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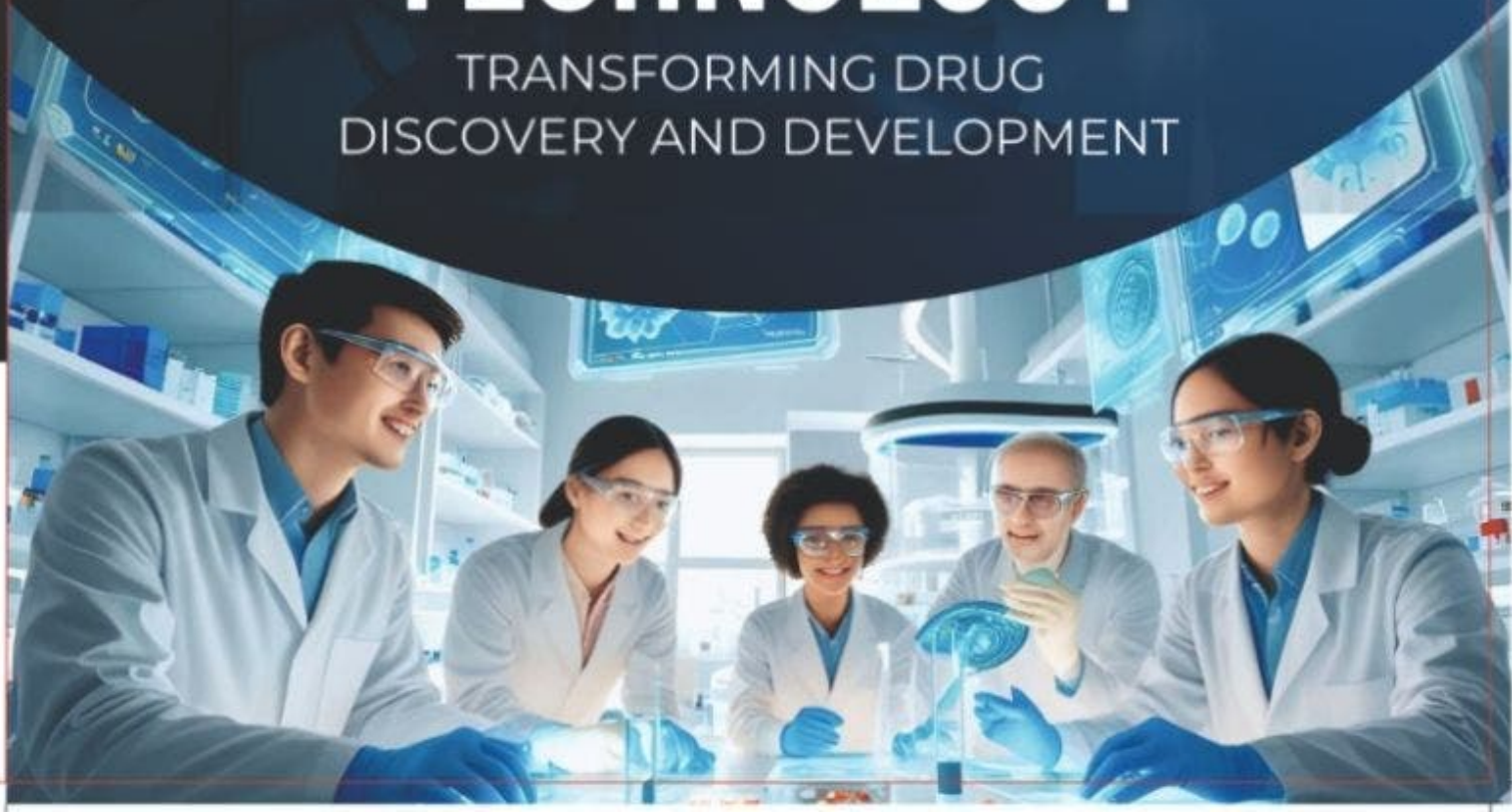
INNOVATION IN PHARMACEUTICAL TECHNOLOGY

TRANSFORMING DRUG DISCOVERY AND DEVELOPMENT



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NANOTECHNOLOGY IN DRUG DELIVERY SYSTEMS

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ABSTRACT : Nanotechnology has revolutionized drug delivery systems; now, therapeutic intervention can be targeted, efficient, and controlled. Traditional methods of administration of drugs often suffer from multiple disadvantages, such as poor bioavailability, non-specific distribution, and systemic toxicity. Nanocarriers such as nanoparticles, liposomes and dendrimers offer solutions to enhance the solubility and stability of drugs through selective targeting, thus improving the efficacy of drug therapy while reducing adverse effects. The main goals of nanotechnology-based drug delivery include optimizing the kinetic release of the drug, enhancing bioavailability, and allowing for site-specific delivery. The delivery is facilitated through the exploitation of both passive and active targeting mechanisms, namely the Enhanced Permeability and Retention (EPR) effect and ligand-mediated targeting, respectively. The strategies of controlled release, such as pH-sensitive, temperature-sensitive, enzyme-sensitive and redox-sensitive systems, enable the accurate delivery of drugs to diseased tissues while maintaining exposure as low as possible in the systemic circulation. Nanocarriers are promising in clinical applications, especially in cancer therapeutics, where they enhance the accumulation of drugs into the tumor. They reduce multidrug resistance and allow combination therapies. They permeate the blood-brain barrier in neurological disorders and improve drug delivery efficiency in conditions like Alzheimer's and Parkinson's disease. As such, they are emerging as promising tools for gene therapy, infectious disease management and regenerative medicine, too. Its large-scale production challenges the very issues of nanomedicine itself because of stability issues, regulatory aspects and eventual long-term toxicities. Future outlooks may include multifunctional and stimuli-responsive nanocarriers, self-assembling systems, and personalized medicine approaches tailored to the patient's specific profile. Nanotechnology-driven perspectives ensure that nanotechnology will soon take over the future of drug delivery, especially in terms of effectiveness, precision and compliance with patients on treatment. Modern medicine will be completely transformed by innovative nanocarriers through new advancements in material science and bioengineering, making treatments safer and more effective in handling the disease.

Key words : Nanotechnology, drug delivery system, self-assembling systems, modern medicine.

Introduction

Nanotechnology the manipulation of matter at the nanoscale 1 to 100 nanometers has revolutionized various fields and especially medicine. Since the surface-to-volume ratio of materials becomes incredibly high and there are strong quantum effects that often enhance their reactivity at the nanoscale, significant advancement in the diagnosis, therapeutic delivery, and treatment of drug administration has become feasible (Bhushan, 2017). Therefore, in the realm of medicine, the promise lies more in challenging problems of drug delivery and