



# A Novel Technology for Bio-Printing



Presented By:

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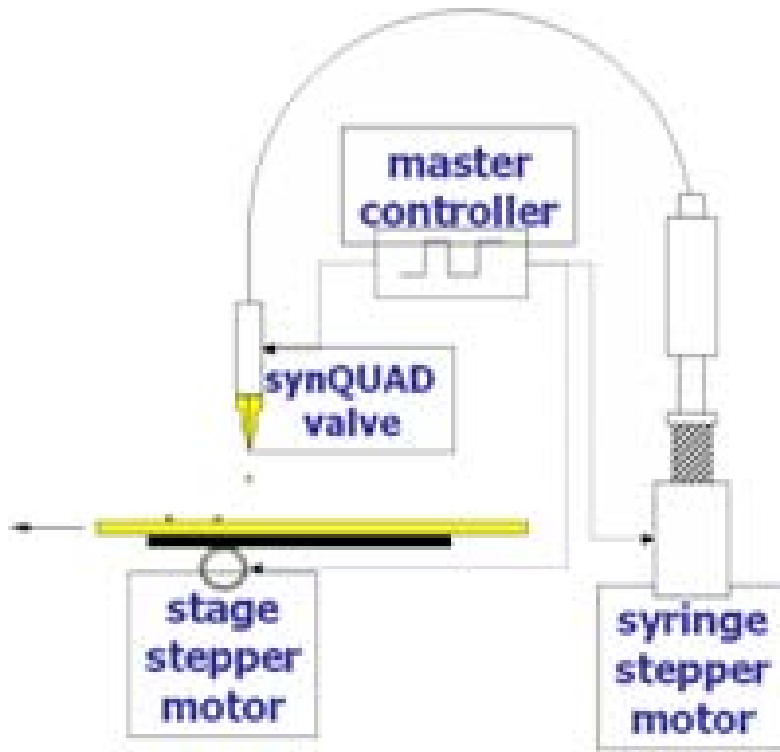
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# Overview

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

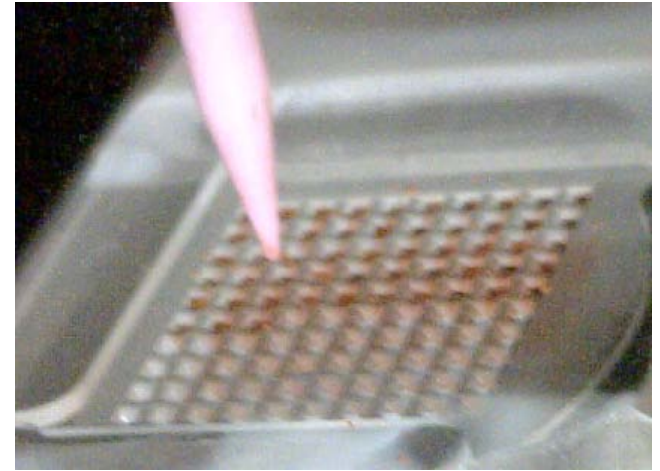
# Basic Operation



# System Capabilities

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



# Bio-Printing Validation

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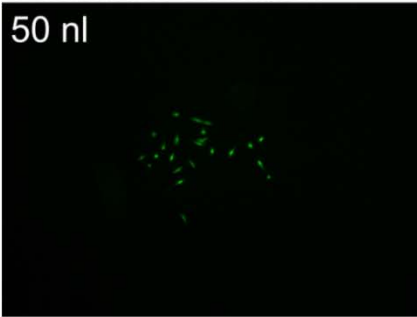
- Printing Cells
  - Viability
  - Functionality
  - Concentration consistency
- Printing Hydrogels
  - Drop dispense at high viscosity
  - 2D Shapes
  - 3D Layering
- 3D Construct – cells in hydrogel architecture

