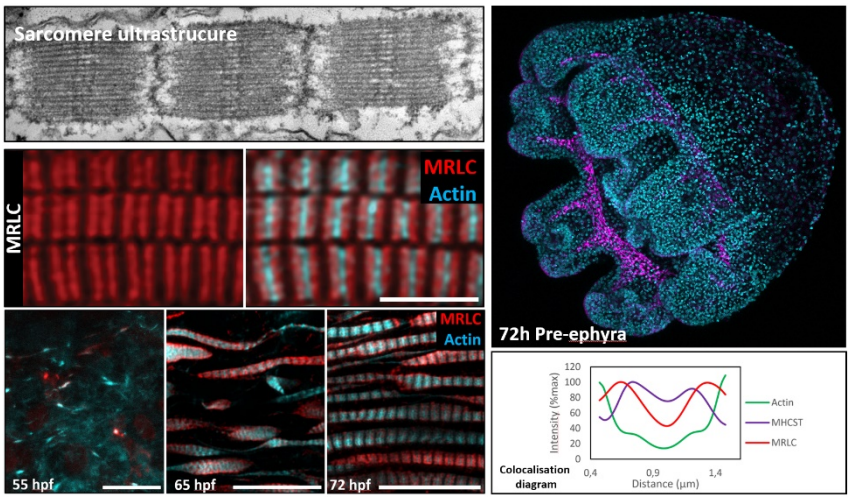
Master 1 or 2 project

Z-disc assembly and Myosin dynamics during striated muscle development in a jellyfish model

Striated muscles are contractile tissues that allow complex movements and behaviors in animals. They are organized into repeated molecular units called sarcomeres. Sarcomeres appeared early during animal evolution as they are found in bilaterian animals, as well as in cnidarian jellyfish. A landmark study proposed the independent evolution of jellyfish and bilaterian sarcomeres (Steinmetz et al. *Nature*, 2012). This hypothesis was supported by the absence of key bilaterian sarcomere protein genes in jellyfish genomes (titin and troponin), and by the ubiquitous expression of Z-disc protein genes. How jellyfish assemble strikingly similar sarcomeric structures from a different set of proteins remains an open question.

The jellyfish *Pelagia noctiluca* is developed as a tractable model for studying striated muscle development. A chromosome level genome assembly and extensive transcriptomic resources are available for this species. Juvenile medusae which display accessible striated muscles develop in the lab in only four days from fertilization.



Using a set of custom-made antibodies, we unexpectedly showed that the molecular structure of *Pelagia* sarcomeres is almost identical to those of bilaterians except for the absence of one major Z-disc protein and the key missing genes mentioned above. These results raise several fundamental questions: (i) How a protein structure as complex as the sarcomere can be functional despite the absence of three major actors? (ii) Is the convergence hypothesis proposed in 2012 still valid? Answering these questions requires a better knowledge of the developmental processes acting during during striated muscle formation in jellyfish. Investigating *Pelagia noctiluca* embryonic development, the student will address: (1) Do Z-discs assemble prior to thick and thin filaments? (2) What proteins are the first to display a striated pattern? (3) Do myosin-II and myosin-V have a functional role during striated muscle development?

This project will include:

- Characterizing the steps of myofibril formation between 2 and 4 days post fertilization using *Pelagia* specific antibodies (e.g. Myosin heavy and light chains, Z-disc proteins) using microdissections, immunofluorescence, confocal microscopy, western blot, electron microscopy (available at the OOB imaging platform), and in vivo approaches (injection of Lifeact-GFP mRNA at the zygote stage to follow actin dynamics during development).
- Assessing the role of muscular and non-muscular actomyosin networks in sarcomere assembly, using chemical inhibitors coupled with phenotypic analysis (macroscopic and immunofluorescence).

This project will be conducted at the Integrative Biology Unit of Banyuls-sur-Mer (BIOM, Sorbonne University) in the Cnidevo team (http://www.cnidevolab.com), in collaboration with the Dr. F. Schnorrer team (http://muscledynamics.org/) from IBDM (Aix-Marseille University), expert in sarcomere structure and assembly. **This internship could potentially lead to a PhD project.**