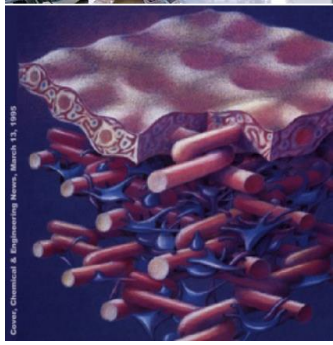
UCD Biomedical Engineering

Prof. Madeleine Lowery
UCD School of Electrical and Electronic Engineering
Dr. Donal Holland
UCD School of Mechanical and Materials Engineering
Laura Buckley
ME Biomedical Engineering Student

Biomedical Engineering



- Biomedical Engineering

  'The application of engineering principles to understand, modify or control biological systems'

- Wide variety of application areas

  Medical device design

  Biosignal, bioimaging and data analytics

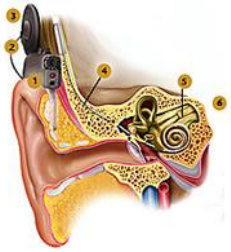
  Biomaterials, cell and tissue engineering

  Biosensors, brain computer interfaces

  Rehabilitation engineering, orthopaedics

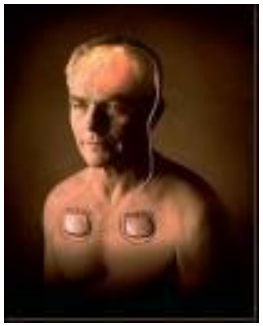
  Biomechanics & Sports Performance

- Foundation in Electrical/Electronic or Mechanical Engineering

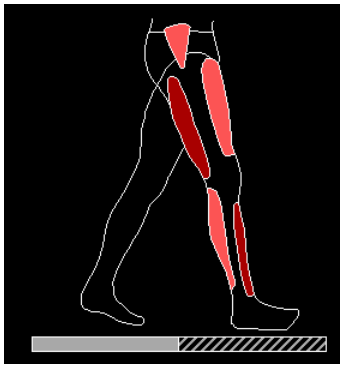


Cochlear implants

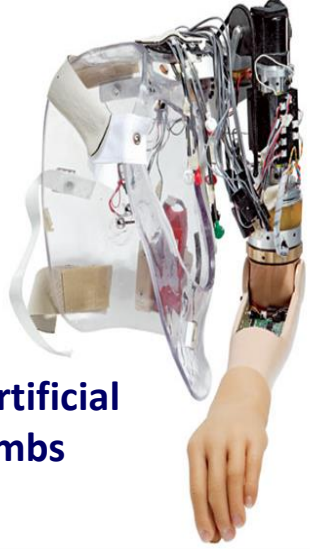
Pacemakers



Deep brain stimulation



Gait analysis

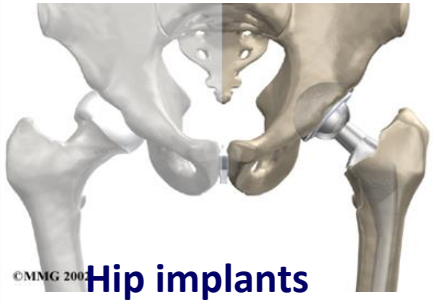


Artificial limbs

Biomedical Engineering

The application of engineering principles to understand, modify or control biological systems

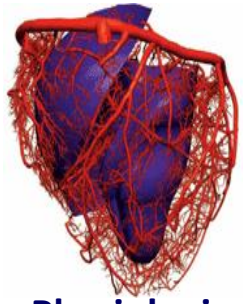
Rehabilitation robotics



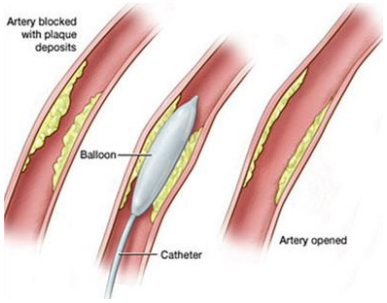
Hip implants

Biomedical signal processing

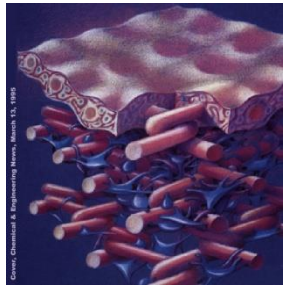
MR imaging



Physiological modelling



Angioplasty



Tissue engineering

Irish Medtech Association
Ibec

Ireland a global hub for Medtech
Sector employs over 40,000 people
14 of the world's top 15 medical technology companies have a base in Ireland.

