The purpose of this project is to design, synthetise and conduct a physicochemical analysis of electrospun materials based on biodegradable polymers as potential artificial extracellular matrix in tissue engineering and an innovative drug delivery system in the treatment of vascular diseases. Nowadays medicine is moving towards new nanomaterials for creating novel, readily available grafts and therapies.
The remarkable geometrical properties as well as facile synthesis of nanofibers offer a unique opportunity to prepare potential drug delivery systems and artificial cell scaffolds. Therefore, we conclude that the basic understanding of electrospinning process has to be extensively studied because the morphological and mechanical properties of nanofibers as well as their impact on cells are controlled by electrospinning parameters. In addition, the influence of active substance incorporation on electrospinning process will be also evaluated. Further research covering this issue may open a new perspective for nanofibers development.

The materials used in our research will be based on polymers, which may be degraded by living organisms. The first stage of the project will be focused on elucidating the fundamental mechanisms of electrospinning process in order to obtain uniform nanofibers with similar characteristics.
Electrospinning process is based on electrostatic forces, which are formed after applying high voltage to a needle of a syringe containing polymer solution. These forces cause polymer jet to burst from the spinneret which then can be compiled on the collector. Despite relatively simple principles electrospinning technique application has still some remaining issues. There are several challenges related to the parameters of the electrospinning process, which affect the morphology of a final product. Therefore, certain polymer solution properties such as concentration of polymer, type of solvent and various incorporated substances require a proper optimization. In the next step a detailed characteristics will be performed in order to determine the effects of synthesis parameters on morphology and mechanical properties of electrospun materials. Moreover, residual solvents levels will be determined in order to verify risk of potential cytotoxicity.

In the next stage of the project, nanomaterial will be collected as a three-dimensional tubular (3D) structure, composed of well-defined single nanofibers. We will compare the obtained data for single nanofibers and verify the influence of nano-tailoring on overall morphological and mechanical properties of 3D structures.
Additionally, an active substance will be incorporated to electrospun tubular structures. The influence of an antiplatelet agent incorporation on electrospinning process and nanofibers properties will be verified. The last step will involve determination of the impact of the obtained material on cell viability and physiology as well as cell culture geometry.