WELCOME ADDRESS

This international inaugural meeting formally marks the birth of the Hearing Institute*, a new Institut Pasteur center created with the objective of promoting integrative approaches to auditory neuroscience and developing innovative diagnostic tools, and preventive and curative treatments for hearing disabilities. It was created with support and funding from the Fondation Pour l’Audition.

We will create an inspiring and dynamic atmosphere, with 19 plenary talks from international speakers alternating with presentations from a selection of Hearing Institute team leaders, and other young scientists from the research community. Participants will have many opportunities for exchanges, not only during the conference sessions, but also during the poster sessions, lunches, and the gala dinner.

We would like to take this opportunity to thank the Collège de France warmly for hosting this inaugural meeting of the Hearing Institute.

* The Hearing Institute, a Center of the Institut Pasteur, created on the initiative of Fondation Pour l’Audition and Institut Pasteur, is an interdisciplinary fundamental and medical research center with the objective of promoting integrative approaches to auditory neuroscience and developing innovative diagnostic tools and curative treatments for hearing disabilities.

The Institut Pasteur, a non-profit foundation with recognized charitable status set up by Louis Pasteur in 1887, is today an internationally renowned center for biomedical research with a network of 32 institutes worldwide. In the pursuit of its mission to prevent and control diseases in France and throughout the world, the Institut Pasteur operates in four main areas: research, public health, education and training, valorisation and technology transfer.

The Fondation Pour l’Audition, created by Françoise Bettencourt Meyers, Jean-Pierre Meyers, and the Fondation Bettencourt Schueller, and recognized as a public-interest organization since 2015, aims to unite talents to promote breakthroughs in hearing health and help improve the everyday lives of people with hearing loss.
INVITED SPEAKERS

May-Britt Moser (NTNU, Norway)
Jean-Julien Aucouturier (IRCAM, Paris)
Karen Avraham (Tel Aviv Univ., Israel)
Volker Bormuth (Sorbonne Univ., Paris)
Steve Brown (MRC Harwell, UK)
David DiGregorio (Institut Pasteur, Paris)
Robert Fettiplace (Univ. of Wisconsin, USA)
Paul Fuchs (J. Hopkins Univ., USA)
Stefan Heller (Stanford Univ., USA)
Ingeborg Hochmair (MED-EL, Austria)
James Hudspeth (Rockefeller Univ., USA)
Andrew King (Oxford Univ., United Kingdom)
Charles Liberman (Harvard Univ, USA)
Brigitte Malgrange (Liège Univ., Belgium)
Pascal Martin (Institut Curie, France)
Tobias Moser (Goettingen Univ., Germany)
Israel Nelken (Hebrew Univ. of Jerusalem, Israel)
Nicolas Renier (ICM, Paris)
Botond Roska (IOB, Switzerland)
Shihab Shamma (ENS, Paris)
Carla Shatz (Stanford Univ., USA)
Christoph Schmidt-Hieber (Institut Pasteur, Paris)
Robert Zatorre (McGill Univ., Canada)
Fan-Gang Zeng (Univ. of California Irvine, USA)

Christine Petit (Hearing Institute)
Luc Arnal (Hearing Institute)
Brice Bathellier (Hearing Institute)
Aziz El Amraoui (Hearing Institute)
Yann Nguyen (Hearing Institute)
Said Safieddine (Hearing Institute)
Hung Thái-Van (Hearing Institute)

ORGANIZING COMMITTEE

Christine Petit, Director of the Hearing Institute
Paul Avan, Director of CERIAH, Hearing Institute
Brice Bathellier, Team leader, Hearing Institute
Nicolas Michalski, Team leader, Hearing Institute
CONFERENCE VENUE

The conference will be held at the Collège de France (11 Place Marcelin Berthellot, 75005 Paris)

The Collège de France, founded in 1530, is a higher education and research establishment. It is located in the Latin Quarter, in the 5th arrondissement of Paris, across the street from the historical campus of La Sorbonne.
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GENERAL INFORMATION

Registration
The registration desk will open at 8.30 am on Monday September 16. Congress assistance staff will also be present during the coffee breaks, lunches and gala dinner.
The Collège de France is open to the public. We would therefore ask you not to leave any personal belongings unattended in the auditorium.

Plenary sessions
Scientific oral presentations will take place in the Marguerite de Navarre auditorium.

Poster sessions
Poster sessions will take place in the rooms adjacent to the Collège de France foyer, during the coffee and lunch breaks.

Lunches and coffee breaks
All coffee breaks and lunches will be held in the Collège de France foyer.
INAUGURAL DINNER

The inaugural dinner will take place at La Coupole restaurant on Monday September 16, at 8 pm.

102, boulevard de Montparnasse
75014 PARIS
SCIENTIFIC PROGRAM
Monday, September 16, 2019

Opening of the registration 8.30 am

Welcome address and introductory words 9 am-9.45 am
9.00 am: Prof. Thomas Römer, Administrator of the Collège de France
9.05 am: Prof. Stewart Cole, President of the Institut Pasteur
9.15 am: Prof. Gilles Bloch, President of the Inserm
9.25 am: Mr. Jean-Pierre Meyers, President of the Fondation pour l’Audition
9.35 am: Prof. Christine Petit, Director of the Hearing Institute, and Prof. Paul Avan, Director of the Center for Research and Innovation in Human Audiology (CERIAH)

Session 1: Inaugural session, Neural circuits 9.45 am – 10.50 am
Chair: Botond Roska and Shihab Shamma

9.45 am: Keynote lecture: The functional diversity of entorhinal cells: space, time and memory
May-Britt Moser, Kavli Institute for Systems Neuroscience, Trondheim, Norway

10.30 am: Cellular and circuit mechanisms of spatial representations
Christoph Schmidt-Hieber, Neuroscience Department, Institut Pasteur, Paris, France

Coffee break (and group photo) 10.50 – 11.10 am

Session 2: Cochlear development and physiology 11.10 am – 1 pm
Chair: Paul Avan and Andrei Kozlov

11.10 am: Mechanical properties of tip-link proteins
James Hudspeth, The Rockefeller University, New York, USA

11.40 am: Mechanical tuning of the hair bundle for frequency-selective auditory detection
Pascal Martin, Institut Curie, Paris, France

12 am: The contribution of TMC1 to hair cell transduction
Robert Fettiplace, University of Wisconsin, Madison, USA

12.30 pm: Human induced pluripotent stem cells as a tool for modeling and understanding hereditary deafness
Brigitte Malgrange, Liège University, Liège, Belgium

