QUB – Mechanical and Aerospace Engineering PhD project 2017-18

Title: Design and optimisation of bioresorbable scaffolds for the repair and regeneration of natural bone.

Project description:

This project is associated with the recently established MATCH (Material and Advanced Technologies for Healthcare) Pioneering Research Programme, an exciting new multidisciplinary initiative involving QUB researchers from School of Chemistry and Chemical Engineering, Pharmacy, and Mechanical and Aerospace Engineering.

Natural bone is a unique composite of interpenetrating microstructures of organic and inorganic mineral phases which contribute (hierarchically) to the whole behaviour of the bone at tissue level. The healthcare challenge of an ageing population (increasing the incidence of fractures and bone loss due to disease) has led to increasing need for developing porous 3D scaffolds that provide the temporary mechanical support and appropriate environment for bone healing (Figure 1). The synthetic scaffolds must possess the essential qualities of biocompatibility, desired architecture and mechanical properties comparable to native tissue. Furthermore degradation and resorption rates in physiological conditions need to be tailored so that the scaffold is retained until the tissue is regenerated at the defect/implant site.

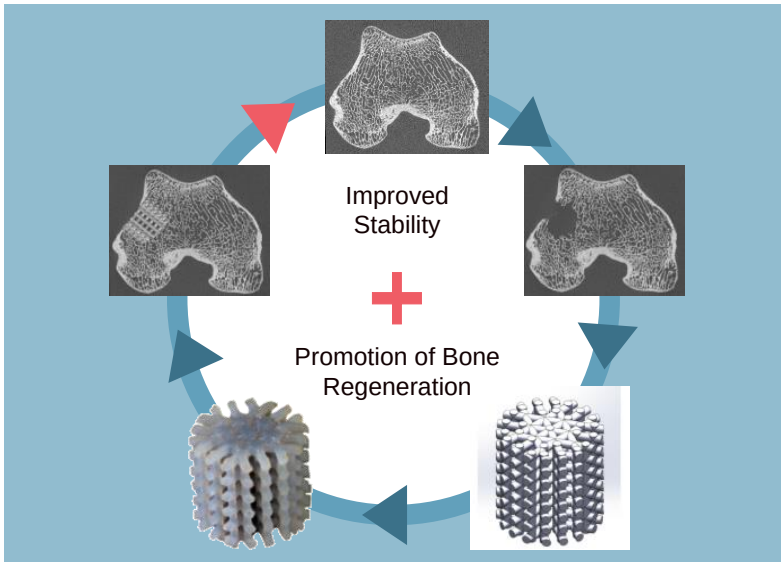

Figure 1. Bioresorbable bone scaffold for bone tissue regeneration

This study aims to develop synthetic composite porous scaffolds by combining bio-ceramics (HA or tricalcium phosphate), bioresorbable polymers (PLGA or PCL) and collagen.

1. Firstly, the scaffold's design (topology, strand thickness, spacing, porosity, etc.) and choice of biomaterials will be established (literature/clinical review, CAD, finite element methods and through optimisation).

2. Then the scaffolds will be manufactured using additive manufacturing methods such as ‘fused deposition modelling’ (FDM) or combined with other bio-fabrication technologies.
3. The necessary qualities required for a scaffold will be investigated through various mechanical experiments and biocompatibility studies.

4. Degradation behaviour will be monitored using long-term *in vitro* test methods (previous developed at QUB) to ensure that bioresorption rates and mechanical properties changes are appropriate for the bone healing environment.
5. A simple 2D mechanobiological model will be implemented to predict the bone tissue regeneration and biodegradation of scaffold with the input from experiments.

Key skills required for the post:

The student should demonstrate enthusiasm for research in the field of bioengineering and be willing to develop the following skills to carry out this project:

- Additive manufacturing, 3D printing
- Physical testing of biological materials
- Finite element analysis and material modelling in software such as *Abaqus* and *Matlab*
- Generate CAD/FE models

Key transferable skills that will be developed during the PhD:

- Training will be targeted towards securing employment in academia or medical/pharmaceutical industries.
- Problem solving and analysis skills will be developed while defining research questions, designing new experiments, processing data and drawing independent conclusions.
- Effective project management, impact and disseminating research findings skills
- The key skills acquired during the course of PhD will also be highly transferrable to careers in R&D in medical device industries and within academia.

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Top-up available for this project?	The studentship covers the full university fees and includes an income of up to £18,500 per annum (comprising a £14,000 stipend, a potential £3,000 top-up and the opportunity to undertake teaching and demonstration duties to earn up to a further £1,500 per annum). The potential top-up is available, dependent on the recommendation of the interview panel.