Presenter Name: Alexander David Olinger
Classification: Graduate Student
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Eric Spangler, P.B. Sunil Kumar, Mohamed Laradji PhD
Title: The Binding and Aggregation of Anisotropic Nanoparticles on Cylindrical Lipid Membranes
Abstract:

Golgi and endoplasmic reticulum in eukaryotic cells, owe their complex membrane conformations to specialized curvature inducing proteins. Using coarse-grained molecular dynamics simulations, we investigated the aggregation and binding of anisotropically curved nanoparticles to cylindrical lipid membranes. Here we consider only the case where the nanoparticle– nanoparticle interaction is repulsive and only the concave surface of the nanoparticle interacts attractively with the lipid head groups. The ability of a nanoparticle to bind to a cylindrical membrane depends on the nanoparticle-lipid interaction strength, mismatch in nanoparticle-membrane curvature, and the nanoparticles's arclength. We found that the minimum interaction strength required for a single nanoparticle binding increases with mismatch in nanoparticle-membrane curvature or increasing the nanoparticle arclength. Additionally, nanoparticles were found to accommodate a tilt angle on cylindrical membranes having a radius of curvature less that of the bound nanoparticles. This tilt angle is well maintained for nanoparticles with large arclengths, while shorter nanoparticles are able to rotationally diffuse more freely. These results are consistent for larger numbers of nanoparticles where they aggregate into various structures depending on nanoparticle-lipid interaction strength, mismatch in nanoparticle-membrane curvature, and the nanoparticles's arclength. This aggregation by many nanoparticle is reminiscent of protein aggregates formed by the BAR-protein family, in spite of the lack of nanoparticle-nanoparticle interactions.

Presenter Name: Amy Koury
Affiliation: Wright Medical Technology, Memphis, TN
***Co- Authors*:** Nate Webb, Jesse Fleming, Doug Linton, Jon Moseley
Title: Wear of a Stabilized Crosslinked UHMWPE Total Ankle Replacement
Abstract:

Abstract withheld per request by company for confidentiality.

Presenter Name: Andrew S Curry
Classification: Graduate
Affiliation: Biomedical Engineering, University of Alabama, Birmingham
***Advisor and/or Co- Authors*:** Nicholas W Pensa, Jennifer L. Bain, Michael S. Reddy, Susan L. Bellis
Title: BMP2-Derived Peptides with Polyglutamate Domains Anchor onto Bone Graft Materials
Abstract:

The osteoinductive factor, BMP2, has been passively adsorbed to commercial bone graft materials to improve osseointegration, however BMP2 disseminates quickly from the graft, resulting in inflammation. Previously we identified a molecular domain of 7 glutamates (E7) which tightly binds to hydroxyapatite, a common graft material. We hypothesize a bioactive peptide derived from BMP2 with an attached E7 domain (E7-BMP2pep) can anchor to hydroxyapatite, increasing bone regeneration without evoking a deleterious immune response. Osteoblastic cells were treated with BMP2pep, with or without E7, to measure osteogenic cell signaling. Peptide-coated hydroxyapatite particles were implanted in rat cranial defects and evaluated by H&E and immunohistochemistry to analyze bone formation, presence of T cells (CD3), and vascularization (CD34). *In vitro* assays showed that the E7 domain greatly improves peptide anchoring to hydroxyapatite without diminishing BMP2pep's capacity to stimulate BMP2-dependent signaling (pSMAD activation) and osteoblastic differentiation (upregulation of alkaline phosphatase, ALP). In fact, cells treated with E7-BMP2pep had equivalent levels of induced ALP expression compared with full-length rBMP2. *In vivo* studies of implanted E7-BMP2pep-coated hydroxyapatite revealed that the peptide strongly stimulated bone formation, and did not hinder vascularization. Furthermore, there was minimal T cell infiltration associated with the E7-BMP2pep group compared with rBMP2-coated samples. E7-BMP2pep offers a valid alternative to full-length rBMP2 because it can prolong osteoblastic signaling at the graft site by strongly adhering to hydroxyapatite, resulting in equivalent bone formation compared to rBMP2, without the inflammatory response commonly seen with rBMP2 treatment.

Acknowledgement: NIH R01 DE024670; DART T90DE022736

Presenter Name: Andrew Dunn[1]
Classification: Graduate Student
Affiliation:
[1]Department of Biomedical Engineering, Parks College of Engineering, Aviation, and Technology, Saint Louis University
[2]Department of Orthopedic Surgery, Saint Louis University
***Advisor and/or Co- Authors*:** Gabriel Haas[1], Madison Marcinczyk[1], Muhamed Talovic[1], Robert Scheidt[1], Anjali Patel[1], Mark Schwartz[1], Katherine R Hixon[1], Hady Elmashhady[1], Sarah H McBride-Gagyi[2], Scott A Sell[1] , Koyal Garg[1]
Title: Biomimetic Collagen Laminin-111 Sponges Promote Myogenic Regeneration in a Murine Volumetric Muscle Loss-Wounding Model
Abstract:

Musculoskeletal injuries are among the most common disabling injuries sustained by athletes and soldiers. Most of these injuries involve volumetric muscle loss (VML), defined as the as the surgical or traumatic loss of muscle tissue with resultant functional impairment. While skeletal muscle is remarkably regenerative, VML injuries are irrecoverable due to the complete loss of the basal lamina and resident satellite cells. There are no approved therapies for the treatment of muscle tissue following trauma, presenting an opportunity to develop tissue-engineered scaffolds for muscle tissue regeneration.

To improve regeneration of skeletal muscle, we have developed biomimetic sponges composed of collagen, gelatin, and laminin (LM)-111. Collagen and LM-111 are crucial components of the muscle extracellular matrix and were chosen to impart bioactivity whereas gelatin was used to provide mechanical strength to the scaffold. Morphological and mechanical evaluation of the sponges showed porous structure, water-retention capacity and a compressive modulus of 590kPa. *In vitro* testing revealed that compared to pure gelatin sponges, the biomimetic sponges supported greater C2C12 myoblast infiltration, myokine production and myogenic marker expression.

The biomimetic sponges were implanted in a mouse model of VML. At 2 weeks post-injury, sponge treated VML injured muscles showed constructive remodeling at the site of injury with the elevated presence of satellite, endothelial and inflammatory cells compared to untreated VML injured muscles. The sponge treated muscles showed several small diameter myosin^{+} myofibers in the defect region. In support, the protein expression of MyoD and desmin was significantly higher, while that of myogenin trended higher on the sponge treated injured muscles. However, the expression of heat shock protein (HSP)-70, a marker of cellular stress was lower with sponge treatment. These results suggest that implantation of the biomimetic sponges is able to promote myogenic activity in the VML injured muscles.

Presenter Name: Brandico Barr
Classification: Undergraduate
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Jessica Amber Jennings, PhD, Joel Bumgardner PhD
Title: Chitosan Composite Coating for Bone Growth in Musculoskeletal Implants
Abstract:

Over 4 million people in the United States alone have at least one internal fixation implant, and due to the rise of elderly need for implants, that number is only increasing. With dental and musculoskeletal implants, integration of implant into bone is a critical step. Release of bioactive molecules from implant coatings may improve bone growth. Recent studies have shown that members of the statin drug family, such as simvastatin, have similar osteogenic properties to growth factors like bone morphogenetic protein-2. However, the hydrophobic nature of statins presents difficulties for loading into traditional local delivery biomaterials. In this study, we evaluated a chitosan composite coating with calcium-phosphate nanospheres loaded with simvastatin (CaP-SMV) to release osteogenic factors from implants.

The main goal of this experiment was to determine the physiochemical properties of the coating by performing a 7 day elution study. Coatings were made with 2% chitosan solution, 1mg/mL simvastatin with a 1:3 ratio of calcium phosphate. High performance liquid chromatography (HPLC) was used to detect simvastatin. Results indicated that the CaP-SMV coating eluted less simvastatin than the pure simvastatin coating. Future studies include spectroscopy to visualize the physical properties of the coating.

