3D Printing for Engineering Complex Tissues

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The generation of complex tissues has been an increasing focus in tissue engineering and regenerative medicine. With recent advances in bioprinting technology, our laboratory has focused on the development of platforms for the treatment and understanding of clinically relevant problems ranging from congenital heart disease to preeclampsia. We utilize stereolithography-based and extrusion-based additive manufacturing to generate patient-specific vascular grafts, prevascular networks for bone tissue engineering, dermal dressings, cell-laden models of preeclampsia, and bioreactors for expansion of stem cells. Furthermore, we have developed a range of UV crosslinkable materials to provide clinically relevant 3D printed biomaterials with tunable mechanical properties. Such developments demonstrate the ability to generate biocompatible materials and fabricated diverse structures from natural and synthetic biomaterials. In addition, one of the key challenges associated with the development of large tissues is providing adequate nutrient and waste exchange. By combining printing and dynamic culture strategies, we have developed new methods for generating macrovasculature that will provide adequate nutrient exchange in large engineered tissues. Finally, the use of stem cells in regenerative medicine is limited by the challenge in obtaining sufficient cell numbers while maintaining self-renewal capacity. Our efforts in developing 3D-printed bioreactors that mimic the bone marrow niche microenvironment have enabled successful expansion of mesenchymal stem cells by recapitulating the physiological surface shear stresses experienced by the cells. This presentation will cover the diverse range of materials and processes developed in our laboratory and their application to relevant, emerging problems in tissue engineering.