Making progress in biomaterial design and tissue validation

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There have recently been several advancements in the world of biomaterial design and tissue validation thanks to the BIODESIGN consortium. Currently, a partnership of 19 research and clinical teams

from academic centres, small biotech and large pharmaceutical companies is designing and developing state-of-the-art therapeutic approaches, with the aim to help treat traumatic damage and degenerative diseases in humans and alleviate patient suffering.

Progress has been made in biomaterial design by a research team from UCL ('University College London'), UK, led by Professor Robert Brown. His team have addressed one of the major issues in utilising collagen based biomaterials for tissue repair; the problem being that when using materials with growth factors and cells the 'mix' can grow out in all directions, which does not correspond to the strict alignment and positioning that occurs during tissue growth. This indicates that a material used for repairing tissue should provide both the structural components and a direction in which the tissue should repair to permit functional integration with the surrounding tissue. By combining compression and photodynamics - light-dependent mixing approaches - Brown's team have managed to create a highly structured material system, which can be tailored for multiple complex tissues.

Similar research has been conducted by research fellow Oommen Varghese's team at the University of Uppsala, Sweden. Studies were conducted on the use of biomaterials based on naturally occurring molecules from the extra cellular matrix. The team has developed a highly versatile system that can be used in therapeutic methods. Injectable hydrogels with tunable release kinetics of therapeutic proteins based on certain molecular structures - Hyaluronic acid and glycosaminoglycans - have been developed which support tissue repair.

Teams from the University of Nottingham, led by Professor Kevin Shakesheff, and the University of Uppsala, have created a series of biomaterials which have been tailored to treat very specific bone disorders. This opens up the market of real options for all possible bone disorders. Materials for bone disorders have previously typically focused

on large bones and the skull; but such materials are not best suited for smaller bones which are equally important, so as bones found in the ear. Shakesheff's team has developed of a biodegradable scaffold tailored for ear bone air-cell regeneration. As far as studies are aware, this is the first such scaffold for this application that can be pasted into a cavity and that hardens in the body. The Uppsala team has taken existing materials and combined them with phosphonates - typical form of drug used to treat osteoporosis - to generate two new types of materials. The first helps correctly form a supportive structure, the second helps perfect, protect and encourage cell growth and interaction.

Teams from the AO Foundation, Switzerland and the University of Southampton, UK have started to identify more informative solutions for providing correlating information that permits correct decision making for the development of human tissue therapeutics. Led by researcher Martin Stoddart, the team from Switzerland has looked into the cells which are used as the starting assays to assess if materials can induce bone generation. The team has successfully identified two immortalised cell lines that very closely correspond to human cells. This has outlined the cells which should be analysed more in depth in future research; only those materials that generate all the required positive outcomes above the required thresholds for the required effect of the material should progress further in development.

Professor Richard Oreffo's team from the University of Southampton aimed to identify lower-cost, faster and more informative models for tissue repair design strategies. He revisited using young chicken bone cultures as the intermediary between the cell assays and the mice studies. Young chicken bones can be surgically removed and grown in petri dishes and the effects of bone promoting repair materials tested as their differential and unique response to exogenous stimuli provides an attractive model for testing growth factors and screening therapies. By using this method the number of materials that are moved into animal

modelling greatly decreases, creating cheaper, quicker, higher impact, more ethical information.

Research on skeletal muscle tissue validation has been worked on by a team at UCL, led by Professor Giulio Cossu. The team, in collaboration Professor Dror Seliktar's team at Technion - Israel Institute of Technology, Isreal, has been finalising the first series of preclinical experiments combining muscle stem cells with biomaterials. Two development signals and one growth factor have been identified; they can have a significant impact on muscle cells in the tissue itself determining and modifying their behaviour. Even though the cells and the material are being tested separately in clinical trials, there is the potential for a rapid combination and testing on humans.

Excitingly these are just the first rounds of research; optimising cell types, newer materials and more precise growth factors and developmental signals all integrated into a common therapeutic represents the future of this therapeutic avenue. As such, this pioneers the new approaches being developed through the BIODESIGN project.

The BIODESIGN project responds to a major demand for a science-technology framework and the production of protocols to select and tailor faster and cheaper functional bio-inspired materials. It aims to successfully use a 'modular' approach to lead material fabrication, use enabling technology and to finally demonstrate such state-of-the-art materials and technology to European investors. The project is co-financed by the EU's FP7 programme and its research is coordinated by Professor Jons Hilborn from the University of Uppsala, Sweden.

"These published results are the first public demonstrations of the relevance and impact of the original BIODESIGN project plan. We have already demonstrated the absence of correlation between clinical outputs in humans and the historical development assays used during preclinical

development and are now progressing in the rational design of real regenerative therapies based upon known patient need and state of the art knowledge. Although still some way from the clinic, the foundations lain by the partners are very solid and hold great promise for the future", stated Professor Hilborn.

More information: www.biodesign.eu.com/

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