INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

This thesis provides a detailed account of how the aggregation behavior of two model proteins, cytochrome C and insulin, is modulated in the presence of intrinsic and extrinsic nanoagents that act as modulators. Under amyloidogenic conditions (pH 9, 75°C, and 192 hours), cytochrome C undergoes self-oxidation, resulting in extensive fragmentation of the protein. These fragments then interact with each other to form aggregates. Additionally, the prosthetic group of cytochrome C, known as heme, dissociates from the holo form and acts as an intrinsic modulator by influencing the structure of cytochrome C. The self-oxidation process leads to the conversion of ferroprotoporphyrin to ferriprotoporphyrin, which further converts to chloro-ferriprotoporphyrin in the presence of Cl- ions, resulting in the formation of fluorescent quantum dots. These quantum dots exhibit lattice planes of Fe_2O_3/ Fe_3O_4/hemin, indicating the formation of a mixed species. In the case of insulin, incubation at 60°C and pH 7.4 for 6 hours, with equimolar Zn2+ concentration, leads to the formation of a dissoluble condensate structure with increased viscosity, a macromolecular network, and shear thickening properties. Extrinsic modulatory nanoagents, including long-length cellulose nanofiber (CNF), iron functionalized CNC (MagCNC), citrate-capped gold nanoparticles (AuNP), and iron (II,III) oxide nanoparticles (IONP), are incubated with the equimolar [Zn2+]:[insulin] reaction mixture. It is observed that the condensate structure undergoes significant changes depending on the properties of the nanoagents, and the nanoparticles themselves undergo transformation. CNF is converted into considerably shorter fibers, which disperse on the condensate surface, leading to the formation of CNR-decorated insulin condensate. MagCNC resolves into ultrafine nanothreads, which form nucleated species within the condensates. These nucleating species then convert into spherical CNCs that are packed within insulin condensate microspheres, resulting in MagCNC-decorated insulin condensate. The metallic nanoparticles, AuNPs, and IONPs, modulate the condensate structure in different ways. Citrate-capped AuNPs interact with amyloidogenic residues of insulin, adsorbing them on the nanoparticle surface and forming dendritic species. These dendritic species interact with each other, creating a reversible condensed assembly presenting AUNPs on the surface. On the other hand, incubation with IONPs leads to the formation of a remarkable two-dimensional nanosheet assembly with ordered surface channels. The IONPs (av. Size 20 nm) oxidizes from Fe_2O_3/ Fe_3O_4 to complete Fe_2O_3 ultrasmall crystallites adhered on the surface. Importantly, all the aforementioned materials demonstrate the potential to support and enhance BHK-21 cell growth without exhibiting any cytotoxicity. Further investigations could pave the way for the development of functional biomaterials with a wide range of applications, from bioelectronics to therapeutics.