DREXEL UNIVERSITY School of Biomedical Engineering, Science and Health System

Composite Hydrogel Platform for High Local Cell Density Cell Culture and Mechanical Testing

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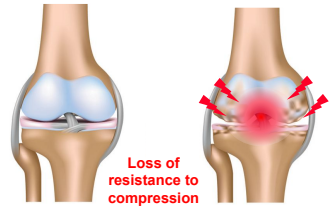
Team 20

Clinical Need and Design Inputs

Osteoarthritis (OA) affects ~32.5 million people in the US annually [1]



Specific Need

- Study cartilage cells and extracellular matrix (ECM) to treat OA
- Mimic compression on cartilage; study **cellular response**

Challenges

- Requires **high cell numbers** to maintain viability
- Ensuring load transmission onto cells

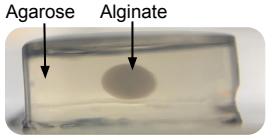
Key Requirements

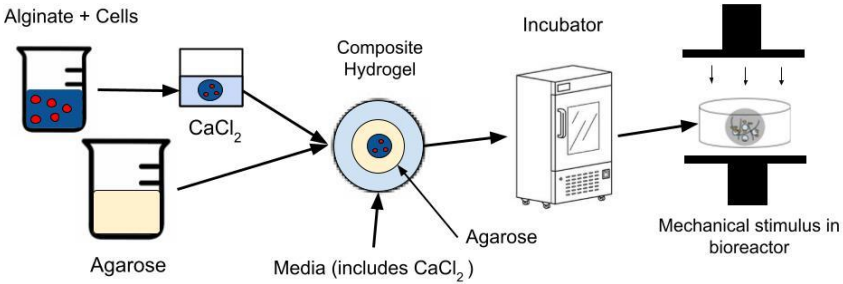
R1 Gel containing cells (alginate bead) must remain solid in polymerized state[2]
R2 Composite gel must remain stable >20% strain[3]
R3 Compressive load applied to entire gel must result in >10% deformation of bead[3]
R4 >80% viability after 1 week in culture[4]

Objective and Solution

Objective

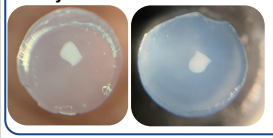
Synthesize a hydrogel that allows compression of a **small cell number** to study the effect of **mechanical loading** on cartilage ECM





Testing and Results

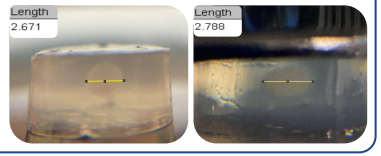
V1 Alginate Polymerization



Results: **Pass**

- Alginate stays polymerized
- P value= 0.347
  No significant change in diameter

V3 Load Sharing



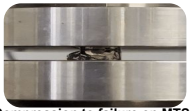
Results: Pass

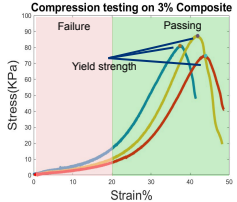
- Change in diameter 14.07% ± 4.6%
- n=3

V2 Mechanical Stability

Results: **Pass**

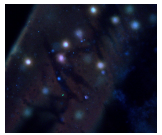
- Composite does not break under 20% strain


Compression to failure on MTS



V4 Cell Viability

Cell viability at Day 6



Results: Inconclusive

- Proof of *some* viable cells
- No accurate method to count cells yet

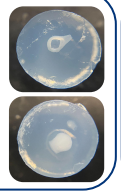
Green= live cells
Red= dead cells

Revisions and Future Work

Revisions

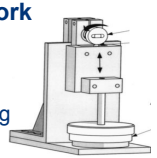
Agarose formulation modified to 3% from 2%

$CaCl_2$ supplemented to culture media



Future Work

Measure cell viability and gene expression with mechanical loading in bioreactor



Impact

- Further understanding of OA upon observing cell mechanosensing in vitro
- Solution may be implemented for other cell types (ex. cancer cells)

References

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3. Mauck, Sofie, M. A., Wang, C. C. B., Wong, D. D., Chao, P.-H. G., Valhmu, W. B., Hung, C. T., & Ateshian, G. A. (2000). Functional Tissue Engineering of Articular Cartilage Through Dynamic Loading of Chondrocyte-Seeded Agarose Gels. Journal of Biomechanical Engineering, 122(3), 252–260. https://doi.org/10.1115/1.429656
4. ISO 10993-5:2009 Biological Evaluation of Medical Devices. Part 5: Tests for In Vitro Cytotoxicity. International Organization for Standardization; Geneva, Switzerland: 2009.