

PASTEUR COURSE

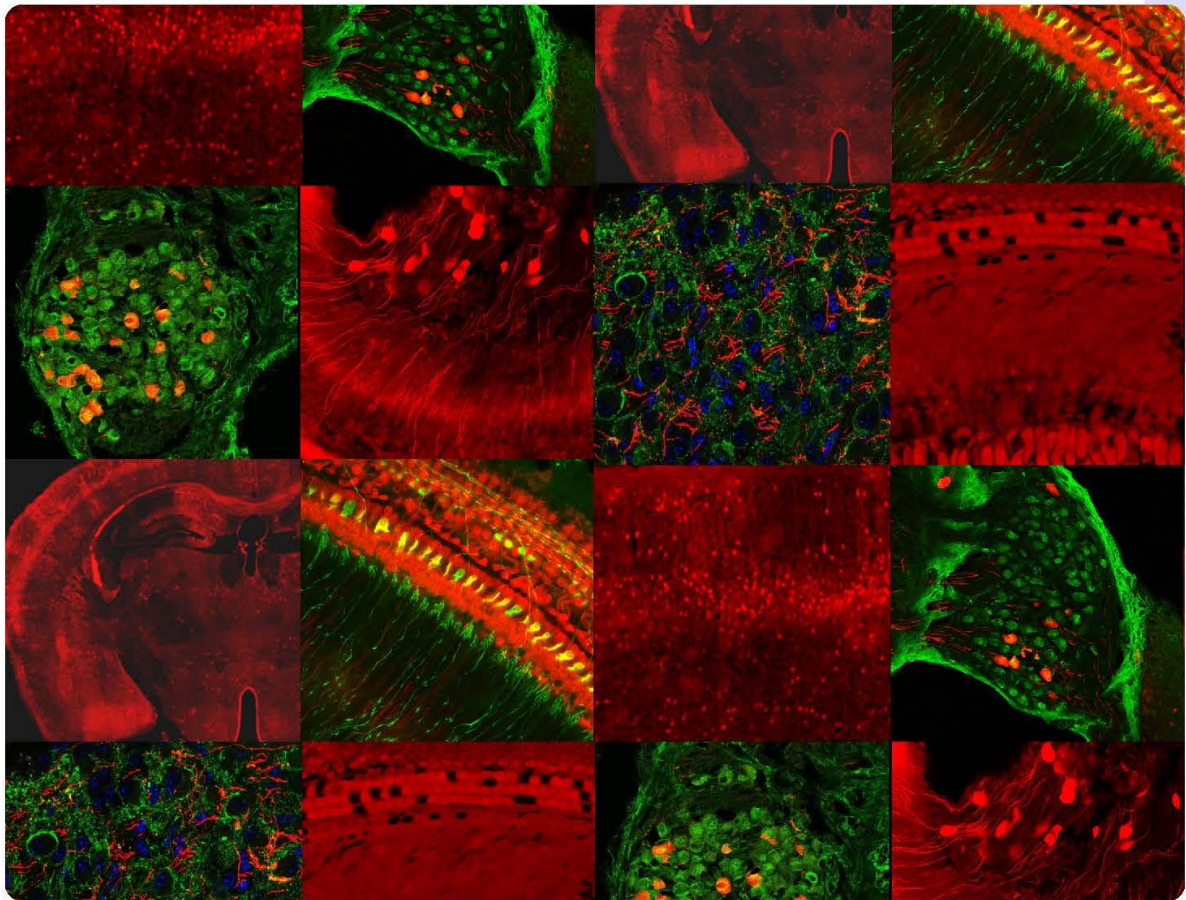
Hearing: from mechanisms to restoration technologies



Institut de l'Audition
Institut Pasteur, Paris



October 19 - 30, 2026



Principles of acoustics and wave signal processing:

- *Sound pressure wave propagation*
- *Effects of the physical environment: absorption, reflection, impedance*
- *Sound pressure measurement scales*
- *Soundscapes and sound proofing*
- *Spectral decomposition and spectrograms*
- *Anatomical and biomechanical characteristics of the outer ear*

9:00 - 9:30	Welcome, general information, student presentation	R. Etournay B. Gourévitch, S. Vitry (IdA, IP - Paris)
9:30 - 10:30	The auditory system - anatomy and principles of hearing	B. Bathellier (IdA, IP - Paris)
10:40 - 12:00	Principles of acoustics	J.L. Le Carrou (LAM - Paris)
12:00 - 13:30	LUNCH BREAK	
13:30 - 18:00 All students	Anatomy, biomechanics and acoustic of the outer ear Introduction to programming of sound synthesis, delivery and recording (Matlab) - Generation of pure tones and more complex sounds - Spectral decomposition - Calibration of sound delivery: intensity and equalisation	A. Coez B. Gourévitch (IdA, IP - Paris)

- *Perceptual features in auditory perception: tonality, sonic, sound localisation, rugosity*
- *Measurement methods in psychoacoustics.*
- *Temporal sequences and predictions*

