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Pictured left to right: Prof J Planell, Prof. J. Kirkpatrick, Prof. K. Vaughan, Dr. P. Geoghegan, Prof. R. Reilly, Dr. K. O'Kelly

Message from the Director

July was a busy month for the Trinity Centre for Bioengineering. We welcomed the announcement by the Taoiseach, Brian Cowen, of government investment in research and innovation which will benefit the Biomedical Sciences Flagship Institute on Pearse Street. The TCBE Summer symposium was held on 12th July 2010. This incorporated our AGM and a visit from the international scientific advisory panel. We also hosted the ESEM International Summer School for two weeks in July.

The summer symposium presented an opportunity for the new International Scientific Advisory Panel to present their comments and feedback from their first visit to TCBE which they cited as enlightening and fruitful to our PI's. Members of the International Scientific Advisory Panel are Prof. James Kirkpatrick, Director Institute of Pathology, Johannes Gutenberg University, Mainz; Prof. Kit Vaughan, Emeritus Professor of Biomedical Engineering, University of Cape Town; Prof. Bernie Conway, Professor of Bioengineering, University of Strathclyde; Prof. Josep Planell, Director Institute of Bioengineering Engineering of Catalunya, Barcelona. During their visit they met with a wide variety of individuals involved in TCBE and were extremely impressed with both the educational programmes and the excellent quality in TCBE's research activities.

At the AGM, Prof. Reilly presented the Annual Review for the Trinity Centre for Bioengineering. The Vice-Provost, Prof. Prendergast, welcomed the International Advisory Panel and emphasised the importance of bioengineering in Trinity College. Clinical collaborative opportunities for TCBE were presented by Prof. Kevin Mulhall from Santry Sports Clinic and Prof. Brendan Whelan from TILDA (The Irish Longitudinal Study on Ageing). We were pleased to have Dr Patrick Geoghegan, Associate Dean of Research, Trinity College present at the AGM. Prof. Bart Verkerke spoke of interaction with TCBE on international educational programs.

Under the HEA Programme for Research in Third-level Institutions (PRTL), the Trinity Biomedical Sciences Development is to receive significant funding of €55 million. TCBE will have three labs in the new building: Regenerative Medicine, Cardiovascular and Materials along with an impact test area. The PRTL program is also funding the Trinity Engineering PhD programme proposal for €2.8 million. This funding will allow us to grow graduate Education and quality research benefiting human health and society.

Prof. Richard Reilly
Director, Trinity Centre for Bioengineering

Recent Seminar

Macro-Micro Scale Interactions Associated with Motility and Nutrient Absorption in the Small Intestine analyzed with Lattice-Boltzmann Models

Speaker: James G. Brasseur
Professor of Mechanical Engineering, Bioengineering, & Mathematics
Dept. of Mechanical Engineering
Pennsylvania State University, USA
When: 19th July 2010

INNOVATION AND INVENTIONS AT THE TCBE

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Medical device design is currently blossoming at the Trinity Centre for BioEngineering. Three invention disclosures for new medical devices have been submitted to the Trinity Research and Innovation office over the last three months.

The projects include:

1. Developing a new transcatheter mitral valve repair/replacement device
2. A surgical tool that will increase the efficiency of open surgical repairs
3. A device to optimise surgical repair of the Achilles tendon

The transcatheter mitral valve solution is a joint venture between NUI Galway and TCD. This program is currently funded by Enterprise Ireland's commercialisation fund. The project is a high risk venture whereby multiple "threats" to the success of this device are always on the horizon. However the combination of the skills of the team members potentially will minimise or eliminate these risks. The team members include a consultant cardiologist (co-PI Jim Crowley), finite element expert (Michael Early), commercially focused R&D (co-PI Bruce Murphy), and a prototyping and *in vitro* testing engineer (Liam Breen). If successful the device could be used in clinical trials in the €1.4bn

The latter two projects are associated with the undergraduate bioengineering design project which proposed to identify a clinical need and deliver a solution for that need. The two projects featured in this article were selected as the top two projects of the 2009-2010 class.

The team involved in developing the surgical tool includes: Gavin Dooley, Ronan Doorley, Thomas Featherstone, Kevin Conway and Stephen Ellis. Over the summer months the team advanced their design and intellectual property application considerably. The mechanical engineering workshop is producing their first prototype and the patent claims and specs are being drafted at present.

