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ROLE OF NANOTECHNOLOGY IN HIV/AIDS TREATMENTS (A REVIEW)

Baaris bashir lone*[1], Kamlesh Mistry[2], Tanya Sharma[3], Dhananjay Mistry[4], Noorul Huda[5]

[1]Research Scholar, Faculty of Pharmaceutical Science, Mewar University, Gangrar, Chittorgarh 312901, Rajasthan, India.

[2]Associate Professor, Department of Pharmacy, Faculty of Pharmaceutical Science, Mewar University, Gangrar, Chittorgarh 312901, Rajasthan, India.

[3]Assistant Professor, Department of Pharmacy, Faculty of Pharmaceutical Science, Mewar University, Gangrar, Chittorgarh 312901, Rajasthan, India.

[4]Lecturer, Department of Pharmacy, Faculty of Pharmaceutical Science, Mewar University, Gangrar, Chittorgarh 312901, Rajasthan, India.

[5]Assistant Professor, Department of Pharmacy, Faculty of Pharmaceutical Science, Mewar University, Gangrar, Chittorgarh 312901, Rajasthan, India.

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***Corresponding Author: Baaris bashir lone**
Research Scholar, Faculty of Pharmaceutical Science, Mewar University, Gangrar, Chittorgarh 312901, Rajasthan, India.

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ABSTRACT

HIV/AIDS is one of the worst crises affecting global health and influencing economic development and social stability. Preventing and treating HIV infection is a crucial task. However, there is still no effective HIV vaccine for clinical application. Nanotechnology has the potential to solve the problems associated with traditional HIV vaccines. At present, various nano-architectures and nanomaterials can function as potential HIV vaccine carriers or adjuvants, including inorganic nanomaterials, liposomes, micelles and polymer nanomaterials. In this review, we summarize the current progress in the use of nanotechnology for the development of an HIV/AIDS vaccine and discuss its potential to greatly improve the solubility, permeability, stability and pharmacokinetics of HIV vaccines. Although nanotechnology holds great promise for applications in HIV/AIDS vaccines, there are still many inadequacies that result in a variety of risks and challenges. The potential

hazards to the human body and environment associated with some nano-carriers, and their underlying mechanisms require in-depth study. Non-toxic or low-toxic nanomaterials with adjuvant activity have been identified. However, studying the confluence of factors that affect the adjuvant activity of nanomaterials may be more important for the optimization of the dosage and immunization strategy and investigations into the exact mechanism of action. Moreover, there are no uniform standards for investigations of nanomaterials as potential vaccine adjuvants.

KEYWORDS: Antibiotic stewardship; Antibiotic resistance; Artificial Intelligence; Acquired Immune Deficiency Syndrome; Anti-Retroviral drugs; Dapivirine (PubChem CID: 214347); Dendrimers; Efavirenz (PubChem CID: 64139); Etravirine (PubChem CID: 193962); Maraviroc (PubChem CID: 30.

INTRODUCTION

Acquired Immune Deficiency Syndrome (AIDS) is a severe health issue and a rapidly spreading incurable condition. It appeared for the first time in the USA in 1981. The virus that causes AIDS was identified by CitationGallo et al. (1984) in the USA. AIDS is a disorder related to cell-mediated immunity of the organism. There is a decreased number of helper T-cells, which activate the B-cells to produce antibodies. AIDS develops as a result of infection by the Human immunodeficiency virus (HIV), which is an RNA virus. The virus was called differently in the literature, namely, human cell leukemia virus-III (HCLV-III), human T-lymphotrophic virus III (HTLV-III), lymphadenopathy-associated virus (LAV), and finally HIV in 1986 by the International Committee on taxonomy of virus (CitationClercq 2009).

The concept of nano-medicine implies the use of nanotechnology (the application of nanoparticles in medicine) for treatment and diagnosis of diseases. Nanoparticles enhance the pharmacokinetics and tissue distribution of drug molecules, thus decreasing toxicity through the preferential accumulation of drugs at the targeted site. Moreover, they increase the efficacy of drugs by promoting intracellular transport and prolongation of their retention in the cell or bloodstream.

At first glance at the composition of the outer layer of the

Defining Nanotechnology

The age of nanotechnology is here and this technological revolution is moving very fast. Nanotechnology, a collective word for the ever-evolving field of technology that utilizes matter manipulated at sub-microscopic levels, includes structures, devices, assemblies, and

several drug delivery systems operating under the scale range of 1 nanometer (nm) to 100 nm.

It has become clear that progress towards a new covalent complexity leads to new.

