Chapter 6
Terpene and Nanotechnology: Targeted Drug Delivery

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ABSTRACT

The amalgamation of terpene chemistry and nanotechnology represents a captivating frontier in the realm of drug delivery, offering a plethora of opportunities for precision medicine and enhanced therapeutic outcomes. Terpenes, abundant in nature and revered for their diverse pharmacological properties, hold immense potential for augmenting drug delivery strategies. Concurrently, nanotechnology empowers researchers with precise control over drug formulation and delivery, paving the way for targeted therapeutics with improved efficacy and reduced side effects. This chapter embarks on a comprehensive journey to unravel the synergistic interplay between terpenes and nanotechnology, elucidating key principles, recent advancements, and promising examples of terpene-based nanocarriers in targeted drug delivery applications.

1. INTRODUCTION

The field of drug delivery is experiencing a paradigm shift, driven by the rapid advancements in nanotechnology and the renewed interest in natural compounds such as terpenes. Drug delivery systems (DDS) are pivotal in determining the success of therapeutic interventions, as they control the release, distribution, and targeting of therapeutic agents. Traditional drug delivery methods often suffer from

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limitations such as poor bioavailability, lack of targeting specificity, and systemic toxicity. These challenges necessitate the development of more sophisticated DDS that can deliver drugs with higher precision and efficacy.

Nanotechnology has emerged as a transformative tool in the design of advanced DDS, enabling the manipulation of materials at the molecular and atomic levels. Nanocarriers, such as liposomes, polymeric nanoparticles, and dendrimers, offer several advantages, including enhanced solubility of poorly soluble drugs, protection of drugs from degradation, prolonged circulation time, and the ability to target specific cells or tissues. The integration of nanotechnology with therapeutic agents has already revolutionized the treatment of various diseases, including cancer, infectious diseases, and neurological disorders.

Simultaneously, terpenes, a diverse group of naturally occurring organic compounds primarily derived from plants, have gained significant attention in the pharmaceutical industry. Terpenes are known for their wide range of biological activities, including antimicrobial, anti-inflammatory, anticancer, and antioxidant properties. Additionally, terpenes have unique physicochemical properties that make them valuable in drug delivery, such as their ability to modulate membrane permeability, enhance drug absorption, and improve bioavailability.

The convergence of terpene chemistry and nanotechnology offers a novel approach to overcoming the limitations of conventional DDS. By leveraging the inherent properties of terpenes in combination with the precision of nanotechnology, researchers are developing innovative drug delivery systems that offer targeted delivery, controlled release, and enhanced therapeutic outcomes. This chapter delves into the synergistic potential of terpene-based nanocarriers, exploring their principles, applications, and future directions in the realm of targeted drug delivery (Singh et al., 2023; Silvestre & Gandini, 2008; Masyita et al., 2022).

2. TERPENES IN DRUG DELIVERY

Terpenes are a diverse class of hydrocarbons produced by a variety of plants, fungi, and some insects. Structurally, terpenes are composed of repeating isoprene units (C5H8) and are classified based on the number of isoprene units they contain (Silvestre & Gandini, 2008).

2.1 Chemical Structure and Classification

Terpenes are classified based on the number of isoprene units they contain. Isoprene (C5H8) is the basic building block of terpenes, and its polymerization leads to the formation of various terpene classes:

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