LITHUANIAN UNIVERSITY OF HEALTH SCIENCES

International Summer School Practice

Designing Injectable and Tough Hydrogels for Controlled Extracellular Vesicle Delivery and Tissue Repair

Hydrogels are water-rich polymer networks that can mimic the extracellular matrix (ECM) and act as depots for sustained drug and biologic delivery. This summer research project introduces visiting students to biomaterials-based regenerative medicine, with a focus on how the structure of a hydrogel network determines its mechanical behaviour, its release properties and its biological performance. The work is carried out in the Institute of Pharmaceutical Technologies within an established research programme on ECM-derived hydrogels, extracellular vesicles (EVs) and drug delivery.

The programme has three connected themes: (1) EV-based regenerative strategies, including how polymer network structure controls EV diffusion and release from hydrogel depots; (2) injectable, in situ-forming collagen-based hydrogels with tunable stiffness, viscoelasticity, stress relaxation and self-healing; and (3) tough ECM-polymer-derived hydrogels for applications that demand mechanical robustness, such as corneal and cardiac implants. Each student will join one of these themes and work on a defined, achievable sub-project, adapted to their background (pharmacy, chemistry, biomedical or materials science, bioengineering or related fields).

Depending on the sub-project, students may: prepare and crosslink hydrogels (for example collagen, or synthetic hydrogels for model systems); characterise their mechanical and viscoelastic properties by rheology, compression and stress-relaxation testing; study swelling, degradation and permeability; follow the diffusion and release of fluorescently labelled particles or EVs by microscopy and fluorimetry; and relate the release curves to network structure using simple transport models. Where appropriate, they will also learn the basics of EV isolation and characterisation and in vitro cell compatibility testing.

Students will receive hands-on, day-to-day supervision in the laboratory from the project supervisor, together with regular weekly meetings and group discussions. They will be trained in laboratory safety and good laboratory practice, in experimental design and in rigorous data analysis and documentation. At the end they will present their results to the group and write the research internship report required by their home institution. Motivated students may be able to contribute data towards a joint scientific publication.

The supervisor has previously supervised about eight international students over five years in comparable summer research internships at Uppsala University and is committed to providing a well-structured, supportive and educational experience. The aim is to give students hands-on experience of translational biomaterials research and to strengthen their skills for a future research career, while building lasting international links for LSMU. No prior experience in hydrogels or EVs is required, only motivation, curiosity and basic laboratory training. The programme suits students at bachelor's, master's or integrated-degree level.