Journal of Drug Delivery Science and Technology 41 (2017) 260–268

Contents lists available at ScienceDirect

Journal of Drug Delivery Science and Technology

journal homepage: www.elsevier.com/locate/jddst

Recent advances in nanoparticle-mediated drug delivery

Bipul Kumar, Kanika Jalodia, Pradeep Kumar, Hemant K. Gautam*

CSIR- Institute of Genomics and Integrative Biology, Sukhdev Vihar, Mathura Road, Delhi 110025, India

ARTICLE INFO

Article history:
Received 7 June 2017
Received in revised form
24 July 2017
Accepted 27 July 2017
Available online 28 July 2017

Keywords:
Nanoparticles
Drug delivery system
Targeting
Liposomes
Dendrimers
Pharmaceuticals

ABSTRACT

The engrossment towards controlled drug delivery seeks the development of suitable drug carriers that can transmit a sufficient dose of the drug to diseased lesions. Various nanostructures including liposomes, polymers, dendrimers, and magnetic nanoparticles have been tested as carriers in drug delivery. Nanoparticles make it possible to achieve improved delivery of drugs which are poorly soluble in water by delivering drug of small particle size allowing faster dissolution in blood stream leading to targeted drug delivery in a cell- or tissue-specific manner. This article provides an overview of the recent developments in the preparation and use of nanoparticles in drug delivery.

Contents

* Corresponding author.
E-mail address: hemant@igib.res.in (H.K. Gautam).

http://dx.doi.org/10.1016/j.jddst.2017.07.019
1773-2247/

1. Introduction

To overcome the limitations and drawbacks of conventional drug administration like limited effectiveness, poor biodistribution, toxicity and lack of sensitivity, controlled drug delivery system is utilized [1]. A comparison of normal and targeted drug delivery is depicted in Fig. 1. In controlled drug delivery systems, the drug is transported to the place of action, increasing its influence on the vital tissues and minimizing its undesirable side effects [2]. Controlled drug delivery is advantageous as it shows improved efficacy, reduced toxicity and improved patient compliance and convenience [3]. In addition, controlled drug delivery system protects drug from rapid degradation or clearance and enhances drug concentration in targeted tissues, therefore, lower doses of drugs are required [1].

Cell-specific targeting is generally achieved by attaching drugs to individually designed carriers [2]. While searching and designing an appropriate carrier for drug delivery, various parameters such as its stability, shelf life, biocompatibility, biodistribution, targeting, functionality, drug incorporation and its release need to be validated [4]. Due to their versatility in targeting tissues, accessing deep molecular targets, and controlling drug release, nanoparticles have a great potential to be employed as drug carriers [5].

Nanoparticles are defined as particulate distribution or solid particles with a size in the range of 10–100 nm [6]. The benefit in nanoparticles designing for drug delivery in the system by controlling the size of particles, surface properties and expulsion of therapeutically active agents in order to achieve the site specific drug action at therapeutically optimal rate [7]. Being small in size, the nanostructures exhibit unique physicochemical and biological properties (e.g., an increased reactive area with an ability to cross cell and tissue barriers) that make them a commendable material for biomedical applications [2]. Nanofiber mats have shown the advantages like high porosity as well as high specific surface areas due to which, it does not only use in drug delivery in the disease condition but also involves to improve the skin quality [8]. Nanoparticles also aid in enhancing the bioavailability of water-insoluble drugs in the system, to carry large payloads, and protect the therapeutic agents from physiological barriers, and also the development of novel classes of bioactive macromolecules (e.g., DNA and siRNA). Certain imaging contrast agents can also be incorporated within the nanoparticles that allow visualization of the site of drug delivery or to monitor the *in vivo* efficacy of the therapeutic agent [9–11]. It has to be acknowledged that not all particles used for medical purposes comply with the recently proposed and generally accepted definition of a size ≤100 nm (The Royal Society and Royal Academy of Engineering 2004). However, this increase in size doesn't affect their biological properties [4]. More than two-dozen of nanotechnology products have been approved by the US Food and Drug Administration (FDA) for clinical use, and many potential nano-products are under clinical and pre-clinical development [12–14] the USFDA approved intravenously administered albumin nanoparticles of size 130 nm which were loaded with paclitaxel (Abraxane™) for cancer therapy [15,16]. It rendered several

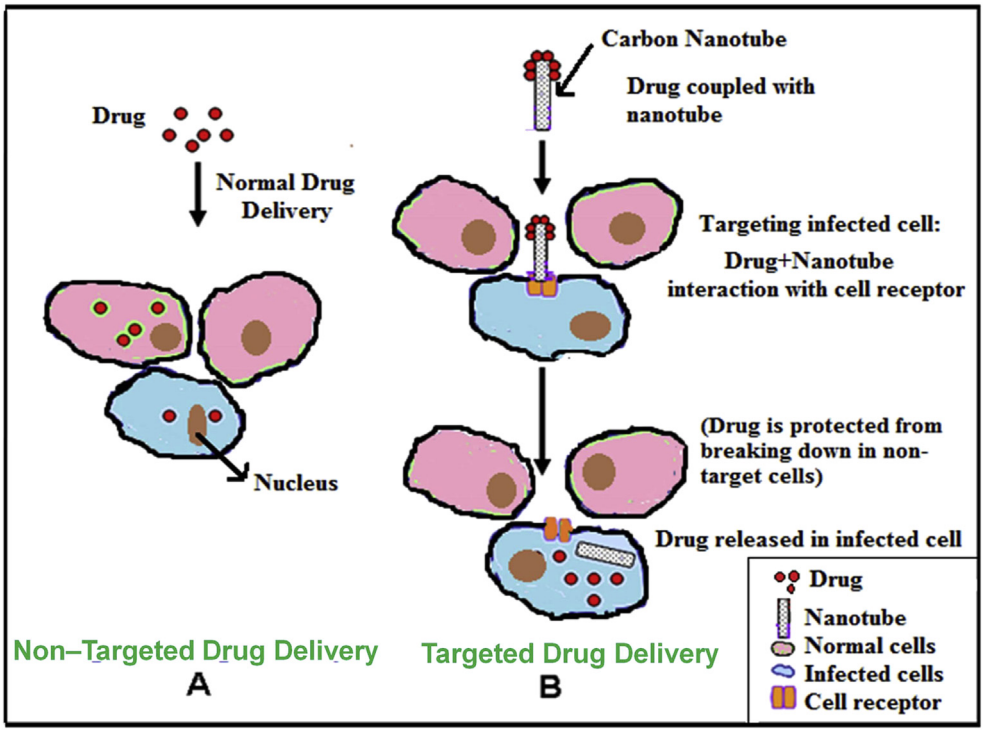

Fig. 1. Schematic presentation of drug delivery approaches. (A) Non-targeted drug delivery, and (B) Targeted drug delivery.