Lunch & Poster Session 1 1 pm – 2.30 pm
Session 3: Central auditory processing 2.30 pm – 4.20 pm
Chair: Luc Arnal and Boris Gourévitch

2.30 pm: Adaptive coding in the central auditory system
Andrew King, University of Oxford, Oxford, United Kingdom

3 pm: Keeping time in the cerebellum
David Digregorio, Neuroscience Department, Institut Pasteur, Paris, France

3.30 pm: Targeted cortical manipulation of auditory perception
Brice Bathellier, Hearing Institute, Paris, France

3.50 pm: Context sensitivity in audition: from perception to the brain and back
Israel Nelken, The Hebrew University of Jerusalem, Jerusalem, Israel

Coffee break 4.20 pm – 4.50 pm

Session 4: Cochlear implants 4.50 pm – 6.40 pm
Chair: Charles Liberman and Adrien Eshraghi

4.50 pm: The importance of translational research with current sensorineural prostheses
Ingeborg Hochmair, MED-EL, Innsbruck, Austria

5.20 pm: RobOtol: a teleoperated robotic system dedicated to middle ear and cochlear implant surgery
Yann Nguyen, CIC AP-HP (Pitié-Salpêtrière)/INSERM, Hearing Institute, Paris, France

5.40 pm: Challenges and opportunities in cochlear implants
Fang-Gang Zeng, University of California – Irvine, USA

6.10 pm: Towards the optical cochlear implant: optogenetic stimulation of the auditory pathway
Tobias Moser, University of Goettingen, Goettingen, Germany

Dinner at La Coupole restaurant 8.00 pm
Tuesday, September 17, 2019

Session 5: Cochlear development and pathology  9 am – 10.50 am
Chair: Paul Fuchs and Raphaël Etournay

9 am: Epigenomics of the auditory system: implications for hearing and deafness
Karen Avraham, Tel Aviv University, Tel Aviv, Israel

9.30 am: Single-cell transcriptomic analysis reveals the temporal order of signaling events during avian cochlear hair cell regeneration
Stefan Heller, Stanford University, Stanford, USA

10 am: Disease mechanisms & therapies in progressive hearing loss: insights from tetraspan-like proteins
Aziz El Amraoui, Hearing Institute, Paris, France

10.20 am: Surveying the genetic landscape of auditory function: mouse models of hearing loss
Steve Brown, MRC Harwell, Oxford, United Kingdom

Coffee break  10.50–11.20 am

Session 6: Sensory circuits and multifaceted plasticity  11.20 am – 1 pm
Chair: David DiGregorio and Nicolas Michalski

11.20 am: Developmental critical periods and synapse pruning: why I can't learn to speak French without an accent!
Carla Shatz, Stanford University, Stanford, USA

11.50 am: Functional whole-brain imaging in larval zebrafish
Volker Bormuth, Laboratoire Jean Perrin, Sorbonne Université, CNRS, Paris, France

12.10 am: Organization and plasticity of the central auditory vasculature
Nicolas Renier, Institut du Cerveau et de la Moëlle Epinière, Paris, France

12.30 am: The human retina at single-cell resolution
Botond Roska, Institute of Molecular and Clinical Ophtalmology, Basel, Switzerland

Lunch & Poster Session 2  1 pm – 2.30 pm
Session 7: Human hearing: from salient sounds to music  2.30 pm – 4.10 pm  
Chair: Andrew King and Israel Nelken

2.30 pm: The sound of salience: how roughness enhances aversion through neural synchronization  
Luc Arnal, Hearing Institute, Paris, France

2.50 pm: Predispositions and plasticity in auditory-motor learning: hemispheric asymmetries  
Robert Zatorre, McGill University, Montreal, Canada

3.20 pm: Reverse-correlation of social prosody in healthy participants and brain-stroke survivors  
Jean-Julien Aucouturier, Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris, France

3.40 pm: Neuroplasticity and the musical experience  
Shihab Shamma, Laboratoire des systèmes perceptifs, Ecole Normale Supérieure, Paris, France

Coffee break  4.10 pm – 4.40 pm

Session 8: Hearing loss and rehabilitation  4.40 pm – 6.30 pm  
Chair: Fan-Gang Zeng and Frank R. Lin

4.40 pm: Hidden hearing loss: mechanisms, prevalence and therapies for cochlear synaptopathy  
Charles Liberman, Harvard University, Boston, USA

5.10 pm: Testing the afferent auditory pathway in subjects with conventional or implanted hearing prostheses: from the periphery to the brain  
Hung Thai-Van, Hearing Institute, Paris, France

5.30 pm: Gene therapy durably reverses profound deafness in a DFNB9 mouse model  
Said Safieddine, Hearing Institute, Paris, France

5.50 pm: Investigating type II cochlear afferents  
Paul Fuchs, John Hopkins University School of Medicine, Baltimore, USA

6.20 pm: Concluding remarks  
Christine Petit, Director of the Hearing Institute, Paris, France
The Institut Pasteur

The Institut Pasteur, a non-profit foundation with recognized charitable status set up by Louis Pasteur in 1887, is today an internationally renowned center for biomedical research with a network of 32 institutes worldwide. In the pursuit of its mission to prevent and control diseases in France and throughout the world, the Institut Pasteur operates in four main areas: research, public health, education and training, and development of research applications.

More than 2,500 people work on its Paris campus. The Institut Pasteur is a globally recognized leader in infectious diseases, microbiology, and immunology. Other avenues of investigation include cancer, genetic and neurodegenerative diseases, genomics and developmental biology. This research aims to expand our knowledge of the living world in a bid to lay the foundations for new prevention strategies and novel therapeutics. Since its inception, 10 Institut Pasteur scientists have been awarded the Nobel Prize for Medicine, including two in 2008 for the 1983 discovery of the human immunodeficiency virus (HIV) that causes AIDS.

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Thank you
To our sponsors, supporters and donors.
ORAL PRESENTATIONS – Abstracts
Session 1: Inaugural session, Neural circuits

Keynote lecture: The functional diversity of entorhinal cells: space, time and memory

May-Britt Moser
Kavli Institute for Systems Neuroscience, Trondheim, Norway

Medial entorhinal cortex is involved in mapping self-motion, self-location and object-location. The first functional cell type to be discovered in the jungle of space-responsive cells in entorhinal cortex was the grid cell. Grid cells show periodic firing patterns when animals move around in open environments, tessellating any environment with a regular hexagonal firing pattern and providing a possible metric for local navigation. Grid cells intermingle with a spectrum of other functional cell types, such as head direction cells, speed cells, border cells and object vector cells. In contrast to the spatial elements in medial entorhinal cortex, the lateral entorhinal cortex associates space and items, and space and time. These neural representations of the medial and lateral entorhinal cortices form a framework for episodic memory in the hippocampal region.