Presenter Name: Caleb Gallops
Classification: Graduate Student
Affiliation: Chemistry, University of Memphis, College of Arts & Sciences, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Yongmei Wang, Dr. Jesse Ziebarth, Chang Yu
Title: Effects of Protonation and Salt Concentration on the Structure of a Polylethylenimine (PEI) in Water

Abstract:

Polyethylenimine (PEI) is the subject of intense study within the field of non-viral gene delivery due to its promising potential as a transfection vector. The polycationic PEI chains bind to the anionic phosphate backbone of nucleic acids, forming complexes and facilitating the delivery of genetic materials. The success of PEI as non-viral gene delivery vector is linked with its pH-responsive properties as PEI becomes more protonated when the pH is lowered. This is thought to cause PEI/nucleic acid complexes to escape from the lysosome as the endosomal pH decreases, resulting in high transfection efficiencies. Computational studies can provide insight on the structural and dynamical changes of PEI chains at different protonation states and different salt concentrations. The goal of this study was to determine the effect of salt concentration on the structure and dynamics of PEI at various protonation states. Series of molecular dynamics simulations were performed on a linear PEI chain in a periodic box of explicit water and NaCl ions at 0mM, 150mM and 500mM. Within each series, nine simulations were performed with protonation states ranging from zero protonation to full protonation. The radius of gyration, persistence length, average N^+-N^+ distance and average Cl^- coordination number were calculated for each state. As expected, the chain becomes more extended and rigid, as it is protonated. The increasing salt concentration was determined to slightly decrease the extension and rigidity of the chain for the highly protonated states. This effect is due to the increased electrostatic screening between positive charges on the chain as the counterion concentration of Cl^- is increased. The computational results reported here provide a microscopic picture of the structural change of PEI chains experienced during the gene delivery process.

Presenter Name: Carlos M. Wells
Classification: Graduate Student
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Jessica A. Jennings
Title: Chitosan-Based Microparticles as Local Delivery Devices
Abstract:

There has been considerable research efforts directed towards the development of safe, customizable and efficient chitosan-based drug local delivery systems. Primary objectives have included minimizing potential toxic systemic side effects while increasing active treatment concentration at wound/target site. Some viable methods have been developed, however they display first order release patterns that are independent of physiological activity. Research activities have proven that chitosan possesses advantages in the development of micro/nanoparticles and local delivery systems in general. Controlled release of active agents, ability to circumvent hazardous organic solvents during fabrication, polyamine linearity with free amine groups facilitating crosslinking, cationic nature nurtures ionic crosslinking with multivalent anions, and some mucoadhesive characteristics are a few examples of said advantages. In efforts to capitalize on these advantages, “smart” or stimuli-responsive delivery systems are being investigated. This study investigated if a local delivery system consisting of iron oxide Fe_3O_4 (MNP) in conjunction with chitosan microbeads cross-linked with polyethylene glycol dimethacrylate (PEGDMA) could release “agent” of choice at therapeutic levels in the treatment of musculoskeletal infections ancillary to orthopaedic surgery or trauma. Rhodamine B was imaging “agent” chosen during this proof of principle study as a supporting aspect of a larger animal study. Additional investigations included if microbeads containing MNP would release at levels statistically different from those without MNP. Additionally, various chitosan concentrations in the microbeads were investigated to ascertain any effects on the chitosan microbeads’ elution kinetics.

Presenter Name: David LeVine
Classification: Senior
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Amber Jennings
Title: Magnetic Chitosan Microbeads for Use as a Local Drug Delivery System
Abstract:

This project focuses on optimizing a novel drug delivery system via magnetic nanoparticle-loaded biopolymers actuated by an external magnetic field. Chitosan based microbeads were fabricated to contain magnetic nanoparticles, the antibiotic vancomycin, and polyethylene glycol dimethacrylate as a cross-linker. Beads measured 210 ± 40 μm in diameter, showing a distinct spherical form with dimples across the entire surface of the bead. The experimental bead group (n=3) was able to elute 20% more drug when stimulated under an external magnetic field compared to their non-stimulated counterparts (n=3). Preliminary *in vivo* work has been started with analysis underway. Further experimentation is planned to investigate drug elution with other antibiotics, chemotherapeutics, and proteins.

Presenter Name: Elyahb Allie Kwizera
Classification: Graduate Student
Affiliation: Chemistry, University of Memphis, Chemistry Department, Memphis, TN
Advisor and Co/Authors: Dr. Xiaohua Huang, Ryan O'Connor ,Vojtech Vinduska, Melody Williams, Elizabeth R. Butch, Scott E. Snyder, Xiang Chen
Title: Molecular Detection and Analysis of Exosomes Using Surface-Enhanced Raman Scattering Gold Nanorods and a Miniaturized Device
Abstract:

Exosomes are 40-200 nm sized vesicles that are shed from every type of cell into an extracellular environment. Recently exosomes have attracted interest due to their potential as cancer biomarkers because they transport molecular contents of the cells from which they originate. Their detection and molecular profiling is technically challenging especially due to their small sizes and environment from which they are found. Here, we report a novel method for exosome detection and protein profiling using Surface Enhanced Raman Scattering (SERS) nanotags in combination with a miniaturized capture platform. A gold-coated glass slide is functionalized with antibodies to enable capture and profiling of exosome surface proteins. We report that exosome derived from breast cancer can be identified by their expression of EpCAM and HER2 biomarkers. This method offers a simple, rapid, highly sensitive Raman based assay for point of care detection and molecular profiling of exosome capable of differentiating different subtypes of cancer cells and able to differentiate cancer cells from normal cells in less than two hours. This next-generation Raman exosome assay has the potential to revolutionize exosome research and realize a novel cancer liquid biopsy approach for cancer research and early detection.

Presenter Name: Eric Spangler
Classification: Graduate Student
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Mohamed Laradji, Sunil P.B. Kumar
Title: Membrane Mediated Cooperative Behavior of Spherical Nanoparticles
Abstract:

Nanoparticle (NP) based technologies, which are becoming increasingly prevalent component in industrial development; have many important potential medical applications including diagnosis, imaging, drug delivery, hypothermia, and photothermal therapy. Since the plasma membrane is the point of entry of cells, biomedical applications of NPs require understanding of their interactions with lipid membranes (LMs). Mixing NPs with soft materials, such as polymers and liquid crystals, often leads to cooperative behavior of NPs manifested in their self-assembly. Recent experiments have shown that the adhesion of NPs onto LMs leads to their aggregation. In order to understand this cooperative behavior, we conducted large scale and systematic molecular dynamics simulations of spherical NPs self-assembly mediated by their adhesion onto LMs using a coarse-grained implicit solvent model. In addition to the linear chains and tubes, indicated earlier by other researchers using dynamic triangulation Monte Carlo method, we observed additional novel self-assemblies corresponding to bitubes and rings. The phase diagram of the system is determined as a function of NPs size, adhesion strength, and number density on the LM. The stability of these self-assemblies, particularly bitubes and rings, was investigated using simulated annealing as well as free energy calculations.

Presenter Name: Evan Glass
Classification: 2nd year graduate student
Affiliation: Biomedical Engineering, Vanderbilt University, School of Engineering, Nashville, TN
Advisor and/or Co-Authors: Dr. Todd Giorgio, Dr. Shirin Masjedi, Stephanie Dudzinski
Title: Optimizing Mannose Conjugation to Polymeric Nanoparticles for Targeted Delivery to Tumor Associated Macrophages in Breast Cancer
Abstract:

Cancer immunotherapies provide durable remission, but only in a minority of patients. An alternative approach for immunotherapy is to deliver small interfering RNA (siRNA) to tumor-associated macrophages (TAMs) designed to repolarize the TAMs from a pro-tumorigenic phenotype to one that is inflammatory and anti-tumorigenic. However, siRNA requires a protective vehicle for *in vivo* delivery to minimize degradation and to restrict immunomodulation to TAMs. We have designed, fabricated and tested mannosylated nanoparticles to target siRNA delivery to TAMs expressing the CD206 mannose receptor. Alkyne-azide “click” chemistry is a straightforward method to conjugate mannose onto polymeric nanoparticles, but uses a copper catalyst that can potentially be toxic to cells. This study aims to optimize the conjugation of mannose via “click” chemistry while minimizing the presence of copper in the resulting nanoparticles. By varying the concentration of copper catalyst used in the “click” reaction from 0.1-1 mM, we demonstrated successful conjugation of mannose onto nanoparticles with significantly reduced residual copper as compared with other approaches. As expected, the nanoparticles fabricated with lower copper concentrations did not demonstrate significant toxicity when added to ThP-1 human macrophages. Nanoparticles containing 1 mM copper showed a significant decrease in cell viability when compared to control cells with no particle treatments ($p<0.05$). Results of the current study enabled us to find an optimized copper concentration that leads to efficient mannose conjugation while reducing the chance of cell toxicity due to nanoparticle treatment. Constructs containing alkyne-azine “click’ chemistry can be fabricated to avoid copper cytotoxicity.

