CELLJET
Cell Printer

A Novel Technology for Bio-Printing

Presented By:

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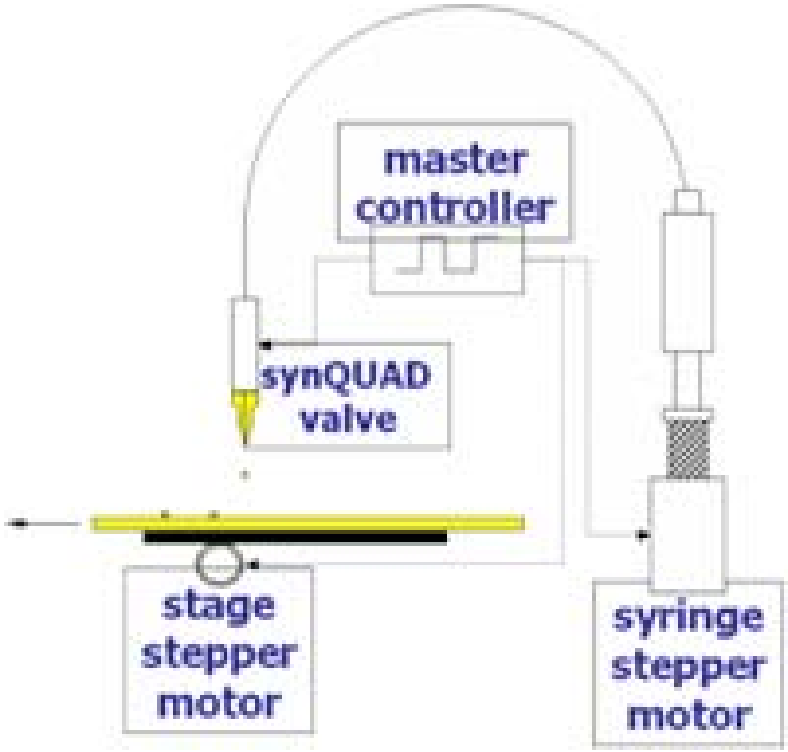
Overview

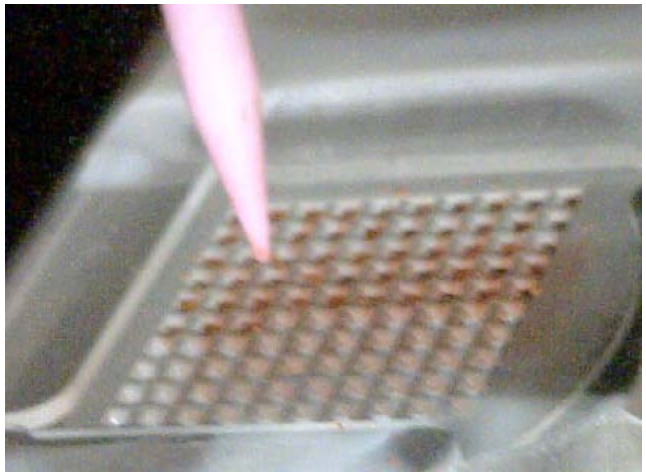
- What is the CellJet?
  - Basic Functioning
  - Live Cell Printing
- How did we use it?
  - Validation as a tool for Biofabrication
- Future Directions

Basic Operation



System Capabilities

- Fast: Fills a 1536 well plate in <1 minute
- Flexible
  - Multi-Channel: Separate paths for cells, media, hyrdrogels, etc.
  - 20 nl – 4 µl volume range
- Accurate: 10 µm spatial accuracy
- Gentle: Non-contact fluid path avoids cell constriction

