Absorbable Hydrodissection Fluid

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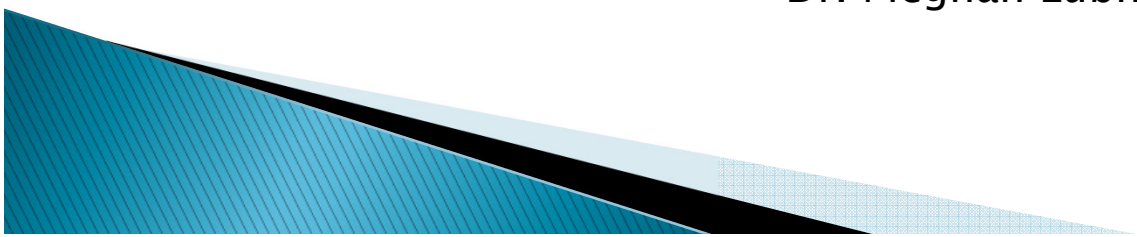
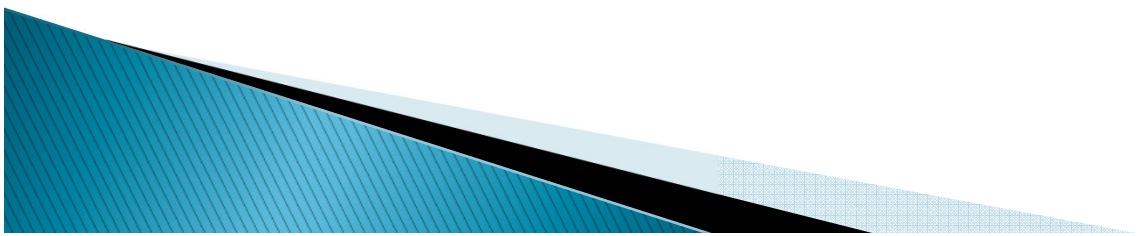
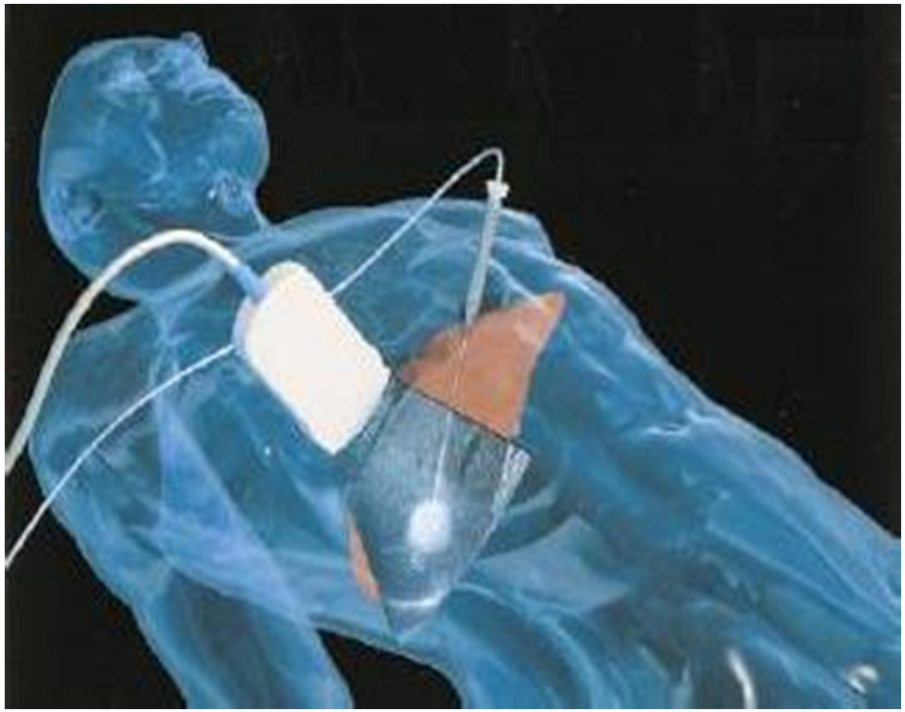