Presenter Name: Ewe Jiun Chng
Classification: Graduate
Affiliation: Mechanical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Kevin Patel, Chris Chattman, Joel D. Bumgardner, Ranganathan Gopalakrishnan
Title: Controlling and Creating Novel Bioactive Implant Material Surfaces via Electrospray Additive Manufacturing
Abstract:

Biomedical implant devices for dental/craniofacial and orthopedic applications are a reliable and effective means for repairing/re-storing function of damaged, diseased or missing tissues. Despite success of these devices, there are still challenges in the use of these devices with respect to improving their integration into boney tissues, promoting healing and resisting/preventing infection. Electrospray coating technologies provide an additive manufacturing technique to endow implant surfaces with new properties to improve implant performance by controlled deposition of different materials, compounds and or agents in the form extremely fine nano or micro sized particles on the surface of implant devices under relatively mild conditions. They also provide a means to precisely control deposition of coatings with a range of novel physical and bioactive properties via incorporation of drugs, growth factors, cells, genes and other factors or agents over complex 3D surfaces of implant devices such as dental implants, total joint replacement devices, and bone plates and screws that is not easily achievable by other manufacturing methodologies such as solution casting, sputter coatings or electrochemical treatments. This project focuses on the development of an electrospray technology to coat model Titanium surfaces with chitosan and asses their adhesion properties to explore their potential for real implant treatment. Current application technique for the implant coating of chitosan is through solution casting. This method limits the coverage of Chitosan on complex surfaces of implants, difficult to control the thickness of the coating and produce excessive wastage. This research aimed to assess the effectiveness of electrospray method as a delivery method to aerosolized Chitosan in order to coat complex implants with precise thickness control, multilayer coatings for timed drugs delivery and less wastage. Adhesion strength values are reported and compared between electrosprayed and solution cast chitosan coatings.

Presenter Name: Fazal Ur Rehman Bhatti, PhD
Classification: Postdoctoral Fellow
Affiliation: Department of Orthopaedic Surgery & Biomedical Engineering, The University of Tennessee health Science Centre, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Hongsik Cho / Dr. John Stuart, Dr. Karen A. Hasty
Title: Characterization Method of Novel Targeted Nanosomes for Detection of Osteoarthritic Cartilage

Abstract:

Background: Targeted nanosomes (nano-sized liposomes) are biodegradable and non-toxic molecules approved by the FDA to be used as drug delivery system (DDS). The efficiency of nanosomes is highly dependent on their physiochemical nature. Therefore, here we describe synthesis, physiochemical characterization, and cytotoxic evaluation of the targeted nanosomes on chondrocytes and in mouse model of spontaneous OA.

Methods: Synthesis, coupling and characterization of nanosomes: Nanosomes were synthesized and coupled with monoclonal anti-type-II collagen antibody (MabCII). The nanosomes were packaged either with the anti-inflammatory drug (TPCA-1) or Fluorescein isothiocyanate (FITC). The nanosomes were characterized by transmission electron microscopy (TEM), dynamic light scattering (DLS), thin-layer chromatography (TLC) and liquid chromatography-mass spectrometry (LC-MS). Furthermore, the amount of antibody bounded to nanosomes was quantified by a simple newly developed method. The IL-1ra$^{-/-}$ mice were used in this study.

Results: Characterization of nanosomes: TEM and DLS showed uniform sized nanosomes with an average diameter of 200 nm. All lipids were identified by Rf values through TLC. The LC-MS data showed that the lyzed TPCA-1 nanosomes contained 1 µM TPCA-1 therapeutic dose. The antibodu concentration in nanosomes ws 70 µM as expected.

Interaction between chondrocytes and nanosomes:The immunofluorescence images showed that nanosomes bind to chondrocytes. Further, 12.7% of cells were found to be FITC positive within 60 min.

Nanosomes bind to cartilage in *in vivo*: Spontaneous OA mice injected with MabCII bound nanosomes only showed signal with IVIS. Thus, the targeted nanosomes are highly specific to the damaged cartilage and can be used to detect cartilage damage *in vivo.*

Discussion: The characterization method presented in this study can be utilized to evaluate the physiochemical nature of nanosomes. The method for quantifying the attached antibody to the targeted nanosomes is practical and easy. Moreover, these nanosomes can be used to deliver diagnostic and therapeutic agents to the damaged cartilage.

Presenter Name: Fernanda Delbuque Guerra,
Classification: Post-Doctoral Fellow
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** J. D. Bumgardner, P. Cameron, V. Murali,
Title: Raspberry Ketone Delivery from Electrospun Chitosan Membranes
Abstract:

Electrospun chitosans have potential as guided bone regeneration (GBR) membranes. Raspberry ketone (RK) is a natural occurring phenolic compound that has exhibited ability to reduce nitric oxide production by macrophages, which may contribute to reduced inflammation and to promote healing process. The aim of this study was to passively load electrospun chitosan membranes and examine the release of RK. Chitosan (71% DDA) was electrospun in 70% (v/v) trifluoroacetic acid 30% (v/v) dichloromethane solution at 25kV and then treated with either acid (AA)-, butyric (BA)-, or hexanoic (HA)- anhydride and measured for hydrophobicity via contact angle. 1cm diameter membrane discs were made aseptic using 70% (v/v) ethanol and UV light, and sterily loaded by swelling with either 100µg, 250µg, or 500µg of RK per disc. RK was eluted from discs over 14 days in 500µL of sterile PBS. Eluates were measured for RK release by HPLC. Results revealed that water contact angles increased from 57º ± 13º to 66º ± 40º to 100º ± 16º for AA, BA and HA treatments but there was no statistical difference. This may be due to nanofibrous structure of membranes which lead to high standard deviations for measurements. A burst release was observed from all membranes, however, peak release significantly decreased from 215 ± 26 to 187 ± 6 to 101 ± 2µg of RK for AA, BA, and HA treated membranes respectively (250ug RK loading). Reduction in peak release lead to extending 100% release of RK from 3 to 6 to 14 days for BA and HA membranes respectively. These results demonstrate that the post-electrospinning treatments may be used to control peak and duration of RK release. Future studies will examine dose and release on macrophage growth and expression of pro-inflammatory cytokines/chemokines.

Acknowledgment: NIH R01 DE026759-011

Presenter Name: Gautam Thamizharasan
Classification: Senior
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Erno Lindner, Dr. Marcin Guzinski
Title: Improving the Reference Electrode in Blood Analyzers
Abstract:

Ion-selective potentiometry is used in clinical settings for the measurement of ions or chemical compounds in body fluids. The setup of potentiometric measurements consists of an indicator and reference electrodes that are immersed in the sample solution and the potential difference between the two electrodes is measured with a voltmeter. A slight variation of this setup that uses solid contact electrodes is used in commercial blood analyzers. The focus of this research involves improving the liquid junction membrane based reference electrodes. This was done by synthesizing various membranes composed of PVC (33 wt.%), plasticizer (60 wt.%), and one of several ionic liquids (6 wt.%). The best membranes will eventually be drop cast onto solid contact electrodes so they can be tested in commercial blood analyzers. Each of the membranes were tested in a range of NaCl and KCl concentrations to measure their response. In a blood analyzer, the sample will be pumped across the solid contact electrodes, so the membranes' sensitivity was also tested. A few promising membranes have been tested, but interference from other common compounds in the blood (such as salicylate) will also need to be tested.

