Introduction to Neuroscience - Syllabus

Class description: Your brain is a bizarre device, formed through natural selection of your ancestors and shaped by your own experience. The goal of this class is to paint the 'big picture' of your brain's organization: from molecules to neurons to the neurological control of novel conscious experiences. We will discuss what makes human language special and how it evolved. The class is intended for a wide audience of individuals interested in neuroscience, psychology, linguistics, as well as for philosophy majors who are fascinated by the neurological basis of behavior.

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Class meets: Tue/Wed/Thur Lect: CAS 428 2:30pm-5:00pm; Tue/Thur; Disc: CAS B06B 1-2pm
Class website: http://stethographics.com/a2/
Textbooks: Brain & Behavior: An Introduction to Biological Psychology by Bob L. Garrett

Office hours: 1 hour after the lecture / Q&A session before each exam

Grading:

Exam I (1-hour)	27%
Exam II (1-hour)	28%
Final Exam	30%
Homework (available on the website; write the answers, make a photograph of your answers and email it before the class to imagirationmailer@gmail.com)	5%
Participation in discussion sessions (TA: conduct a quiz that consist of three simple comprehension question based on the discussed article)	10%
Extra credit: Research paper or presentation	10%

Absolute Scale:
92-100 = A
86-91 = A-
82-85 = B+
76-81 = B
71-75 = B-
67-70 = C+
62-66 = C
58-61 = C-
52-57 = D

Exams: Closed books

Make-ups: Make-ups are allowed in exceptional circumstances, talk to the instructor as soon as possible

Research paper (Optional for extra credit) If you are taking this class, you probably have THE QUESTION that you wanted to answer for a long time. Any question. Really. Let's dig into literature and investigate. I will help you. If you don't want to write a paper, you can present your findings in an oral presentation.

