Project title: Functional Regeneration of the Intervertebral Disc using Silk Biomaterial

Project leader: Dr. Samaneh Ghazanfari/ Prof. Stefan Jockenhövel

Function: Group Leader/ Professor

Collaborators: Dr. Jules Harings

Proposal (250 words):

Introduction: Low back pain, often associated with degeneration of the intervertebral disc (IVD), is the leading cause of disability worldwide. Due to the limited success rate of currently available medical interventions, tissue-engineering is studied as a promising alternative. The IVD consists of two components: a sponge-like nucleus pulposus in the core surrounded circumferentially by lamellae of aligned collagen fibers, called the annulus fibrosus. Thus far, successful engineering of the IVD has failed since replication of its heterogeneous architecture, mechanical properties and anatomic form have proven difficult.

Hypothesis and Objectives: Regeneration of a functional native IVD analogue containing its two individual components using proper materials and fabrication techniques will lead to long term functionality of the IVD implant.

Setting and Methods: First, the annulus fibrosus using silk fibers and a textile technique will be fabricated to mimic the IVD native lamellae structure. Then, the silk-based hydrogel will be injected into the core of fabricated annulus fibrosus to form the nucleus pulposus. Human mesenchymal stem cells, as an appropriate cell source, will be then seeded into the annulus fibrosus and the nucleus pulposus regions. Finally, histological, biochemical and mechanical properties will be assessed.

Impact: Creating a well-organized and functional tissue is one of the greatest challenges in the field of tissue engineering. The output of the proposed study will have a tremendous impact on understating of the pattern formation and therefore functional regeneration of not only the IVD, but also other mechanically-functional lamellar tissues found throughout the body such as blood vessels.

Requirements candidate: We are looking for an excellent and enthusiastic candidate with excellent communication skills holding a master's degree in Bioengineering, Materials Science, or relevant fields.

Keywords: Functional intervertebral disc tissue-engineering; Extracellular matrix arrangement; Functionalized silk biomaterials, Fiber-guided regeneration; Textile-reinforced implants.

Top 5 selected publications:

1. S. Ghazanfari, A. Driessen-Mol, C.V. C. Bouten, F.P.T. Baaijens, Modulation of collagen fiber orientation by strain-controlled enzymatic degradation, **Acta Biomaterialia**, 35, 118-126, 2016.
2. S. Ghazanfari, A. Khademhosseini, T.H. Smit, Mechanisms of collagen lamellar structure formation in connective tissues, **Biomaterials**, 97, 74-84, 2016.
3. S. Ghazanfari, A. Driessen-Mol, B. Sanders, P. Dijkman, S.P. Hoerstrup, F.P.T. Baaijens, C.V.C. Bouten, In-vivo collagen remodeling in the vascular wall of decellularized stented tissue engineered heart valves, **Tissue Eng Part A**, 21, 2206-15, 2015.
4. R. Moreira, C. Neusser, M. Kruse, S. Mulderrig, F. Wolf, J. Spillner, T. Schmitz-Rode, S. Jockenhoevel, P. Mela, Tissue-Engineered Fibrin-Based Heart Valve with Bio-Inspired Textile Reinforcement, **Adv Healthc Mater**, 5, 2113–2121, 2016.
5. S. Weinandy, S. Laffor, A. Dreier, R. Unger, R. Loesel, T.C. Flanagan, M. van Zandvoort, B. Herrmann-Sachweh, D. Klee, S. Jockenhoevel**,** Biofunctionalised microfibre-assisted formation of intrinsic three-dimensional (3-D) capillary-like structures, **Tissue Eng Part A**, 20, 1858-69, 2014.