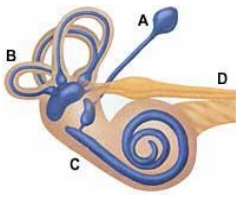
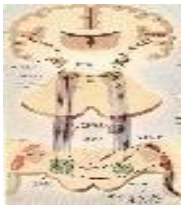
**DEPARTMENT OF AUDIOLOGY AND SPEECH-LANGUAGE PATHOLOGY**
**UNIVERSITY OF NORTH TEXAS**
**ASLP 6200 – Fall 2023**
**Neuroanatomy and Neurophysiology of the Auditory and Vestibular Systems**



**INSTRUCTOR:** Kamakshi V. Gopal, Ph.D., CCC-A.
**Email ID:** Kamakshi.Gopal@unt.edu
**CLASS:** Fridays 9 to 11:50 AM
**PLACE:** Chilton Hall 274
**OFFICE:** UNT Speech and Hearing Center - 258
**OFFICE HRS:** Mondays 1–3:00 pm BY APPOINTMENT
**Teaching Assistant:** Paola Bautista
**Email ID:** PaolaBautista@my.unt.edu

Course Description:

Neuroanatomy and Neurophysiology of the hearing and balance systems. Emphasis on both afferent and efferent systems.

Course Objective:

The objective of this course is to provide the students with a strong background in anatomy and physiology of the auditory and vestibular systems. This course will facilitate learning of pathologies of the auditory and vestibular structures, as well as understanding of the principles that underlie diagnostic test procedures used in audiological and vestibular assessment.

Learning Outcomes:

At the end of the course, the students should be knowledgeable in basic neurological principles as well as in the anatomy and physiology of the auditory and vestibular systems.

Required Text:

Webster, D.B. 1999. Neuroscience of communication. (II ed). Singular Publishing Group, Inc., San Diego.

Primal Pictures weblink

https://www.anatomy.tv/titles

Additional Text recommended but not required: The Auditory System: Anatomy, Physiology, and Clinical Correlates (2nd Edition, 2018) by Frank Musiek and Jane Baran.

Course Requirement:

Satisfactory completion of all readings, presentation, term paper, and passing of all exams and quizzes. Neuro Lab observations at UNT Health Science Center is an initiative that was started in Fall 2021 to enhance learning opportunities of neuroanatomical structures. This is done in collaboration with the Director, Center for Anatomical Sciences, UNTHSC. Students are given the opportunity to attend a three-hour lab at UNTHSC and integrate their observations and comments during their individual presentation. Students who are unable to attend the lab session must contact Dr. Gopal for an alternate activity, which will include submitting an individual paper describing classical and non-classical auditory pathways.

Learning Objectives of Course and Program, and Standards of Profession
This course fulfills the following competencies from the Knowledge and Skills Outcomes required for clinical certification in Audiology by the American Speech-Language and Hearing Association.
Standard II-A-A1. Anatomy and physiology, neuroanatomy and neurophysiology of hearing and balance.
Standard II-A-A2. Effects of pathogens, and pharmacologic and teratogenic agents, on the auditory and vestibular systems
Standard II-C-C4. Identifying, describing, and differentiating among disorders of the peripheral and central auditory systems and the vestibular system

**Course Outline:**

| Days | Topics | Readings |
|---|---|---|
| 08-25 | INTRODUCTION/ SYLLABUS<br>**General Neuroscience**<br>Organization of the brain<br>a. CNS<br>b. PNS<br>c. Neuronal components & descriptors of the brain | Webster Ch 1-5 |

