CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
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Project Number
34200

Project Title
Engineered Chitosan Based Multi-reservoir Devices for Effective Localization to Treat a Multifaceted Set of Diseases

Abstract

Objectives/Goals
Substantial challenges of drug delivery to treat various diseases exist in our modern world. For example; the acidic environment of the stomach, combined with an array of intestinal digestive enzymes, poorly permeable mucous layer, and peristaltic shear conditions have made oral drug delivery challenging. Therefore, there is an inherent need for the development of novel micro- and nanostructured platforms for the oral delivery of proteins. As most GI pathologies are frequently expressed at localized sites of the intestine, novel strategies of localized drug delivery will prove a blessing for patients with GI and inflammatory bowel diseases, such as Crohn#s disease for which current preventative medications include anti-inflammatory drugs, steroids, immune system suppressors, biological therapeutics, and antibiotics.

Methods/Materials
I utilized microfabrication techniques such as photolithography and etching to create my oral drug delivery devices. The methodology I utilized to accomplish my engineering goal was to microfabricate microdevices using a series of photolithography and reactive ion etching. Using this technique, more than 500,000 microdevices were fabricated within 2 hours. The advantage of this technique is that photolithography controls the size and shape of the microdevice and etching controls the depth of the reservoir. This ensures that a drug or dye of different dosages can be loaded into the devices with ease by just varying the reservoir volume. The microdevices were composed of chitosan: an FDA approved, naturally occurring polymer, well known for its mucoadhesive property as the microdevice material property to target the excess mucus produced at sites of inflammation. It also invokes specific binding/adhesion for longer retention time.

Results
Through my results I was able to see that dye was released at different time points, thus confirming the finite creation of time dependent drug delivery devices.

Conclusions/Discussion
Unlike current micro- and nanoparticulate systems that require cumbersome synthesis steps to introduce multiple drugs, chitosan microdevices will be fabricated with multiple reservoirs to load multiple antioxidant enzymes with ease. Further, the unidirectional release from these reservoirs should achieve a highly localized enzymes concentration in close proximity to the intestinal cells and result in an increase of enzyme permeation.

Summary Statement
I have microfabricated drug delivery devices that can localize in a specific area and exhibit controlled release of drug.

Help Received
Used lab equipment at UCSF under supervision of Dr. Hari Chirra