One of the top 5 global medtech hubs competing with the likes of Massachusetts, Minnesota and California in the USA

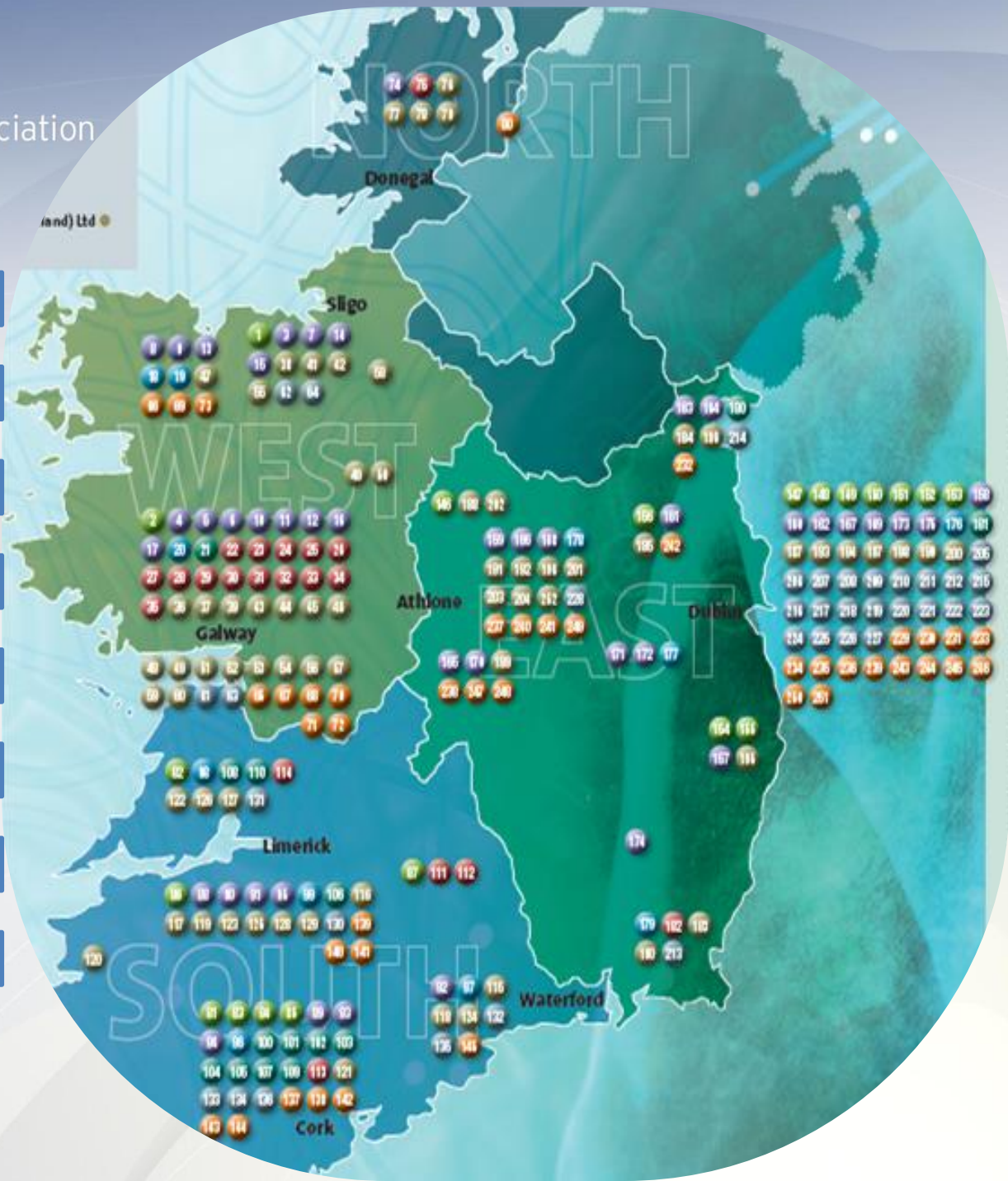
Medtech is a driver of regional growth with major clusters in Galway, Limerick, Cork, Waterford, Sligo and Dublin

https://www.irishmedtechassoc.ie/

https://www.idaireland.com/explore-your-sector/business-sectors/medtech

Irish Medical Devices Association

- diagnostic
- hospital and/or homecare products
- Ophthalmic
- orthopaedic
- vascular
- contract research, development,
- connected health
- service



Ireland continues to be a leading global hub for medtech

1st

Ireland is the no. 1 exporter of contact lenses from the EU and globally.

