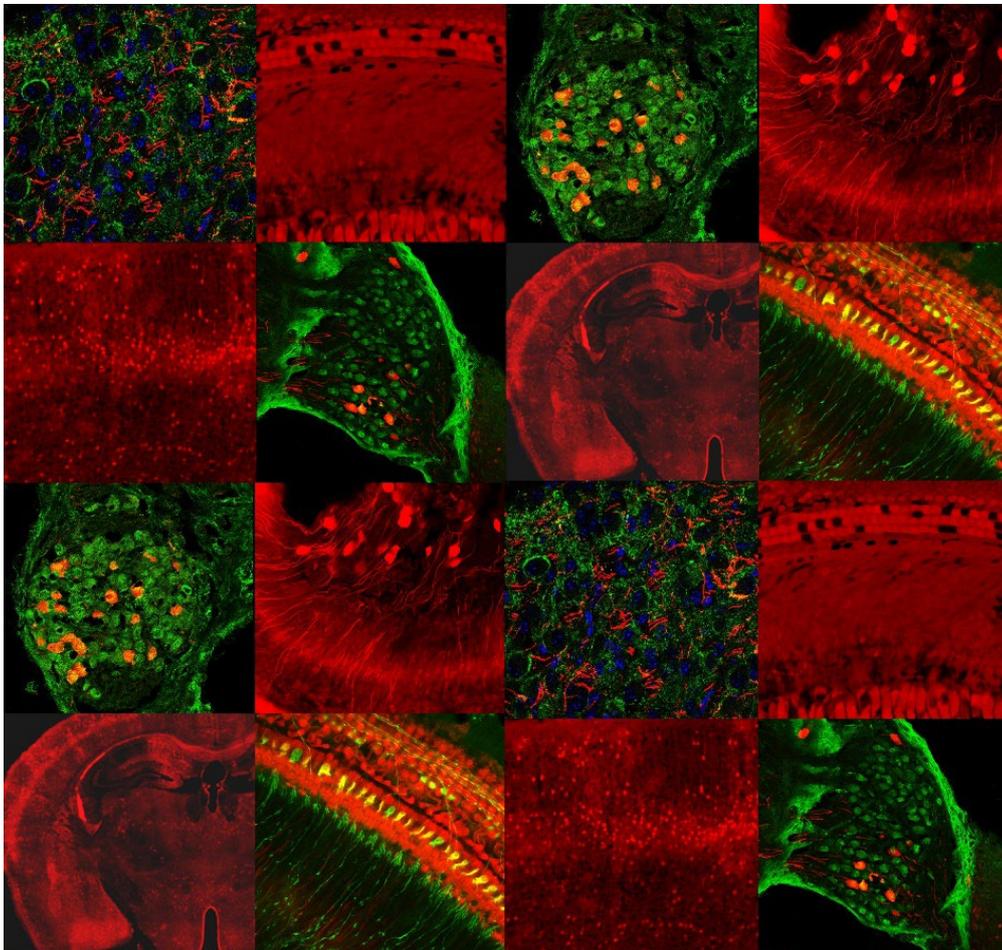


PASTEUR COURSE

HEARING: FROM MECHANISMS TO RESTORATION TECHNOLOGIES (HEAR)



Credit: N. Michalski, M. Gagliardini.

