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, 2026-2027

Unité INSERM ou CNRS ou Université : U1050/UMR7241, CIRB, Collège de France **Intitulé Equipe :** Oocyte Mechanics and Morphogenesis **ED d'appartenance :** SdV-PSL – 657 **Responsable de l'Equipe :** Marie-Emilie Terret/Marie-Hélène Verlhac	**Responsable du Stage :** Lucie Barbier/ Marie-Emilie Terret/ **Contacts** Adresse : CIRB, Collège de France, 11 place Marcelin Berthelot, 75005 Paris. Email : lucie.barbier@college-de-france.fr Tel : 01 44 27 14 42

Titre du projet :
Regulation of osmotic response in oocytes during their development

Résumé du Projet de Stage (en 300 mots maximum, mots clés en gras)
The ability of an embryo to develop into a healthy offspring is closely related to the **oocyte quality**, also known as its developmental potential. In the lab, we study the final stages of mammalian oocyte formation (morphogenesis) to understand the cellular and molecular mechanisms regulating this process, the consequences when it goes awry, and their impact on oocyte quality.

In mouse and human, **mechanical properties** are tightly regulated during oocyte morphogenesis [1]. Mechanical defects lead to alterations in division geometry, chromosome alignment[2], and cytoplasmic organization[3], all of which are deleterious for embryo development. So far, we have focused on the role of the actomyosin cortex in regulating oocyte mechanical properties and meiotic divisions. However, the plasma membrane and **osmotic forces** are also known to contribute to cell mechanics. Moreover, several models coupling membrane mechanics, osmotic forces, and the actin cortex have been described in somatic cells[4] but remain unexplored in oocytes. **Our project aims to characterize the osmotic forces at play during oocyte morphogenesis, their regulatory mechanisms, and their impact on oocyte quality.**

To address these questions, we have developed innovative tools combining i**maging, microfluidics, and biophysical approaches**[1-3;5]. Using these tools, we will, in the **short term (Master's project) and long term (PhD project):**

1/ Characterize the osmotic response of oocytes at different stages of growth and meiotic division. Using physical models, quantitative parameters will be extracted, such as osmotically active volume, water and ion permeability, as well as pumping rates.

2/ Explore the **molecular and cellular mechanisms regulating osmotic response** in oocyte. Based on the results from (1), we will investigate the involvement of aquaporins, ion pumps, amino acid transporters, the existence of mechano-osmotic coupling, and the role of the actin cortex in this process.

3/ Finally, we will assess the **impact of osmotic response on oocyte morphogenesis** in physiologically relevant contexts, such as the transition from follicular fluid to the fallopian tube environment at ovulation. We will also assess its implications in assisted reproductive technologies, where oocyte morphogenesis and/or fertilization are performed *in vitro*

Publications relatives au projet de stage (max 5)

1. Bulteau R *et al. Small* e2500221 (2025).
2. Bennabi I *et al. Nat Commun* 11(1):1649 (2020).
3. Nikalayevich E *et al. Dev Cell* 59(7):841-852 (2024).
4. Roffay *et al PNAS* Nov; 118(47) (2021)
5. Barbier L *et al. Sci Adv* 11(8) :eadr9869 (2025).