of conditioned fear: role of the medial prefrontal cortex.

Student presentations:

Quirk, G. J., Russo, G. K., Barron, J. L., Lebron, K. (2000) The role of ventromedial prefrontal cortex in the recovery of extinguished fear. J Neurosci 20: 6225-6231.

Milad, M. R., Quirk, G. J. (2002) Neurons in medial prefrontal cortex signal memory for fear extinction. Nature 420:70-74.

Compulsory readings:

Pavlov, I. P. (1927) Conditioned reflexes: an investigation of the physiological activity of the cerebral cortex. Classics in the history of psychology.

Milad, M.R., Quirk, G. J. (2002) Neurons in medial prefrontal cortex signal memory for fear extinction. Nature 420:70-74.

Berman, D. E., Dudai, Y. (2001) Memory extinction, learning anew, and learning the new: dissociations in the molecular machinery of learning in cortex. Science 291: 2417-2419.

Quirk, G. J., Russo, G. K., Barron, J. L., Lebron, K. (2000) The role of ventromedial prefrontal cortex in the recovery of extinguished fear. J Neurosci 20: 6225-6231.

Royer, S., Paré, D. (2002) Bidirectional synaptic plasticity in intercalated amygdala neurons and the extinction of conditioned fear responses. Neuroscience 115: 455-462.

Herry, C., Garcia, R. (2002) Prefrontal cortex long-term potentiation, but not long-term depression, is associated with the maintenance of extinction of learned fear in mice. J Neurosci 22: 577-583.

Walker, D. L., Davis, M. (2002) The role of amygdala glutamate receptors in fear learning, fear-potentiated startle, and extinction. Pharmacol Biochem Behav 71: 379-392.

Class 8: The prefrontal cortex, the amygdala and the reward system.

Student presentations:

Wise, R. A. (2002) Brain reward circuitry: insights from unsensed incentives. Neuron 36: 229-240.

Schultz, W. (2002) Getting formal with dopamine and reward. Neuron 36: 241-263.

Compulsory readings:

Schoenbaum, G., Setlow, B. (2001) Integrating orbitofrontal cortex into prefrontal theory: common processing themes across species and subdivisions. Learning and memory 8: 134-147.

Baxter, M. G. and Murray, E. A. (2002) The amygdala and reward. Nature Reviews Neuroscience 3: 563573.

Class 9: To be determined by the students

Class 10: Involvement of normal fear learning processes in human anxiety disorders.

Student presentations:

Jacobs, W. J., Nadel, L. (1985) Stress-induced recovery of fears and phobias. Psychol Rev 92: 512-31.

Davis, M., Whalen, P. J. (2001) The amygdala: vigilance and emotion. Molecular Psychiatry 6: 13-34.

Compulsory readings:

Klein, D. F. (1993) False suffocative alarms, spontaneous panics, and related conditions: An integrative hypothesis. Archives of General Psychiatry 50: 306-317.

Mowrer, O. H. (1939) A stimulus-response analysis of anxiety and its role as a reinforcing agent. Psychological Review 46: 553-565.

Öhman, A. (1992) Fear and anxiety as emotional phenomena: Clinical, phenomenological, evolutionary perspectives and information-processing mechanisms. In Handbook of the emotions, eds. M. Lewis and J. M. Haviland. 511-536. New York: Guilford.

Shalev, A. Y., Rogel-Fuchs, Y., Pitman, R. K. (1992) Conditioned fear and psychological trauma. Biological Psychiatry 31: 863-865.

Wolpe, J. (1988) Panic disorder: A product of classical conditioning. Behavior Research and Therapy 26: 441-50.

Class 11: The human amygdala and episodic memory.

Student presentations:

Anderson, A. K., Phelps, E. A. (2001). Lesions of the human amygdala impair enhanced perception of emotionally salient events. Nature 411: 305-309.

Phelps, E. A., O'Connor, K. J., Gatenby, J. C., Grillon, C., Gore, J. C., Davis, M. (2001). Activation of the left amygdala to a cognitive representation of fear. Nature Neuroscience, 4, 437-441.

Compulsory readings:

Funayama, E. S., Grillon, C. G., Davis, M., Phelps, E. A. (2001). A double dissociation in the affective modulation of startle in humans: Effects of unilateral temporal lobectomy. Journal of Cognitive Neuroscience, 13, 721-729.

