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Editorial

Tissue Mechanics and Tissue Engineering

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1. Introduction

Tissue engineering (TE) combines scaffolds, cells, and chemical and physical cues to replace biological tissues. Several disciplines, such as biology, chemistry, materials science, mathematics, and most branches of engineering, support this goal while improving the quality of the reconstructed tissues. Scaffolds are designed to mimic the native extracellular matrix, thus allowing cell growth and differentiation while avoiding adverse reactions [1,2]. Autologous cells or co-cultures of donor cells either encapsulated or seeded on scaffolds are deeply studied in response to chemical and physical stimuli with an effort to make them survive, grow, and differentiate [3].

As far as concerns with physical stimulation, scaffolds seeded with cells are subjected to mechanical stimuli through a bioreactor to obtain the desired functional tissue in vitro. Moreover, the scaffold itself must have mechanical properties similar to the ones of the native tissue. Tissue mechanics (TM) study the response of living tissues to applied loads, which is important for understanding the structural role of tissues and how cells respond to mechanical stimuli. Hence, mechanical properties used to quantify the load response are usually measured for native tissues and serve as reference properties for regenerated tissues. In other words, obtaining the normal living tissue mechanical properties is one of the goals of researchers for tissue regeneration. Diseases often change tissue mechanical properties, and therefore, their measurement may help detect and follow the evolution of pathologies, thus improving the clinical outcome of the patients [4,5].

2. Review of Special Issue Contents

Contributions to this Special Issue focus on different aspects of Tissue Mechanics and Tissue Engineering, giving valuable examples of applied research in the field. Two papers face different applications of tissue regeneration: the skin [1] and the retina [2]. One paper [3] deals with cell encapsulation in biomaterials for protection against immune reactions. Two papers underline that tissue mechanics play a key role in understanding tissue functions, the former focusing on the role of biomechanics related to the prediction of aortic aneurysm rupture [4], whereas the latter on the role of biomechanics for early diagnosis of glaucoma [5].

Eisler et al. [1] investigated the behavior of two dermal substitutes—a crosslinked and a non-crosslinked collagen biomatrix—applied topically on full-thickness skin defects paravertebrally on the back of female Göttingen Minipigs. Although positive results demonstrate that the single biomatrix application might be used in a clinical routine with small wounds, the authors conclude that the overarching aim is still the development of an innovative skin substitute to manage surface reconstruction without additional skin grafting.

Belgio et al. [2] provide an overview of retinal anatomy and diseases and a comprehensive review of retinal regeneration approaches. Scaffold-free approaches such as gene therapy and cell sheet technology are presented, as well as the fabrication techniques that can be used to produce retinal scaffolds with a particular emphasis on recent trends and

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advances in fabrication techniques, such as electrospinning, 3D bioprinting and lithography for retinal regeneration.

Nurhayati et al. [3] propose a novel design of a three-dimensional (3D) scaffold for encapsulating CD34+ cells and the idea of co-culturing CD34+ cells from different donors. Microencapsulated CD34+ cells showed no toxicity for surrounding CD34+ cells and improved their proliferation. The microencapsulation of non- or low-matched CD34+ cells is therefore proposed for protection against immune rejection and to facilitate paracrine excretion.

Forneris et al. [4] extensively investigated the structural and biomechanical heterogeneity of human abdominal aortic aneurysm tissue along the length and circumference of the aorta by means of regional ex vivo and in vivo properties. Results uniquely show the importance of regional characterization for aortic assessment and the need to correlate heterogeneity at the tissue level with non-invasive measurements aimed at improving clinical outcomes.

Messenio et al. [5] compared the intraocular pressure (IOP) measured by the Goldmann applanation tonometer (GAT) and by a pressure transducer inserted into the anterior chamber of pig eyes in vitro. Mechanical properties were also measured for the corneas of the analyzed pig eyes. As a novel result, statistical analysis revealed a correlation between the corneal mechanical properties and IOP measured by GIOP. Obtained data showed a discrepancy between the values of IOP measured by GAT and by the pressure transducer, more evident for softer and thinner corneas, which is very important for glaucoma detection.

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