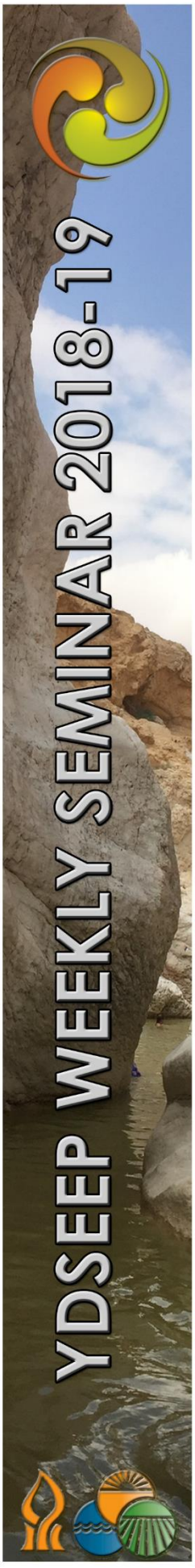


Ben-Gurion University of the Negev
Blaustein Institutes for Desert Research
The Swiss Institute for Dryland Environmental and Energy Research
Alexandre Yersin Department of Solar Energy and Environmental Physics

Nanodevices for the Study of Immune Cell Function

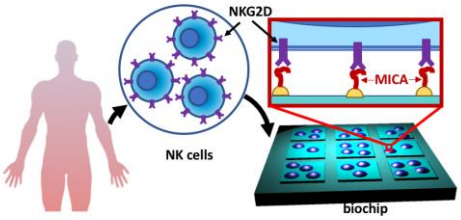


Figure 1. Scheme of the nanochip for NK cell study

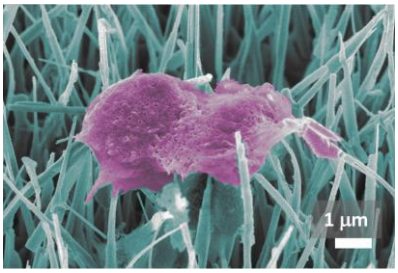


Figure 2. NK cells stimulated on nanowires - SEM

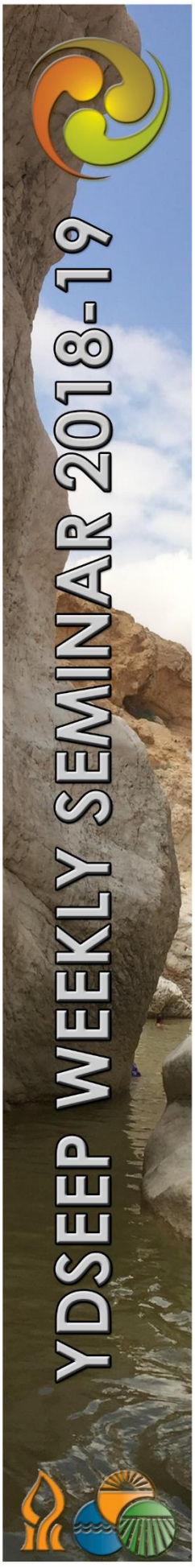
Mark Schvartzman
Department of Materials Engineering
Ben-Gurion University of the Negev

Abstract

Department of Materials Engineering and Ilse Katz Institute for Nanoscale Science & Technology, Ben-Gurion University of the Negev, Beer Sheva, Israel.

Immune cells recognize tumorous and viral cells by binding using receptors that bind to ligands (antigens) on the membrane of target cells. Although this recognition and following immune activation are extensively studied today, their exact mechanism is barely understood. Here, applied a concept of controlled nanoscale assembly[1] to engineer a biochip, which can be used as an "artificial antigen presenting cell" for study of role of ligand arrangement in function of Natural Killer cells – lymphocytes of the innate immune system. The chip contained nanoimprinted matrices[2] with sub-10 nm metallic nanodots functionalized with antigens. By studying the NK cell immune response to the matrix geometry, we discovered the minimal ligand distribution needed to stimulate the cell activation[3].

Remarkably, in-vivo function of NK cells is regulated by the signaling balance of activating and inhibitory receptors. To explore the role of the receptor spatial arrangement in this signaling crosstalk, we engineered a more complex multifunctional biochip that simultaneously regulates both receptors. The chip contains mixed nanodots of different metals, selectively functionalized with activating and inhibitory ligands[4]. We fabricated the chip using novel nanoimprint lithography and sequential angle evaporation, combined with our recently developed orthogonal biofunctionalization.



Finally, we explored the nanoscale mechanical sensitivity of Natural Killer cells, by interfacing them with vertical ligand-functionalized nanowires[5]. We indicated mechanical forces applied by the cells *via* enhanced cell contraction and the nanowire bending. Furthermore, we found that while ether nanowires or ligand presence alone was insufficient to stimulate cell immune response, their combination substantially boosted NK cell degranulation. In this sense, NK are analogous to Boolean "AND gate" with independent mechanical and chemical logic inputs. Our findings provide an important insight into the mechanism of NK cell function, and demonstrate a novel toolbox for the study of the cell immune activation with an unprecedented spatial and mechanical resolution.

[1] A. Marcovici, G. Le Sux, P. Rekenstein, K. Flomin, K. Shreteh, R. Golan, T. Mokari, M. Schvartzman, ***ACS Nano*** - *in press.*

[2] V. Bhingardive, L. Menahem, M. Schvartzman, ***Nano Res.*** 2018, *11*, 2705.

[3] Y. Keydar, G. Le Saux, A. Pandey, E. Avishay, N. Bar-Hanin, T. Esti, V. Bhingardive, U. Hadad, A. Porgador, M. Schvartzman, ***Nanoscale*** 2018, *10*, 14651.

[4] G. Le Saux, A. Edri, Y. Keydar, U. Hadad, A. Porgador, M. Schvartzman, ***ACS Appl. Mater. Interfaces*** 2018, *10*, 11486.

[5] G. Le Saux, N. Bar Hanin, A. Edri, U. Hadad, A. Porgador, M. Schvartzman, ***Adv. Mater***. - *in review*

Date & Location:

Tuesday, November 20, 2018, 11:00
Lecture room, Physics Building (ground floor)