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) : Neuroscience Paris Seine (UMR 8246)
Research Unit Director : Hervé Chneiweiss
Research Team Director : Pascal Legendre/Jean-Marie Mangin
Team name : Development of Spinal Cord Organization

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2. Internship project title:

Deciphering the role of excitable glial cells in the generation of animal movement

3. Internship Description :

From peristaltic crawling in earthworms to bipedal walking in humans, animal locomotion often rely on repeated sequences of muscle contractions triggered by motor neurons located in the nerve cord or spinal cord. These rhythmic motor sequences have been shown to result from the activity of central pattern generators (CPGs), a specific type of neural circuit able to intrinsically generate the rhythmic electrical activity necessary for repetitive movement such as locomotion, breathing or chewing. Because of its central role in locomotion, the spinal CPG has been the subject of numerous studies in the past decades. However, the cellular identity and exact location of the neurons composing the spinal CPG remain elusive. Here, we propose that previous attempts to identify the neurons forming the CPG have failed not because of its complex neuronal architecture but because its core pacemaker is made of glial cells instead of neurons. Indeed, while studying how the first motor rhythms are generated at fetal stages, our research team discovered that the floor plate - a group of mono-ciliated glial cells located at the base of the central canal - is not only able to generate and propagate action potentials but can also activate motor neurons in a recurrent manner. By showing that glial cells can act as an electrical pacemaker, this discovery profoundly changes how we conceive and understand CPGs in the central nervous system.

Therefore, the objective of this project will be to investigate whether the rhythmic locomotor movements generated at postnatal stages could still rely on a glial electrical pacemaker. In adult vertebrates, floor plate cells differentiate into ependymocytes, a specialized group of multi-ciliated glial cells surrounding the central canal of the spinal cord. For this project, the student will use optical and electro-physiological methods developed in our team in order to manipulate and visualize the electrical activity of these ependymocytes. More precisely, the project will be performed using transgenic mice models allowing the specific expression of genetically-encoded optogenetic actuators (channelrhodospins) and genetically-encoded calcium sensors (Gcamp6) in floorplate-derived ependymocytes. These tools have already been validated and the specific objective of the 6-month internship will be to determine whether floor-plate derived ependymocytes are still able to generate action potentials during fictive locomotion in preparation of whole neonatal mouse spinal cord.

On the longer term, the proposed project could be a major milestone in understanding the cellular nature of the spinal CPG and how it may be manipulated to restore locomotor function in various pathological conditions. This work could also provide an important key to understand how the neuromuscular locomotor system found in bilaterian animals could have evolved from the ciliary motor system used by basal animals such as sponges and ctenophores. Indeed, floor plate cells and ependymocytes have the same type of motile cilia used for locomotion in basal animals.