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|---|---|---|
| 09-01 | The Cerebral Hemispheres and<br>Sub-cortical structures<br>**Quiz 1** | Webster Ch 1-5 |
| 09-08 | Neurons and glial cells<br>Physiology of nerve cells<br>Cranial Nerves<br>Neurotransmitters<br>Neurovasculature | Webster Ch 1-5 |
| 09-15 | Neurovasculature<br>Ventricular System<br>Review<br>**Quiz 2** | Webster Ch 1-5 and class lectures |
| 09-22 | **Exam 1**<br>**Lecture - Auditory System**<br>Anatomy and physiology of the peripheral auditory system<br>The Cochlea | Webster Ch 8 |
| 09-29 | The Cochlea<br>Transduction in the cochlea<br>Eighth Nerve | Webster Ch 8 |
| 10-06 | The eighth nerve, Cochlear Nucleus and Superior Olivary Complex<br>**Quiz 3** | Webster Ch 8, 9 |
| 10-13 | Lateral lemniscus, Inferior colliculus, MGB and AC | Webster Ch 9, 10 |
| 10-20 | Review<br>**The Vestibular system**<br>Peripheral vestibular system<br>**Quiz 4** | Webster Ch 7 |
| 10-27 | **Exam 2**<br>Peripheral and central Vestibular system | Webster Ch 7 |
| 11-03 | 9 am to 10 am – Dr. Labue's Class | Webster Ch 7 and class lectures |

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|---|---|---|
| | UNT HSC Neuro Lab from 1 to 4 pm | |
| 11-10 | Vestibular system … continued<br>**Quiz 5** | |
| 11-17 | Student Classroom Presentations<br>Review | |
| 11-24 | THANKSGIVING HOLIDAYS<br>NO CLASS | |
| 12-01 | **Exam 3**<br>Paper discussion | |
| 12-08 | READING DAY<br>NO In-Person CLASS AS PER UNT REGULATIONS | |
| **12-11 Monday** | **Final Paper due at 8:00 am** | |

Additional readings may be recommended as needed

GRADING

| Activities | Points |
|---|---|
| Presentation | **20** |
| Paper | **20** |
| Quizzes | **10** |
| Exam 1 | **50** |
| Exam 2 | **50** |
| Exam 3 | **50** |
| | **------** |
| TOTAL | 2**00** |
| | **------** |

All exams are cumulative; however, exams 2 and 3 will emphasize course material covered in later classes. Final % will be computed and grades will be assigned according to the following criteria:

| Percentage | Final Grade |
|---|---|
| 90-100 | A |
| 80-89 | B |
| 70-79 | C |
| 60-69 | D |
| 0-59 | F |

Students will work in groups of three for the presentation and paper activities. Each group will pick a topic of interest in the area of neuroanatomy and neurophysiology of auditory or vestibular systems, discuss it with Dr. Gopal, conduct a thorough review of literature of the topic, compile information from at least 5 authoritative sources (journal articles and/or books other than the textbook), integrate the information and make a 25 minute presentation in the class. Each group should follow a logical method of presentation and ensure that each member has an equally important role in the presentation activity.

Each group will also be required to write a comprehensive team paper on the same topic as their presentation. The paper should be no more than 6 pages in length (double space, excluding references) and must be submitted by the deadline to Dr. Gopal via UNT email (one copy from each group with all participating members listed). This is an opportunity for students to develop skills in identifying relevant subject matter, process the information, critique the studies, synthesize, and effectively integrate the information using the mechanics of writing to clearly convey their thoughts. The paper must be submitted by 8 am Dec 11, 2023, and should contain all corrections made by Dr. Gopal during classroom presentations. Students will be graded individually on their presentation. Grade assigned to the group paper will apply to all members of the group uniformly.