The undergraduate team of Rossa Miller, Claudine Murphy, Emeline Mongellaz, and Mattieu Lassel identified a more complicated biological problem to resolve. While the French students returned to France, Claudine and Rossa continued to research their challenges in more detail over the summer months, and potentially they have identified a number of device embodiments that could be used to provide early stabilisation for a ruptured tendon and subsequently decrease the immobilisation time for a patient. However their invention requires further research and development before passing out of the "on paper concept stage".

Papers & Publications

Understanding the effect of mean pore size on cell activity in collagen-glycosaminoglycan scaffolds

Ciara M. Murphy¹ and Fergal J. O'Brien^{1,2,†,*} ¹Department of Anatomy; Royal College of Surgeons in Ireland; Dublin, Ireland; ²Trinity Centre for Bioengineering; Trinity College Dublin; College Green, Dublin Ireland

Buckley, C.T., Vinardell, T., Kelly, D.J. Oxygen Tension Differentially Regulates the Functional Properties of Cartilaginous Tissues Engineered from Infrapatellar Fat Pad Derived MSCs and Articular Chondrocytes. *Osteoarthritis and Cartilage* (in press).

Vinardell, T., Buckley, C.T., Thorpe, S.D., Kelly, D.J. Composition-function relations of cartilaginous tissues engineered from chondrocytes and mesenchymal stem cells isolated from bone marrow and infrapatellar fat pad. *Journal of Tissue Engineering and Regenerative Medicine* (in press).

Boccaccio, A., Kelly, D.J., Pappalettere, C. A Multi-scale Mechano-Regulation Model of Fracture Repair in Vertebral Bodies. *Journal of Orthopaedic Research* (in press).

Skeletal Muscle in Compression: Modelling approaches for the Passive Muscle Bulk

Authors: CK Simms, M Van Loocke, CG Lyons. Special Issue of the International Journal of Multiscale Computational Engineering Titled 'Active Tissue Modeling - From Single Muscle Cells to Muscular Contraction' Paper accepted:

Acoustic and temporal analysis of speech: A potential biomarker for schizophrenia. Rapcan V, D'Arcy S, Yeap S, Afzal N, Thakore J, Reilly RB. *Medical Engineering & Physics*. In press.

Neural responses to uninterrupted natural speech can be extracted with precise temporal resolution. Lalor, E.C., & Foxe, J.J. *European Journal of Neuroscience*, 31(1):189-193, 2010

Stimulation of osteoblasts using rest periods during bioreactor culture on collagen-glycosaminoglycan scaffolds Sonia Partap • Niamh A. Plunkett • Daniel J. Kelly • Fergal J. O'Brien ISSN 0957-4530, Volume 21, Number 8

Development and characterisation of a collagen nano-hydroxyapatite composite scaffold for bone tissue engineering

Grainne M. Cunniffe • Glenn R. Dickson • Sonia Partap • Kenneth T. Stanton • Fergal J. O'Brien ISSN 0957-4530, Volume 21, Number 8

Tissue differentiation in an in vivo bioreactor: in silico investigations of scaffold stiffness Hanifeh Khayyeri • Sara Checa • Magnus Ta"gil •

Fergal J. O'Brien • Patrick J. Prendergast. *J Mater Sci: Mater Med* (2010) 21:2331–2336

TCBE PEOPLE & ACTIVITIES

Prof. Paddy Prendergast gave an invited talk at the **World Congress of Biomechanics in Singapore** titled "Mechanobiology of tissue differentiation: experiment and computation".

The 6th World Congress of Biomechanics was hosted by Biomedical Engineering Society of Singapore (BES) together with the Global Enterprise for Micromechanics and Molecular Medicine (GEM4) and the National University of Singapore (NUS). Over 2,000 delegates from all over the World attended this congress. Special emphasis was placed on state-of-the-art technology and medical applications, for example in areas of sports medicine and crash injuries.

The following postdoctoral research fellows gave oral presentations at the World Congress of Biomechanics in Singapore:

Hanifeh Khayyeri - Mechanobiological simulations of variable cell mechanosensitivity explains variability in tissue differentiation in vivo.

Colin Boyle - A Computational Technique for Simulating Restenosis in Arteries due to Stenting using the Lattice-based Approach

Feng Xue - Does Biophysical Stimuli of Mesenchymal Stem Cells Change with Age during Strain-induced Differentiation?

