Biomaterials Design for Tissue Engineering Through Hydrogels

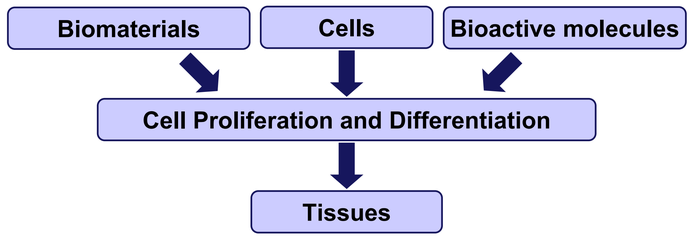
Jon Bernhard[1,2], Margaret Boushell[1,2], Philip Chuang[1,3], Dovina Qu[1,2], Nina Sinatra[1,3]
***Advisors:* Lauren Prentiss[4], Helen H. Lu, Ph.D.[1,2]**

[1]Society for Biomaterials Student Chapter, Columbia University, New York, NY, [2]Department of Biomedical Engineering, Columbia University, New York, NY
[3]Materials Science and Engineering, Columbia University, New York, NY, [4]M.S. 247 Dual Language Middle School, New York, NY

INTRODUCTION

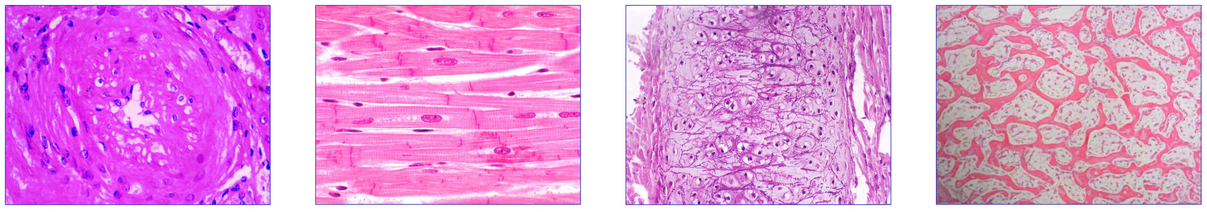
Tissue Engineering

- Need materials that are biocompatible and can integrate with native tissues ➔**BIOMATERIALS!**



Structure-Function Relationships

- Native and regenerated tissue must have similar mechanical properties
- Adjusting the mechanical properties of a scaffold is a crucial aspect of tissue engineering and regeneration



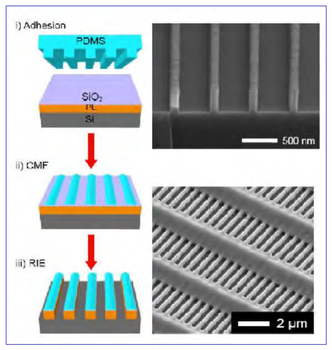
Hydrogels

- Hydrogel scaffolds are used in cartilage tissue engineering
  - Significant water content mimics native tissue properties


Self-healing polymer hydrogels

Photolithography

- Proteins and cells can be patterned using soft lithography
- Important for:
  - Fundamental cell biology
  - Biosensors
  - Tissue engineering



Sample photolithography process

METHODS

1. Structure-function relationships:
- Make Jell-O at three concentrations: 4x, 2x, and 1x
- Observe differences in mechanical stiffness among gels

2. Cell-seeded scaffolds:
- Insert seeds or beans into gels from Step 1

3. Defect repair:
- Using aluminum foil, make a model bone with a defect
- Pour Jell-O mixture into defect and allow gel to set
- Observe integration of gel with model defect

4. Patterning:
- Using aluminum foil, make a stamp
- Pour Jell-O mixture into petri dish, place stamp on Jell-O, and allow gel to set before removing stamp

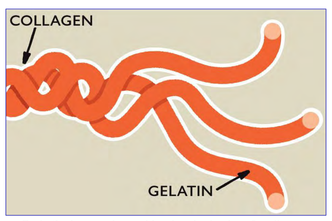
Students at M.S. 247 explore material structure-function relationships and applications of hydrogels for tissue engineering

MATERIALS

Jell-O: Gelatin

- Collagen $\xrightarrow{hydrolysis}$ Gelatin
  - **Collagen:** Water-insoluble protein found in bone, connective tissues, and skin
  - **Gelatin:** Water-soluble protein


The primary ingredient of Jell-O is gelatin

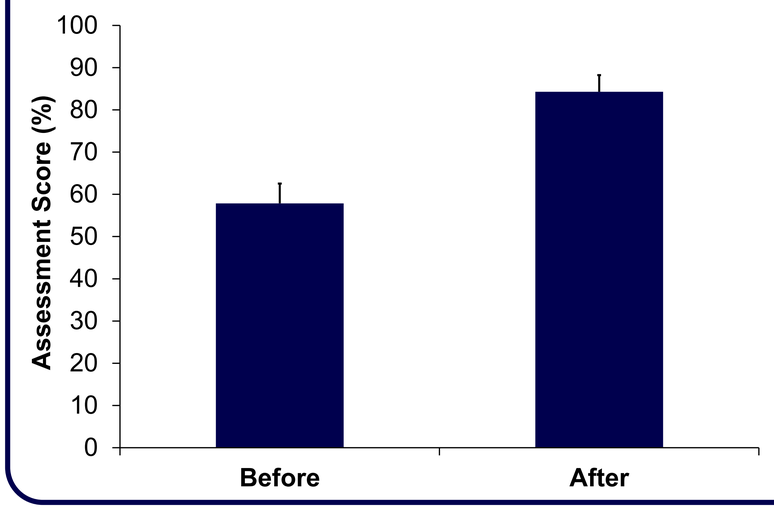


Gelatin is produced by hydrolysis of collagen

Materials

- Jell-O mix
- Water
- Seeds
- Ice
- Petri dish
- Stirring rod
- Aluminum foil
- Plastic cups
- Graduated cylinder

STUDENT ASSESSMENT



- Students were tested on biomaterials properties and tissue engineering concepts before and after participating in education module
- Significant improvement in assessment scores after participation

REFERENCES Kane RS, et al. Biomaterials 20(1999); http://fand.kaist.ac.kr/Research3.htm; http://arstechnica.com/science/2012/06/organic-hydrogel-outperforms-typical-carbon-supercapacitors/; http://www.madehow.com/Volume-5/Gelatin.html; http://www.americastestkitchenfeed.com/cooking-science/2012/11/we-prove-it-cook-tough-cuts-beyond-well-done/