Vascularizing Engineered Tissues for *In Vivo* and *In Vitro* Applications

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Tissue engineering holds enormous potential to replace or restore function to a wide range of tissues, as well as to capture and control three-dimensional physiology. Despite advances in materials for scaffolding, and stem cell preservation and differentiation, the most successful applications of implantable tissues have continued to be in thin (< 2 mm) avascular tissues in which delivery of essential nutrients occurs primarily by diffusion. More complex organs or thicker connective tissue (>1cm) will only survive implantation if the tissue is rapidly vascularized, thereby ensuring an adequate supply of oxygen and nutrients to the resident cells. The development of thick tissues beyond the diffusion limitation remains, perhaps, the greatest challenge facing the field of tissue engineering. Furthermore, while human capillaries can be grown *in vitro*, there are no three-dimensional models of human tissue that contain perfused human capillaries. The past decade has brought tremendous advances in our understanding of new blood vessel formation, providing a rich environment for innovative designs of vascularized engineered tissues for both *in vivo* and *in vitro* applications. Our methods combine natural and synthetic materials with co-cultures of endothelial progenitor cell-derived endothelial cells and stromal cells to: 1) prevascularize tissues for implantation, and 2) create high throughput microfluidic-based platforms of microtissues perfused with human capillaries.