Katey McKayed - Age-related Changes in Mesenchymal Stem Cell Mechanoresponsiveness with Applied Mechanical Strain

IMPACT FACTOR FOR JMBBM

The Journal of the Mechanical Behavior of Biomedical Materials, edited by David Taylor, Fergal O'Brien, Ciaran Simms and Clive Lee, has received its first Impact Factor, a very impressive 3.2, which is more than the Journal of Biomechanics and places it very competitively amongst other journals in the fields of biomaterials and bioengineering.

TCBE PEOPLE & ACTIVITIES

Dr. Danny Kelly's year in Columbia University as a Fulbright Scholar

I recently returned to Ireland after a wonderful year living and working in New York City. I was very fortunate to have been granted a Fulbright award to take a sabbatical position in Prof. Chris Jacobs's lab at the Department of Biomedical Engineering in Columbia University, New York. Prof. Jacob's and his group were very welcoming and supportive for the entire duration of my stay.

Professionally I achieved my two main objectives for the year, I got back into the lab and started doing my own experiments again, and I got to see the other side of a classroom once more, auditing a couple of graduate courses on mixture theory. In the lab I was working on two projects, one looking at the role of 'Hedgehog' signalling in mechanically mediated stem cell differentiation, and the second looking at how flow stimulated osteocytes promote osteogenic differentiation of stem cells. All going well, you might get to hear a little more about them at BINI this January!

My acclimatisation into Columbia University life was made much easier by the presence of another Irishman, Dr. David Hoey, who is currently working as a postdoctoral research fellow in the same lab. It was great to have someone to cry into my tea (just tea!) with when experiments weren't doing what they were told.

Besides being a wonderful University, Columbia also has the advantage of being located in the heart of New York.

Most people know what a great city New York is to visit, but we were slightly apprehensive about what life would be like there for a young family. Thankfully Catherine and the kids quickly settled into life in New York, made lots of new friends and we thoroughly enjoyed all the parks, playgrounds, museums, zoos, restaurants etc the city had to offer. Hopefully Ben will lose the American accent soon!

I would like to thank all my colleagues in Columbia University and here in Trinity College who helped facilitate this sabbatical. The people at Fulbright were also a great help, I'd highly recommend that people consider applying for this program. Finally I'd like to congratulate all the members of my lab for their patience (particularly with skype), for keeping focused during the year and for all their hard work.



It wasn't all hard work. Pictured here are Prof. Jacobs and some of his lab at a Mets game.

Congratulations to **Amro Widaa** who won 1st Prize in the Best Commented Poster Category at the recent Biomedical Sciences Section of Royal Academy of Medicine in Ireland Conference with a presentation entitled 'The effects of staphylococcus aureus on osteoblasts in osteomyelitis'

Hanni Kiiski,

a PhD student in Neural Engineering, attended the

ICA Conference 1st InterBrain Symposium and 10th EEGlab Workshop which was held in the scenic town of Jyväskylä, Finland from 14-17 June.

Keynote speakers included Scott Makeig who gave an inspiring lecture on "New perspectives on imaging distributed brain dynamics supporting human agency" and Aapo Hyvärinen who delivered a thought-provoking talk on ICA and blind source separation. The EEGlab Workshop gave a thorough overview on how to use EEGlab including hands-on exercises and an opportunity to analyse your own data. The lectures and tutorials were presented by Scott Makeig, Arnaud Delorme and Julie Onton, the very same people behind EEGlab. They also presented new developments in EEGlab such as Information Flow Analysis Toolbox and NFT Head Modeling Toolbox. All in all, the workshop gave basic tools for beginners to analyse their own data and introduced beneficial developments and their theoretical background to the most experienced EEGlab users.

We would like to welcome a **new IRCSET postdoctoral researcher** to TCBE. Jan-Henning Dirks who recently completed a PhD in Cambridge, is joining TCBE to work with David Taylor. Jan-Henning will be studying the mechanical properties of insect cuticle; that is to say, he will be pulling the legs off locusts for the next two years, thanks to generous support from ICRSET.