PROGRAM
FROM 5 TO 21 JUNE, 2023



HEARING COURSE 2022-2023

JUNE 5-21, 2023

DIRECTORS OF THE COURSE

BRICE BATHELLIER

**INSTITUT PASTEUR
INSTITUT DE L'AUDITION
(PARIS)**

✉: brice.bathellier@pasteur.fr

BORIS GOUREVITCH

**INSTITUT PASTEUR
INSTITUT DE L'AUDITION
(PARIS)**

✉: boris.gourevitch@pasteur.fr

HEAD OF PRACTICALS

**SANDRINE VITRY
INSTITUT PASTEUR
INSTITUT DE L'AUDITION**

✉: sandrine.vitry@pasteur.fr

Course content

Course locations.....	3
Day 1: Acoustics, signals and anatomy	4
Day 2: Auditory perception and psychoacoustics.....	4
Day 3: Mechano-electric transduction and amplification	5
Day 4: Auditory impairments and cochlear implant.....	5
Day 5: Synaptic transmission in the auditory system	6
Day 6: Inner ear: development, evolution and genetics of associated disorders	6
Day 7: Full day practical courses.....	7
Day 8: Hearing restoration by gene therapy and genetically-driven audiology	7
Day 9: Central auditory system.....	8
Day 10: Cortical circuits and plasticity	8
Day 11: Auditory cognition and communication: predictive and emotional processing	9
Day 12: Language processing and deep neural networks	9
Day 13: Vestibular function and disorders. Complex auditory deficits.	10
Wednesday, June 21rd 2023, Institut de l’Audition.....	10

Course locations

Day 1, 05/06	Day 2, 06/06	Day 3, 07/06	Day 4, 08/06	Day 5, 09/06
IdA	IdA	IdA	IdA	IdA
Day 6, 12/06	Day 7, 13/06	Day 8, 14/06	Day 9, 15/06	Day 10, 16/06
Institut Pasteur	IP (am) / IdA (pm)	IdA	IdA	IdA
Day 11, 19/06	Day 12, 20/06	Day 13, 21/06		
IdA	IdA	IdA		

IdA: Institut de l’Audition, 63 rue de Charenton, 75012 Paris

Mornings: Ground floor, Auditorium. Afternoons: Ground floor, Teaching room (salle modulable)

Institut Pasteur: 28 rue du Dr Roux, 75015 Paris. Education Center Classroom 2 (Pavillon Emile Roux) and Practicals (Pavillon Louis Martin).

Day 1: Acoustics, signals and anatomy

Monday, June 5th 2023, Institut de l'Audition

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 et biomechanical characteristics of the outer ear*

MORNING

09:00-09:30	Welcome, general information, student presentation	
9:30-10:30	The auditory system – anatomy and principles of hearing	B. Bathellier
	BREAK	
10:40-12:30	Principles of acoustics	O. Warusfel
	LUNCH BREAK: Buffet at Ida	

AFTERNOON

13:30-18:00	PRACTICAL COURSE 1: Anatomy, biomechanics and acoustic of the outer ear Introduction to programming of sound synthesis, delivery and recording (Matlab/Python) - Generation of pure tones and more complex sounds - Spectral decomposition - Calibration of sound delivery: intensity and equalisation	A. Coez B. Gourevitch
All students		

Day 2: Auditory perception and psychoacoustics

Tuesday, June 6th 2023, Institut de l'Audition

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

MORNING

09:30-11:15	Perception and psychoacoustics	D. Pressnitzer
11:30-12:30	A broadoverviewof threemain auditoryattributes:Loudness, Pitch and Timbre	O. Macherey
	LUNCH BREAK	

AFTERNOON

13:30-18:00	PRACTICAL COURSE 2: Using Matlab/Python for generating and quantifying experiments auditory perception experiments. Psychoacoustic protocols: - Sound localization - Measuring intensity perception - Simple auditory illusions	B. Gourevitch O. Macherey
All students		

Day 3: Mechano-electric transduction and amplification

Wednesday, June 7th 2023, Institut de l'Audition

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

MORNING

09:00-09:55	Sound amplification and distortions by hair cells	P. Martin
10:00-10:55	Genetics of mechano-electrical transduction	N. Michalski
11:00-11:55	Cochlear physiology and mechanics	J. Barral
	LUNCH BREAK	

AFTERNOON

13:30-18:00 Group 1	PRACTICAL COURSE 3: Otoacoustic emissions and distortion products. - Better understand the meaning of otoacoustic emissions and their link to normal and impaired cochlea performances - Electrocochleography	Paul Avan, CERIAH staff
13:30-18:00 Group 2	PRACTICAL COURSE 8: Functional exploration of the audiovestibular deficits in transgenic mice: - ABR recordings and interpretation in Shaker mutant and WT mice, including masking conditions - behavioral tests for locomotion swimming and occulo-vestibular reflex	S. Vitry and IdA/CERIAH staff

