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

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### Clinical Need and Design Inputs

**Osteoarthritis (OA)** affects ~32.5 million people in the US annually

- **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

### 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

**Key Requirements**

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

### Testing and Results

#### V1 Alginate Polymerization

- **At synthesis** 72 hours
- **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 testing on 3% Composite**
  - Measurement: 2.671

#### 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%
  - CaCl₂ 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

1. The University of North Carolina at Chapel Hill. (2022, October 12). Oa Prevalence and Burden. Osteoarthritis Action Alliance. Retrieved October 28, 2022, from [https://oaaction.unc.edu/oa-module/oa-prevalence-and-burden/#:~:text=CDC%20estimates%20that%201%20in,million%20by%20the%20year%202040.&text=While%20there%20are%20estimated%20to,affecting%2032.5%20million%20US%20adults](https://oaaction.unc.edu/oa-module/oa-prevalence-and-burden/#:~:text=CDC%20estimates%20that%201%20in,million%20by%20the%20year%202040.&text=While%20there%20are%20estimated%20to,affecting%2032.5%20million%20US%20adults)