Cellular and circuit mechanisms of spatial representations

Christoph Schmidt-Hieber
Neuroscience Department, Institut Pasteur, Paris, France

How are neuronal representations of the spatial environment generated at the level of synapses, neurons, and neuronal circuits? Neurons in the hippocampal formation produce striking spatial firing patterns that may provide the brain with a cognitive map of the environment. In this talk I will show how we combine computational modelling, in vivo and in vitro recordings to understand how multisensory inputs contribute to spatially modulated firing at the synaptic, cellular and network level. We address this question in several key circuits that are critical for spatial cognition and memory, such as the medial entorhinal cortex, the dentate gyrus, and the medial prefrontal cortex.
Session 2: Cochlear development and physiology

Mechanical properties of tip-link proteins
James Hudspeth
The Rockefeller University, New York, USA
An essential feature of every sensory hair cell is an array of filamentous tip links, consisting of the proteins protocadherin 15 (PCDH15) and cadherin 23 (CDH23), whose tension gates the cell's transduction channels. Using a high-precision optical trap, we show that an individual monomer of PCDH15 acts as an entropic spring that is much softer than its enthalpic stiffness alone would suggest. This low stiffness implies that the protein is a significant part of the gating spring that controls a hair cell's transduction channels; moreover, the tip link's entropic nature allows for control of its stiffness through modulation of its tension.

Mechanical tuning of the hair bundle for frequency-selective auditory detection
Pascal Martin
Institut Curie, Paris, France
Sound analysis by the cochlea relies on frequency tuning of mechanosensory hair cells along a tonotopic axis. Different frequencies are detected by different hair cells, which are each dedicated to the detection of a particular frequency component of the sound input. Despite its critical importance for hearing, the mechanism that specifies the characteristic frequency of a given hair cell has remained elusive. In this talk, I will focus on the contribution of active and passive micromechanical properties of the hair bundle—the mechanoreceptive antenna of the hair cell—and argue that their tonotopic gradients may help tune the characteristic frequency of the hair cell.
The contribution of TMC1 to hair cell transduction
Robert Fettiplace
University of Wisconsin, Madison, USA

Cochlear hair cells transduce sound into electrical signals by activation of mechano-electrical transducer (MET) channels localized in the stereociliary bundle and thought to be formed partly by transmembrane channel-like protein TMC1. We have obtained a range of evidence that TMC1 contributes to the channel properties, tonotopic gradient and adaptation of the MET channels. Most recently, we generated a single aspartate/asparagine substitution in mouse TMC1, homologous to a human genetic deafness. The main consequence was reduction in the calcium permeability of the MET channel, which was accompanied by much reduced channel expression, leading within four weeks to death of outer hair cells and deafness. Our findings on the mouse mutant account for the dominant human deafness, and imply that TMC1, besides forming the MET channel, can regulate its own expression.

Human induced pluripotent stem cells as a tool for modeling and understanding hereditary deafness
Brigitte Malgrange
Liège University, Liège, Belgium

Centrosomal genes are targeted by mutations in numerous human disorders characterized by numerous clinical symptoms including deafness. The molecular mechanisms that give rise to deafness are still unknown. Here, we used human induced pluripotent stem (hiPS) cells generated from fibroblasts of healthy and patients with centrosomal mutations to decipher to pathophysiological role of mutated centrosomes in deafness. We established hiPS cells from patient fibroblasts using non-integrative Sendai viral vectors. These cell lines were validated in vitro and in vivo. Using a 3D protocol, we generate inner ear organoids and demonstrate that healthy and pathological hiPSCs can generate a population of otic progenitor cells that are then able to differentiate into hair cells (HCs), supporting cells and neurons. Using this model, we characterized proliferative capabilities, differentiation aptitudes and cell death in normal and pathological organoids. This new human derived organoid model provides insights regarding molecular mechanisms that drive centrosomal network during normal and pathological inner ear development.
Adaptive coding in the central auditory system
Andrew King
University of Oxford, Oxford, United Kingdom
This talk will consider the neural circuits and strategies that enable the brain to adjust to the statistics of the auditory scene—such as variations in contrast as the background noise level changes—and the functional consequences of doing so, as well as to longer lasting changes in inputs that result from hearing impairments. In addition to providing insights into the adaptive capabilities of the auditory system, our findings indicate that different forms of plasticity may represent therapeutic targets for restoring perceptual abilities following hearing loss.

Keeping time in the cerebellum
David Digregorio
Neuroscience department, Institut Pasteur, Paris, France
Humans process auditory information spanning a bandwidth of three orders of magnitude, from tens of kilohertz to seconds. Speech perception spans phonemes (tens of milliseconds), syllables (hundreds of milliseconds) and intonation (up to a second) and requires the ability to predict sequences of sounds. How the brain uses networks of neurons to precisely represent this information is not known. The cerebellar feedforward neural circuit excels in precise temporal representation of information, and that can be used to learn well-timed behaviors. Although it is not considered a classical auditory processing region, growing evidence suggests the cerebellum is critical for the precise representation of temporally rich sounds. We recently demonstrated that synapses in the cerebellar input layer exhibit diverse short-term changes in synaptic strength that act as dynamic variables in the circuit, and thus could provide the cellular substrate for representing and learning temporal patterns of sensory information in the sub-second range. I will summarize our recent experimental and theoretical work showing that synaptic dynamics is necessary to encode temporal features of sensory stimuli, and present our hypothesis for how these mechanisms might be important for sound duration discrimination.
Targeted cortical manipulation of auditory perception
Brice Bathellier
Hearing Institute, Paris, France
Driving perception by direct activation of neural ensembles in cortex is a necessary step for achieving a causal understanding of the perceptual code and developing central sensory rehabilitation methods. Here, using optogenetic manipulations during an auditory discrimination task in mice, we show that auditory cortex can be short-circuited by coarser pathways for simple sound identification. Yet, when the sensory decision becomes more complex, involving temporal integration of information, auditory cortex activity is required for sound discrimination and targeted activation of specific cortical ensembles changes perceptual decisions as predicted by our readout of the cortical code. Hence, auditory cortex representations contribute to sound discriminations by refining decisions from parallel routes.