Problem Motivation

- Over 500,000 new incidences of liver cancer annually
- Ablation used to treat tumors
  - Unwanted tissue damage
- Hydrodissection fluid separates tissues
  - Unintended migration
  - Quick absorption
  - Barrier degradation
  - Leads to excess liquid use



Radiofrequency (RF) Ablation

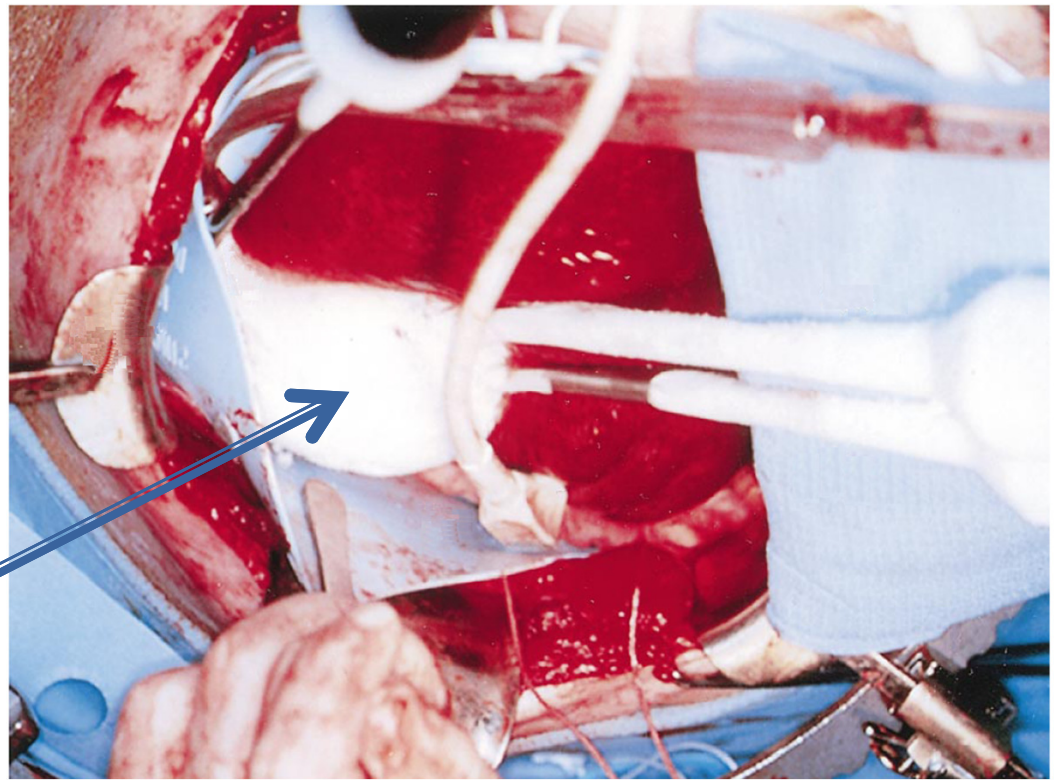


G. D. D. III, *et al.*, "Minimally Invasive Treatment of Malignant Hepatic Tumors: At the Threshold of a Major Breathrough," *RadioGraphics,* vol. 20, p. 19, 2000

- Uses RF AC current to generate heat in an electrode and 'burn out' tumors
- Few patient complications
- > 85% success in eliminating tumors

