**Chapter Contents Page No.**

**1. Introduction**

1 Introduction 1

1.2. Nanomaterials 1

**1.3. Classification of nanomaterials 3**

1.4. Main differences between nanomaterials and bulk materials 4

1.5. Synthesis of nanomaterials **7**

1.6. Bio–functionalization of nanomaterials 9

1.6.1. Amino acids 9

1.6.2. Drug molecules 12

1.7. Nanomaterial in biological applications 14

1.7.1. Metal and metal oxides nanomaterials 14

1.7.1.1. Gold nanoparticles 15

1.7.1.2. Silver nanoparticles (Ag NPs) 18

1.7.1.3. Magnetic iron oxide nanoparticles 21

1.7.1.4. ZnO nanoparticles 23

1.8. Nanomaterial–protein interactions 24

1.8.1. Serum albumin 25

1.8.2. Bovine haemoglobin 26

1.9. Haemolysis assay 27

1.10. Antibacterial studies 28

1.11. Scope of the present work 30

References 33

**2. Materials and Methods**

2.1. Chemicals 45

2.2. Solvents 45

2.3. Cell cleaning solution 45

2.4. Analytical Instruments used 45

2.4.1. UV-vis spectrophotometer 45

2.4.2. FTIR spectrometer 46

2.4.3. X-ray diffractometer (XRD) 46

2.4.4. Scanning electron microscope (SEM) 46

2.4.5. High resolution transmission electron microscopy

(HRTEM) 46

2.4.6. Vibrating sample magnetometer (VSM) 46

2.4.7. Surface area and porosity analyser 46

2.4.8. ICP–OES 46

2.4.9. Fluorescence microscope 47

2.4.10. Emission spectroscopy 47

2.4.11. Circular dichroism (CD) spectroscopy 47

2.5. Protein binding studies 47

2.5.1. Preparation of HSA/BSA/BHb 47

2.5.2. Determination of Stern-Volmer quenching constant 48

2.5.3. Binding constant and binding Sites. 48

2.6. Haemolysis assay 48

2.7. Evaluation of bactericidal activity 49

References 51

**3. Facile Synthesis of Arginine Functionalized Gold Nanoparticles and their Interaction with Bovine Serum Albumin**

3.1. Introduction 53

3.2. Experimental 54

3.2.1. Synthesis of arginine functionalized gold

nanoparticles (Au@arg NPs) 54

3.2.2. Protein–Au@arg NPs interaction studies 55

3.3. Results and discussion 55

3.3.1. Characterization of arginine functionalized gold

nanoparticles (Au@arg NPs) 55

3.3.2. BSA–Au@arg NPs interaction studies 58

3.3.2.1. Absorption spectra of BSA in presence of Au@arg NPs 58

3.3.2.2. Fluorescence quenching studies 59

3.3.2.3. Binding parameters 63

3.3.2.4. Thermodynamic parameters and binding forces 64

3.3.2.5. Secondary structural changes of BSA 65

3.4. Conclusions 67

References 68

**4. Green Synthesis of Curcumin Functionalized Silver Nanoparticles, their Binding with BSA and Haemolytic Activities**

4.1. Introduction 77

4.2. Experimental 79

4.2.1. Synthesis of curcumin functionalized silver

nanoparticles (Ag@curc NPs) 79

4.2.2. BSA−Ag@curc NPs interaction studies 79

4.3. Results and discussion 80

4.3.1. UV−visible spectroscopic study 80

4.3.2. X-ray diffraction (XRD) analysis 80

4.3.3. Electron microscopic studies 81

4.3.4. FTIR spectroscopic studies 85

4.3.5. Protein binding studies 86

4.3.5.1. Absorption spectra of BSA in presence

of Ag@curc NPs 86

4.3.5.2. Fluorescence spectral studies 87

4.3.5.3. Binding parameters 89

4.3.5.4. CD spectral studies 90

4.3.6. Haemolytic activity 91

4.4. Conclusions 93

References 94

**5. Facile and Eco-friendly Synthesis of Rutin Functionalized Silver Nanoparticles (rAg NPs), and their Biocompatibility with Bovine Haemoglobin (BHb)**

5.1. Introduction 101

5.2. Experimental 103

5.2.1. Synthesis of rutin functionalized silver nanoparticles (rAg NPs) 103

5.2.2. BHb–rAg NPs interaction studies 103

5.3. Results and discussion 105

5.3.1. UV−visible absorption spectra 105

5.3.2. XRD analysis 106

5.3.3. Electron microscopy studies 107

5.3.4. FT‒IR analysis 108

5.3.5. rAg2 NPs–Bovine haemoglobin interaction studies 111

5.3.5.1. UV-vis spectral studies 111

5.3.5.2. Fluorescence quenching of BHb by rAg2 NPs 112

5.3.5.3. Binding constant and binding sites 116

5.3.5.4. Thermodynamic parameters 118

5.3.5.5. Circular dichroism studies 119

5.3.6. Biocompatibility of rAg2 NPs 121

5.4. Conclusions 122

References 124

**6. Tryptophan Assisted Hydrothermal Synthesis of Hierarchical ZnO Architectures and their Antibacterial Efficacy**

6.1. Introduction 133

6.2. Synthesis of ZnO nanostructures 135

6.3. Results and discussion 137

6.3.1. Optical characterization 137

6.3.2. X−ray Diffraction (XRD) analysis. 138

6.3.3. Scanning electron microscopy analysis 139

6.3.4. Surface area and porosity 143

6.3.5. Bactericidal activity of ZnO nanostructures 144

6.4. Conclusions 147

References 148

**7A. Green Synthesis of Monodispersed Magnetic Fe3O4 Nanoparticles and their Interaction with Serum Albumin (BSA, HSA)**

7A.1. Introduction 153

7A.2. Experimental 155

7A.2.1. Synthesis of magnetic Fe3O4 nanoparticles

(Mag-Fe3O4 NPs) 155

7A.2.2. Serum albumins–Mag-Fe3O4 NPs interaction studies 156

7A.3. Results and discussion 156

7A.3.1. Characterization of Mag-Fe3O4 NPs 156

7A.3.2. Protein binding studies 162

7A.3.2.1. Absorption spectra of serum albumin in the

presence of Mag-Fe3O4 NPs 162

7A.3.2.2. Fluorescence quenching studies. 163

7A.3.2.3. Binding parameters 165

7A.3.2.4. Circular dichroism spectral studies 166

7A.3.3. Bactericidal activity of Mag-Fe3O4 NPs 168

7A.3.4. Haemolytic activity of Mag-Fe3O4 NPs 170

7A.4. Conclusions 171

References 172

**7B. Template Free Solvothermal Synthesis of Single Crystal Magnetic Fe3O4 Hollow Spheres, their Interaction with Bovine Serum Albumin and Antibacterial Activities**

7B.1. Introduction 179

7B.2. Experimental 182

7B.2.1. Synthesis of magnetic Fe3O4 hollow sphere (MFHS) 182

7B.2.2. BSA– MFHS interaction studies 182

7B.3. Results and discussion 183

7B.3.1. XRD analysis 183

7B.3.2. SEM and TEM studies 184

7B.3.3. VSM and BET surface area studies 189

7B.3.4. Protein binding studies 191

7B.3.4.1. Absorption spectra of BSA with MFHS 191

7B.3.4.2. Fluorescence quenching of BSA 192

7B.3.4.3. Circular dichroism spectroscopy 195

7B.3.5. Bactericidal activity of MFHS 197

7B.4. Conclusions 199

References 200

**8. Summary** 207

9.1. List of publications 212

9.2. List of papers presented in national & international conferences 213