**Rubrics for presentation**

| **Presentation** | Proficient - 20 pts | Emerging - 10 pts | Needing a lot of improvement - 4 pts |
|---|---|---|---|
| Classroom presentation | Interesting and new material included.<br><br>Organized, easy to follow, good delivery, kept to time limit. | Cluttered, hard to understand. | Sparse info, not enough depth. |

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|---|---|---|---|
| | Did not read off of the slides.<br><br>Answered questions professionally. | | |
| Research articles | Used a variety of references, translated into own words, summarized when needed. | References were not related well to topic. Did not discuss in own words. | References were sparse, verbatim. |
| Abstract/Summary | Concise summary of topic | Basic summary of topic | No summary |
| Sources Cited | 5 minimum other than class textbook<br><br>References/research articles cited in APA format.<br><br>Emailed to Dr. Gopal's UNT address prior to presentation | Fewer than five references/research articles cited in APA format.<br><br>Emailed to Dr. Gopal's UNT school address after presentation. | Fewer than two references. Did not follow APA format.<br><br>Had fewer than three references.<br><br>Did not email the presentation |
| Attitude toward presentation project | Excited, willing to take suggestions.<br><br>Good teamwork.<br><br>Contributed significantly to the team effort. | Accepting of suggestions.<br><br>Fair interest demonstrated in chosen topic. | Uninterested.<br><br>Did not contribute significantly and meaningfully to the team effort. |

**Rubrics for Paper**

| **Paper** | Proficient - 20 pts | Emerging - 10 pts | Needing a lot of improvement - 4 pts |
|---|---|---|---|
| Paper | Interesting and new material included. | Cluttered, hard to understand. | Sparse, not enough depth. |

| | | | |
|---|---|---|---|
| | Organized, easy to follow, provided relevant and high quality figures and tables<br><br>Stayed within the page limits.<br><br>Included Professors feedback provided during presentation. | Poor illustrations | Did not incorporate Professor's feedback.<br><br>Did not provide any new information, repeated info from class lectures. |
| Research articles | Used a variety of references, summarized articles well. | References were not related to topic | References were sparse. |
| Written abstract | Succinct summary of topic in 1 or more paragraphs consisting of 5+ sentences. | Basic summary of topic in a single paragraph consisting of less than 5 sentences. | No abstract |
| Sources Cited | Five minimum other than class textbook<br><br>References/research articles cited in APA format. | Fewer than five references/research articles. Not cited in APA format | Chose irrelevant sources, did not integrate the material well.<br><br>Fewer than two references. Did not follow APA format |
| Attitude toward team paper project | Excited, good team work.<br>Contributed significantly to the paper. | Fair interest demonstrated in chosen topic. | Uninterested. Did not contribute significantly and meaningfully to the team effort.<br>Paper did not provide any new information |

No alternate exams will be provided, except in emergency cases (proof required). Failure to be present for a scheduled exam or presentation will result in a failing grade on that activity.

**Respect for Diversity**
I am committed to creating a highly positive and inclusive learning environment for ALL students in my classes. I respect your identities and diversity of thoughts. I welcome your unique perspectives which will be viewed as a strength and resource in this class. Please do not hesitate to talk to me if you have any issues in the classroom that are impacting your learning.

**Academic Dishonesty**
UNT promotes the integrity of learning processed and embraces the core values of trust and honesty. Academic integrity is based on educational principles and procedures that protect the rights of all participants in the educational process and validate the legitimacy of degrees awarded by the university. In the investigation and resolution of allegations of student academic dishonesty, the university's actions are intended to be corrective, educationally sound, fundamentally fair, and based on reliable evidence."
The faculty expects a high level of responsibility and academic honesty. Any form of academic dishonesty will not be tolerated and will result in formal disciplinary action.

**Use of Artificial Intelligence for Assignments:**
According to the UNT Academic Integrity Policy (UNT Policy 6.003), any form of "unauthorized assistance" constitutes cheating. As a result, use of any artificial intelligence is not authorized for assignments in this course.

**Attendance Policy**
Students are expected to attend classes regularly and to abide by the attendance policy established for this class. Any student wanting accommodation to observe a religious holiday must inform the instructor a minimum of three days prior to the observed religious holiday and make appropriate arrangements for the class activities that they will be missing. It is important that you communicate with me prior to being absent, so we can discuss and mitigate the impact of the absence on your attainment of course learning goals. Please inform me if you are unable to attend class meetings because you are ill, in mindfulness of the health and safety of everyone in our community.