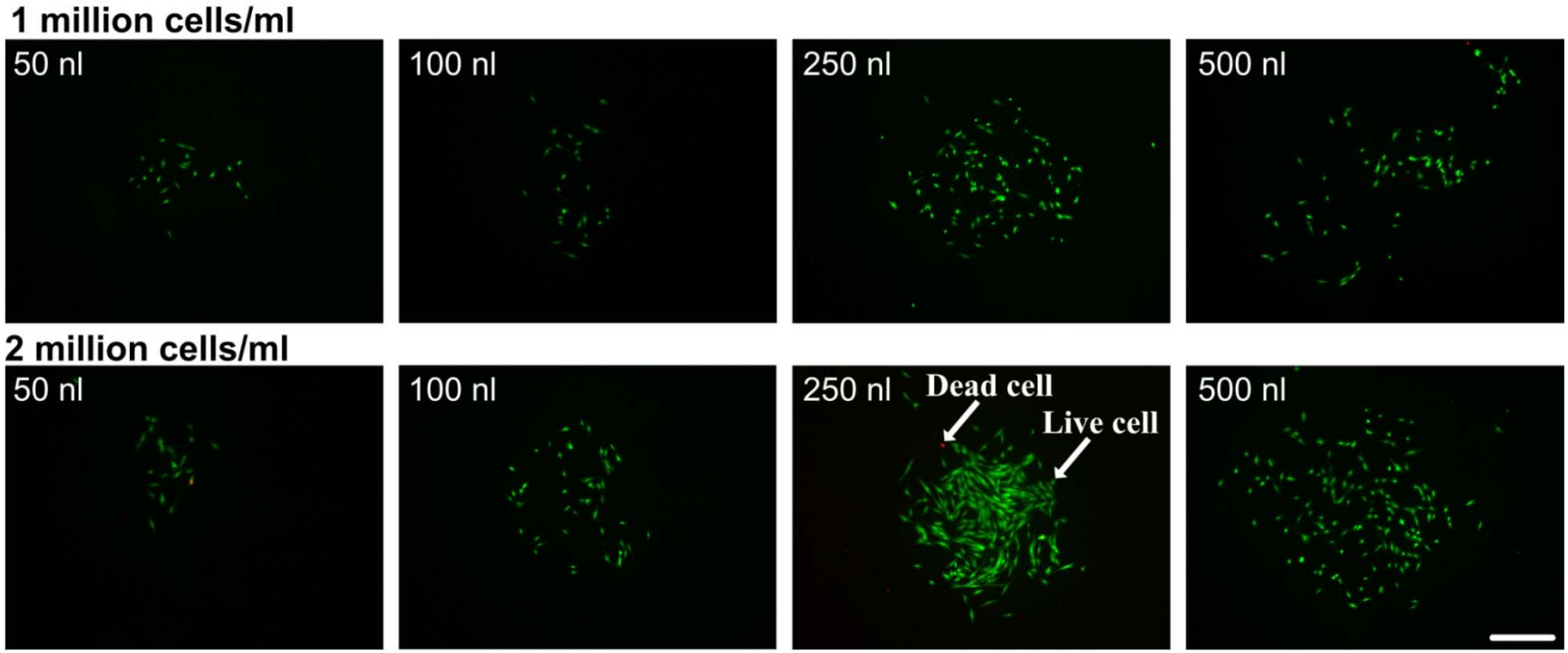


Bio-Printing Validation

- Printing Cells
  - Viability
  - Functionality
  - Concentration consistency
- Printing Hydrogels
  - Drop dispense at high viscosity
  - 2D Shapes
  - 3D Layering
- 3D Construct – cells in hydrogel architecture

Cell Viability

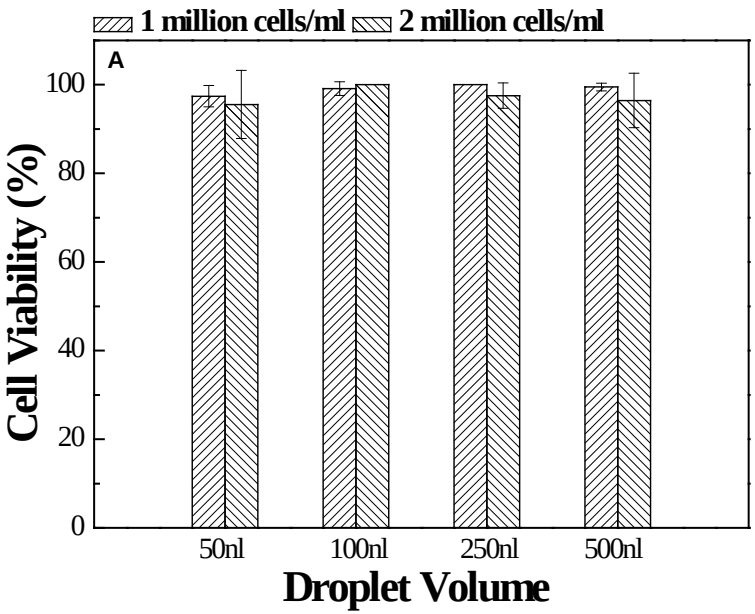
Human Muscle Stem Cells stained for live/dead assay



