Chapter 7
Applications of Nanotechnology in Cancer

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ABSTRACT

This chapter examines the importance of nanotechnology in cancer prevention, cure, and diagnosis. This chapter deals with the applications of nanomedicine in cancer and various strategies to target cancer cells by using nanotechnology such as gold nanoparticles, liposomes, nanodots, nanorods, etc. Nanotechnology is an interdisciplinary area with potential applications in fighting many diseases including cancer. Conventional drugs have poor cell specificity, solubility, and high toxicity. The continued development of cancer nanotechnology holds the promise for personalized oncology. For accurate and self-confirming cancer diagnosis, it is essential to combine dual-mode and multi-mode imaging functionalities within one nanoparticle system. Nanoparticles improve the solubility of poorly water-soluble drugs and prolong the half-life of drugs. Disadvantages of nanotechnology include the potential for mass poisoning. Understanding how nano-materials affect live cell functions, controlling such effects, and using them for disease therapeutics are now the principal aims and most challenging aspects of nanobiotechnology and nanomedicine.

INTRODUCTION

Nanotechnology can be defined as the design, characterization, production and application of structures, devices and systems by controlling shape and size at a nanometer scale. Nanoparticles, according to the American Society for Testing and Materials (ASTM) standard definition, are particles with lengths that range from 1 to 100nm in two or three dimensions. Potential benefit of nanomaterial's are well recognized in the literature and some commentators argue that nanotechnology promises to far exceed the impact of the Industrial Revolution, projecting to become a $1 trillion market by 2015. In medicine, interest is in the use of nanoparticles to enhance drug delivery; in *in vitro* diagnostics, novel biomaterial design, bio-imaging, therapies and active implants.

Nanotechnology is an interdisciplinary research field involving chemistry, engineering, biology and medicine. It has great potential for early detection, accurate diagnosis, and personalized treatment of cancer. Nanoparticles are typically smaller than several hundred nanometers in size, comparable to large biological molecules such as enzymes, receptors, and antibodies. With the size of about one hundred to ten thousand times smaller than human cells, these nanoparticles can offer unprecedented interactions with biomolecules both on the surface of and inside the cells, which may revolutionize cancer diagnosis and treatment.

Over the last decade, there have been many nanotechnology centers established worldwide. In the United States alone, more than six billion dollars have been invested in nanotechnology research and more than sixty centers, networks, and facilities, funded by various agencies, are in operation. After establishing an interdisciplinary nanotechnology workforce, it is expected that nanotechnology will mature into a clinically useful field in the near future. For *in vitro* and *ex vivo* applications, the advantages of state-of-the-art nano-devices (e.g., Nano-chips and Nano-sensors) over traditional assay methods are obvious. However, several barriers exist for *in vivo* applications in preclinical and potentially clinical use of nanotechnology, among which are the biocompatibility, *in vivo* kinetics, tumor targeting efficacy, acute and chronic toxicity, ability to escape the reticulo-endothelial system (RES), and cost-effectiveness (Cai and Chen 2007, 2008).

Nanotechnology and Cancer

It has been almost four decades since the "war on cancer" was declared. It is now generally believed that personalized medicine is the future for cancer patient management. Possessing unprecedented potential for early detection, accurate diagnosis, and personalized treatment of cancer, nanoparticles have been extensively studied over the last decade.

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