Preface

The growing need for artificial biomaterials for the restoration of bone and dental defects has urged the search for optimally designed materials as a joint effort of physicians, engineers, chemists and physicists. Among the several materials available today, hydroxyapatite (HA) was recognized as one of the attractive materials for the restoration of bone and dental defects since it resembles the mineral component of bones and teeth. Synthetic HA exhibits specific properties of biomaterials such as biocompatibility, bioactivity, osteoconductivity, etc., hence it has been widely used as a bone defect filler, coating on metallic implants, scaffold for tissue engineering and carrier for drug delivery. The major drawbacks of HA are poor mechanical performance, less resorption and uncontrolled drug delivery that has limited its utilization for advanced functional applications. Hence tailoring the different properties of HA bioceramics for enhanced biomedical applications has got great attention and has been the topic of research interest for many years.

The ***first chapter*** provide a comprehensive source of information on research and development of nano-HA biomaterial and various approaches to tailor the properties of nano-HA. Successive five chapters are on tailoring the properties of nano-HA by employing different approaches for biomedical applications.

In ***chapter–2*** we present a systematic facile strategy for the synthesis of nanocrystalline HA with enhanced sinterability and mechanical properties via precipitation method coupled with ultrasonication and freeze drying process. Role of ultrasonication and freeze drying on the characteristic of HA are explained based on observed results from the various characterizations. Thermal stability, crystallinity, microstructure and densification behavior of HA obtained from conventional and ultrasonication assisted freeze drying methods are discussed. Comparison of mechanical properties of HA (sintered at 1100 ºC) obtained from both methods also forms part of this chapter.

In ***chapter–3***, we demonstrate a novel method for *in situ* fabrication of HA - calcite nanocomposite using calcium nitrate, di-ammonium hydrogen phosphate and citric acid as the starting materials. The mechanism of formation of HA - calcite nanocomposite is discussed elaborately in this chapter. In addition, effect of citric acid concentration on the composition of HA - calcite nanocomposite is also discussed. Density, porosity, mechanical properties, *in vitro* bioactivity, *in vitro* dissolution and biocompatibility of the *in situ* formed HA - calcite nanocomposite are presented in this chapter.

Chapter–4 is focused on the effect of Zn and carbonate co-substitution on the properties of nanocrystalline HA. Zinc and carbonate co-substituted nano-HA have been synthesized by precipitation method and characterized by various techniques. Effect of Zn and carbonate substitution on the thermal stability of HA has been investigated in detail. Subsequently *in vitro* studies such as apatite forming ability, dissolution behavior and cytocompatibility are reported. It is found that simultaneous substitution of Zn and carbonate in HA alters the crystallite size, crystallinity, lattice distortion, etc., which consequently affects the thermal stability, dissolution and bioactivity of nanocrystalline HA.

Chapter–5 deals with the preparation of flower-like Mg containing carbonated HA nanostructure from eggshell biomineral using a simple and rapid microwave irradiation method with the help of EDTA as a complexing agent. Various characterization studies on prepared HA are described. The mechanism of the formation of flower-like Mg containing carbonated HA from eggshell biomineral is presented in detail. This chapter also provides apatite forming ability, biocompatibility, drug adsorption/desorption behavior, antibacterial activity and photoluminescence property of prepared flower-like HA nanostructure.

Chapter–6 deals with the *in situ* preparation of ciprofloxacin loaded HA nanoparticles and its characterization by different techniques. The *in situ* formation of ciprofloxacin loaded HA nanoparticles and effect of concentration of ciprofloxacin on

the crystallite size and particle size of HA are explained based on above studies. Finally, drug release behavior, antibacterial activities, *in vitro* apatite forming ability and cytocompatibility of ciprofloxacin loaded HA nanoparticles are discussed.

The final chapter (***chapter–7***) presents an overall summary of all the chapters and suggestions for future work.