LadHyX Seminar – November 4, 11:00, Amphi Lagarrigue and Zoom

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Topography-driven large-scale ordered collective motion in endothelial cells

In healthy arteries, endothelial cells (ECs) are elongated and aligned in the direction of blood flow. Interestingly, atherosclerotic lesions develop preferentially at bifurcations where ECs exhibit a cuboidal shape and a random orientation. Therefore, factors that regulate EC morphology and alignment are of interest. The basement membrane to which ECs adhere is a topographic surface. We are interested in how this topography may regulate EC shape and alignment and are exploring this question in vitro using substrates with micron-scale grooves.

We demonstrate that ECs align and elongate in the direction of the grooves, and this effect increases with groove depth (1 to 6 μm). Live cell imaging of EC monolayers revealed preferential cell migration along the grooves, with more directed motion for the deepest grooves. Surprisingly, the grooves induced the emergence of antiparallel streams of EC movement with a characteristic width of 100-150 μm, considerably larger than either the grooves (width and spacing of 5 μm) or individual cells. These cell streams and their characteristic size can be predicted by a model based on active gel theory that accounts for the effect of the grooves on the free energy of the system. The model shows that the spatial periodicity of the streams is modulated by the extent to which the grooves constrain cell orientation.

The present findings describe a new pattern of large scale collective cellular motion driven by substrate topography. If corroborated in vivo, such motion may modulate collective cell migration during embryonic development, tissue morphogenesis or cancer invasion.