Context sensitivity in audition: from perception to the brain and back
Israel Nelken
The Edmond and Lily Safra Center for Brain Sciences and the Dept. of Neurobiology, the Silberman Institute of Life Sciences, Hebrew University, Jerusalem, Israel
Context influences heavily responses to sounds as well as its perception. This is a well-known fact, and yet its consequences are not always fully appreciated. I will discuss a number of case studies of contextual effects, large and small, in perception and in brain responses. I will describe what we know about the underlying mechanisms, and speculate about the reasons for their existence.
Session 4: Cochlear implants

The importance of translational research with current sensorineural prostheses
Ingeborg Hochmair
MED-EL, Innsbruck, Austria

RobOtol: a teleoperated robotic system dedicated to middle ear and cochlear implant surgery
Yann Nguyen
CIC AP-HP (Pitié-Salpêtrière)/INSERM, Hearing Institute, Paris, France
Otolological surgery is performed in a deep workspace through a narrow approach (external auditory meatus or mastoid) and requires long and thin instruments with sub millimetric precision and precise amplitude of motion. It could benefit from a robot-based assistance. The RobOtol project was developed to fulfill these objectives. A functional prototype of a surgical assistance robot was developed. It has been evaluated on multiple models and has reached a clinical stage. The first results on patients will be reported.
Challenges and opportunities in cochlear implants
Fang-Gang Zeng
University of California – Irvine, USA
Cochlear implants have restored partial hearing to more than half million deaf people worldwide. The cochlear implant allows most users to carry on a conversation over phones, but the implant performance is limited in music perception and noisy listening situations. The implant accessibility is also limited as most people in low-to-middle income countries cannot afford it. To address the performance limitation, we need to improve the electrode design from an intra-cochlear array to an intra-neural array or even optogenetic stimulation. To address the accessibility limitation, we need to encourage competition, build infrastructure, and most importantly change the present low-volume, high-price business model to a low-price, high-volume one.

Towards the optical cochlear implant: optogenetic stimulation of the auditory pathway
Tobias Moser
University of Goettingen, Goettingen, Germany
When hearing fails, cochlear implants (CIs) provide open speech perception to most of the currently half a million CI users. CIs bypass the defective sensory organ and stimulate the auditory nerve electrically. The major bottleneck of current CIs is the poor coding of spectral information, which results from wide current spread from each electrode contact. As light can be more conveniently confined, optical stimulation of the auditory nerve presents a promising perspective for a fundamental advance of CIs. Moreover, given the improved frequency resolution of optical excitation and its versatility for arbitrary stimulation patterns the approach also bears potential for auditory research. Developing optogenetic stimulation for auditory research and future CIs requires efforts toward design and characterization of appropriate optogenetic actuators, viral gene transfer to the neurons, as well as engineering of multichannel optical CIs. The presentation will summarize the current state of optogenetic stimulation of the auditory pathway and report on recent breakthroughs on achieving high temporal fidelity and frequency resolution and establishing multichannel optical CIs.
Tuesday, September 17, 2019

Session 5: Cochlear development and pathology

Epigenomics of the Auditory System: Implications for Hearing and Deafness
Karen Avraham
Department of Human Molecular Genetics & Biochemistry, Sackler Faculty of Medicine and Sagol School of Neuroscience, Tel Aviv University, Tel Aviv, Israel

Given that hearing loss affects hundreds of millions of people worldwide, the challenge in auditory science is to determine how a pathogenic variant in a gene or regulatory element can cause the entire hearing system to fail. Our team is asking the questions: How does regulation of gene expression govern the pathways that determine inner ear function and how do alterations in regulation, on a genetic and epigenetic level, contribute to the pathology of deafness? To answer these questions, we are exploring a genome-wide view of the regulatory elements playing a role at different steps of maturation and functionality of the inner ear.

Single cell transcriptomic analysis reveals temporal order of signaling events during avian cochlear hair cell regeneration
Stefan Heller
Stanford University, Stanford, USA

Despite decades of studies, we still do not fully understand the mechanisms by which the normally mitotically quiescent chicken cochlea orchestrates a regenerative program. We have analyzed single cell RNA-Seq data from pure cochlear sensory epithelia obtained at various time points during and after aminoglycoside-induced hair cell death. We found evidence for a regenerative program that is distinctively different from simply utilizing developmental mechanisms. Specifically the candidates for early triggers that lead to cell cycle entry of supporting cells are comprised of a number of pathways previously not considered in the context of hair cell regeneration. I will talk about our efforts to functionally link these candidate pathways with cell cycle entry.
Disease mechanisms & therapies in progressive hearing loss: insights from tetraspan-like proteins
Aziz El Amraoui
Hearing Institute, Paris, France
Progressive hearing impairment, the most frequent sensory deficit, causes communication difficulties, often associated with social isolation, depression and reduced physical and cognitive function, with a dramatic economic impact on healthcare systems worldwide. Whatever the cause, genetics, environmental factors, or aging; the pathology of hearing deterioration often includes irreversible damage of sensory hair cells and/or the associated auditory primary neurons: the cellular targets we are focusing on in the team. Recently, we characterized the role of clarin-1, a tetraspan-like protein whose defect is responsible for post-lingual hearing loss in humans, combined with vision loss. In a collaborative work with M. Bowl, S. Brown (MRC, Harwell), a newly identified mutation was observed in clarin-2 encoding gene also causing hearing impairment, supporting a key role of this clarin family in the inner ear. Using these mutant deaf mice as model systems, we bring together a wide spectrum of experimental approaches to i) better understand the related-disease mechanisms and relationship with environment, and iii) devise and validate solutions for the underlying pathogenic processes.

Surveying the genetic landscape of auditory function: mouse models of hearing loss
Steve Brown
MRC Harwell, Oxford, United Kingdom
Much of the human and mouse genomes remains dark, and we know little of the function of around half of the genes in the mammalian genome. Indeed, large-scale genetic screens in the mouse indicate that there is an extensive and unexplored landscape of genes involved in auditory function, with potentially hundreds of uncharacterised genes involved with hearing impairment. Exploration of this unexplored landscape can bring huge benefits to our understanding of the auditory machinery and, importantly, translational insights that will underpin the developments of novel therapies for hearing loss. I will illustrate this by focusing on the discovery and characterisation of mouse models of chronic otitis media and their role in understanding mechanisms of middle ear inflammation and the development of new therapeutic approaches.
Session 6: Sensory circuits and multifaceted plasticity

Developmental critical periods and synapse pruning: why I can't learn to speak French without an accent!
Carla Shatz
Stanford University, Stanford, USA
Neural activity and sensory experience are needed to fine tune brain circuits during developmental critical periods. Neural activity also regulates the expression of sets of genes, including several previously thought to act only in the immune system. Certain activity-regulated genes — including major histocompatibility class I family members and paired immunoglobulin-like receptor B — are required in neurons for synapse pruning and plasticity. Unexpectedly, they may also contribute to excessive synapse pruning in Alzheimer’s disease.