		Cellular Neuroscience / Neurophysiology (videos are listed in order of their relevance to the class)
1	**1**	**Movement of molecules across cell membranes.**
Tu	**2**	**Principles of electricity, Ion channels; Mediated transport systems.**
	W	Watch: Single cell electrophysiology in the fly brain: http://www.youtube.com/watch?v=vw_w1TveM5E ; http://www.youtube.com/watch?v=mJJGZP9Dtq4
	R	Book chapters: CH2: "The cells that Make us who we are"
	D	Discussion articles: no discussion session before the first class
2	**1**	**Neural control mechanisms: Resting membrane potential, Action potential**
W	**2**	**Discussion: Movement of molecules across cell membranes**
	R	CH2: How neurons communicate with each other
3	**1**	**Synaptic transmission, exocytosis, endocytosis; postsynaptic cell.**
Th	**2**	**Signaling at the neuromuscular junction, other types of synapses**
	R	CH2: How neurons communicate with each other
	W	- Christof Koch a in the National Geographic Live! - Mapping the Brain (22min, 2014: at 8min there is the best presentation of a slice of a mouse brain with synapses): https://www.youtube.com/watch?v=7_drJyNMXbw
	D	Action Potential, resting membrane potential
4	**1**	**Types of ion channels. NMDA and AMPA channels. Other types of postsynaptic receptors. Drugs of abuse.**
Tu	**2**	**Secondary messengers. Role of calcium in short-term and long term memory formation / Q&A**
	W	-Hydrocodone addiction: http://www.youtube.com/watch?v=SQEsPIS4oY4&NR=1 -Heroin addicts speak: http://www.youtube.com/watch?v=kOPOK24g9Cc -Cocaine addicts speak: http://youtu.be/qvUq6-g-9kI
	R	CH5: Psychoactive Drugs
	D	Synaptic transmission
5	1	**Midterm Exam (lectures 1, 2, and 3 only; lecture 4 is NOT included))**
Wd	2	Exam Discussion
		Systems Neuroscience
6	**1**	**CNS, Organization of the brain. Executive control, Prefrontal cortex: lateral prefrontal cortex versus medial prefrontal cortex. Posterior cortex. Cerebellum. Organization of the somatosensory cortex. Perception of touch.**
Th	**2**	**How we observe the brain: fMRI, EEG, TMS, single cell recording.**
	W	- 3D brain: http://www.g2conline.org/2022 - The Brain: Teaching Modules. (1997). http://www.learner.org/resources/series142.html : 1. Organization and Evaluation of Brain Function, 25. Frontal Lobes and Behavior: The Story of Phineas Gage https://www.youtube.com/watch?v=l1SAC1HcAzc - How a CT scan works: http://www.youtube.com/watch?v=M-4o0DxBgZk ; http://www.youtube.com/watch?v=Tx-0emi4m8s - How an MRI works: http://www.youtube.com/watch?v=ctwXQ5xK4PU - How a PET scan works: https://www.youtube.com/watch?v=GHLBcCv4rqk
	R	CH3: The Central nervous system. CH4: Research Techniques.
	D	Types of ion channels. NMDA and AMPA channels. Other types of postsynaptic receptors. Drugs of abuse.
7	**1**	**The Senses. We'll focus on vision. Blindsight, Hemispatial neglect: Conscious vision versus unconscious vision**
Tu	W	-"Electrical Stimulation of Human Fusiform Face-Selective Regions Distorts Face Perception" http://www.jneurosci.org/content/32/43/14915.full - Unilateral neglect example: http://www.youtube.com/watch?v=HFTBC1ixfNk - Prosopagnosia and Neglect examples from Brain Story, a 6-part series by the BBC: http://www.youtube.com/watch?v=ADchGO-0kGo - The Brain: Teaching Modules. (1997). http://www.learner.org/resources/series142.html : 8. Visual Information Processing: Elementary Concepts, 9. Visual Information Processing: Perception, 10. Perception: Inverted Vision -David Eagleman (TED) Can we create new senses for humans? (Good talk about the senses in general and brain plasticity) http://www.ted.com/talks/david_eagleman_can_we_create_new_senses_for_humans?language=en -Daniel Kish (TED): How I use sonar to navigate the world: https://www.ted.com/talks/daniel_kish_how_i_use_sonar_to_navigate_the_world?language=en -Paul Bach-y-Rita and Neuroplasticity: https://youtu.be/7s1VAVcM8s8
	R	Ch10 Vision and Visual Perception. CH15: The neural Basis of Consciousness.
	D	Watch the video: "Electrical Stimulation of Human Fusiform Face-Selective Regions Distorts Face Perception": http://www.jneurosci.org/content/32/43/14915.full Read the discussion in SciAM mind: http://www.scientificamerican.com/article/the-face-is-an-entryway-to-the-self/
		Neuropsychology: Encoding and mental manipulation of objects in the brain
8	**1**	**Memory and hippocampus. Single cell recording. The Hebbian principle: cells that fire together, wire together. Object encoding in the brain: Neuronal ensembles. Neuronal synchronization.**
W	**2**	**The principle of brain organization across motor and sensory modalities: neural processes that underlie motor and sensory perception are also used in imagery of that modality**
	W	- The Brain: Teaching Modules. (1997): http://www.learner.org/resources/series142.html : 20. A Super-Memorist Advises on Study Strategies - Sandrine Thuret: You can grow new brain cells. Here's how: https://www.ted.com/talks/sandrine_thuret_you_can_grow_new_brain_cells_here_s_how#t-85220
	R	CH12: Learning and Memory
9	**1**	**The organization of movement. Everything that can be automated is automated. Basal ganglia.**
Th	**2**	**A model of the prefrontal cortex: organization of action by the frontal lobe, organization of thought by the PFC.**

