QUB – Mechanical and Aerospace Engineering PhD project 2019-2020

Title: 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.

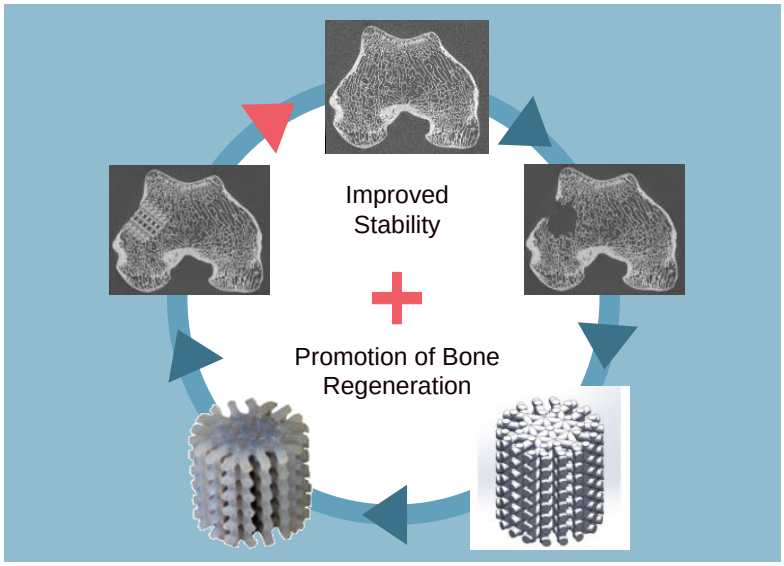

Figure 1. Bioresorbable bone scaffold for bone tissue regeneration

This study aims to develop functional, bioresorbable bone scaffolds that recapitulate the biomimetic properties of native bone tissue using a combination of reinforced bioresorbable materials and 3D bioprinting, and to investigate the mechanobiological bone regeneration in such scaffolds using an *in vitro* bioreactor system.

1. Firstly, the scaffold's design (topology, strand thickness, spacing, porosity, etc.) and choice of biomaterials will be established (literature/clinical review and CAD). Then the scaffolds will be manufactured using additive manufacturing methods such as 'fused deposition modelling' (FDM) or combined with other bio-fabrication technologies.
2. The necessary qualities required for a scaffold will be investigated through various mechanical experiments and biocompatibility studies.

3. 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.
4. The bone regeneration in 3D printed scaffolds due to an applied mechanical stimulation will be investigated using an *in vitro* bioreactor system. 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
- Cell and tissue engineering skills
- Physical testing of biological materials
- 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 at the home rate and a stipend of approx. £14,925 per annum. The potential top-up of £3000 is available dependent on the recommendation of the interview panel. PhD students in the School have the opportunity to apply to be demonstrators on undergraduate modules. Compensation for this can amount to in excess of £2,400 per year.