1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan, all in English)

Project title:

Biodegradable scaffolds of potential application in orthopaedic and maxillofacial surgery – the synthesis, structural and morphological characteristics, analysis of corrosion susceptibility and biological activity

1.1. Project goals

The scientific goal of the proposed project is to gain the comprehensive knowledge about the synthesis and relationship between the structure and the morphology of newly produced biodegradable nano- and microarchitectonic 3D iron and iron-based systems (with the addition of other biodegradable metals, such as Mg and Zn), and their mechanical properties, wettability, corrosion susceptibility as well as biocompatibility and biological activity.

1.2. Outline

Bone fracture and defect are becoming more and more common with the rapid increase of aging population, traffic accidents, sport injuries, and illness. Although autologous bone and allogeneic bone are considered to be ideal candidates for bone repair, they are restricted by either limited source or immunologic rejection. In view of this, numerous research efforts have been made to develop implants as bone substitutes. A desired bone implant is supposed to uniformly degrade in the human body and be progressively replaced by the growing tissue until the bone repair process is completed. The mechanical properties, such as strength, elastic modulus, and hardness, etc., should be comparable with or slightly higher than those of natural bone for sufficient load-bearing capacity without looseness or displacement. Moreover, it should not cause toxicity or inflammation in the human body, but meanwhile, promote bone regeneration by osteoinduction and osteogenesis [1-4]

Mg and Mg alloys (Mg-based alloys), Zn and Zn alloys (Zn-based alloys), and Fe and Fe alloys (Fe-based alloys), are proposed for use as bone implants. Mg is one of the most abundant cations in the human body and exists primarily in bone, positively affecting the metabolism of enzymes and the structures of RNA and DNA [5]. Zn plays a key role in physiological functions such as bone metabolism, gene expression, and synthesis of various transcription factors [6]. Fe is one of essential trace elements in the human body and plays a major role in oxygen transport and many enzymatic reactions [7]. All three elements are recognized to be biodegradable and exhibit potential application for bone repair [8]. However it is important to synthesize them in the adequate form, from structural and morphological point of view, to obtain material of optimal susceptibility to corrosion in the human body environment, and at the same time material of optimal biointegrity, actively participated in the bone formation.

1.3. Work plan

1. Synthesis of iron-based materials (pure iron and the combination of iron with Mg and Zn) with defined nano / microarchitecture given by the template;

2. Enrichment of iron-based materials with other individuals of potential biological activity

3. Structural and morphological characteristics of obtained iron-based materials;

4. Analysis of physico-chemical properties, wettability and free surface energy of obtained iron-

based materials;

5. Studies on the susceptibility of obtained iron-based materials to corrosion;

6. Analysis of mechanical properties of obtained iron-based materials;

7. Analysis of the obtained iron-based materials in terms of their biocompatibility and osteointergration potential.

1.4. Literature

[1] X. Liang, Y. Qi, Z. Pan, Y. He, X. Liu, S. Cui and J. Ding, *Mater. Chem. Front.*, 2018.
[2] Y. Nakamura, Y. Tsumura, Y. Tonogai and T. Shibata, *J. Health Sci.*, 2008, **45**, P15-15.
[3] Q. Xu, M. Hashimoto, T. T. Dang, T. Hoare, D. S. Kohane, G. M. Whitesides, R. Langer and D. G. Anderson, *Small*, 2009, **5**, 1575.
[4] D. Mushahary, R. Sravanthi, Y. Li, M. J. Kumar, N. Harishankar, P. D. Hodgson, C. Wen and G. Pande, *Int. J. Nanomed.*, 2013, **2013**, 2887-2902.
[5] C. M. Serre, M. Papillard, P. Chavassieux, J. C. Voegel and G. Boivin, *J. Biomed. Mater. Res.*, 1998, **42**, 626-633
[6] L. Rink and L. Rink, *Zinc in Human Health*, 2011, **11**, 63-87
[7] E. Zhang, H. Chen and F. Shen, *J. Mater. Sci. - Mater. Med.*, 2010, **21**, 2151-2163
[8] A. Oriňák, R. Oriňáková, Z. O. Králová, A. M. Turoňová, M. Kupková, M. Hrubovčáková, J. Radoňák and R. Džunda, *J. Porous Mater.*, 2014, **21**, 131-140.

1.5. Required initial knowledge and skills of the PhD candidate

The basic knowledge in the field of inorganic and coordination chemistry, materials engineering, spectroscopic methods of materials and nanomaterials characterization, is required. Moreover, skills of the PhD candidate in the synthesis of coordination compounds and use of analytical methods in structural characterization of new compounds will be warmly welcomed. Moreover, the good command of English in writing and speaking, and also ability to teamwork and willingness to the competence improves in field of the nanomaterial and biomaterial chemistry, will be an advantage.

1.6. Expected development of the PhD candidate's knowledge and skills

The PhD student will acquire interdisciplinary knowledge in the field of modern nanomaterials, biomaterials, material engineering, instrumental analysis, spectral and structural characterization of coordination compounds, as well as basic knowledge in the field of *in-vitro* biological research. In addition, the doctoral student will gain experience in preparing conference presentations and publications.