This thesis deals with the research work carried out for the development of novel applications by integrating biomolecules with various nanostructures. The thesis is organized as follows:

Chapter 1 reviews the properties of nanomaterials which are important to consider while developing them for various biological and other applications. It discusses the factors which affect the cytotoxicity of nanocrystals towards living cells, photocatalytic mechanisms of nanocrystals that work behind the inactivation of bacterial cells and gas sensing properties of nanocrystals. It also mentions about the integration of biomolecules with nanomaterials which is useful for the development of biosensors, materials that are presently used for fabricating biosensors and the challenges associated with designing successful biosensors.

Chapter 2 presents the antibacterial and anticancer properties of ZnO/Ag nanohybids. In this study a simple route to synthesize ZnO/Ag nanohybrids by microwave synthesis has been established where ZnO/Ag nanohybrids have shown synergistic cytotoxicity towards mammalian cells. The observed synergism in the cytotoxicity of ZnO/Ag nanohybrids could lead to the development of low dose therapeutics for cancer treatment.

Chapter 3 presents photocatalytic inactivation of bacterial cells by pentavalent bismuthates class of materials. $AgBiO_3$ which was obtained from $KBiO_3$ by ion-exchange method was investigated for its photocatalytic inactivation properties towards *E.coli* and *S.aureus* cells under dark and UV illumination conditions.

Chapter 4 presents the integration of DNA molecules with ZnO nanorods for the observation of Mott-Gurney characteristics. In this study, ZnO nanorods were synthesized hydrothermally and were characterized by TEM and XRD analysis. DNA molecules were immobilized over ZnO nanorods which were confirmed by UV-Vis spectroscopy and confocal florescence microscopy. Solution processed devices were fabricated by using these DNA immobilized nanostructures and I-V characteristics of these devices were taken in dark and under illumination conditions at different wavelengths of light at fixed intensity. Interestingly, Mott-Gurney law was observed in the I-V characteristics of the devices fabricated using DNA immobilized ZnO nanorods.

Chapter 5 presents the chemical synthesis of molecular scale ultrathin Au nanowires. These nanostructures were then used for fabricating electronic biosensors. In this study, the devices were fabricated over Au nanowires by e-beam lithography and a methodology to functionalize Au nanowires and then characterize them by florescence microscopy as well as AFM has been established. The fabricated biosensors were employed for the label free, electrical detection of DNA hybridization process.

Chapter 6 presents a simple, cost effective and solution processed route to fabricate devices using ultrathin Au nanowires. The devices were then used for sensing ethanol, H_2 and NH_3. An important property of these devices is that they can sense these gases at room temperature which reduce their operation cost and makes them desirable to use under explosive conditions.