Traditional metallic stents are commonly used; these stay in the body permanently, leading to long-term issues like inflammation, risk of thrombosis, or restenosis that can be life-threatening. To overcome this, our research focuses on developing materials that provide temporary support during the necessary healing and remodeling of the artery while they safely dissolve. Special attention is given to Zn as a biomaterial due to its natural presence in the human body and optimal degradation rate that matches those required for temporary cardiovascular stenting applications (<0.02 mm/year) compared to Mg and Fe, which show certain disadvantages due to the hydrogen gas production and hard-to-metabolize corrosion products. However, Zn shows insufficient mechanical properties (~20 MPa), which can be improved by alloying at the same time Zn has poor processability at room temperature due to their hexagonal crystal lattice (hcp) configuration, which results in low efficiency and high cost in traditional processes such as casting, rolling, and extrusion—the challenge of being produced limits their applications in the biomedical field. Additive manufacturing, specifically laser powder bed fusion (LPBF), allows for the variation in its parameters during the process, which can be tailored to overcome the challenges of Zn and its alloys. Moreover, LPBF technology can produce a unique microstructure formation that can improve mechanical, corrosive, and biological properties.

This project aims to optimize the manufacturing process and thoroughly explore the properties of the obtained Zn-based materials produced using LPBF. Furthermore, the results will be compared to Zn materials after ingot metallurgy.

The systematic work involves the manufacture of Zn-Mg and Zn-Mg-Ag alloys. Firstly, the control and optimization of the LPBF parameters will be carried out. The resulting materials will be studied to understand the relationship between the properties and the LPBF process. Adjusting the parameters to minimize defects, such as crack initiation and porosity, while increasing density during fabrication, will be an important step to continue. Afterwards, LPBF parameters for materials with optimal properties and maximum density will be used for cardiovascular stent prototypes. At the final step, the stents will be tested in vitro to understand their capacity to be the next generation of biodegradable biomaterials. A flowchart of the project is shown in Fig. 1.

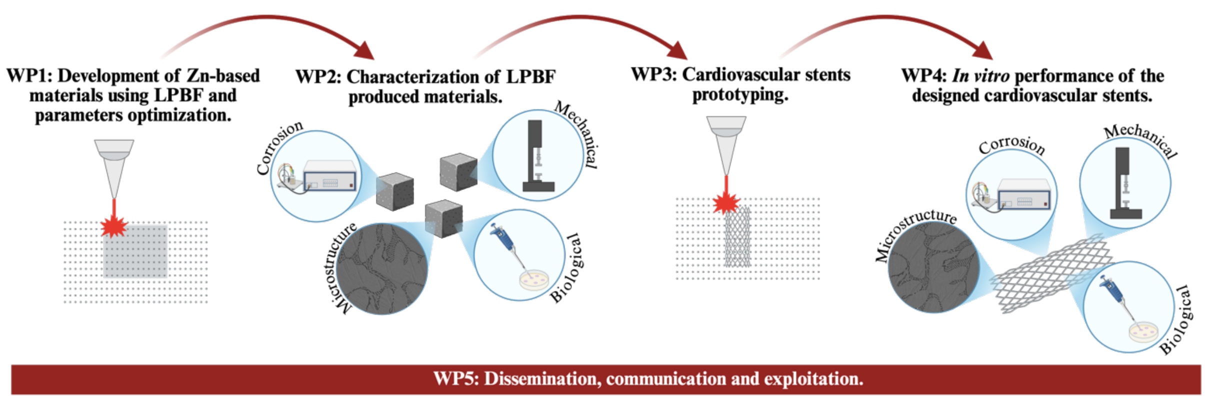

Figure 1. Flowchart of the project. Created in https://Biorender.com

As a result of the project, knowledge about the properties of both Zn-Mg and Zn-Mg-Ag alloys developed via laser powder bed fusion will be obtained. This will allow us to better understand the LPBF parameters and their influence on the mechanical, corrosive, and biological properties of temporary biodegradable biomaterials.