FMRI RET 2014- Viable Printing of Tissues with Thermo-responsive Hydrogel

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Abstract

The use of a thermally responsive hydrogel, poly *N*-isopropylacrylamide (PNIPAAm) as a cell culture platform allows the release of intact cells in defined geometries or sheets without the damage to the extracellular matrix (ECM). As a cell release platform, when PNIPAAm swells, the strain between the polymer and the cells causes the cells to detach intactly from the polymer due to disruptions of the cell matrix caused by the expansion of the polymer.

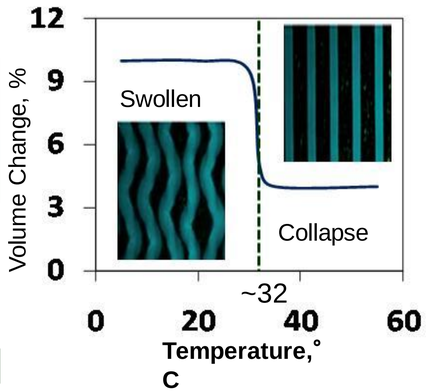


Figure 1 Microstructural change of PNiPAAm around its LCST and exposure to water [1].

Background

Tissue regeneration is an exciting field of research that is showing advances from the traditional methods of scaffolding, where immune system responses have been a problem, to using functional materials to create viable three-dimensional tissues. PNIPAAM has a lower critical solution temperature (LCST) of 32*C; below this temperature, the polymer becomes hydrophilic and swells while above this temperature, the polymer becomes hydrophobic and collapses.

Objective

To examine the feasibility of printing viable cells for building robust three-dimensional tissues.

Approach

A silicon wafer with microbeam patterns is used to create polydimethylsiloxane (PDMS) master molds. Once the polymer beams have been fabricated, the microbeams are seeded with NIH-3T3 mouse fibroblasts and cultured at 37*C until confluency is reached. These beams with cells are then placed on top of another confluent layer of cells with a 1-2 gram weight added to enhance conformal contact.

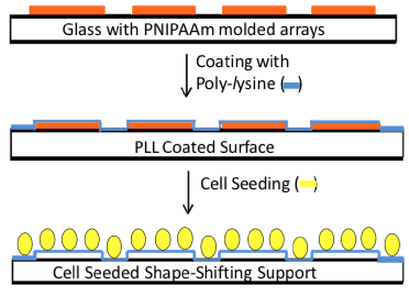
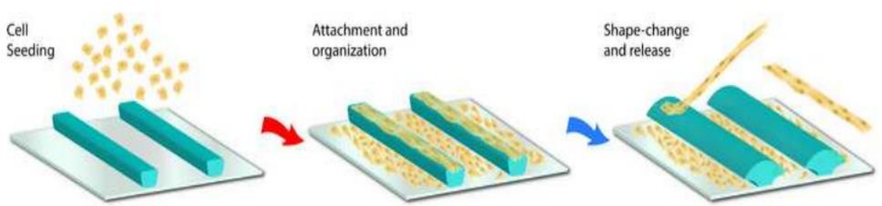
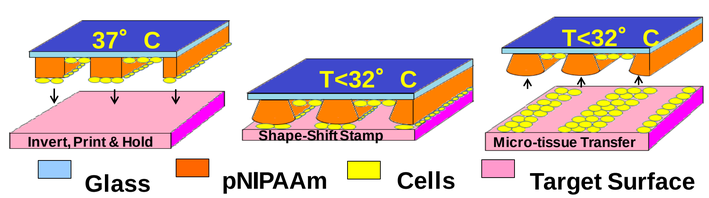


Figure 2 Construction of PNIPAAm mold with seeded cells.



These layers are incubated and then cooled to below 32*C to allow the cells to be released from the microbeams onto the new layer of cells, thus creating two layers of cells.



Results

❖The seeded microbeams stained green were layered and printed onto a confluent layer of cells.

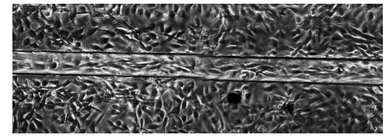


Figure 3 Seeded microbeam prior to printing.

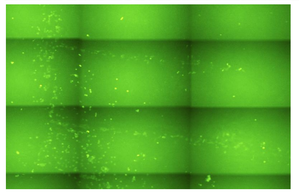


Figure 4 Printed green layer on confluent layer.

After the print, another layer of seeded microbeams stained red were layered and printed on top, creating a tri-layer of cells.

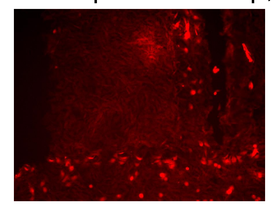


Figure 5 Printed red layer on bilayer.

Conclusion

A trilayer of cells shows proof of concept that cells can be layered using a thermo-sensitive polymer. Future research will include cell printing using different types of cells including myoblasts and cardiomyocytes, which are are not density dependent cells.

Acknowledgements

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Referenced Resource

[1] DuPont, S.; Cates, R.; Stroot, P.; Toomey, R.; Swelling-induced Instabilities in Microscale, Surface-confined Poly(N-isopropylacrylamide) Hydrogels. Soft Matter 2010, 6, 3876-3882.

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