Efficient Green Nanotechnology Application in Cancer Drug Delivery Systems

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Due to their safety, accessibility, and widespread acceptance, the use of natural ingredients as chemopreventive and chemotherapeutic agents has increased as part of the numerous efforts being made to defeat cancer. Green nanotechnology is a cutting-edge approach to research that incorporates application components for design and development, enabling the efficient manufacturing of items that can reduce the amount of compounds that are harmful to human health. Regarding bio, organic, inorganic, analytical, and even physical chemistry, green nanotechnology focuses solely on large-scale applications. The goal of these new green nanotechnology projects is to reduce the risks to human and environmental health. In turn, the creation and use of nanomaterials necessitate the replacement of more recent nano-based goods that may be beneficial in this regard.

Keywords: Nano technology, drug delivery system, Green Nanotechnology, Health.

1. Introduction

Cancer is the second most prevalent cause of mortality worldwide, only heart disease, accounting for one in six fatalities. According to World Health Organisation (WHO) projections, there will be a nearly 70% increase in new cancer cases over the course of the next two decades, with low- and middle-income nations bearing the brunt of this increase [1]. According to a recent prediction by the Indian Council of Medical Research (ICMR), by 2024 there may be over 17 lakh new instances of cancer in India and over 8 lakh cancer-related fatalities. Despite significant government investment and valiant efforts to reduce mortality and increase survival rates through cancer research, cancer remains one of the world's most destructive diseases [3]. The word "cancer" is well known these days. The majority of us are aware of at least one person who has been diagnosed with cancer—be it a friend, colleague, neighbour, or cousin. Many people believe that the number of cancer cases is significantly rising [2], which they attribute to a rise in environmental toxins. Gene alterations cause aberrant cells to proliferate and divide abnormally and uncontrollably, leading to the complex disease known as cancer [6]. Cancer cells exhibit specific characteristics as a result of mutation, such as proliferation, resistance to signals that limit their growth, and resistance to signals that signal the end of a cell's existence. It is challenging to treat this illness because of

these features. A set of disorders known as cancer share similar features in that their cells grow unnaturally and uncontrolled, defying the laws of normal cell division. Cancer is mostly caused by a combination of internal (inherited mutations, hormones, immunological conditions, and mutations resulting from metabolism) and external (tobacco, infectious organisms, chemicals, and radiation) causes. These causative variables may work in concert or sequentially to start or accelerate the growth of cancer [11]. All of the body's living cells are susceptible to cancer, which can strike people of any age or gender. A cancer diagnosis frequently results in catastrophic personal health costs. Such expenses could push the family's total financial situation below the poverty line [9].

The rest of the paper is organized as follows: Section 2 provides the classification scheme for the survey; Section 3 provides an overview of proposed architecture. Section 4 provides a summary and comparison of the results of the various papers discussed in this taxonomy. Finally, Section 5 concludes the paper.

2. Literature Review

Nanoscience and technology are receiving unprecedented levels of interest due to their promising potential to virtually revolutionise any area in which they are used. Because of this, researchers have only just become interested in using biofunctionalized noble metal nanoparticles in drug delivery systems [4]. Functionalized noble nanoparticles can function as medications or drug vehicles and have a wide range of uses in pharmaceutical and medical research, thanks to the recent and exciting development of nanotechnology-based drug delivery. One of the most important factors to take into account in noble metal-based drug delivery systems is the safe and advanced manufacturing process. It is a great idea to apply green chemistry principles, such as bio-route production of medicinally beneficial functionalized metal nanoparticles, which is rarely found in practice [5]. Poor ability, short-term stability, and safety issues when using these particles are the issues with the current physical and chemical approaches. Biosynthetic procedures can satisfactorily address these issues. The ultimate goal of producing these bio-routed functionalized noble nanoparticles is to create a medication delivery system and make them helpful for patient formulations that have a high degree of safety and specificity [14]. When utilising these novel drug delivery systems as active ingredients, components, or excipients, the pharmaceutical and biotech sectors exercise extreme caution in order to adhere to safety regulations. Therefore, it is crucial to conduct a thorough analysis of the systemic safety criteria while utilising the novel bio-synthesized nanomaterials [14]. It won't be worthwhile to formulate medications for the future if there is only a slight improvement made to the drug's parameters or the delivery mechanism, as is done traditionally. However, there is little doubt that nanotechnology has the potential to improve things since it greatly boosts safety and efficacy [7]. For instance, functionalized gold nanoparticles can be employed as a carrier for other drugs from the injection site and as an effective contrast agent for diagnosis and treatment.

