# LS24-038 - Decoding and engineering multiscale mechanoresponses in synthetic and biological tissues


## Abstract

Physical forces play central roles in development, homeostasis and disease. Recent work revealed that tissues exhibit complex mechanical properties, such as viscoelasticity, strain-stiffening or phase transitions, which are key for their biological functions. Yet, the mechanistic basis for such macroscopic mechanical features remains fundamentally unclear. Indeed, they can arise from purely passive physical effects, as previously shown for soft inert materials such as glasses or polymer gels. While this may suggest that passive effects could dominate the rheology of living tissues, it is well-known that cells not only exert, but also actively respond to, mechanical forces, a key process known as mechanosensing. Since both passive material properties and active mechanosensing involve multiple length and time-scales, it remains surprisingly difficult to dissect their respective contributions to tissue mechanics. A key challenge in tackling this question has been methodological, as we lack tools to measure the macroscopic mechanical properties of tissues whilst simultaneously imaging passive and active responses at the molecular and cellular scales. Thus, to uncover how the physical properties of living tissues are encoded across biological scales, we must employ a novel reductionist approach blending material science, developmental biology and physics. We will leverage functionalized biomimetic emulsions and zebrafish gastruloids to create a spectrum of materials with tunable mechanoresponses. Their mechanical properties will then be characterized across scales using a novel opto-rheological platform. The findings will be integrated into a biophysical theory to define how divergent properties of synthetic and living tissues arise from local mechanical interactions. Overall, by rebuilding in synthetic systems how passive mechanics and active mechanosensing cooperate to shape emergent tissue properties, we will pave the way for a more rational design of living materials.


Scientific disciplines:
Developmental biology (40%) | Biophysics (40%) | Materials physics (20%)


Keywords:
mechanosensingtissue material propertiessynthetic tissuescell-cell adhesiongastruloids


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| Principal Investigator: | Diana Pinheiro |
| Institution: | IMP - Research Institute of Molecular Pathology |
| Co-Principal Investigator(s): | Roberto Cerbino (University of Vienna)<br>Edouard Hannezo (Institute of Science and Technology Austria (IST Austria)) |


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Status: Ongoing (01.07.2025 - 30.06.2029)
GrantID: 10.47379/LS24038


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Further links to the persons involved and to the project can be found under
https://www.wwtf.at/funding/programmes/ls/LS24-038/