Migration of immune cells in an obstacle park

Doriane Vesperini[2], Zeinab Sadjadi[1], Franziska Lautenschläger[2,3], Heiko Rieger[1]

1 Theoretical Physics, Saarland University, 66123 Saarbrücken, Germany

2 INM-Leibniz Institute for New Materials, 66123 Saarbrücken, Germany

3 Experimental Physics, Saarland University, 66123 Saarbrücken, Germany

Several crucial processes in biological systems can be described as a search problem such as: finding food resources or pathogens. The presence of obstacles like non-targeted cells or extracellular matrix in biological environments induces a perturbation of the initial cell trajectory. For example, the presence of bystander cells has been shown to increase the velocity and the persistency of natural killer cells [1]. Besides obstacles density, their spatial disposition may also influence the search efficiency. It has been demonstrated that the density and geometry of pillar lattices affect the guidance and migration strategies of Dictyostelium discoideum cells [2].

Here, we investigate how search efficiency is influenced by spatial arrangement of obstacles. Migration patterns of cells are studied experimentally and in computer simulations. In experiments, a microfluidic device is designed to track HL-60 cells differentiated into neutrophils in confined 2D environments whose thickness vary from 3 µm to 10 µm. Our device consists of pillar forests of different diameters distributed in triangular, square or random arrangements. The device, fabricated in PDMS and sealed in a glass bottom dish, is mounted on an inverted microscope. Cell nuclei are stained with Hoechst in order to track cell location overtime. We study similar geometriesby means of numerical simulations. We calculate the mean first passage time and diffusion properties of the searcher in different densities and geometries of pillars and investigate the influence of key parameters on the search efficiency.

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Doriane Vesperini 2 , Zeinab Sadjadi 1 , Franziska Lautenschläger 2, 3 , Heiko Rieger 1