	W	Christof Koch a in the National Geographic Live! - Mapping the Brain: https://www.youtube.com/watch?v=7_drJyNMXbw Daniel Wolpert. TED lecture. http://www.ted.com/talks/daniel_wolpert_the_real_reason_for_brains.html
	R	CH3: The Central nervous system. CH11: The Brain and Movement.
	D	Gelbard-Sagiv, H., Mukamel, R., Harel, M., Malach, R., & Fried, I. (2008). Internally generated reactivation of single neurons in human hippocampus during free recall. Science, 322(5898), 96-101. Quiroga, R. Q., Kreiman, G., Koch, C., & Fried, I. (2008). Sparse but not 'grandmother-cell' coding in the medial temporal lobe. Trends in cognitive sciences, 12(3), 87-91.
10	**1**	**Language. Critical period for language acquisition. Evolutionary aspects of language acquisition. / Q&A**
Tu	W	-The Brain: Teaching Modules. (1997): http://www.learner.org/resources/series142.html : 6. Language and Speech: Broca's and Wernicke's Areas -Broca's aphasia: http://www.youtube.com/watch?v=f2IiMEbMnPM -Wernicke's aphasia: http://www.youtube.com/watch?v=aVhYN7NTIKU -Washoe, Koko, and the social exchange of language in non-human primates: http://www.youtube.com/watch?v=3V_rAY0g9DM -Kanzi in a research session, converting human language to arbitrary symbols: http://www.youtube.com/watch?v=wRM7vTrIIis -Genie: https://www.youtube.com/watch?v=hmdycJQi4QA -Brilliant Bird Brains Podcast: https://itunes.apple.com/us/podcast/on-point-with-tom-ashbrook/id121534955?mt=2&i=366715450
	R	CH9: Hearing and Language
	D	Anguish of the abandoned child, by Charles A. Nelson III, Nathan A. Fox and Charles H. Zeanah, Jr. Scientific American, April, 2013
11	**1**	**Midterm Exam (cumulative: up to and including lecture 9)**
W	**2**	**Exam Discussion / Research paper topic decision is due.**
12	**1**	**Left hemisphere vs. right hemisphere functions. Corpus callosum. Why language is localized to one hemisphere?**
Th	W	-TED talk by Jill Bolte Taylor: My stroke of insight: http://www.ted.com/talks/jill_bolte_taylor_s_powerful_stroke_of_insight?language=en -The Brain: Teaching Modules. (1997): 5. The Divided Brain: http://www.learner.org/vod/vod_window.html?pid=1573 -The girl with half brain recovered all movement: http://youtu.be/2MKNsI5CWoU -Stephen Wiltshire draws Tokyo from memory: https://www.youtube.com/watch?v=95L-zmIBGd4
	R	CH9: Hearing and Language
	D	The Split Brain Revisited by Michael S. Gazzaniga, Scientific American, July 1998
13	**1**	**Innate visual recognition. How can a naive chimp recognize a snake?**
Tu	**2**	**Human brain evolution.**
	W	Laetoli footprints: http://www.pbs.org/wgbh/evolution/library/07/1/l_071_03.html
	R	N/A
	D	Tracey j. Shors, "Saving New Brain Cells" SciAm 2009
		Clinical neuropsychology
14	**1**	**Special states of mind: Sleep and dreams; Hallucinations; Meditation, Hypnosis, Anesthesia**
W	W	-The Science of Sleep (2008): http://www.cbsnews.com/videos/the-science-of-sleep/ -The Brain: Teaching Modules. (1997). http://www.learner.org/resources/series142.html : 13. Sleep and Circadian Rhythms, 14. Sleep: Brain Functions, 15. REM Sleep and Dreaming -Podcast: BSP 107 Sleep Science with Dr. Penny Lewis, Released Mar 18, 2014: https://itunes.apple.com/us/podcast/brain-science-podcast/id210065679?mt=2&i=280085092 -Characteristics of sleepwalking: http://www.youtube.com/watch?v=HNj04Omq60U. -A child with cataplexy: http://youtu.be/qVu-IcLoZtU; A dog with narcolepsy: http://www.youtube.com/watch?v=X0h2nleWTwI -Meditation effect on the size of amygdala (Sara Lazar TED talk): http://tedxtalks.ted.com/video/TEDxCambridge-Sara-Lazar-on-how -Neuroscience of emotions: http://www.youtube.com/watch?v=3oGSyWkGhYA; http://youtu.be/65e2qScV_K8 -Wendy Chung shares what we know about autism (TED) http://www.ted.com/talks/wendy_chung_autism_what_we_know_and_what_we_don_t_know_yet?language=en
	R	CH15: Sleep and Dreaming
15	**1**	**Nature vs. nurture. Neuroscience of sexual orientation. Psychological disorders. Autism and other developmental disorders.**
	2	**Optical Illusions**
Th	W	-TED talk Sherwin Nuland tells about electroshock therapy: http://www.ted.com/talks/sherwin_nuland_on_electroshock_therapy -Eleanor Longden, a research psychologist, talks about her struggles with Schizophrenia when getting her Master's degree in Psychology: https://www.ted.com/talks/eleanor_longden_the_voices_in_my_head - The Brain: Teaching Modules. (1997). http://www.learner.org/resources/series142.html : 30. Understanding the Brain Through Epilepsy - A startling commercial showing how people with anorexia view themselves: http://www.youtube.com/watch?v=qFbYW6bNViw -Wendy Chung: Autism — what we know (and what we don't know yet) | Talk Video | TED.com: http://www.ted.com/talks/wendy_chung_autism_what_we_know_and_what_we_don_t_know_yet?language=en#t-509168 -Steve Silberman: The forgotten history of autism: https://www.ted.com/talks/steve_silberman_the_forgotten_history_of_autism?language=en - The woman who thinks like a cow (Temple Grandin): http://www.youtube.com/watch?v=46ycu3JFRrA http://www.youtube.com/watch?v=f-iy7GNsmm0 - Temple Grandin , Brain Science Podcast: http://brainsciencepodcast.com/bsp/2013/interview-temple-grandin-bsp-99 - ADHD and the brain: https://www.youtube.com/watch?v=u82nzTzL7To - The life of Kim Peek: http://www.youtube.com/watch?v=dhcQG_KItZM -TED talk Vilayanur Ramachandran (Dissociation between vision and emotions, Phantom limb pain, Synesthisia): http://www.ted.com/talks/vilayanur_ramachandran_on_your_mind - National Geographic- Developmental effects on sexual orientation: http://www.youtube.com/watch?v=saO_RFWWVVA . Note- this is a clip from "In the womb: Identical Twins found in Videos.
	R	CH7: The Biology of Sex and Gender. CH14: Psychological Disorders.
	D	CH7: The Biology of Sex and Gender & CH14: Psychological Disorders.