Whalen, P. J. (1998). Fear, vigilance, and ambiguity: Initial neuroimaging studies of the human amygdala. Current Directions in Psychological Science, 7, 177-188.

Class 12: Mechanisms of conscious and unconscious emotional processing.

Student presentations:

Bechara, A., Tranel, D., Damasio, H., Adolphs, R., Rockland, C., Damasio, A. R. (1995). Double dissociation of conditioning and declarative knowledge relative to the amygdala and hippocampus in humans. Science 269: 1115-8.

Buchel, C., Morris, J., Dolan, R.J., Friston, K. J. (1998). Brain systems mediating aversive conditioning: An event-related fMRI study. Neuron 20: 947-57.

Compulsory readings:

Vuilleumier, P., Armony, J. L., Driver, J., Dolan, R. J. (2001). Effects of attention and emotion on face processing in the human brain: An event-related fMRI study. Neuron 30: 829-41.

Learning and Memory: From Brain to Behavior (26:112:632)

Spring 2013. Wednesdays. 3:30-5:30pm
Location: Aidekman Seminar Room (Rear Seminar Area)

Goal: Provide a comprehensive and accessible introduction to the interdisciplinary field of learning and memory that encompasses and integrates behavioral processes, brain systems, and clinical perspectives, incorporating findings from both animal and human research. There are no specific prerequisites and students are welcome to attend from psychology, biology, neuroscience, nursing, or biomedical departments.

Instructor: **Mark A. Gluck** (gluck@pavlov.rutgers.edu)
TA: Mohammad Herzallah (mohammad.m.herzallah@gmail.com)

Audience: Graduate students from all departments or advanced undergraduate honors students who are working on honors thesis in the behavioral or brain sciences

Textbook: Gluck, Mercado, & Myers (2013). *Learning and Memory: From Brain to Behavior, 2nd Edition*. Worth Publishers.
http://www.worthpublishers.com/Catalog/product/learningandmemory-secondedition-gluck

Format: Most Wednesday classes will begin with a lecture by on the foundations of learning and memory, covering and expanding on material in the corresponding chapter of the textbook (with additional examples, videos, elaborations). This will run from 3:30pm to 4:30pm. Following a 15 minute break, we will reconvene from 4:45 – 5:30pm for a seminar by a graduate student, postdoctoral fellow, or visiting guest lecturer who will speak on current research topics in that area of learning and memory.

SCHEDULE & SYLLABUS

INTRODUCTION MODULE

JANUARY 23: Introductory Course Meeting

Course Introduction and Overview (Gluck)

JANUARY 30: The Neuroscience of Learning and Memory

Optional (for non-BNS): The Neuroscience of Learning and Memory **(Herzallah)**
Reading: Chapter 2. *The Neuroscience of Learning and Memory*

ONLINE: http://www.youtube.com/watch?v=AnytDv-vvNA&feature=youtube_gdata

FEBRUARY 6: The Psychology of Learning and Memory: A Historical Introduction

Lecture Overview: Gluck
Reading: Chapter 1. *The Psychology of Learning and Memory*

LEARNING MODULE

FEBRUARY 13: Non-Associative Learning

Lecture Overview: Gluck

Reading: Chapter 3. *Habituation, Sensitization, and Familiarization: Learning about Repeated Events*

FEBRUARY 20: Classical Conditioning

Lecture Overview: Gluck
Research Topics: Sue Peters. Papers TBA.

Reading: Chapter 4. *Classical Conditioning: Learning to Predict Important Events*

FEBRUARY 27: Operant Conditioning

Lecture Overview: Gluck
Research Topics (3:30pm):
Elizabeth Tricomi (RU-Newark, Psychology),
"Striatal influences on learning and motivation."

Reading: Chapter 5. *Operant Conditioning: Learning the Outcome of Behaviors*

MARCH 6: Generalization and Discrimination Learning

Lecture Overview: Gluck
Research Topics: Gluck. Papers TBA.

