**Hearing & Communication Neuroscience Core Course**

**BISC 521/NEUR 542 Spring Semester 2016**

**14 Jan 2016**

Instructors:

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See below for **Schedule of Lectures**.

**Location: HNB 120 Time: Tuesdays and Thursdays 10-11:50am Units: 4**

**Course Description:**

This course is intended to provide graduate students with a basic grounding in broad aspects of the neuroscience of hearing and vocal communication (e.g., development, structure and function of the inner ear, neural circuitry for transmission and analysis of auditory information, audiology, psychophysics, vocal perception and production, language, etc). This course serves as the graduate core course for our Training Program in Hearing & Communication Neuroscience.

**Grading (letter)**: Evaluation will be based on scores on six take-home exams. The course is divided into 6 modules: (1) Physics, Transduction and Peripheral Physiology (lectures 1-5), (2) Physiology and CNS (lectures 6-11), (3) Development and Genetics (lectures 12-17), (4) Speech (lectures 18-23), (5) Perception (lectures 24-26), (6) Assessment and Disorders (lectures 27-30). Each module will give a take home assignment which will be scored. The score for each module will be weighted according to the number of lectures in that module.

**Course Material**: Course materials (syllabus, readings, lecture figures, etc.) will be available on Blackboard: <https://blackboard.usc.edu>. Be sure to check this site frequently. Many important announcements will appear first on Blackboard. Pre-requisite: BISC 421 or NEUR 524.

**Students with Disabilities:** Students requesting academic accommodations based on a disability are required to register with Disability Services and Programs (DSP) each semester.  A letter of verification for approved accommodations can be obtained from DSP when adequate documentation is filed.  Please be sure the letter is delivered to one of the instructors as early in the semester as possible.  Disability Services and Programs is located in Student Union 301 and their phone number is (213) 740-0776.

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**SCHEDULE OF LECTURES**

***Module 1: Physics, Transduction and Peripheral Physiology (lectures 1-5; Abdala)***

1. Tuesday, Jan 12: *From the Ear to Hearing: An Overview of the Auditory System* (Shannon, Abdala).

 A general introduction to the ear, hearing and communication science.

 Overview of the course.

2. Thursday, Jan 14: *Physics of Sound* (Shannon)

Sine waves, noise, bandwidth, filters, harmonics, dB

Temporal and spectral representation of sound.

3. Tuesday, Jan 19: *Auditory Physiology: Outer and Middle Ear* (Abdala)

 NOTE: there is an HCN Grant Writing Workshop immediately following this class.

4. Thursday, Jan 21: *The Inner Ear: Cochlear Mechanics* (Abdala, Kalluri)

Biomechanics and electrophysiology of hearing and the cochlea.

5. Tuesday, Jan 26: *Cochlear Hair Cells* (Abdala, Kalluri)

 The cochlear amplifier—active mechanisms and otoacoustic emissions.

***Module 2: Physiology and CNS (lectures 6-11; Bottjer)***

6. Thursday, Jan 28: *Physiology Boot Camp* (Bottjer)

Action potentials, patch clamp, stria vascularis.

7. Tuesday, Feb 2: *Peripheral Auditory Physiology* (Kalluri)

Getting the signal to the brain: cochlear innervation. Type 1 and Type 2 afferent neurons, lateral and crossed efferent neurons. Synaptic patterns on inner and outer hair cells. Synapse dynamics.

8. Thursday, Feb 4: *The Auditory Circuits of the Brain* I (Bottjer)

Functional circuits for brainstem and midbrain—processing and integration; auditory localization - physiology of the auditory nerve (rate-intensity functions, phase locking, high and low spontaneous rate fibers), transduction.

9. Tuesday, Feb 9: *The Auditory Circuits of the Brain* II: Localization (Bottjer)

Cochlear nucleus (SCC, choppers, octopus cells, bushy cells, AVCN, PVCN, DCN), olive complex (medial and lateral, laminaris in birds), lateral lemniscus, inferior colliculus.

10. Thursday, Feb 11: *The Auditory Circuits of the Brain* III: Cortex (Bottjer)

Functional circuits for auditory thalamus and cortex; representing complex sounds; role of experience in cortical development. Beyond primary auditory cortex.

11. Tuesday, Feb 16: *Brain Specialization for Speech and Language (*Aziz-Zadeh*)*

***Module 3: Development and Genetics (lectures 12-17; Segil)***

12. Thursday, Feb 18: Cellular and molecular biology boot camp (Ohyama)

13. Tuesday, Feb 23: [ARO San Diego] Development, disease, and evolution of the middle ear (Crump)

14. Thursday, Feb 25: [ARO San Diego] no class

15. Tuesday, March 1: *How the Ear Develops I:* (Ohyama, Segil)

 Morphogenesis and cellular development of the peripheral auditory system;

 Early embryology and neurogenesis

16. Thursday, Mar 3: *How the Ear Develops II:* (Segil)

Cochlear morphogenesis and the origin of sensory, non-sensory, and neuronal structures; Cellular differentiation, maturation and regeneration of the organ of Corti.

