The treatment of many tissue defects, especially large defects due to trauma, infections, tumors or genetic malformations, represents a major challenge for modern medicine. Autologous tissue grafting is considered the most effective treatment; in practice, however, this approach is limited by insufficient amount of donor tissue and tissue incompatibility problems. Allogeneic or xenogeneic tissue grafts, on the other hand, have obvious clinical limitations due to immunological reactions in the host recipient. Tissue engineering and regenerative medicine offer a promising and alternative therapeutic strategy for regeneration of damaged or diseased tissues and organs. The main approach for this strategy is the use of three dimensional, highly porous, biocompatible and biodegradable scaffold that provide appropriate environment for tissue regeneration. Scaffold designing and fabrication are major areas of biomaterial research, and they are also important subjects for tissue engineering and regenerative medicine research. The possibilities of controlling the material properties, including microstructure, mechanical and biological parameters, is key to creating ideal porous scaffolds. Appropriate properties of biomaterials for regeneration of various tissues will be achieved by the use of adequate fabrication methods and also by the application of composite materials which allow us to design materials with a wide range of properties. **The primary goal of our research is to determine correlation between the mechanical and physico-chemical properties as well as architecture of porous bioresorbable polymer and composite poly(ε-caprolactone)-based (PCL) materials and the preparation methods and their parameters. The second equally important goal of our Project will focus on the recognition and indication of dependence between the mechanical and physico-chemical properties of porous polymer-based composite materials and the material modification parameters (chemical composition and grain fraction of gel-derived bioactive glass particles), with respect to particular preparation methods and their conditions.** The third goal of this Project is preliminary in vitro biological evaluation, which is aimed at: (i) indication of materials that support cell proliferation and also possibly stimulate bone tissue formation, (ii) determination of the effect of preparation methods, their parameters and modification of polymer matrix with glass particles on in vitro cell response.

Research methodology used in the Project will include: (i) designing and fabrication of bioglasses particles (SBG) of established chemical compositions and grain fractions by low-temperature sol-gel method; (ii) designing and synthesis of 3D and 2D bioresorbable poly(ε-caprolactone) (PCL) material and PCL-based composites by solvent-casting particulate leaching (SCPL), solid-liquid phase separation (SLPS) as well as freeze-immersion precipitation (FIP) with modification of at least four various parameters for each preparation methods; (iii) full material investigation for morphology, chemical compositions, mechanical properties, surface properties (topography, nanotopography, zeta potential, wettability), thermal properties and crystallinity of polymer matrix; (iv) evaluation of bioactive potential of obtained materials by incubation in simulated body fluid as well as degradation rate and products by incubation in phosphate saline buffer/distilled water and study of chemical, phase, structural and thermal changes of incubated materials; (v) after full, comprehensive analysis of material research results, the most promising biomaterials will be selected, for these materials will be conducted in vitro tests by culturing of osteoblastic cells in contact with materials and examination of morphology, distributions, proliferation level and also representative biomarkers (ALP activity, collagen level and mineralisation of ECM) of the osteoblast activity and phenotype.

We believe this project is of great importance for the development of basic research in the field of biomaterials, since its realization will make it possible to consciously design materials with required properties for regenerative medicine and tissue engineering.