# Investigation of a polyether urethane-based polymer for promoting bone tissue healing

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## Research Hypothesis:

It is predicted that a polyether urethane-based polymer as a component will help develop an effective technology for the repair and promotion of healing in bone tissues of patients with major fractures and/or defects in bone.

## Background

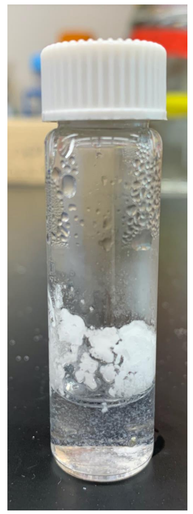
- ~10 million people in the US suffer from bone disorders and would benefit greatly from bone and tissue regeneration technologies [1]
- Bones become very brittle and prone to breakage in disease and with aging → Increased risk of bone fractures and bone loss [2]
- Polyurethanes have a wide range of mechanical properties with favorable biocompatibility qualities [3], and hence are used in many health care applications as a component in catheters, heart valves, tissue regeneration efforts, including bone.

## Methods

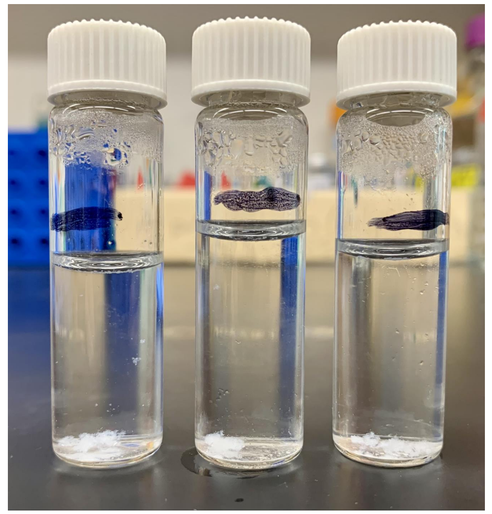
- A diol, a diamine, and diisocyanate were used in the reactions
- Synthesis of polymer:
  - Synthesis, precipitation, and filtration
- Characterization:
  - $^{1}$H Nuclear Magnetic Resonance ($^{1}$H-NMR), accelerated degradation study at 70 °C and 37 °C

## Results


(A)



(B)



(C)

**Figure 1. Accelerated Degradation Study Conducted at 70 °C**

(A) Set-up of the study. 4 different time-points were selected: 2 weeks, 4 weeks, 8 weeks, and end-of-semester. 3 samples were prepared for each time duration.

(B) 1 week after beginning the study. The polymer condensed up the sides of the vial.

(C) 2 weeks after beginning the study. The polymer was mostly dissolved.

[1] M. E. Furth and A. Atala, "Chapter 6 - Tissue Engineering: Future Perspectives," in Principles of Tissue Engineering (Fourth Edition), R. Lanza, R. Langer, and J. Vacanti, Eds. Boston: Academic Press, 2014, pp. 83–123.
[2] "What is Osteoporosis? | International Osteoporosis Foundation," International Osteoporosis Foundation, 2020. https://www.iofbonehealth.org/what-is-osteoporosis (accessed Apr. 14, 2020)
[3] H.-Y. Mi, X. Jing, G. Yilmaz, B. S. Hagerty, E. Enriquez, and L.-S. Turng, "In situ synthesis of polyurethane scaffolds with tunable properties by controlled crosslinking of tri-block copolymer and polycaprolactone triol for tissue regeneration," Chemical Engineering Journal, vol. 348, pp. 786–798, Sep. 2018, doi: 10.1016/j.cej.2018.04.198.

## Discussion

- Several synthesis reaction times were tested to see which would produce a favorable polymer for the degradation study.
- A 4-hour synthesis was initially used for the degradation study; however, due to its low molecular weight, it was almost completely dissolved by 2 weeks at 70 °C.
- Synthesis time was increased to 24-hours to increase the polymer's molecular weight.

## Future Work

- A second accelerated degradation study at 70 °C and 37 °C is ongoing.
- Several batches of polymer of varying monomers and monomer ratios will be synthesized and characterized.

## Acknowledgements

Research described in this poster is supported by the National Center for Dental and Craniofacial Research of the National Institutes of Health under award number 1R44DE028213-01 and NuShores Biosciences LLC.

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