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Persistent random walk model of cell migration over curved substrate

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Cell migration is a key process in tissue formation which occurs during embryo's development or regeneration. Among the numerous factors in the cell environment that impact cell behavior, substrate cell-scale curvature is a mechanical cue which redirects cells toward concave areas [1]. However, the process of change in directionality remains unknown: it may emerge from the activation of signal pathways by the curvature and/or the cell would be mechanically limited by the curvature.

Here, a persistent random walk (PWR) model adapted from [2] has been developed in order to assess the mechano-sensitivity of the cell to curvature. The action of the curvature is modeled by a force which triggers inner cell signal pathways and/or acts as an external passive force. Also, the sensibility to curvature can emerge from a local measure at the position of the cell (i.e. a gradient) or a global measure at the cell-scale (i.e. difference of curvature between the center and the cell membrane). Our study aimed to test all these hypotheses.

First simulations on wavy substrates show that cells behave differently depending on the hypotheses. Preliminary results compared with experiments enabled to argue that, by a cell-scale measure of the curvature, the cell is mostly limited mechanically.

The PRW model is able to reproduce trajectories of migrating cells on curved surface. Further analysis will give more details about the activation of signal pathways. A recent numerical study showed as a proof-of-concept, that dynamic surfaces can guide cells in a given direction [3] and implementing dynamic surface with the PRW model will make emerge new methods to guide cells with topographical cues.

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