Day 4: Auditory impairments and cochlear implant

Thursday, June 8th 2023, Institut de l'Audition

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

MORNING

09:00-10:00	Clinical survey of middle and inner ear pathologies	E. Ferrary D. Dulon
10:00-10:30	Inner and middle ear surgery	Y. Nguyen
10:30-11:15	Hearing aids	C. Coudert
11:15-12:00	Electrical stimulation and coding strategies for cochlear implants	M. Cosnard
	LUNCH BREAK	

AFTERNOON

14:00-18:00 All students	PRACTICAL COURSE 5: - Simulation of a surgery with a robot or a virtual simulator - Analysis of scanner images from post-surgery patients	Y. Nguyen E. Ferrary
------------------------------------	--	-------------------------

Day 5: Synaptic transmission in the auditory system

Friday, June 9th 2023, Institut de l'Audition

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

MORNING

09:00-09:45	Molecular anatomy of auditory synapses	S. Safieddine
09:50-11:05	Synaptic transmission of the ribbon synapse	D. Dulon
11:10-12:00	Auditory nerve processing and giant synapses	N. Michalski
12:00-12:15	Feedback session 1	
	LUNCH BREAK	

AFTERNOON

13:30-18:00 Group 2	PRACTICAL COURSE 4: 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: - responding sub-populations - synchrony - stability of unitary responses - associated psychoacoustics	P.Avan and CERIAH staff
13:30 - 18:00 Group 1	PRACTICAL COURSE 8: Functional exploration of the audiovestibular deficits in transgenic mice: - ABR recordings and interpretation in Shaker mutant and WT mice, including masking conditions - behavioral tests for locomotion swimming and occulo-vestibular reflex	S. Vitry and IdA/CERIAH staff

Day 6: Inner ear: development, evolution and genetics of associated disorders

Monday, June 12th 2023, Institut Pasteur

- *Development and evolution of the cochlea.*
- *Functional interpretations in the light of the major genes involved.*

MORNING

09:00-10:00	From inner ear development to basic principles of inner-ear organoid generation	R. Etournay
10:00-11:00	Evolution of inner ear and hair cells : effects and consequences	A. El Amraoui
11:00-12:00	Hereditary auditory and vestibular defects : from genes to functions	C. Petit
	LUNCH BREAK	

AFTERNOON

13:30-18:00 All students	PRACTICAL COURSE 6: Dissection of the cochlea of mutant and wild type Shaker mice for staining and imaging in PRACTICAL COURSE 7 on on day 7	S. Vitry
------------------------------------	---	----------

Day 7: Full day practical courses

Tuesday, June 13th 2023, Institut Pasteur/ Institut de l'Audition

MORNING (IP)

09:00-12:00 All students	PRACTICAL COURSE 6: Immuno-staining <i>in toto</i> of the cochlea of mutant and wild type Shaker mice for imaging in PRACTICAL COURSE 7 Course on fluorescence microscopy	S. Vitry
LUNCH BREAK		

AFTERNOON (IdA)

14:30-18:30 Group 1	PRACTICAL COURSE 7: 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	S. Vitry M. Brunstein
14:30-18:30 Group 2	PRACTICAL COURSE 3: Otoacoustic emissions and distortion products. - Better understand the meaning of otoacoustic emissions and their link to normal and impaired cochlea performances - Electrocochleography	Paul Avan, CERIAH staff

Day 8: Hearing restoration by gene therapy and genetically-driven audiology

Wednesday, June 14th 2023, Institut de l'Audition

- *Role of genes in auditory-vestibular defects*
- *Gene therapy approaches*
- *New directions in audiology exploration opened by genetic results*

MORNING

09:00-10:00	Replacement Gene Therapy for Inner Ear Defect: from animal models to the clinic	S. Safieddine
10:00-11:00	Gene editing for hereditary deafness	C. Petit
11:00-12:00	How molecular physiology of the auditory system underpins a new audiology	P. Avan
LUNCH BREAK		

AFTERNOON

13:30-18:00 Group 2	PRACTICAL COURSE 7: 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	S. Vitry M. Brunstein
-------------------------------	---	--------------------------

