Due to the rapid societal development, the design of novel materials is of utmost importance. Such materials can be further utilized in various branches of science and industry, with healthcare materials (biomaterials) being particularly crucial. They play a significant role in diagnosing and treating human diseases, as well as improving human well-being. The combination of a personalized approach with the application of the latest discoveries in medicine ensures the required success. Despite extensive research conducted to assess their distinct physical, structural, and magnetic characteristics, the scientific community has yet to fully grasp the potential impact that magnetic particles (MPs) could have on the future of medicine. Combination of MPs with biomaterials and active molecules (growth factors, stem cells, drugs) opens up a possibility to develop smart magneto-responsive material with specific applications in drug delivery systems and tissue regeneration.

The aim of this project is to develop innovative magnetic biomaterials based on zeolites and zeolite imidazolate frameworks (ZIFs) as a multifunctional bone healing and regeneration tool. Such biomaterials will be responsive to static magnetic field (SMF), enhancing the recruitment and differentiation of mesenchymal stem cells and bone-forming cells (osteoblasts) and thus the regeneration of bone tissue. The implantation of the biodegradable biomaterial containing zeolites or ZIFs as highly biocompatible implant that can serve as a great underlay for human cells, and iron magnetic particles (MPs) serving as magnetic field responsive part that also improves the adherence of the desired cells, should result in improved regeneration and healing of different bone defects.

The idea of this project is to employ the best qualities of zeolites/ZIFs and iron MPs, while minimizing the negative effects. Combination of those materials enables the development of porous, magnetic composite characterized by better cell adhesion and improved regeneration under the influence of static magnetic field. Stimulation with a magnetic field expedites the bone healing process by improving the integration between scaffolds and the host bone. It also augments calcium content, promoting increased bone density and the formation of new bone. Expanding the research idea from zeolites to ZIFs allow to obtain the most versatile material for personalized magnetotherapy of different bone diseases and defects. According to our best knowledge, our team is the first to come up with an idea to combine zeolites/ZIFs and iron MPs in biomedical applications. **We aim to develop material solution to the problems of modern biomedicine**. Combining the chemistry, biology, engineering and medicine will allow our team to look at the picture from a bigger perspective: synthesizing the novel materials by means of chemical methods, modifying its properties with biopolymers and chosen drugs for a sustained release, optimizing the process parameters of each part of the project, biological characterization, and in the end medical application. **Therefore, we will obtain specialized chemical and biological knowledge, that could be useful to solve the real-life problems.**

Project highlights:

- In this project a smart zeolite/ZIF-chitosan magnetic biomaterial will be developed.
- The originality of the idea is based on the application of biomaterial that subjected to external magnetic field will lead to enhanced regeneration, better bone healing, and sustained drug delivery to the diseased parts.
- **To the best our knowledge we are the first to develop and apply such biomaterial in biomedicine.**
- The presence of zeolite or ZIFs will guarantee the expected porosity and good physical and chemical stability, whereas addition of iron magnetic particles will increase the surface roughness influencing the cell adhesion and better regeneration.
- Functionalization with chitosan will result in better biocompatibility of the obtained material, whereas the addition of different bioactive molecules (drugs) will be used with accordance of personalized medicine allowing better healing process of different bone fractures and diseases.
- Iron MPs will also grant better imaging and diagnostics of the diseased parts.