Post-Doctoral Position (36 Months)

@ BioImage Analysis Unit, Institut Pasteur, Paris
https://research.pasteur.fr/en/team/bioimage-analysis/

Starting date: As soon as possible. This position will remain open until filled.

In collaboration with Rafael Yuste's lab @ Columbia University, New-York
https://blogs.cuit.columbia.edu/rmy5/

Profile
Strong background in image analysis (e.g. particle detection and tracking, machine-learning…). Motivation to apply this knowledge to biology is required.

General environment:

The post-doc will be based at **Institut Pasteur in Paris**. With more than 2,000 collaborators and 100 research units, Institut Pasteur has a vibrant interdisciplinary academic community. The recruited post-doc will work under the **supervision of Dr. Thibault Lagache**, with frequent interactions with the neighboring experimental and computational scientists of the BioImage Analysis Unit. Joint meetings and trips to Rafael Yuste's lab in New-York are also planned.

How to apply
Please send CV and two reference contacts to **Dr. Thibault Lagache (thibault.lagache@pasteur.fr)**

General information about the project:

Background
Although a lot is known about how the structure of the nervous system develops, it is still unclear how functional modularity arises during development. A dream experiment would be to observe the entire development of a nervous system, correlating the emergence of specific functional units and their associated behaviors. To explore this, we will use the small cnidarian *Hydra vulgaris*, a representative of some of the simplest nervous systems in evolution. Indeed, Hydra possess the fascinating property of being able to reassemble itself into a normal animal, after its complete dissociation into individual cells. To examine how functional modularity arises during development, and the role of the Hydra nervous system in organizing and coordinating muscular patterns into pre-defined behaviors, we will take advantage of Hydra's unique regeneration properties and image the neuronal and muscle calcium activity of dissociated preparations as they re-aggregate into a synchronized system over a period of several days. Indeed, Hydra's remarkable ability to self-assemble into a normal animal from a dispersion of dissociated cells represents a phenomenal challenge for biologists and remains poorly understood. (**Figure**)

Mission

From the two-color high-speed imaging of the calcium activity of individual neurons and muscular cells in regenerating hydra (Yuste's lab), the project of the recruited post-doc will be to develop a robust methodology to track the calcium activity of individual neurons in re-aggregating animals. Indeed, the motion and deformation of the regenerating animal, together with the intermittent activity, and therefore detectability with calcium sensors, of neurons call for the development of innovative tracking strategy. Another challenge will be the characterization of the emergence of functional modules in the neuronal population from the monitoring of the calcium activity of individual neurons. To relate these emergent properties with the onset of coordinated muscle activity, we will use statistical models and test our predictions with optogenetic perturbation of emergent neuronal ensembles (Yuste's lab).
These developments will provide a pioneer experimental and analytical framework to monitor the real-time emergence of functional modules in the uniquely plastic nervous system of Hydra, and the onset of coordinated muscle activity and behavior. This could reveal some of the basic principles of the self-assembly of neural circuit dynamics underlying behaviors throughout the animal kingdom.

References :

- Lagache, T., Hanson, A., Pérez-Ortega, J. E., Fairhall, A., & Yuste, R. (2021). Tracking calcium dynamics from individual neurons in behaving animals. *PLOS Computational Biology*, *17*(10), e1009432.
- Lovas, J. R., & Yuste, R. (2021). Ensemble synchronization in the reassembly of Hydra's nervous system. *Current Biology*, *31*(17), 3784-3796.
- Dupre, C., & Yuste, R. (2017). Non-overlapping neural networks in Hydra vulgaris. *Current Biology*, *27*(8), 1085-1097.
- Szymanski, J. R., & Yuste, R. (2019). Mapping the whole-body muscle activity of Hydra vulgaris. *Current Biology*, *29*(11), 1807-1817.

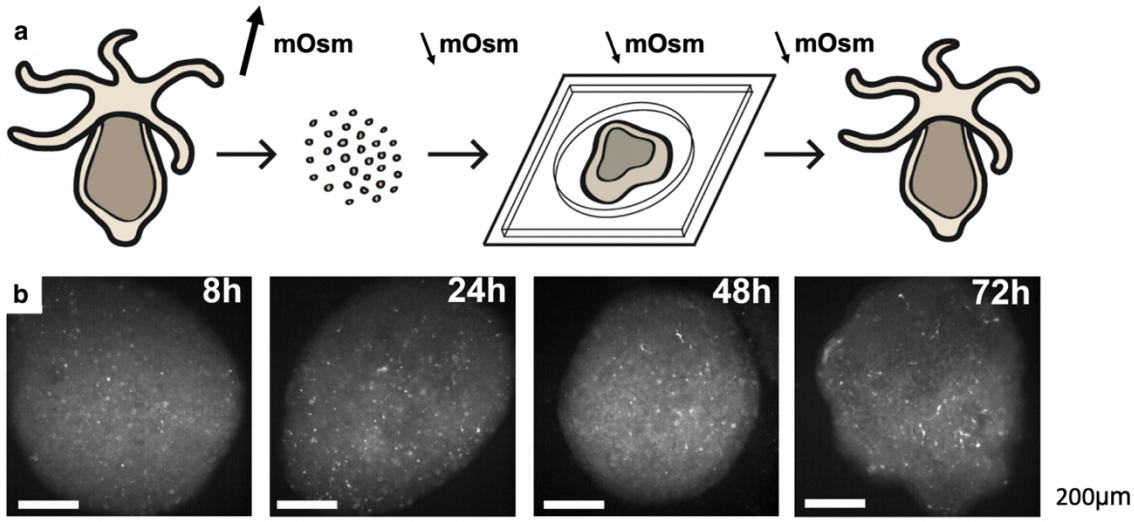

Figure: Hydra dissociation-re-aggregation. a- General experiment workflow. Hydra are mechanically dissociated into individual cells after a two-hour incubation in higher-osmolarity dissociation media. At various intervals throughout the process regenerating cellular aggregates are mounted and imaged to monitor changes in the functional architecture of developing neural circuits. With enough time, aggregates reestablish body axes, grow tentacles, and are indistinguishable from untreated animals. **b-** Representative cellular aggregates from each imaging time point. Scale bar = 200 µm.