Chapter 9

Impact of Electrospun Biomimetic Extracellular Environment on Proliferation and Intercellular Communication of Muscle Precursor Cells: An Overview – Intercellular Communication of Muscle Precursor Cells with Extracellular Environment

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ABSTRACT

Nanotextured materials or nanomaterials offer diverse remarkable applications in various walks of life owing to their unique geometry. This chapter is focused on the synthesis and characterization of electrospun nanofibrous matrices as a novel biomimetic scaffold for the cultivation of cells and tissues; in particular muscle cells and tissues. Tissue engineering is exceedingly interdisciplinary branch of science which integrates the benefits of life sciences and medicine with those of engineering. In order to cultivate muscle cells in-vitro, it is necessary to have a 3D scaffold. In tissue engineering applications or even in 3D cell cultures, the biological cross talk between cells and the scaffold is controlled by the material properties and scaffold characteristics. This chapter provides a general overview of the common approaches and techniques used for designing nanofibrous scaffolds for culture of cells specifically muscle cells. The limitations and benefits of the tissue engineering are discussed.

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INTRODUCTION

Materials with nanoscale dimensions offer diverse attention-grabbing applications due to their unique geometry and versatile characteristics. This chapter will mainly focus on the synthesis and characterization of nanofibrous electrospun matrices as a novel biomimetic scaffold for cultivation of muscle precursor cells. The intention of this chapter is to provide a general overview of the common approaches and techniques used for designing three-dimensional (3D) culture models for the cultivation of muscle precursor cells and intercellular communication with extracellular matrix. Generally speaking, the nanotechnology refers the appreciative understanding of nano-phenomenon using tools and methods for fabrication, analysis and application of materials that possess nanometer scale measurement. Modern trends in nanomaterial synthesis deal with the preparation of hybrid nano-constructs with a variety of architectures such as nanowires, core shells, nano-flowers, nanofibers and so on through various synthetic routes. Electrospinning, an electrostatic fiber production practice has substantiated concentrated notice and attention during recent years due to its flexibility and potential for applications in diverse fields. The noteworthy applications include tissue engineering, biosensors, filtration, wound dressings, drug delivery, enzyme immobilization (Hao Fong, Liu, Wang, & Vaia, 2002; Kenawy et al., 2002; Kenawy et al., 2003; Smit, Büttner, & Sanderson, 2005) and so on. However, our research group has made significant efforts during the past few years in order to design the biocompatible materials that can promote adhesion (Amna, Hassan, Sheikh, et al., 2013; Amna, Hassan, Shin, et al., 2013; Amna, Van Ba, et al., 2013; Amna, Hassan, Pandeya, Khil, & Hwang, 2013; Amna, Hassan, Van Ba, et al., 2013), proliferation of muscle precursor cells besides maintaining cell normal phenotype and functions (Shamshi Hassan, Amna, Hwang, & Khil, 2013; Shamshi Hassan, Amna, Sheikh, et al., 2013). In this chapter, we will discuss the fabrication of biomimetic scaffolds for in vitro cell culture; particularly our emphasis will be on skeletal muscle precursor cells. We will mainly describe the fabrication of high aspect ratio nanofibrous matrices by electrospinning technique and their utilization as biomimetic scaffolds for adhesion and propagation of muscle precursor cells, such as C2C12 myoblasts (Amna, Hassan, Shin, et al., 2013) and indigenous Korean Hanwoo muscle satellite cells (Amna, Hassan, Van Ba, et al., 2013) and fibroblasts etc.

In general terms the scaffold or/biomimetic scaffold could be defined as the ideal substrate/or support which provides an ideal environment for maintenance of tissue specific cell phenotype. The extracellular matrix (ECM) not only serves as a supporting material, but also acts to regulate cellular functions, such as cell proliferation, migration and differentiation. A detailed understanding of the biophysical features that affect cell growth and development is important in guiding the design of biomimetic scaffolds. The cellular microenvironment is a network of structural and functional components that provide mechanical and chemical stimuli, which influence cell function and fortune. Important developmental signals are conveyed to the cells through interactions with neighboring cells, the ECM and growth factors. In other words, the scaffold should substitute the missing ECM. It should possess the ability to host cell adhesion, proliferation and promote cell growth and spreading behavior. A variety of scaffolds such as membranes or tubes, gels, or 3D-matrices can be developed (Mooney et al., 1997; Rose & Oreffo, 2002) depending on the requirements and functions. However, it has been already established that certain factor needs to be given proper thought while fabricating the scaffolds such as the morphological features of scaffold. The morphology of scaffolds should be designed to have proper porosity, high surface area, a fully interconnected geometry, structural strength, and a specific 3D shape. Besides, scaffold materials should be biocompatible and degradable or resorbable; so as to allow replacement of newly formed tis-