Linking Neural Circuits and Behaviour (LNCB)

Course layout, content and projects

COURSE CONTENT
A major challenge in system neuroscience is to understand how the mammalian brain support sensory perception and stores/recalls information that are necessary to the elaboration of an optimal action in an ever-changing environment. Cross-disciplinary technologies have provided unprecedented tools for mapping, visualizing and functional probing of single neural circuit in freely-moving animals.

Thus, it is now possible to link complex cell circuit activity to specific behaviour, ranging from precise visualization of cellular, synaptic or dendritic activities to opsion-based activation/silencing in freely-moving animals performing specific tasks. Integration of multimodal strategies - including electrophysiology, cellular imaging, behaviour - now allow both correlational and causal dissection of the brain, and, ultimately allow for more naturalistic, physiologically-relevant, understanding of single circuit integration into brain-wide assemblies supporting brain functions.

The goals of this 3-weeks advanced Cajal Course is to provide an in-depth exposure to current technologies in neurosciences through lectures and technical trainings. This will include hands-on training in state-of-the-art methods used for the anatomical and functional dissection of neural circuits underlying learning/memory, sleep, goal-oriented behaviours. These include optical microscopy, electrophysiology, optogenetic in freely behaving animals and functional imaging in human. Emphasis will be put on new methods for connectivity tracing, recordings and analysis of multichannel unit and local field potential data in behaving animals and data presentation.

In this 3-week course attendees will have the opportunity to hear state-of-the-art lectures from some of the most distinguished scientist and pioneers in the field of Neural circuits & Behaviours. In addition, over this 3-weeks course, all attendees will perform hands-on training in multiple key techniques used for the anatomical and functional dissection of neural circuits underlying learning/memory, sleep, goal-oriented behaviours.

COURSE LAYOUT and PROJECTS
The hands-on training includes core workshops and 2 modules of 9 days each.

During the workshops, all attendees will get hands-on training in 4 different approaches:
1) Opto-electronics: tetrodes, microdrives, tetrode and lens implantation
2) Basics of in vivo surgeries (anesthesia; stereotaxic injection; cranial window, post-op procedures)
3) Spiking data analysis (coding, spike sorting, high dimensionality reduction...)
4) Imaging data analysis (coding, spike sorting, ImageJ / Matlab)

These procedures & methods will be applied on consecutive days during the hands-on modules, working in small groups (4-5), to the anatomical and functional dissection of neural circuits. Based on their interests and set up availability, each student will follow two hands-on modules of 9 days each. Results of these hands-on modules will be presented and discussed at the end of the school. The lists of hands-on modules include:

Module #1: STED microscopy Imaging
Module #2: Clarity & light-sheet microscopy
Module #3: Correlation 2P-Electron microscopy

Module #4: 2P calcium imaging in cortex (soma, dendrites)
Module #5: 2P imaging of axonal long-range projection during anesthesia
Module #6: In vivo imaging of sleep circuit in the hypothalamus/thalamus/cortex (Miniscope, Inscopix)

Module #7: Optogenetic control of long-rang projection during patch-clamp/unit recording recording in awake head restrained mice.

Module #8: Optogenetic control of & unit recording in freely-moving mice – Sleep

Module #9: Optogenetic control of & unit recording in freely-moving mice – fear learning

Module #10: Optogenetic control of & unit recording in freely-moving mice – decision-making and spatial navigation

For the hands-on module, students should indicate their preferences (in order of preference; 1-5) at the time of registration, after they have been selected to attend, and will be distributed among projects accordingly.

**TYPICAL DAILY PROGRAM**

9.00-12.30: Seminars (1h30 per lecture, including questions and discussion/twice a week) with 2-3 speakers addressing innovative and advanced methodology as well as current results and questions in the field of “Neural circuits and Behaviour”. The students will introduce each speaker and will chair the session and “lunch with the speaker” discussions.

12.30-14.00: Lunch at the University cafeteria with the invited lecturers of the day.

9.00-20.00: Mini-projects, by group, under the supervision of one or two tutors.

20.00-21.00: Dinner

21.00-23.00: Scientific discussions, outreach or social event.

It is our aim that all attendees will leave this course with an excellent summary of the state of the art in this rapidly expanding field and with the essential skills to be implemented in their own scientific project. Finally, CAJAL courses should be exciting, interactive and fun!