Functional whole-brain imaging in larval zebrafish
Volker Bormuth
Laboratoire Jean Perrin, Sorbonne Université, CNRS, Paris, France
The larval zebrafish brain is in toto accessible to optical microscopy thanks to is small size and its transparency. Using light-sheet microscopy it is now possible to record simultaneously all 100k neurons of the larval brain with single-cell resolution. I will present system level analysis of spontaneous and stimulus evoked brain-wide neuronal activity. And I will highlight our recent development of a rotating light-sheet microscope that compares to a flight simulator and that makes dynamic vestibular stimulation compatible with function whole-brain imaging. The system provides a unique tool for systematically studying vestibular processing in the vertebrate brain and extends the potential of virtual-reality systems to explore complex multisensory and motor integration during simulated 3D navigation.
Organization and plasticity of the central auditory vasculature
Nicolas Renier
Institut du Cerveau et de la Moelle Epinière, Paris, France
The vasculature of the brain is a complex network of arteries, capillaries and veins that provide nutrients to neurons and glia. However, the rules that govern the homeostatic organization of the topology of this network to match the demands of neurons are unclear. The challenge in deciphering those rules lie in our current limited capacity to reconstruct the organization and orientation of blood flow through the brain in 3D with accuracy at a large scale. We present here tools for the reconstruction and analysis of the oriented graph of the cerebral blood vessels based on light sheet microscopy and tissue clearing. The analysis of these graphs provides insights into the variations, consistency and dynamic adjustments of the brain vasculature in the auditory regions of the brain in normal or deaf mouse models.

The human retina at single cell resolution
Botond Roska
Institute of Molecular and Clinical Ophthalmology Basel, Basel, Switzerland
The cell types and circuits of the human retina are not well understood. Here I discuss a set of new technologies that enable us to study the structure, function and disease mechanism of human retinal circuits at single cell resolution. First, I will discuss our work on post mortem human retinas, either naturally light responsive or artificially made light sensitive by cell type targeted optogenetic tools. Second, I discuss work on human retinal organoids with multiple nuclear and synaptic layers that we developed in large quantities. I will show how we model disease and develop therapies using these organoids.
Session 7: Human hearing: from salient sounds to music

The sound of salience: how roughness enhances aversion through neural synchronization
Luc Arnal
Hearing Institute, Paris, France
Human alarm vocalizations exploit aversive acoustic modulations in the roughness range (30-150 Hz) to capture attention and elicit rapid reactions. Here, I aim to describe the perceptual and neural mechanisms underlying aversion to such salient sounds. Using intracranial recordings, I will show that rough sounds do not merely affect local auditory processes but instead synchronize large-scale, supramodal, salience-related networks in a steady-state, sustained manner. This pattern correlates with subjective aversion, consistent with the hypothesis that roughness enhances auditory aversion through the spreading of neural synchronization.

Predispositions and plasticity in auditory-motor learning: hemispheric asymmetries
Robert Zatorre
Université McGill, Montréal, Canada
Our lab has focused on music as a powerful model for understanding plasticity in a human cognitive neuroscience context. This talk will present evidence that musical training modifies auditory and motor networks, and their functional and anatomical relationships, and that important asymmetries exist across the two hemispheres in these systems. We will also discuss evidence that individual differences in learning are related to functional features that may serve as predictors of later learning success. Our goal is to develop a better model of how the large-scale organization and asymmetries of auditory-motor networks relate to the experience-dependent plasticity that underlies complex skills such as playing a musical instrument, which may also have implications for speech.
Reverse-correlation of social prosody in healthy participants and brain-stroke survivors
Jean-Julien Aucouturier
Institut de Recherche et Coordination Acoustique/Musique (IRCAM), Paris, France
The CREAM ERC project (Cracking the emotional code of music, http://cream.ircam.fr), hosted in IRCAM, Paris, aims to bring together new technologies in audio signal processing and experimental research in the affective psychology/neuroscience of speech and music. In this talk, I will present a new research paradigm in which a voice manipulation tool (CLEESE, available here: http://forumnet.ircam.fr/product/cleese) is used to generate realistic and standardized voice stimuli to reverse-correlate cognitive judgements of social prosody, e.g. whether a speaker appears reliable, dominant or trustworthy. I will also describe how the paradigm can be used to study impairments of prosodic perception in right-hemisphere stroke patients.

Neuroplasticity and the musical experience
Shihab Shamma
Laboratoire des systèmes perceptifs, Ecole Normale Supérieure, Paris, France
How does the musical experience happen in the brain? What are the neural underpinnings that make music an emotive force that can simultaneously shape the mood and engage the intellect. In this talk, I shall first review recent findings on the encoding of music and its attributes both in human and animal brains. Then I describe experiments that explore the implicit learning of music, the process by which we acquire the music of our culture and immediate environment, and which in turn shapes our reactions to the music we hear. Finally, I shall discuss how one might track and quantify the active ongoing engagement with music during listening. It is our hope that understanding how music affects the human mind opens pathways to harnessing its emotive power in promoting health and healing.
Session 8: Hearing loss and rehabilitation

Hidden hearing loss: mechanisms, prevalence and therapies for cochlear synaptopathy
Charles Liberman
Harvard University, Boston, USA
In either noise-induced or age-related hearing loss, synaptic connections between cochlear sensory cells and primary sensory neurons are the first to degenerate. This cochlear synaptopathy can be widespread, even in ears where all the sensory cells survive. It affects our ability to understand speech in a noisy environment, without changing audiometric thresholds, and thus, has been called “hidden hearing loss”. Here, we will describe the histopathological evidence for the phenomenon in both animal and human ears, the mechanisms underlying its generation and the progress to date in developing therapies for synaptic reconnection.