Presenter Name: Hengjie Su
Classification: Graduate student
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Joel D Bumgardner
Title: *In Vitro* Raw 264.7 Monocyte Biocompatibility of Casting Chitosan Film and Electrospun Chitosan Membranes Treated by Two Methods
Abstract:

Guided Bone regeneration (GBR) membranes are widely used in clinical surgery as a barrier to direct the formation of bone in the graft space by protecting it from soft tissue intruding during healing. Chitosan is explored for making GBR membrane because of its biocompatibility and degradability. In the previous study, trimethylamine (TEA)/acetone and di-tert-butyl dicarbonate (tBOC) treatment was investigated for acidic salt removal from chitosan electrospun instead of the common Na_2CO_3 treatment to keep the nano-fibrous structure. In this study, electrospun chitosan membranes treated by TEA/tBOC method and Na_2CO_3 method, and casting film were evaluated in cytocompatibility with TIB 71TM RAW 264.7 monocyte cells. All the TEA/tBOC treated and Na_2CO_3 treated membranes and casting film were cytocompatible and supported cell proliferation for 3 days. TEA/tBOC treated membrane did not active monocytes to produce nitric oxide (NO) *in vitro* in the absence of lipopolysaccharide (LPS). In the presence of 2 μg/ml LPS, TEA/tBOC treated membrane and casting film inhibited LPS-induced NO production of RAW 264.7 cells by 50% - 75% as compared to tissue culture plastic and Na_2CO_3 treated membrane. Further evaluation are needed in the fibroblasts and osteoblasts compatibility and *in vivo* study.

Presenter Name: Houston Linder
Classification: Graduate Student
Affiliation: Biomedical Engineering, Saint Louis University
***Advisor and/or Co- Authors*:** Austin Glass, Koyal Garg, Scott Sell
Title: Manipulating Air-Gap Electrospinning to Create Polymer Nanofiber-Wrapped Glass Microfibers for Regenerating Critical Size Bone Defects of Cortical Bone
Abstract:

Osteons are the repeating unit throughout cortical bone, consisting of canals filled with blood and nerve vessels surrounded by concentric lamella of hydroxyapatite-containing collagen fibers, which provides mechanical strength. The osteogenic cells residing in this bone matrix are responsible for the constant remodeling of the bone, by either adding more bone matrix to strengthen the bone or removing bone matrix to release the mineral ions into the blood for further use. Creating a biodegradable scaffold that mimics the osteon structure is crucial for optimizing cellular infiltration and ultimately the replacement of the scaffold with native bone. Recent studies have shown that highly aligned nanofibers increased directional cell migration, fabricated by electrospinning across two positively charged plates called air-gap electrospinning. In this study, a modified air-gap electrospinning setup was exploited to continuously wrap highly aligned polycaprolactone polymer nanofibers around individual 1393 bioactive glass microfibers, resulting in a synthetic structure similar to osteons. By varying the disc diameter, charge, rotation speed, and the location on the glass fiber, polymer fibers that were wrapped at angles between 10-30° to the glass fiber were chosen, although fibers wrapped as large as 45-90° were possible. Compared to randomly aligned electrospun fibers, this scaffold is expected to increase migration along the fiber direction, as shown in recent work regarding nerve and muscle regeneration along aligned fibers. There was no change in the fiber diameter, although the porosity decreased from 90% to 70% due to consolidation of the aligned fibers during wrapping. Encapsulating the glass with polymer nanofibers is expected to cause viscoelastic deformation during 3-point bending. It is predicted that the bioactive glass microfibers will convert into hollow fibers, allowing blood vessel ingrowth, while the aligned polymer fibers will stimulate cell migration into the scaffold.

Presenter Name: Huda .M. Almabadi
Classification: Ph.D. Student
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN.
***Advisor and/or Co- Authors*:** Dr. Prabhakar Pradhan, Dr. Eugene Eckstein.
Title: Quantification of Nano- to Sub-Micron Scale Intracellular Structural Alterations in Biological Materials: Application in Cancer Diagnostics.
Abstract:

We explore the light- matter interaction phenomena to quantify the spatial structural disorder properties of intracellular materials by applying two different mesoscopic approaches based imaging and quantification techniques, namely partial wave spectroscopic microcopy technique to probe light scattering and inverse participation ratio technique to probe light localization. It is now known that several disease processes are accompanied with structural alterations in the basic building blocks of the cells, varying from nano- to sub-micron-scales. We have used the biophysical (structural) information to differentiate between cancerous and normal cells taken from breast, brain and prostate human cell lines. In addition, we assess the drug resistance in the human prostate cancer cell lines based on their structural disorder quantification. The results reveal a pattern that suggests a higher structural disorder is accompanied with cancer cells compare to the normal cells. Moreover, the drug-resistance cancer cells showed an increased structural disorder compare to the drug-sensitive cancer cells. The scientific goal of the proposed study is to gain unprecedented insight in the biological processes such as cancer progression and in therapeutic treatment such as chemotherapy resistance, and to investigate the potential of physical biomarker (intracellular structural disorder) in cancer diagnosis application.

Presenter Name: Hugo Gonzalez
Classification: Graduate Student
Affiliation: Biomedical Engineering, Parks College of Engineering, Aviation, and Technology
***Advisor and/or Co- Authors*:** Katherine Hixon, Scott A. Sell
Title: 3D Printing a Perfusion Bioreactor System for Optimal Cell Infiltration into Cryogels
Abstract:

One of the main goals of tissue engineering is to create a fully cellularized scaffold so that it can be implanted in a patient and promote wound healing. Cryogels are scaffolds created by freezing and thawing a crosslinked polymer solution in a controlled manner to produce a spongy and macroporous structure with interconnected pores. As a result, cryogels have a surface area-to-volume ratio ideal for culturing cells. The most common way to achieve scaffold cellularization is to seed cells via static seeding and allow the cells to infiltrate the scaffold on their own. Although the cryogels have ideal physical characteristics for cell infiltration, cells tend to only proliferate on the surface of the scaffold and do not infiltrate deep enough into the cryogel. A 3D perfusion bioreactor system would alleviate this problem by allowing cell media to flow through the cryogel and allowing the fluid flow to move the cells deeper into the macropores of the cryogel. The current setup uses a 3D printed bioreactor chamber where the cryogel is being contained and a cell media reservoir powered by a peristaltic pump. Media is being flowed at 6 mL/min and cell infiltration and viability will be measured. Current work includes checking the efficacy of the perfusion bioreactor system by testing cell infiltration of the cryogels.

Presenter Name: John Tyson
Classification: Undergraduate
Affiliation: Department of Agricultural and Biological Engineering at Mississippi State University
***Advisor and/or Co- Authors*:** C. LaShan Simpson Ph.D.
Title: Understanding Mechanisms Involved in Cardiovascular Calcification through the Mathematic Modeling of the Canonical WNT Signaling Pathway
Abstract:

The impact of cardiovascular calcification on arterial tissues has shown to be lethal due to its eroding nature of compliance and elastance, production of aortic stenosis in valves, and alterations to atherosclerotic plaque stability. Osteoblast-like cells, differentiated heavily from vascular smooth muscle cells (VSMCs), are responsible for the deposition of mineral into arterial layers, inducing calcification. Understanding the processes behind VSMC differentiation into osteoblast-like cells on a pathway level is crucial for exploring possible preventative and therapeutic routes. One such pathway is the ubiquitous canonical WNT signaling cascade. Modeling this ancient pathway mathematically has the potential for explaining calcification on the level of protein by protein interaction.Created using SimBiology, the model is a multifaceted mathematic program that incorporates simple stoichiometric reactions to calculate protein interactions. It begins with WNT binding to LRP5,6 and Frizzled to form the WNT signalosome, demonstrating a 3:1 ratio as required by the cascade to activate. Following with consistent1:1 interactions, Dishevelled is recruited by the signalosome, and the Axin scaffolded ‘destruction complex’ is dismantled, allowing for a β-catenin to be released. The β-catenin gradually pools with each iteration, allowing for user-selected expression of targeted genes. Interestingly, the cascade can down regulate by expression of SOX9, a β-catenin inhibitor expressed by mesenchymal stem cells, expression of Dkk, a cascade antagonist, and Axin. These allow for negative feedback loops in the system GSK3, once tied to the ‘destruction complex’, is freed and moves to phosphorylate LRP5,6. This is currently the only positive feedback loop in the model. SimBiology allows for initial assignments of values and timed doses for each individual species placed. Once the model is expanded further, these timed doses will become very practical in applications such as drug therapy development by utilization of specific proteins.

