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Review Article

Carbon Nanotubes in Cancer Therapy and Drug Delivery

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Carbon nanotubes (CNTs) have been introduced recently as a novel carrier system for both small and large therapeutic molecules. CNTs can be functionalized (i.e., surface engineered) with certain functional groups in order to manipulate their physical or biological properties. In addition to the ability of CNTs to act as carriers for a wide range of therapeutic molecules, their large surface area and possibility to manipulate their surfaces and physical dimensions have been exploited for use in the photothermal destruction of cancer cells. This paper paper will discuss the therapeutic applications of CNTs with a major focus on their applications for the treatment of cancer.

1. Introduction

The major aim of developing nanocarrier drug delivery systems is to enhance the therapeutic effect or reduce toxicity of therapeutically active materials. This is conventionally achieved using spherically shaped vesicle nanocarriers such as liposomes. Alternatively, carbon nanotubes (CNTs) are essentially cylindrical molecules made of carbon atoms. CNTs are graphene sheets rolled into a seamless cylinder that can be open ended or capped, having a high aspect ratio with diameters as small as 1 nm and a length of several micrometers. CNTs made from a single graphene sheet results in a single-walled nanotubes (SWNT) while several graphene sheets make up multiwalled carbon nanotubes (MWNTs) [1, 2] (Figure 1). Ever since their discovery in 1991 by Iijima [1], there has been intense interest in these allotropes of carbon due to their unique physical and chemical properties and potential applications in a wide range of fields, from electronic devices and sensors to nanocomposite materials of high strength and low weight. Pristine CNTs are not soluble. It was only after the development of strategies to functionalize these molecules with organic groups and render them soluble that opened the way to bioapplications of CNTs. Due to their high surface area, they are capable of adsorbing or conjugating with a wide variety of therapeutic molecules. Thus, CNTs can be surface engineered (i.e., functionalized) in order to enhance their dispersability in the aqueous phase or to provide the appropriate functional groups that can bind to the desired therapeutic material or the target tissue to elicit a therapeutic effect. CNTs might help the attached therapeutic molecule to penetrate through the target cell to treat diseases [3–6] and a recent example of CNTs with a variety of functional groups relevant to cancer therapy [7] is shown in Figure 2. Here, we provide an overview of the therapeutic applications of CNTs with a major focus on their use in the treatment of cancer.

2. Cellular Uptake of CNTs

The cellular uptake of CNTs has been confirmed in a range of studies but the mechanism of CNT penetration into cells is still not well understood. Because of their needle-like shapes,