# Cell Viability

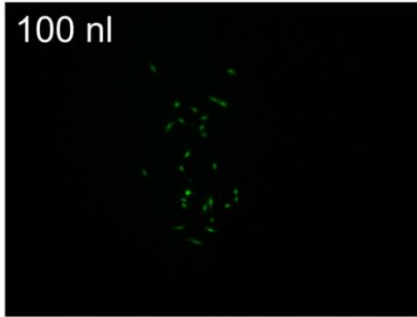
Human Muscle Stem Cells stained for live/dead assay

**1 million cells/ml**

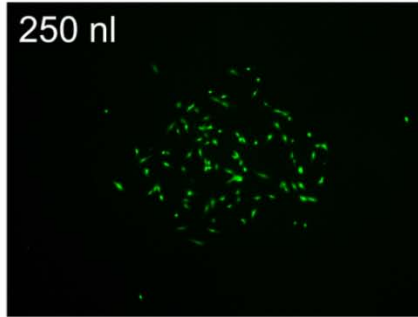
50 nl



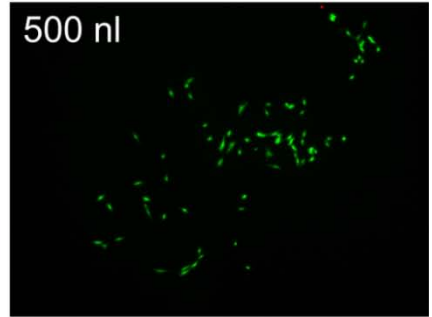
