Title: Exploration Of Biomedically Relevant Spectroscopic Techniques For Potential Clinical Diagnostic And Therapeutic Procedures

Abstract:

The key focus of this thesis is to utilize spectroscopic tools and techniques for the development of novel clinical diagnostic and therapeutic approaches. In one of our studies, we have demonstrated that the conjunctiva could be a target organ to diagnose jaundice independent of race, age, and sex by using a simple diffused reflection measurement technique. Based on the aforementioned principle, we have also developed a noninvasive, easy, expeditious, reliable, and practical device for routine measurement of bilirubin levels. In another study, we have demonstrated that citrate–Mn\textsubscript{3}O\textsubscript{4} nanoparticles (NPs) can catalytically decompose bilirubin to its oxidative break down products quickly without any photo-activation. The remarkable in vitro reactivity of the catalyst towards the suppression of bilirubin level in the whole blood specimens of hyperbilirubinemia patients, without much affecting other important blood constituents has also been represented. Furthermore, we confirmed that citrate–Mn\textsubscript{3}O\textsubscript{4} NPs are safe and effective therapeutic agent for hyperbilirubinemia in mice model based on the in vitro and in vivo assessments of the mechanism and biocompatibility, especially without any toxicological implications. We have also demonstrated the efficacy of evanescent field based strategy in maintenance of controlled bilirubin level in a blood-phantom solution (mixture of hemoglobin and Human Serum Albumin (HSA)). In a prototype experiment we have designed a way to detect the level of bilirubin (diagnosis) and its photodegradation (therapy) simultaneously, using a single fiber. The present research also includes the validation of resonance type energy transfer scheme in a model Förster Resonance Energy Transfer (FRET) based fiber optic sensor for the first time using picosecond resolved Time Correlated Single Photon Counting (TCSPC) technique. The efficacy of the designed fiber sensor for the detection of various dielectric constants of a liquid medium has also been established. In an additional study, we have developed a DNA-based optical fiber sensor for the in situ selective measurement of mercury contamination with parts per billion (ppb) detection efficiency. Impregnated citrate capped silver NPs in a water insoluble DNA-lipid complex at the tip of a multimodal optical fiber is shown to play crucial role in the ultra-sensitive sensing mechanism.

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