

**The Auditory System**  
Bi 410/510 – Winter 2019

**Lecture** 2-2:50 pm MWF 225 Friendly Hall  
**Lab/Discussion Section** 11-11:50 W 129 Huestis Hall

**Instructor:** Terry Takahashi  
**Office hrs:** 1-2 pm MF & by appointment  
**e-mail:** [terry@uoregon.edu](mailto:terry@uoregon.edu)  
**Office:** 224A Huestis Hall  
**phone:** 6-4544

**Course materials:**

**Text** (*recommended*)- *The Sense of Hearing* by Christopher J. Plack (Lawrence Earlbaum Associates, Mahwah ISBN 0-8058-4884-3)

**Spreadsheet** - Microsoft Excel (download from <https://it.uoregon.edu/about-office-365>)

**DAW** - Audacity v 2.1.2 (freeware download from <http://www.audacityteam.org/>)

**Headphones** (bring your own)

Hearing is the ability to use sound. This simple statement encompasses the abilities to map out our environment without sight, to be moved by music, and to communicate with one another. Helen Keller said, “*Blindness separates people from things; deafness separates people from people.*”, thus emphasizing the importance of hearing to human life.

This course is an introduction to the physiology and psychophysics of hearing. We will start with the physics of sound and its analysis, and proceed into the auditory system starting at the periphery, with emphasis on the neural mechanism of auditory perception. Although most of the topics will be based on the normal function of the human auditory system, as time allows, I will introduce topics of clinical interest and the question of what it means to be deaf in a species, such as humans, where vocal communication is paramount. We will also study active echolocation in bats and time-allowing, acoustically guided navigation in blind humans.

The lectures are accompanied by discussion sections in which students will explore the synthesis and analysis of sounds, discuss the primary literature, and explore the deafness culture.

Your grade is based on an average of the scores of a set of assignments, a midterm exam, and a non-cumulative final all equally weighted. The questions will be of the short-answer and multiple-choice types. Materials covered in lecture, readings, and discussions will be covered in the tests. To be successful in this class, you must keep up with the material. If you have any questions, ask immediately. The grading scale is as follows:

- A 100 - 90
- B 89 - 80
- C 79 - 70
- D 69 - 60
- F < 59

The exam dates on the schedule are approximate and should not be used to plan trips etc that will cause you to miss class. Exams must be taken at the time and place scheduled. There are no early or make-up exams, except in the case of a medical emergency.

1. Learning Outcomes: If you passed this course, you should be able to explain basic acoustics, auditory transduction and processing, and the neural mechanisms of some aspects of auditory perception.

2. The University of Oregon is working to create an inclusive learning environment. Please notify me, within the first 2 weeks of class, if you have a disability that could impede your learning experience in this class. Please contact Disability Services for further information (164 Oregon Hall; 6-1155 or [disabserv@uoregon.edu](mailto:disabserv@uoregon.edu)). I will work with you and Disabilities Services to help facilitate your learning experience.

### Journal Articles (Available on Canvas)

- Baxter, C. S., B. S. Nelson and T. T. Takahashi (2013). The role of envelope shape in the localization of multiple sound sources and echoes in the barn owl. J Neurophysiol.
- Carr, C. E. and M. Konishi (1990). A circuit for detection of interaural time differences in the brain stem of the barn owl. J Neurosci **10**(10): 3227-3246.
- Clifton, R. K. (1987). Breakdown of echo suppression in the precedence effect. J Acoust Soc Am **82**(5): 1834-1835.
- Jusczyk, P. W. and P. A. Luce (2002). speech perception and spoken word recognition: Past and present. Ear & Hearing **23**: 1-39.
- Knudsen, E. I. and M. Konishi (1978). Space and frequency are represented separately in auditory midbrain of the owl. J Neurophysiol **41**(4): 870-884.
- Nelson, B. S. and T. T. Takahashi (2010). Spatial hearing in echoic environments: the role of the envelope in owls. Neuron **67**(4): 643-655.
- Simmons, J. A. (1979). Perception of echo phase information in bat sonar. Science **204**(4399): 1336-1338.
- Sullivan, W. E. and M. Konishi (1984). Segregation of stimulus phase and intensity coding in the cochlear nucleus of the barn owl. J Neurosci **4**(7): 1787-1799.
- Takahashi, T., A. Moiseff and M. Konishi (1984). Time and intensity cues are processed independently in the auditory system of the owl. J Neurosci **4**(7): 1781-1786.
- Yin, T. C. (1994). Physiological correlates of the precedence effect and summing localization in the inferior colliculus of the cat. J Neurosci **14**(9): 5170-5186.
- Zeng, F. G., S. Rebscher, W. Harrison, X. Sun and H. Feng (2008). Cochlear implants: system design, integration, and evaluation. IEEE Rev Biomed Eng **1**: 115-142.

### Other Resources

**Houtsma AJM, Rossing TD, Wagenaars WM** 1987 *ASA Auditory Demonstrations*, Philips

**Geisler CD** 1998 *From Sound to Synapse*, Oxford Press, NY

**Hartman WM** *Signals, Sound, and Sensation*, Springer NY

**Moore BCJ** 1989 *An Introduction to the Psychology of Hearing 3<sup>rd</sup> edition*, Academic Press

**Pickels JO**, 1988 *An Introduction to the Physiology of Hearing 2<sup>nd</sup> edition*, Academic Press

1. Learning Outcomes: If you passed this course, you should be able to explain basic acoustics, auditory transduction and processing, and the neural mechanisms of some aspects of auditory perception.

