DESCRIPTION FOR THE GENERAL PUBLIC

Fast development of new therapeutic techniques, observed in the last decades, is possible mainly due to the progress in materials science. Tissue engineering is an interdisciplinary field combining the principles of medicine and materials science in order to regenerate damaged tissues and organs. Civilizational and social changes, aging societies are natural stimuli for development of this field. The subject of this project is focused on obtaining new materials for tissue engineering applications and in particular concerning bone defects. The aim of this project is to obtain multicomponent magnetic hybrid materials potentially useful in bone tissue regeneration.

Materials in form of multicomponent scaffolds will be based on hydrogel matrix composed of polymers of natural origin: collagen, chitosan, hyaluronic acid. These polymers were chosen due to their biocompatibility and biodegradability. Collagen plays an important role in the organism and in particular it is an important component of bone tissue. Chitosan exhibit antibacterial and antifouling properties. Hyaluronic acid is a component of extracellular matrix located in human body.

Taking into account that static magnetic field accelerates the regeneration of bone tissue, helps in fracture healing, has positive influence on the process of bone formation, magnetic nanoparticles will be dispersed in hydrogel matrix. Core-shell type nanoparticles will be prepared using coprecipitation method and coated with cationic derivative of chitosan at the stage of synthesis and next with polyanion.

Pioneering method of obtaining magnetic hydrogels by immobilization of polymer-coated magnetic nanoparticles in the biopolymer matrix by covalent bonds is proposed in this project. Permanent immobilization of nanoparticles will allow to prevent the undesirable processes of aggregation and phase separation under influence of external magnetic field.

Bioactivity is a desired property in the case of scaffolds designed for bone tissue regeneration, thus also for those proposed here. This will be possible due to properly designed nanoparticle coatings and polymer selection. The presence of carboxylic and sulfonic functional groups in the outer coatings of nanoparticles and in polymer chains will allow for controlled hydroxyapatite (the main inorganic constituent of bones and teeth) deposition in simulated body fluid conditions.

In order to enhance bone forming potential of proposed materials introduction of additional biologically active agents using magnetic nanoparticles as carriers is planned. One of them is insulin, which has an impact on differentiation of stem cells towards osteoblast and other one is BMP-2. It has the ability to stimulate new bone formation.

Physicochemical, mechanical and magnetic properties of obtained scaffolds will be investigated. Biological experiments concerning cell viability, adhesion, proliferation using different cell lines (fibroblasts, osteoblasts) will be also performed. In the last step osteogenic stem cell differentiation on hybrid magnetic scaffolds will be also tested.

The concept of multifunctional magnetic scaffolds exhibiting bioactivity, enriched with biologically active agents which stimulate bone formation and osteogenic differentiation of stem cells seems promising concerning bone defects regeneration.