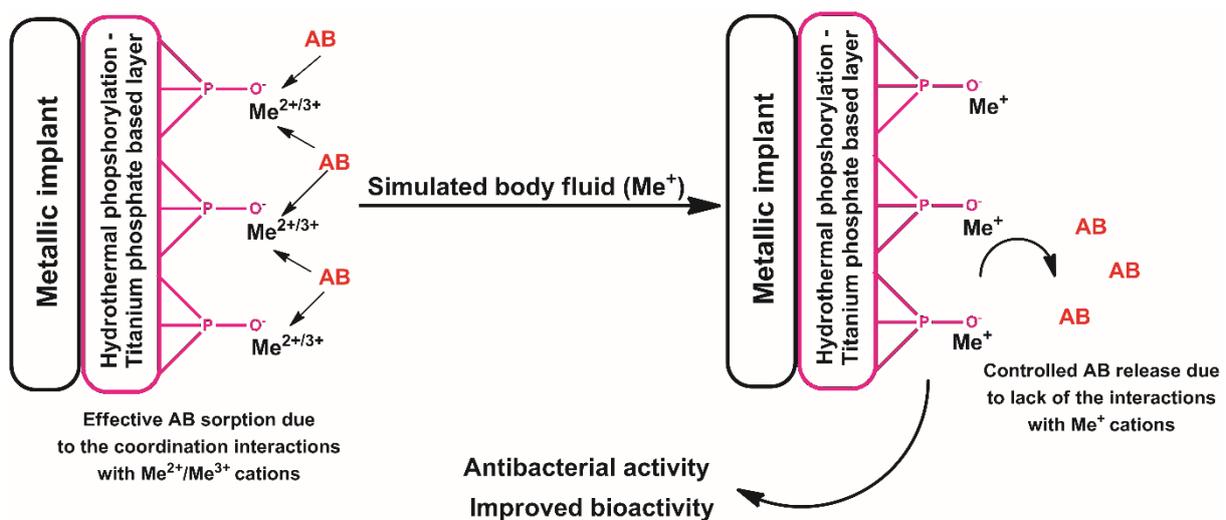


Metallic biomaterials made from metals such as titanium are commonly used in implants to reinforce, repair, or replace damaged bone tissue. Their surface properties, such as hydrophilicity, roughness, and surface energy, greatly influence the success rate of the implant. The main advantage of implants made from titanium is their mechanical properties and bio-inertness. Unfortunately, despite the lack of interactions between the implant and the cells, the body still recognizes the implant as a foreign object. This causes the implant to be rejected by the cells, leading to inflammation. Another drawback of metallic implants is that their surface is prone to microbial adhesion. As a result, a serious bacterial infection may develop after implantation, leading to implant removal or, in some cases, even death. Currently, post-implantation infections are treated by administering antibiotics orally and intravenously. Although this method is widely used, it is not ideal due to the low efficacy of some antibiotics and their side effects. A potential solution to these problems is to modify the implant surfaces in such a way that they are strongly antibacterial and additionally enhance bioactivity to facilitate bone integration with the implant surface. This can be achieved, for example, by modifying the implant surfaces with antibiotics. The advantage of such a system over standard oral administration is the ability to deliver a lower dose of the antibiotic, which acts locally directly on the microorganisms without affecting healthy tissues. Another approach to improving the properties of metallic implants is to coat them with layers that support osseointegration. By delivering bioactive substances (drugs) from the implant surface, the implant will not be rejected, and the patient will recover more quickly after surgery. Currently, drugs that support osseointegration are also taken orally, which is ineffective due to the small amount of the drug reaching the implant site. Given these issues, modifying the surface of metallic biomaterials is necessary.

This project aims to develop innovative coatings for titanium and titanium alloy implants. These coatings are based on titanium phosphate (TiP) layers created through hydrothermal phosphorylation. They will be enriched with bioactive metal ions (such as calcium, magnesium, strontium, zinc, cerium, and others) to support bone regeneration. Moreover, they will serve as carriers for antibiotics like ciprofloxacin or tetracycline, enabling localized, controlled drug release directly from the implant surface. The research not only focuses on developing these coatings but also on understanding the mechanisms behind ion and drug binding and release. The materials will be tested for antibacterial effectiveness and their ability to stimulate bone cell growth (bioactivity). The outcomes of this study may lead to a new generation of smarter implants that are more infection-resistant, promote faster healing, and reduce the need for systemic antibiotics—an important step in combating antimicrobial resistance and improving patient outcomes.



The aim of the work presented graphically.