Impact of repeated acoustic trauma on presbycusis

Institut presentation

The Hearing Institute (Institut de l'Audition, IdA, Paris 12eme) is a new center for basic and translational neuroscience research in the field of hearing, which opened in 2020 at the initiative of the Fondation Pour l'Audition and the Institut Pasteur. The overarching goal of the Institute is to elucidate the principles underpinning the workings of the auditory system, auditory perception and cognition from the molecular to the cognitive level. Optical techniques are key for this endeavor.

Scientific Context

Age-related hearing loss (presbycusis) progressively impairs auditory function in approximately one-third of individuals over 65. A central feature of this pathology is damage to cochlear hair cells. Epidemiological studies indicate that environmental factors—particularly repeated exposure to loud noise—contribute to its variability and severity, although the underlying mechanisms remain poorly understood. Emerging evidence suggests that temporary threshold shifts (TTS) caused by acoustic overexposure (e.g., concerts, machinery) disrupt tip links—nanoscale protein complexes (CDH23/PCDH15) essential for sound transduction. While this disruption is reversible, we hypothesize that repeated TTS episodes may compromise tip link integrity and ultimately accelerate presbycusis. This project seeks to elucidate how recurrent acoustic trauma affects tip link structure and regeneration.

Internship Objectives

The student will characterize the structural and functional consequences of acoustic trauma on hair cell tip links in mouse models. Key aims include:

1. Quantifying tip link breakage after single/repeated TTS using super-resolution microscopy.
2. Correlating ultrastructural damage with functional hearing thresholds.

Methodology

The internship integrates three experimental phases:

- **Acoustic Trauma Induction:** The student will expose mice to calibrated noise (8–16 kHz, 95 dB SPL, 2 hours) to induce TTS. Auditory Brainstem Responses (ABRs) and otoacoustic emissions will monitor pre/post-trauma hearing thresholds.
- **Cochlear Dissection & Immunolabeling:** The student will carry out dissection of cochlea and immunostaining of CDH23, PCDH15, and actin. She/he will then visualize the sample under confocal or STED microscope.

- **Structural-Functional Correlation:** Using confocal/STED imaging, the student will quantify tip link integrity via CDH23/PCDH15 colocalization. Time-series sampling (1h–48h post-trauma) will track regeneration dynamics. Data will be cross-referenced with ABR thresholds to establish mechanistic links between tip link disruption and hearing loss.

Training and Skills Development

The student will gain rare expertise in auditory neuroscience techniques: murine auditory phenotyping, cochlear dissection, microscopy (confocal/STED), and quantitative image analysis. They will participate in interdisciplinary team meetings, contributing to experimental design and data interpretation.

Scientific or technical background required for work program

We seek a master's student in neuroscience, cell biology, or biomedical engineering with a strong academic record. Prior experience in histology or microscopy is advantageous but not essential. The ideal candidate should be meticulous, with problem-solving aptitude and enthusiasm for translational sensory research.

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