100 nl



250 nl

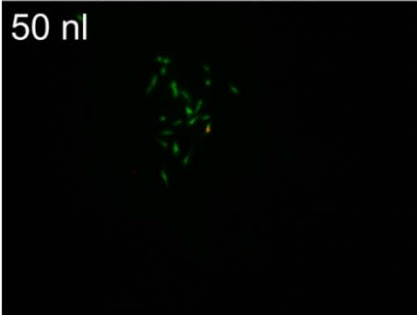


500 nl

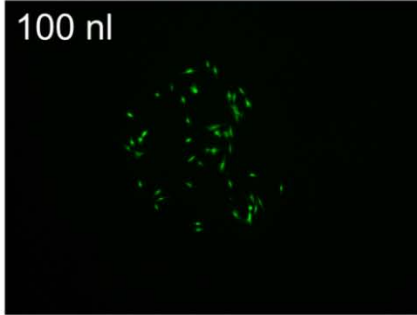


**2 million cells/ml**

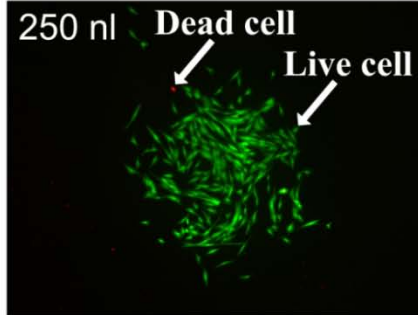
50 nl



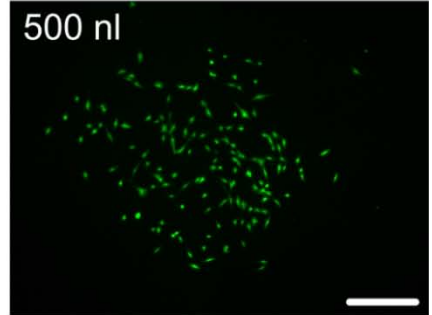
