Necrotic wounds, such as pressure ulcers, diabetic ulcers, and venous ulcers, pose a significant challenge to healthcare systems. Due to their slow healing and high risk of complications, including infections, sepsis, and kidney failure, they require special attention. Traditional treatment methods are often ineffective for wounds characterized by tissue loss, chronic inflammation, and limited blood flow. These wounds lead to chronic pain, reduced mobility, and a substantial decrease in patients' quality of life, while simultaneously placing a significant financial and resource burden on healthcare systems. Addressing this issue necessitates innovative and sustainable approaches that improve treatment effectiveness and alleviate the strain on healthcare providers. Effective treatment of these hard-to-heal skin injuries requires novel strategies and materials that not only promote tissue regeneration but also prevent infections and provide optimal conditions for the healing process.

Necrotic wounds present a significant challenge in medicine due to poor vascularization, chronic inflammation, and a high risk of infection. In response to these challenges, innovative biomaterials are being developed that combine tissue regeneration capabilities with effective infection protection. Biomaterials designed for the treatment of necrotic wounds must meet a range of requirements, including biocompatibility and the ability to create an optimal environment to support regenerative processes. Additionally, such biomaterials should exhibit flexibility and adequate mechanical strength to withstand stress in demanding locations, such as diabetic foot ulcers. They should also enable controlled release of bioactive components, reduce the risk of infection, and maintain appropriate hydration to promote healing processes. With these characteristics, these biomaterials have the potential to significantly improve the effectiveness of necrotic wound treatment. **The project proposes biomimetic scaffolds based on collagen and hyaluronic acid, enriched with ferulic acid dimers exhibiting antioxidant, anti-inflammatory, and antibacterial properties.**

The materials developed within the project are based on collagen and hyaluronic acid, which, due to their biocompatibility and ability to mimic the extracellular matrix, support the regeneration of damaged tissues. A key innovative element of the project is the modification of ferulic acid, leading to the synthesis of dimers using a novel method involving low-temperature plasma. These dimers are characterized by enhanced chemical and mechanical stability, as well as high bioactive properties. Thanks to these features, the materials not only provide protective functions but also promote tissue regeneration and effectively prevent infections. Moreover, the use of plasma as an innovative and eco-friendly method avoids the need for harsh chemicals and minimizes the formation of by-products, offering a sustainable approach to the dimerization process. The biomedical materials developed in this project will undergo comprehensive testing to evaluate their suitability for treating necrotic wounds. Their mechanical stability and resistance to enzymatic degradation will be assessed under conditions simulating the wound environment. Additionally, extensive biological studies will be conducted using human cells, in accordance with international standards, to confirm the safety of these materials in contact with tissues. The antibacterial properties of the materials will be evaluated for their effectiveness against bacteria commonly found in infected wounds, such as *S. aureus*, *P. aeruginosa*, and *E. coli*. Their antioxidant properties will also be examined. Advanced biological studies will leverage a state-of-the-art bioreactor capable of simulating dynamic conditions in the human body, such as fluid flow and pressure changes. This approach will allow for a more precise evaluation of the functionality of the materials under realistic clinical conditions.

The design and development of new biomaterials will not only enhance our understanding of the interactions between materials and environmental factors in the wound healing process but also accelerate this process, potentially significantly improving patients' quality of life in the long term. Furthermore, the use of biomaterials derived from natural raw materials as wound dressings supports an eco-friendly approach, encouraging patients and caregivers to adopt environmentally friendly products.

The results of this project have the potential to revolutionize the treatment of chronic wounds, combining improved patient quality of life with advancements in regenerative medicine, carried out in accordance with the principles of sustainable development and environmental protection.