Testing the afferent auditory pathway in subjects with conventional or implanted hearing prostheses: from the periphery to the brain
Hung Thai-Van
Hearing Institute, Paris, France
Millions of people across the world are hearing impaired, and rely on hearing aids to improve their everyday life. Electrophysiological markers of sound encoding have been proposed for optimizing the fitting of various types of hearing aids, either conventional or implanted. As a reflection of signal processing in the afferent auditory pathway, such markers are of paramount importance in non-communicative subjects, for whom they could serve as a basis for estimating audiometry thresholds. Here, I will review a 20-year experience of auditory evoked potentials’ recording, analysis and interpretation in subjects wearing a cochlear implant or an air conduction hearing aid. Interests, limitations, and perspectives of these audiological procedures will be discussed with respect to the future of hearing rehabilitation techniques.
**Gene therapy durably reverses profound deafness in a DFNB9 mouse model**

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Autosomal recessive genetic defects account for most cases of profound congenital deafness forms. Adeno-associated virus (AAV)-based gene therapy is a promising treatment option, but it is limited by a potentially short therapeutic window and the constrained packaging capacity of the AAV vector. In this study, we focus on the otoferlin (*OTOF*) gene underlying DFNB9, one of the most prevalent genetic forms of congenital deafness. We adopted a dual AAV approach allowing us to extend the limited packaging capacity (< 5 kb) of the AAV vector, and deliver the entire coding sequence of the otoferlin cDNA (6 kb) to the mouse inner hair cells. The otoferlin cDNA was split into two parts, which were inserted into two expression cassettes sharing a recombinogenic bridging sequence. These recombinant vectors were packaged in two individual AAV2 capsids. Upon co-infection of the same cell, the two AAV recombinant vectors formed head-to-tail concatamers that recombined, leading to the production of the full-length otoferlin. We report here, for the first time that single cochlear delivery of a fragmented cDNA by a dual-AAV vector approach can effectively restore the production of the full-length protein in a DFNB9 deaf mouse model, and results in a long-lasting restoration of hearing. Remarkably, this local gene therapy not only prevented deafness in *Otof*−/− mice when administered before hearing onset, but also reversed the deafness phenotype in a sustained manner when administered well after hearing onset. These results are highly significant for the future design of gene therapy trials in DFNB9 patients.

**Investigating type II cochlear afferents**

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Type II cochlear afferents are unmyelinated and project extensively along the rows of outer hair cells. This is in striking contrast to myelinated type I afferents that contact single inner hair cells to provide acoustic information. Available evidence shows that type II afferents are insensitive to sound and only weakly depolarized by outer hair cell release of glutamate, but respond strongly to ATP released by tissue damage. Genetically modified mice are used for specific expression of optogenetic or chemogenetic tools to advance our understanding of type II afferent function.
POSTER PRESENTATIONS – Titles
1. Unconventional secretory pathway activation restores hair cell mechanotransduction in an USH3A model
Alagramam Kumar (1,2,3), Gopal Suhasini (1), Lee Yvonne (1), Stepanyan Ruben (1,2), Mcdermott Jr Brian (1,2,3,4)
1 - Department of Otolaryngology, Case Western Reserve University (United States), 2 - Department of Neurosciences, Case Western Reserve University (United States), 3 - Department of Genetics and Genomic Sciences, Case Western Reserve University (United States), 4 - Department of Biology, Case Western Reserve University (United States)

2. Is the auditory pathway a feedforward network?
Barral Jérémie (1), Minocci Daiana (1)
1 - Institut de l'Audition (France)

3. A late critical period for complex sounds in the mouse auditory system
Bhumika Stitipragyan (1), Valerio Patricia (1), Solyga Magdalena (1), Barkat Tania (1)
1 - Department of Biomedicine, Basel University (Switzerland)

4. Transformation of sound representations between inferior colliculus and auditory cortex
Bourg Jacques (1), Kempf Alexandre (1), Tarpin Thibault (1), Bourien Jerome (2), Puel Jean-Luc (2), Bathellier Brice (1)
1 - Institut des Neurosciences de Paris-Saclay (France), 2 - Institut des Neurosciences de Montpellier - Déficits sensoriels et moteurs (France)

5. Local gene therapy durably restores vestibular function in a mouse model of Usher syndrome type 1G
Calvet Charlotte (1,2,3), Emptoz Alice (1,2,3), Michel Vincent (1,2,3), Lelli Andrea (1,2,3), Akil Omar (4), Boutet De Monvel Jacques (1,2,3), Lahlou Ghizlene (1,2,3), Meyers Anais (1,2,3), Dupont Typhaïne (1,2,3), Nouaille Sylvie (1,2,3), Ey Elodie (3), Franca De Barros Filipa (5), Beraneck Mathieu (5), Dulon Didier (2,6), Hardelin Jean-Pierre (3,2,1), Lustig Lawrence (7), Avan Paul (8), Petit Christine (3,2,9,1), Safieddine Saaid (3,2,10,1)
1 - Sorbonne Universités (France), 2 - INSERM, (France), 3 - Institut Pasteur (France), 4 - Department of Otolaryngology-Head and Neck Surgery, University of California (United States), 5 - Université Paris-Descartes (France), 6 - Laboratoire de Neurophysiologie de la Synapse Auditive, Bordeaux Neurocampus, Université de Bordeaux (France), 7 - Department of Otolaryngology-Head and Neck Surgery, Columbia University Medical Center and New York Presbyterian Hospital (United States), 8 - Laboratoire de Biophysique Sensorielle, Faculté de Médecine, Centre Jean Perrin, Université d'Auvergne (France), 9 - Collège de France (France), 10 - CNRS (France)
6. Targeted cortical manipulation of auditory perception in a challenging sound discrimination
Ceballo Sebastian (1), Zuzanna Piwkowska (2), Jacques Bourg (1), Daret Aurélie (1), Bathellier Brice (1)
1 - Paris-Saclay Institute of Neuroscience (NeuroPSI, France), 2 - Institut Pasteur (France)

7. A Theory for Measuring Tension Anisotropy using Non-Contact FM-AFM
Chadwick Richard (1,2)
1 - National Institutes of Health [Bethesda] (United States), 2 - NIDCD Scientist Emeritus (United States)

8. Size Control of the Hair-cell Bundles for Frequency-Selective Auditory Detection
Chaiyasitdhi Atitheb (1), Martin Pascal (1)
1 - Institut Curie (France)

