Cell Membrane Engineering to Investigate Cell-Cell Interactions and Tissue Patterning

Nidhanjali Bansal, Bioengineering

Advisers: Gregory Underhill, Bioengineering; Rashid Bashir, Electrical and Computer Engineering and Bioengineering

Key Research Aims and Goals
Utilize cell membrane engineering principles in combination with synthetic biomaterial linkers to enable the following efforts:

1. Systematic manipulation and analysis of cell-cell mechanical interactions.
2. Cellular patterning to control larger scale tissue geometries and observe effects on cell differentiation.

Research Highlights and Results

• We are utilizing mouse embryonic stem cells (mESC) as our model system, and are investigating the effects of modular synthetic cell linkers and defined 3D patterns on pluripotency and differentiation.

• In initial experiments, we have demonstrated the labeling of mESC surface proteins with NHS-PEG-Biotin linkers, which react with available amines to form amide bonds. The fidelity and stability of the membrane conjugations can be assessed by fluorescent cell imaging and flow cytometry (Fig. 1).

Future Research Plans

• Ongoing time-course experiments are aimed at determining the stability of cell membrane protein modifications during culture and differentiation.

• Building on our proof-of-concept results, we aim to engineer stem cell membrane proteins to present linkers that will support the controlled crosslinking of adjacent cells.

• Determine the effects of polymer linker properties (e.g. chain length) on cell-cell mechanical interactions and further integrate this approach with stereolithography (SLA) methods to pattern multilayer cellular constructs.

• Utilize modular biomaterial linkers and patterning tools to study the multiscale (i.e. cell-cell interactions, tissue geometry-defined) mechanical regulation of mESC differentiation trajectories.

Fig 1: Mouse Embryonic Stem Cells with NHS-PEG-Biotin/SAV – AF488

(a) Fluorescence image of mESC with surface proteins conjugated with a NHS-PEG-Biotin linker and subsequently labeled with Streptavidin-Alexa 488 (b) Quantitative assessment of surface protein conjugation with flow cytometry. NHS-PEG-Biotin treated (red histogram), untreated (black histogram).