Fabricating Different Biomaterials For Use In Bioengineering Applications

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Motivation

- Recently, researchers have discovered that stem cell fate decision can be drastically affected by the microenvironment.
- Specifically, the elastic modulus of the microenvironment in particular, has been shown to influence stem cell differentiation (1).
- For example, when stem cells are put on a soft gel, they grow to mimic brain cells. When they are put on an intermediate still gel, they grow to mimic muscle cells. When they are put on a rigid gel, they grow to mimic bone cells.

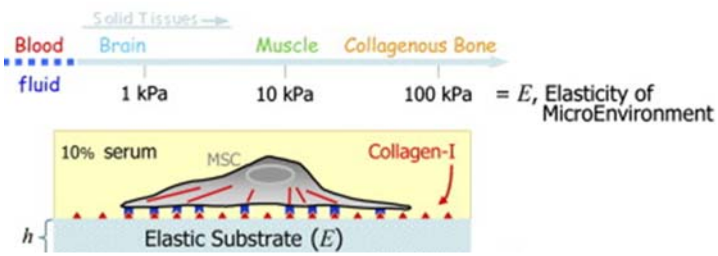

Figure 1: Diagram of a stem cell on a substrate, illustrating the effect of stiffness on cell fate(1).

- The Underhill lab studies the role of microenvironmental effects on the cells found in the liver.
- Over the past 6 weeks, we have studied the different biomaterial platforms that are used in their research.
- This work will contribute to a better understanding of the liver and how better treatments for liver disease can be developed.

Approach

- To study the effects of elastic modulus, we used Polyacrylamide (PA) and Polydimethylsiloxane (PDMS) hydrogels as biomaterials.
- We chose PA and PDMS because they have highly tunable elastic moduli, are biocompatible, and are well established in the Underhill lab (2).

To make PDMS, we mixed pre-polymer with curing agent at different ratios. These were then poured into a mold and baked (at 80 C for 4 hours).

- For PA gels, we cleaned, etched, and salinized the glass slides before applying the PA. We mixed different ratios of acrylamide/bis-acrylamide pre-polymer and a photocrosslinker. We would then deliver them on a glass slide and expose them to UV light for them to crosslink.

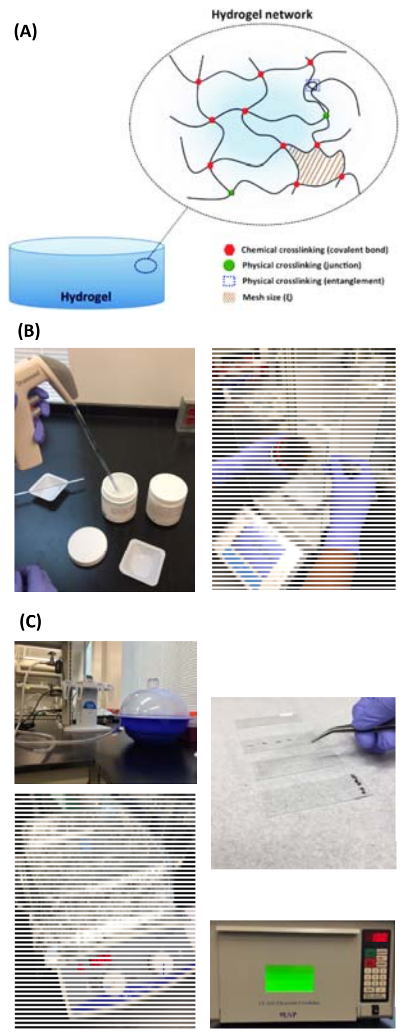

Figure 2: (A) Schematic of generalized hydrogel network, indicating the crosslinked properties after polymerization (3). (B) Preparation of ingredients for PA and PDMS hydrogels. (C) Images detailing the process of hydrogel fabrication.

Results

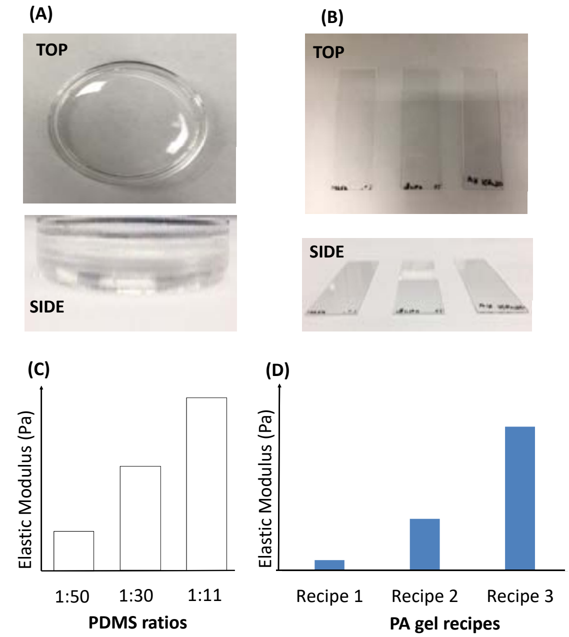

Figure 3 (A): Image of fabricated PDMS hydrogel (B): Image of fabricated PA hydrogel (C): Graph showing the elastic modulus of each PDMS curing/polymer ratio. D) Graph showing the elastic modulus of each PA recipe.

- We fabricated PA and PDMS hydrogels at 3 different stiffnesses.
- The Underhill lab uses these biomaterials to manipulate and model cell microenvironments using 2D and 3D technologies ranging from cellular microarrays to cell spheroids.

References:

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2. Thiele, Julian, et al. "25th anniversary article: designer hydrogels for cell cultures: a materials selection guide." *Advanced materials* 26.1 (2014): 125-148.
3. Fajardo, André & G. B. Pereira, Antonio & Rubira, Adley & Valente, Artur & Muniz, Edvani. (2015). Stimuli-Responsive Polysaccharide-Based Hydrogels. 10.1201/b19751-10.

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