SEMS: RESEARCH PROJECT DESCRIPTION

1. Project Background and Description

3D perfusion bioreactor development for screening of bioactive bone-graft substitutes

Global healthcare expenditures are projected to increase at an annual growth rate (AGR) of 5.4% between 2017-22, from $7.7-$10 trillion, reflecting increases in life expectancy, and non-communicable diseases such as cancer, osteoarthritis and diabetes. Similarly, the global market for medical devices is projected to rise from $521-$674B between 2017-22, AGR 5.3%.

Due to on-going advances in technology and manufacturing processes, new and improved medical devices are constantly being developed, often driven by innovation in materials. However high-profile cases involving failing implants causing harm to patients have triggered a review of regulation to strengthen evidence & safety requirements for implants, challenging manufacturers to validate efficacy & safety while pursuing innovation. In vitro cell testing within this area has become increasingly important as a mechanism to interrogate biological efficacy, gaining in recognition from regulatory bodies.

However, with an increasing number of materials to assess, and recognition that structural morphology is at least as critical to biological function of bone graft substitutes as substrate chemistry, a rapid through-put mechanism is needed which allows for quantification of 3D graft efficacy and safety. Moreover, many such implantable materials are subjected to the mechanical forces generated by the body, both by mechanical strain to the graft and through fluid shear interactions within the open pore structure. The experimental selection procedure must, therefore, accommodate evaluation of material or devices performance in a suitable physio-mechanical environment.

Accordingly, the aim of this studentship is to develop modifications to an existing piece of apparatus in SEMS to address this specific issue and thus facilitate investigation of the mechanisms of action behind sensitivity of graft performance to porosity. This knowledge and capability could be key to innovating and screening next generation bioactive bone-graft substitutes.

2. Project Scope

To extend the use of a 3D perfusion bioreactor system that accepts 'cartridges' of novel granular materials seeded with cells that can be subjected to differing fluid flow rates or viscosities, by:

1) Development and testing of hardware to apply mechanical load to engender physiological levels of bulk strain directly to the graft material in conjunction with fluid shear.

2) Characterizing differences/sensitivity in the magnitude of the response between uncommitted hMSC and committed osteogenic precursor cells to manipulation of perfusion profiles/strain application.

3) Development and testing of capability to run serial and parallel co-cultures.

3. Desired Skills from the Student

A first degree (BEng/BSc Hons 2:1 or First) in either Materials Science and Engineering, Biomedical Materials Science, Biology, Biomedical sciences or a closely allied discipline such as Biomedical Engineering.

Some expertise in in vitro cell testing techniques.

Some exposure to the field of materials science.

Excellent communication (written and oral), inter-personal and organisational skills.

4. Supervisory Team

Primary: Dr Karin Hing

Secondary: Dr Simon Rawlinson (SMD)

Additional: Mr Dan Johnson (Baxter)