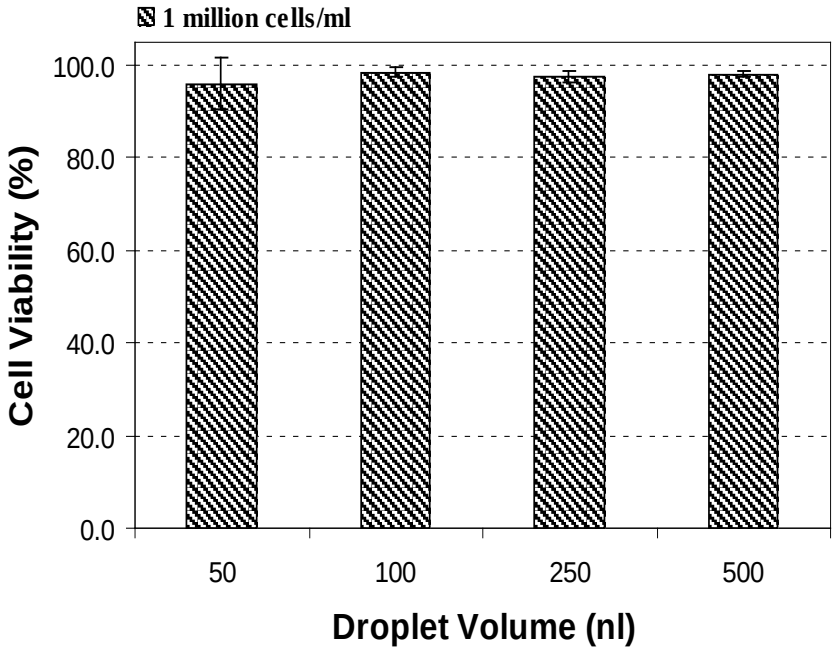
Scale bar: 200 µm

Cell Viability

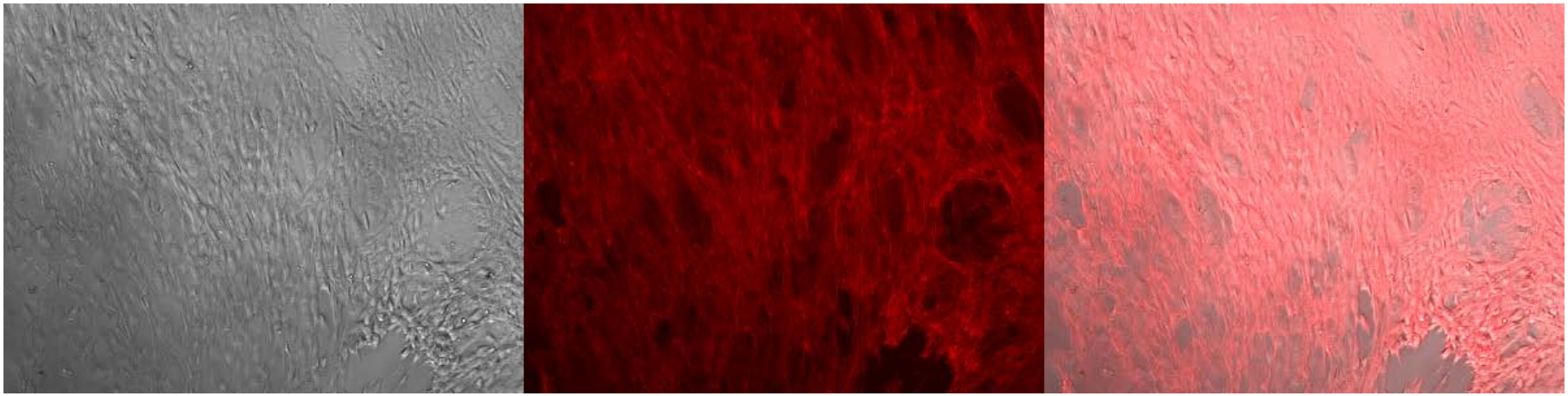
Human Muscle Stem Cell Viability



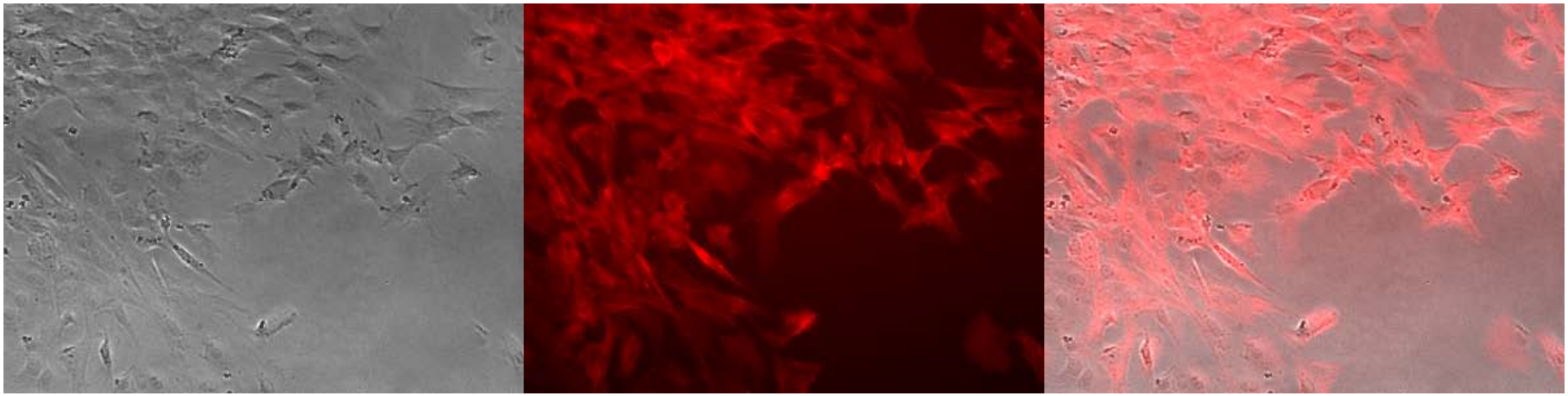
