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Towards the Design of 3D Multiscale Instructive Tissue Engineering Constructs: current approaches and trends

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Abstract

The design of 3D constructs with adequate properties to instruct and guide cells both *in vitro* and *in vivo* is one of the major focuses of tissue engineering. Successful tissue regeneration depends on the favorable crosstalk between the supporting structure, the cells and the host tissue so that a balanced matrix production and degradation is achieved. Herein, the major occurring events and players in normal and regenerative tissue are overviewed. These have been inspiring the selection or synthesis of instructive cues to include into the 3D constructs. We further highlight the importance of a multiscale perception of the range of features that can be included on the biomimetic structures. Lastly, we focus on the current and developing tissue-engineering approaches for the preparation of such 3D constructs: top-down, bottom-up and integrative. Bottom-up and integrative approaches present a higher potential for the design of tissue engineering devices with multiscale features and higher biochemichal control than top-down strategies, and are the main focus of this review.

Keywords: scaffolds, construct, multiscale, instructive, integrative, bottom-up, top-down, building-blocks, nano, biomaterials, nanobiomaterials.

1. Introduction

Tissue engineering aims to restore the loss of tissue and organ's functionality resulting from injury, aging or disease.(Lanza, et al., 2011) Biomaterials, cells and bioactive factors, are commonly considered the key elements needed for the preparation of 3D tissue engineered constructs for the regeneration of those damaged tissues.(Langer and Vacanti, 1993; Hench and Polak, 2002) Those act primarily as supportive and informative platforms that guide cell behavior.