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# Manipulation of Cell Behavior Enabled by E-jet Technology

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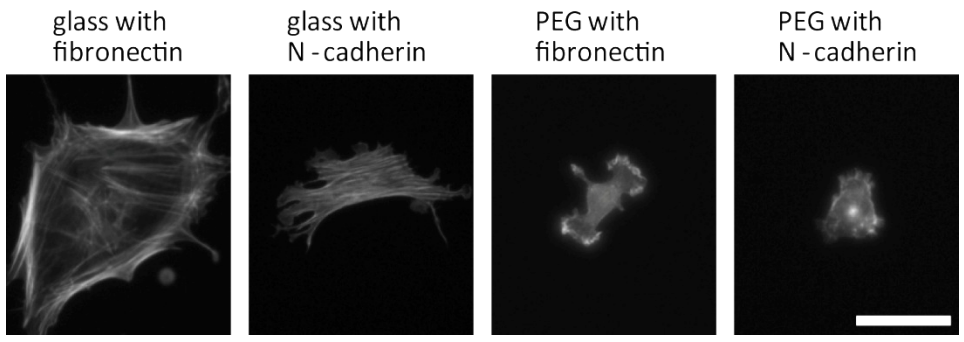
## *Goals*

- Develop methods to print proteins on hydrogel surfaces for the purpose of cell adhesion using an electrohydrodynamic jet (E-jet) printer.
- Print cell adhesion proteins in combinatorial patterns for the evaluation of cell behavior.

## *Fundamental Questions/Challenges*

- Cell behaviors such as proliferation, migration, differentiation, and matrix deposition are influenced by extracellular factors such as adhesion proteins, geometry, and mechanical properties. It is difficult to evaluate these factors in conventional cell culture environments, which are typically rigid, solid glass or plastic surfaces.
- Hydrogels such as polyacrylamide and polyethylene glycol)provide a promising platform for engineered cell culture environments. The gels:
  - Are architecturally similar to natural tissue.
  - Have precisely controlled mechanical properties.
  - Are resistant to protein adsorption and therefore cell adhesion.

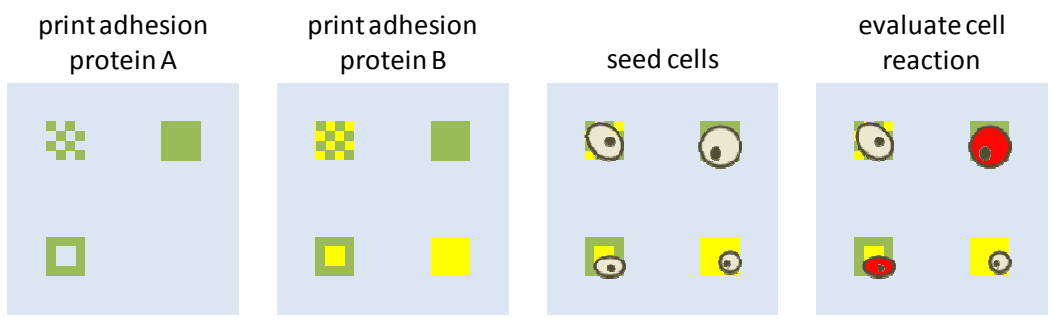
However, they may be chemically modified to contain specific proteins.




**Cell shape and cytoskeletal structure depend on adhesion proteins (fibronectin and N-cadherin) and surface properties (rigid glass and polyethylene glycol).**

## *Research Plan*

- Demonstrate high resolution printing of proteins on polyacrylamide or polyethylene glycol hydrogels with immunohistochemistry.
- Demonstrate cell attachment to patterned hydrogels.
- Evaluate influence of patterned hydrogels on cell behavior.




**Plan for printing multiple patterns of two different cell adhesion proteins on an otherwise-inert hydrogel surface and evaluating cell behavior (e.g. expression of an intracellular protein).**

## *Preliminary Research Results*

Determined a conjugation buffer containing salts and glycine that is:

- Compatible with the E-jet system.
- Preserves conductivity.
- Limits volume change in the hydrogel due to evaporation.
- Has a high enough viscosity to keep droplets from spreading too thin.

## *Broader Impact*

- E-jet printing could enable patterning of proteins at submicron resolution; significantly better than current published feature sizes with soft lithography stamping or photolithography.
- Flexible, programmable printing may be used to pattern substrates in combinatorial fashion for evaluating the influence and interactions of chemical, geometric, and mechanical extracellular factors on cell behavior.

## *Future Efforts*

- Print multiple adhesion proteins on hydrogel surfaces.
- Evaluate cell behaviors, such as differentiation, on substrates with well-controlled chemical, geometric, and mechanical properties.

**Seed Projects**

Center for Nanoscale Chemical-Electrical-Mechanical Manufacturing Systems
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