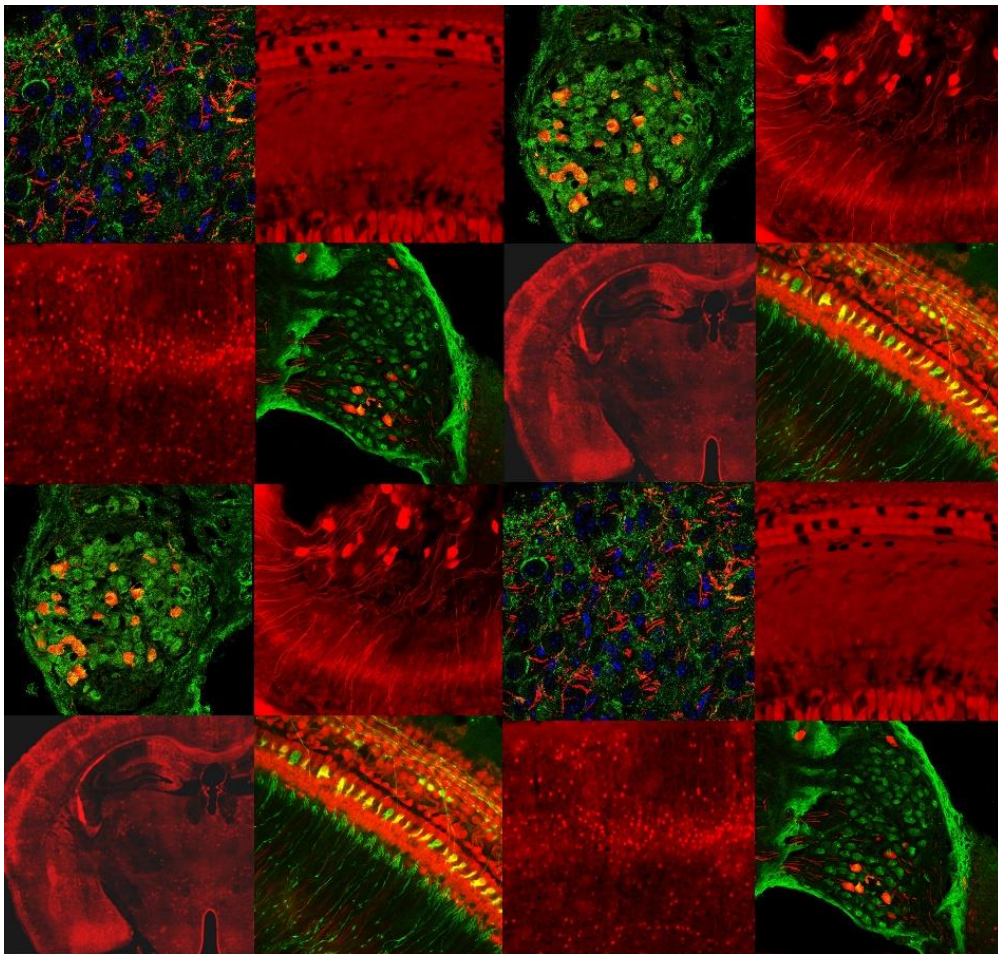


PASTEUR COURSE

HEARING: FROM MECHANISMS TO RESTORATION TECHNOLOGIES (HEAR)



Credit: N. Michalski, M. Gagliardini.

PROGRAM
FROM 7 TO 23 JUNE, 2022

HEARING COURSE 2021-2022

JUNE 7-23, 2022

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Day 1: Acoustics, signals and anatomy

June 7th 2022

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

9:00-10:50	Principles of acoustics	O. Warusfel
	BREAK	
11:00-12:00	Anatomy, biomechanics and acoustic of the outer ear	A. Coez
	LUNCH BREAK	

AFTERNOON

13:30-18:00	Introduction to programming of sound synthesis, delivery and recording (Matlab/Python)	B. Gourevitch A. Coez
All students	<ul style="list-style-type: none"> - Generation of a pure tone and more complex sounds - Spectral decomposition - Calibration of sound delivery: intensity and equalisation 	

Day 2: Auditory perception and psychoacoustics

June 8th 2022

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

MORNING

9:00 - 10:45	Perception et psychoacoustics (TBC)	D. Pressnitzer
11:00 - 12:00	TBA	O. Macherey
	LUNCH BREAK	

AFTERNOON

13:30-18:00	Using Matlab/Python for generating and quantifying experiments auditory perception experiments.	B. Gourevitch O. Macherey
All students	Psychoacoustic protocols: <ul style="list-style-type: none"> - Sound localization - Measuring intensity perception - Simple auditory illusions 	

Day 3: Mechano-electric transduction and amplification

June 9th 2022

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

MORNING

9:00 – 9 :55	Cochlear physiology and mechanics	J. Barral
10:00 - 10:55	Genetics of mechano-electrical transduction	N. Michalski
11:00 - 11:55	Sound amplification and distortions by hair cells	P. Martin
	LUNCH BREAK	