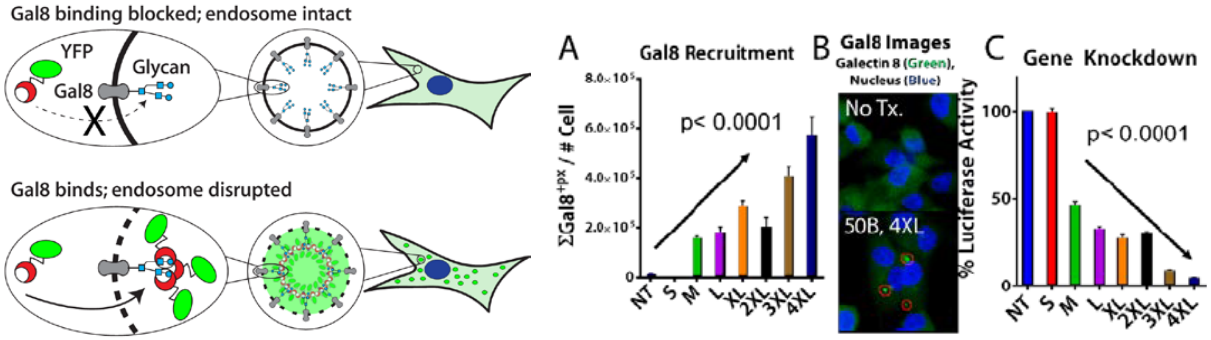
Presenter Name: Kameron V. Kilchrist
Classification: Graduate Student
Affiliation: Department of Biomedical Engineering, Vanderbilt University
***Advisor and/or Co- Authors*:** Somtochukwu C. Dimobi, Thomas A. Werfel, Eric A. Dailing, Meredith A. Jackson, Isom B. Kelly, Craig L. Duvall
Title: Intracellular Biologic Drug Bioactivity Correlates to Endosomal Disruption as Measured by Gal8 Recruitment

Abstract:

Endo-lysosome escape is the rate-limiting step of intracellular biologic drug delivery. Following cellular endocytosis, nucleic acids, proteins, and peptides are normally degraded by the lysosomal pathway, so endosome escaping nanocarriers are often used. Screening prospective endosome-disrupting technologies is currently both indirect and cumbersome.

Here, we validate Galectin 8 intracellular tracking as an alternative approach that is direct, quantitative, and predictive of therapeutic cargo intracellular bioactivity. Galectin-8-YFP is an engineered fluorescent reporter that selectively binds to the inner surface of endosomes, which are only accessible upon endosome disruption. We show that quantifying the redistribution of a Galectin-8-YFP from the cytosol into endosomes is a real-time, live cell assessment of endosomal integrity, and further does not require labeling or modification of either the carrier or biologic drug. Through screening a series of thirteen different polymeric siRNA carrier compositions and three dosages, we show that Galectin 8 endosomal recruitment correlates strongly ($r = 0.95$, $p < 10^{-4}$) with intracellular siRNA delivery as measured by protein knockdown.

Galectin-8-YFP recruitment predicts intracellular bioactivity better than the current gold standard methods such as Lysotracker colocalization (n.s.), pH dependent hemolysis (n.s.), or cellular uptake ($r = 0.73$, $p < 10^{-3}$), and this method, combined with quantitative image analysis, is amenable to high-throughput, fully-objective, and automated screening. Finally, application of Galectin 8 recruitment imaging in the current work provides novel insights into impact of composition and molecular weight on endosomal escape of poly[(ethylene glycol)-b-[(2-(dimethylamino)ethyl methacrylate)-co-(butyl methacrylate)]] [PEG-(DMAEMA-co-BMA)] siRNA delivery systems, confirming utility of this tool for rapid optimization of intracellular delivery technologies.



Presenter Name: Kevin Patel
Classification: Senior
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Joel D. Bumgardner
Title: Evaluation of Two Different Neutralization Methods for Chitosan Coatings
Abstract:

Chitosan has been extensively investigated as an organic coating for musculoskeletal and dental implants due to its osteoconductive properties and local drug and growth factor delivery capabilities. Since chitosan is dissolved in dilute organic acid, the residual acid components must be removed post coating, which is typically completed using alkali and/or ethanol treatments. Neutralization affects coating surface chemistry, substrate adhesion, swellability, and many other characteristics. The aim of this study was to compare the effects of NaOH neutralization, which a common neutralization method, versus phosphate buffer neutralization, which is a less common neutralization method, on solution cast coatings on commercially pure titanium. Properties evaluated were contact angle, coating swelling, growth factor release, coating adhesion, cell attachment, cell proliferation, and cell mineralization. Results show that phosphate buffer neutralization produces coatings with properties that are more favorable for musculoskeletal and dental implant device applications. These results can be rationalized by the fact that NaOH neutralization causes deprotonation of the chitosan amine, while the phosphate buffer is speculated to not cause this, leading to favorable characteristics including extended elution profile, more swelling, greater coating adhesion strength, and cell growth.

Presenter Name: Landon R. Choi
Classification: Sophomore
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Jessica A. Jennings, Logan R. Boles
Title: Antibiotic Elution and Cytocompatibility of Chitosan Derivative Paste for Periprosthetic Joint Infection.

Abstract:

Periprosthetic joint infection (PJI) is a significant cause of total joint arthroplasty failure. It is in the top three causes for failure in both primary total knee arthroplasty (16.8%) and primary total hip arthroplasty (14.8%). Treatment of these infections can cost up to $60,000-$100,000 and imposes a significant burden on healthcare systems. Chitosan is a cheap and bountiful biomaterial that is a derivative of chitin, with advantages of biocompatibility and biodegradability. Its versatility allows for fabrication of various physical forms, such as sponges, microbeads, or injectable pastes, which are useful for delivery of antibiotics or other drugs. In this research, we investigate a chemically modified chitosan mixture for efficacy in eluting antibiotics and for compatibility with mammalian cells.

Chitosan (1% w./v.) was solubilized in a mixture of acetic and lactic acid (1% v./v.) and reacted with polyethylene glycol diacrylate 8000 (PEGDA) (1% w./v.) at 60°C for 3 hours to form polyethylene glycol diacrylate chitosan (PEGDAc). Control chitosan was fabricated by mixing chitosan (1% w./v.) with acetic acid (0.85% v./v.) and polyethylene glycol 8000 (PEG) (1% w./v.). Solutions were frozen at -80°C and lyophilized. PEGDAc was neutralized with 0.25M NaOH, and control was not neutralized. Final products were ground into flakes using a conventional coffee grinder and hydrated with phosphate buffered saline (PBS) or vancomycin solution. PEGDAc alone and a combination of PEGDAc and unmodified chitosan eluted for 6 days, while control only eluted for 4 days. The combination of PEGDAc and control was as cytocompatible as the historical control when added to cultures of NIH3T3 fibroblast cells. Control paste was significantly less cytocompatible compared to the combination (41% vs. 97%). Based on these early results the combination of PEGDAc and control have potential to be an adjunctive treatment for the prevention of PJI.

Presenter Name: Leslie Pace
Classification: Graduate Student
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** J. Amber Jennings, PhD
Title: Tobramycin and Water Content Effects on Set Time for Tri-Phasic Bone Void Filler
Abstract:

Bone void fillers (BVF) have long been used in the field of orthopedics to fill osseous voids or defects as a substitute for autografts or allografts. Tri-phasic BVF consists of hydroxyapatite, calcium sulfate, and tri-calcium phosphate. The combination of these biomaterials has advantages of biocompatibility, bioresorption, and osteoconductivity. Another use of these products is for local delivery of antibiotics under the direction of the surgeon. With the addition of different antibiotics, especially tobramycin, the set time of BVF has said to increase. The goal of this is study was to evaluate the effects of antibiotics used in combination with tobramycin as well as the amount of water added on set time for the OsteoBoost ® BVF. Kits of OsteoBoost ® were obtained from OsteoRemedies (Memphis, TN). BVF beads were cast into rubber molds after mixing the powder BVF for 1 minute with varying antibiotic (tobramycin sulfate and/or vancomycin chloride) and DI water amounts. Set time was judge based on friability of pellets as would be determined in an operating room. The addition of tobramycin extended the set time for the BVF considerably compared to non-antibiotic loaded BVF, which sets within 8 minutes. Reducing the amount of DI water added to the tobramycin combination groups decreased set time needed for the BVF. Based on this knowledge for applications clinically, a surgeon choosing to incorporate tobramycin into the BVF could know choose to reduce the amount of DI water added or allow for a longer set time.

