Master Biologie Moléculaire et Cellulaire 'BMC',
Université Paris Cité - *UFR Sciences du Vivant*

Parcours : **Biologie et Développement Cellulaires 'BDC'**
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Fiche de Projet de Stage de M2, 2025-2026

Unité INSERM ou CNRS ou Université : Development Adaptation Ageing (Dev2A) - UMR 8263, Institut de Biologie Paris Seine (IBPS) – CNRS-INSERM-Sorbonne Université **Intitulé Equipe:** Equipe "Long-range signal integration during development" **ED d'appartenance :** ED 515 "Complexité du vivant " **Responsable de l'Equipe :** Yasmine CANTAUT-BELARIF	**Responsable du Stage :** Yasmine CANTAUT-BELARIF **Contacts** Adresse : 7-9 Quai Saint Bernard, 75005 Paris - Campus Pierre et Marie Curie, Bâtiment C, 6e étage, Bureau 614 Email : yasmine.cantaut-belarif@cnrs.fr Tel : +33685796842

Titre du projet: Understanding the role of noradrenergic integration during axial morphogenesis in zebrafish embryos

Résumé du Projet de Stage: Recent studies focusing on the role of the cerebrospinal fluid (CSF), a protein rich solution filling the cavities of the nervous system, have elucidated the importance of an intriguing acellular structure running from the roof of the brain ventricles to the caudal end of the central canal of the spinal cord: the Reissner fiber. This acellular polymer, formed by the self-aggregation of the Sspo protein secreted into the CSF and conserved in vertebrates, was described more than a century ago but its function remained elusive until recently. By generating the first *sspo* mutants in zebrafish (Cantaut-Belarif et al. 2018, Current Biology) we revealed that the **formation of the Reissner fiber is a crucial event controlling the geometry of the embryonic posterior axis**. Further observations of juvenile *sspo* mutants showed that they develop 3D-torsions of the spine at juvenile stage reminiscent of adolescent idiopathic scoliosis observed in human patients during growth spurt. Thus, mechanisms shaping the form of the body axis might share fundamental principles from embryos to juveniles and may rely on a Reissner fiber-dependent pathway.

Using a combination of genetics and *vivo* imaging in embryos, we identified the molecular signature underlying the Reissner fiber-dependent straightening of the body. We showed that the Reissner fiber controls the expression of a peptide expressed in spinal cells contacting the CSF involved in axial straightening. In addition, we found that the Reissner fiber binds endogenous noradrenaline, which is in turn able to influence axial and peptide expression defects in *sspo* mutants (Cantaut-Belarif et al. 2020, Elife). **Yet, the precise mechanisms by which noradrenaline contributes to the Reissner fiber-dependent straightening of the embryonic body are poorly understood.**

This project aims to further characterize the pathway controlled by the Reissner fiber and modulated by luminal noradrenergic signals to ensure a correct morphogenesis of the embryonic body. During his/her internship, the student will: **1/.push the characterization of the role of noradrenaline on their newly identified cell targets surrounding the central canal of the spinal cord; 2/.identify how the Reissner fiber contributes to the detection and the integration of noradrenergic signal *in vivo*.** In this project, the student will **combine the power of genetics and *in vivo* imaging in the zebrafish embryo**. He/she will learn state-of-the-art live imaging techniques and analysis methods, including imaging of genetically encoded sensors and optical manipulations *in vivo*, coupled to imaging investigations on fixed samples. Highly motivated students interested in molecular and cellular developmental biology/neuroscience are encouraged to apply. If the student performs well, her/his project is **open to compete for a PhD project in the host lab**.

Publications de l'équipe relatives au projet de stage

- Cantaut-Belarif et al., *2018*, **Current Biology,** The Reissner fiber in the cerebrospinal fluid controls morphogenesis of the body axis." doi: 10.1016/j.cub.2018.05.079.

- Orts-Del'Immagine*, Cantaut-Belarif* et al., *2020*, **Current Biology**, "Sensory neurons contacting the cerebrospinal fluid require the Reissner fiber to detect spinal curvature *in vivo".* doi: 10.1016/j.cub.2019.12.071.

- Cantaut-Belarif et al., *2020*, **Elife**, "Adrenergic activation modulates the signal from the Reissner fiber to cerebrospinal fluid contacting neurons during development." doi: 10.7554/Elife.59469.