AFTERNOON

13:30-18:00 Group 1	<u>PRACTICAL COURSE 3</u> : 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	<u>PRACTICAL COURSE 8</u> : 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: Synaptic transmission in the auditory system

June 10th 2022

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

MORNING

9:00 - 9 :45	Molecular anatomy of auditory synapses	S. Safieddine
9: 50 - 11:05	Synaptic transmission of the ribbon synapse	D. Dulon
11:10 - 12:00	Auditory nerve processing and giant synapses	N. Michalski
	LUNCH BREAK	

AFTERNOON

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: - responding sub-populations. - synchrony, - stability of unitary responses - associated psychoacoustics.	P.Avan and CERIAH staff
13:30-18:00 Group 1	<u>PRACTICAL COURSE 8</u> : 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 5: Inner ear: development, evolution and genetics of associated disorders

June 13th 2022

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

MORNING

9:00 - 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	<u>PRACTICAL COURSE 5</u> : Immuno-staining <i>in toto</i> of the cochlea of mutant and wild type Shaker mice for imaging in PRACTICAL COURSE 7	S. Vitry
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Day 6: Auditory impairments and cochlear implant

June 14th 2022

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

MORNING

9:00-10:00	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	Electrical stimulation and coding strategies for cochlear implants	V. Pean
11:15-12:00	Hearing aids	J. Flament
	LUNCH BREAK	

AFTERNOON

13:30-18:00 All students	<u>PRACTICAL COURSE 6</u> : <ul style="list-style-type: none"> - Simulation of a surgery with a robot or a virtual simulator. - Analysis of scanner images from post-surgery patients. 	Y. Nguyen E. Ferrary
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Day 7: Hearing restoration by gene therapy and genetically-driven audiology

June 15th 2022

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

MORNING

9:00 - 10:00	Gene editing for hereditary deafness	C. Petit
10:00 - 11:00	Replacement Gene Therapy for Inner Ear Defect: from animal models to the clinic	S. Safieddine
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 1	<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.	S. Vitry M. Brunstein
13:30-18:00 Group 2	<u>PRACTICAL COURSE 3</u> : 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: Vestibular function and disorders. Complex auditory deficits.

June 16th 2022

- *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

9:00 - 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

13:30-18:00 Group 2	<u>PRACTICAL COURSE 7</u> : Confocal microscopy of mutant and wild type mice cochlea stained in <u>PRACTICAL COURSE 5</u> : Quantitative analysis for a comparative study of cochlear morphology in normal and hearing-impaired mutant mice.	S. Vitry M. Brunstein
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: - responding sub-populations. - synchrony, - stability of unitary responses - associated psychoacoustics.	P.Avan and CERIAH staff

Day 9: Central auditory system

June 17th 2022

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

MORNING

9:00 - 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	PRACTICAL COURSE 9 : Two-photon imaging in vivo - Theory of two-photon microscopy and calcium imaging - Training on commercial two-photon microscope - Imaging in auditory and other sensory cortex in vivo in mice during stimulus presentation - Data analysis using state of the art pipelines.	B. Bathellier M. Brunstein
All students split in two halves (Analysis / Imaging)		

Day 10: Cortical circuits and plasticity

June 20th 2022

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

MORNING

9:00 - 10:00	The forefront of central auditory system research	A.King
10:00 - 10:55	Experience dependent plasticity in the auditory cortex	T. Barkat
11:00 - 12:00	Central deficits in genetic models of hearing impairments	N. Michalski
	LUNCH BREAK	

AFTERNOON

13:30-18:00	PRACTICAL COURSE 10 : Two-photon imaging in vivo - Theory of two-photon microscopy and calcium imaging - Training on commercial two-photon microscope - Imaging in auditory and other sensory cortex in vivo in mice during stimulus presentation - Data analysis using state of the art pipelines.	B. Bathellier M. Brunstein
All students split in two halves (Analysis / Imaging)		

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

June 21st 2022

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

9:00 - 10:25	Auditory perception and predictions	B. Morillon
	BREAK	
10:35 - 12:00	Vocal communication and auditory emotions	L. Arnal
	LUNCH BREAK	

AFTERNOON

13:30 - 18:00 Half-group	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 <ul style="list-style-type: none">- data preprocessing and filtering- Evoked potentials (oddball paradigm)- Spectro-temporal analysis (auditory steady-state responses)	L. Arnal
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Day 12: Language processing and deep neural networks

June 22nd 2022

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

MORNING

9:00 - 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 Half-group	PRACTICAL COURSE 12: Introduction to the tools used in artificial intelligence in Python. <ul style="list-style-type: none">- Classification of sensory object (images and sounds).- Classification of musical genres.	B. Bathellier
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Day 13: Course exam

June 23rd 2022

- *Format of the exam : TBA*

MORNING

LUNCH BREAK

AFTERNOON