Presenter Name: Logan Boles
Classification: Graduate
Affiliation: Biomedical Engineering, University of Memphis
***Advisor and Coauthors*:** Dr. Jessica Jennings
***Title*:** Evaluation of Lyophilized Chitosan Derivatives for Degradable Antimicrobial Delivery
Abstract:

Infection is a serious complication that occurs in up to 30% of open fractures in civilian populations and nearly 40% in U.S. military personnel. Chitosan, a natural glycomaterial, has been developed into many different delivery systems such as hydrogels, particles, sponges, tissue scaffolds, and paste. This material has been shown to be biocompatible and degrades into products that invoke a minimal inflammatory response. It also possesses reactive functional groups that makes this natural polymer amenable to selective chemical modification. The primary objective of this research is to modify the chemical structure of chitosan to match its degradation rate to the release rate of antimicrobials without increasing cytotoxicity. Chitosan with a degree of deacetylation of 82.46% and molecular weight of 250.6 kDa was used to prepare two derivatives: trimethyl chitosan (TMC) and polyethylene glycol diacrylate chitosan (PEGDAc). TMC was produced by the addition of methyl groups to the primary amine group on chitosan and tailored by varying the degree of quaternization. PEGDAc was formed by reacting PEGDA with chitosan and refined by changing the molar ratio of PEGDA molecules to amine groups on chitosan. Varying the reaction time for TMC tailored the degradation rate in an accelerated degradation assay. TMC reacted for 24 hours, 48 hours, and 72 hours degraded in 2, 3, and 4 hours, respectively. PEGDAc produced using 0.5%, 1.0%, and 2.0% (w./v.) PEGDA had a higher swelling ratio than control chitosan sponges (23 vs. 12). PEGDAc sponges also degraded more rapidly than control sponges in accelerated degradation tests (1 hour vs. 3 hours). TMC and PEGDAc were cytocompatible with NIH3T3 fibroblasts and Saos-2 osteosarcoma cells compared to blank tissue culture plastic and control sponges. These preliminary results may demonstrate that TMC and PEGDAc could be developed for local, degradable antimicrobial delivery.

Presenter Name: Martina Rodriguez Sala
Classification: Graduate
Affiliation: Department of Physics and Materials Science, University of Memphis, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Firouzeh Sabri
Title: PC-12 Cell Adhesion and Differentiation on Carbon Aerogel Scaffold
Abstract:

Traumatic injuries to the peripheral nervous system have life changing consequences such as loss of sensitivity and mobility. Existing techniques to accelerate nerve repair consist of passive materials where the total nerve repair is not accomplished. Therefore, there is a need to keep researching new methods. The design of smart materials rather than passive ones are needed. Consequently, the long-term goal of this research is to design a smart implant that would accelerate and make more efficient the regeneration of nerves. The first step towards achieving this goal is to understand the *in vitro* the behavior of neuron like cells onto different substrates. PC-12 cells are neuron like cells used for *in vitro* studies. Therefore, the focus of this research is the cell adhesion and differentiation of PC-12 cells onto a conductive aerogel such as carbon aerogel.

Presenter Name: Michael Harris
Classification: Graduate Student
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Leslie Pace, Karen Beenken, Mark Smeltzer, J. Amber Jennings
Title: Development of a Polymicrobial Murine Model of Periprosthetic Joint Infection
Abstract:
Introduction: Preclinical animal models of orthopedic infection are required to screen biomaterial based drug delivery systems for efficacy as well as adverse *in vivo* reactions. Recent research has suggested that polymicrobial biofilms with *Staphylococcus aureus* and *Pseudomonas aeruginosa* are more virulent and delay wound healing compared to monomicrobial infections. The goal of this study was to adapt an existing animal model to include both gram positive *S. aureus* and gram negative *P. aeruginosa*.
Methods: C57BL/6 mice were anesthetized and a hole was bored into the left distal femur using syringe needles. The wound was inoculated with 104 colonies of *S. aureus* and 104 colonies of *P. aeruginosa*. A sterile 1 cm stainless steel Kirschner wire was then inserted into the hole and the wound was closed. Animals either received no treatment or a systemic injection of amikacin and vancomycin (n=4). Live bacterial colonies were counted for both the wire implant and the surrounding bone after 1 week.
Results: *S. aureus* was detected on the wire implant and in the surrounding bone tissue of all four control animals. Only one mouse that received systemic antibiotics tested negative for *S. aureus* in both the implant and bone tissue. *P. aeruginosa* was detected in the surrounding bone of all 4 controls but only ¾ wires. *P. aeruginosa* was detected on the wire implant and/or surrounding bone of animals receiving the systemic injection.
Discussion: The presence of live *S. aureus* and *P. aeruginosa* in all control animals indicates that polymicrobial biofilms were established at the surgical site. Systemic antibiotic delivery similar to prophylactic doses at the time of surgery lowered the average CFU counts but was unable to eradicate infection.

Presenter Name: Nate Webb
Affiliation: Wright Medical Technology, Memphis, TN
Co- Authors: Nate Webb, Jesse Fleming, Doug Linton, and Jon Moseley
***Title*:** Effects of Kinematics on the Surface Wear Scarring and Wear Debris in a Total Ankle Replacement

Abstract:

Abstract withheld per request by company for confidentiality.

Presenter Name: Nicholas L Pensa
Classification: Graduate Student
Affiliation: Biomedical Engineering, University of Alabama at Birmingham, Birmingham, AL
***Advisor and/or Co- Authors*:** Susan L Bellis, Andy S Curry, Michael S Reddy
Title: Graft delivery of VEGF mimetic peptides to induce angiogenesis within a bone injury site.
Abstract:
Introduction: Engineering bone graft materials with gradient release of angiogenic factors such as VEGF is a major research focus, given the need for neovascularization for efficient bone healing. To address this issue, we synthesized the VEGF mimetic peptide, QK, with three different polyglutamate domains (diglutamate, tetraglutamate, and heptaglutamate) that selectively release from Ca^{2+} found within bone grafts based upon the number of glutamate residues. A mixture of these peptides ("PGM-QK") was used to develop a proangiogenic gradient on graft materials.
Methods: Solution fluorescence assays were conducted with FITC-labeled components within PGM-QK to quantify release from bone grafts. PGM-QK was evaluated for proangiogenic bioactivity through endothelial tube formation assays, scratch test, and activation of signaling proteins.
Results: Individual peptides within the PGM-QK mixture are released in accordance with polyglutamate domain length, creating a gradient. Additionally, we confirmed that the polyglutamate domain does not interfere with the bioactivity of QK, as measured by endothelial cell migration, tubule formation, and activation of signaling molecules (pAkt and p-eNOS). Finally, bone graft materials coated with PGM-QK elicited a greater angiogenic response in endothelial cells compared with grafts passively coated with rVEGF or QK.
Conclusions: PGM-QK offers a new approach for gradient delivery of proangiogenic factors from bone grafting material, thus facilitating bone tissue neovascularization.

Acknowledgements: NIH R01 DE024670 ; NASA NNX15AJ18H.

Presenter Name: Patrick Barton
Affiliation: BioHorizons
***Title*:** An Overview on the Role of Biomaterials Used in Biohorizons' Products and the Dental Industry
Abstract:

Abstract withheld per request by company for confidentiality.

