A microfluidic device for measuring cell migration towards substrate-bound and soluble chemokine gradients

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Cellular locomotion is a central hallmark of eukaryotic life. It is governed by cell-extrinsic molecular factors, which can either emerge in the soluble phase or as immobilized, often adhesive ligands. To encode for direction, every cue must be present as a spatial or temporal gradient. Here, we developed a microfluidic chamber that allows measurement of cell migration in combined response to surface immobilized and soluble molecular gradients. As a proof of principle we study the response of dendritic cells to their major guidance cues, chemokines. The majority of data on chemokine gradient sensing is based on in vitro studies employing soluble gradients. Despite evidence suggesting that in vivo chemokines are often immobilized to sugar residues, limited information is available how cells respond to immobilized chemokines. We tracked migration of dendritic cells towards immobilized gradients of the chemokine CCL21 and varying superimposed soluble gradients of CCL19. Differential migratory patterns illustrate the potential of our setup to quantitatively study the competitive response to both types of gradients. Beyond chemokines our approach is broadly applicable to alternative systems of chemo- and haptotaxis such as cells migrating along gradients of adhesion receptor ligands vs. any soluble cue.
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