Section 1: General Information

Title of the proposal (if applies)

Personalized Bone Regeneration via Immunomodulatory GBR/BSM Platforms

Name of the applicant/organization - *Full legal name of the organisation submitting the EoI*

NMI Natural and Medical Sciences Institute at the University Tübingen

PIC number

DE146484816

Country/Region

Germany

Section 2: Project/Idea Overview

1. **Project summary (max. 2.000 characters): *Briefly describe the project/idea objectives, expected outcomes, its relevance to the call's challenges, and approximate duration.***

Concept Overview

We propose a novel approach to *personalized bone regeneration* by developing *immunomodulatory Guided Bone Regeneration (GBR) membranes* and *Bone Substitute Materials (BSMs)* tailored to each patient's immune and healing profile. Unlike conventional "one-size-fits-all" solutions, our platform enables **material-level personalization**, not only in shape or size, but in biological function—guided by **patient-specific biomarkers** (e.g., cytokine levels, immune phenotypes). Advanced therapeutic medicinal products (ATMPs) proposed promising alternative therapeutic modalities by application of cell-based and tissue engineering approaches. Cell-based therapies are likely to be clinically supported by the new ATMPs, innovative fabrication processes, and enhanced surgical approaches. The development and standardization of methodologies is still a major challenge. (see review by Diaz-Solano et al., 2024).

According to the call's challenges, our project aims to:

- Connect innovative clinics and research institutes for bone regeneration
- Promote a more efficient development towards personalized Bone Regeneration membranes and Bone Substitute Materials
- Transfer best practices and solutions for patient treatment between the involved partners from 3 different regions in Europe

Expected outcome after 4 years' project duration - Key Components of the Platform:

1. **Modular Scaffold Architecture:** A core structure (e.g., collagen-mineral composite, synthetic polymer, or ceramic) serves as a universal base.
2. **Immunoregulatory Surface Toolbox:** A library of surface modifications—including peptides, nanostructures, and cytokine-mimetic agents—enables targeted immune modulation.
3. **Predictive Personalization Algorithm:** A machine-learning-driven tool integrates patient immune profiles to recommend optimal material compositions and functionalizations.
4. **Point-of-Care Adaptability:** Functional elements can be applied via:

    - Pre-fabricated modular inserts
    - On-site 3D printing or micro-dosing techniques
    - Surgeon-driven customization at the time of implantation

2. **Key innovation and impact:** ***Explain the innovative aspects of your project and how it will impact your target audience or sector. Indicate the current Technology Readiness Level (TRL) of your proposal and the one to be achieved.***

Clinical Relevance and Impact

Immunomodulatory materials offer a transformative advantage in regenerative medicine by actively shaping the local immune environment to support healing rather than merely avoiding adverse reactions. In bone regeneration, this is particularly crucial: an early pro-regenerative immune response can determine the success of osseointegration and long-term implant stability. By tailoring immunomodulatory cues to each patient's immune profile, we can significantly reduce the risk of chronic inflammation, infection, or fibrosis—especially in high-risk or immunocompromised individuals. This approach not only enhances healing but also supports long-term functional integration of the graft.

This strategy enables **real-time adaptation** of implants to each patient's biology, leading to:

- Improved bone regeneration outcomes
- Reduced complication rates (e.g., inflammation / premature degradation, infection)
- Enhanced predictability and scalability in clinical workflows
- Progression toward TRL 6–7 and industrial feasibility

Summary of Innovation:

- ☑ *Modular material platform* adaptable to various clinical indications
- ☑ *Transferable coating toolbox* for immunomodulation and bioactivity
- ☑ *Algorithm-driven personalization* based on patient-specific biomarkers
- ☑ *Scalable and surgeon-friendly application* via pre-fab or intraoperative delivery

TRL:

Current: 6; the one to be achieved: 8

3. **Alignment with PRECISEU project objectives:** ***Detail how your project aligns with the objectives of the call***

Our project aligns with the core goal of PRECISEU to operationalise precision medicine through harmonised, patient-centered innovation as follows:

Healing variability among patients, especially in compromised conditions (e.g., diabetes, smoking, aging), is often driven by differences in immune response. By **profiling patients preoperatively**—e.g., via blood-based cytokine analysis—we can **predict the optimal material configuration** for each individual. This includes:

- Surface functionalization (e.g., immunomodulatory peptides, cytokine mimics, antimicrobial agents)
- Controlled delivery of osteostimulative factors
- Scaffold selection from a base of standardized, modular materials
- Integration in the diagnostic and the perioperative surgical process.