Cryoablation

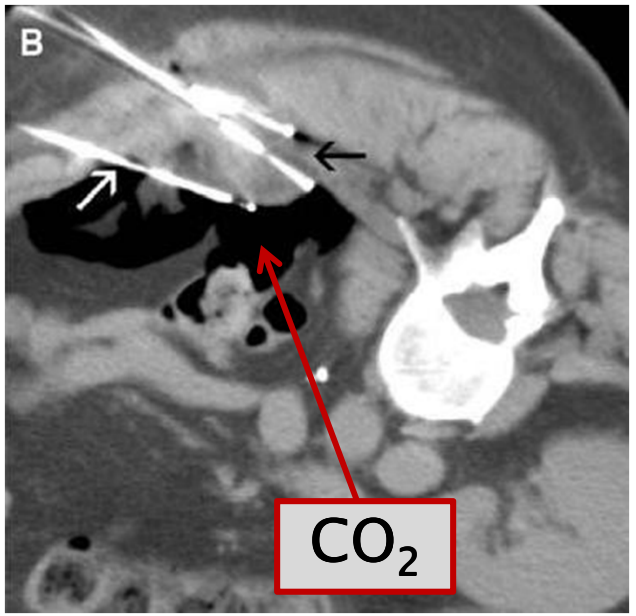
- Freezes target tissue
- Can treat larger tumors than RFA
- Better control



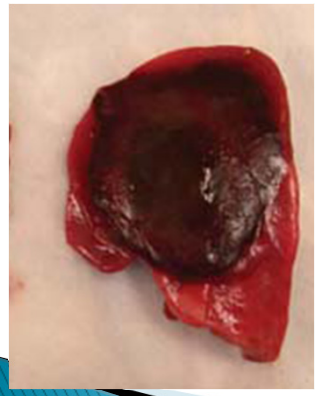
Adapted from G. D. D. III, *et al.*, "Minimally Invasive Treatment of Malignant Hepatic Tumors: At the Threshold of a Major Breathrough," *RadioGraphics,* vol. 20, p. 19, 2000

Current Treatments

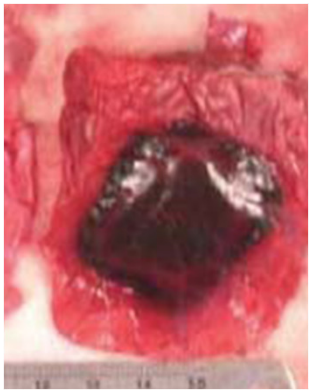
- 5% Dextrose in Water (D5W)
- CO_2 gas bladder or insufflation
- Saline



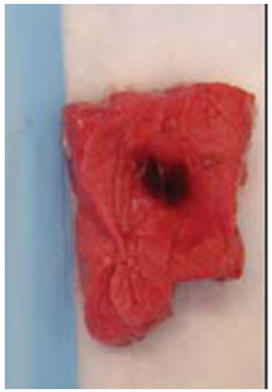
No Treatment



Saline



D5W



Adapted from Buy, X., et al., *Thermal protection during percutaneous thermal ablation procedures: interest of carbon dioxide dissection and temperature monitoring.* Cardiovascular and interventional radiology, 2009. **32**(3): p. 529-534.

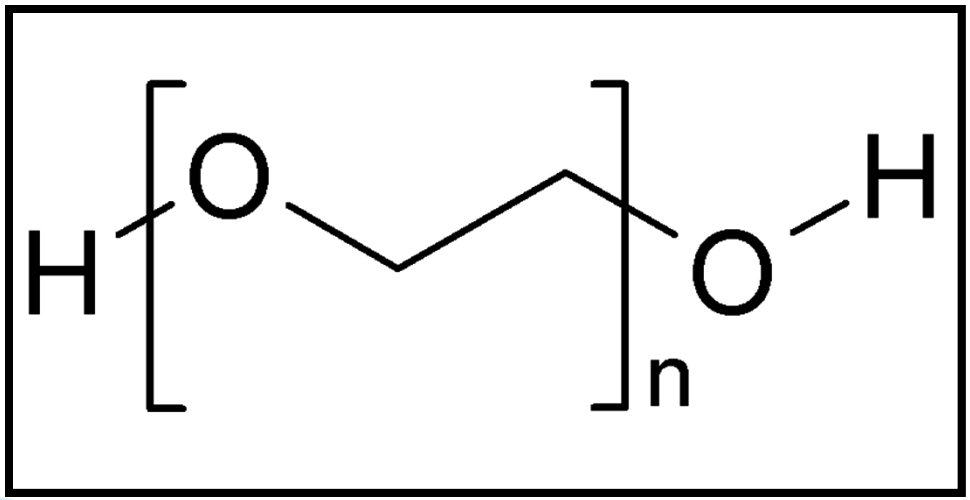
Adapted from P. F. Laeske, *et al.*, "Uninte[illegible] injuries from radiofrequency ablation: Protection with 5% dextrose in water," *Am. J. Roentgenology*, vol. 186, pp. 5249-5254, 2006.

Design Specifications

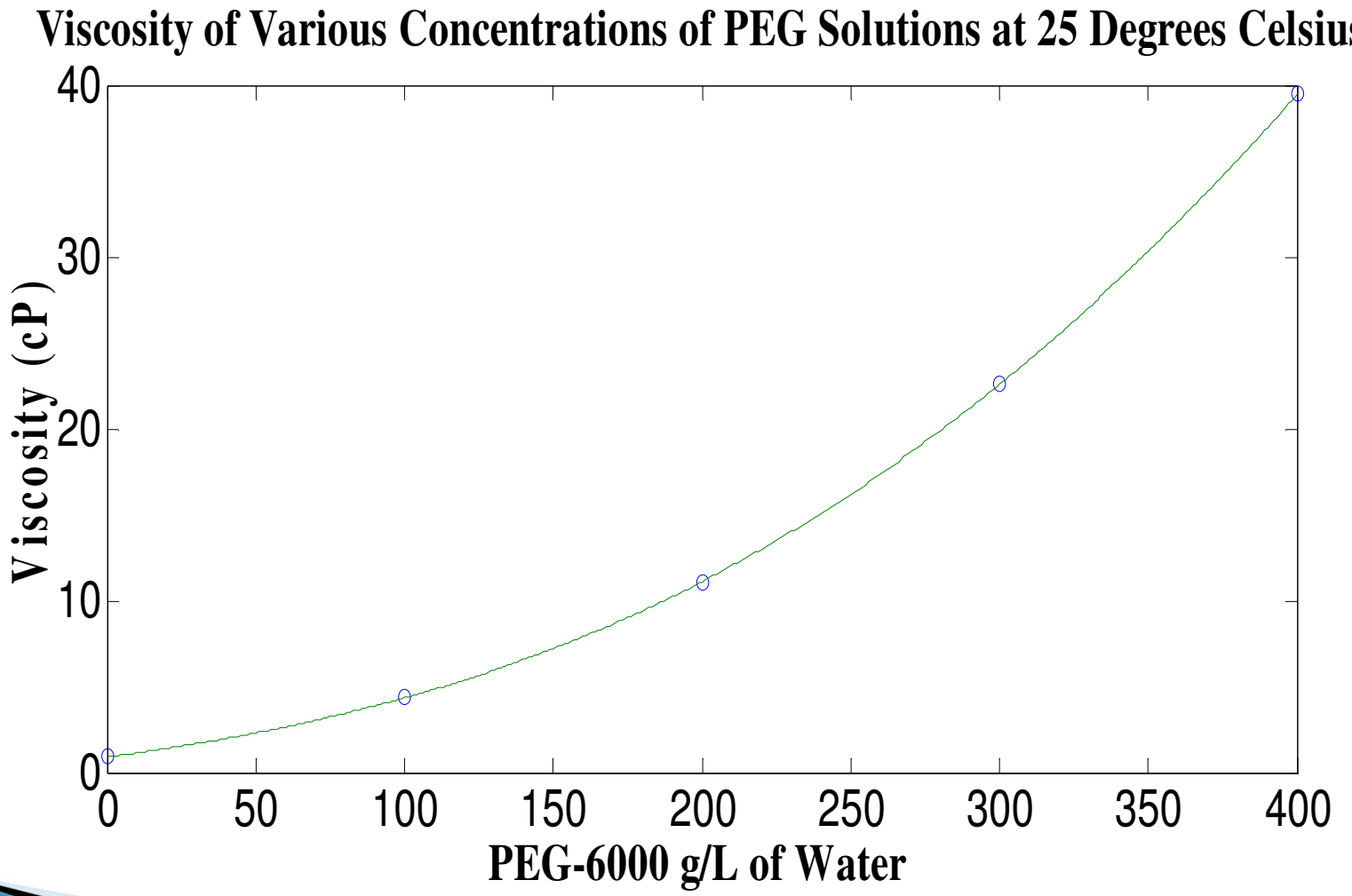
- Easy to inject
- Visible with imaging techniques
  - Ultrasound
  - CT/MRI
- Biocompatible
- Insulator
  - Thermal
  - Electrical
- Less than $200

