הטכניון - מכון טכנולוגי לישראל

TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

הפקולטה להנדסה כימית
ע״ש וולפסון
The Wolfson Department of Chemical Engineering

Wolfson Department of Chemical Engineering Seminar

Monday, September 29th, 2025 at 13:30

Room 1

Engineering Multifunctional Polymeric Hydrogels for Biomedical Applications

Qi Wu

PhD Final Seminar

Advisor: *Asst. Prof.* Shady Farah
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Hydrogels, owing to their high-water content, tunable mechanical properties, and biocompatibility, have emerged as one of the most versatile classes of biomaterials. Their soft, hydrated networks closely resemble the native extracellular matrix (ECM), enabling intimate integration with biological tissues. Over the past decade, hydrogels have been extensively engineered to serve as carriers for controlled drug release, scaffolds for cell and tissue regeneration, wound dressings, tissue adhesives, etc.[1] Recent advances highlight the importance of multifunctionality—hydrogels that not only provide mechanical support but also actively regulate the biological microenvironment. Such systems can be designed to control infection, modulate immune responses, promote vascularization, and guide stem cell fate, making them highly attractive for complex clinical challenges, including chronic wounds, trauma repair, and regenerative medicine.

My PhD research focuses on developing next-generation multifunctional polymeric hydrogels for diverse biomedical applications, which is divided into four chapters. In the first chapter[2], we designed novel polymeric tissue-like IU-based bioactive hydrogels for infectious wound care and explored their intrinsic antimicrobial mechanism by employing extensive MD simulation and fluorescence-based experimental assays. In the second chapter[3], we developed several bio-inspired and biomimetic polymeric hydrogel bioadhesives made of natural components via 4D printing for rapid, trauma-free tissue repair, including sealing leakages, hemostasis, and simultaneously controlling infection to facilitate wound healing. In the third chapter, we designed amino acid-based adaptive polymeric hydrogels and investigated their capacity to promote fibroblast migration and direct mesenchymal stem cell differentiation for regenerative medicine, such as wound closure and bone regeneration. In the fourth chapter, we developed injectable and printable carbohydrate–protein hydrogels with drug-

loading/release, infection control, and macrophage modulating capabilities for potential diabetic wound management.

[1] Qi Wu, Eid Nassar-Marjiya, Mofeed Elias, and Shady Farah. Fundamentals and biomedical applications of smart hydrogels. In Biomaterials and Biopolymers, *Springer Nature*, 2023, 71-93.

[2] Qi Wu, Krishanu Ghosal, Nadine Kana'an, Shounak Roy, Nagham Rashed, Ranabir Majumder, Mahitosh Mandal, Liang Gao, and Shady Farah. On-demand imidazolidinyl urea-based tissue-like, self-healable, and antibacterial hydrogels for infectious wound care. *Bioactive Materials*, 2025, 44, 116-130.

[3] Qi Wu, Meenakshi Chauhan, Bassma Khamaisi, Eid Nassar-Marjiya, and Shady Farah. Biomimetic 3D-Printed Adaptive Hydrogel Bioadhesives Featuring Superior Infection Resistance for Challenging Tissue Adhesion, Hemostasis, and Healthcare. *Advanced Materials*, 2025, 2502850.