Diabetes mellitus is a chronic metabolic disease characterized by elevated blood glucose levels associated with impaired insulin secretion or activity. It is estimated that 463 million adults worldwide suffered from diabetes in 2019, and forecasts indicate that this number will increase in the coming years.

Diabetes can affect the functioning of the entire body and lead to many complications, including diabetic retinopathy, chronic kidney failure, and ischemic heart disease. Diabetic ulcers are also a frequent complication of diabetes. The presence of these wounds not only significantly reduces the patient's quality of life, but can lead to limb amputation or even death. It is estimated that 15% of people with diabetes will develop such wounds during their lifetime. Diabetic foot ulcers account for 85% of diabetic amputations. Moreover, treating these wounds is costly.

There are many wound treatment methods available on the market. They include not only all kinds of dressings (bandages, gauze, hydrogel, hydrocolloid dressings), but also skin substitutes, negative pressure, and hyperbaric therapy. However, these methods are not fully effective in treating diabetic wounds, which are often large and irregularly shaped. Therefore, intensive research into new therapies is carried out. Regenerative medicine and tissue-engineered products, as well as 3D bioprinting, can be helpful.

Regenerative medicine is an interdisciplinary branch of science, operating based on the so-called tissue engineering triad of cells (e.g. stem cells), scaffolds, and signaling factors. In recent years, intensive research has been carried out on the use of different cells, including skin cells (fibroblasts and keratinocytes) in the treatment of various diseases, including wound healing. The results of these studies are not fully satisfactory, which indicates the need to develop methods of increasing their pro-regenerative properties so that they can be used in everyday clinical practice. For this purpose, the prestimulation of these cells with, for example, growth factors or peptides can be used. In addition, the use of scaffolds, e.g. hydrogels, to support the cells, allowing them to grow and multiply properly, also may increase the activity of skin cells after their application to a wound.

In the project, clinical material (skin, medical waste) will be collected during surgery from patients diagnosed with diabetes and patient not suffering from this disease (control). It will be used to isolate skin cells (keratinocytes and fibroblasts). The project will use advanced research methods to compare fibroblasts, and keratinocytes from non-diabetic and diabetic patients.

The main goal of the project is to assess the possibility of using PDGF-BB or its peptide derivative PDGF2 for preconditioning of skin cells (keratinocytes and fibroblasts) to increase their pro-regenerative activity. The stimulated cells will then be used to obtain a bio-printed hydrogel dressing, the activity of which will be assessed in vivo using a model of dorsal skin damage in mice. The biocompatibility of prepared wound dressings will be analyzed in vitro. Flow cytometry will be used to access the effect of hydrogel wound dressings containing preconditioned cells on the activation of immune cells. The use of 3D bioprinting allows the dressing to be adjusted to the shape and size of the wound (personalized medicine), which may facilitate the healing of large and irregularly shaped diabetic wounds.

This project will provide a wealth of information on the properties of skin cells from diabetic patients. It will also allow us to understand the mechanisms related to the response of skin cells to stimulation with PDGF-BB and PDGF2. This project has the potential to contribute to the development of new treatment methods for diabetic wounds, as well as the development of regenerative medicine and 3D bioprinting.