		Evolutionary neuroscience
16	**1**	**Open questions in neuroscience: What makes modern humans so much different from other animals. Predictions of the MS theory. Symbolic abstract thinking.**
Tu	W	- "Ape Genius" (Nova, 2008) documents an amazing range of problems that can be solved by chimpanzees: http://www.pbs.org/wgbh/nova/apegenius/program.html -TED: Susan Savage-Rumbaugh talk about her work with bonobos: http://www.ted.com/talks/susan_savage_rumbaugh_on_apes_that_write
	R	N/A
	D	Ian Tattersall, "How we came to be Human" SciAm Dec 2001
17	**1**	**Research paper presentations / Q&A**
18	1	**Final Exam** (Cumulative) / **Research paper final version is due**

Other good videos:

1. Ed Boyden explains Channelrhodopsin: "A light switch for neurons": http://www.ted.com/talks/ed_boyden?language=en
2. Steve Ramirez and Xu Liu have used Channelrhodopsin to modify fear memory in rodents: "A mouse. A laser beam. A manipulated memory": https://www.ted.com/talks/steve_ramirez_and_xu_liu_a_mouse_a_laser_beam_a_manipulated_memory?language=en
3. Suzana Herculano-Houzel: What is so special about the human brain? Suzana Herculano-Houzel presents good evidense that the human brain isjust a scaled-up primate brain. https://www.ted.com/talks/suzana_herculano_houzel_what_is_so_special_about_the_human_brain?language=en