Presenter Name: Paul Cameron
Classification: Senior
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. J. Bumgardner
Title: Effect of Raspberry Ketone-Loaded Chitosan Membranes on Saos-2 Cell Growth
Abstract:
Background: Chitosan when electrospun into a membrane, has a fibrous structure that mimics the extracellular matrix and provides a scaffold for cell growth. This characteristic, along with its degradation properties and cell impermeability, make it a promising material for GBR applications. Raspberry ketone (RK) is a compound that has shown the ability to reduce nitric oxide production by macrophages, reducing the risk of chronic inflammation and expediting the healing process. RK can be loaded onto electrospun chitosan membranes via simple adsorption. This study examined the effect of RK on Saos-2 cell growth.
Methods: Electrospun membranes were treated with either acetic anhydride, butyric anhydride, hexanoic anhydride, or trimethylamine (TEA) and tertbutyl bicarbonate (tboc) solutions. Discs of the membranes of each treatment were loaded with 250 µg RK (n=4). After drying, membranes were transferred to a 24-well plate and each was covered with 0.75 mL DMEM media. A cell culture insert was placed in the wells on top of the membranes and Saos-2 cells were seeded at ~3,000 cells/well and covered with 0.25 mL media. CellTiter-Glo assay was performed on Days 1, 3, 7 and 12 to analyze cell growth.
Results: The CellTiter-Glo assay data shows that the addition of RK to the butyryl treated membranes does not have a negative effect on the growth of the Saos-2 cells through the first 7 days of the growth study (Figure 1). The assay is showing similar, if not higher luminescence levels in the cells that were submitted to RK. This study is still in progress and the membranes of the three other treatments will also be loaded with RK and undergo their own 12-day cell growth studies.

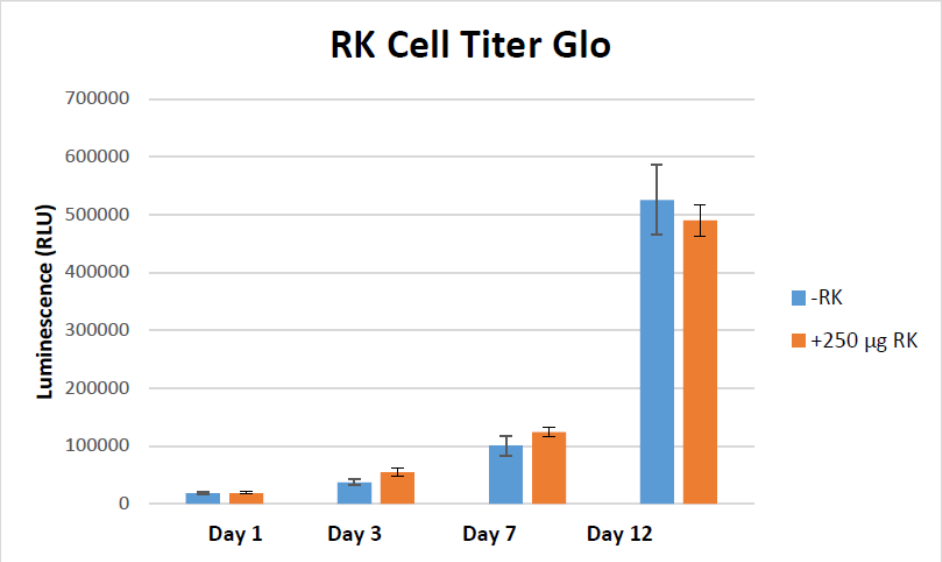


Figure 1. Luminescence produced by Saos-2 cells exposed to butyryl treated membranes with and without RK using CellTiter-Glo assay at Days 1, 3, 7, and 12.

Presenter Name: Rukhsana Awais
Classification: Graduate student
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and /or Co-Authors*:** Dr. J. Amber Jennings, Brandico Barr
Title: Comparative Antimicrobial Activity of Commercially Available Veterinary Wound Care Sprays
***Abstract*:**

Methicillin–resistant *Staphylococcus aureus (*MRSA) infections are becoming a significant problem in veterinary population. Treatment of wounds in veterinary care often requires infection control for which several topical sprays and hydrogels are available commercially over the counter. These formulations contain antimicrobial molecules that may include hypochlorous acid, chlorhexidine, Benzalkonium chloride or antimicrobial peptides. Some formulations may also contain biomaterials that enhance tissue adhesion and retention of the therapeutic molecules in the wound. In our study, we evaluated the compatibility of seven commercially available veterinary care sprays and hydrogels against MRSA. This strain of bacteria has shown resistance to beta-lactam antibiotics including penicillin (methicillin, oxacillin) and cephalosporin. Microbial inhibition of each group was measured using turbidity, bacterial viability, and zone of inhibition (ZOI) assays. Bacterial biofilm was formed in microtiter plates overnight and treated with a ¼ dilution of sprays or controls. Viability was measured using BacTiter Glo (Promega). Results were recorded for six and twenty four hours of exposure. Groups having chlorhexidine and chitosan showed enhanced inhibitory action after six hours of exposure compared to the groups with hypochlorous acid. The product with 24-oic acid and antimicrobial peptides inhibited the microbial growth in turbidity and viability assays but had limited inhibition in ZOI. The benzalkonium chloride based compound exhibited inhibition in all studies. We concluded that the products with chitosan chlorhexidine and silver showed increased antimicrobial activity in the turbidity, viability and zone of inhibition assays. These products can prove potential to combat infection caused by MRSA in chronic wound care by topical use.

Presenter Name: Saghar Gomrok
Classification: Graduate student
Affiliation: Physics and Materials Science, University of Memphis, College of Art and Science, Memphis, TN
***Advisor and/or Co- Authors*:** Dr. Muhammad Shah Jahan
Title: Long-Term Effects of Vitamin E on Free Radicals Behavior and Thermoluminescence Properties of Medical-Grade UHMWPE
Abstract:

Ultra-high molecular weight polyethylene (UHMWPE) is very high density polyethylene (C2H4)n which has been used as a bearing surface in total joint replacements (TJR) for nearly five decades. Free radicals, acting as precursors to oxidative degradation in UHMWPE, can be caused by radiation exposure during sterilization and/or cross-linking. These radicals can be quenched or stabilized, and oxidative degradation of the joint components eliminated or reduced, by adding vitamin E (α-Tocopherol) to UHMWPE. In this study, free radical analyses were performed on X-ray irradiated vitamin E-containing UHMWPE (GUR 1050), following shelf aging for 10 years at room temperature in open air. Vitamin E was consolidated with GUR 1050 at concentration levels varying between 0% (no Vitamin E) and 15% in 2006. The purpose of using high concentrations of α-T was to facilitate the detection of vitamin E radicals (α-T-O•). To investigate the effects of vitamin E, we used two spectroscopy methods: ESR and Thermally Simulated Luminescence (TSL). The glow peaks of the TSL analyses appeared at temperatures around 70°C, 200°C, and 260°C, in UHMWPE samples without vitamin E. These peaks did not appear in UHMWPE which contained vitamin E. ESR spectra, resulting from free radical detection, were present in all samples (with or without vitamin E). Each spectrum was a superposition of different kinds of free radicals; mostly allyl, alkyl and polyenyle. There was also observed a change in position of peaks as a function of time, indicative of reactions of the radicals with oxygen, and therefore probable oxidation.

Presenter Name: Samer Abdulahi
Classification: Undergraduate Senior
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** J. Amber Jennings,PhD, Leslie Pace
Title: An Investigation of Chitosan Thermo-Gels for Local Antibiotic Delivery
Abstract:

The most prevalent type of injury in the United States are musculoskeletal wounds. These wounds can become infected due to contamination, damaged vasculature, and impaired immune response. Chitosan sponges and pastes have been found to be effective local drug delivery vehicles as they can elute out antibiotics and slowly biodegrade. When chitosan is mixed with ionic components such as beta glycerophosphate (BGP), a thermally induced gel can form when heated. The objective of this study is to develop thermally induced chitosan paste modifications to offer extended and predictable local antibiotic delivery to the site of infection. Chitosan sponges were made by lyophilizing chitosan, BGP, and 0.85% acetic acid solution. The solutions were made with different amounts of chitosan (2% and 3%) and BGP (10% and 15%) as well as some being pre-heated. The sponges were then hydrated with 10 mg/mL vancomycin in phosphate buffered saline (PBS). Once hydrated to a gel-like consistency, the gel was injected into a cell crown to be suspended in a PBS solution allowing the vancomycin to elute out. Eluate samples were retrieved every 24 hours for 3 days with complete solution replacement at every time point. Eluate analysis showed that lower percentages of chitosan resulted in less burst and increased concentrations at day 3. There were no significant differences between the heated and non-heated groups in regards to elution on the first day of elution, but non-heated 2% chitosan with 10% BGP showed higher elution on days 2 and 3. This formulation would likely be more favorable clinically, due to the need for steady rates of elution for an extended period of time. This extended release may be due to the lower burst release on the first day since less drug release initially may leave more antibiotic to be released at subsequent time points.

