Smart Nanomaterials Technology

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Azamal Husen *Editors*

Carbon-Based Nanomaterials

Synthesis, Agricultural, Biomedical, and Environmental Interventions

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Contents

Smart Nanomaterials in Drug Delivery for Cancer Therapy

Asim Rahman, Nazish Naseem, Amreen Fatima, and Md. Faheem Haider

Abstract In today's world, one of the leading diseases people are facing is cancer, and liver cancer is one of them. Though various drugs acting via different mechanisms of action are present in the market as conventional formulations for the treatment of liver cancer they face substantial challenges regarding their bioavailability, low solubility and associated adverse effects which greatly limit their therapeutic efficacies. Nanotechnology has emerged as a promising tool for cancer therapy. Smart nanomaterials, in particular, have gained significant attention due to their unique properties, such as high surface area, biocompatibility, and the ability to be functionalized with targeting moieties. Smart nanomaterials can be designed to selectively deliver drugs to cancer cells, improve drug efficacy, and reduce toxicity. Various studies exhibit that nanocarriers can significantly increase drug bioavailability and increase solubility. The present chapter summarizes nanoformulations used in the treatment of liver cancer. It also highlights the available therapeutics in the market which is used for the treatment of liver cancer along with their side effects and drawbacks and how nanoformulation can overcome these drawbacks of present therapeutics.

Keywords Liver cancer · Anticancer · Nanoformulation · β-catenin · Therapies

1 Introduction

Cancer is a complex and multifaceted disease that can arise from various factors like environmental exposures, genetic mutations, chemical exposures, and lifestyle choices. In general terms, it is defined as the growth and spread of abnormal cells in the body in an uncontrolled manner, which leads to the invasion of nearby organs and tissues and forms tumours. Cancer development involves a series of cellular and molecular events, which include alteration in signalling pathways inside the cell, changes in the genes that are involved in cell proliferation and survival, and the

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acquisition of invasive and migratory capabilities. Cancer cells have the capability to evade the immune system, which makes them more dangerous, and they can develop strategies to escape elimination and detection by the immune system. This process is known as immune evasion, which is a huge obstacle in the development of cancer treatment [3, 41].

There are various types of cancer, and each type has its own treatment plan [41].

1. Lung cancer
2. Breast cancer
3. Prostate cancer
4. Colorectal cancer

Early diagnosis of cancer is essential in the treatment of cancer and can be done using different methods, which include imaging tests and biopsies [38]. Treatment of cancer can be done through surgery, radiation therapy, targeted therapies, and chemotherapy [34]. Advancements in cancer research have shown us new therapeutic strategies and technologies, including nanoparticles and immunotherapy. Despite advances in the medical field, cancer remains a leading cause of death worldwide [9].

2 Liver Cancer

Hepatocellular carcinoma (HCC), in general, known as liver cancer, is a malignancy of the liver that arises from hepatocytes, which are the primary functional cells of the liver. In the list of cancers worldwide, liver cancer holds the sixth position, and in cancer-related deaths, it holds the 4th position, with the death toll accounting for approximately 782,000 annually. In recent years, liver cancer has been increasing due to the growth of potential risk factors such as alcohol consumption, metabolic disorders, viral hepatitis, non-alcoholic fatty liver diseases, diabetes, and obesity [44]. A key factor in the cause of liver cancer is chronic liver inflammation. and injury, which can occur due to viral infections of the liver such as Hepatitis B and C, consumption of alcohol, or metabolic disorders [47]. The mentioned factors lead to epigenetic alterations and the accumulation of genetic mutations that can disrupt normal cellular functions, leading to proliferation and uncontrolled cell growth inside the liver [46]. In the development of liver cancer, several molecular pathways have been implicated, including PI3K/AKT/mTOR, Wnt/β-catenin and MAPK/ERK signalling pathways. The mentioned pathways play a vital role in regulating cellular processes, which are proliferation, cell growth, and apoptosis. Dysregulation of any of these pathways leads to the development of hepatocellular carcinoma (HCC) or liver cancer [46]. The diagnosis of hepatocellular carcinoma involves a series of imaging tests like ultrasound, computer tomography (CT), and magnetic resonance imaging (MRI) [17]. Biomarkers like blood tests to assess and find out liver function and if there is the presence of tumour markers like alpha-fetoprotein (AFP) and other biomarkers such as des-gamma-carboxy prothrombin (DCP) and glypican-3 (GPC3) can help