Poly(ethylene glycol) – PEG

- History – additive
- Biologically inert
- FDA approved
- Viscosity is concentration dependent

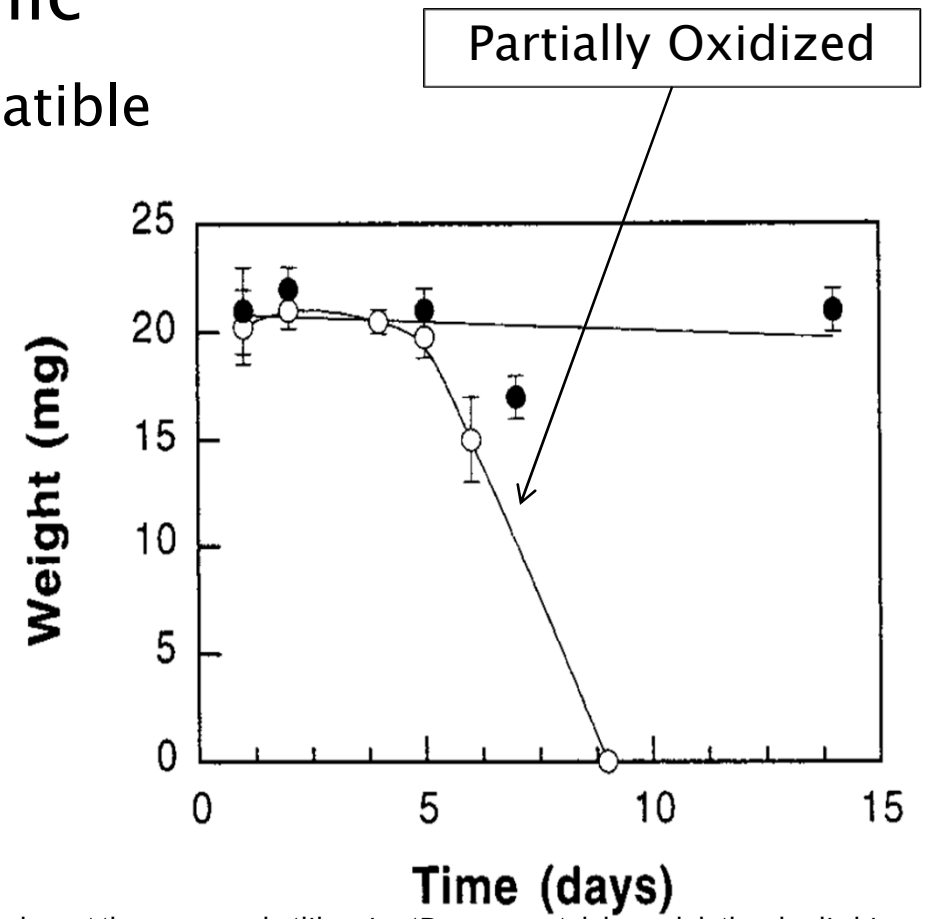


PEG


Viscosity of Various Concentrations of PEG Solutions at 25 Degrees Celsius
Viscosity (cP)
0
10
20
30
40
0
50
100
150
200
250
300
350
400
PEG-6000 g/L of Water