**Access to Information - Eagle Connect**
The students' access point for business and academic services at UNT is located at: my.unt.edu. All official communication from the University will be delivered to a student's Eagle Connect account. For more information, please visit the website that explains Eagle Connect and how to forward e-mail Eagle Connect (https://it.unt.edu/eagleconnect).

**Rules of Engagement**
Here are some general guidelines:

- Treat your instructor and classmates with respect in email or any other communication.
- Always use your professors' proper title: Dr. or Prof., or if in doubt use Mr. or Ms.
- Use clear and concise language.

- Do not send confidential information via e-mail.

**UIT Help Desk**: UIT Student Help Desk site (http://www.unt.edu/helpdesk/index.htm)
**Email**: helpdesk@unt.edu
**Phone**: 940-565-2324
**In Person**: Sage Hall, Room 130
**Walk-In Availability**: 8am-9pm
**Telephone Availability**:

- Sunday: noon-midnight
- Monday-Thursday: 8am-midnight
- Friday: 8am-8pm
- Saturday: 9am-5pm

**Laptop Checkout**: 8am-7pm

For additional support, visit Canvas Technical Help (https://community.canvaslms.com/docs/DOC-10554-4212710328)

**Student Support Services**

UNT provides mental health resources to students to help ensure there are numerous outlets to turn to that wholeheartedly care for and are there for students in need, regardless of the nature of an issue or its severity. Listed below are several resources on campus that can support your academic success and mental well-being:

- Student Health and Wellness Center (https://studentaffairs.unt.edu/student-health-and-wellness-center)
- Counseling and Testing Services (https://studentaffairs.unt.edu/counseling-and-testing-services)
- UNT Care Team (https://studentaffairs.unt.edu/care)
- UNT Psychiatric Services (https://studentaffairs.unt.edu/student-health-and-wellness-center/services/psychiatry)
- Individual Counseling (https://studentaffairs.unt.edu/counseling-and-testing-services/services/individual-counseling)

Other student support services offered by UNT include

- Registrar (https://registrar.unt.edu/registration)
- Financial Aid (https://financialaid.unt.edu/)
- Student Legal Services (https://studentaffairs.unt.edu/student-legal-services)
- Career Center (https://studentaffairs.unt.edu/career-center)
- Multicultural Center (https://edo.unt.edu/multicultural-center)
- Counseling and Testing Services (https://studentaffairs.unt.edu/counseling-and-testing-services)
- Pride Alliance (https://edo.unt.edu/pridealliance)

- UNT Food Pantry (https://deanofstudents.unt.edu/resources/food-pantry)

Academic Support Services

- Academic Resource Center (https://clear.unt.edu/canvas/student-resources)
- Academic Success Center (https://success.unt.edu/asc)
- UNT Libraries (https://library.unt.edu/)
- Writing Lab (http://writingcenter.unt.edu/)
- MathLab (https://math.unt.edu/mathlab

**Acceptable Student Behavior**

Student behavior that interferes with an instructor's ability to conduct a class or other students' opportunity to learn is unacceptable and disruptive and will not be tolerated in any instructional forum at UNT. Students engaging in unacceptable behavior will be directed to leave the classroom and the instructor may refer the student to the Dean of Students to consider whether the student's conduct violated the Code of Student Conduct. The University's expectations for student conduct apply to all instructional forums, including University and electronic classroom, labs, discussion groups, field trips, etc. Visit UNT's Code of Student Conduct (https://deanofstudents.unt.edu/conduct) to learn more.