Reading: Chapter 6. *Generalization and Discrimination Learning*

MARCH 13: Midterm

MARCH 20: < No Class: Spring Break>

MEMORY MODULE

MARCH 27: Semantic and Episodic Memory

Lecture Overview: Gluck
Research Topics: Itamar Learner, “Sleep and Memory: Episodic Memory”

Reading: Chapter 7. *Semantic and Episodic Memory: Memory for Facts and Events*

APRIL 3: Skill Memory

Lecture Overview: Gluck
Research Topics: @

Reading: Chapter 8. *Skill Memory: Learning by Doing*

APRIL 10: Working Memory and Executive Control

Lecture Overview: Gluck
Research Topics: ?

Reading: Chapter 9. *Working Memory and Cognitive Control*

APRIL 17: <No class; CNS Conference> / Guest Lecture?

INTEGRATIVE TOPICS MODULE

APRIL 24: Emotion and Memory

Lecture Overview: Gluck
Research Topics: Mohammad Herzallah, "Clinical Depression and Memory"

Reading: Chapter 10. *Emotional Influences on Learning and Memory*

MAY 1: Learning and Memory Across the Lifespan

Lecture Overview: Gluck
Research Topics: Jessie Simon, "Striatal Function, Dopamine and Aging"

Reading: Chapter 12. *Development and Aging: Learning and Memory across the Lifespan*

MAY 15: Final Exam

HUMAN NEUROANATOMY (26:546:629)

Instructor: Laszlo Zaborszky, MD,PhD

(zaborszky@axon.rutgers.edu. T:973-353-3659)

Semester: Fall 2012

Credit: 3 units

Course Description

The human brain is covered in detail. The course format is a combination of lectures and laboratory sessions and consist of three major parts. **Part 1** will include the development of the nervous system, brain dissection, neuroanatomical techniques, CNS vasculature, including cerebrovascular diseases **Part 2** discusses the functional anatomy of the basal ganglia, cerebellum and thalamus and the organization of major ascending (sensory) and descending (motor) pathways. **Part 3** will overview the functional anatomical basis of cognitive functions, including memory, emotion, motivation and attention. An important goal of this course is to familiarize the students with functionally relevant anatomical features, to study the principles of organization of the brain and get an insight how 'structural' and 'functional' connectivity relate to each other. Readings draw from classical papers in the field and short papers, discussing human imaging studies. There will be three guest lecturers from MIT, Boston University and UMDNJ, who are experts in primate anatomy and human imaging.

Enrollment

No more than 10 students. The course is open to graduate students, provided that they have already taken Foundations of Neuroscience (26:112:565). Undergraduates can enroll by permission of the instructor. Prior courses for Undergraduates: Anatomy & Physiology (21:120:241), Mammalian Physiology (21:120:340) or Comp Vert Anatomy (21:120:320) or similar courses are required.

Requirements

Course grade will be based 1) a paper on a specified topic relevant to the course; 2) one short presentation; 3) written exams (2 midterm, 1 final) consisting of multiple choice questions and short essays; 4) final oral and practical exam.

Learning Objectives:

I. BASIC DESIGN OF THE NERVOUS SYSTEM

1. Gross anatomical features of the brain. Orientation on frontal, horizontal and sagittal sections of the brain,

a)major arteries, circle of Willis

b)major fiber systems (fornix, corpus callosum, anterior, posterior commissure)

c)major division of the cerebral cortex, frontal, temporal, parietal, occipital, limbic lobes, insula, special functional areas, major gyri and sulci

d)components of the basal ganglia; internal capsule,

2)Describe the sequence of events leading to the formation of a C shaped cerebrum from a linear neural tube

3)Primary and secondary embryonic vesicles, their derivatives

4)Describe the origin of neural crest cells and the fate of these cells

5)Rhombomeres and prosomers

6)What forebrain structures develop from the subpallium?

7)Origin, migration and specification of cortical neurons

8)Ischemic, hemorraghic stroke, CVA, TIA; amnesias with aneurysms of the ACA

9)Major arterial supply of the neocortical mantle by the aa. cerebri ant, media and posterior

9)Blood supply of the basal ganglia

10)Basic design of the blood supply of the brainstem

11)Ventricular system, mechanism of production of CSF

12)Meningeal coverings of the brain and spinal cord

II. FUNCTIONAL ANATOMY OF THE SOMATOSENSORY, MOTOR SYSTEMS, BASAL GANGLIA and CEREBELLUM

1)Muscle spindle, Golgi tendon organ, stretch (myotatic, proprioceptive) reflex in the spinal cord and brainstem 2)Mechanism of gamma loop, reciprocal inhibition

