Modular Volumetric Bioprinted Vascular Models to Study Cell–Flow Interactions

Understanding how **geometry and flow conditions influence cellular behavior** is crucial for studying vascular biology, disease development, and tissue engineering. Recent advances in volumetric bioprinting enable the rapid fabrication of complex hydrogel structures with precisely defined internal geometries. These structures can be used as model systems to investigate how physical cues affect cell responses in engineered microenvironments.

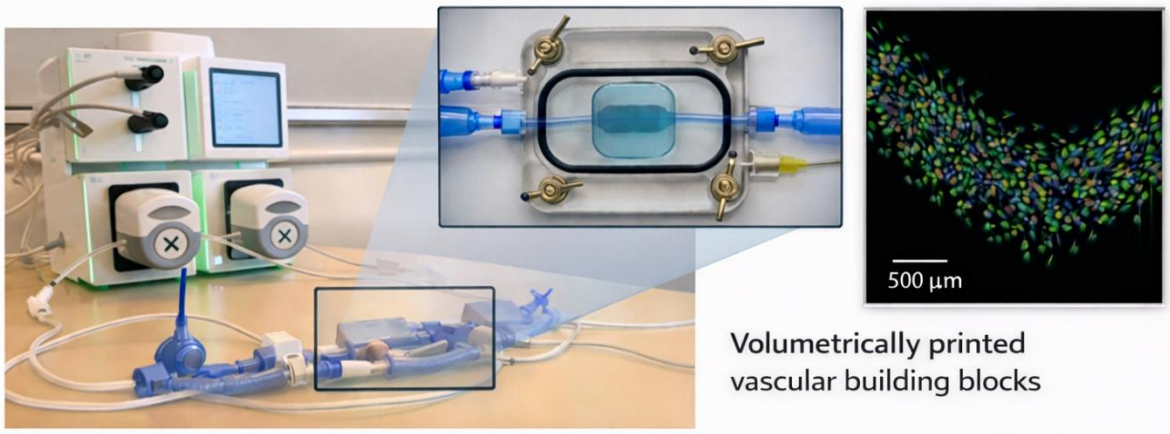
In this project, you will develop **modular hydrogel building blocks containing internal channel geometries** that can be linked together to form artificial vessel-like networks. Using **volumetric printing**, these building blocks will be fabricated with features such as constrictions, angles, and porous regions that create distinct flow regimes (e.g., altered shear stress, recirculation zones, or diffusion-dominated regions).

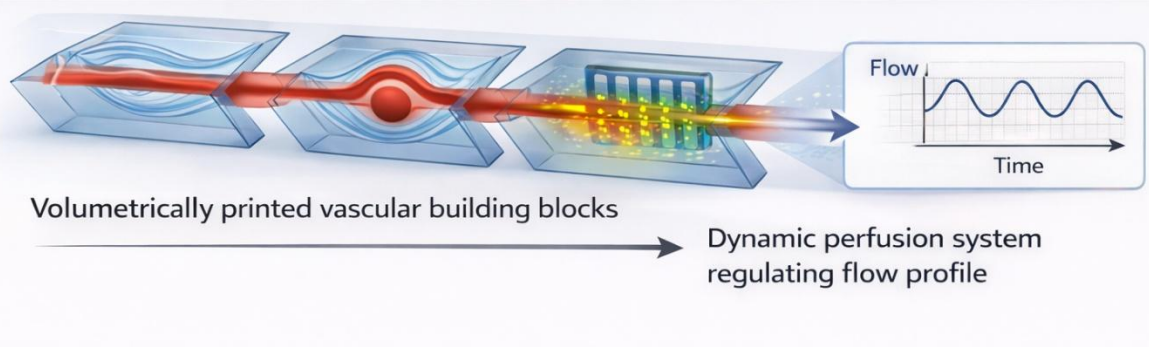
Some tasks will involve:

- Design and **volumetrically print modular hydrogel blocks with embedded channels**.
- Assemble these blocks into **customizable artificial vascular systems**.
- Introduce cells into the channels and apply **controlled perfusion flow**.
- Investigate how **channel geometry, flow patterns, and shear stress** influence cell behavior such as adhesion, morphology, migration, and proliferation.
- Analyze how **porous or structured regions affect diffusion and cell–material interactions**.

The project combines **advanced biofabrication, microfluidics, and cell biology**, providing a platform to systematically study how **physical microenvironmental parameters regulate cellular responses**. It will help to uncover fundamental principles governing cell behavior in vascular-like environments.

***See** - J. Stanny et. al. – Geometrical designs in volumetric bioprinting to study cellular behaviors in engineered constructs. Advanced Healthcare Materials, 2025.*


500 µm
Volumetrically printed
vascular building blocks


Flow
Time
Volumetrically printed vascular building blocks
Dynamic perfusion system
regulating flow profile