**Office of Disability Accommodation (ODA)**

The University of North Texas makes reasonable academic accommodation for students with disabilities. Students seeking reasonable accommodation must first register with the Office of Disability Accommodation (ODA) to verify their eligibility. If a disability is verified, the ODA will provide you with a reasonable accommodation letter to be delivered to faculty to begin a private discussion regarding your specific needs in a course. You may request reasonable accommodations at any time; however, ODA notices of reasonable accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of reasonable accommodation for every semester and must meet with each faculty member prior to implementation in each class. Students are strongly encouraged to deliver letters of reasonable accommodation during faculty office hours or by appointment. Faculty members have the authority to ask students to discuss such letters during their designated office hours to protect the privacy of the student. For additional information see the Office of Disability Accommodation website at *http://www.unt.edu/oda*. You may also contact them by phone at *940.565.4323*.

**Student Absence Due to Religious Holy Day**

A student may be excused from attending classes or other activities, including examinations, for observance of a religious holy day, including travel for that purpose. A. A student should notify a faculty member of anticipated absence to observe religious holy days as early in the semester as possible. B. An excused student may not be penalized for the absence and must be allowed to complete any examination or an assignment missed during the absence within a reasonable period after the absence. The faculty member may take appropriate action if a student fails to satisfactorily complete an assignment or examination within a reasonable time. C. If a student and faculty member disagree about whether the absence is due to observance of a religious holy day or whether the

student has been given reasonable time to complete any missed assignment or examination, they may appeal the decision using the process outlined in UNT Policy 07.016, Student Complaint Policy or UNT Policy 06.040, Grade Appeals.

**Sexual Harassment**

It is the policy of the University of North Texas that acts of sexual harassment, as defined herein, toward guests of and visitors to the campus or any member of the University community including faculty, staff, students and candidates for positions at the University (regardless of the individual's gender) will not be tolerated. All members of the administration, faculty, staff and students will be subject to disciplinary action for violation of this policy. Members of the public doing business with the University who violate this policy may be subject to sanctions. Full policy available at *https://policy.unt.edu/sites/default/files/16.005_SexualHarassment_2003.pdf*

Emergency Notification & Procedures

UNT uses a system called Eagle Alert to quickly notify students with critical information in the event of an emergency (i.e., severe weather, campus closing, and health and public safety emergencies like chemical spills, fires, or violence). In the event of a university closure, please refer to Blackboard for contingency plans for covering course materials.

Retention of Student Records

Student records pertaining to this course are maintained in a secure location by the instructor of record. All records such as exams, answer sheets (with keys), and written papers submitted during the duration of the course are kept for at least one calendar year after course completion. Students have the right to view their individual record; however, information about student's records will not be divulged to other individuals without proper written consent. Students are encouraged to review the Public Information Policy and the Family Educational Rights and Privacy Act (FERPA) laws and the University's policy. See UNT Policy 10.10, Records Management and Retention for additional information.

Course Evaluation

Student Perceptions of Teaching (SPOT) is the student evaluation system for UNT and allows students the ability to confidentially provide constructive feedback to their instructor and department to improve the quality of student experiences in the course. A short survey will be made available to you at the end of the semester, providing you with a chance to comment on how this class is taught. I am very interested in the feedback I get from students, as I work to continually improve my teaching. I consider the SPOT to be an important part of your participation in this class, so please do not forget to fill out the SPOT.

Syllabus Policy

The syllabus is not a contract, it is a guide for students regarding academic success and behavior. The Professor reserves the right to change the contents if required, and students will be notified of the changes.

**Recommended readings**

Ansorge, J., Wu, C., Shore, S.E., Krieger, P. (2021). Audiotactile interactions in the mouse cochlear nucleus. Sci Rep. 2021; 11: 6887.
Published online 2021 Mar 25. doi: 10.1038/s41598-021-86236-9

Appler, J.M. & Goodrich, L.V. (2011). Connecting the ear to the brain: molecular mechanisms of auditory circuit assembly. Prog. Neurobiol, (4): 488-508.