3)Flexion-crossed extensor (withdrawal) reflex

4)Referred pain (Fig. 8-9; SC; 38SC)

5)Diagram of the major pathways by which information from the body about pain and temperature reaches consciousness

6)Diagram of the major pathways by which information from the body about touch, vibration and limb position reaches consciousness

7)Medial and lateral descending motor pathways

8)Upper and lower motor neuron lesion of the facial nerve

9)Cortical regions participating in motor coordination

10)Emotional motor system

11)Apraxia

12)Ventral striatum, dorsal striatum, ventral pallidum, dorsal pallidum

13)Synaptology of the basal ganglia

14)Parallel channels in the basal ganglia circuitry

15)Operational features of the basal ganglia (convergence-divergence)

16)Action of dopamine in the striatum.

17)Parkinson's disease

18)Huntington's disease

19)Drug addiction and putative circuits

20)Diagram of the microcircuits in the cerebellar cortex

21)Sagittal organization of the cerebellar cortex

22)Function, connection of the 'spinocerebellum'

23)Function-connection of the cerebrocerebellum

24)Function-connection of the vestibulocerebellum

25)Explain the cerebellar syndromes

III. COGNITIVE NEUROANATOMY

1)The three macro system of the basal forebrain (ventral striato-palldial system; ‘extended amygdala’; corticopetal system)

2)The Limbic System concept (Basal Forebrain Organization text and Hipp lecture)

3)Functional association of the ‘nucleus basalis’

4)Majori inputs to cholinergic neurons of the basal forebrain

5)The issue of degeneration of cholinergic neurons in Alzheimer’s disease and Mild Cognitive deficits

6)NGF, TrkA, p75 receptor, transport deficit, Beta amyloid and cholinergic BF neurons

7)Cholinergic, GABAergic and peptidergic neurons in the basal forebrain

8)The role of basal forebrain neurons in cortical activation

6)Pathways for emotions through the prefrontal cortex, amygdala and thalamus (Barbas)

10Parcellation of the cerebral cortex into cytoarchitectonical areas (Broadmann)

13) The default/resting state network (Biswal)

14) Multimodal atlasing the human brain (Zilles article, Reza, Dana’s presentations)

15)Cortical afferents

16)Main cortical neuronal types (pyramidal, spiny stellate, various inhibitory neurons: basket, axo-axonic) and their transmitter (cortex precoll and hippocampus lecture)

17)Cortical columns (cortex precoll lect+Rockland)

18)Dorsolateral prefrontal cortex

19)Orbitofrontal cortex

20)Cingulate cortex

21)Hippocampus, main intrinsic circuitry

22)Hippocampal input-output relations

23)Hippocampal-entorhinal cortex and Alzheimer's disease

24)Septum

25)Amnesias with hippocampal lesions

26) Broca's area and language functions (Grodzinskys lecture)

Schedule

BASIC DESIGN OF THE NERVOUS SYSTEM

Sept 5 The Neuron Doctrine. Neuroanatomical Methods. Brain Organization. Development

Sept11 Dissection of the Human Brain; Surface features, Gyri, Sulci, Lobes, Major Functional Areas

Sept18 Ventricular System, Hippocampus, Thalamus, Basal Ganglia, Brainstem, Cerebellum, (DVD+Lab)

Sept26 Blood Supply, Meninges, CSF, Cerebrovascular Diseases

FUNCTIONAL ANATOMY OF THE SOMATOSENSORY, MOTOR SYSTEMS, BASAL GANGLIA, and CEREBELLUM

Sept 26 Organization of the Ascending (sensory) Pathways

Oct2 The Motor System and Descending pathways

Oct10 The Basal Gganglia)

Oct23 The Cerebellum

COGNITIVE NEUROANATOMY

Nov 6 Cortex introduction

Nov7 Feedback connections and implications for cortical functions Prof. Rockland (MTI)

Nov14 Resting state functional connectivity Prof. Biswal (UMDNJ)

Nov20 The prefrontal cortex. Executive Functions

Nov27 Attention for emotion through the amygdala, prefrontal cortex and thalamus

Nov 28 Basal forebrain

Dec5 Representation of language in the human brain: a multimodal approach. Prof. Grodzinsky/ McGill