1st

Ireland is the no. 1 exporter of stents in the EU and globally.

2nd

Ireland is the 2nd largest exporter of medtech in Europe.

4th

Ireland is the 4th largest exporter of artificial joints in the EU.

4th

Ireland is the 4th largest exporter of diagnostic reagents from the EU.

14th

14 of the world's global 15 medtech companies are in Ireland.

450

42,000 directly employed in medtech across 450 companies making it the largest employer of medtech professionals in Europe, per capita.

12BN

Annual exports of c.€12.6 billion.

75%

75% of global medtech companies with operations in Ireland are carrying out R&D.

https://www.ibec.ie/connect-and-learn/industries/life-sciences-and-healthcare/medtech-strategy-2025

Defining Ireland's medical technology sector

Medical technology companies are defined as companies that:

- Design and/or manufacture medtech products and/or solutions, including software and hardware for healthtech.
- Manage significant international shared services from Ireland.
- Directly service the medtech sector.

The sector is diverse, and the following seven broad categories have been established to describe and the sector in Ireland:

1. Diagnostic
Devices or software used to identify a disease, condition, or injury.

2. Ophthalmic
Diagnosis and treatment of conditions relating to the eye.

3. Vascular/ Endovascular
Relating to the treatment of vascular disease.

4. Orthopaedic
Relating to the treatment of musculoskeletal system including muscles, bones, joints, ligaments, and tendons.

5. Hospital/ Homecare
Other segments of the market not captured here such as respiratory, surgical devices, minimally invasive devices and so forth.

6. Neurology
Concerning disorders and diseases of the nervous system including the brain and spinal cord, peripheral nerves and muscles.

7. Service
Outsourced function to a third party such as product development, design, manufacturer and generation of intellectual property.

https://www.ibec.ie/connect-and-learn/industries/life-sciences-and-healthcare/medtech-strategy-2025

Defining Ireland's digital healthtech sector

The digital healthtech sector in Ireland is diverse and the following nine broad headings have been established to describe and categorise the sector in Ireland. These categories broadly reflect solution types to offer a consistent view of digital health activity in Ireland.

1. Connected medical devices

Wearable and wireless medical devices; software driven diagnostic products; therapy delivery devices; biometric sensors.

2. Digital therapeutics

Software driven therapeutics.

3. Mobile health (mHealth) and wellness

Wellness, fitness trackers, nutrition and lifestyle apps; virtual health assistants; healthcare coaching.

4. Personalised healthcare

Precision medicine; personalised support, symptom management and interventions; Clinical decision support solutions.

5. Remote patient monitoring & telehealth

Remote patient monitoring solutions; medication adherence tools; telemedicine virtual visits and remote care programmes.

6. Health Information Technology (HIT)

Electronic medical record systems; electronic prescribing and order entry systems; consumer health IT applications

7. Connected care management

Care management platforms, staffing, and financial management solutions.

8. Data, analytics and cyber security

Patient data hosting; encryption and cyber security; AI and predictive analytics; digital biomarkers.

