Functionalized Carbon Nanotube and m-RNA Self-assembly: A Stabilization Perspective

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Abstract

Carbon nanotubes (CNT) have emerged as one of the most advanced material. They offer several appealing features with well-defined physico-chemical properties as well as unique optical and electrical properties. Self-assembly of m RNA and functionalized carbon nanotube would give biostability complex which result in protecting m RNA from various enzymes.

Introduction

Discovery of Carbon nanotube (CNT)[3] as a nanomaterial and its application in different field like biochemical, electronics, biomedical is an attraction today. Refer figure 1. Effective Studies have been going on with functionalized single walled carbon Nanotubes (SWNTs) either covalently or non- covalently interact with nucleic acids[1] and proteins[2,4]. Stability of m-RNA plays a major role in a cell growth, differentiation and overall control of gene expression. To increase the stability of m-RNA and to prevent it from enzymatic degradation we are trying to bind m-RNA with SWNTs. As SWNTs lack chemical recognition[3] we modify SWNTS with carboxyl and hydroxyl group to get functionalized carbon Nanotubes. Refer figure 2. Carboxyl and hydroxyl modified SWNTS would bind with single stranded m-RNA to form a self assemble complex like structure. This interaction could be studied by AFM, SEM, TEM, NMR spectroscopy and circular dichroism.

Experiment to be done

Our experiment basically divided into 4 steps.

1.Functionalization of carbon Nanotubes: carboxyl-modified and hydroxyl-modified SWNTs
2. RNA extraction and identification of m-RNA from total RNA extraction.
3. Reaction between Functionalize carbon Nanotubes and m-RNAs.
4. Check self assembly of Functionalize carbon Nanotubes and m-RNAs by UV melting, Atomic force microscopy (AFM), circular dichroism, NMR studies, SEM, and TEM.

We are planning to get carboxyl modified SWNTs by sonicating the primitive SWNTs in a 3:1 v/v solution of concentrated sulfuric acid (98%) and concentrated nitric acid (70%) for 24 h at 35-40^0 C and washed with water, leaving an open hole in the tube side and functionalized the open end of SWNTs with carboxyl groups to increase their stability in aqueous solution. [6,7,12,13].TEM image of Carboxyl Functionalized SWNTs is present in figure 2.
The hydroxyl modified SWNTs will be obtained by reducing carboxyl-modified SWNTs using lithium aluminum hydride in anhydrous tetrahydrofuran . [5,6,12]

We are trying to extract RNA from plant tissue and from that identification and purification of m-RNA. Furthermore; we will carry out AFM, circular dichroism and NMR by routine methods.[13]

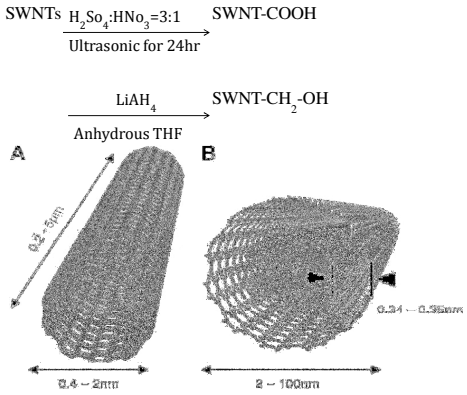

Figure 1:SWNT and MWNT: R.M.Reilly, Journal of Nuclear Medicine ,48(7),2007.

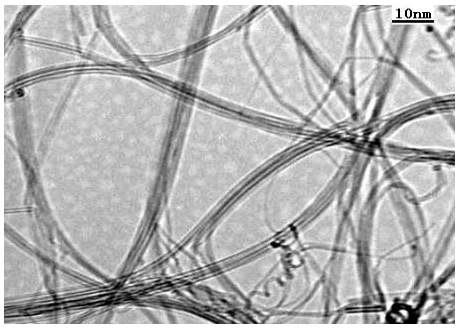

Figure 2: TEM image of functionalized SWNTs with COOH: Robert R.Johnson et al. Nano Letters.8,69(2008).

Application

Medical perspective: The greater the stability of an mRNA the more protein may be produced .So in particular disease which is because of protein deficiency or lack of protein. We can provide stabilize m- RNA into body so body can produce that protein. Thus we can design a new class of RNA targeted therapeutics. [10,11] Example:
Stabilization of insulin mRNA in response to glucose is a significant component of insulin production. [9]

Research perspective: For long term storage of mRNA in research perspective and as sequence storage. Example: m-RNA stability is of importance to biotechnology- Unaltered Bt toxin genes produce unstable mRNAs in plants.[8]

Future work

Spontaneous Insertion of RNA into Carbon Nanotubes-Encapsulated CNT–RNA molecular complex can be further exploited for applications such as molecular electronics, molecular sensors, electronic RNA sequencing, and nanotechnology of gene delivery systems.

Conclusion

We are expecting binding of Carboxyl and Hydroxyl Functionalized carbon nanotubes with m-RNA which increase the stability of m-RNA and we would protect m-RNA from degradable enzymes. Furthermore; Self Assembly of Functionalized Carbon Nanotubes and m-RNA would provide broad area of application in different field in future.

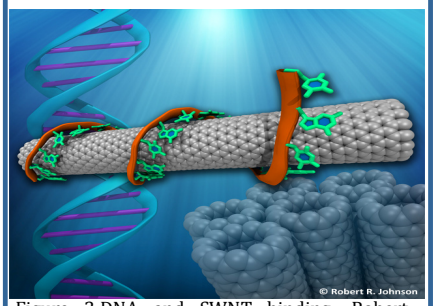

Figure 3:DNA and SWNT binding: Robert R.Johnson et al. Nano Letters.8,69(2008).

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