Dec12 Hippocampus, memory systems, amnesias with hippocampal lesions

Paper due: December 17

EXAM: Dec 20 9-11AM

SUGGESTED READING:

Nolte: The Human Brain. An Introduction to its Functional Anatomy, Mosby, 6^{th} ed, 2009; ISBN: 978-0-323-04131-7

Further special reading: The Human Nervous System. Mai, Paxinos (ed), 3rd edition, Academic press, 2012

http://zlab.rutgers.edu/modules/teaching/

Functional NEUROANATOMY
J.I. Morrell
An introduction to the vertebrate nervous system – rat brain for the future neuroscientist
Course 26 112 501
Class times: Twice a week 3-5 pm

Learning Goals and Objectives
Graduate students who will become neuroscientists using basic laboratory rodent models for their work will attain a practioners level of knowledge with the rat brain, including all key systems and connections.
Proficency in funtional neuroanatomy of mammals is the objective such that systems are understood in detail in rodent brain, but the level of understanding generalizes to all mammals.

SESSION TOPIC
1. Introduction to course; discussion of required reading, student presentations
Techniques used in neuroanatomical research.
Basic divisions of the nervous system as visible in stained sections.
What a neuron, nucleus, tract, decussation, etc, LOOKS LIKE!
Spinal cord structure.
Assignment of gross dissection of sheep brain – everyone to do a basic dissection on their own and then will also prepare a dissection illustration for a subsequent next class; dissection guides will be provided.
2. Gross dissection of the sheep brain
Nervous system divisions as visible on gross specimen, and some sections.
Basics of meninges, vascularization of brain, ventricles, CSF
Rat brain and spinal cord optional project
3.Ascending "somatosensory"systems - Focus is on systems that have a sentient endpoint, but lecture includes some systems that do not.
posterior column system
spinothalamic tracts (neospinothalamics/ paleospinothalamics)
spinoreticular
spinocervical thalamic
trigeminal
4. Slide viewing to orient you to the slide collection and its purpose, both rat and human and specifically on the topics of the previous session. Detailed orientation to an atlas.
5. Descending "motor" systems
corticospinal, corticobulbar,rubrospinal, reticulospinal, vestibulospinal, tectospinal/interstitiospinal
6. Finish prior Lecture and maybe start slide viewing on next two topics
At some point when new dissection materials come we will decide on a mutually convenient way to work them into a class time.
7. Slide viewing on the descending plus some slides of next two topics
8. Cerebellum with some slide viewing
9. Basal ganglia with some slide viewing

10. MIDTERM EXAM – *you take this in my lab area at a private computer so you may take it any time of the day you choose and work on it as long or short as you chose*
11. Cranial Nerves II - the visual system
Slides
12. Cranial Nerves 3,4,6,12
Slides
13. Cranial Nerves 5,7,9,10,11.
Slides
14. Vestibular System with slides
15. Auditory System with slides
16. Limbic system orientation and amygdala with slides
17. Olfactory and vomeronasal systems with slides
18. Hippocampus with slides
19. Hypothalamus
20. Short Introduction to the Parasympathetic and Sympathetic Systems
Slides on prior sessions
21. Thalamus & slides
22. 4/27/12 Cerebral cortex & slides
23. FINAL EXAM
24. student presentations

Additional Information:

The vast majority of the class slide material will be from rat.
Gross and slide material will be available for study outside of class.
A large collection of both rat and human slide material is available for study.
Exams will be written and will consist of short answer, essay, slide and gross specimen identification. The final will cover all material.
For identification of written exams students will use a code number.
Please make a point of not showing me any samples of your handwriting at any time other than on the exams.
Students will be evaluated partly on their willingness to actively participate in slide viewing sessions

Student Presentations/ Projects

1. Each student will be required to make a presentation to the class. This should be a graduate level presentation designed to take 20-30 minutes. The general topic is some aspect of current work on one of the systems that I have presented in class, with strong emphasis on the current literature. It should synthesize a handful of papers, not just one. The idea would be to combine papers focused on tools to uncover the connections of the system, this would include neuroanatomical, cell biological , neurochemistry or any tool measuring the of function of the system.
Students are advised to choose a topic that is different from their current laboratory work or area of best expertise. Idea is to grow some dendrites!
It should be something that interests you, and I would be happy to chat about it more specifically if you come up with a few areas of interest to you.
Please select a topic and provide this information to me in email for my approval.
2. Students will also be required to do a series of anatomical drawings of a particular subdivision/set of structures of the brain which are DIFFERENT from their presentation area. This will be a complete series, in three planes.

