DESCRIPTION FOR THE GENERAL PUBLIC

Taking into account the requirements of modern, regenerative medicine and using the experience gained during many years of work on biomaterials the authors of the proposal implemented a new solution in the field of materials for implantology. The concept that is proposed in the application was not yet described in the literature, and cannot be found among the bone substitutes available on the market. There is a high probability that this new material, as opposed to the already existing ones, **will meet simultaneously a number of the requirements for bone substitutes,** such as biocompatibility, bioactivity, surgical handiness, gradual, controllable resorption and biodegradation, good mechanical strength, favorable microstructure after setting and hardening, suitable working time which will allow the surgeon to insert a specimen to the bone defect, good adhesion and stability in the bone void, lack of exothermal setting process, antibacterial character and a relatively low price.

The aim of the project is to obtain new bio-microconcrete type bone substitutes from the $\alpha Ca_3(PO_4)_2$(αTCP) - $Ca_{10}(PO_4)_6(OH)_2$(HAp) - chitosan (CTS) system and to determine the factors influencing the properties of these biomaterials. The choice of the type and form of components was dictated by the need to:

1. satisfy the requirement of regenerative medicine to combine in composites the bioactive materials (in this case HAp and αTCP ceramics) with bioresorbale polymers so as to reproduce microstructure of the bone as closely as possible and activate the natural mechanisms of bone tissue regeneration,
2. create a material that is easy to apply (aggregate in the form of granules associated with cement-based phase αTCP is firmly placed in the cavity) and exhibiting gradual resorption,
3. introduction of the fast biodegradable chitosan with antibacterial properties and additional double doping of material with Au and Si for increasing of antibacterial activity (Au) parallel with good osteogenesis (Si), which is important in bone surgery.

In the context of basic research factors affecting the physicochemical properties of these bone repair products, such as phase composition, microstructure, mechanical strength, chemical stability will be dteremined. Special attention will be focused on understanding the process of setting in bio-microconcretes and evaluating interactions between the various components of this complex composite materials. Factors affecting adhesion of αTCP based cement phase to the surface of HAp / CTS granules, performing the role of aggregates in the concrete, will be examined. Consistency, biodegradability and chemical stability of the developed materials in simulated body fluid (SBF) will be assessed. Biological evaluation of the materials will include cultures of human osteoblasts (cytotoxicity) and the cultures of three different types of bacteria that cause infections of the bone. Research techniques such as SEM, TEM, AFM, XRD, FTIR, mercury porosimetry, apparatus for testing mechanical strength, ICP-OES, the Gillmore needles will be used in our studies.

The original, not studied yet, ie. completely innovative **aspects of our work** will be:

- application of chemical modification of granules and binder phase, which allows our materials to fulfill some additional functions (eg. to serve as a carrier of the drug, a drug carrier of antibacterial agents).
- usage of highly reactive αTCP, characterized by phase purity and a suitable crystallinity, in obtaining the microconcrete, which allows for good bonding of the continuous phase of cement to the surface of granules (factors affecting the adhesion of the matrix to the surface of granules in microconcretes).
- determine the effect of composition and size of the granules and their amount in bio-microconcrete on the physicochemical properties of the final product, that meets the requirements for bone implants in a greater extent than previous bone substitutes formulations.

The results of the tests that will be carried out in the project:

- will allow to obtain new surgically handy biomicroconcrete-type bone substitutes revealing enhanced mechanical strength with desired microstrusture, chemical stability, antibacterial properties and bioactivity,
- will provide new knowledge regarding the manufacture of composite HAp / CTS granules serving as an aggregate for bio-microconcrete,
- will allow for a detailed understanding of the setting processes taking place in the concrete, in which a continuous binding phase is based on αTCP and the discontinuous, reinforcing phase is a hybrid aggregate HAp / CTS,
- will allow to choose systems for further studies *in vivo.*