INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

Name of the Student : **PRIYA MULLICK**

Roll Number : 156106004

Programme of Study : Ph.D.

Thesis Title: Generation of Hydroxyapatite Nanomaterial through Biomineralization for Potential Biomedical Applications

Name of Thesis Supervisor(~~s~~) : Prof. Aiyagari Ramesh

Thesis Submitted to the Department/ ~~Center~~ : Biosciences and Bioengineering

Date of completion of Thesis Viva-Voce Exam : 7 October 2021

Key words for description of Thesis Work : Hydroxyapatite, Biomineralization, Lactic Acid Bacteria, Antibiofilm, Bone Cell

---

SHORT ABSTRACT

Hydroxyapatite (HA)-based nanomaterials have elicited enormous interest owing to their fascinating physico-chemical properties and their application potential in healthcare. Given the use of toxic reagents in chemical synthesis of hydroxyapatite nanoparticles (HANPs), alternate methods of generating biocompatible HANPs and leverage their biomedical prospect are warranted. The current investigation addresses this issue and illustrates a biomineralization-based method of HANP synthesis using extracellular or secreted proteins (SLPs) as well as cell surface-associated proteins (CSPs) from lactic acid bacteria (LAB), which has a GRAS (Generally Regarded As Safe) status. Mechanistic studies could unravel the key secreted LAB protein, which guided biomineralization-based HANP synthesis. Subsequently, a non-toxic polymyxin B-loaded hydroxyapatite nanocarrier (PB-HNC) was generated that displayed potent activity against *Pseudomonas aeruginosa* biofilm. In a separate study, biomineralization-based HANP synthesis was accomplished by deploying the CSP of the human probiotic strain *Lactobacillus rhamnosus* GG as a nucleation scaffold. Interestingly, whole cell of *L. rhamnosus* GG could also direct mineralization and yield HANPs of uniform size and shape. A chitosan-gelatin porous scaffold reinforced with CSP-mineralized HANPs (H-CG) was generated, which exhibited favorable porosity, swelling property and biodegradation profile. In an *in vitro* cell culture model, the H-CG scaffold could support proliferation, mineralization and osteogenic marker gene expression in MG-63 bone cell (human osteosarcoma cell). The final research endeavor of the Ph.D. thesis highlights a biomineralization-inspired approach for the generation of HANPs using a rationally designed ligand 2-dodecylmalonic acid (MA). In order to leverage the generated HANPs in orthopaedic application, titanium wire (TW) was coated with collagen type I incorporated with the generated HANPs. Interestingly, the HANP-coated titanium wire (H-TW) rendered significant MG-63 bone cell growth, mineralization and osteogenic marker gene expression in an *in vitro* model. The novel approach of using LAB proteins and rationally designed synthetic amphiphile for biomineralization-based synthesis of HANPs and their potential to develop antibiofilm agents and bone tissue engineering scaffolds as highlighted in this Ph.D. thesis provides a promising framework to generate biocompatible therapeutic materials.