NANOANALYSIS OF SINGLE LIVING CELLS ON CHIPS: COMBINING NANOTECHNOLOGIES AND MICROSYSTEMS (CELL-ON-CHIP)

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Nanotechnology offers powerful tools for probing single living cells. However, most of the currently available nanotools require manual alignment of the probe or the target cell and measurements cannot be performed simultaneously in multiple cells. As a result, statistically significant measurements are often very time consuming and demand a high degree of expertise. These shortcomings hinder the application of nanotechnology in living cell assays. Lab-on-a-chip techniques provide useful approaches to manipulating and controlling single cells, offering novel opportunities for improving the application of nanotechnology to living cell assays. Accordingly, the general aim of this research line is the combination of microsystems and nanotechniques for the analysis of the mechanical and adhesive properties of single living cells. Applications will be focused on the response of leukocytes to inflammatory activation and on the response of adherent cells to mechanical signaling from their microenvironment. To this end, we will develop (i) microsystems based on microfluidics and dielectrophoresis for the analysis of leukocytes using atomic force microscopy and single molecule fluorescence microscopy, (ii) optonanomechanical based biosensors for probing living leukocytes and (iii) microsystems for probing living adherent cells using atomic force microscopy and optical nano-tools under controlled microenvironmental conditions. These approaches will lead to improved and more user-friendly nanotechnologies for straightforward and high-throughput single cell assays. The innovations resulting from this research line will facilitate the biomedical applications of nanotechnology.

References:

- Castellarnau M, Errachid A, Madrid C, Juárez A, Samitier J. Dielectrophoresis as a tool to characterize and differentiate isogenic mutants of Escherichia coli. Biophys J 91:3937-3945, 2006.

- de Bakker BI, de Lange F, Cambi A, van Hulst, NF, Figdor CG, Garcia-Parajo MF. Nanoscale organization of the pathogen receptor DC-SIGN mapped by single molecule high resolution fluorescence microscopy. ChemPhysChem 8: 1473-1480, 2007.

- Engel E, Michiardi A, Navarro M, Lacroix D, Planell JA. Nanotechnology in regenerative medicine: the materials side. Trends Biotechnol 26:39-47, 2008.

- Moreo P, García-Aznar JM, Doblaré M. Modeling mechanosensing and its effect on the migration and proliferation of adherent cells.
Acta Biomater 4:613-621, 2008.

- Roca-Cusachs P, Almendros I, Sunyer R, Gavara N, Farré, Navajas D. Rheology of passive and adhesion-activated neutrophils probed by Atomic Force Microscopy. Biophys J 91:3508-3518, 2006.

- Zinoviev K, Dominguez C, Plaza JA, Lechuga LM. Optical waveguide cantilever actuated by light. Appl Phys Lett 92: 011908, 2008.