Development of a Two-Component Hybrid Bioink for 3D Bioprinting of Vascularized Constructs

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The main research problem addressed by this project is the lack of effective vascularization in thick 3D bioprinted constructs, which limits the creation of functional, physiologically relevant tissues for both transplantation and drug testing. The project aims to develop a two-component hybrid bioink compatible with both extrusion-based and innovative volumetric 3D bioprinting technologies, combining biocompatible natural proteins, innovative recombinant polypeptides, and cell-laden microspheres to overcome this challenge.

This bioink will enable the creation of vascularized, perfusable, physiologically relevant 3D tissue models, such as tubular structures and complex scaffolds, which are crucial for advancing tissue engineering and personalized medicine. A key innovation is the inclusion of endothelial cell-laden microspheres derived from human induced pluripotent stem cells, which promote vascular network formation within printed constructs. This approach addresses a major limitation in regenerating thick, functional tissues and sets a foundation for novel clinical applications.

The dual compatibility of the bioink with traditional and volumetric bioprinting technologies represents a breakthrough, enabling efficient fabrication of large-scale, biologically functional constructs. The project holds significant potential for regenerative medicine, driving progress in treating chronic wounds, addressing cardiovascular conditions, and advancing organoid-based platforms for drug testing. The project is conducted in collaboration with leading scientists from top institutions, including Åbo Akademi University, Bellvitge Biomedical Research Institute – IDIBELL, Universidad de Valladolid, and University of Colorado Boulder, as well as two domestic industrial partners.

By leveraging materials science, advanced bioprinting techniques, stem cells and international collaborations, this project demonstrates significant scientific potential and offers transformative opportunities for translational applications, addressing critical challenges in tissue engineering and paving the way for impactful innovations in regenerative medicine and biotechnology.