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PERSISTENT RANDOM WALK MODEL OF CELL MIGRATION OVER CURVED SURFACE

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INTRODUCTION

Cell migration is a key process in tissue formation which occurs during embryo development or regeneration. Among the numerous factors that impact cell behavior, substrate cell-scale curvature redirects cells toward concave areas [1] (Fig.1). Yet, the mechanism driving this directional change remains elusive-whether it emerges from signal pathway activation induced by curvature and/or mechanical constraints imposed by curvature.

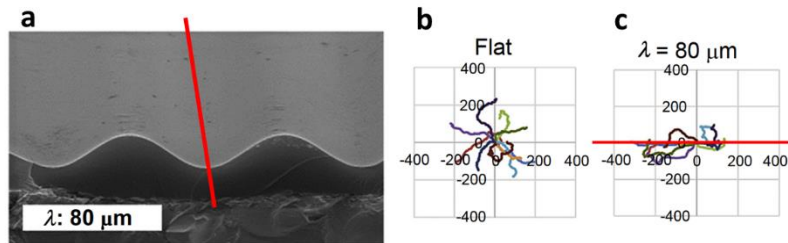


Figure 1: a. Sinusoidal wavy substrate with a wavelength (distance between two consecutive peaks) of $80\mu\text{m}$. b. c. Trajectories of T-cells cultivated on flat and wavy substrates. Cells predominantly migrate along the valleys (indicated by red axes) on the wavy substrate. Images reproduced from [1].

MATERIALS AND METHODS

Here, a persistent random walk (PRW) model [2] has been developed in order to assess the mechano-sensitivity of cells to substrate curvature. A parameter $\beta \in [0,1]$ regulates whether curvature activates signal pathways (β close to 1) or not (β close to 0). Sensibility to curvature may arise from a local gradient measurement at the cell's position or a cell-scale measurement at the periphery. Our study aims to test all these hypotheses.

RESULTS

Simulations were conducted for 10 hours on a sinusoidal wavy surface with an amplitude of $10\mu\text{m}$ and a wavelength $\lambda = 80\mu\text{m}$ (Fig. 2).

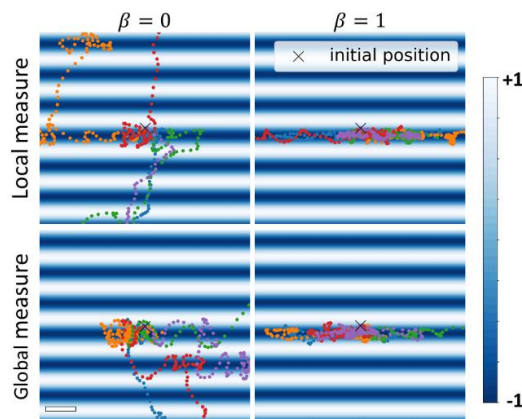


Figure 2: Trajectories of five cells under different parameters conditions. Scale bar is $80\mu\text{m}$ and color bar is the normalized height of the substrate (+1 is peaks and -1 is valleys).

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Preliminary results, when compared with experiments (Fig. 1c), suggest that cells change of directionality is mostly caused by signal pathway activation (β close to 1).

DISCUSSION AND CONCLUSIONS

The PRW model reproduces cell trajectories on curved surface. A numerical study [3] showed that dynamic surfaces can guide cell migration in a given direction. Adapting the PRW model to dynamic substrates can reinforce the development of methods to guide cell migration.

References

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