INTRODUCTION TO NEUROCHEMISTRY/PHARMACOLOGY (26:112:589)

Instructor: Professor Elizabeth Abercrombie

Due to the format of this course, enrollment is limited to 15 students.

Learning Outcomes

On successful completion of this course students will be able to:

1.-give a detailed description of chemical transmission within the central nervous system;

2.-understand experimental approaches to the study of neuropharmacology;

3.-demonstrate knowledge of the biology of major classes of neurotransmitters;

4.-describe the mechanism of action of specified neuropharmacological drugs;

5.-demonstrate understanding of key CNS disorders and their treatments;

6.-critically evaluate neuropharmacological data.

Course Content

A survey of how drugs affect the nervous system. We will begin with a general introduction to pharmacological principles and the chemical basis of signaling in the nervous system. We will follow with an evaluation of major neurotransmitter systems and drug classifications. We will emphasize the biological and clinical dimensions of drug actions including contemporary drug treatment strategies for a range of pathological and neurological disorders. General topics will include:

1.-Principles of pharmacokinetics and dynamics

2.-Brain chemistry/chemical signaling

3.-Methods of research in neuropharmacology

4.-Major neurotransmitter systems

5.-Mechanisms of action for common psychoactive drugs

6.-Drug treatments in neurological and psychiatric disorders

Important

This course is designed, in part, to educate students about a number of psychiatric and neurological diseases and treatments. However, the instructor of this course is not a medical professional. The information contained in this course, while believed to be correct and current, should not be regarded as medical advice, and should not be used for diagnosis or treatment.

Bibliography

Nestler, E, Hyman, S and Malenka R (2009) Molecular Pharmacology: A Foundation for Clinical Neuroscience, 2nd Ed. McGraw-Hill

Meyer, JS and Quenzer LF (2004) Psychopharmacology: Drugs, the Brain and Behavior. Sinauer Assoc.

Prerequisites for this course are Foundations in Neuroscience I & II (26:546:565, 566) or the equivalent. General chemistry will be helpful but is not a requirement.

Syllabus

Lecture/exam schedule and topics (see next page)

Note: Course assessment consists of several exams (multiple choice and short essay answers), a number of small assignments designed to assess your understanding with rapid feedback, and a written and oral report on selected topics derived from the primary literature in peer-reviewed journals such as Journal of Neuroscience, Neuroscience, Neuropsychopharmacology, Journal of Neurochemistry, Biological Psychiatry, Journal of Pharmacology and Experimental Therapeutics etc..

Written report due on December 22

9/3	**Welcome to the Course!** No class meeting.
9/10	**Introduction to Pharmacokinetics & Pharmacodynamics**
9/17	**Synaptic Transmission and Signaling Mechanisms**
9/24	**Neuropharmacology & Neuropsychopharmacology**
10/1	**EXAM 1**
10/8	**CNS Neurotransmitters I - Biogenic Amines**
10/23*	**CNS Neurotransmitters II - Amino Acids**
10/29	**CNS Neurotransmitters III - Neuropeptides**
11/5	**EXAM 2**
11/12	**Cognitive Function & Psychomotor Stimulants**
11/18	**SPECIAL LECTURE:** "Neural Mechanisms for Decision Making", Dr. Paul Glimch 12:00, CMBN Seminar Room.
11/19	**Cognitive Function & Antipsychotic Drugs**
11/26	No class meeting -Thanksgiving Recess.
12/3	**Mood & Emotion: Anxiolytic and Antidepressant Drugs**
12/10	**EXAM 3**
12/14	(1:00 - 2:30 p.m.)

Foundations of Neuroscience I & II
(Fall 26:546:565, Spring 26:546:566)

Course Director: Ian Creese

Office Hours: By Appointment

T: 973 353 3608
Office: Aidekman 312.
E: creese@axon.rutgers.edu

Course Instructors: Team taught by BNS Faculty

Narrative/Catalogue Description: This course is designed to be a foundational overview of the many fields of neuroscience.

Course Objectives: To learn about the many different fields of neuroscience from the molecular/cellular to the behavioral/cognitive and their research methodologies.