Smooth Muscle Cell Viability



Cell Functionality

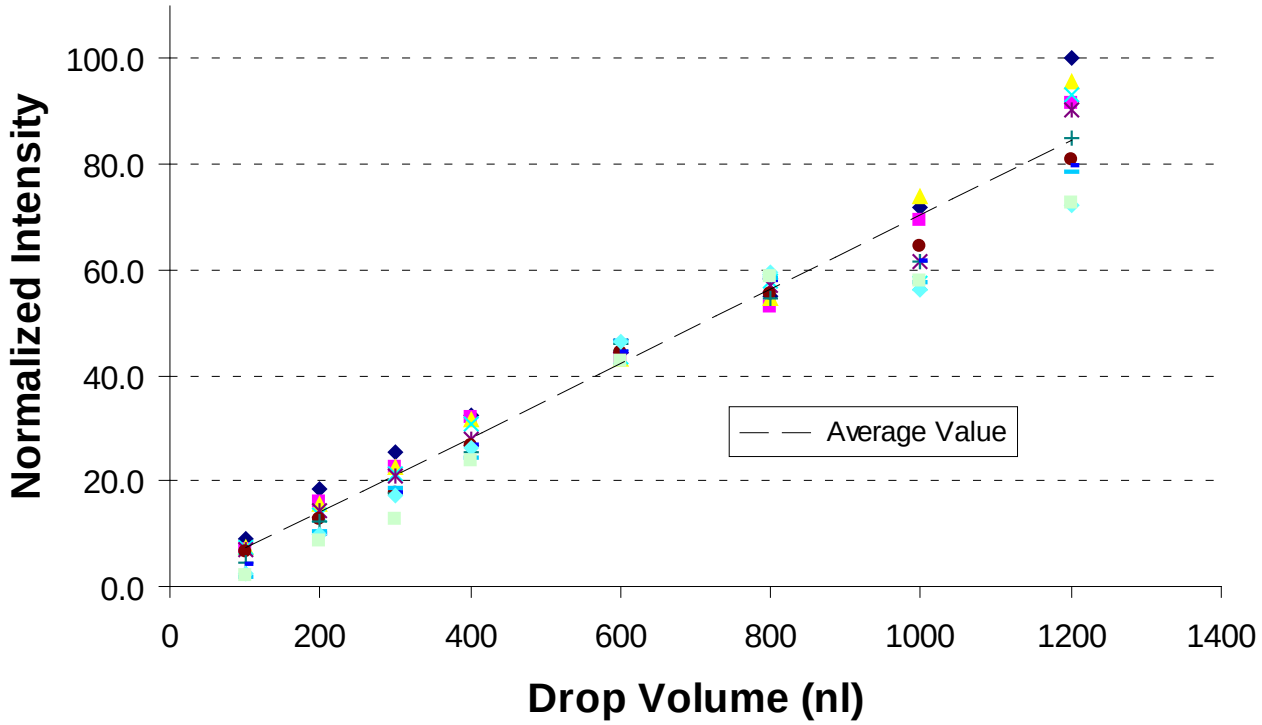


F-actin staining of Smooth Muscle Cells at 10x Magnification



F-actin staining of Smooth Muscle Cells at 20x Magnification