9:00 - 10:50	Perception and psychoacoustics	D. Arzounian (IdA, IP - Paris)
11:00 - 12:00	Auditory attributes (Course delivered remotely)	O. Macherey (CNRS - Marseille)
13:30 - 18:00 All students	Using Matlab for generating and quantifying experiments auditory perception experiments Psychoacoustic protocols: - Sound localization - Measuring intensity perception - Simple auditory illusions	B. Gourévitch (IdA, IP - Paris)

Wednesday, October 21st 2026 Institut de l' Audition Day 3: Mechano-electric transduction and amplification

- *Physical principles governing the mechano-electric transduction and sound amplification.*
- *Molecules, cells and structures involved in sound detection and spectral analysis.*

9:00 - 10:25	Sound amplification and distortions by hair cells	P. Martin (Institut Curie - Paris)
10:30 -11:55	Genetics of mechano-electrical transduction	M. Bowl (UCL - London)
13:30 -18:00 Group 1	<u>Practical Course 3:</u> Otoacoustic emissions and distortion products. - <i>Better understand the meaning of otoacoustic emissions and their link to normal and impaired cochlea performances</i> - <i>Electrocochleography</i>	P. Avan (IdA, IP - Paris) CERIAH staff
13:30 -18:00 Group 2	<u>Practical Course 8:</u> Functional exploration of the audiovestibular deficits in transgenic mice: - <i>ABR recordings and interpretation in Shaker mutant and WT mice, including masking conditions.</i> - <i>Behavioral tests for locomotion swimming and oculo-vestibular reflex</i>	S. Vitry (IdA, IP - Paris) CERIAH staff

Thursday, October 22nd 2026 Institut Pasteur Day 4: Synaptic transmission & organoids

- *Synaptic exocytosis, neurotransmitters and the molecular specificities of the auditory system from hair cells to brainstem*

9:00 - 10:00	The ribbon synapse: molecular anatomy and pathophysiology	S. Safieddine (IdA, IP - Paris)
10:15 - 11:45	From inner ear development to basic principles of inner-ear organoid generation.	R. Etournay (IdA, IP - Paris)
13:30 - 18:00 All students	<u>Practical Course 6:</u> Dissection and staining of mouse cochlea for imaging in PRACTICAL COURSE 7 on days 7 and 8	S. Vitry (IdA, IP - Paris)

Friday, October 23th 2026 Institut de l'Audition Day 5: Auditory impairments and cochlear implant

- *Clinical survey of middle and inner ear pathologies (presbycusis, ototoxicity, sound trauma)*
- *Inner and middle ear surgery*
- *Cochlear implants and hearing aids*

9:00 - 10:00	Clinical survey of middle and inner ear pathologies	V. Torres Lazo (IdA, IP - Paris)
10:05 - 11:00	Electrical stimulation and coding strategies for cochlear implants	M. Hoen (Cochlear - Toulouse)

11:15 - 12:00	Hearing aids	C. Coudert (Audika - Paris)
---------------	--------------	---------------------------------------

LUNCH BREAK + feedback session

13:30 -14:00	Inner and middle ear surgery	Y. Nguyen (IdA, IP – Paris)
--------------	------------------------------	---------------------------------------

All students 14:00 -18:00	<u>Practical Course 5:</u> - <i>Simulation of a surgery with a robot or a virtual simulator</i> - <i>Analysis of scanner images from post-surgery patients</i>	Y. Nguyen, V. Torres Lazo (IdA, IP - Paris)
------------------------------	--	---

Monday, October 26th 2026	Institut de l'Audition	Day 6: From molecules to functions
---	-------------------------------	---

- *From anatomy to audiology*

9:00 - 10:25	How molecular physiology of the auditory system underpins a new audiology	P. Avan (IdA, IP - Paris)
--------------	---	-------------------------------------

10:30 - 11:55	Hereditary auditory and vestibular defects: from genes to functions	C. Bonnet (IdA, IP - Paris)
---------------	---	---------------------------------------

13:30 - 18:00 Group 2	<u>Practical Course 3:</u> Otoacoustic emissions and distortion products - <i>Better understand the meaning of otoacoustic emissions and their link to normal and impaired cochlea performances</i> - <i>Electrocochleography</i>	P. Avan (IdA, IP - Paris) CERIAH staff
--------------------------	--	---

13:30 - 18:00 Group 1	<u>Practical Course 8:</u> Functional exploration of the audiovestibular deficits in transgenic mice: - <i>ABR recordings and interpretation in Shaker mutant and WT mice including masking conditions.</i> - <i>Behavioral tests for locomotion swimming and oculo-vestibular reflex</i>	S. Vitry (IdA, IP - Paris) CERIAH staff
--------------------------	--	--

Tuesday, October 27th 2026	Institut de l' Audition	Day 7: Central auditory system
--	--------------------------------	---------------------------------------

