

Defence Seminar

Seminar Title	: Optimization of metal oxide nanoparticle-induced conformational dynamics of α -Synuclein and RNA with associated flocculation for biological applications.
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Venue	: Life Science Seminar Hall
Date and Time	: 16 Sep 2025 (4:00 PM)
Abstract	: The advent of nanotechnology has been immense in recent times in biomedical research, especially for using metal nanoparticle due to its tuneable size and surface physicochemical properties. The prominence of metal nanoparticles in physiological environment needs to be assessed thoroughly to understand the subsequent changes after its exposure to a multifaceted biological system. The biomolecules as per their affinity and concentrations in the biological system, interacts with the nanoparticle interface, resulting in a continuous process of adsorption and desorption. This leads to formation of dynamic nano-corona that decides dispersivity and cytocompatibility of the nanoparticle. Thus, the interactions of protein or RNA biomolecules (relatively dynamic biomolecules of cytosol) with metal nanoparticle surfaces provides valuable insights about its interfacial behaviour in biological milieu. Moreover, the effect of such interactions help in understanding the associated conformational changes in biomolecules that can either be beneficial or detrimental. The current work explores the influence of metal oxide nanoparticle on conformational dynamics and associated biomolecule-nanoparticle complex formation, i.e., flocs formation. The work initially focused on the interactions of bare and surface functionalised zinc oxide nanoparticles (ZnONPs) with intrinsically disordered protein (IDP), like α -synuclein (α S), which upon misfolding leads to onset/progression of Parkinson's disease. The findings provide insights on ZnONP-mediated mitigation of protein fibrillation propensity and aggregation-mediated cytotoxicity. It was observed that the ZnONP interfaces, with moderated physicochemical properties, efficiently trap α S monomers into nano-corona forming the non-amyloidogenic and non-cytotoxic flocs. Furthermore, the oxidative stress, serves as a critical molecular mediator of different irreversible changes in biomolecules, like glycation, which is anticipated as another pathophysiological mechanism underlying the neurodegenerative disease. The glycation of protein occurs when an aldehyde or ketone group of sugar reacts with the amino group of protein in a non-enzymatic process and the subsequent formation of reactive oxygen species further leads to advanced glycation end-products formation. Therefore, the second objective of the thesis focused on understanding the effect of ZnONP interfaces on moderating α S glycation and consequential formation of toxic intermediates associated with aggregation of the glycated protein. It was observed that α S adsorption onto ZnONP surfaces reduces the extent of glycation by sterically inhibiting the initial interaction between the oxidation-prone amino acid side chains and glycating agents. This occurs by preferentially sequestering α S monomers into nano-corona, forming flocs. The nanoparticle-based moderation of the protein amyloidosis and glycation were predominantly dependent on the biomolecule-induced flocculation by kinetically trapping the molecule in flocs....