Day 9: Central auditory system

Thursday, June 15th 2023, Institut de l'Audition

- *Anatomy and physiology of the central auditory system*
- *Main structures, connectivity, receptive fields, neural coding schemes*
- *Models of auditory processing*

MORNING

09:00-10:50	Auditory system anatomy and main functions	J.M. Edeline
--------------------	--	--------------

11:00-12:00	Neural population imaging in the auditory system	B. Bathellier
--------------------	--	---------------

LUNCH BREAK

AFTERNOON

13:30-18:00 All students split in two halves (Analysis / Imaging)	PRACTICAL COURSE 9: Two-photon imaging <i>in vivo</i> <ul style="list-style-type: none">- Theory of two-photon microscopy and calcium imaging- Training on commercial two-photon microscope- Imaging in auditory and other sensory cortex <i>in vivo</i> in mice during stimulus presentation- Data analysis using state of the art pipelines	B. Bathellier M. Brunstein
--	--	-------------------------------

Day 10: Cortical circuits and plasticity

Friday, June 16th 2023, Institut de l'Audition

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

MORNING

09:00-10:30	The forefront of central auditory system research	A. King
--------------------	---	---------

10:30-12:00	Experience dependent plasticity in the auditory cortex	T. Barkat
--------------------	--	-----------

12:00-12:30	Feedback session 2	
--------------------	---------------------------	--

LUNCH BREAK

AFTERNOON

14:00-18:00 All students split in two halves (Analysis / Imaging)	PRACTICAL COURSE 10: Two-photon imaging <i>in vivo</i> <ul style="list-style-type: none">- Theory of two-photon microscopy and calcium imaging- Training on commercial two-photon microscope- Imaging in auditory and other sensory cortex <i>in vivo</i> in mice during stimulus presentation- Data analysis using state of the art pipelines	B. Bathellier M. Brunstein
--	---	-------------------------------

Day 11: Auditory cognition and communication: predictive and emotional processing

Monday, June 19th 2023, Institut de l'Audition

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.

MORNING

09:00-10:25	Auditory perception and predictions	K. Doelling
	BREAK	
10:35-12:00	Vocal communication and auditory emotions	L. Arnal
	LUNCH BREAK	

AFTERNOON

13:30-18:00	PRACTICAL COURSE 11: Acquisition and analysis of EEG data using classical paradigms and applying the signal processing techniques acquired at the beginning of the course - data preprocessing and filtering - Evoked potentials (oddball paradigm) - Spectro-temporal analysis (auditory steady-state responses)	L. Arnal
Half-group		

Day 12: Language processing and deep neural networks

Tuesday, June 20nd 2023, Institut de l'Audition

- Language processing.
- Automated speech recognition, voice synthesis.
- Deep networks and artificial intelligence: principles, comparisons with brain circuit computations and potential for restoration approaches.

MORNING

09:00-10:50	Introduction to deep networks and automated speech processing	R. Serizel
11:00-12:00	Analogies and differences between deep neural networks and sensory systems	B. Bathellier
	LUNCH BREAK	

AFTERNOON

13:30 - 18:00	PRACTICAL COURSE 12: Introduction to the tools used in artificial intelligence in Python - Classification of sensory object (images and sounds) - Classification of musical genres	S. Bagur
Half-group		

Day 13: Vestibular function and disorders. Complex auditory deficits

Wednesday, June 21rd 2023, Institut de l'Audition

- *Supraliminal deficits and new pathologies of hearing.*
- *Partial auditory disorders, central distortions, tinnitus, hyperacusia, neuropathies and synaptopathies.*
- *Vestibular physiology and disorders, multisensory integration and conflicts, static and dynamics balance.*
- *Vestibular aging*

MORNING

09:00 - 9:55	Diagnosing complex auditory disorders with speech-in-noise and objective measures	H. Thai Van
10:00 - 10:55	The molecular and cellular bases of auditory synaptopathies	D. Dulon
11:00 - 12:00	TBA	S. Wiener-Vacher
	LUNCH BREAK	

AFTERNOON

13:30 - 14:00	Feedback session 2	
14:00 - 16:00	Course exam. Format of the examen: written exam with questions on most theoretical parts of the course (except day 13)	