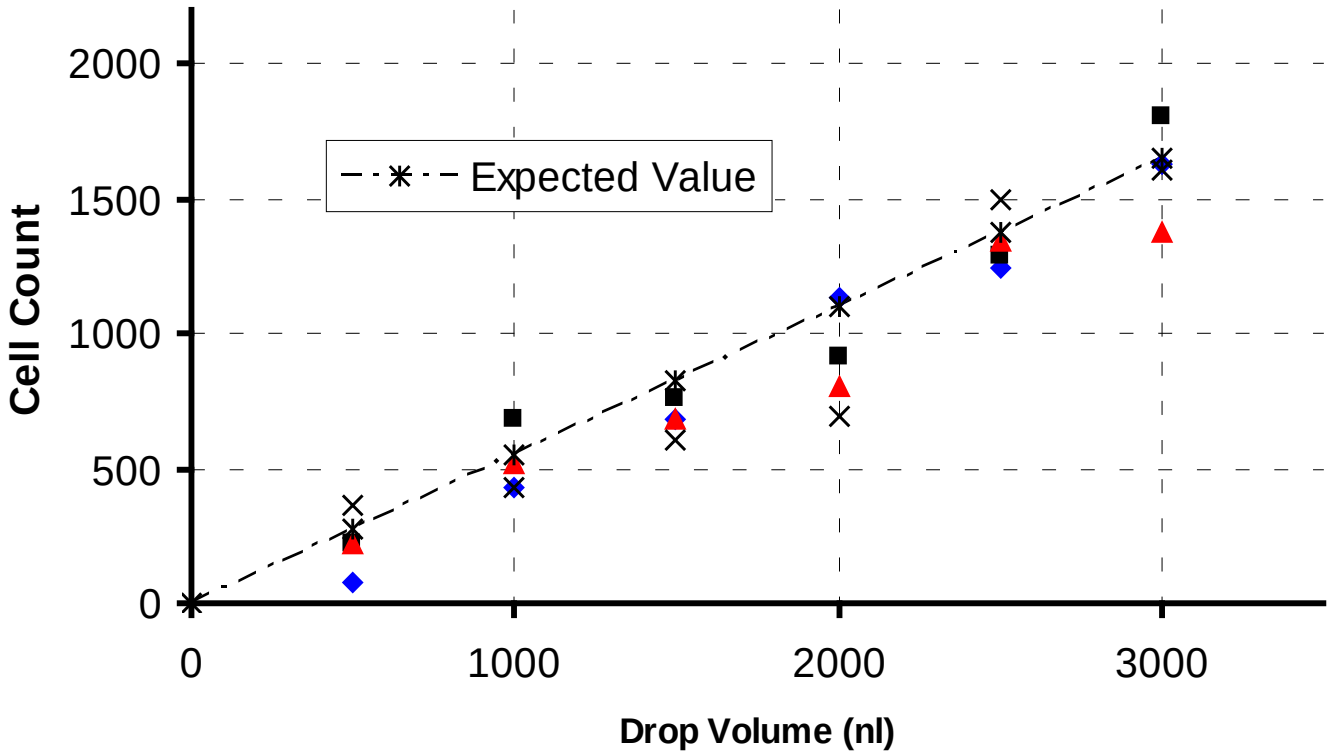
Cell Consistency – Fluorescent Dye



Rhodamine fluorescence intensity as a function of Drop volume after CellJet Printing.

