The Norman Seiden Multidisciplinary Graduate Program
in Nanoscience & Nanotechnology

Seminar lecture

Faculty members, students and the general public are hereby invited to a seminar given by

Noy Hen

The Multidisciplinary Program for Nano Sciences and Nano Technology

Doctoral thesis on

"Design, characterization and utilization of novel granular support materials for 3D bioprinting"

which will take place on *Thursday*, *15.5.2025*, at *10:00*

in Hall no. *334* (Conference Room) at the Michael Sobell Chemical Engineering Building

Light refreshments at 09:45

Under the guidance of: *Prof. Havazelet Bianco Peled*

The Norman Seiden Multidisciplinary Graduate Program
in Nanoscience & Nanotechnology

"Design, characterization and utilization of novel granular support materials for 3D bioprinting "

Noy Hen

Supervisor: Prof. Havazelet Bianco Peled

Granular hydrogels have gained significant attention in the field of 3D bioprinting due to their unique viscoelastic properties, which make them ideal as support materials for embedded bioprinting. These materials are composed of jammed microgels that provide mechanical support to cell laden bioinks and enabling the precise fabrication of complex structures using low viscosity biomaterials. Despite their potential, the use of granular support materials presents several challenges including mechanical stability, reproducibility and limited ability for real-time monitoring. To address these limitations, we developed a new granular support material composed of κ-Carrageenan microgels (CarGrow) that can support the bioprinting of various cellular bioinks. We characterized the microgels properties in terms of size, morphology, rheological behavior and stability. Furthermore, we introduced a "print and grow" approach, in which the printed cellular constructs are cultured directly within the granular matrix. This approach enhances the structural stability of printed objects, reduces deformation and maintains cell viability .

In the second part of the research, we conducted in-depth rheological characterization of key properties of the microgels, including stiffness and packing density. Through both linear and nonlinear rheological measurements, we found that the storage modulus, energy dissipation and solid-fluid transition point are significantly influenced by these parameters. Specifically, stiff and high packing microgels improved printing quality and reduced cellular filament deformation during cultivation. Leveraging the unique properties of this granular hydrogel, we further explored CarGrow potential to serve as a granular bioink for the localized release of bioactive molecules. By freeze-drying and rehydrating the microgels in specific medium composition, the granular hydrogel can absorb and release bioactive molecules. As a proof of concept, we demonstrated that CarGrow can be printed at specific locations, enabling the formation of distinct microenvironments within the support material. By dividing the granular matrix into regions containing distinct medium compositions, we can spatially control a specific differentiation of cells offering a new approach to engineer complex tissue constructs. Overall, this research advanced the application of granular hydrogels in 3D embedded bioprinting, by integrating soft materials science with tissue engineering application, offering new insights for the precise fabrication of cellular scaffolds.