Sodium Alginate

- Natural: non-antigenic
  - Biodegradable, biocompatible
- Degradation rate
  - Control with partial oxidation
- Instant gelation
  - Ionic crosslink
- Two injections



http://bme.case.edu/libraries/Document/alsberg_lab/bouhadir.biotechprog.2001.pdf

Sodium Alginate Injections

- Three Injections
  1. $CaCl_2$
  2. D5W Flush
  3. Sodium Alginate

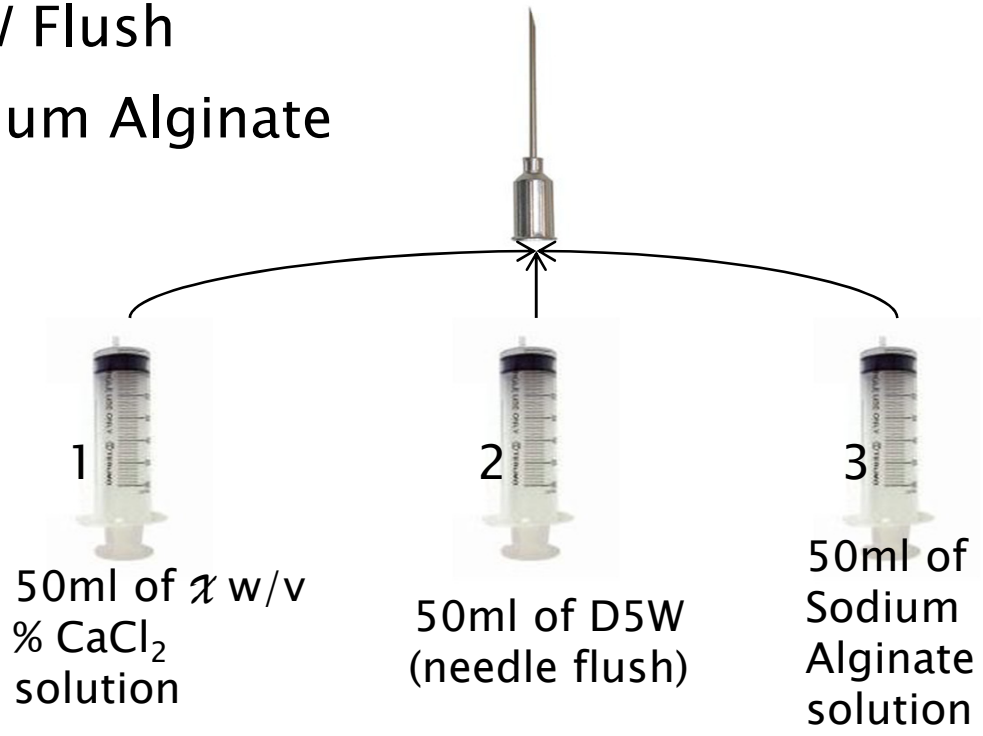
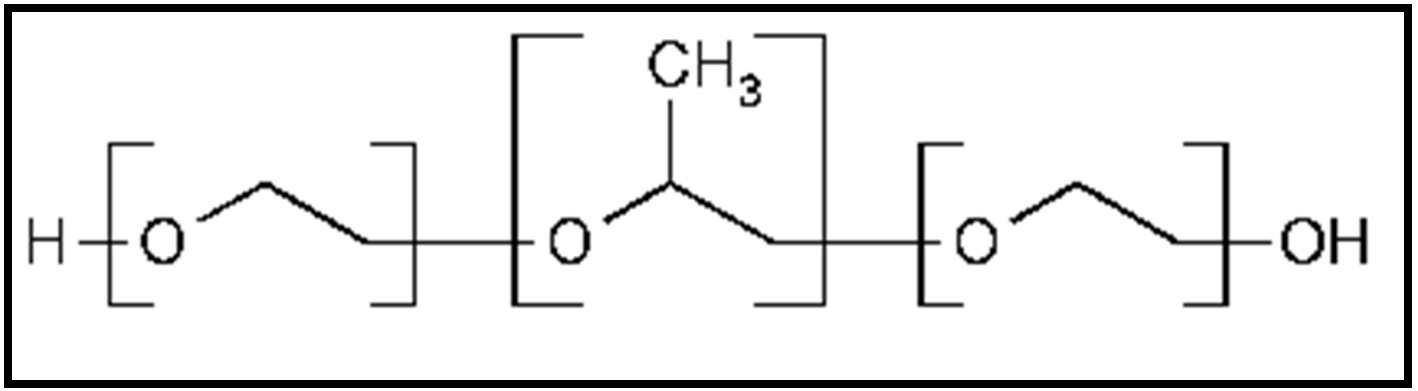


