

# The Role of Physical Factors in Cell Differentiation, Tissue Repair and Regeneration

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## 1. Introduction

Physical factors may induce significant biological effects, therefore they can be applied in biomedical and biotechnological fields in order to drive and modulate biological processes. It is well known that both humoral and physical factors (in particular, but not limited to the mechanical ones) are necessary for maintaining tissue homeostasis. Both biochemical and physical factors can induce the cells to reprogram their functions to adapt dynamically to the environmental conditions.

It is evident, therefore, that the only way to approach functional tissue regeneration and repair is to supply combined humoral and physical stimuli in a dose- and time-dependent manner. For example, *in vitro* studies have shown that a biomimetic environment simulating pulsatile flow is an indispensable condition for the tissue engineering of functional trileaflet heart valves from human marrow stromal cells. Static controls show morphological alterations and weaker mechanical properties (Hoerstrup et al., 2002).

Studies on the role of physical factors in tissue repair and regeneration cover a very broad field that extends from investigations aimed at deepening our understanding of the physiological mechanisms of tissue repair and regeneration to biotech advances in tissue engineering, such as development of biocompatible scaffolds, 3D cell culture systems and bioreactors, which in the future must integrate the delivery of biochemical factors with the provision of physical stimuli that are equally necessary. In this chapter, far from providing a comprehensive overview of this field of studies, we introduce some issues concerning the application of physical factors in biomedicine and biotechnology and report the results of our research on the application of various physical stimuli (gravitational and mechanical stresses, laser radiation, electromagnetic fields (EMF)) for modulating cell commitment and differentiation, cell adhesion/migration, production and assembly of extracellular matrix (ECM) components, with the final aim of understanding when and how physical stimuli can be useful for promoting tissue repair and formation of functional tissue constructs. We also briefly mention how, in past centuries, the role of physical factors in biological processes has been understood and physical stimuli have been applied for therapeutic purposes.