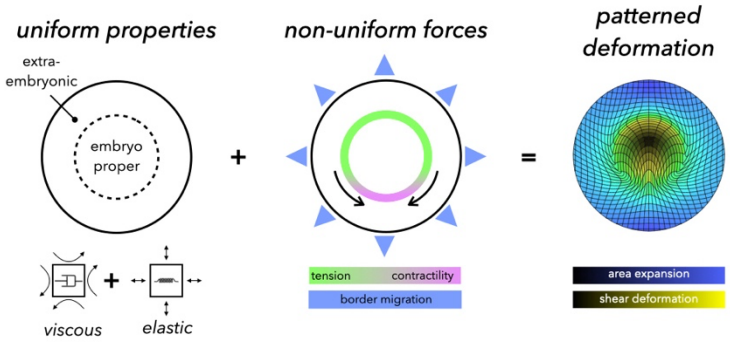
Master 2 Internship 2025/2026

Team: Dynamic regulation of morphogenesis (Jérôme Gros, Institut Pasteur, Paris, France)
Internship project: Studying the cellular basis of the embryonic mechanical plasticity during gastrulation.
Keywords: mechanics, gastrulation, dynamic imaging, image analysis, biophysics



After egg laying, the avian embryo consists of a large epithelial epiblast disk (3.5mm diameter). The central region of the epiblast, which will give rise to the embryo proper (EP), is connected to a ring of tissue that will differentiate into the extraembryonic (EE) yolk sac. Upon incubation, gastrulation begins: cells converge towards the posterior end of the EP to form the primitive streak (PS), where they will internalize and differentiate into mesendodermal germ layers. Concomitantly, the EE tissue undergoes area expansion in a process named epiboly that will ultimately result in the engulfment of the entire yolk. Work from the lab has identified that two sets of forces drive these morphogenetic movements: ***(i)*** a supracellular actomyosin contractile ring at the interface between the EP and EE whose graded contraction entrains fluid-like rotational flows (*1, 2*); ***(ii)*** an outward migration of the epiblast edge stretches the EE territory elastically. Importantly, these seemingly opposite behaviors—fluid in the EP and elastic in the EE—are not the result of differential material properties within these territories. Instead, we found that the entire epiblast can be equally sheared and stretched, and it is the local forces that dictate its deformation: the EE is primarily stretched by the isotropic stresses produced by epiboly, whereas the EP, which exhibits fluid-like deformation, is shielded from the isotropic stresses by the tensile margin (*3*). In the lab, we have developed a bespoke micro-manipulator to measure tissue mechanical properties and apply controlled deformation (*4*). The goal of this internship will be to investigate the cellular basis of the fluid and elastic responses by developing new mechanical assays using our micro-manipulator. These new manipulations will be monitored at high resolution by confocal microscopy to elucidate the cellular processes underlying the tissue response.

Candidate profile: the M2 student can be a biologist or a physicist by training and needs to have a strong interest in interdisciplinary and experimental approaches.
Lab environment: The internship will be supervised by Arthur Michaut, a CNRS researcher in the team.

References

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2. P. Caldarelli, A. Chamolly, A. Villedieu, O. Alegria-Prévot, C. Phan, J. Gros, F. Corson, Self-organized tissue mechanics underlie embryonic regulation. *Nature* **633**, 887–894 (2024).
3. A. Michaut, A. Chamolly, A. Villedieu, F. Corson, J. Gros, A tension-induced morphological transition shapes the avian extra-embryonic territory. *Current Biology* **35**, 1681-1692.e4 (2025).
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