Presenter Name: Sean K. Bedingfield[1]
Classification: Senior
Affiliation:
[1]Department of Biomedical Engineering, Vanderbilt University, Nashville, TN, 37235
[2]Departments of Orthopaedic Surgery, University of Tennessee, Memphis, TN, 38163
***Co- Authors*:** Fang Yu[1], Danielle D. Liu[1], Hongsik Cho[2], Karen A. Hasty[2], Craig L. Duvall[1]
Title: Targeted Nanoparticles for Delivery of siRNA to Sites of Early Onset Post-Traumatic Osteoarthritis
Abstract:

The presented carrier specifically targets this early Post-traumatic osteoarthritis (PTOA) biomarker (exposed CII) to deliver therapy to prevent PTOA progression by blocking MMP13 degradation of CII. PTOA occurs after a traumatic injury to the bone or soft tissue including ligament and meniscal tears, and there is currently no cure, only medications to relieve the pain. Type II collagen (CII) becomes exposed at sites of injury. Subsequent degradation of exposed CII represents the irreversible step in OA pathogenesis that initiates a degenerative cycle of inflammation and cell death that leads to permanent cartilage damage and advanced OA. Matrix metalloproteinase 13/collagenase 3 (MMP-13) activity is significantly increased in human osteoarthritic cartilage and is thought to be the primary mediator of CII degradation. Because initial cartilage/polysaccharide damage and initial CII exposure is believed to be reversible.

For targeting, a C-II specific antibody (MabCII) was developed that specifically binds to early OA damage sites. This custom antibody was conjugated to the terminus of the PEG chain for an optimized ratio of the polymer. A BMA-DMAEMA copolymer was incorporated to form the core, creating a MabCII conjugated PEG diblock copolymer (MabCII-DB-PEG). Pharmacokinetics, targeting, and therapeutic effects of MabCII-DB-PEG micelles were evaluated in mechanically induced PTOA mice. Self-assembly of MabCII-DB-PEG conjugates was triggered by siRNA complexation and increasing pH, resulting in efficient nucleic acid condensation with a hydrodynamic radius of ~110 nm. Cartilage explant binding demonstrated significantly increased affinity for damaged cartilage over DB-PEG coupled to an isotype control antibody. *In vivo* experiments showed the over twice the persistence of MabCII-DB-PEG in PTOA joints and demonstrated effective knockdown of MMP-13 expression. We have developed MabCII-decorated DB-PEG that preferentially binds to early PTOA sites *in vivo*; these antibody-targeted micelles have significantly improved pharmacokinetics and serve as an optimized, versatile platform for antibody-functionalized siRNA carriers.

Presenter Name: Virginia Mullins
Classification: Junior
Affiliation: Biomedical Engineering, Mississippi State University, Bagley College of Engineering, Starkville, MS
Advisor and/or Co- Authors: Dr. C. LaShan Simpson
Title*:* Alginate Hydrogels as an Injectable Cell Delivery System
Abstract:

Calcification of the arteries is an indicator of future heart disease and occurs primarily in patients with chronic kidney disease. A breakthrough in the study of vascular calcification was the realization that the process is similar to osteogenesis. This discovery led to the idea of using osteoclasts as a mechanism of reversing calcification just as osteoclasts reverse bone formation. My project studies alginate hydrogels as a means of directly delivering osteoclasts to sites of calcification. Alginate hydrogels are biocompatible and are highly useful in biological engineering. A calcium chloride ($CaCl_2$) solution is used to ionically cross-link by using its divalent cations to bind to the guluronate blocks of the alginate that causes adjacent polymer chains to form junctions. The cross-linking process results in a gel structure. These hydrogels can also be formed in the shape of microbeads. These beads have a potential use in therapy for vascular calcification by encapsulating osteoclasts and then being injected directly into sites of calcification. Alginate microbeads can be formed quickly using a 1% sodium alginate solution and a 20% $CaCl_2$ solution. The alginate solution is then dropped into the calcium solution using a syringe pump. The syringe pump allows a steady flow of alginate which causes consistent formation of beads. Production of microbeads capable of delivering osteoclasts to sites of calcification could prove to be an important step in therapy for vascular calcification.

Presenter Name: William J. Ona
Classification: Graduate student
Affiliation: Biomedical Engineering, Saint Louis University Parks College of Engineering, Aviation, and Technology
***Advisor and/or Co- Authors*:** Xorge A. Hernandez, Benjamin T. Mehl, Chengpeng Chen, Robert S. Martin, Scott A. Sell
Title: Incorporating Microfluidic-Fabricated Alginate Nanoparticles into an Electrospun Scaffold for Chronic Wound Healing Applications
Abstract:

In America, 2.5 million people suffer from pressure ulcers every year. Treatment of pressure ulcers usually consists of wound debridement, wound cleaning, and wound dressing. This study developed a method of creating a biocompatible, biodegradable wound dressing that enhances the healing response and reduces the healing time necessary to cure the chronic wound. This tissue engineering product consisted of a fibrous scaffold incorporated with alginate nanoparticles containing Manuka Honey. Electrospinning techniques were used to fabricate a scaffold, while alginate nanoparticles were synthesized via microfluidic flow focusing and nebulization techniques and were incorporated into the electrospun scaffold. The electrospun scaffold is a structure comprised of fibers that mimics the structure of the extracellular matrix. The scaffold's ability to resemble the ECM allows it to acts as a structure that will support cells and allow them to infiltrate the structure while travelling along the fibers within it. The presence of the fibers within the scaffold allows the repair process to be directed in specific directions. Placing an electrospun scaffold at the site of the wound will also help prevent scar formation since its physical presence will hinder wound and myofibroblastic contraction. Manuka Honey is known for its antibacterial properties and ability to assist the wound healing process. In addition, alginate has been known to be effective in drug delivery and display favorable release kinetics. In this study, alginate nanoparticles were loaded with Manuka Honey, and were made available within the scaffold as a drug delivery vehicle. In past trials, alginate nanoparticles around the size of 477 nm have been successfully fabricated, and particles have also been added to an electrospun scaffold. Ongoing studies include investigating different methods of incorporating particles into an electrospun scaffold, investigating the release kinetics of Manuka Honey encapsulated within particles, and conducting cellular proliferation studies.

Presenter Name: Zoe Harrison
Classification: Junior
Affiliation: Biomedical Engineering, University of Memphis, Herff College of Engineering, Memphis, TN
***Advisor and/or Co- Authors*:** J. Amber Jennings, PhD, Rukhsana Awais, Ranganathan Gopalakrishnan, PhD.
Title: Comparison of Elution of Antibiotic from Manually Applied and Spray Deposited Phosphatidylcholine Coatings
Abstract:
When implanting medical devices, the resultant wounds are often at high risk of infection. This infection is often caused by the formation of a biofilm, which occurs when microorganisms attach to the surface of the implanted device. Previous work in our lab has shown the effectiveness of cis-2-decenoic acid (C2DA) to disperse and inhibit biofilm, especially when combined with antibiotics. Previous studies have shown that phosphatidylcholine (PtC) can be loaded with C2DA and antibiotics to create a crayon-like solid, which can be used to “draw” a thick layer of coating onto an implant and thus prevent infection. While this application method showed promising results in regards to drug elution and prevention of bacterial growth, this method of application has drawbacks of slow application process and uneven coating, especially for devices with complex shapes.

To overcome these clinical issues, a system has been developed to spray phosphatidylcholine directly onto the device via an aerosol sprayer. This study seeks to determine if this aerosol spraying method provides similar drug elution capabilities as the previously manual coating method. PtC crayons loaded with 15% ciprofloxacin and 15% C2DA were dispersed in water and sprayed onto stainless steel coupons. Manually applied coatings were used as controls. Elution over 7 days in PBS was analyzed using high performance liquid chromatography. Results indicate that though mass of coating applied was lower using the spray setup, coating uniformity is improved with this method. Elution study results indicate that while the thicker manual coating showed higher elution of ciprofloxacin per day, the spray coating only eluted concentrations above inhibitory levels of ciprofloxacin through day 3. In future studies, modifications to improve the portability of the system, the speed of coating, and the thickness of the sprayed coating will be evaluated in addition to efficacy of released antimicrobials against bacteria.