- *From genes to functions*
 - *Anatomy and physiology of the central auditory system*
 - *Main structures, connectivity, receptive fields, neural coding schemes*

9:00 - 10:25	Neural population codes and links with artificial intelligence	B. Bathellier (IdA, IP - Paris)
--------------	--	---

10:35 - 12:00	Auditory system anatomy and main functions	J.M. Edeline (CNRS - Saclay)
---------------	--	--

13:30 - 18:00 Group 1	<u>Practical Course 4:</u> Access the temporal aspects of auditory processing through field recordings electrophysiology in humans, by in depth dissection of ABR signals to extract the following concepts: - <i>responding sub-populations.</i> - <i>synchrony,</i> - <i>stability of unitary responses</i> - <i>associated psychoacoustics</i>	P. Avan (IdA, IP - Paris) CERIAH staff
13:30 - 18:00 Group 2a	<u>Practical Course 9:</u> Two-photon imaging in vivo - <i>Theory of two-photon microscopy and calcium imaging</i> - <i>Training on commercial two-photon microscope</i> - <i>Imaging in auditory and other sensory cortex in vivo in mice during stimulus presentation</i> - <i>Data analysis using state of the art pipelines</i>	B. Bathellier M. Brunstein (IdA, IP - Paris)
13:30 - 18:00 Group 2b	<u>Practical Course 7:</u> Confocal microscopy of mutant and wild type mice cochlea stained in PRACTICAL COURSE 5. Quantitative analysis for a comparative study of cochlear morphology in normal and hearing-impaired mutant mice.	M. Brunstein S. Vitry (IdA, IP - Paris)

Wednesday, October 28th 2026 Institut de l' Audition Day 8: Cortical circuits and plasticity

- *Functional architecture of the cortical circuits*
- *Plasticity of the auditory system and critical periods*

09:00 -10:25	Optogenetics as a tool to study and restore auditory functions	J. Barral (IdA, IP - Paris)
10:30 - 11:55	Experience dependent plasticity in the auditory cortex	T. Barkat (University of Basel - Paris)
13:30 - 18:00 Group 2	<u>Practical Course 4:</u> Access the temporal aspects of auditory processing through field recordings electrophysiology in humans, by in depth dissection of ABR signals to extract the following concepts: - <i>responding sub-populations.</i> - <i>synchrony,</i> - <i>stability of unitary responses</i> - <i>associated psychoacoustics.</i>	P. Avan (IdA, IP - Paris) CERIAH staff
13:30 - 18:00 Group 1a	<u>Practical Course 9:</u> Two-photon imaging in vivo - <i>Theory of two-photon microscopy and calcium imaging</i> - <i>Training on commercial two-photon microscope</i> - <i>Imaging in auditory and other sensory cortex in vivo in mice during stimulus presentation</i> - <i>Data analysis using state of the art pipelines.</i>	B. Bathellier M. Brunstein (IdA, IP - Paris)

13:30 - 18:00 Group 1b	<u>Practical Course 7:</u> Confocal microscopy of mutant and wild type mice cochlea stained in PRACTICAL COURSE 5. Quantitative analysis for a comparative study of cochlear morphology in normal and hearing-impaired mutant mice.	M. Brunstein S. Vitry (IdA, IP – Paris)
---	---	---

Thursday, October 29th 2026 Institut de l'Audition Day 9: Auditory, cognition and communication: predictive and emotional processing

The lectures will present the neural bases of auditory perception and communication with an emphasis on vocal, musical, and emotional processing. In particular, they will focus on:

- *recent cognitive and neurophysiological models of auditory processing that emphasize the hierarchical and predictive nature of perception.*
- *the neural pathways and mechanisms involved in the processing of ecologically relevant sounds, with a particular focus on vocal communication signals, whether verbal or non-verbal*

9:00 - 10:25	Auditory perception and predictions	K. Doelling (IdA, IP - Paris)
10:35 - 12:00	Vocal communication and auditory emotions	L. Arnal (IdA, IP - Paris)
13:30 - 18:00 All students	<u>Practical Course 11:</u> Acquisition and analysis of EEG data using classical paradigms and applying the signal processing techniques acquired at the beginning of the course - <i>data preprocessing and filtering.</i> - <i>Evoked potentials (oddball paradigm)</i> - <i>Spectro-temporal analysis (auditory steady-state responses)</i>	L. Arnal (IdA, IP - Paris)

Friday, October 30th 2026 Institut de l'Audition Day 10: Perspectives

- *Gene therapy approaches.*
- *New directions in audiology exploration opened by genetic results.*

9:00 - 10:25	Replacement Gene Therapy for Inner Ear Defect: from animal models to the clinic	S. Safieddine (IdA, IP - Paris)
10:35 - 12:00	Gene editing for hereditary deafness	A. El Amraoui (IdA, IP - Paris)
13:30 - 15:30	<u>Course Exam</u> Format of the examen: written exam with question on most theoretical parts of the course (except day 10).	R. Etournay, B. Gourevitch (IdA, IP - Paris)