About

I left my home in Palestine at age 15 to seek a better education where more resources and scientific infrastructure are available. This has taught me the importance of embracing any educational opportunity that nourishes my curiosities and brings me a step closer to my ultimate goals. Each of these opportunities comes with an incredible reward that is worth the challenge. Ultimately, I aim to utilize my doctoral research to make an impact on people's health by contributing to the development of Osteoarthritis treatment. I am also passionate about helping transform the education system in Palestine for the better.

I am incredibly grateful for every step in my journey that has brought me here today, a PhD student in Biomedical Engineering with a focus on cell and tissue engineering. I completed my Bachelor's degree in Physics and Computer Science from Quest University in Canada in 2020 where I focused on interdisciplinary approaches to problem-solving. This program provided me with a unique research opportunity where I pursued an undergraduate thesis dissertation investigating the impact of radiation dosimetry quantity perturbations in patients with metal implant prostheses undergoing Carbon-ion therapy. My thesis also included a reflection of this field of science within our society. This study was conducted at the Nuclear Physics Institute of the Czech Academy of Sciences at the department of radiation dosimetry: https://www.youtube.com/watch?v=Es4kMCH0H48

Research

My journey as a Biomedical Engineering (BME) doctoral student started in the fall of 2020, when I joined the Polymeric Biomaterials and Tissue Engineering Laboratory of Professor Georgia Papavasiliou. Although the first semester brought about logistical challenges that required completion of coursework and research virtually as a result of the pandemic, I was able to successfully complete the first semester of my doctoral program. I participated in weekly remote meetings with Dr. Papavasiliou and her research lab and conducted an extensive literature search on characterization and design of biomimetic hydrogel scaffolds for tissue engineering. I also had the fortunate opportunity to work with former doctoral students who served as mentors and recently graduated from the lab on implementation of novel thermodynamic equations of hydrogel swelling to more accurately estimate network mesh size. allowing researchers to make predictions of how to design these biomaterials to more efficiently encapsulate and control

transport of a wide size range and conformation of molecules for tissue engineering and drug delivery applications. I moved to Chicago in the spring 2021semester and started to work on my PhD thesis project in Professor Papavasiliou's laboratory.

My doctoral thesis focuses on the development of gradient biomimetic hydrogel scaffolds that encapsulate mesenchymal stem cells (MSCs) instructing them to regionally differentiate into osteogenic (bone) and chondrogenic (cartilage) cells. The goal is for this scaffold to be implanted and used as a minimally invasive cellular therapy for the treatment of osteochondral defects, localized areas of permanent injury or degeneration of articular cartilage and underlying (subchondral bone), resulting from trauma, disease and aging. The resultant pathology of these defects, osteoarthritis, is the most common disease world-wide affecting ~ 30% of the geriatric population and is a major cause of pain, disability and global burden. Because damage of the osteochondral interface involves tissues exhibiting spatial morphologic and molecular composition, treating these lesions is exceedingly challenging. Current treatments including bone marrow stimulation, allografts and autografts may improve clinical symptoms but are unable to completely restore the complex osteochondral tissue architecture comprised of continuous gradients in cellular and biochemical composition and mechanical properties.

Mesenchymal stem cells, readily isolated from adult bone marrow, hold promising potential for repair of osteochondral defects as they can be probed mechanically and biochemically to differentiate into desired cell types, including cartilage and bone. Although various state-of-the-art tissue engineering strategies involving use of gradient-based polymeric scaffolds have been developed for restoration of the osteochondral interface, most studies have focused on stimulating the differentiation of MSCs based on gradients of a single factor (mechanical or biochemical properties) or using multilayered scaffold designs that do not emulate the gradual and continuous transition in material properties and biochemical composition of the native bone-cartilage tissue interface. My doctoral thesis work, supported through funding from the National Institutes of Health and the Pritzker Institute of Biomedical Science and Engineering Fellowship program, focuses on engineering scaffolds with highly controllable gradients in biochemical composition, cell-mediated degradation rate and mechanical properties, to spatially and temporally regulate the differentiation of MSCs into functional cartilage and bone phenotypes. This will be achieved using photopolymerization approaches for creation of cell-laden gradient scaffolds developed by Professor Papavasiliou and her research team. This semester I have been actively involved in the synthesis of biomimetic peptides that will be incorporated within the scaffolds to instruct MSC differentiation and cell-mediated material degradation and in design and synthesis of the gradient scaffolds. Central to this work is the issue of gender-related differences in differentiation of MSCs obtained from male and female donors, which is also being explored in this project. Excitingly, after the first semester of beginning my doctoral program in BME at IIT, I was able to contribute rigorous data on the analysis of hydrogel mesh size of gradient hydrogel scaffolds that supported directed and regional vascularization in 3D culture. This work was recently published as a cover feature in the journal of *Advanced Healthcare Materials* in which I am now included as a co-author (https://doi.org/10.1002/adhm.202170030)

I am excited to continue to be part of this thesis project as it will provide the first evidence of the impact of spatiotemporal modulation of multiple types of biomaterial gradients on MSC

osteochondral differentiation in 3D culture. The success of this thesis work will facilitate clinical translation of scaffolds that can be used as stem cell delivery vehicles for the treatment of osteoarthritis following implantation.

Extracurricular activities

Throughout my undergraduate studies in Canada, I sought to maintain a strong involvement in community-oriented activities. I co-directed the undergraduate academic conference Our Futures, where a space is created for students and the wider public to come together to question insightfully and dabble in disciplines that may be "outside their own".

Leading this conference allowed me to closely connect with many inspiring people and to discuss critical issues that are pertinent to our common future including climate change, global development and education.

I was also an active member of the student association as well as the university's academic journal throughout my undergraduate studies. I have grown professionally and personally from all these experiences and most importantly I learnt how to constructively approach challenges.

I have been actively engaging in programs held by Scientists for Palestine, an international organization to promote science and support the integration of the occupied Palestinian territories in the international scientific community. I have participated in their summer school projects and several of their workshops and discussions. Engaging with academic institutions in Palestine allowed me to understand the lack of infrastructure and resources which the country has—but also the abundance of potential and great minds. I strongly believe that the skills and knowledge I am gaining here at IIT will equip and prepare me to be an active contributing member in Scientists for Palestine and other organizations. This will allow me to work hand in hand with other scientists seeking to pursue research and projects directly on the ground.

Physics summer school in Ramallah held by Scientists for Palestine in 2019.

Conference in education Pedagogy held by AGYA in Jordan in 2019