Image from Syringe - http://www.ausjetinks.com.au/p/50ml-Syringe-Eccentric-Tip/Syringes-Injectors/INK-30-SYRINGE50ML
20 gauge needle - http://www.ekosmet.com/index.php?main_page=product_info&cPath=1_54_116&products_id=551&zenid=6d7de31218abb4cc13c05c28571b3dbe

Poloxamer

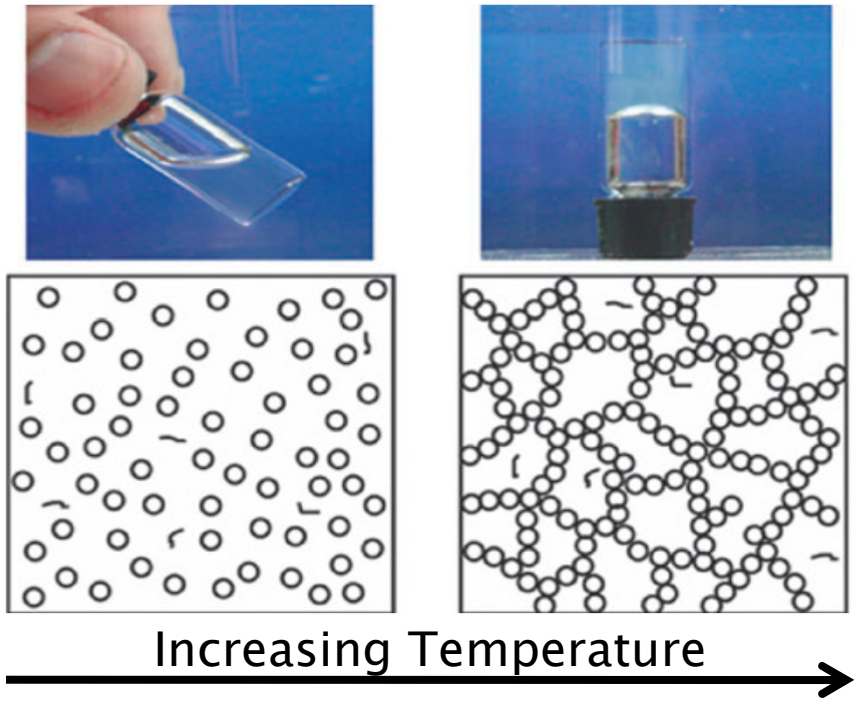
Poly(ethylene oxide)–*b*–poly(propylene oxide)–*b*–poly(ethylene oxide) or PEO–PPO–PEO triblock copolymer



http://www.uspbpep.com/usp28/v28230/usp28nf23s0_m66210.htm

Poloxamer 407

- Thermoreversible solution to gel phase change
- Considered bioabsorbable if MW <13kDa
- Low mechanical strength
- Rapid erosion
- Non-ionic

