Conclusion

Chapter-1

Synthesis and characterization of different types of magnetic nanoparticles. Application of synthesized nanoparticles as vehicle to load hydrophobic drug for target specific drug release. Evaluation of synthesized nanoparticles as MRI contrast agent. Application of as-synthesized magnetic nanoparticles as catalysts for various organic transformations trying to make reaction parameters 'Green'.

Fe3O4 NPs with transition metal dopant ions were capped with amino acid molecules to tune magnetism. To adjust the solubility and toxicity parameters, as-synthesized NPs were encapsulated with Pluronic F127 block copolymeric micelle (M2+/Fe3O4@AA/P), to load the hydrophobic anti-cancer (and in one case anti-malarial) drugs and used as targeted delivery platforms for various cell-lines. Fe3O4 NPs with different amino acids using as capping ligands were applied as catalyst for different organic reactions.

Chapter-2

L-arginine capped and transition metal ions (Zn^{2+}, Mn^{2+}, and Ni^{2+}) doped Fe_3O_4 nanoparticles are successfully synthesized by wet chemical methods. As-synthesized nanoparticles were characterized by various techniques.

(i) FTIR spectroscopy confirms the way of interaction of amino acid molecules with the surface of the nanoparticles.

(ii) The purity of the phase and lattice structure of doped and undoped nanoparticles were studied by XRD and Mossbauer spectroscopy. The particle size calculated by FWHM values derived from XRDs were in the nano regime. It confirms that there is a negligible effect of doping on particle size of as-synthesized magnetite.

(iii) Successful doping of the transition metal ions was also confirmed by elemental analysis.

(iv) Particle size and shape were also studied by TEM analysis.

(v) VSM analysis nicely explains the variation in magnetic properties of the material on doping.

(vi) The as-synthesized nanoparticles were coated with Pluronic®F127.

The resulting magnetic micelle was acted as drug delivery carrier. Moreover, the successful

encapsulation of NPs surfaces by the Pluronic-F127 layer was also confirmed by the thermal analyses.

Chapter-3

The synthesized Pluronic-encapsulated and L-Arg-capped Fe3O4 magnetic micelles can act as drug delivery platforms to load the hydrophobic anti-cancer drug brigatinib in their hydrophobic shells. Blank, Mn2+, and Ni2+ -doped Fe3O4@L-Arg NPs reveal T1 contrasting ability while those of Zn2+-doped NPs show T2 contrasting due to the modification in relaxivity ratio.

Mn2+ doped vehicles are more efficient. Only a very low dosage is required for cell death, and it is also true for clonogenic assay.

Toxicity studies confirm the safety of the developed iron oxide nanoparticle-based magnetic micelles as drug delivery vehicles at a dosage range of 0.125–0.25 mg/mL. Rationally, it can be claimed that Mn2+- doped USIONs are very suitable for theranostic applications.

In vitro cellular uptake of drug-loaded magnetic micelles by epidermoid carcinoma cell line (A431) shows more internalization than the bare drug. The overall size of the drug loaded magnetic micelles allowed prolonged circulation and sustained drug delivery.

Chapter-4

Synthesis and characterization of different types of (magnetic) nanoparticle systems: To achieve this objective, Fe_3O_4 nanoparticles being capped with various amino acid molecules had been synthesized by simple wet chemical methods.

To design new ligands act as anticancer agents and their anchoring on the surface of the NPs system for sustainable release of the drug at the target site was also the aim of the proposed work. The resulting products were first characterized and their biological activity as an anticancer agent and also their toxicity were evaluated. The results were encouraging. Based on these data, the alteration and modification in the molecular framework of the as-synthesized derivatives were carried out and the effective ligands were anchored on the surface of NPs vehicle. Pluronic-encapsulated and L-Proline-capped Fe_3O_4 magnetic micelles can act as drug

delivery platforms to load the hydrophobic anti-cancer drug brigatinib in their hydrophobic shells.

From this study, it can be concluded that: (i) drug can makes stable bonding with nanoparticles on its surface by intermolecular H-bonding or by entrapping inside cavities; (ii) pluronic like copolymeric surfactant which are capable to acquire 'mild' positive charge in the intra cellular environment can provide stealth and flexible surface to the delivery vehicle. More experiments are needed to establish this claim for eukaryotic cells in a large scale. Hence, iron oxide nanoparticles can serve as non-toxic, biodegradable and safe vectors to load a variety of drug/gene of useful products like enzymes, proteins, peptides, hormones etc into the cells. Such a carrier can also be used for delivering genes into eukaryotic cells and can be a potential candidate for use in gene therapy also.

Chapter-5

By introducing amino acid-like components as a base catalyst on a robust host like Fe_3O_4 NPs, we have shown that one-pot multi-step synthesis of pharmaceutically significant intermediate can be carried out sequentially. The Knoevenagel reaction can simply be carried out by base catalysis due to amino acid molecules that are present on the surface of a single nanoparticle. The product of this reaction was then condensed with nitromethane, a Michael donor, yielding a product useful in the production of numerous pharmaceutically active compounds. It can be concluded that by adopting all the optimal process parameters, (i) the developed process becomes more cost-effective than those based on bare noble metal catalysts (ii) catalyst recovery is made simple by using a magnetic field (iii) The catalyst Fe_3O_4@L-Arg is more effective than Fe_3O_4@L-Hist for both sequential reactions (iv) the as-synthesized catalyst Fe_3O_4@L-Arg NPs maintained its efficiency for five cycles (in this study) for 2-way catalysis (v) the reaction is "green" because no hazardous solvents are used, and the entire one-pot process can be carried out in solvent-free conditions with short reaction times, high product yields, and high activity and stability of the catalyst under the optimized reaction conditions. This work brings up new possibilities for the development of multi-component catalysts that can produce materials on a large scale while being environmentally friendly. The next investigation will focus on developing a tandem process for the mass production of enantio-pure Baclofen and Pregabalin.