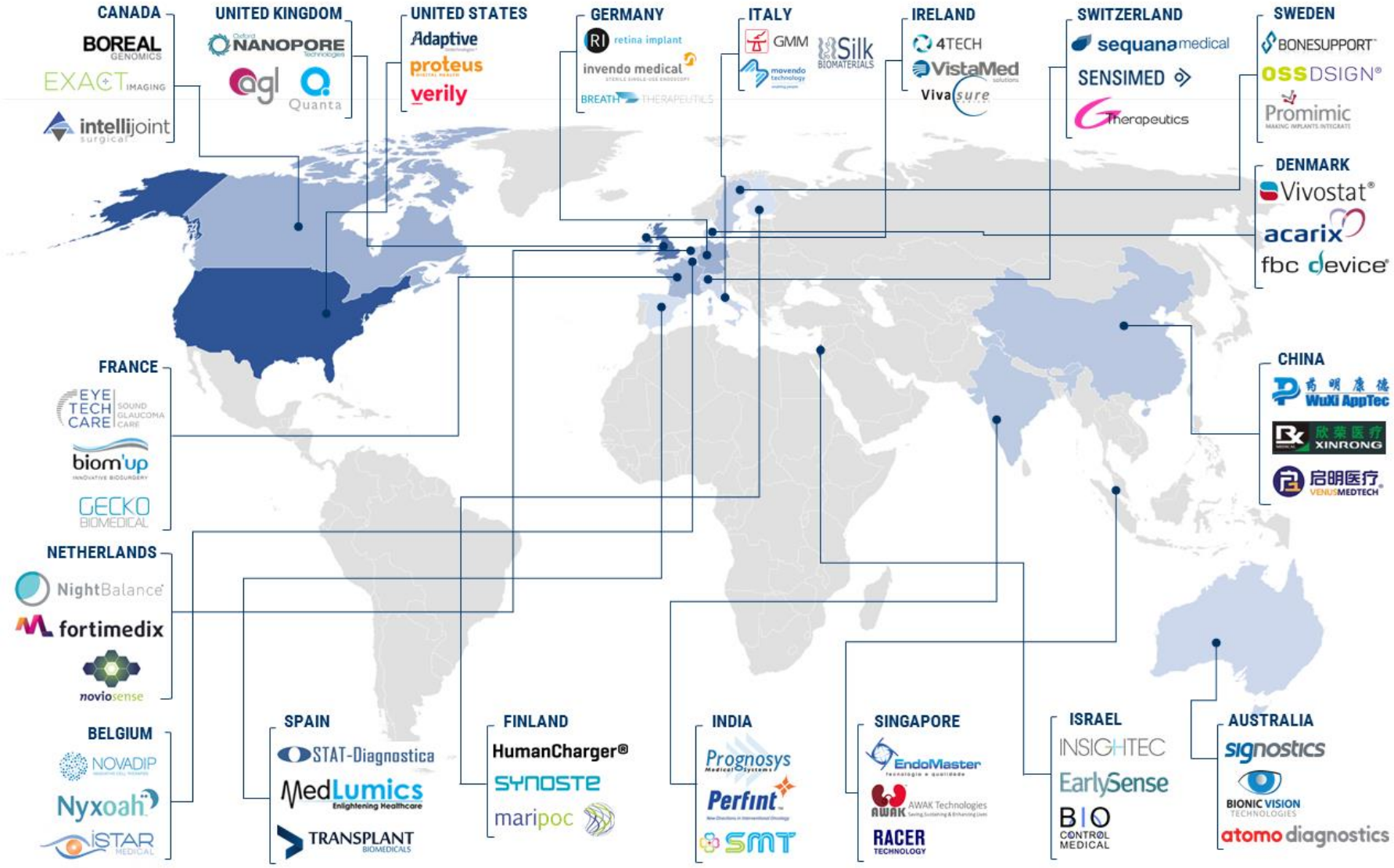
9. Technology solutions and infrastructure

ICT services and infrastructure; IoT solutions.

https://www.ibec.ie/connect-and-learn/industries/life-sciences-and-healthcare/medtech-strategy-2025

