CHAPTER - 6

SUMMARY
SUMMARY

DNA based nanotechnology, in many ways, has been one of the most intensively studied fields in recent times that involves the use and the creation of bio-inspired materials and their technologies for highly selective biosensing, nanoarchitecture engineering and nanoelectronics.

Increasing researches on Nanoparticle–DNA interactions and their impact on molecular functionalities offered an understanding of interactions between the nanoparticles and DNA molecules and their influence on DNA molecular structure and biochemical activities.

This study is a research on various aspects associated with nanoparticle–DNA and applicability of the nanoparticle–DNA interaction binding devices in molecular detection. The present research, thus, dwells on studies of nanoparticle and their interaction with nucleic acid.

The chapter I, besides having an abstract contains introduction, literature review aims and objectives of the study. Three different types of nanoparticles have been considered with an aim to study their Interaction in biosensing applications: gold nanoparticles, Silver nanoparticles and Halloysite nanotubes. The focus of the chapter is on the following:-

1. Mechanisms of DNA–nanoparticle binding
2. DNA–gold nanoparticle binding
3. DNA–silver nanoparticle binding
4. Significance of Nanoparticle–DNA binding in medical biotechnology
5. Overview about Halloysite nanotubes as support matrices

The Chapter II describe the interference potential of Halloysite nanotubes with acridine orange and their applicability as support matrices were also studied. Acridine orange is a cationic dye, intercalating within DNA bases and produce carcinogenic effects. It was reported that binding of HNT with can inhibit or reduce binding carcinogenic acridine orange with DNA. The potential mechanism behind
this is through formation of polarization bonding complexes between HNT and the acridine orange. This interaction also renders acridine orange less available for DNA intercalation, in the presence of HNT environment. This study demonstrates the applicability of Halloysite nanotubes as support matrices and offers a platform for the study of biomolecular interactions in diverse application. It also broadens the possibility of using Halloysite nanotubes for development of wide variety of biosensors for broad range of biological and non biological applications.

The Chapter III & IV deals with potential of nanoparticles for the development as biosensor. The role of HNTs (nanotubular structure, high surface area and their abundance) has been studied together with conductive properties of AuNPs and AgNPs in the development of nanocomposites and their ability to use in DNA damage studies. Double and single stranded oligonucleotides (ds-DNA and ss-DNA) show different adsorption behaviour with AgNPs/AuNPs and these binding interactions were monitored by the colorimetric and fluorometric changes to sense the patterning of DNA damage. Using AuNPs/AgNPs and Halloysite based composites, the advantages of HNT's nanotubular support matrices in embedding AuNPs/AgNPs was taken, which ameliorate their DNA binding capacity, and improve their functionality that is required for the development of highly sensitive biosensors.

The chapter V describe the applicability of AuNPs for the development of probe for monitoring DNA and drug interaction. Qualitatively as well as quantitatively, gold nanoparticles were used for estimation of DNA-MTX. Our study confirmed that DNA has affinity for AuNPs but in the presence of DNA and Methotrexate (MTX), competition between DNA and MTX takes place for AuNPs and there will less ds-DNA available for the interaction with AuNPs. Our observation also confirm the possibility to use AuNPs coupled with spectroscopy techniques could be provide a convenient way to characterize both the binding mode and the interaction mechanism of MTX binding to DNA, which is important for the design of new biosensor for examine the toxicity of anticancer drugs. So time is not too far when this strategy will be used for the development of nanoparticle based biosensors.
In conclusion, results have demonstrated that nanoparticles can be used for the potential development of bionanosensor. In order to achieve high sensitivity and enhance the response of DNA biosensors many techniques have been developed but modifying the sensors with different functional materials is the need of time. Due to the diverse properties of different nanoparticles, utilizing two or more types of nanomaterials could enhance the good qualities as well as offset the insufficiency of each individual nanomaterial, which could produce better results than that using only one type of nanomaterials.
Future goals

Gold, Silver, and Halloysite nanoparticles are witnessing the widest variety of applications in medical field. Major obstacle behind implication of nanoparticles in medical field is their unreported molecular interactions and the mechanics behind nanoparticles and DNA binding.

To overcome the limitations associated with currently available diagnosis strategies, an understanding of molecular interactions and mechanisms of nanoparticle-DNA binding are needed urgently. A long term goals of these studies is the development of a universal platform, based on nanoparticle and DNA binding.

The AuNPs and AgNPs can be detected due to their optical and electrical sensitivity and sometimes DNA functionalized AuNPs/AgNPs are fabricated to utilise for the sequence specific detection. These DNA functionalized nanoparticles have major constraints of sensitivity, recovery and aggregation; therefore support matrices can be used. And recently, Halloysite nanotubes has emerged as support matrices with lots of desirable properties like their size, selectivity, higher reactivity and higher cationic exchange which make them an important constituent for biosensor development.

Sometimes two or more nanoparticles can be combined with the intention to enhance the resultant properties of composites so Halloysite nanotubes based composites have great perspectives. Hence, Halloysite nanotubes based metal composites will be a thrust area to develop and utilise it for DNA based biosensors for molecular diagnosis.

Hence, the development of nanoparticles with smaller size and/or with improved biological and chemical properties would substantially raise the accuracy, selectivity and sensitivity of DNA biosensors.