Online Proceedings

Poster Session 1

MGH 241, Easel 156

11:00 AM to 1:00 PM

A Biodegradable, Multifunctional Hydrogel as Pro-Healing Vascular Graft Sealant

Tanmay R Sapre, Senior, Bioengineering
Mary Gates Scholar
Mentor: Buddy Ratner, Bioengineering
Mentor: Le Zhen, Chemical Engineering

The average number of coronary artery bypass surgeries performed annually in the United States is roughly half a million. Recently, extensive research has been conducted on the use of acellular tissue engineered vascular grafts which could be implanted into the body to replace the blood vessels that fail due to cardiovascular disease. The Ratner lab is working on creating a novel vascular graft based on a pro-healing porous material which is best suited to guide native blood vessels to heal into the material so that the vascular graft can transform into a living blood vessel. However, a paradox in this design is that right after the graft replaces the blood vessel, before the healing happens, the pores in the graft could give rise to bleeding if not monitored properly. This project addresses that problem by creating a hydrogel that seals the pores, preventing initial bleeding, while degrading at a rate in sync with the rate of healing and is ultimately replaced by vascular tissue. Initially, a series of hydrogels with varying crosslinker levels were made. Subsequentially, an in-vitro degradation assay was used to test each hydrogel in a cell culture medium. This assay showed that the higher the concentration of crosslinker, the slower the hydrogel degrades. In addition, the hydrogel was implanted under the skin of a mouse and the observed degradation of the hydrogel in vivo closely matched the in vitro data but was slightly slower. In the future, the hydrogel with the optimized crosslinking will be applied to a vascular graft for large animal experiments in sheep and pigs and the healing and degradation rates will be observed to measure the effectiveness of the hydrogel as a sealant.

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Exploring the Biochemistry of ABO Blood Types

Neona Lowe, Senior, Bioengineering
Megan Elaine Allen, Senior, Microbiology
Mentor: Daniel Ratner, Bioengineering

Blood transfusion is a cornerstone of modern medicine, with a transfusion performed every 2 seconds in the United States. It is critical to accurately determine both patient and donor blood type prior to transfusion, as mixing non-complementary blood types can trigger life threatening reactions. While the ABO antigen system was first described over a century ago by Nobel Laureate Karl Landsteiner, to this day safe transfusion remains burdened by the nuance of blood type. Many of the current blood typing tests over simplify classification and often disregard ABO subgroups, despite widespread recognition of their significance. Moreover, our understanding of the ABO blood types (A, B, AB, and O) is still incomplete, as the full structure and microheterogeneity of these ubiquitous blood group antigens is not yet fully described. This project characterizes the biochemistry of ABO blood types through an interdisciplinary collaboration between UW Bioengineering, Medicinal Chemistry, and Bloodworks Northwest (the regional blood center). Our study employs exhaustive isolation of red blood cell (RBC) membranes from genotyped donors for comprehensive biochemical and biophysical analysis. The RBC membranes are treated with cocktails of enzymes - namely PNGase F, EGCase and Neuraminidase - to cleave glycan structures at specific locations. Reactivity to different antibodies and lectins provides insight into the structure of the glycan antigen. Results have shown that the clinical anti-A antibody binds disproportionally to N-linked associated antigens. These findings inform ongoing mass spectrometric and biosensing work to further elaborate ABO structure and bioactivity, with implications for transfusion and transplant medicine.

Session 1T

Brain Function, Dysfunction and Repair

Session Moderator: Kathleen Millen, Pediatrics

JHN 175

12:30 PM to 2:15 PM

* Note: Titles in order of presentation.

Optimizing Biocompatibility and Conductivity of Brain-Computer Interfaces

Manjari M G (Manjari) Anant, Junior, Bioengineering
Mentor: Buddy Ratner, Bioengineering

Neurological diseases like stroke, paralysis and spinal cord injuries are some of the leading causes of disability and death across the world. Current medical treatments are not effective, and there is a world-wide effort to investigate new ways to restore function in the central nervous system. A treatment option that is gaining momentum is the use of brain-computer interfaces (BCIs), which has the potential to treat neurological diseases through reading and analyzing signals from the brain and sending electrical impulses to disease-affected areas. A significant obstacle that BCI implementation faces is biocompatibility, the ability for invasive devices to coexist with living tissues. Current BCIs are metal-based interfaces; their conductive properties allow them to efficiently record and send electrical brain signals. However, the human body elicits a foreign body reaction (FBR)- an immune reaction- in response to the "foreign" metal material. As a result, a capsule of scar tissue forms around the site of implantation, which mitigates the efficiency and longevity of BCIs. Hydrogels are an exciting organic material that have the potential to reduce FBRs and create biocompatible BCIs because of their elasticity, pliable material properties, and complex network structures. My project focuses on using poly(hydroxyethyl)methacrylate (pHEMA) as the base material of BCIs due to its ability to be accepted by the brain tissue after implantation. While pHEMA is biocompatible, it can not be used as a BCI in its current form because it is not conductive (not able to send and receive electrical signals in the brain). As a result, the gel is copolymerized with the conductive monomer 3,4-ethylenedioxythiophene (EDOT). This research project balances the conductivity and biocompatibility of the pHEMA-EDOT matrix to produce a new breed of long-lasting, efficient BCIs.