Nanotechnology-based drug delivery systems for HIV-AIDS treatment

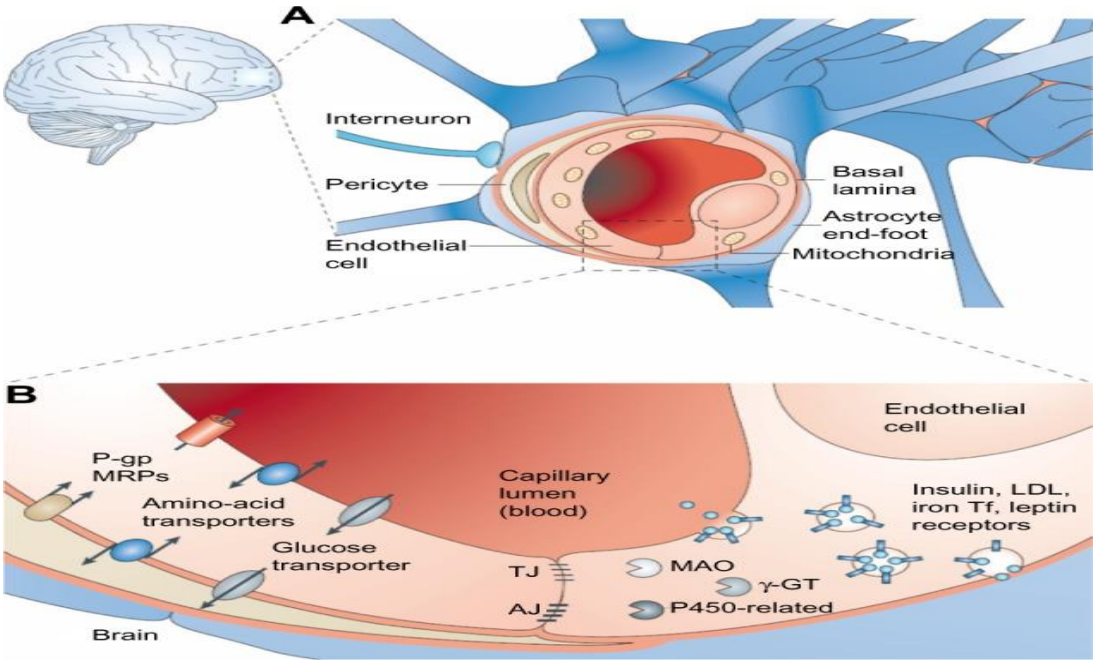
Nanotechnology denotes technological innovation in the domain of pharmaceutical drug delivery systems. According to the principle of nanotechnology, the pharmacokinetics of an encapsulated compound need to be altered so that it becomes valuable enough to effectively eliminate HIV. Once the ARV drug is encapsulated within the nano-formulation, it does not depend on the physicochemical properties of the drug, but on the physicochemical features of the nano-formulation, such as molecules present on its surface and electric charges as well as its size (CitationLi and Huang 2008, CitationLaVan et al. 2002). The incorporation of nanotechnology into drug delivery system for ARVs has great prospects in curing HIV because it can alter the tissue distribution of drugs and increase their half-lives (CitationAmiji et al. 2006).

Nanotechnology Approaches for HIV/AIDS Treatment

Currently, there is no cure for HIV/AIDS; without treatment, infection with HIV leads to death within a period of 5-10 years. In this case, lifetime treatments have been employed to increase expectancy and improve the quality of life of HIV patients. Currently, the treatment for HIV/AIDS entails the use of antiretroviral therapy or highly active antiretroviral therapy in which a combination of three or more antiretroviral drugs is applied. Looking at the replication process of HIV, as well as the molecular target sites of HIV, a large number of orally administrable antiretroviral drugs have been developed and used in highly active antiretroviral therapy.

Drug delivery to the CNS: focus on nanotechnology

The CNS represents an exceptional and highly complex milieu with limited physical accessibility owing to structures like brain barriers. The BBB represents a highly dynamic interface between blood and the brain that exerts neuroprotective actions, facilitates the influx and efflux of various molecules/cells from the brain, and controls the microenvironmental homeostasis of the brain.51,52 The limited accessibility in particular arises from the TJs formed by the endothelial cells of the blood vessels in proximity to the brain.



IN Vitro BBB Model

The vitro BBB model involved the use of in vitro primary cultures of both BMVECs (Cat# ACBRI-376) and normal human astrocytes (NHAs, Cat# ACBRI-371) that were provided by Applied Cell Biology Research Institute (ACBRI) Kirkland, WA. Characterization of BMVECs showed that more than 95% of cells expressed cytoplasmic von Willibrand's factor/Factor VIII. The BMVECs were grown in serum-free media CS-C (ABCRI, Cat # SF-4Z0-500) with attachment factors (ABCRI, Cat # 4Z0-210) and Passage Reagent Group™ (ABCRI, Cat # 4Z0-800). NHAs were grown in the serum-free CS-C media containing 10 µg/ml of human epidermal growth factor, 10 mg/ml of insulin, 25 µg/ml of progesterone, 50 mg/ml of transferrin, 50 mg/ml of gentamicin, 50 µg/ml of amphotericin-B, and 10% of FBS.

CONCLUSION

To conclude, it is necessary to note that the complexity of viral latency is emphasized and its key importance in ensuring the survival and reproduction of such viruses as herpesvirus, HIV, HPV and others is explained. Studying different types of latency mechanisms shows how complicated are the processes viruses go through to survive and resist elimination when integrated into or co-existing with the host genome. Such information is very important due to the fact that currently the biggest problem faced in fighting with latent viruses, especially in case of HIV, is to get rid of the reservoir of latently infected cells. The development and improvement of the concept of nanoparticles and nanotechnologies, including various methods for delivering drugs, gene editing, and vaccination, is a great perspective in treating

patients suffering from viral infections. In terms of viral latency, nanoparticles possess the ability to be delivered directly into virus-infected cells while allowing for epigenetic and genetic interventions which are able to reactivate viruses and provoke the immune response against them. The combination of nanoparticles with molecular research and treatment techniques can become a breakthrough in the field of antiviral treatments.

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