100 nl



250 nl



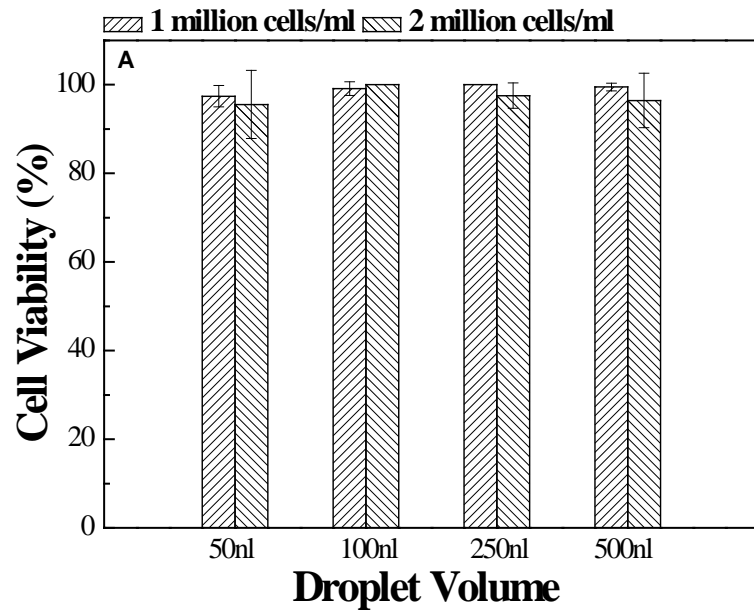
500 nl



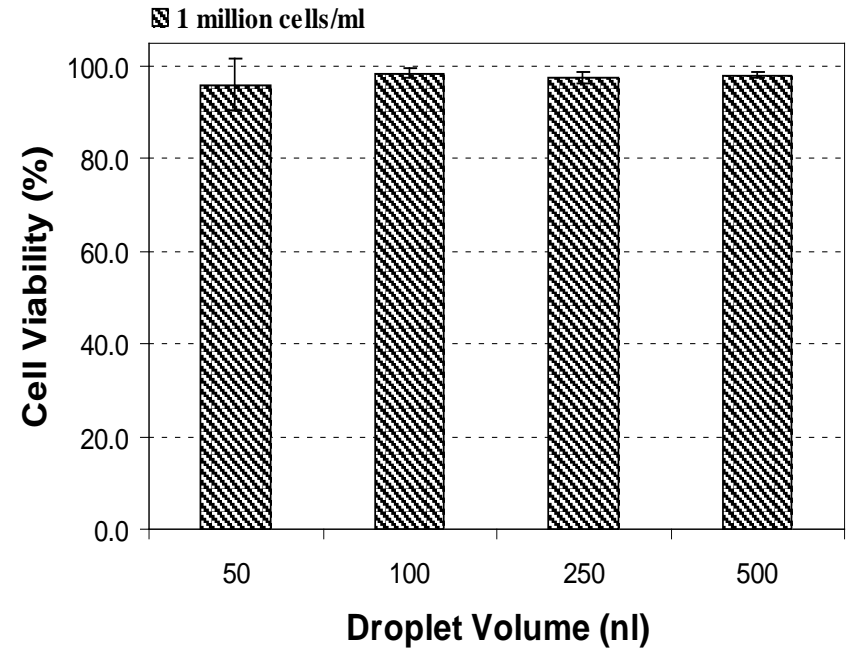
Scale bar: 200  $\mu$ m

# Cell Viability

## Human Muscle Stem Cell Viability

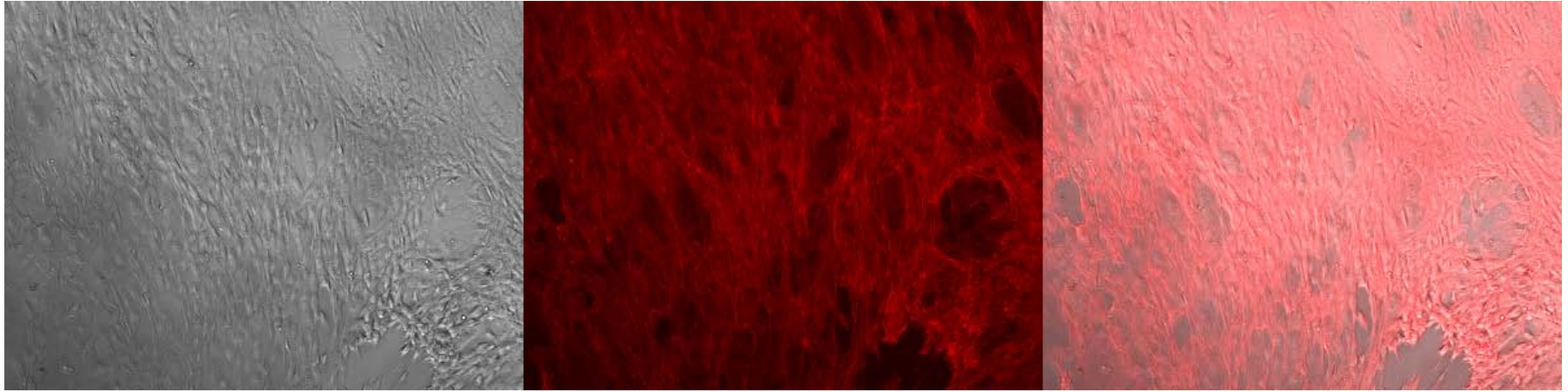


