INTERNSHIP PROPOSAL

Laboratory name: Physico-Chimie Curie
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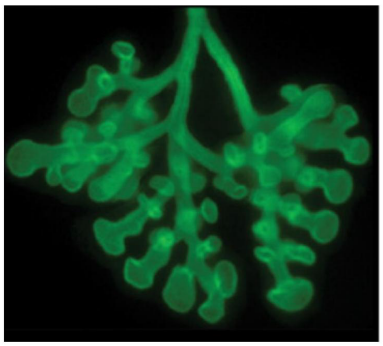
Thesis possibility after internship: YES
Funding: NO If YES, which type of funding:

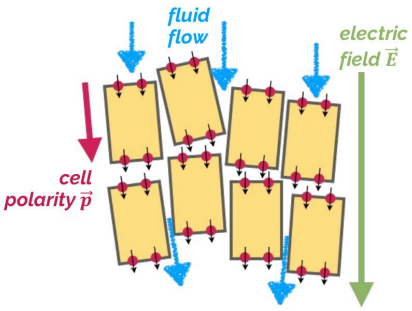
Electrohydraulic properties of tissues

In addition to generating forces and reacting to mechanical cues, tissues are capable of actively transporting fluids and of creating electric currents. Tissues hydraulic properties are crucial during morphogenesis: for instance, mammalian embryos self-organize around spherical fluid cavities (lumens) [1]. Similarly, bioelectric properties of nonexcitable cells are crucial during wound healing [2], and suspected to play a role in tissue patterning [3].

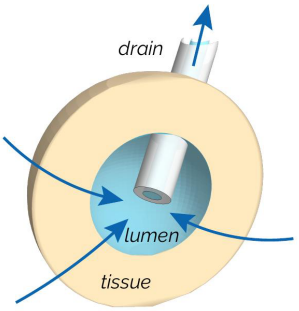
Theoretical modelling of cell tissues however often focuses on their active mechanical properties, while their bioelectric and hydraulic abilities have remained largely undiscussed. The goal of this internship will therefore be to construct and explore cell-based or continuum models that bring together tissue mechanical, electrical and hydraulic properties. Depending on the student skills and tastes, several directions could be considered:
- construct cell-based numerical models, inspired by the vertex model [4], that include explicitly fluid transport,
- develop coarse-grained, continuum models of tissues that include electrohydraulic properties [5,6]



Lumen formation during lung development



Polar cells can generate fluid flows and electric fields



Cell spheroid with a drain imposing an external hydraulic or electric perturbation

[1] Chan, Costanzo, Ruiz-Herrero, et al., Nature 571, 112 (2019)
[2] Kennard and Theriot, eLife 9, e62386 (2020)
[3] Stewart, Le Bleu, Yette, et al., Development 148, dev199384 (2021)
[4] Farhadifar, Röper, Aigouy, et al., Curr. Biol. 17, 2095 (2007)
[5] Duclut, Sarkar, Prost, and Jülicher, PNAS 116, 19264 (2019)
[6] Duclut, Prost, and Jülicher, PNAS 118, e2021972118 (2021)

Condensed Matter Physics: YES/NO Soft Matter and Biological Physics: YES
Quantum Physics: YES/NO Theoretical Physics: YES