Doctoral Dissertation Defense Announcement

“Development of a New Generation of Nanoparticles using Acellular Porcine Bone for Image Guided Regenerative Engineering”

Austin J. Stellpflug
Candidate for Doctor of Philosophy
Joint Department of Biomedical Engineering
School of Graduate Studies
Medical College of Wisconsin

Date: Wednesday, February 7th, 2024
Time: 3:00 PM (CST)
Defense Location: Bolger Auditorium

Zoom: https://mcwedu.zoom.us/j/95662849287?pwd=KzE0N3J6Y0lVNXRsN0xFTDVMQnBUz09
Meeting ID: 956 6284 9287 Passcode: kjQA17RJ
Committee in Charge:
Bo Wang, PhD (Mentor)
Brandon Tefft, PhD
Amit Joshi, PhD
James Hokanson, PhD
Ofer Kedem, PhD

Graduate Studies:
Introduction to Tissue Engineering
Advanced Tissue Engineering
Nano Science & Materials
Biomedical Optics and Nanophotonics
Analysis of Trauma
Systems Physiology
Biomechanics of Sports & Injury
Image Processing for Biomedical Sciences
Statistical Methods
Advanced Engineering Analysis
Functional MRI Contrast Mechanisms & Applications
Transport Phenomena
Seminar in Biomedical Engineering
Ethics & Integrity in Science
Research Ethics Discussion Series
Reading and Research
Doctoral Dissertation
Abstract

Bone related diseases such as osteoporosis, osteoarthritis, metastatic bone cancer, osteogenesis imperfecta, and Paget’s disease, are primarily treated with pharmacologic therapies that often exhibit limited efficacy and substantial side effects. Bone injuries or fractures are mainly repaired with biocompatible materials; however, many current options are also inefficient and produce mixed results in sufficiently regenerating healthy and homogenous bone tissue. Each of these bone conditions, both localized and systemic, use different strategies with the same goal of achieving a healthy bone environment.

In this study, we developed a new type of bone-based nanoparticles (BPs) using the entire organic extracellular matrix (ECM) of decellularized porcine bone, additionally encapsulating indocyanine green dye (ICG) for in vivo monitoring capability. Utilizing the regenerative capability of bone ECM and the functionality of nanoparticles, the ICG encapsulated BPs (ICG/BPs) have been demonstrated to be utilized as a therapeutic option for localized and systemic orthopedic conditions. Additionally, ICG enables an in-situ monitoring capability in the Short-Wave Infrared (SWIR) spectrum, capturing the degradation or biodistribution of the ICG/BPs after both local implantation and intravenous administration, respectively. The efficacy and safety of the ICG/BPs lay the foundation for future investigations, which will delve into optimization for clinical translation.
Education
Ph.D., Biomedical Engineering  Aug. 2019 - May 2024 (Expected)
Medical College of Wisconsin & Marquette University, Milwaukee, WI
Advisor: Bo Wang, PhD
Dissertation Title: Development of a New Generation of Nanoparticles using Acellular Porcine Bone for Image Guided Regenerative Engineering

B.S., Biophysics  Aug. 2014 - May 2018
Marquette University

Research Experience
Graduate Research Assistant  May 2020 - Present
Medical College of Wisconsin & Marquette University, Milwaukee, WI
Doctoral Student - Tissue and Regenerative Engineering Lab (TRE)
Advisor: Bo Wang, PhD

- Developed a process to synthesize Nanoparticles using the Extracellular Matrix of decellularized bone tissue, with characterization using various techniques and equipment
  - Design and conduct small animal procedures for in vivo testing and material evaluation using bone defects in the tibia and cleft palate
- In Vivo evaluation and quantitative analysis of bone-targeting peptides for potential therapeutic interventions and nanoparticle modification
- Nanoparticles derived from the entire Decellularized amniotic membrane as a potential mediation for cardiac regeneration

Teaching Experience
Graduate Teaching Assistant  Aug. 2019 - Dec. 2020
Marquette University, Milwaukee, WI

- Instructor for senior-level engineering biomechanics design lab
  - Managed the transition and continuation of lab-oriented class structure with the COVID-19 pandemic
Mentoring
Marquette University, Milwaukee, WI  
- Senior Biomechanics Capstone Project  
  o Served as project advisor for year-long senior engineering capstone project  
  o Assisted with the design and implementation of experiments centered around replicating biological materials

Medical College of Wisconsin, Milwaukee, WI  
Declan Vick, Marquette University Undergraduate Student  
Kat Meza, Marquette University Undergraduate Student  
Jeff Zhao, High School Student  
Cynthia Yu, High School Student  
Milan Patel, MCW Medical Student  
Kaleb Keener, MCW Medical Student

Related Professional Experiences
- Patent Pending - “Generation of Nanoparticles with Acellular Porcine Bone for Orthopedic Regeneration and Imaging”. Docket No.: 650053.00981  
- Small Business Technology Transfer (STTR) Program Grant Submission as Co-Founder and CEO of Tissue Nanovation Technologies, LLC (Submission Apr. 2024)

Publications
Stellpflug, A., Keener, K., Patel, M., Walls, J., Wang, B. Bone-Based Nanoparticles with Bone Morphogenetic Protein 2 for Enhanced Bone Regeneration In Vivo. In Preparation  
Poster Presentations


Oral Presentations