Nanotechnology has shown to have a lot of promising applications in drug delivery systems. In contrast to traditional approaches, the nanotechnology-focused medication delivery system will expand quickly if we prioritise the proper fabrication and manufacturing of materials.

3. Nanotechnology In Cancer

Generally speaking, nanotechnology is a multidisciplinary scientific field that is constantly growing. The phrase nanotechnology comes from the Greek word "nano," which meaning "dwarf." It is described as the science and engineering of putting together and building things at the nanoscale, or one millionth of a metre. Nanomaterials' sizes are perfect for boosting oral bioavailability, surface area, drug loading, and other properties like quick onset of therapeutic action. In contrast, traditional medications quickly leave the body, which lowers their concentration at the cancer site.

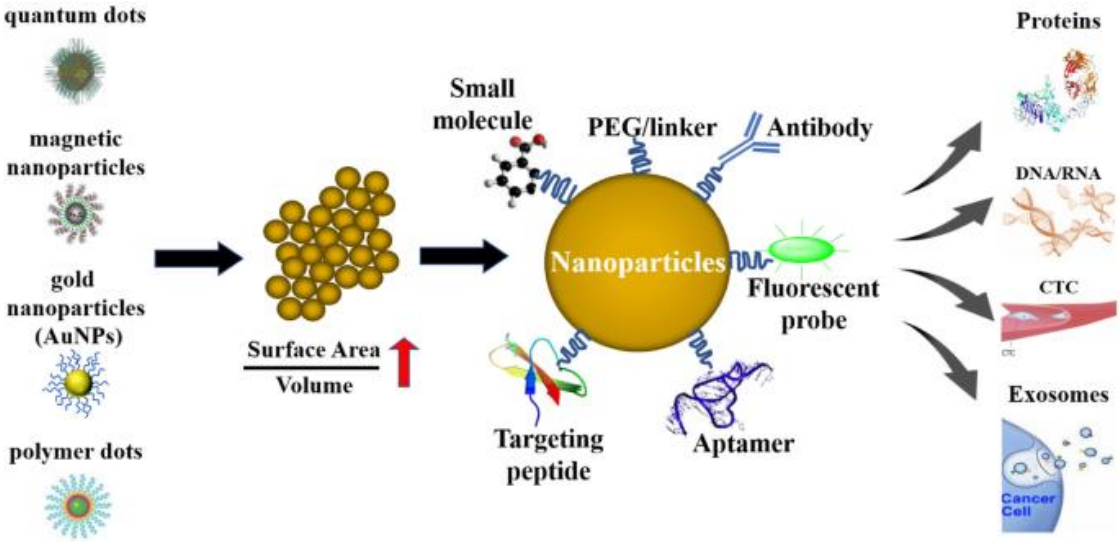

Figure 1: Nano technology in cancer

Drug-containing nanocarriers lengthen their half-lives and circulation times, which increases the quantity of medication that can reach the target site [8]. Because of the enhanced pharmacokinetics, drug distribution, and drug accumulation at the tumour site, anticancer medications in nanoformulations exhibit a higher therapeutic index. The permeability of nano-sized systems into cancer sites is higher because the vasculature at tumour sites is leaky. A smaller size makes it easier to administer drugs topically, transdermally, nasally, orally, parenterally, and intraocularly. As a result, nano drug delivery devices have the potential to be effective cancer treatment instruments. Many nanostructures have been investigated for the treatment of cancer, including vesicular systems (liposomes, niosomes), biodegradable polymers, lipidic nanoparticles, micelles, carbon nanotubes, and metallic nanoparticles (gold, silver nanoparticles).

4. Green Nanotechnology

When it comes to producing nanoparticles, green nanotechnology offers an advantage over chemical and physical approaches because it is more affordable and easily scalable. Additionally, because it doesn't require harmful chemicals or high temperatures, pressures, or energies, it is environmentally benign. The design of procedures to maximise the quantity of

raw material turned into the product, the use of environmentally friendly compounds, energy-efficient processes, reactions in water, etc. are all included in the concept of green chemistry [13].

