An Evaluation of Nanotechnology in the Field of Medicine

Dr. Jalari Ramu[1*]

***Associate Professor of Biochemistry, School of Medicine, WSU Teaching and Referral Hospital, Ministry of Health, Ethiopia.**

Corresponding Author:

***[1]Email ID: ramujalari@gmail.com**

Mobile: +91-9492633090

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Abstract: Nanotechnology involves exploring systems at the molecular and cellular levels, with a primary focus on science and engineering at a minuscule scale, specifically within the Nanoscale (approximately 1-100 nanometers). Nanotechnology enables a comprehensive understanding of the foundational elements of physical sciences, analytical chemistry, and, predominantly, molecular biology, especially when examining objects of exceedingly diminutive size. Contemporary scientists are designing nanomaterials with increased strength, reduced weight, and enhanced chemical reactivity compared to their large-scale counterparts. This innovative approach facilitates the creation of nanomaterials showcasing superior properties, significantly contributing to advancements in various scientific and technological domains. The current scientific landscape benefits from the transformative potential of nanotechnology, as researchers persist in pushing the boundaries of what is achievable at the nanoscale, shaping the future of scientific exploration and technological progress.

Keywords: Nano-science, Medical Nanotechnology, Biomedical Devices.

Introduction

The intersection of nanotechnology and medicine presents captivating opportunities for research and significant advancements in Science and Technology. Ongoing investigations in medical-related fields promise to unravel new dimensions in the synergy between these disciplines. Nanomedicine, a specialized branch of nanotechnology, not only provides a promising avenue for research but also holds the potential to introduce a valuable array of research tools and clinically useful devices in the foreseeable future [1-7]. The focal point of nanomedicine revolves around nanomaterials, biological devices, and nanoelectronics biosensors, extending the applications of molecular-related nanotechnology to include biological tools and machines. However, a prominent challenge faced by nanomedicine pertains to issues related to the toxicity and environmental impact of nanoscale materials [8-15]. As researchers delve deeper into the realm of nanomedicine, addressing these challenges becomes imperative to ensure the safe and effective integration of nanotechnologies innovations into the domain of medical science. The continuous exploration of these opportunities and challenges underscores the dynamic nature of the evolving relationship between nanotechnology and medicine.

Advancement in Drug Delivery through Nanotechnology

Recent advancements in Nanoscience, Nanophysics, and nanotechnology signify groundbreaking progress, setting the stage for a transformative era. In this landscape, Nanomedicine emerges as a pivotal contributor to the future of Science, Technology, and Medicine [16-20]. Its importance is derived from the potential applications it holds across various domains, specifically in improving the quality of life and introducing a new era in the field of Medicine. Nanomedicine employs nanoparticles as carriers for drug delivery, utilizing diverse modalities like heat, light, or other substances to selectively target tumor-related cells responsible for cancers or carcinoma. Specifically engineered Nano Particles are tailored to attract and treat diseased cells, thereby reducing side effects on healthy cells and facilitating the early detection of cancer [21-27]. Illustratively, nanoparticles are designed to exclusively target cancer cells, avoiding healthy ones. Ongoing research explores nanomaterials for efficient cancer detection, acknowledging potential life-threatening implications. Companies and research organizations seek patient consent for the seamless delivery of nanomaterials, aiming for direct utilization in cancer patients without adverse effects. Rigorous trials are underway globally, conducted by various research groups, companies, and organizations, to ensure the safe release of drugs into cancer cells, minimizing side effects on patients [28-34]. A global collaborative effort is underway among researchers to develop orally administered medically related nanoparticles that traverse the digestive system, releasing into the bloodstream. Extensive investigations are being conducted on lab animals, such as lab mice, to refine drug delivery methods to target specific cells [35-40]. In essence, the ongoing developments in Nanomedicine, driven by nanotechnological innovations, hold immense promise for revolutionizing healthcare practices. These strides not only present opportunities for advanced drug delivery systems but also underscore a commitment to ensuring the safety and efficacy of these transformative technologies in the pursuit of improving global health outcomes.

