CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Maggie S. Chen

Project Number

S1504

Project Title

Combating Antibiotic Resistant Bacteria Using Tissue Adhesive Hydrogel with Cell-Membrane Coated Nanotherapeutics

Abstract

Objectives/Goals

As strains of bacteria have evolved to acquire resistance against antibiotics, they have also developed mechanisms to evade the immune system. High dosages of antibiotics have the ability to eliminate these mutated bacteria, but are highly toxic to the individual due to the sheer volume needed to counteract the effects of diffusion and circulation. I aimed to synthesize a thermosensitive hydrogel containing cell membrane coated, drug loaded nanoparticles to provide localized and controlled delivery of drugs, targeting both the bacteria themselves and the external toxins secreted by them. This platform can deliver high concentrations of antibiotics directly to the infection source. Thus, it has the ability to eradicate antibiotic resistant bacteria, otherwise known as superbugs, without posing a threat to the patient.

Methods/Materials

First, I developed the formulation and methodology for synthesis of the thermosensitive, tissue-adhesive hydrogel and cell-membrane (from red blood cell) coated nanoparticles using double emulsion and nanoprecipitation methods. I then combined these two elements into a single platform, and tested the platform's ability in eliminating the growth of E. Coli and MRSA bacteria.

Results

Through extensive testing and positive results, I found that my drug-delivery platform was effective in delivering the drug and eliminating the growth of various strains of antibiotic bacteria; additionally, it was shown to absorb the secretory toxins from these bacteria to alleviate the effect of the pathogens on the immune system.

Conclusions/Discussion

My hydrogel-nanoparticle composite displays drug retention and toxin absorption abilities, as well as localized and controlled drug release properties. Moreover, my platform was able to use minimal antibiotic volume for maximum eradication efficiency. Therefore, my drug-delivery platform can be used as an injectable, effective method for treating strains of antibiotic resistant bacteria.

Summary Statement

I engineered a drug delivery platform with thermosensitive, tissue-adhesive hydrogel and cell-membrane coated nanotherapeutics to localize and control drug delivery for eradication of antibiotic resistant bacteria.

Help Received

Used the lab equipment of Dr. Liangfang Zhang at the University of California, San Diego