2. The University of Oregon is working to create an inclusive learning environment. Please notify me, within the first 2 weeks of class, if you have a disability that could impede your learning experience in this class. Please contact Disability Services for further information (164 Oregon Hall; 6-1155 or [disabserv@uoregon.edu](mailto:disabserv@uoregon.edu)). I will work with you and Disabilities Services to help facilitate your learning experience.

### *Approximate Schedule*

Date	Day	Lecture topic	Chpt	Source material
1/7/19	<b>M</b>	Intro	2	Basic acoustics.pdf
1/9/19	<b>W</b>	Excel - sinusoids	2	Sinusoids.docx
1/9/19	<b>W</b>	Basic acoustics & follow up on lab exercise	2	Basic acoustics.pdf
1/11/19	<b>F</b>	More basic acoustics	2	Basic acoustics.pdf
1/14/19	<b>M</b>	Anatomy of auditory periphery - pinna to cochlea		
1/16/19	<b>W</b>	Excel - Fourier transform		Fourier.ppt; fourier_handout&lec.doc; Harmonics.docx
1/16/19	<b>W</b>	Anatomy of auditory periphery - pinna to cochlea		
1/18/19	<b>F</b>	Basilar membrane & trav wave		
1/21/19	<b>M</b>	<b>No classes - MLK Day</b>		
1/23/19	<b>W</b>	Excel - synthesis & analysis of complex signals. OR using Audacity		Build & analyze AMs
	<b>W</b>	Hair cells - transduction		
1/25/19	<b>F</b>	Auditory nerve physiology		
1/28/19	<b>M</b>	Auditory nerve physiology		
1/30/19	<b>W</b>	Cochlear implants		Zeng et al., 2008, IEEE Rev Biomed Eng 1:115-142 (read sxns I-IV.)
1/7/00	<b>W</b>	Cochlear nuclei		based on Sullivan & Konishi, 1984
2/1/19	<b>F</b>	Inferior colliculus		based on Knudsen & Konishi, 1978
2/4/19	<b>M</b>	Auditory cortex (guest lecture by Prof. Mike Wehr)		
2/6/19	<b>W</b>	Review for midterm exam		
1/14/00	<b>W</b>	<b>Midterm</b>		Exact date tbd
2/8/19	<b>F</b>	<b>Midterm</b>		Exact date tbd
2/11/19	<b>M</b>	Pitch		

1. Learning Outcomes: If you passed this course, you should be able to explain basic acoustics, auditory transduction and processing, and the neural mechanisms of some aspects of auditory perception.

2. The University of Oregon is working to create an inclusive learning environment. Please notify me, within the first 2 weeks of class, if you have a disability that could impede your learning experience in this class. Please contact Disability Services for further information (164 Oregon Hall; 6-1155 or [disabserv@uoregon.edu](mailto:disabserv@uoregon.edu)). I will work with you and Disabilities Services to help facilitate your learning experience.

2/13/19	W	Audacity - missing fundamental and dominance of partials using pre-made wav files.	ASA demo 37-45; Also Fig. 7.1 pg 134 of Plack
1/21/00	W	Speech sounds	based on Juzsyck & Luce, 2002
2/15/19	F	Non-human vocalizations - birdsong	based on Margoliash & Konishi, 1983
2/18/19	M	Spatial hearing - general principles (ITD, ILD, spectral shape)	
2/20/19	W	Neural computation of ITD	Jeffress model - Car & Konishi, 1991
1/28/00	W	Neur. ITD computation delay lines & coinc det	
2/22/19	F	Neur. ITD computation phase ambig	
2/25/19	M	Complex acoustical environments - acoustical superposition, binaural correlation	
2/27/19	W	Precedence effect - traditional view	Yin 1994
2/4/00	W	PE - novel view	Nelson & Takahashi, 2010
3/1/19	F	PE & cocktail party effect	Baxter & Takahashi, 2013
3/4/19	M	PE & cocktail party effect	
3/6/19	W	PE & cocktail party effect	
2/11/00	W	Echolocation in bats - intro	
3/8/19	F	Evidence of x-corr in echo delay - hyperacuity	Simmons, 1979
3/11/19	M	Human echolocation	Guest spkr Ms. Heidi vonRavensberg
3/13/19	W	Psychoacoustical basis of human echolocation	Clifton JASA 1987 82:1834
2/18/00	W	Catch up	

1. Learning Outcomes: If you passed this course, you should be able to explain basic acoustics, auditory transduction and processing, and the neural mechanisms of some aspects of auditory perception.

2. The University of Oregon is working to create an inclusive learning environment. Please notify me, within the first 2 weeks of class, if you have a disability that could impede your learning experience in this class. Please contact Disability Services for further information (164 Oregon Hall; 6-1155 or [disabserv@uoregon.edu](mailto:disabserv@uoregon.edu)). I will work with you and Disabilities Services to help facilitate your learning experience.

3/15/19      **F**      Review for final  
**3/21/2019**      **Th**      **Final exam 2:45 pm**

1. Learning Outcomes: If you passed this course, you should be able to explain basic acoustics, auditory transduction and processing, and the neural mechanisms of some aspects of auditory perception.
2. The University of Oregon is working to create an inclusive learning environment. Please notify me, within the first 2 weeks of class, if you have a disability that could impede your learning experience in this class. Please contact Disability Services for further information (164 Oregon Hall; 6-1155 or [disabserv@uoregon.edu](mailto:disabserv@uoregon.edu)). I will work with you and Disabilities Services to help facilitate your learning experience.