## Smooth Muscle Cell Viability

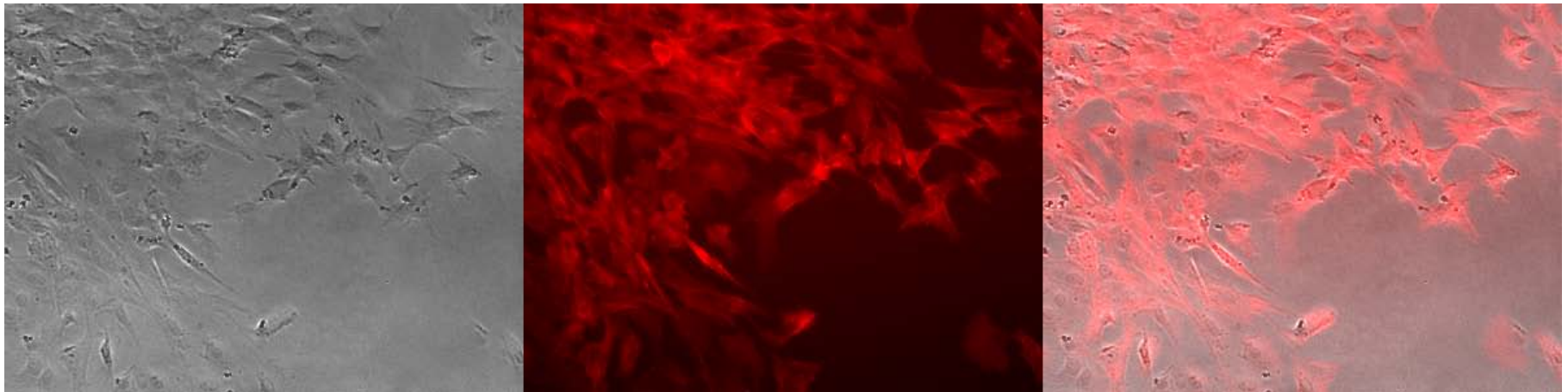


# Cell Functionality

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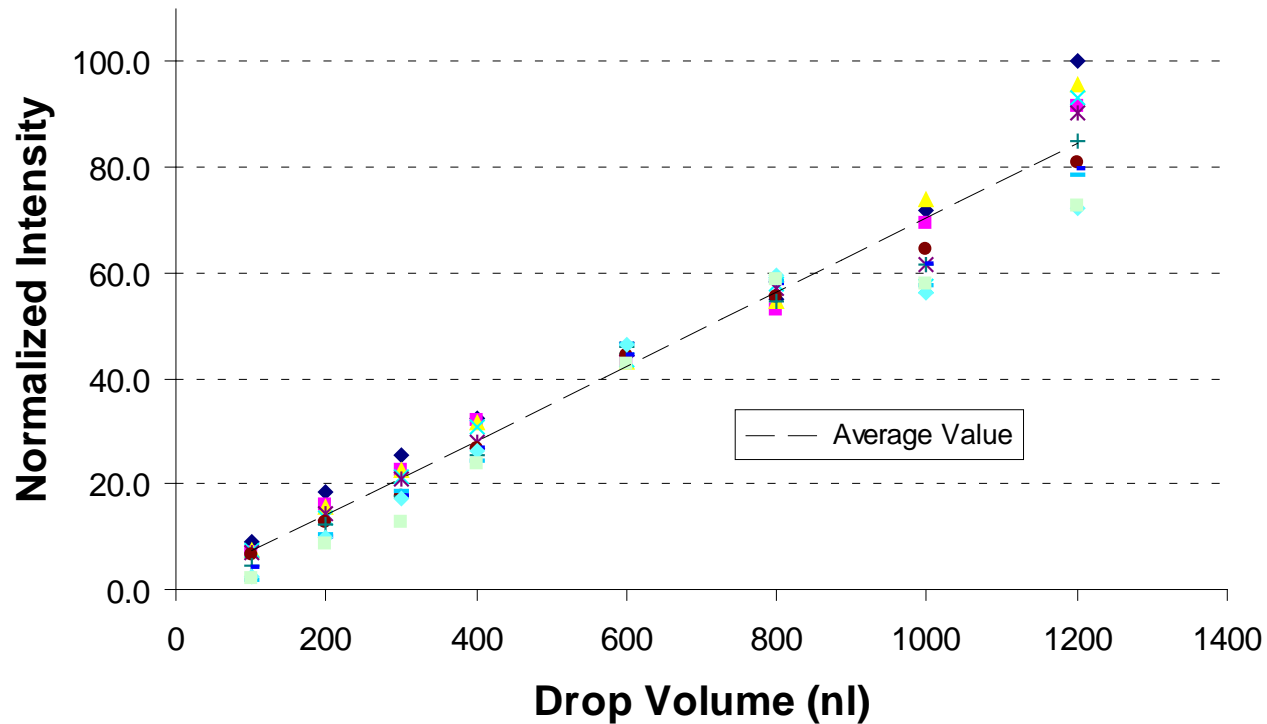


