Carbon nanotubes- liposomes conjugate for advanced drug delivery system

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Abstract

Carbon nanotubes (CNTs) are promising nanomaterials with great potential for biomedical applications, they possess outstanding properties and a unique physicochemical architecture. Owing to their large surface area CNTs can be conjugated with various biological species such as proteins, enzymes, nucleic acids and drugs. In addition, their needle like structure enables them to penetrate cell membrane and be uptaken by cells. However, only a limited amount of drug can be loaded onto the CNT surface [1]. In order to deliver a sufficient amount of drug there is a need to increase the CNT concentration which can cause toxic effect. Liposomes, on the other hand, are one of the most studied and applied drug delivery systems (DDS) which can encapsulate large doses of drug. However, current liposomes and other DDSs suffer from few major limitations, of which the major one is the lack of ability to penetrate cells. In this study we present a solution for this problem in the form of CNT-liposome conjugate (CLC) in which drug-loaded nano-liposomes are covalently attached to carboxyl-functionalized CNTs (Figure 1) [2]. This new platform for drug delivery combines the efficient cell uptake of CNT with the well-known high drug loading capacity of liposomes (Figure 2). In vitro studies proven unequivocally an uptake of the CLC by the cells, as opposed to free liposomes (unattached to CNTs), which have showed relatively low uptake. In addition the CLC have showed about 100 times higher drug dose administration into cells in comparison to direct attachment of drugs to CNT. In order to perform in vivo studies the CLC must be dispersed in the blood, however CLC aggregate in the presence of salts due to charge screening effects. For dispersing the CLC complex in physiological solution the best bio compatible surfactant was found to be bovine serum albumin (BSA). This opens the road for further in vivo testing.

References

[1] Peretz S, Regev O. Carbon nanotubes as nanocarriers in medicine. Current Opinion in Colloid & Interface Science 2012; 17:360-368.
[2] Karchemski F, Zucker D, Barenholz Y, Regev O. Carbon nanotubes-liposomes conjugate as a platform for drug delivery into cells. Journal of Controlled Release 2012; 160:339-345.

Figures

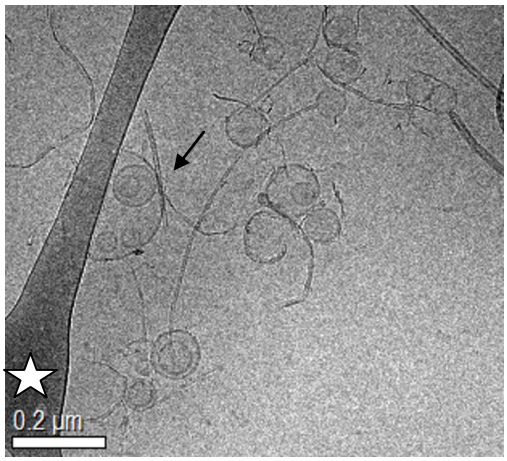

Figure 1: Cryo-TEM micrograph of the CLC complex: The spherical liposomes are covalently attached to oxidized MWCNTs (see arrow). The TEM grid polymer support is starred.

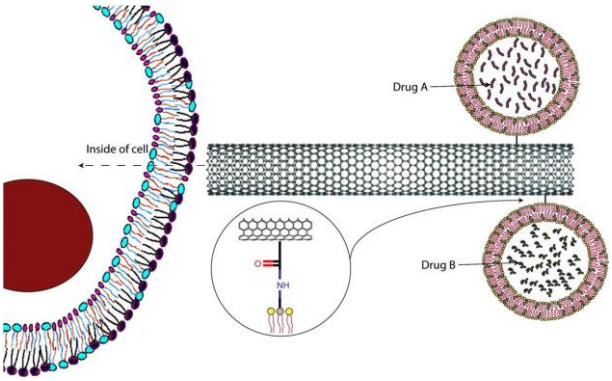

Figure 2: Illustration of CLC penetration into cells.