

# Chapter 9

## Role of Drug Delivery in Cancer Theranostics: From Designing to Delivery of Drug

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### **ABSTRACT**

*Cancer presents a formidable challenge in oncology due to its aggressive nature and propensity for metastasis. This chapter delves into advanced drug delivery strategies and theranostic innovations tailored specifically for cancer. Theranostics, integrating diagnostic and therapeutic functionalities, are explored for their potential in personalized cancer treatment modalities as they are crucial for accurate diagnosis, disease staging, and treatment response assessment. Regulatory guidelines and clinical trials governing the development and approval of novel cancer therapeutics are comprehensively enveloped. Also, the chapter forecasts a future where personalized therapies and tailored drug delivery systems. Ultimately, the chapter emphasizes the transformative impact of advanced drug delivery and theranostics in cancer therapy, heralding a future marked by enhanced efficacy, safety, and precision in treatment interventions..*

### **INTRODUCTION**

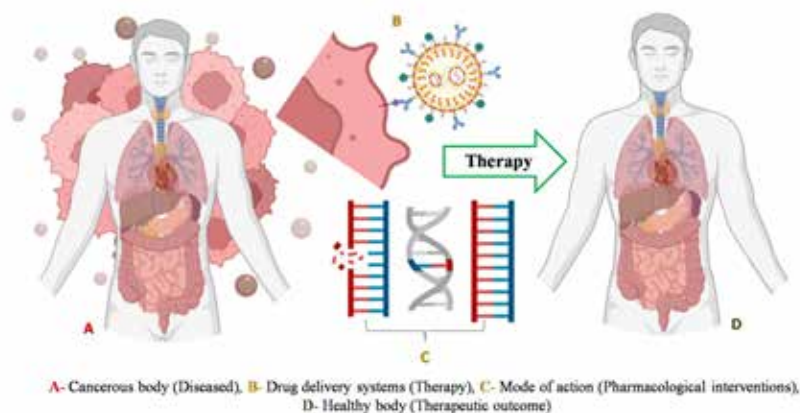
Cancer represents a complex and multifaceted challenge in oncology due to its heterogeneous nature and propensity for metastasis. Traditional cancer treatments, including chemotherapy, radiation, and surgery, have had a significant impact on cancer management but are often limited by their lack of specificity, systemic toxicity, and variable effectiveness across different patients. Chemotherapy, while effective against rapidly dividing cells, does not distinguish between cancerous and healthy cells, leading to a range of side effects such as nausea, hair loss, and immunosuppression (Kris et al., 2004). Radiation therapy, though targeted, can cause damage to surrounding healthy tissues and organs, contributing to adverse effects such as fatigue, skin irritation, and organ dysfunction (Wazer et al., 2005). Surgery, while effective in removing localized tumors, may not address microscopic metastases that have spread

DOI: 10.4018/979-8-3693-5400-1.ch009

beyond the primary site, highlighting the need for more comprehensive treatment approaches (Harlow et al., 2015).

In response to these limitations, there has been a substantial shift towards more targeted and personalized approaches in cancer treatment. The advent of advanced drug delivery systems (DDS) and theranostic technologies has revolutionized the field by offering strategies to improve drug targeting, reduce off-target effects, and enhance real-time monitoring of disease progression (Jain, 2005; Ferrari, 2005). Theranostics, which integrates diagnostic imaging with targeted therapy, has emerged as a promising approach for personalized cancer treatment. By combining diagnostic imaging with targeted therapy, theranostics enables clinicians to tailor treatments to individual patient profiles, thereby improving treatment outcomes and minimizing adverse effects (Bobo et al., 2008; Peer et al., 2007; Meher et al., 2018).

*Figure 1. Figure depicts the overall process to repair a cancerous body to a healthy body by the application of drug delivery systems to treat cancer*



This chapter aims to provide a comprehensive overview of the latest advancements in drug delivery systems and theranostics in the context of cancer therapy as shown in Figure 1. We will explore the mechanisms and applications of these innovations, highlighting their role in enhancing the precision and efficacy of cancer treatments. Additionally, we will address the regulatory and clinical considerations associated with novel cancer therapeutics, providing insights into the future directions of cancer care. By examining these advancements, we hope to shed light on how these transformative technologies are shaping the future of oncology and offering new possibilities for improving patient outcomes (Barenholz, 2012).

## 1. THE CHALLENGE OF CANCER

Cancer is a disease characterized by uncontrolled cell growth and the ability to invade surrounding tissues and organs. This aggressive nature arises from genetic mutations and dysregulation of cellular signaling pathways that drive tumor proliferation and metastasis (Hanahan & Weinberg, 2011). The variability of cancerous tumors, both inter- and intra-patient, poses a significant challenge for treatment.

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