Dallos, P. (2008). Cochlear amplification, outer hair cells and prestin. Review Curr Opin Neurobiol, 2008 Aug;18(4):370-6. doi: 10.1016/j.conb.2008.08.016.

Goodman, SS., Lee, C., Guinan, Jr., J.J., Lichtenhan, J.T. (2020). The Spatial Origins of Cochlear Amplification Assessed by Stimulus-Frequency Otoacoustic Emissions. Biophys J. 2020 Mar 10; 118(5): 1183–1195.
Published online 2020 Jan 3. doi: 10.1016/j.bpj.2019.12.031

Gusta van Zwieten et, al., (2021). Noise-induced neurophysiological alterations in the rat medial geniculate body and thalamocortical desynchronization by deep brain stimulation. J Neurophysiol 125(2):661-671. doi: 10.1152/jn.00752.2019.

Hunter, C., Doi, K., & Wenthold, R.J. (1992). Neurotransmission in the auditory system. *Otolaryngologic Clinics of North America*, 25, 1027-1052.

Kingsley, R.E. (2000). *Concise Text of Neuroscience.* (II edition). Lippincott Williams and Wilkins. Philadelphia.

Khan, S. & Chang, R. (2013). Anatomy of the vestibular system: a review. NeuroRehabilitation, 32(3):437-43. doi: 10.3233/NRE-130866.

Marchioni, D., Rubini, A., Soloperto, D. (2021). Endoscopic Ear Surgery: Redefining Middle Ear Anatomy and Physiology. Otolaryngol Clin North Am, 2021 Feb;54(1):25-43. doi: 10.1016/j.otc.2020.09.003.

Moore, J.K. (2000). Organization of the human superior olivary complex. Review Microsc Res Tech, 15;51(4):403-12. doi: 10.1002/1097-0029(20001115)51:4<403::AID-JEMT8>3.0.CO;2-Q.

Musiek, F.E., & Baran, J.A. (1986). Neuroanatomy, neurophysiology, and central auditory assessment. Part I: Brain stem. *Ear and Hearing*, 7, 207-219.

Musiek, F.E. (1986). Neuroanatomy, neurophysiology, and central auditory assessment. Part II: The cerebrum. *Ear and Hearing*, 7, 283-294.

Musiek, F.E. (1986). Neuroanatomy, neurophysiology, and central auditory assessment. Part III: Corpus callosum and efferent pathways. *Ear and Hearing*, 7, 349-358.

Ono, M., Ito, T. (2015). Functional organization of the mammalian auditory midbrain. J Physiol Sci, 65(6):499-506. doi: 10.1007/s12576-015-0394-3.

Rabbitt, R.D. (2020). The cochlear outer hair cell speed paradox. Proc Natl Acad Sci U S A 2020 Sep 8;117(36):21880-21888. doi: 10.1073/pnas.2003838117. Epub 2020 Aug 26.

Rubel, E.W., Fritzsch, B. (2002). Auditory system development: primary auditory neurons and their targets. Annu. Rev. Neurosci. 25, 51–101.

Seikel, J.A., King, D.W., Drumright, D.G. ( 2010). Anatomy and Physiology for Speech, Language and Hearing. Delmar Cengage Learing. Australia.

Sitek, K.R., Gulban, O.F., et al. (2019) Mapping the human subcortical auditory system using histology, postmortem MRI and in vivo MRI at 7T. Elife. 2019 Aug 1;8:e48932. doi: 10.7554/eLife.48932.

Suthakar, K., Ryugo, D.K. (2021). Projections from the ventral nucleus of the lateral lemniscus to the cochlea in the mouse. J Comp Neurol, 529(11):2995-3012. doi: 10.1002/cne.25143.

Tritsch, N.X., Yi, E., Gale, J.E., Glowatzki, E., Bergles, D.E., (2007). The origin of spontaneous activity in the developing auditory system. *Nature* 450, 50–55.