Centre de Recherche en Biologie Cellulaire de Montpellier

*CRBM external seminar*
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# Spatial mechano-transcriptomics of the early mouse embryo


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*Adrien initially trained as a physicist and a chemist in Paris, and developed his interest for quantitative approaches of biological systems during his Master and PhD in Biophysics at the University of Cambridge. He is now a Research Fellow at Darwin College and a Herchel Smith Research Fellow in the group of Professor Benjamin Simons, where his work combines theoretical methods from statistical and soft matter physics with wet lab biology experiments to understand the role of cellular heterogeneity in cell fate decision, pattern formation and tissue function during development, homeostasis and tumorogenesis.*


Abstract

Cell morphology, mechanical forces, and gene expression act together to orchestrate cell fate decisions and tissue morphogenesis during embryogenesis. Analysis into the nature of this cooperation is therefore required to fully understand the nature of the highly complex mechanisms which sculpt the developing embryo in space and time. Here, I will present a new and unique computational approach combining image-based mechanical force inference and spatial transcriptomics and demonstrate its applicability to derive at both single cell and tissue level mechanical and morphometric information alongside gene expression levels. Using a seqFISH dataset of the E8.5 mouse embryo, we show that an integrated analysis of these modalities enables resolution of functional cell subtypes that cannot be distinguished by gene expression alone, as well as identification of gene modules predictive of the mechanical and morphological state of a cell, and of the formation of boundaries between tissue compartments. This method can be applied to any spatial transcriptomics dataset with sufficient cell membrane segmentation quality, enabling further analysis into the complex interactions between cell morphology, mechanical forces, and gene expression.


Selected publications


Deep learning for bioimage analysis in developmental biology A Hallou, HG Yevick, B Dumitrascu and V Uhlmann, Development 148(18) dev199616 (2021)

A biomechanical switch regulates the transition towards homeostasis in oesophageal epithelium J McGinn, A Hallou, S Han et al., Nature Cell Biology 23 511 (2021)

On growth and force: mechanical forces in development A Hallou and T Brunet, Development 147(4) dev187302 (2020)

Theory of mechanochemical patterning in biphasic biological tissues P Recho, A Hallou and E Hannezo, PNAS 116(12) 5344 (2019)

Tumour heterogeneity promotes collective invasion and cancer metastatic dissemination A Hallou, J Jennings and AJ Kabla, R. Soc. Open Sci. 4 161007 (2017)