F-actin staining of Smooth Muscle Cells at 10x Magnification



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

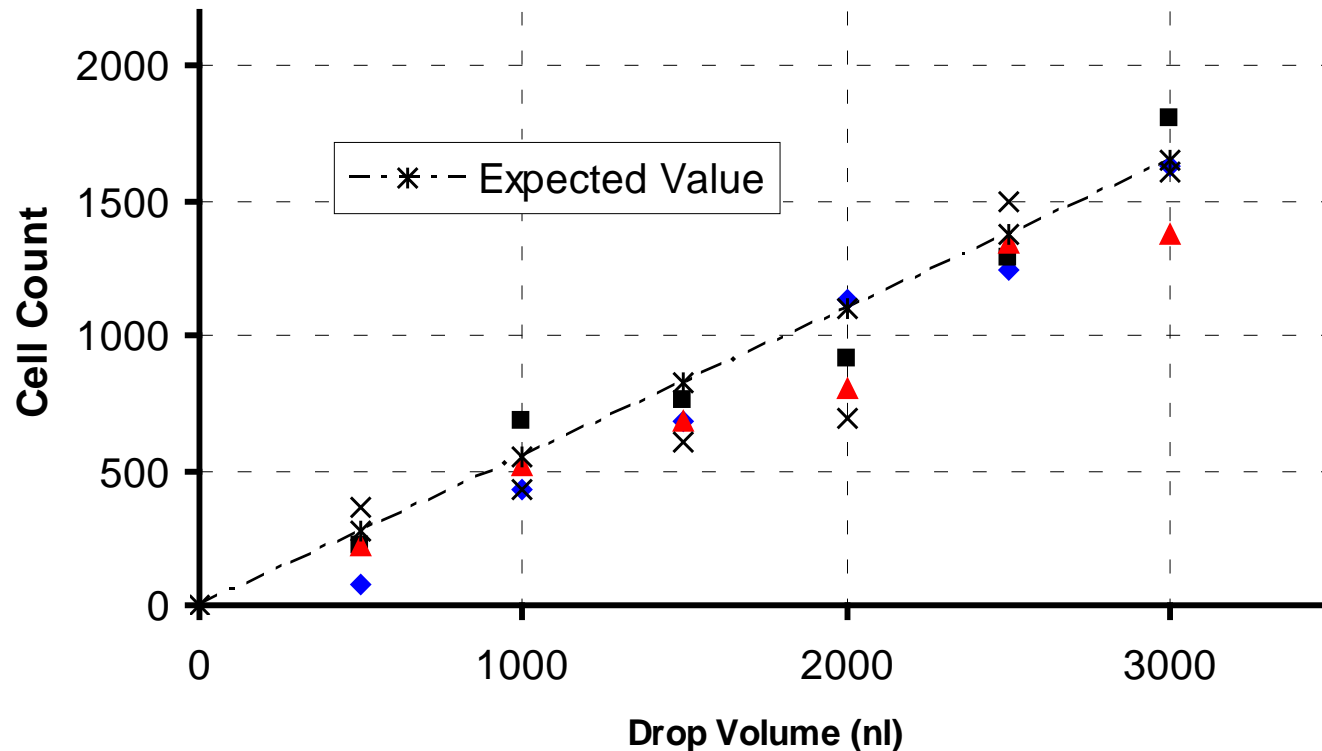
# Cell Consistency – Fluorescent Dye



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

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- Viability

- Smooth Muscle Cells 97.5%
- Human Muscle Stem Cells 98.4%

- Functionality

- F-actin Staining

- Consistency

- Fluorescent Dye Printing  $\pm 4.8\%$
- Rat Arterial Smooth Muscle Cells

# Hydrogel Printing

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

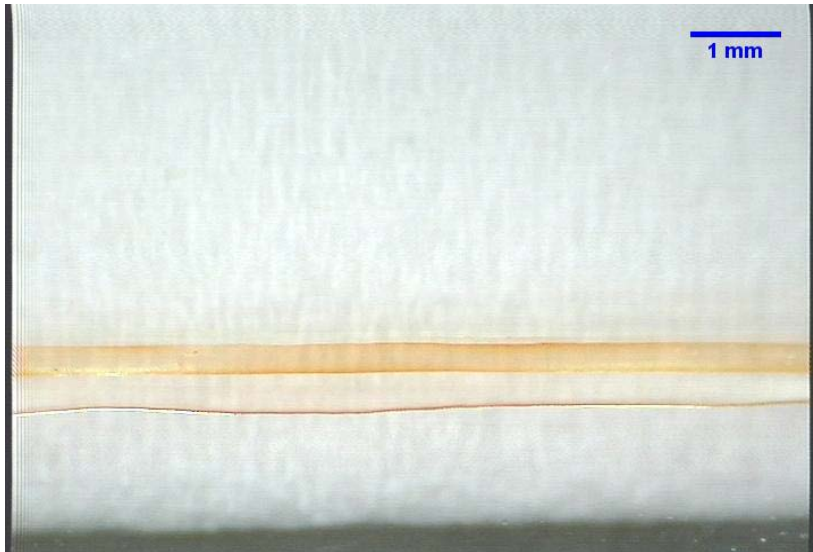
# Hydrogels – Drop Dispense

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- 0.5% <sup>w</sup>/<sub>w</sub> Sodium Alginate
  - Viscosity: 58.5 cP
  - Volume Range: 100nl - 4μl
- 1.0% <sup>w</sup>/<sub>w</sub> Sodium Alginate
  - Viscosity: 269.5 cP
  - Volume Range: 125nl - 4μl
- 1.5% <sup>w</sup>/<sub>w</sub> Sodium Alginate
  - Viscosity: 1180.2 cP
  - Volume Range: 250nl - 4μl