Cell Consistency – Rat Arterial Smooth Muscle Cells

Cell concentration as a function of Drop volume after CellJet Printing



Cell Printing Validation

- Viability
  - Smooth Muscle Cells 97.5%
  - Human Muscle Stem Cells 98.4%
- Functionality
  - F-actin Staining
- Consistency
  - Fluorescent Dye Printing ± 4.8%
  - Rat Arterial Smooth Muscle Cells

Hydrogel Printing

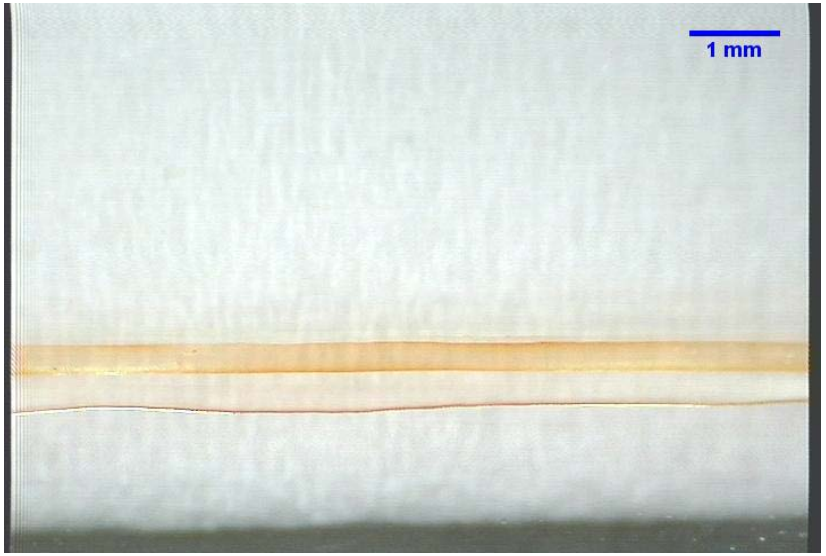
- Sodium Alginate
  - Chemically dependent hydrogel – solidifies with Ca^{2+} ions
- Drop Dispense at High Viscosities
- 2D Shapes
  - Lines
  - Circles
- 3D Layering

Hydrogels – Drop Dispense

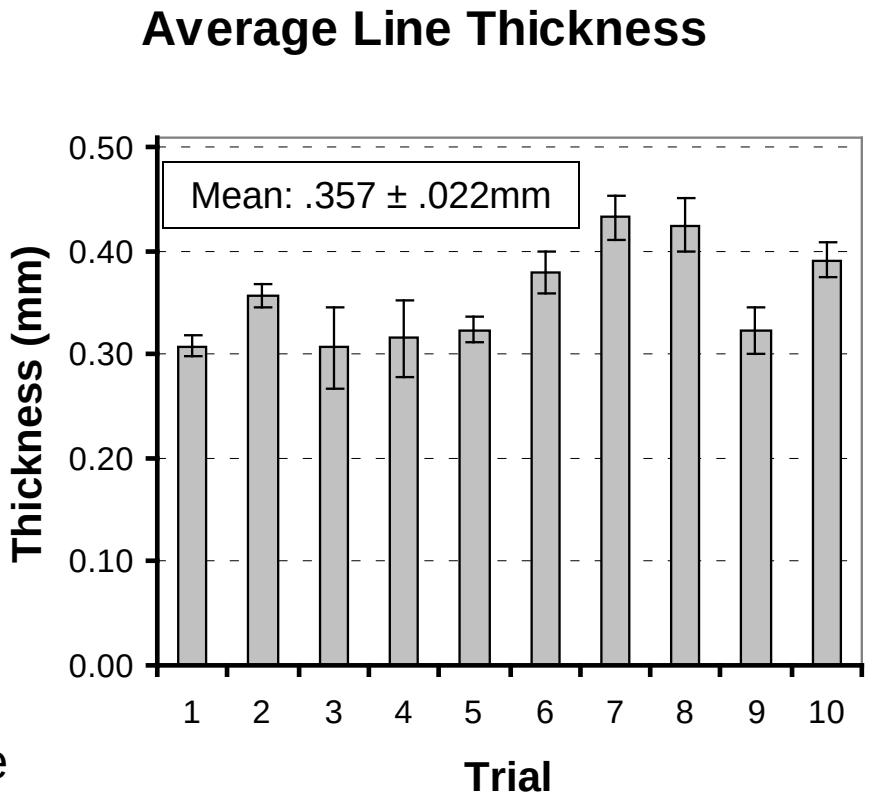
- 0.5% $^{w}/_{w}$ Sodium Alginate
  - Viscosity: 58.5 cP
  - Volume Range: 100nl - 4µl
- 1.0% $^{w}/_{w}$ Sodium Alginate
  - Viscosity: 269.5 cP
  - Volume Range: 125nl - 4µl
- 1.5% $^{w}/_{w}$ Sodium Alginate
  - Viscosity: 1180.2 cP
  - Volume Range: 250nl - 4µl