Students working on tibial osteosyntheses in the Biomaterials laboratory under the supervision of Prof. Dr. Nerlich, Head of the Department of Trauma at the University of Regensburg Academic Medical Center Surgery and President of the International Society for Telemedicine and eHealth



Vice Provost, Prof. Prendergast presented each student with their certificate at the closing awards ceremony. L-R: Prof. Prendergast, Ting (Ken) Chu Liu, RCSI, Prof. Verkerke, ESEM



Group photo of all thirty international summer school students



Press coverage for this year's summer school: this article featured in the Irish Examiner on 5th August 2010 highlighting the focus on healthcare challenges.

Thirty engineering, medical and biomedical engineering undergraduate students from across Europe are designing next generation medical devices at the Trinity Centre for BioEngineering at Trinity College Dublin as part of the European Society for Engineering and Medicine (ESEM) Summer School this week (July 11th -23rd). This is the second year for this unique European summer school, organised in collaboration between eight leading universities in biomedical engineering and medicine, apart from Trinity College Dublin these are the University of Groningen (NL), Ghent University (B), Brno University of Technology (CZ), Czech Technical University in Prague (CZ), RWTH University Aachen (D), University of Applied Sciences Regensburg (D) and the Royal College of Surgeons in Ireland (IRL).

“Current healthcare challenges, such as the ageing of Europe’s population as well as big killers such as cardiovascular disease, require multidisciplinary approaches for diagnosis and treatment. The focus therefore of this unique summer school is to establish a platform of cooperation between medicine and engineering across Europe starting at an undergraduate level”, explained Professor Richard Reilly, Director of the Trinity Centre of BioEngineering and organiser of the Summer School.

With different working cultures and educational backgrounds, the aim of the European Society for Engineering and Medicine Summer School at Trinity College has been to teach students how to work together efficiently by getting small groups to design new, novel medical devices targeting specific medical and clinical problems. These include the design of a cardiovascular monitoring system and a system to prevent bone loss, both for use in long-duration deep-space flights, as well as technologies to monitor the healthcare of the elderly and the design of artificial ventilation systems.

To have the educational basis to undertake this challenge, the students are taking courses delivered by 15 leading Professors of Biomedical Engineering and Medicine, who also join the students at Trinity College. The medical students are instructed in bioengineering methods (materials science, mathematics, biomechanics, signals and systems) necessary to successfully work in biomedical engineering while engineering students are instructed in anatomy and physiology at the Royal College of Surgeons in Ireland. Both groups of students are taught design methodologies for furthering their understanding and capability to understand, analyse and successfully conceptualise innovative medical device concepts using a multidisciplinary team approach. The students are also exposed to some of the ongoing multidisciplinary research in Trinity College, including demonstrations on Sports Physiology in the School of Medicine and also The Longitudinal Study on Ageing (TILDA), which is studying 8,000 people, aged 50 and over, charting their health, social and economic circumstances over a 10-year period.

“We want future biomedical engineers and clinicians to understand each other's discipline,” said Professor Bart Verkerke of the Department of Biomedical Engineering at the University Medical Center Groningen and ESEM President.

“The impact of this summer school has been to ignite enthusiasm and passion among undergraduate engineers and medical students for the challenges and opportunities in bioengineering,” continued Professor Richard Reilly, Director of the Trinity Centre of BioEngineering.

“There are currently over 11,000 medical technology companies in Europe, exporting €65 billion worth of products annually and employing 500,000 people. It is critical that we can demonstrate to these students that engineering innovation and creative design can meet the challenges in healthcare, continue the growth of medical device sector and the delivery of the best medical care possible,” concluded Professor Reilly. Students participating in the summer school are learning in a unique environment which was reflected in their comments of the programme:

“I am learning the differences in culture between medics and engineers. And I am learning to follow the Methodological Design Method for generating ideas concerning a specific problem and to optimise the organisation of a multidisciplinary project team.”

“The ESEM summer school will give me the opportunity to improve my knowledge of engineering in medicine and healthcare, meet other students from different countries and discuss with them in a constructively critical atmosphere.”

“I am amazed by what can be done and the directions one can take with this specialisation. I also have gained an overall understanding of modelling and simulation.”

‘I gained a lot of knowledge from the medical environment provided through the ESEM Summer School and the participating professors. It helped me carry out our project and to understand other participants' projects as well. ‘

The outcome of the collaboration will lead to continued interaction of the students throughout their undergraduate and also postgraduate career through the network established by ESEM. The novel project outcomes will be published on the society's website (www.esem.org) to further disseminate to the medical device industry and wider community.