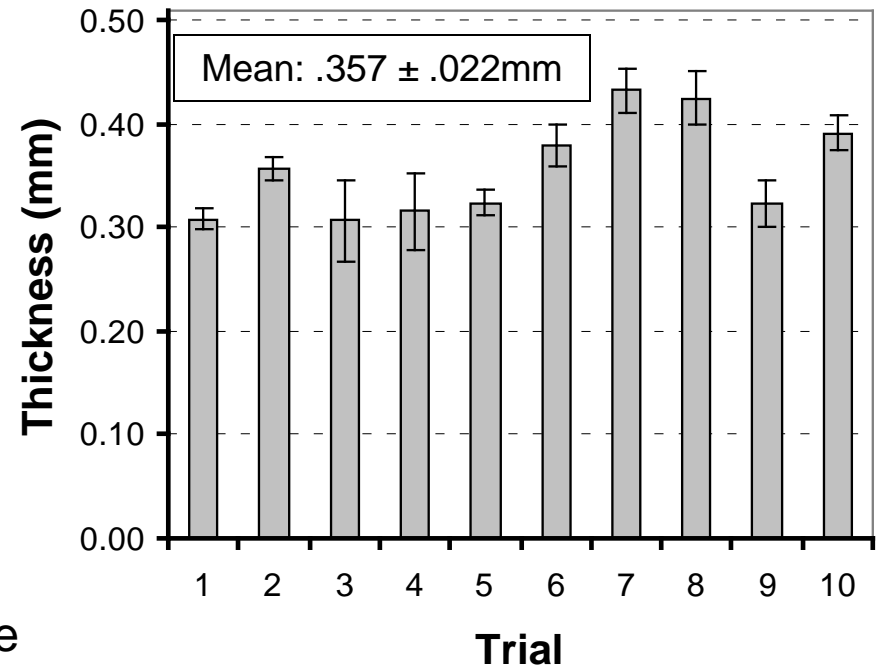
# Hydrogels – 2D Shapes

- Lines:



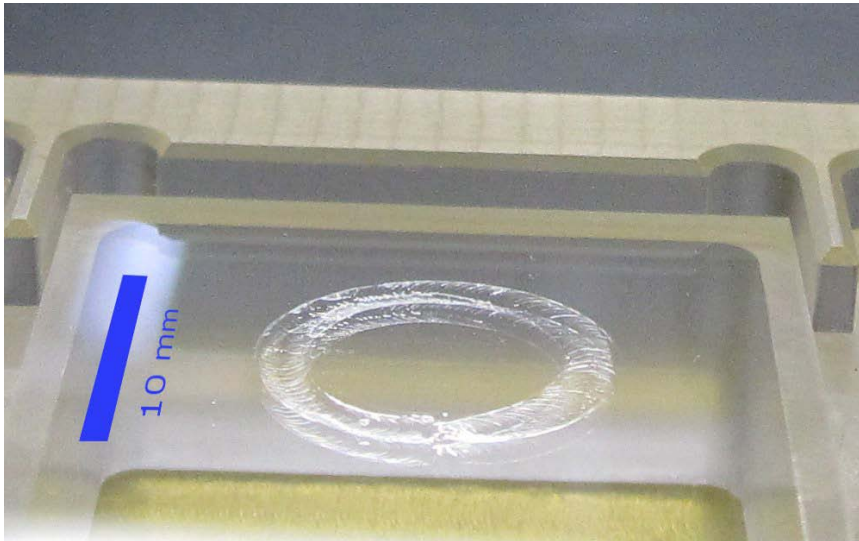
Sodium Alginate gel printed to a glass slide