Pre-requisites: Although a basic undergraduate background in biology or chemistry will be helpful, they are not pre-requisites for the course. Students with undergraduate majors in Psychology or Computer Sciences for example should be able to successfully understand the material presented. Students typically take both semesters in sequence. Special permission is required to take just Foundations II.

Learning outcomes

An understanding of the structure, function and development of the mammalian nervous system and its components and the various techniques used in current research.

Textbook: *Neuroscience*, 4th Edition, D. Purves et al., Sinauer Associates,

Principles of Cognitive Neuroscience, Purves et al.. 4th Edition. Sinauer Associates

Evaluation Criteria: Two exams will be given each semester, in the middle and the end of the course. Each exam will refer only to the lectures preceding it and not to the whole semester.

CLASS MEETS AT 10AM-12.30PM AIDEKMAN SEMINAR ROOM ON TUESDAYS AND THURSDAYS

Enrollment Cap : 12
Credits: 4 and 4

Fall 26:546:565

Lecture Topic		*Assigned Reading*	*Lecturer*
1. History of Neuroscience/Intro to Neurocytology		Notes	JM Tepper
2.	Cells of the Nervous System	Chap 1	L Zaborszky
3.	Organization of the Nervous system I	Appendix	J Morrell
4.	Organization of the Nervous system II	Appendix	J Morrell
5.	Development I	Chap 22-25	T Tran
6.	Development II	Chap 22-25	T Tran
7.	Resting Membrane potentials	Chap 2	D Pare
8	Voltage Dependent Membrane Permeability	Chap 3	J Tepper
9.	Action Potentials I	Chap 3	F Nadim
10.	Action Potentials II	Chap 4	F Nadim
11.	Ligand gated channels and transporters	Chap 4	JM Tepper
12.	Molecular approaches	Notes	T Koos
13.	**REVIEW SESSION**		
14.	**MIDTERM EXAM**		
15.	Synaptic Transmission I	Chap 5,	D Paré
16.	Synaptic Transmission II	Chap 5,8	D Paré
17.	Transmitters and Modulators	Chap 6	E Abercrombie
18.	Neuropharmacology Society for Neuroscience	Chap 6	E Abercrombie
19.	Intracellular signaling I	Chapter 7	E Abercrombie
20.	Intracellular signaling II	Chapter 7	E Abercrombie
21.	Thalamocortical System	Notes	D Paré
23	Hypothalamus and Autonomic Function	Chap 21	B Levin
	THANKSGIVING BREAK		
24.	Sleep and Wakefulness	Chap 28	L Zaborszky

25. Monoamine Systems Notes JM Tepper

26. Basal Ganglia Notes JM Tepper

27. **REVIEW SESSION**

28. FINAL EXAM

Spring 26:546:566

	Lecture Topic	*Lecturer*
1/19	Brain Imaging Methods I	Krekelberg
1/24	Visual Perception I	Heider
1/26	Visual Perception II	Krekelberg
1/31	Brain Imaging Methods II	Hanson
2/2	Auditory System	Fitch
2/7	Cognitive Development I	Benasich
2/9	Cognitive Development II	Benasich
2/14	Amygdala & Emotion	Pare
2/16	Working Memory and Executive Function I	Tricomi
2/21	Working Memory and Executive Function II	Moustafa
2/23	Learning and Memory I	Gluck
2/28	Learning and Memory II	Gluck
3/1	**REVIEW SESSION FOR MIDTERM**	
3/8	Midterm Exam	
3/13	Molecular genetic tools I	Koos
3/15	Molecular genetic tools 2	Koos
3/20	Speech and Language	Tallal
3/22	Social Cognition & Decision Making	Delgado
3/27	Reproductive Hormones and Behavior	Morrell

3/29	Cognitive Neuroscience of Reading	Graves
4/3	No Class: Cognitive Neuroscience Society in Chicago	
4/5	Clinical Perspectives: Reward and Addiction	Morrell
4/10	Motivation and Incentive Learning	Shiflit
4/12	Clinical Perspectives: Depression	Herzallah
4/17	Clinical Perspectives: Autism and Other Developmental Disorders	Heim
4/19	Aging & Dementia	Zaborszky
4/24	Clinical Neuroscience	Graves
4/26	**REVIEW SESSION FOR FINAL!!**	
5/3	**Final Exam**	