9. Dual AAV-mediated gene therapy restores hearing in a DFNB9 mouse model
Ciric Danica (1,2,3), Calvet Charlotte (1,2,3), Akil Omar (4), Dyka Frank M. (5), Emptoz Alice (1,2,3), Lahlou Ghizlane (1,2,3), Nouaille Sylvie (1,2,3), Boutet De Monvel Jacques (1,2,3), Hardelin Jean-Pierre (1,2,3), Hauswirth William W (5), Avan Paul (6), Petit Christine (1,2,3,7), Lustig Lawrence R (8), Safieddine Saaid (1,2,3,9)
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10. Evaluating the Efficacy of Otoprotective Drugs for Cochlear Implantation Trauma with Electrical Stimulation using in vitro and in vivo Models
Eshraghi Adrien (1), Mittal Jeenu Shah Viraj, Garnham Carolyn, Shahal David, Bulut Erdoğan, Sinha Priyanka, Bohorquez Jorge, Mittal Rahul
1 - University of Miami Leonard M. Miller School of Medicine (United States)
11. Interaction between endogenous and evoked dynamics in the auditory cortex of awake mouse
Filipchuk Anton (1), Destexhe Alain (1), Bathellier Brice (1)
1 - Institut des Neurosciences de Paris-Saclay (France)

12. Audiogenic seizures, a paradigm to study the neuronal microcircuits of the auditory cortex
Gagliardini Mathilde, Dias Mora Monica, Michel Vincent, Delmaghani Sedigheh, Verpy Elizabeth, Dupont Typhaine, Postal Olivier, Gourévitch Boris, Petit Christine, Michalski Nicolas (1)
1 - Unité de Génétique et Physiologie de l'Audition (France)

13. The development of cooperative channels explains the maturation of hair cell's mechanotransduction
Gianoli Francesco (1), Risler Thomas (2), Kozlov Andrei (1)
1 - Department of Bio-Engineering [Imperial College London] (United Kingdom), 2 - Laboratoire de Physico-Chimie (France)

14. Implicit temporal predictions enhance pitch discrimination sensitivity, but do not improve duration discrimination
Herbst Sophie (1,2), Obleser Jonas (3), Van Wassenhove Virginie (1,2)
1 - CEA, DRF/Joliot, NeuroSpin, Saclay; INSERM, U992, Cognitive Neuroimaging Unit, Gif/Yvette (France), 2 - Université Paris-Saclay, Gif/Yvette (France), 3 - Department of Psychology, University of Luebeck, Germany (Germany)

15. Speech Auditory Brainstem Response through hearing amplification: A biomarker of hearing aid benefit
Joly Charles-Alexandre (1,2), Bellier Ludovic (3), Veuillet Evelyne (1,2), Vession Jean-François (1), Caclin Anne (2), Thai-Van Hung (1,4)
1 - Audiology and Otoneurological Diagnostic (France), 2 - Lyon Neuroscience Research Center (France), 3 - The Helen Wills Neuroscience Institute (United States), 4 - Hearing Institute - Paris (France)

Joly Charles-Alexandre (1,2), Truy Eric (3), Péan Vincent (4), Thai-Van Hung (1,5)
1 - Audiology and Otoneurological Diagnostic (France), 2 - Lyon Neuroscience Research Center (France), 3 - Department of Ear, Nose, Throat (France), 4 - MED-EL GmbH - France (France), 5 - Hearing Institute - Paris (France)
17. Cochlear implant in children: the first evaluation of the results in Tunisia
Marrakchi Jihene (1), Ksentini Amal (1), Mkaouar Rahma (2), Riahi Zied (2), Bonnet Crystel (3), Chahed Houda (1), Ben Amor Mohamed (1), Trabelsi Mediha (4), Petit Christine (5), Mokni Mourad (6), Mrad Ridha (4), Abdelhak Sonia (2), Besbes Ghazi (1)
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18. Spectrum of Syndromic Hearing Loss in Tunisia
Mkaouar Rahma (1), Mezzi Nessrine (1), Romdhane Lilia (1), Riahi Zied (1), Trabelsi Mediha (2), Marrakchi Jihene (3), Ksentini Amal (3), Bonnet Crystel (4), Chargui Mariem (1), Messaoud Oufa (1), Kraoua Ichraf (5), Zaouak Anissa (6), Turki Ilhem (5), Mokni Mourad (7), Petit Christine (8), Besbes Ghazi (3), Mrad Ridha (2), Abdelhak Sonia (4)
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19. Alpha-Mannosidosis: The first Report of Tunisian Patients
Mkaouar Rahma (1), Riahi Zied (1), Chelly Imen (2), Trabelsi Mediha (2), Boudabbous Hela (3), Marrakchi Jihene (4), Bonnet Crystel (5), Petit Christine (6), Tebib Neji (3), Besbes Ghazi (4), Abdelhak Sonia (1), Mrad Ridha (2)
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20. Clinical and Genetic Heterogeneity of Waardenburg Syndrome in Tunisian Population
Mkaouar Rahma (1), Riahi Zied (1), Charfeddine Cherine (1), Marrakchi Jihene (2), Bonnet Cristel (3), Chargui Mariem (1), Petit Christine (4), Besbes Ghazi (2), Mrad Ridha (5), Abdelhak Sonia (1), Trabelsi Mediha (5)
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21. Sea anemone Nematostella vectensis as a model to study Usher proteins interaction networks.
Michel Vincent (1), Carvalho Joao E (3), Ciric Danica (1), Röttinger Eric (3) and Petit Christine (1,2).
1 - Genetics and Physiology of Hearing Laboratory. Inserm UMRS 1120. UPMC. Institut Pasteur (France), 2 - Collège de France (France), 3 - Embryogenesis, Regeneration and Aging Laboratory, Institute for Research on Cancer and Aging (IRCAN), Inserm U1081-CNRS UMR7284 (France).

22. RobOtol: a robotic system for otology from lab to operating room
Yann Nguyen (1,2,3), Isabelle Mosnier (1,2,3), Ghizlene Lalhou (1,2,3), Daniele Bernardeschi (1,2,3), Stéphane Mazalaigue (2,3) Armand Czapinski (2,3) Evelyne Ferrary (1,2,3), Olivier Sterkers (1,2,3)
1 - Otolaryngology Department, Unit of Otology, Auditory Implants and Skull Base Surgery, Hospital Pitie-Salpêtrière, AP-HP (France), 2 - Sorbonne University, UMR S 1159 “Minimally Invasive Robot-based Hearing Rehabilitation”, UPMC University (France), 3 - Institut de l’Audition (France)