## Average Line Thickness



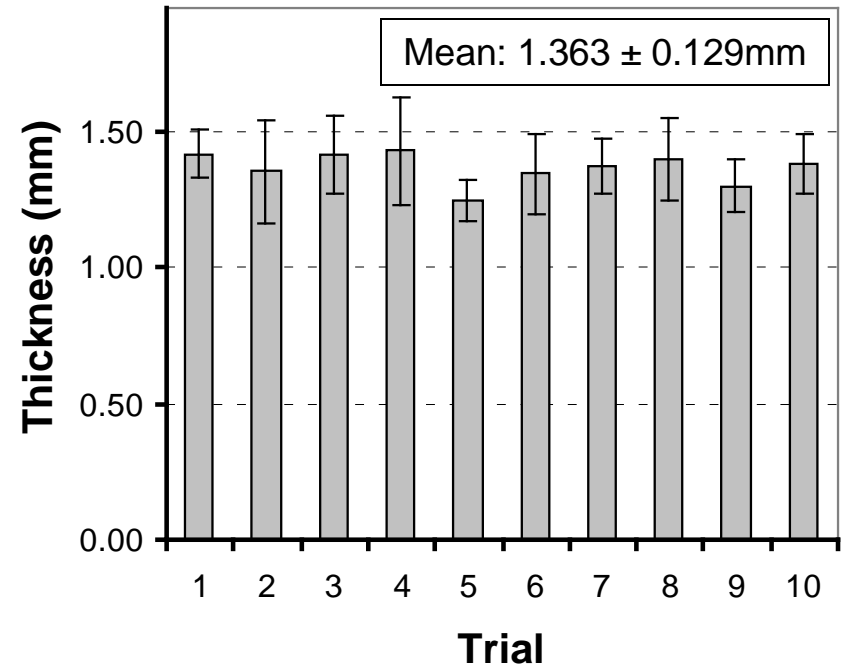
# Hydrogels – 2D Shapes

- Circles:



Sodium Alginate printed in 10mm circle

### Average Ring Thickness



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

# Hydrogels – 3D Layering

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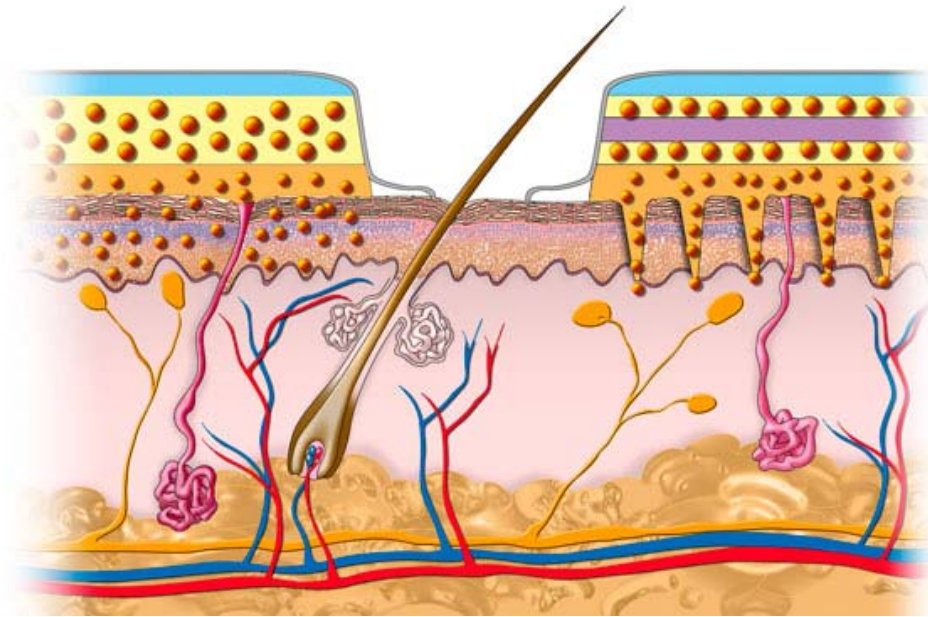
- Sodium Alginate
  - 2D Shapes – Controllable
  - 3D Layering – Unexpected Results
- Further Investigation
  - Alternative Dispense Methods
  - Other Hydrogels



# Future Direction

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



# Bio-Printing Validation

- **Printing Cells**

- Viability > 95%
- Functionality
- Concentration consistency



- **Printing Hydrogels**

- Drop dispense at high viscosity
- 2D Shapes
- 3D Layering

In Progress



In Progress

- **Future Direction – Functional 3D Construct with Cells**



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# THANK YOU!

Download: <http://www.digilabglobal.com/CellJet>

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