

Current Research Projects

Project 1: Understanding the bio-physicochemical interactions of metallic and non-metallic nanoparticles with biomolecules.

Nanoparticles (1-100 nm) are particularly useful in medicine and biology as they are of comparable size to important biological components (e.g. DNA, proteins, cell membranes) with which they interact. Over the last two decades, numerous potential applications of nanoparticles have been reported in biomedical imaging, biosensing, and drug delivery. Despite the considerable progress in the synthesis of nanoparticles with precise dimensions, geometries and surface properties, relatively little is known about the interactions of nanoparticles with biological systems.

Recently, the interaction of nanoparticles with proteins has emerged as a key area of study. Most nanoparticles, upon contact with biological matrices, are immediately coated by proteins leading to the formation of protein corona that largely defines the biological identity of the particle. This protein-nanoparticle interaction might alter protein conformation, expose new epitopes on the protein surface or perturb the normal protein function which could induce toxicity. The adsorbed proteins determine the route of internalization, organ disposition and rate of clearance of nanoparticles from bloodstream. The protein-nanoparticle interactions are important for understanding biodistribution, biocompatibility and therapeutic efficacy of nanoparticles. Currently the mechanism of protein binding on nanoparticles is not well characterized.

This project focuses on characterization of the interactions of model nanoparticles with biomolecules (e.g. proteins, lipids, amino acids) and investigating nanoparticle induced structural and functional changes in biomolecules under physiological conditions.

Project 2: Development and optimization of HPLC method for determination of 2-amino-2-thiozoline-4-carboxylic acid (ATCA), a breakdown product of cyanide.

Cyanide, a naturally occurring chemical found in many plants, is known to be highly toxic. When inside body, cyanide reacts and breaks down quickly making it very difficult to detect. 2-amino-2-thiazolone-4-carboxylic acid (ATCA) is one of the most stable breakdown products of cyanide under physiological conditions. Many spectrophotometric and mass spectrometric (MS) methods have been reported for detection of ATCA that are complex, time consuming and suffer from poor detection limits. 4-Chloro-7-nitrobenzo-2-oxa-1,3-diazole (NBD-Cl) is a fluorescent reagent that reacts readily with amine groups to produce a NBD-tagged amine that can be detected using High Performance Liquid Chromatography (HPLC). Because ATCA contains an amine group, there is a potential that NBD-Cl could be used to label and detect ATCA.

The aim of this project is to develop and optimize a simple, selective, and sensitive HPLC method for determination of ATCA in biological samples.