Tissue Engineering From Bench to Bedside and Back

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The field of tissue engineering sprang to life almost 3 decades ago with the promise of replacing human heart, liver, cartilage and other tissues using scaffolds to guide growth of donor or endogenous cells. The road to clinical success has arguably been longer and more challenging than expected for many applications, but at the same time, exciting new frontiers for tissue engineering have emerged as demand grows for better in vitro physiological mimics of human physiology and pathophysiology. Such models are becoming essential tools in basic sciences of cell and developmental biology, and increasingly being adapted to technological applications in drug development, from target validation to safety. Hence, a future promise of tissue engineering is to decrease the need for organ transplants and tissue replacement by enabling the development of therapies that prevent or cure underlying diseases – and to similarly enable new therapies for diseases like cancer, infection, and autoimmunity. This new goal does not entirely replace the original vision of regenerative medicine applications of tissue engineering, as there will likely be an enduring need for clinical replacement of tissues damaged in trauma. Uniting these goals is an emerging set of design principles for how cells respond, quantitatively, to the multifaceted chemical and mechanical cues in the microenvironments. This talk will highlight the integration of molecular and macroscopic design principles in tissue engineering, with an emphasis on two problems: design of materials and devices for cell-mediated bone regeneration, and bench-scale physiological models of human tissue using liver as a paradigm.