

The aim of this project is to develop advanced, eco-friendly materials that support the regeneration of damaged bone and cartilage in the human body. By utilizing advanced 3D printing technologies, we aim to create precise, porous scaffolds that facilitate the effective growth of new tissue at the injury site.

The project focuses on producing innovative biocomposites that combine natural polymers with carbon derived from plant biomass through pyrolysis, along with graphene-based nanomaterials. This combination ensures that the scaffolds possess high strength, lightness, and biocompatibility. Their unique, hierarchical porous structure will enable cells to settle within and facilitates efficient nutrient flow, which is crucial for tissue regeneration.

3D printing technology will enable precise fabrication of implants with varied porosity and shapes tailored to the individual needs of patients and the specific characteristics of damaged tissues such as bone or cartilage. Moreover, advanced computer modeling will enable the design of scaffolds perfectly matched to the shape and mechanical properties of the target tissues, thereby enhancing the effectiveness and durability of the implants.

The research will utilize specialized cells obtained through the transdifferentiation of fibroblasts and/or fat-derived mesenchymal stem cells. This approach will enable the assessment of the scaffolds' impact on cell survival, proliferation, differentiation, and extracellular matrix production, as monitored by immunocytochemical and molecular methods. The project integrates interdisciplinary knowledge from materials science, cell biology, and biomedical engineering to develop innovative solutions in regenerative medicine. The materials and technologies developed may contribute to the creation of safe, effective, and personalized therapies for patients with bone injuries and cartilage damage, improving their recovery and quality of life.