CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Maggie S. Chen

Project Number

S1607

Project Title

Cell Membrane-Coated Nanodevice for Anti-Virulence Therapy against Antibiotic Resistant Bacteria

Abstract

Objectives/Goals

With the growing issue of antibiotic resistant bacteria, anti-virulence therapies have emerged as an attractive and effective treatment regimen against pathogenic proliferation, which does not induce resistance in the bacteria as antibiotics do. Furthermore, removing the secretory toxins of these bacteria facilitates immune clearance of the toxin-secreted bacteria, without interference by drug molecules. I aimed to develop a hydrogel tubular nanostructure with through channels to promote blood flow, and encapsulated cell membrane-coated nanoparticles within the structure for detoxification. Thus, this nanodevice has the ability to absorb bacterial toxins for combating antibiotic resistant bacteria without using antibiotics, in a patient specific and effective manner.

Methods/Materials

First, I designed the hydrogel tubular nanostructure incorporating through channels in the shapes of stars, circles, or triangles. The red blood cell (RBC) membrane coated nanoparticles were synthesized through self-assembly methods, and were then incorporated into the hydrogel monomer solution. This solution was polymerized layer-by-layer by a 3D bioprinting method, creating the hydrogel tubular device with through channels and embedded with RBC membrane coated nanoparticles.

Results

Through extensive testing and positive results, I found that my nanodevice was extremely effective in absorbing a wide variety of secretory toxins from antibiotic resistant bacteria. The thorough channels in the hydrogel structure allowed for uninhibited blood flow without any blockage, and enhanced interaction between the toxins within the blood and the structure itself.

Conclusions/Discussion

My nanodevice displays nanoparticle retention and toxin absorption abilities, is both time and cost efficient, and allows for patient specific shapes, sizes, and designs. The personalization of treatment discourages immunosuppression, and the detoxification ability facilitates immune clearance of antibiotic resistant bacteria without the usage of antibiotics.

Summary Statement

I created a cell membrane coated nanodevice, the first of its kind combining 3D bioprinting with nanotherapeutics, to eliminate antibiotic resistant bacteria without the usage of antibiotics through anti-virulence therapy.

Help Received

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