



Chapter 8

Therapeutic Applications of Palladium Nanoparticles (PdNPs)


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ABSTRACT

PdNPs have received much attention in nanomedicine due to their unique physicochemical values such as high thermal and chemical stability, high surface area, & tuneable optical properties. These characteristics make them suitable for many biomedical applications, including cancer therapy, antibacterial treatments, drug delivery, & biosensing. In this chapter, synthesis methods for PdNPs are reviewed from the environmental friendliness view point, & the properties are described. Enhanced PdNPs' stability, biocompatibility, and efficacy in biological systems are explored through the development of functionalization strategies. PdNPs possess great promise for photothermal therapy in targeted cancer treatment, antibacterial effectiveness against multidrug-resistant pathogens, & drug delivery vehicles. They also offer support for early disease detection in biosensing technologies. Finally, safety and toxicity issues are also examined, emphasizing the need for careful evaluation of safe and effective clinical applications of PdNPs.

DOI: 10.4018/979-8-3373-0055-9.ch008

1. INTRODUCTION

The emergence of nanotechnology has been, and continues to be a transformative field of modern science in the development of novel therapeutic agents. Metal nanostructures such as palladium nanoparticles (PdNPs) have received great attention for their peculiar physicochemical properties and their possible biomedical applications (Phan et al., 2019; Yaqoob et al., 2020; Leso & Iavicoli, 2018). PdNPs display excellent chemical, and thermal stability, and profound optical and photocatalytic properties, with relative cost effectiveness (Phan et al., 2019). Nanotechnology received formal recognition in the late 20th century but researchers from the 4th century used the Lycurgus Cup to demonstrate nanoscale optical effects. The scientific investigation of nanomaterials began when Michael Faraday examined colloidal gold in 1857 while the field experienced significant development after scientists invented the Scanning Tunnelling Microscope in 1981 (Bayda et al., 2019). This instrument enabled atomic-level manipulation. Advancements in nanomaterials research during this period resulted in discovering such as fullerenes in 1985 and carbon nanotubes in 1991 as well as graphene in 2004. These materials demonstrated exceptional mechanical properties and outstanding electrical functionality (Bayda et al., 2019). The US National Nanotechnology Initiative (2000) used its accelerated research funding to expand nanotechnology into electronics and energy systems as well as environmental science and advanced materials which revolutionised miniaturisation and energy efficiency and pollution cleanup and smart materials development. Nanotechnology has enabled better results in medicine through its use in targeted drug delivery systems as well as diagnostic biosensors and nanomedicine-based treatment methods which lead to more effective personalised medicine (Bayda et al., 2019). Figure 1 shows a clear representation of evolution of nanotechnology and its expansion in medicine.

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