Hydrogels – 2D Shapes

- **Lines:**

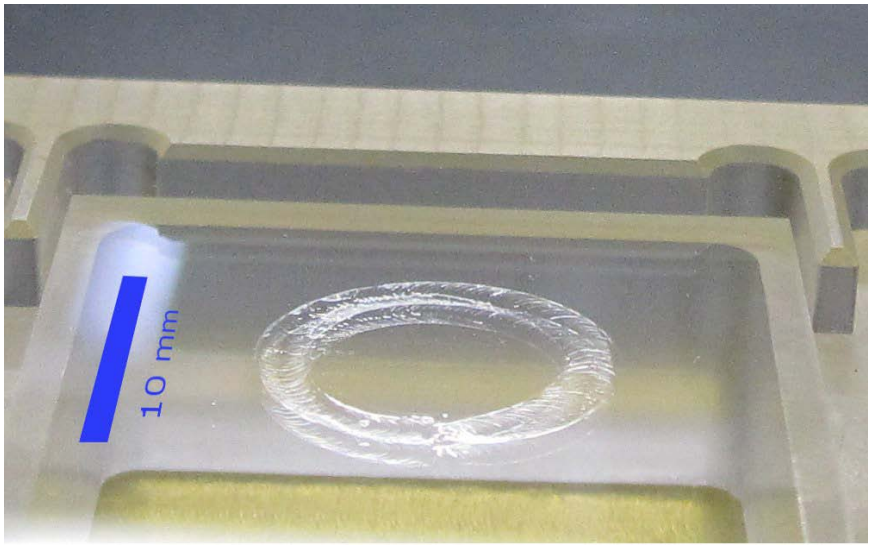


Sodium Alginate gel printed to a glass slide

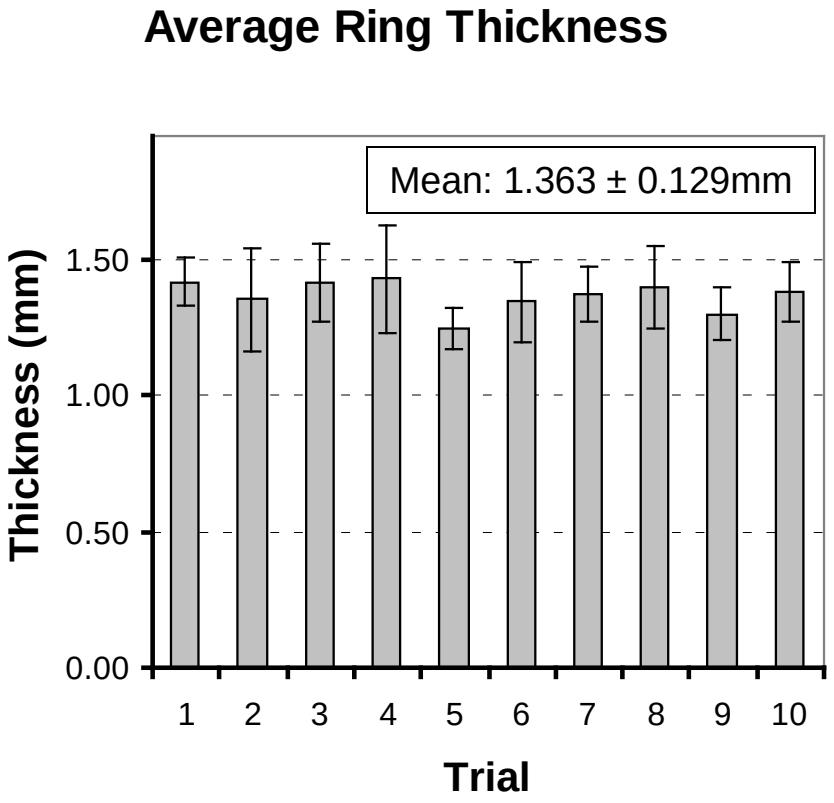


Hydrogels – 2D Shapes

- **Circles:**



Sodium Alginate printed in 10mm circle



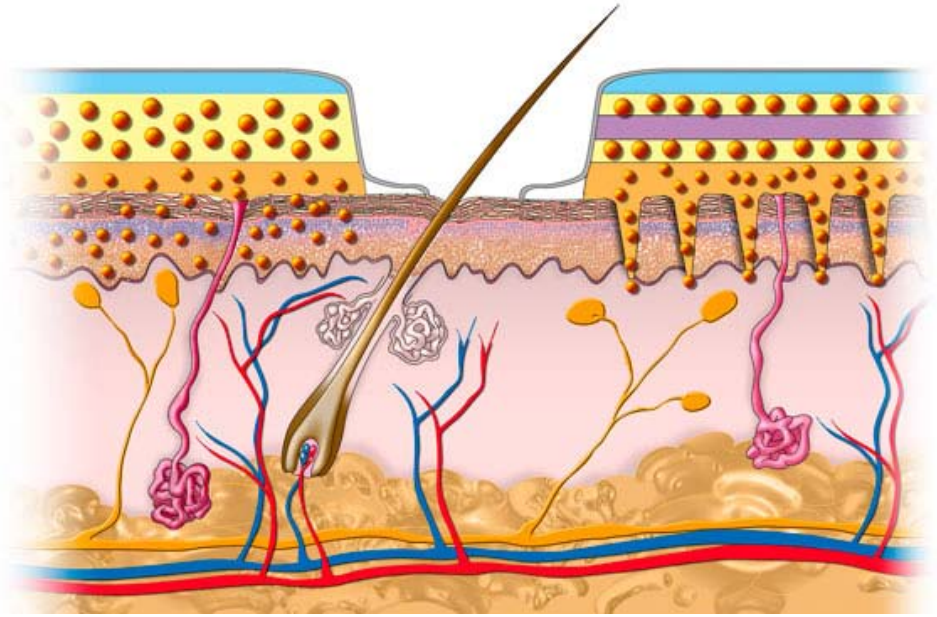
Printed Geometry – controlled by Dispense Volume, Height, and Speed

Hydrogels – 3D Layering

- Sodium Alginate
  - 2D Shapes – Controllable
  - 3D Layering – Unexpected Results
- Further Investigation
  - Alternative Dispense Methods
