Chapter 3
Carbon Nanotubes:
Basics, Biocompatibility, and Bio-Applications Including Their Use as a Scaffold in Cell Culture Systems

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ABSTRACT

Carbon-based nanotechnology has been rapidly developing, with a particular interest in the bio-application of carbon nanotubes (CNTs) as a scaffold in tissue engineering. It is essential that the materials used in scaffold fabrication are compatible with cells, as well as with the biological milieu. Many synthetic polymers have been used for tissue engineering so far; however, many lack the necessary mechanical strength and may not be easily functionalized, in contrast to CNTs, which have shown very attractive features as a scaffold for cell culture system. In spite of many attractive features, the toxicity of CNTs is a prime concern. The potential applications of CNTs seem countless, although few have reached a marketable status so far and there is need of more studies on CNTs biocompatibility issues. This chapter aims to revisit the basics of CNTs with their bio-applications including their use as a scaffold in cell culture systems.

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INTRODUCTION

Nanotechnology is a creation and utilization of materials measured in billionths of a meter. Nanotechnology is poised to make potentially revolutionary innovations in areas of biomedical science such as, diagnostics, drug therapy, imaging and tissue engineering. Following the discovery of carbon nanotubes by lijima (1991), carbon-based nanotechnology has been rapidly developing as a platform technology for variety of uses including biomedical applications. A particular area that is generating particular interest as illustrated by an increasing publication rate is the bio-application of carbon nanotubes as a scaffold in tissue engineering (Edwards *et al.,* 2009). The core of the tissue-engineered replacement is the biomaterial construct or scaffold, in which a given cell population is seeded. Ideally, a biomaterial scaffold should have well-controlled microarchitectures with well controlled pore sizes and porosity, reproducibility, biocompatibility, thermal and biochemical stability.

In tissue engineering, carbon nanotubes have been mainly used for structural support. There are various reports which suggest use of carbon nanotubes as a scaffold for cell culture (Harrison and Atala, 2007; Edwards et al., 2009, Rafeeqi and Kaul, 2010a). While popular synthetic polymers such as poly(lactic-co-glycolic acid) (PLGA) and poly(lactic-acid) (PLA) have been used for tissue engineering, they lack the necessary mechanical strength. In addition, such polymers cannot easily be functionalized in contrast to carbon nanotubes which can be readily functionalized. In spite of many attractive features, the toxicity of CNTs is a prime concern, with several groups pointing to their similarity to asbestos fibers. CNT toxicity in both *in vivo* and *in vitro* studies has been attributed to various factors and there is need of more studies on CNT toxicity and biocompatibility issues. We should appreciate the pros and cons of each system and should make every effort to refine them to further enhance their therapeutic potential.

As we continue exploring nanotechnology for biomedical applications, it is essential for us to ensure that the nanotechnologies developed are safe. The focus of this book chapter is on basics of carbon Nanotubes with their method of preparation and purification, which is fundamental prerequisite for applications of carbon Nanotubes in biological system. Further, this chapter also deals with biocompatibility and bio-applications of carbon Nanotubes with emphasis on its use as a scaffold in cell culture systems.

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