DEPARTMENT OF BIOMEDICAL ENGINEERING
COLLEGE OF ENGINEERING & APPLIED SCIENCE

RESEARCH OPPORTUNITIES FOR UNDERGRADUATE students

APPLICATION DEADLINE: April 27, 2025

PROJECT TITLE: Inflammation-responsive antibiotic coatings to prevent infections in tracheostomy patients

Physical Requirement : Must be able to lift 10 lbs
Project's Technical Skills Requirement : Basic lab experience (using a mass balance, micropipettor, etc.) preferred but not required
Project's Available Positions : 1-2 research co-op positions available for fall 2025

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Project Description

Tracheostomies, or surgical incisions created through a patient’s neck to directly access their trachea (wind pipe), are common procedures in the hospital setting. These openings can be created for emergency airway access following trauma but are more commonly created to allow for insertion of a tracheostomy tube that allows for breathing to occur without the nose or mouth. Between 50-100k patients receive tracheostomy tubes each year in the US, with implant placement duration ranging from short-term usage to a permanent requirement for facilitating long-term breathing assistance with mechanical ventilators. Because these tubes allow for direct external access to the trachea, bacterial infections are a persistent issue and develop in up to 90% of long-term tracheostomy tube patients. Moreover, persistent bacterial presence is heavily implicated in the development of dangerous airway closures (stenosis) in both adult and pediatric patients. This project seeks to create antibiotic coatings on the surface of tracheostomy tube implants that selectively release antimicrobials in response to bacterial infections. This specifically-triggered system will discharge antibacterial therapies only when needed, thereby significantly extending the drug delivery window of local antibiotic treatments by creating “on-demand” drug release for combating bacterial re-infection.

For this projected work, the co-op student will fabricate environmentally-responsive antibiotic coatings on the surface of clinically-utilized tracheostomy tubes. These thin film coatings will contain potent antibiotics that target the most common bacteria that infect tracheostomy patients.

However, the films will also contain binder materials that are selectively broken down by free radicals generated through the body’s natural defenses during a bacterial infection. Therefore, the coatings will remain inert under normal conditions but will degrade and release their antibiotic payload only when an infection is detected. They will be responsible for fabricating coatings, characterizing films, and measuring drug release. This project will be completed in the Bioresponsive Materials Lab in the UC Department of Biomedical Engineering alongside a team of graduate and undergraduate researchers. Moreover, this work will be done in collaboration with clinicians in the Department of Otolaryngology at UC College of Medicine