Master de Sciences et Technologies
Mention Biologie Intégrative et Physiologie
Parcours : Neurosciences
Responsable : Professeur Régis Lambert

Internship Proposal
Academic Year 2019-2020

1. Host team :

Research Unit (e.g. Department or Institute) : NeuroPSI, CNRS UMR 9197 (department ICN, Integrative and Computational Neuroscience)

Research Unit Director : Philippe Vernier

Research Team Director : Thierry Bal

Team name : Thalamocortical Neurocybernetics (in 2020 the team name will be: Homeostasis, Perception and States)

Address : CNRS, 1avenue de la Terrasse, 91198, Gif-sur-Yvette (address will change in 2020)

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2. Internship project title :

Activity states in cortico-claustrum networks in a brain slice in vitro

3. Internship Description :

We use refined techniques to maintain spontaneous slow oscillations (resembling up and down states oscillations present in vivo during sleep and quiet wake) in preserved neural circuits in mouse brain slices, and explore dendritic dynamics in individual neurons using voltage sensitive dye imaging. In a recently designed slice, various cortical areas and the claustrum are synaptically active.

The claustrum (and the endopiriform nucleus) form a complex containing a small proportion of interneurons and a majority of far-projecting excitatory neurons that lay deep below the insular cortex in all mammals. –It is the most reciprocally connected structure in the brain– and receives a variety of neuromodulatory inputs from subcortical structures (Goll et al., 2015). Its functional role remains largely unknown. Due to his high connectivity in the brain it has been proposed to be a “seat of consciousness” (Crick & Koch, 2005) a hub for attention (Atlan *et al.*, 2018), for multi-sensory binding, or for the synchronization of neocortical slow-wave activity (Narikiyo *et al.*, 2018). Little is known on the claustrum circuit properties or on its cell-types: the membrane and synaptic properties, the sensitivity to neuromodulation, and spontaneous states of activities.

Unpublished preliminary results obtained in vitro in the T. Bal team shows the occurrence of neuromodulation-dependent slow oscillations of synaptic origin. There is therefore a series of possible explorations, from the biophysical properties of different cell-types, to various types of neuromodulation

at the network or individual cell levels, down to their dendritic properties, within endogenously active claustrum and cortical regions preserved in the same slice. Interestingly, the entorhinal cortex is the site of slow waves (up-and down states) in the same slice and is known to be highly connected to the claustrum.

The project will explore the mechanisms of oscillations in the claustrum and the cortex, at circuits and cellular levels. It will contribute to examine the integrative properties of principal cells and interneurons in the claustrum, within a synaptically active environment and its neuromodulation. Cells and circuits dynamics will be explored using a variety of tools: patch-clamp, dynamic-clamp (Behuret et al., 2015), calcium and voltage-sensitive dye imaging (Casale et al., 2015), neuromodulation by exogene application of neurotransmitters, and computational modeling through collaborations with the team of Alain Destexhe in the NeuroPSI and EITN institutes.

Atlan, G., Terem, A., Peretz-Rivlin, N., Sehrawat, K., Ben Jerry Gonzales, Pozner, G., Tasaka, G.-I., Goll, Y., Refaeli, R., Zviran, O., Lim, B.K., Groysman, M., Goshen, I., Mizrahi, A., Nelken, I., & Citri, A. (2018) The Claustrum Supports Resilience to Distraction. *Curr. Biol*, **28**, 2752–2762.e2757.

Behuret, S., Deleuze, C., & Bal, T. (2015) Corticothalamic Synaptic Noise as a Mechanism for Selective Attention in Thalamic Neurons. *Front Neural Circuits*, **9**, 80.

Casale, A.E., Foust, A.J., Bal, T., & McCormick, D.A. (2015) Cortical Interneuron Subtypes Vary in Their Axonal Action Potential Properties **35**, 15555–15567.

Crick, F.C. & Koch, C. (2005) What is the function of the claustrum? *Philosophical Transactions of the Royal Society B: Biological Sciences*, **360**, 1271–1279.

Goll, Y., Atlan, G., & Citri, A. (2015) Attention: the claustrum. *Trends Neurosci*, **38**, 486–495.

Narikiyo, K., Mizuguchi, R., Ajima, A., Mitsui, S., Shiozaki, M., Hamanaka, H., Johansen, J.P., Mori, K., & Yoshihara, Y. (2018) The Claustrum Coordinates Cortical Slow-Wave Activity 1–38.