23. Clarin-2, a new tetraspan-like protein necessary for hearing
Patni Pranav (1,2), Dunbar Lucy, Aguilar Carlos, Delmaghani Sedighah, Parker Andrew, Lelli Andrea, Petit Christine (1,2), Dawson Sally, Marcotti Walter, Brown Steve, Bowl R., El-Amraoui Aziz (1,2)
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24. Clarin-1 defect results in a rescuable auditory hair cell synaptopathy in mice
Patni Pranav (1), Michel Vincent (2), Delmaghani Sedigheh (1), Aghaie Alain (2), Avan Paul (3), Safieddine Saaid (2), Dulon Didier (4), Petit Christine (2), El Amraoui Aziz (1)
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25. Age-related structural and functional changes at auditory hair cell ribbon synapses
Peineau Thibault (1), Bouleau Yohan (1), Belleudy Severin (1), Dulon Didier (1)
1 - Inserm et université de Bordeaux (France)

26. Dentate granule cells show different intrinsic properties depending on the behavioral context of their recruitment
Pléau Claire (1,3), Peret Angélique (1,3), Pearlstein Edouard (1,3), Scalfati Thomas (1), Vigier Alexandre (1), Marti Geoffroy (2), Michel François (1), Marissal Thomas (1), and Crépel Valérie (1)
1 - INMED, INSERM UMR1249, Aix-Marseille Université (France). 2 - ISM, Aix-Marseille Université, CNRS (France). 3 - These authors contributed equally to this work

27. Probing spectrotemporal modulation processing to better understand supra-threshold hearing deficits
Ponsot Emmanuel (1), Varnet Léo (1), Daoud Elza (2), Lorenzi Christian (1), Shamma Shihab (1), Wallaert Nicolas (1), Neri Peter (1)
1 - Laboratoire des systèmes perceptifs, Département d’études cognitives Ecole normale supérieure PSL University CNRS 75005 Paris France (France), 2 - Laboratoire Neurosciences Intégratives et Adaptatives, Aix-Marseille Université, UMR CNRS 7260, Centre Saint-Charles, Marseille France (France)

28. Characterizing the roles of parvalbumin interneurons requiring cdhr23 during development in sound processing of the auditory cortex
Postal Olivier (1,2), Dupont Typhaine, Libé-Phillippot Baptiste (1), Petit Christine (1), Michalski Nicolas (1), Gourévitch Boris (3)
1 - Unité de Génétique et Physiologie de l’Audition (France), 2 - Sorbonne Universite (France), 3 - Neuroscience Paris Saclay Institute (France)
29. Mice Like It Rough
Postal Olivier, Dupont Typhaine, Bakay Warren, Dominique Noémi, Petit Christine, Michalski Nicolas, Gourévitch Boris (1)
1 - Institut de l'Audition, UMR1120 (France)

30. Olfacto-tactile interactions in mice somatosensory areas wS1 and wS2
Renard Anthony (1), Harrell Evan (1), Bathellier Brice (1)
1 - Institut des Neurosciences de Paris-Saclay (France)

31. Is Serious Game-Based Learning a Good Therapeutic Option in Adult Cochlear receivers? Preliminary Results from an Intensive Listening-in-Noise Training Program
Reynard Pierre (1,2), Attina Virginie (1), Veuillet Evelyne (1,2), Thai-Van Hung (1,2)
1 - Department of Audiology and Otoneurological Evaluation (France), 2 - Paris Hearing Institute, Institut Pasteur, (France)

32. Modifying the resonance frequency between perilymphatic/endolymphatic spaces as an innovative treatment for third window lesions
Reyrand Pierre (1,2,3,4), Thai-Van Hung (5,6,7,8), Roiban Lucian (9), Veuillet Evelyne (1,10), Avan Paul (11,8,12), Ionescu Eugen (13,14,15)
1 - Hospices Civils de Lyon (France), 2 - Université Claude Bernard (France), 3 - Institut Audition (France), 4 - Inserm 1120 (France), 5 - Hospices Civils de Lyon (France), 6 - Inserm 1120, 1128 (France), 7 - Université Médecine Claude Bernard Lyon (France), 8 - Institut Audition (France), 9 - INSA Lyon (France), 10 - Inserm 1120 (France), 11 - Biophysique Neurosensorielle (France), 12 - INSERM 1107, INSERM 1120 (France), 13 - Hôpital Edouard Herriot (France), 14 - Inserm 1120 (France), 15 - Institut Audition (France)

33. Endoscopic calcium imaging of brainstem V2a stop neurons
Schwenkgrub Joanna (1), Gatier Edwin (1), Bouvier Julien (1), Bathellier Brice (1)
1 - Institut des Neurosciences de Paris-Saclay (France)

34. Auditory offset responses: from mechanisms to behavioural relevance
Solyga Magdalena (1), Barkat Tania (1)
1 - Department of Biomedicine, Basel University (Switzerland)

35. Composite receptive fields in the mouse auditory cortex
Steadman Mark (1), Kozlov Andrei (1)
1 - Department of Bioengineering, Imperial College London (United Kingdom)
36. **DNABarcodeCompatibility: an R-package for optimizing DNA-barcode combinations in multiplex sequencing experiments**
Trébeau Céline, Wong Jun Tai Fabienne, Boutet De Monvel Jacques (1,2,3), Etournay Raphael
1 - Sorbonne Universités (France), 2 - INSERM, (France), 3 - Institut Pasteur (France)

37. **A fast block of Ca2+ channels by proton release at mammalian auditory ribbon synapses: evidence for an otoferlin-dependent multivesicular process**
Vincent Philippe, Bouleau Yohan, Von Gersdorff Henrique, Dulon Didier (1)
1 - Inserm et université de Bordeaux (France)

38. **Setting-up of a Science Shop project on the early detection of hearing impairment among preschool and school children**
Zitouna Nadia (1), Zekri Lotfi Ali (2), Wardi Nesrinew (2), Marrakchi Jihene (3), Yosra Bouattour (2), Ben Hassine Hichem (4,5), Mkaouar Rahma (1), Mezzi Nesrine (1), Trabelsi Mediha (6), Tounsi Amel (7), Romdhane Lilia (1), Sakly Mouna (8), Hammouda Chokri (8), Mbarek Chiraz (9), Besbes Ghazi (3), Mrad Ridha (6), Abdelhak Sonia (1), Beltaief Lilia (10)
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39. **From marine invertebrate eggs to hearing loss: cyclin-dependent kinases inhibitors as drug candidates.**
Laurent Meijer(1) & Jonathan Elie(1)
1 - Perha Pharmaceuticals, Presqu’île de Perharidy, 29680 Roscoff, France

40. **Sponsor poster: Cochlear.**

41. **Sponsor poster: Sensorion.**

41. **Sponsor poster: Oticon.**
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