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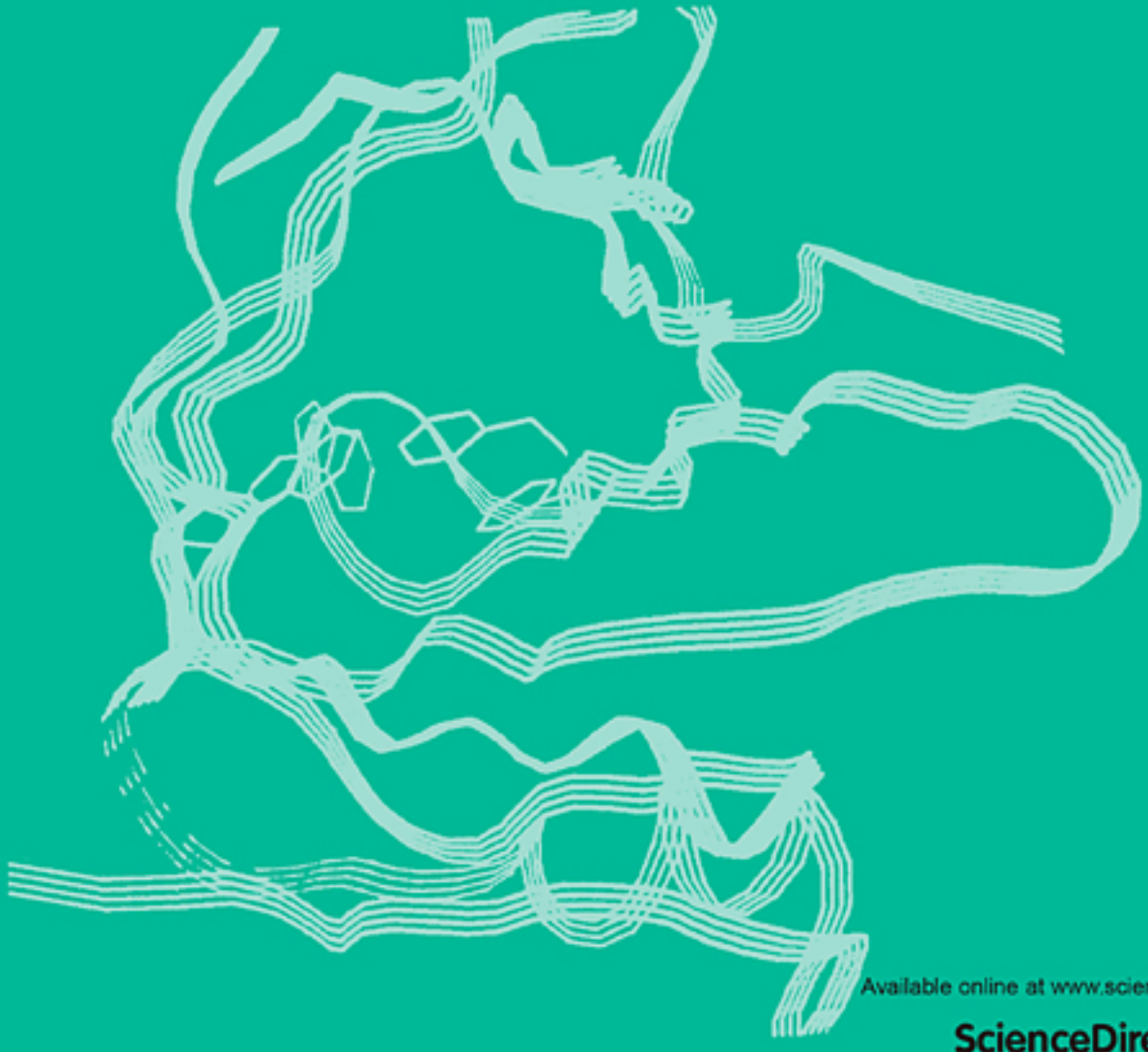

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Preferential photochemical interaction of Ru (III) doped carbon nano dots with bovine serum albumin over human serum albumin

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ABSTRACT

The excitation wavelength dependent emission of carbon nano dots (CNDs) restricts their use in photophysical studies. However, instead of bare CNDs, the amine coated Ru (III) doped CNDs (Ru:CNDEDAs) are quite eligible to generate excitation wavelength independent fluorescence with high quantum yield. Herein, we report a detailed study on the photochemical interaction between two different serum albumins, bovine serum albumin (BSA) and human serum albumin (HSA), with Ru:CNDEDAs synthesized in our laboratory, using steady-state and time-resolved spectroscopic techniques. Absorption study reveals the formation of ground state complex between Ru:CNDEDAs and BSA/HSA while the circular dichroism study implies that Ru:CNDEDAs perturbs the secondary structure of the albumin proteins. Steady-state fluorescence study helps in understanding energy transfer from tryptophan, the fluorophore moiety of BSA and HSA, to Ru:CNDEDAs. Time-resolved studies within nanosecond time domain clarify the phenomenon of energy transfer from BSA/HSA to Ru:CNDEDAs with varied efficiency. Molecular dynamic simulation ascertains that the efficiency of energy transfer is highly dependent on the stability of protein-nanoparticle complex. This study provides a qualitative description regarding the structural rigidity of transport protein, BSA compared to HSA, which determines the transport ability of CNDs to deliver the desired drug molecule to the targeted cells.

1. Introduction

Since last few decades nanoparticles have gained significant interest owing to their unique properties useful for biomedical and chemical applications. In fact, in recent years, nanomaterials are being used as potential competitors to traditional fluorescent dye molecules and subsequently this field of research is developing fast due to extensive demand of fluorescent probe in chemical sensing, biological monitoring, electronic devices and other related fields [1]. The quantum size and other unique effects provide higher stability, slower photobleaching, stronger fluorescence intensity, etc. to the fluorescent nanomaterials compared to the traditional fluorescent dye molecules [2]. Among different kind of nanoparticles the carbon based quantum dots have become the focus of attention because of their chemical stability, excellent water solubility, tuneable fluorescent properties, low cost, low toxicity, good biocompatibility and environment-friendly nature [3–6]. Owing to considerable surface activity, nanoparticles interact immediately with cell surface of proteins, DNA, serum proteins, carbohydrates, etc. while introduced to living systems [7–9]. Recent study of protein interaction with flat surface indicates that distortion of protein takes place upon adsorption that provides a new class of biological entity called 'nanoparticle protein corona' (NP-PC) in the biological milieu [10–18]. The overall NP-PC formation is a multifunctional process and depends not only on the characteristics of the nano particle but also on the interacting proteins and media [19]. Irreversible binding of protein on surface of nanoparticles leads to the formation of 'hard corona' whereas quick or reversible binding of proteins on nanoparticles with faster exchange rates produces 'soft corona' [20–24]. Of late much attention has been paid to the interaction of nanoparticles with plasma proteins [25]. New biomimetic nanoparticles coated with membrane directly derived from RBCs have been synthesized by Zhang et al. [26] and that provides a major breakthrough in nano particle drug delivery system. Such membrane coated nanoparticles have prolonged 'particle systemic circulation half life' than corresponding PEGylated system. It has been reported that gold nanoparticles with increasing concentration are capable of influencing the conformational change of bovine serum albumin (BSA) [27]. Jungbauer et al. thoroughly

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