

Introduction

- Polycystic kidney disease is a genetic condition that affects 600,000 people in the U.S. [1]. It causes fluid filled sacs, called cysts, to develop in the kidneys, resulting in decreased kidney function.

POLYCYSTIC KIDNEY DISEASE

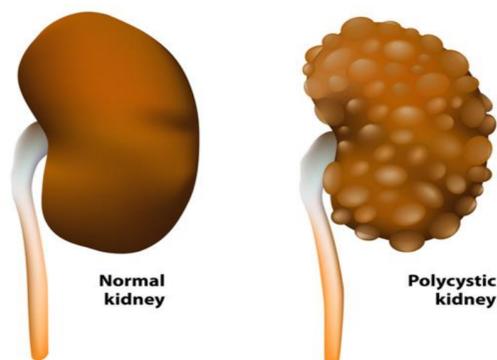


Figure 1. Left: A healthy kidney
Right: A diseased kidney affected by PKD [2].

- One problem with current potential therapeutics is that small molecules are degraded and denatured in the gastrointestinal (GI) tract, and have cannot efficiently enter the bloodstream.
- Chitosan nanoparticles are one possible solution to this oral delivery problem. Chitosan is a polysaccharide synthesized from arthropods, and is biocompatible with no known deleterious side effects. Chitosan also is mucoadhesive, which means it can penetrate the mucus covering epithelial cell layers. [3]

Objective & Impact of Professor's Research

- Self-assembling, multimodal micelle nanoparticles are developed to target various diseases.
- These micelles can deliver therapeutics specifically to organs of interest, which minimize off-target side effects, as well as enhance imaging capabilities.
- The lab has works with stem cells and aims to treat atherosclerosis, smooth muscle degeneration, and cancer [4].

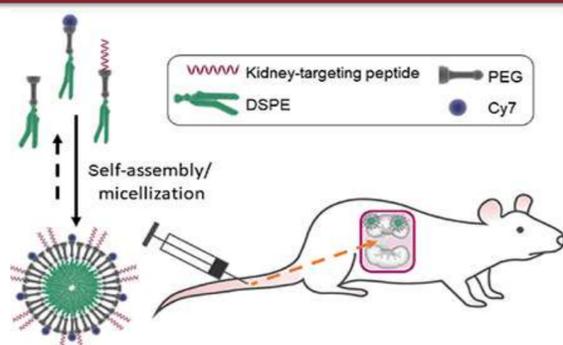


Figure 2. An image showing kidney targeting micelles being injected into a mouse [5].

Skills Learned

Dynamic Light Scattering (DLS)

- Brownian motion measurements obtain surface charge and particle size.
- A solution is put into a cuvette and measured.

Transmission Electron Microscopy (TEM)

- Electrons are fired from an electron gun and condensed into a beam by magnets.
- Lenses help focus the electrons so an image can be seen.

Matrix Assisted Laser Desorption/Ionization (MALDI) Mass Spectrometry

- MALDI is used to measure molecular weight of peptides.
- The sample is mixed with a matrix solution and then pulsed with a laser.



Figure 3. A DLS instrument interface [6].

Methods

Synthesis of Chitosan Nanoparticles by Ionic Gelation

- Chitosan is dissolved in acetic acid solution, and dripped into a solution of tripolyphosphate.
- DLS and TEM to look at size of nanoparticles.

Transwell Mucus Permeation:

- Transwell plates have an apical (top) and a basolateral side (bottom), separated by a membrane.
- We applied a mucus layer over the membrane and measured the weight of chitosan in the basolateral and apical layers over time.

Results

- Most of the chitosan has a radius of roughly 148 ± 0.2 nm via DLS. Sonicating and filtering helps to make more consistently sized nanoparticles.

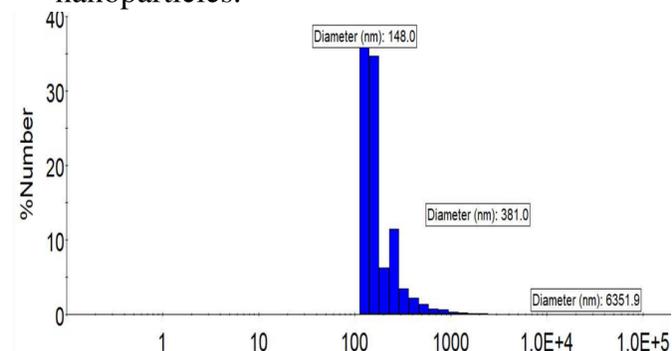


Figure 4. Representative % number size distribution of chitosan nanoparticles via DLS. (N=3). Data source: Clarence Dureg.

- The transwell results showed that chitosan could penetrate a mucus layer, affirming chitosan's mucoadhesive properties.

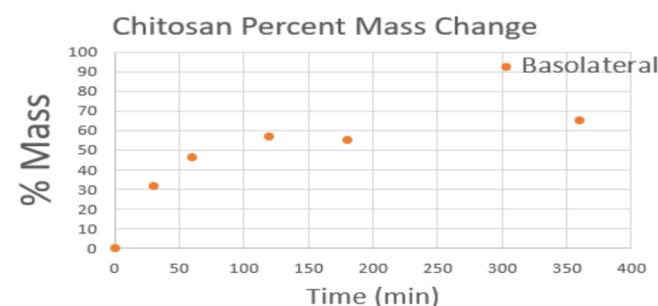


Figure 5: Percent mass of chitosan in the basolateral side of the transwell plates.

How This Relates to my STEM Course Work

- AP Biology** helped me understand how chitosan travels down the GI tract into the bloodstream and why peptide molecules are degraded in the GI tract.
- AP Chemistry** taught me how to make solutions of varying concentrations. It also helped me understand some of the more conceptual ideas about chitosan and micelles structure and how different pHs affected their function.
- I have learned at SHINE how to be more accurate in lab procedures, how many lab machines work, as well as how the sciences can apply to engineering.

Next Steps for You OR Advice for Future SHINE Students

- Make sure you understand your topic and work conceptually.
- Ask questions to your PhD mentors. They want to help you and are great at explaining any questions you have.
- You will encounter errors at some point, so don't get discouraged and be ready to start again.
- You get out what you put in. Try to get the most out of the program that you can.

Acknowledgements

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