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Author: Amir Shamloo Negar Mohammadaliha Mina Mohseni

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Integrative Utilization of Microenvironments, Biomaterials and Computational Techniques for Advanced Tissue Engineering

Amir Shamloo[1,2], Negar Mohammadaliha[1], Mina Mohseni[1]

[1] Center of Excellence in Energy Conversion (CEEC), School of Mechanical

Engineering, Sharif University of Technology, P.O. Box 11155-9567, Tehran, Iran

)shamloo@sharif.edu[2] To whom correspondence should be addressed: Dr. Amir Shamloo (

Highlights

►• ing the role of microfabricated systems, biomaterials and computational methods to address biological problems ▯ • ing the advantages of the integrated use of microfabricated systems, biomaterials and computational methods to design, optimize, and construct controllable artificial microenvironments similar to native extracellular matrix ▯ • Utilization of microfluidic devices along with natural, synthetic, and engineered biomaterials to construct in vitro platforms in order to mimic the physical, mechanical, and biological properties of native extracellular matrix ▯ The advantages of integrating computational technique with experimental advances to control the cellular condition in biology systems with the approach of system-level

Abstract

This review aims to propose the integrative implementation of microfluidic devices, biomaterials, and computational methods that can lead to a significant progress in tissue engineering and regenerative medicine researches. Simultaneous implementation of multiple techniques can be very helpful in addressing biological processes. Providing controllable biochemical and biomechanical cues within artificial extracellular matrix similar to *in vivo* conditions is crucial in tissue engineering and regenerative medicine researches. Microfluidic devices provide precise spatial and temporal control over cell microenvironment. Moreover, generation of accurate and controllable spatial and temporal gradients of biochemical factors is attainable inside microdevices. Since biomaterials with tunable properties are a worthwhile option to construct artificial extracellular matrix, *in vitro* platforms that simultaneously utilize natural, synthetic, or engineered biomaterials inside microfluidic devices are phenomenally advantageous to experimental studies in the field of tissue engineering. Additionally, collaboration between experimental and computational methods is a useful way to predict and understand mechanisms responsible for complex biological phenomena. Computational results can be verified by using experimental platforms. Computational methods can also broaden the understanding of the mechanisms behind the biological phenomena observed during experiments. Furthermore, computational methods are powerful tools to optimize the fabrication of microfluidic devices and biomaterials with specific features. Here we present a