  - Other Hydrogels

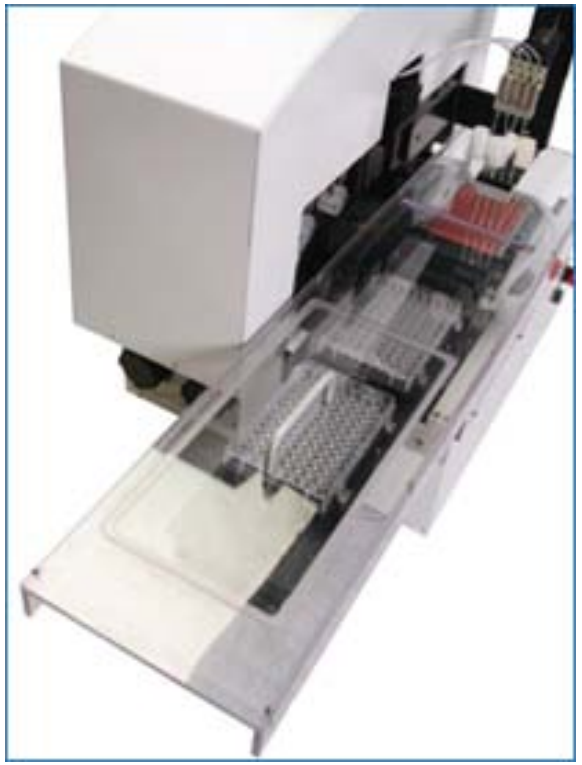
Future Direction

- Print Hydrogels for support
- Print Cells suspended in Hydrogel in precise locations



Bio-Printing Validation

- Printing Cells
  - Viability > 95% ✓
  - Functionality ✓
  - Concentration consistency ✓
- Printing Hydrogels — In Progress
  - Drop dispense at high viscosity ✓
  - 2D Shapes ✓
  - 3D Layering — In Progress
- Future Direction – Functional 3D Construct with Cells



THANK YOU!

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