Nanotechnology Applications in Therapeutic Techniques

Nano sponges, a recent advancement in nanotechnology, serve a pivotal role in absorbing toxins from the bloodstream and effectively eliminating them. Coated with a red blood cell membrane, these nano sponges can freely traverse the bloodstream, primarily attracting toxins [41-46]. For noninvasive and other surgeries, researchers have showcased a method involving the generation of powerful sound waves precisely focused on target cells. Using a lens coated with carbon nanotubes, this study aims to convert laser light into focused sound waves. The primary goal is to ensure drugs reach target cells while sparing healthy ones, preventing tissue damage [47-54]. Several investigations are in progress on the use of bismuth nanoparticles for the treatment of cancer tumors and carcinomas. Initial findings suggest that these nanoparticles can maximize radiation doses to tumors while minimizing side effects [55-58]. Polyethylene glycol-hydrophilic carbon clusters (PEG-HCC) play a crucial role in absorbing free radicals from proteins and amino acids. By absorbing free radicals, PEG-HCC may mitigate the harm caused by the release of free radicals following brain-related injuries [59-63]. Targeted heat therapy is employed in treating breast-related cancers. In this approach, antibodies strongly bind to proteins in a specific type of breast cancer cell attached to nanotubes, causing the nanotubes to accumulate at the tumor site [64-69].

Application of Nanotechnology in Diagnostic Procedures

For the examination of nitric oxide levels, carbon nanogels are injected beneath the skin, contributing to the crucial role of nitric oxide in bodily inflammation and the straightforward monitoring of inflammatory diseases. Continuous investigations are centered on developing sensors specifically designed to identify minute quantities of cancer cells or cells that induce tumors in blood samples [70-73]. Presently, the early detection of cancer cells has become a streamlined process. Nanoparticles tightly bind to blood molecules, serving as markers for the initial stages of infection that may lead to cancer. In this method, the sample undergoes scanning for nanoparticles to enhance the Raman signal, enabling the practical identification and destruction of cancer-causing cells [74-82]. Nanorods ease the detection of kidney damage. Proteins released by the kidneys adhere to the nanorods, aiding in the identification of cancer-causing cells and the destruction of tumor cells [83-86]. This innovative approach holds promise for enhancing diagnostic capabilities and advancing early intervention strategies in various medical conditions.

Application of Nanotechnology in Antimicrobial Methods

Scientists are actively engaged in the development of an antimicrobial technique utilizing nanoparticles and infrared light rays, with the primary objective of eradicating bacteria. This innovative approach holds particular significance in the context of cleaning instruments, especially within hospital settings, and contributes to the effective management of biomedical wastes [87, 88]. Concurrently, ongoing studies are delving into the potential use of quantum dots to combat antibiotic-resistant infections. Additionally, there is a focus on exploring the application of polymer-coated iron oxide nanoparticles for the treatment of chronic bacterial infections. In the realm of wound care, Nano crystalline silver serves as an effective antimicrobial agent. The use of nanoparticle cream has shown effectiveness in combating microbial infections. This cream utilizes nitric oxide gas to actively combat bacteria, thereby reducing the incidence of bacterial-related infections. Another notable advancement involves the use of nano capsule-coated burn dressings, representing a significant leap forward in nanotechnology integrated with antibiotics. These specialized burn dressings play a crucial role in both the treatment and prevention of infections, offering a notable reduction in the frequency of dressing changes and contributing to the overall effectiveness of infection management [89-91]. This collective progress underscores the diverse applications of nanotechnology in advancing antimicrobial techniques and addressing various medical challenges.

Application of Nanotechnology in Cellular Repair

Nano robots, a recent advancement in nanotechnology, have become crucial in targeting specific disease-causing cells and facilitating natural healing processes. Their primary applications are concentrated in the healthcare sector, with a particular emphasis on the fascinating field of cellular repair, presenting the potential to mend our bodies at the cellular level. Various techniques for constructing nanorobots are currently in development, holding the promise of enabling sophisticated cell repair methodologies [92-94]. The capabilities of nanorobots extend to repairing damaged DNA and promoting the proper functioning of other cells. Operating at the cellular level, these nanorobots precisely target and impair diseased cells, thereby preventing their proliferation into tissues and impeding the development of tumor cells at the cellular level [95,96]. This signifies a remarkable advancement in medical technology with the potential to revolutionize treatment modalities and enhance our ability to address complex cellular issues for improved health outcomes.

Conclusion

A nanoparticle demonstrates significant efficacy in precisely delivering drugs to target cells, mitigating damage to healthy cells. This capability is harnessed by a burgeoning branch of nanotechnology dedicated to treating specific diseased cells while preserving the integrity of healthy cells. The growing interest in nanotechnology in recent years stems from its potential to overcome challenges associated with gene and drug delivery. Researchers have extensively explored various nanomaterials with diverse compositions, encompassing a range of chemical and biological properties, to advance drug and gene delivery applications. This comprehensive strategy shows potential for transforming targeted therapeutic interventions in the field of medicine.

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