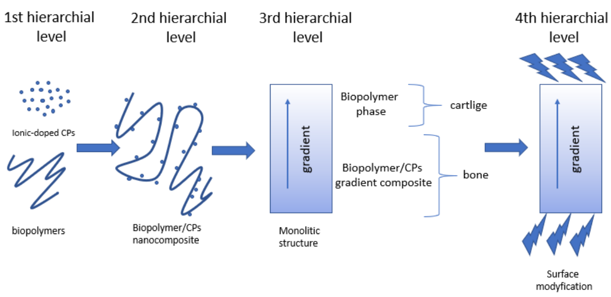
Hierarchical approaches for osteochondral tissue engineering
"OsteoHierarch"

ABSTRACT FOR THE GENERAL PUBLIC

A major challenge in engineering Osteochondral OC tissues is to generate a functionally integrated stratified cartilage-bone structure. The main purpose for OC tissue engineering is to recreate a biomimetic and biocompetent scaffold combining different materials with cell-recognition sites of naturally derived materials. In addition, looking to the architectures of bone and cartilage, specific structured scaffolds are demanding for OC defect treatment. In fact, bone and cartilage have complete different properties.

The **overall goal** of the project is to design a new composite biomaterial hierarchal system based on enriched calcium phosphate, polymer matrix and bioactive factors with enhanced properties, which could be used for surgical implants. The project will **develop a new step-by-step method** for obtaining gradient materials using techniques such as salt-leaching, photo-crosslinking, solvent casting, freeze-drying and enzymatic cross-linking, 3D printing. A major hurdle in treating osteochondral (OC) defects is the different healing abilities of two types of tissues involved - articular cartilage and subchondral bone. Bio-mimetic approaches to OC-construct engineering, based on recapitulation of biological principles of tissue development and regeneration, have potential for providing new treatments and advancing fundamental studies of OC tissue repair. The overall goal of the project is to design a new hierarchal, gradient composite biomaterial based on biopolymer matrix contains incl. structural protein (i.e. silk fibroin), natural polysac-charides (pullulan) and CaPs (HAp, brushite, TCP) with enhanced properties. **We hypothesize** that the development of a gradient biomaterial composed of biopolymers and enriched calcium phosphates (CaPs) as well as growth factors will improve the biocompatibility and



osteoconductivity of the material system as well as its tribological performance and lifetime. **The motivation** of the proposed work is to develop specially designed hierarchic biomaterials based on biopolymers and calcium phosphates for a future generation of implants with enhanced osteoconductivity and long lifetime. This modification is crucial as state-of-the-art implant materials, especially in scaffolds designed for osteochondral repair and regeneration, suffer from low wear resistance against fretting, potential toxicity problems, and poor attachment. **The originality of the proposed work is based upon a bottom-up approach** taking into consideration the entire material system: from the fabrication of enriched CaPs particles with specified morphology over the controlled processes of cross-linking for obtaining composites to advanced surface functionalization by active compounds. The scaffolds will be loaded with a range of growth factors that have been shown to have some osteogenic and angiogenic potential. The main research question focuses on the interfacial synergistic and antagonistic interaction between the CaPs/biopolymer matrix as well as mechanism of incorporation of ionic-dopants do CaPs, which will play vital roles in biomechanics and stimulating the stem cells niche towards osteo- and chondro- genesis/angiogenesis. Nanocomposite scaffolds hierarchically structured composed of biopolymers (proteins/ poly-saccharides) and calcium-phosphate incorporating bioactive ions for osteochondral (OC) tissue engineering will be major field of investigations. The efforts will focused on **multistep production process** and with regard to the scientific goal. The results of research will answer the question of whether it is possible to produce a composite material intended for osteochondral tissue engineering applications based on a poly-mer matrix with hierarchical and gradient structure. **The main research question focuses** on the interfacial synergistic and antagonistic interaction between the hierarchic structures of loaded-CaPs composite, polymer matrices, growth factors affecting the bio-integration of the material system.