

Geometric Control of Cell Behavior by Biomolecule Nanodistribution

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Many dynamic interactions within the cell microenvironment modulate cell behavior and cell fate. However, the pathways and mechanisms behind cell–cell or cell–extracellular matrix interactions remain understudied, as they occur at a nanoscale level.

Recent progress in nanotechnology allows for mimicking of the microenvironment at nanoscale in vitro; electron-beam lithography (EBL) is currently the most promising technique. Although this nanopatterning technique can generate nanostructures of good quality and resolution, it has resulted, thus far, in the production of only simple shapes (e.g., rectangles) over a relatively small area ($100 \times 100 \mu\text{m}$), leaving its potential in biological applications unfulfilled.

Here, we used EBL for cell-interaction studies by coating cell-culture-relevant material with electron-conductive indium tin oxide, which formed nanopatterns of complex nano-hexagonal structures over a large area ($500 \times 500 \mu\text{m}$). We confirmed the potential of EBL for use in cell-interaction studies by analyzing specific cell responses toward differentially distributed nano-hexagons spaced at 1000, 500, and 250 nm.

We found that our optimized technique of EBL with HaloTags enabled the investigation of broad changes to a cell-culture-relevant surface and can provide an understanding of cellular signaling mechanisms at a single-molecule level.¹

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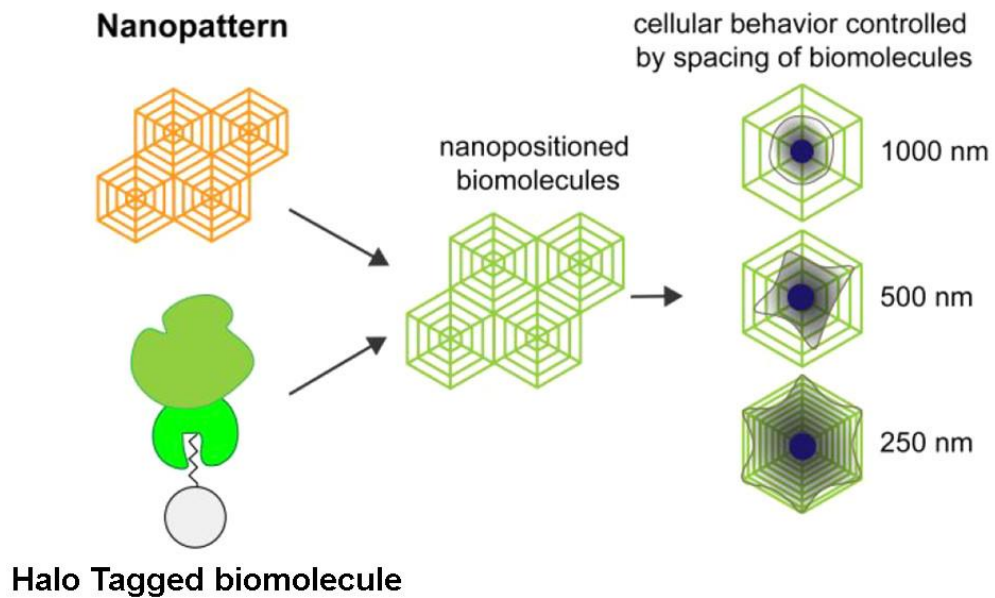


Figure 1: Quick overview how the combination of geometrical shape control of hexagonal nanopatterns and the use of Halo tags combines into a nanopositioned biomolecule of different size to control the behavior of cells.