Thematic Actions

Coordinating Universities for the Proposal: UCM and UPM

Title of Action	**Workshop for the Design of Biomaterials for Bone Tissue Regeneration**		
Participating partners	UCM, UPM, CSIC	**Other participants**	
Personnel involved (indicate institution)	M. Vallet Regí (UCM), T. Portolés (UCM), J. I. Pastor (UPM), L. Escudero (CSIC)		
Start date	1-1-2010	**End date**	31-12-2012
Cluster	Materials for the Future	**Other clusters**	Agri-food and i-Health
Areas of action	Research / Knowledge Transfer		
Location	Department of Inorganic and Bioinorganic Chemistry, Faculty of Pharmacy, UCM		
Infrastructures involved	Advanced Electron Microscopy		
Keywords	Tissue Engineering; Biomaterials		

Objectives:

The main objective of this project is to design new materials with potential applications in bone regeneration medicine. UCM and UPM both possess the human and material resources needed to undertake biomedical engineering projects, dealing with topics such as prosthesis and implants, instrumentation and equipment, modelling, simulation and biomechanics, with help from biology and chemistry specialists involved in these biomedical and biotechnological issues. The combined actions of different groups of specialists (chemists, physicists, engineers, biologists, veterinaries and clinical professionals) will have a common purpose of developing new implantable materials to offer solutions to different bone tissue pathologies where tissue regeneration is a requirement. The final goal is to develop materials that can be patented and used in clinical trials, providing new clinical products designed to regenerate bone and/or restore its function in the human body.

Description of the action:

The project contains a range of actions related to the key challenges in the field of bone regeneration today:

- Implants for bone regeneration, with applications in osteoporosis fractures, maxilofacial deformities, critical posttraumatic defects and bone tumours. Structural (ceramics, metal and polymers) and biological (collagen, demineralised bone matrix,…) materials will be used as starting elements. The participation of UPM and CENIM (CSIC) in the development of structural materials is essential, and will give an added value to the research carried out into these materials by the Department of Inorganic and Bioinorganic Chemistry at the Faculty of Pharmacy, and the Biochemical Department at the Faculty of Chemistry.
- Implanted local release systems of osteoinducing factors, such as BMPs, growth factors or antiosteoporosis drugs
- Development of tissue engineering scaffolds. This action includes the surface design to facilitate cell-material interaction and the design of 3D macroporous structures by fast prototyping techniques.

The aim is to provide a solution with a regenerative response, not only replacing damaged bone. The series of actions will tackle the problem comprehensively, from a multidisciplinary point of view, encompassing:

a. Synthesis and control of the material structure at different matter ordering scales, from the nanostructure to the final morphology.

b. Morphology design based on biomechanical principles to optimise the implant functionality.

c. Integration of stimulus-response properties (smart biomaterials).

d. Assessment of in vitro biocompatibility with cell cultures.

e. In vivo assessment with animal models.

Much of the structural characterisation work will be carried out at the ICTS of Advanced Electron Microscopy which, thanks to their new generation of STEM microscopes with aberration correctors, which provides new information on the composition-structure-properties equation.

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Key planned results:

- The production of new materials for use in clinical trials with subsequent applications in bone regenerative clinical practice.
- Improved strategies for bone pathology treatments.
- Increased competitiveness in the biomedical and biomaterial industries.

Rationale for the action:

Bone pathologies are currently one of the main sources of chronic pain, physical disability and absenteeism from work, both in developed and underdeveloped countries, affecting millions of people throughout the world. Thus bone regeneration materials provide new solutions to these problems as opposed to materials designed to replace damaged bone.

International aspects:

The different research groups involved have established scientific cooperation with various international prestige centres in the field of biomaterials, both in Europe, USA and Japan. Furthermore, some members belong to European Networks of Excellence (NoE) and international institutes in Science of Materials. A consequence of this action is predicted to be the difussion of results at international conferences such as the World Biomaterials Conference, European Society for Biomaterials Conference, etc., which are the reference in the field.

Planned impact:

This action involves a multidisciplinary group of specialists from UCM, UPM and CSIC, coordinated to solve the issues of the most widespread bone pathologies currently affecting our society. The social impact of potential solutions is patent given that more than 100 million Europeans are affected by pain and physical disabilities due to osteopathies and maxillofacial deformities. Some 40% of women over the age of 50 are estimated to suffer at least one osteoporosis fracture during their lifetime. From a financial standpoint, the direct costs associated with these pathologies in the USA alone are calculated to be more than USD 35 billion per year. The inclusion of bone regenerators in clinical practice would lead to remarkable cost reductions, most likely stemming from reduced hospital bed occupancy and post-implant failures.