Section 3: Team and collaboration2

1. **Are you submitting this EoI as leading partner of the proposal of an existing consortium?**

   Yes

2. **Team involved in the Project (if any):** ***Names and roles of your organisation team key members (up to 3). Relevant expertise and background of the team (3 lines max per team member).***

NMI Reutlingen, Prof. Dr. Xin Xiong: Modulation and analysis of osteoinductive Mg-based membrane materials; including growth factors, antimicrobial components

NMI Reutlingen, Dr. Hanna Hartmann: Application and analysis of immunoregulatory 3D bioprinted hydrogel coating; including collagen and drug particles

3. **Entities involved in the consortium (if answer to question 1 is "Yes") / Potential Partners or Collaborators (if answer to question 1 is "No"):** ***List any organizations you collaborate or plan to collaborate or are foreseen to be needed, indicating their region and typology (public, private, profit/non-profit, enterprise…).***

Research center for Periodontal Peri-implant Diseases, Ferrara, Italy, Prof. Dr. Trombelli: Delivery of clinically relevant data; animal studies

Bokštų Dental Clinic, KLAIPĖDA, Lithuania, Dr. Tadas Korzinskas: Delivery of clinically relevant data

University of Reutlingen, Reutlingen, Germany, Prof. Burgert: Setup of predictive personalization algorithm, surgical process integration

4. **Resources and Infrastructure:** ***Describe the resources or infrastructure available to implement your project.***

NMI: Fully equipped cell culture lab, 3D bioprinter, Confocal laser scanning microscope, XX

Kommentiert [HH1]: Xin: Ergänzen

Research center for Periodontal Peri-implant Diseases: Animal testing facility

Bokštų Dental Clinic: Modern dentistry equipment for dental implantation, microsurgical endodontics and tooth canal treatment

University of Reutlingen: Research operating room for early tests of intra-operative applicability and surgical process integration, machine learning infrastructure (lab-size, and large-scale high-performance computing cluster access).

Section 4: Mentoring and support needs

1. **Support required for the proposal:** ***Specify the type of mentoring or support you would need to refine your proposal***

   fine-tune the idea, objectives, and tasks

   find possible partners

2. **Need for capacities:** ***Indicate specific areas where additional capacities or partners would be beneficial.***

To strengthen the clinical foundation in the initial phase, additional dental clinics as partners would be beneficial. This would allow broader access to clinical data, enabling more robust training and validation of the personalization algorithm.

3. **Support required to reach out to international partners:** ***Indicate how we can help you create links to stakeholders in the regions of the project***

Support in identifying and connecting with clinical or industrial partners in the target regions—particularly those with experience in bone regeneration, biomaterials, or personalized medicine—would be highly valuable. Assistance with facilitating introductions, hosting joint virtual meetings, or leveraging existing bilateral cooperation platforms (e.g., EU–Asia, EU–US research networks) would help establish strong, regionally relevant collaborations. Also expertise in field of regulatory affairs for AI, AI based decisions, software and software/AI validations will be beneficial.

Section 5: Funding rate (informative section)

Approximate overall budget forecast (in €) (Optional and not binding) Total:

NMI 600 T€

Clinic Italy 300 T€

Clinic Lithuania 200 T€

University Reutlingen 300 T€

= 1,4 Mio €

Section 6: Consent and declaration (data privacy acknowledgment and declaration of authenticity)

Simplified technical route: