

# Engineering strategies for building hearts

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## **Abstract**

The heart is a non-regenerating organ. Consequently, the loss of cardiac cells and formation of scar tissue after extensive myocardial infarction frequently leads to congestive heart failure. Given the scarcity of cardiac donors, a potential approach to treat the infarcted heart is to repopulate the 'dead zone' with cells capable of spontaneous contraction. Cellular therapy evolved to introduce cells into diseased areas and regain function. However, two main drawbacks of this approach are the lack of control of cell accumulation site after injection, and cell death before forming cell-cell or cell-matrix interactions. These shortfalls motivated the development of the tissue engineering concept, where 3-dimensional (3D) biomaterials serve as extracellular matrix-like scaffolds to the cells, enabling the cells to assemble into effective tissue substitutes, that may restore tissue or organ function. After transplantation the scaffolds either degrade or metabolize, eventually leaving a vital tissue instead of the defected tissue. In this talk I will discuss the recent advancements in the field of cardiac tissue engineering. I will describe cutting-edge technologies for engineering functional cardiac tissues, focusing on the design of new biomaterials mimicking the natural microenvironment of the heart, or releasing biofactors to promote stem cell recruitment and cardioprotection. In addition, I will discuss the development of patient-specific materials and 3D-printing of personalized vascularized cardiac patches and whole hearts. Finally, I will show a new direction in tissue engineering, where, micro and nanoelectronics are integrated within engineered tissues to form cyborg tissues. In this new concept the built-in electronic network is used to on-line record cellular electrical activity and when needed to provide electrical stimulation for synchronizing cell contraction. Furthermore, electroactive polymers containing biological factors can be deposited on designated electrodes to release drugs in the cellular microenvironment on demand, affecting the engineered tissue or the host.