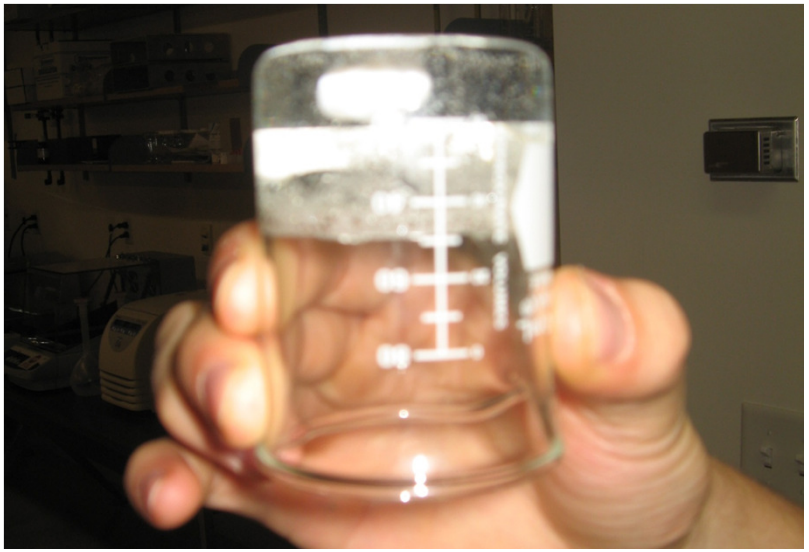


Adapted from L. Yu and J. Ding, "Injectable hydrogels as unique biomedical materials," Chemical Society Reviews, vol. 37, pp. 1473-1481, 2008.

Poloxamer Testing

- Determine concentration (w/v%) and gelation temperature relationship

Concentration (w/v %)	Gelation Temp (ºC)
15	N/A
17.5	N/A
18.75	N/A
20	25.7±1.5
22.5	23.1±0.3



Design Matrix

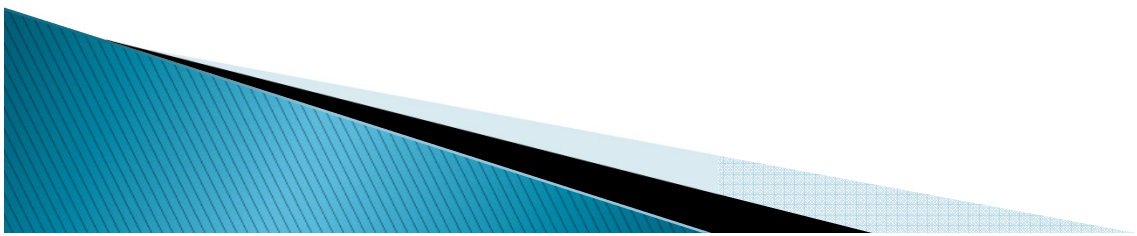
	Poly(ethylene glycol)	Poloxamer 407 Gel	Sodium Alginate Gel
Biocompatibility (30pts)	30	25	20
Viscosity (20pts)	15	20	20
Cost of Materials (10 pts)	5	10	5
Ergonomics (15 pts)	10	15	5
Temperature Range (25 pts)	25	20	25
Total	85	90	75

Future Work

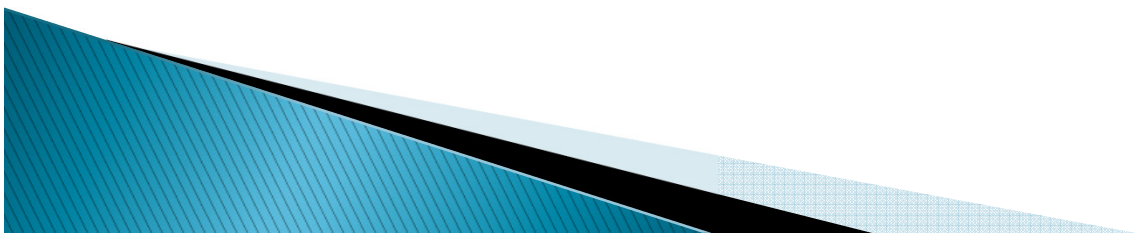
- Testing
  - Concentration
  - Tissue-equivalent phantoms
- Optimization
  - Viscosity
  - Imaging contrast
- Cost
  - Lab supplies: ≈$30
  - Estimated cost of product: $10/unit

Acknowledgements

- Dr. John Puccinelli
- Dr. Chris Brace
- Dr. James Hinshaw
- Dr. Meghan Lubner
- Dr. William Murphy



Questions?



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