The 2011 ESEM Summer School is also scheduled to take place at Trinity College. There is considerable opportunity for the medical device sector to get involved in the Summer School and participate in the lectures and project assignments. Interested industries can contact ESEM (www.esem.org).

Former students of 2009 Summer School have already decided to take their biomedical engineer career to the next level, by registering for the new Erasmus Mundus MSc in Biomedical Engineering. This funded postgraduate programme is also organised by the same consortium of European universities and is also focusing on preparing students for an international career in Biomedical Engineering.

There are a number of interesting postgraduate opportunities, all of which can be viewed on our website. The most recent positions posted include:

Postdoctoral Researcher & PhD Positions in Cartilage Tissue Engineering at the Trinity Centre for Bioengineering (Trinity College Dublin, Ireland)

Project 1: Development of a growth factor delivery scaffold incorporating minimally manipulated mesenchymal stem cells for use in articular cartilage repair.

Description: The objective of the project will be to determine whether freshly isolated mesenchymal stem cells (MSCs), embedded in a hydrogel containing microbead-encapsulated growth factors, can be used to treat damaged articular cartilage. The project will involve the development and evaluation of a novel growth factor delivery scaffold to support the viability, proliferation and chondrogenic differentiation of minimally manipulated MSCs. A further component of the project will include magnetic microbead selection for cells with surface markers associated with MSCs. The ultimate aim of the project is to develop a cell based therapy that from MSC isolation to construct implantation could be undertaken within hours in the clinical setting.

The successful applicants will join a multidisciplinary team of scientists, engineers and clinicians working in the field of tissue engineering and regenerative medicine in the Trinity Centre for Bioengineering. The project will involve collaborating with leaders in the field of mesenchymal stem cell biology and regenerative medicine.

Please see our website for details of positions available on project 1.

TCBE CURRENT OPPORTUNITES

Project 2: Engineering a tissue with a composition and zonal structure mimicking that of normal hyaline cartilage using mesenchymal stem cells.

Description: To date no cell based therapy has been developed that can consistently regenerate hyaline cartilage. The objective of this project is to engineer a functional cartilage tissue *in vitro* with a composition and structure approaching that of normal articular cartilage using mesenchymal stem cells (MSCs). It is hypothesised that such a zonal structure can be recreated or generated by controlling the oxygen tension and mechanical environment within the developing tissue. The project will involve the development and use of novel bioreactors to achieve this goal.

Position Available:

PhD Studentship – Applications are welcome from anyone holding a first class honours degree in Engineering or Science interested in the field of cartilage tissue engineering. The student will receive an annual stipend and will have their fees paid for the duration of their PhD.

Interested candidates in the above Cartilage Tissue Engineering positions should send a cover letter and a CV by email to Dr. Daniel Kelly (kellyd9@tcd.ie). Informal enquiries are welcome at the same e-mail address. The positions will remain open until they are filled by suitably qualified candidates.

PhD/postdoctoral position in the School of Engineering, TCD

The Irish National Roads Authority (NRA) will be funding a PhD/postdoctoral position in the School of Engineering at Trinity College Dublin. The PhD position will be funded for three years while the postdoctoral position will be funded for two years.

Project title: Experimental and Numerical Characterization of Low-Cost Roadside Barrier Solutions

Description: The current project proposes to use computational modelling techniques to evaluate the potential for proposed new designs that are based on freely available low-cost natural building materials (e.g. stone, earth etc.) and which meet cost, aesthetic and engineering requirements. The proposed designs will simultaneously be evaluated for aesthetics and lifecycle cost. A scaled prototype of the final proposed design will be produced and physically crash tested. A computational model of the scaled test will be developed and a comparison of the scaled and full-size computational model results will be used to predict the likely performance of the proposed new design in a future full-scale crash test.

Candidate Profile: Candidates for the PhD position should have a Bachelor's degree in Civil or Mechanical Engineering or a related field; a master's degree will be preferred. A strong background in Finite Element Analysis and mechanics is highly desirable.

Candidates for the postdoctoral position must have completed all the requirements for a PhD in Civil or Mechanical Engineering or a related field by the start date. Research experience in crash modelling using MADYMO or similar software packages is required. Previous work in the area of crash barrier designing is desirable. Interested applicants should contact Dr. Ciaran Simms csimms@tcd.ie or Dr. Bidisha Ghosh bghosh@tcd.ie