Fabrication of real-size multi-scale biomimetic vascular networks via microfluidic bioprinting

Organ and tissue loss due to disease and injury is inevitable and the current medical solutions are only based on organ transplantation and use of artificial prosthetic organs. Yet there is no perfect solution for the patients who suffer organ and tissue loss, tissue engineering, an interdisciplinary field that applies engineering and life science principles to promote regeneration, was proposed to potentially restore diseased/injured tissues with engineered tissues. Despite the clinical success in a number of studies, the success of the clinical trials in the field was mainly precluded due to the lack of vascularization for volumetric tissue regeneration for developing functional tissue constructs, because without a readily perfusable circulatory network, the diffusion of the nutrients into engineered tissues is limited to only several hundred micrometers in thickness. Thus, apart from the avascular tissues, for each engineered tissue, design of the built-in vascular network should also be considered. Moreover, when designing the vascular network, creating a biomimetic architecture, designing the biomaterial and specifying the manufacturing strategy should be considered as the key players of this task.

In this project it is aimed to develop a methodolgy for engineering real size, hierarchically branched, functional vascular systems which can perfuse 3D tissue and organ constructs.

The project objectives will be met by focusing on three main essential elements of 3D bioprinting. First a biomaterial ink will be designed which would consist of hydrogel materials. Thereafter a biomimetic model of the 3D vascular network is going to be created. And lastly the biomimetic model is going to be 3D printed using the biomaterial ink and this engineered tissue will be then testted with peristaltic flow to ensure perfusablitiy.

The outcome of the project is going to help the researchers working in tissue engineering field to understand complexity of vasculature formation and tissue vascularization. By extension, these studies would impact biomaterial science, tissue design and manufacturing as well as biomedical engineering significantly.