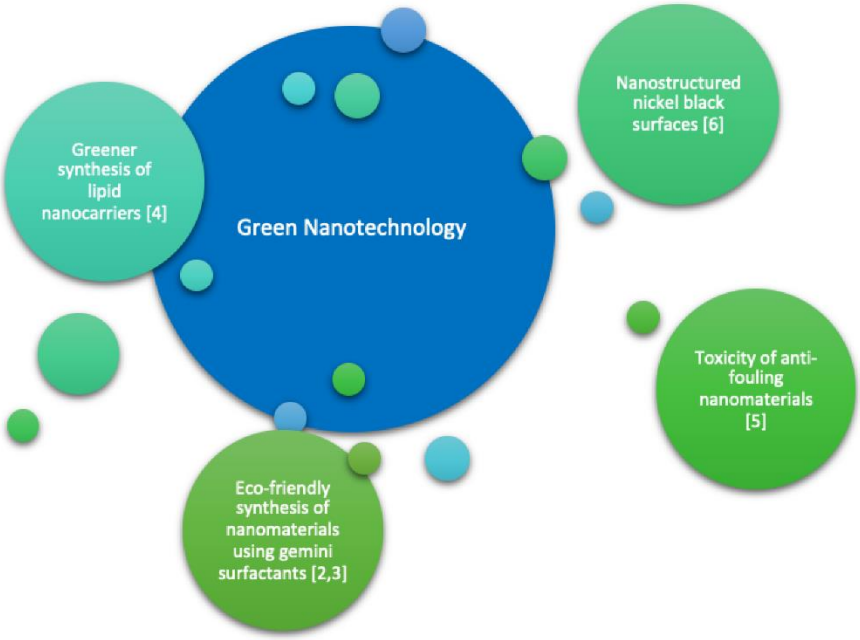

Figure 2: Green nanotechnology

The most popular way for creating nanoparticles is the chemical method, but its uses are limited because it may require costly and hazardous monomers as well as reducing/stabilizing agents. Furthermore, in biomedical applications, these produced nanoparticles might have detrimental impacts. Thus, it is imperative that cost-effective, environmentally friendly nanotechnology-based methods be developed without utilising dangerous processes or poisonous substances.

Mechanisms of drug targeting

Increasing the amount of medication accumulated at the tumour site is essential for the efficacy of cancer treatment. Once the medicine reaches the tumour site, it must be precisely concentrated in order to reach the malignant tissue. To lessen toxicity and negative effects, it is necessary to eliminate cancer cells selectively while protecting healthy organs. Passive and active processes are the two ways that help drug-loaded nanoparticles get to the tumour location.

- Passive drug targeting

As shown by Maeda and Matsumura [10], in passive targeting, nanosized drug delivery devices take advantage of features of the tumour vasculature to accumulate in the neoplastic site through the increased permeability and retention (EPR) phenomenon. The pathologic traits of leaky vasculatures and lymphatic drainage are key components of the EPR idea. EPR facilitates the penetration of circulating nanoparticles into cancer tissues while keeping healthy

tissues safe. The majority of the time, biopolymers like polyethylene glycol (PEG) are used to surfacecoat nanoparticulate delivery systems for passive targeting in different cancer types. Determining the amount of nanoparticle accumulation in cancer tissue is challenging since it depends on a variety of parameters, including the size, shape, and zeta potential of the individual particles. As a result, a tiny portion of the dose that is given accumulates in the target location, severely limiting the effectiveness of passive medication targeting. These days, active medication targeting is concentrated in light of these constraints.

- Active drug targeting

The goal of active drug targeting is to deliver medication just to the tumor's tissues. The targeting moiety or ligand is affixed to the nanocarrier surface in this targeting approach. These moieties recognise the epitopes unique to tumours and facilitate the binding of nanocarriers to these receptors, which are often overexpressed at the location of cancer growth. These particular receptors are indicators for tumours and are either not expressed in healthy or normal cells, or they are expressed at reduced levels. A significant number of targeting moieties are required for the effective targeting of nanoparticles at the tumour location. Currently, there are several methods for creating active targeting drug carriers, and a wide range of moieties—such as proteins, small compounds, aptamers, monoclonal antibodies, and nucleic acids—that precisely recognise overexpressed receptors on cancer cells are at hand.

5. Conclusion

Cancer is still a disease that can be fatal everywhere. In underdeveloped countries like India, it is the third most fatal illness. The patient's suffering is increased by the exorbitant cost of current therapies and medications. Strong, affordable, and readily available medicines are desperately needed for cancer treatment and prevention. The proposed research project aimed to develop an efficient and environmentally friendly (using natural entities instead of synthetic drugs, using fewer organic solvents, etc.) cancer treatment system that could identify and target only cancerous cells while sparing healthy body cells. Numerous efforts are being undertaken to aid in the prevention of cancer, and as a result of their availability, safety, and widespread acceptability, the use of natural ingredients as chemotherapeutic and preventative agents has increased.

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