17. Friday, Mar 4 (NOTE new date!): *Genetics of Hearing and Communications: The Awesome Power of Modern Genetics* (Friedman).

Identifying genes: From Mendelian genetics to whole genome studies;

The genetics of susceptibility: Natural variation, and why some of us lose our hearing; The genetics of language.

***Module 4: Speech (lectures 18-23; Goldstein)***

18. Thursday, Mar 10: *Speech Production (*Goldstein*)*

Speech Production -- Articulation and linguistic contrast, vocal tract anatomy, source filter theory, parameters of linguistic contrast, co-articulation and parallel transmission, Instrumental techniques for articulation research. (12-2pm?)

**USC Spring Break; Mar 13-20**

Saturday March 19: USC/Caruso Otolaryngology Clinical Symposium 7:30am-5:45pm, Huntington Gardens, San Marino (Niparko, Friedman, Kari, Eisenberg, Segil, Abdala) Tinnitus, Meniere’s, CAPD, Diplacusis, Otitis Media, ABI in children, OAEs, Hair cell regeneration. <http://www.keck.usc.edu/events/breakthroughs-in-clinical-otolaryngology-pragmatic-cost-effective-approaches/>

19. Tuesday, Mar 22: *Songbirds as a model system for Human Speech* (Bottjer)

20. Thursday, Mar 24: *Speech Perception and Sound Patterns in Language* -- (Walker)

Typology of sound patterns in language, perception of consonants and vowels, syllable structures and speech perception, (mis-)perception of speech and theory of language typology.

21. Tuesday, Mar 29: *Development of Speech Perception* (Mintz)

Infants' innate capacities for categorizing speech sounds, the tuning of perceptual categories in the first year of life and proposed mechanisms, the fragility of perceptual contrasts in early word learning, Infants' segmentation of continuous speech in to words.

22. Thursday, Mar 31: *Development of Speech Production* (Goldstein)

Emergence of phonological structure, self-organization models, sensorimotor abilities of young infants, onset and structure of babbling, attunement of vocal actions to the ambient language, phonetic and phonological structure of early words. (12-2pm?)

23. Tuesday April 5: *Signal processing of speech* (Narayanan)

Extraction of features from speech—F0 extraction, formant extraction, automatic speech recognition, noise reduction processing for speech.

***Module 5:*** ***Perception (lectures 24-26; Shannon)***

24. Thursday, Apr 7: *Auditory Perception* *I* (Shannon)

Auditory Psychophysics—loudness, frequency selectivity, the critical band

25. Tuesday, Apr 12:Cortical representations of pitch (Bottjer, Goldstein)

26. Thursday, Apr 14: *Auditory Perception II* (Goldsworthy)

Auditory Psychophysics—pitch, temporal processing, localization.

***Module 6: Assessment and Disorders (lectures 27-30; Eisenberg)***

27. Tuesday, Apr 19: *Audiology* (Eisenberg, Abdala)

Audiology and Hearing Impairment—Clinical assessment of hearing, electrophysiology, otoacoustic emissions, conductive vs. cochlear hearing loss, flat vs. sloping audiograms, loss of sharpness in auditory filters, auditory neuropathy.

28. Thursday, Apr 21: *Development of Speech Perception in Children with Hearing Loss* (Eisenberg) Phonetic contrast and phoneme perception, word and sentence recognition, primitive and complex vocalizations, phonemic-syllabic vocal representations.

29. Tuesday, Apr 26: *Prosthetic Hearing* (Shannon)

Cochlear Implants - electric activation of neurons, safety concerns of electric stimulation of neurons, cochlear implant history and development. Cochlear Implant speech perception, speech processing for implants, central pattern processing in implants, Auditory Brainstem Implants

30. Thursday Apr 28: *Speech Pattern Recognition and Adaptation* – (Goldsworthy)

Robustness of central pattern recognition to distortion in speech spectral and temporal patterns. Plasticity in adapting to distorted speech patterns.

**HCN Retreat Catalina Island May 9-10.**

**Statement on Academic Integrity:** USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one’s own academic work from misuse by others as well as to avoid using another’s work as one’s own. All students are expected to understand and abide by these principles. Scampus, the Student Guidebook, contains the Student Conduct Code in Section 11.00, while the recommended sanctions are located in Appendix A: http://www.usc.edu/dept/publications/SCAMPUS/gov/. Students will be referred to the Office of Student Judicial Affairs and Community Standards for further review, should there be any suspicion of academic dishonesty. The Review process can be found at: <http://www.usc.edu/student-affairs/SJACS/>.