MOST WELL-FUNDED MEDICAL DEVICE COMPANIES ACROSS THE GLOBE

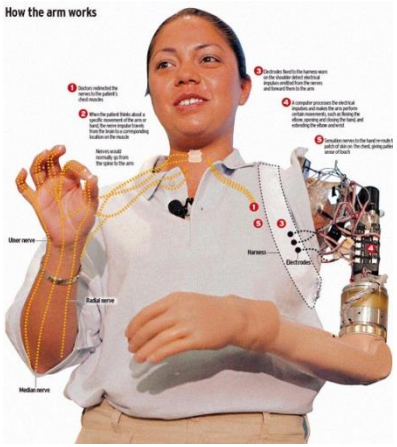
As of 5/4/17



CBINSIGHTS

Biomedical Engineering at UCD: Bioelectronics

Rehabilitation Robotics

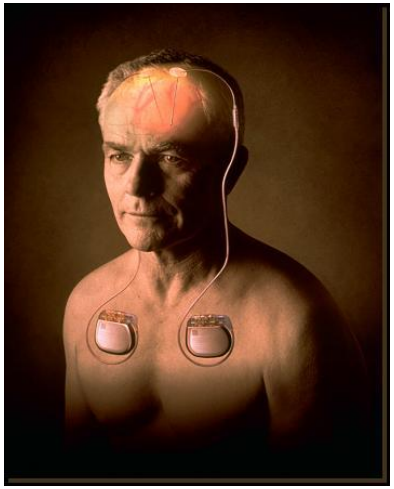


Prosthetics

Neuromuscular Stimulation

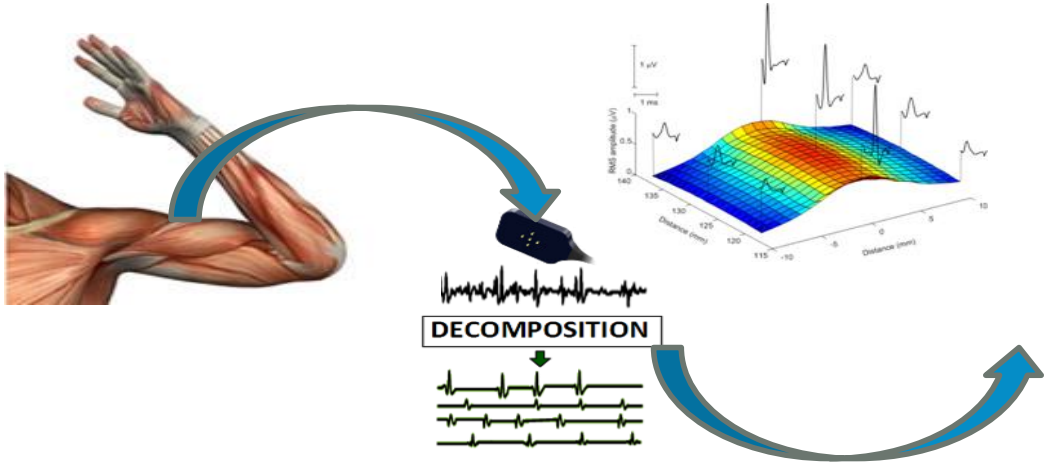
Cochlear implants

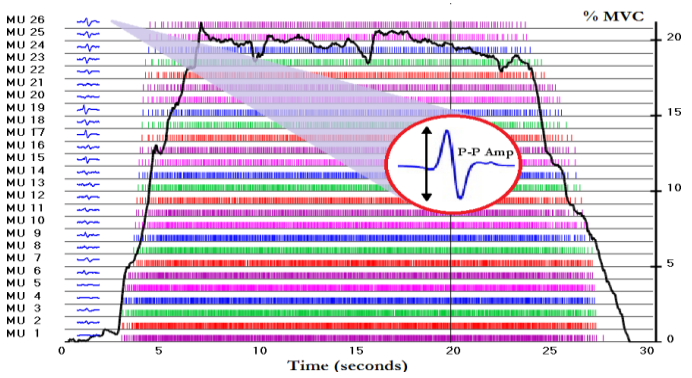
Brain Machine Interfaces

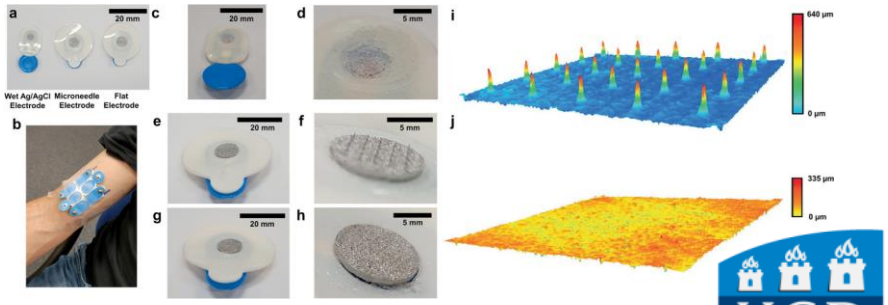


Deep brain stimulation

Sample research areas:
Neural Control of Movement

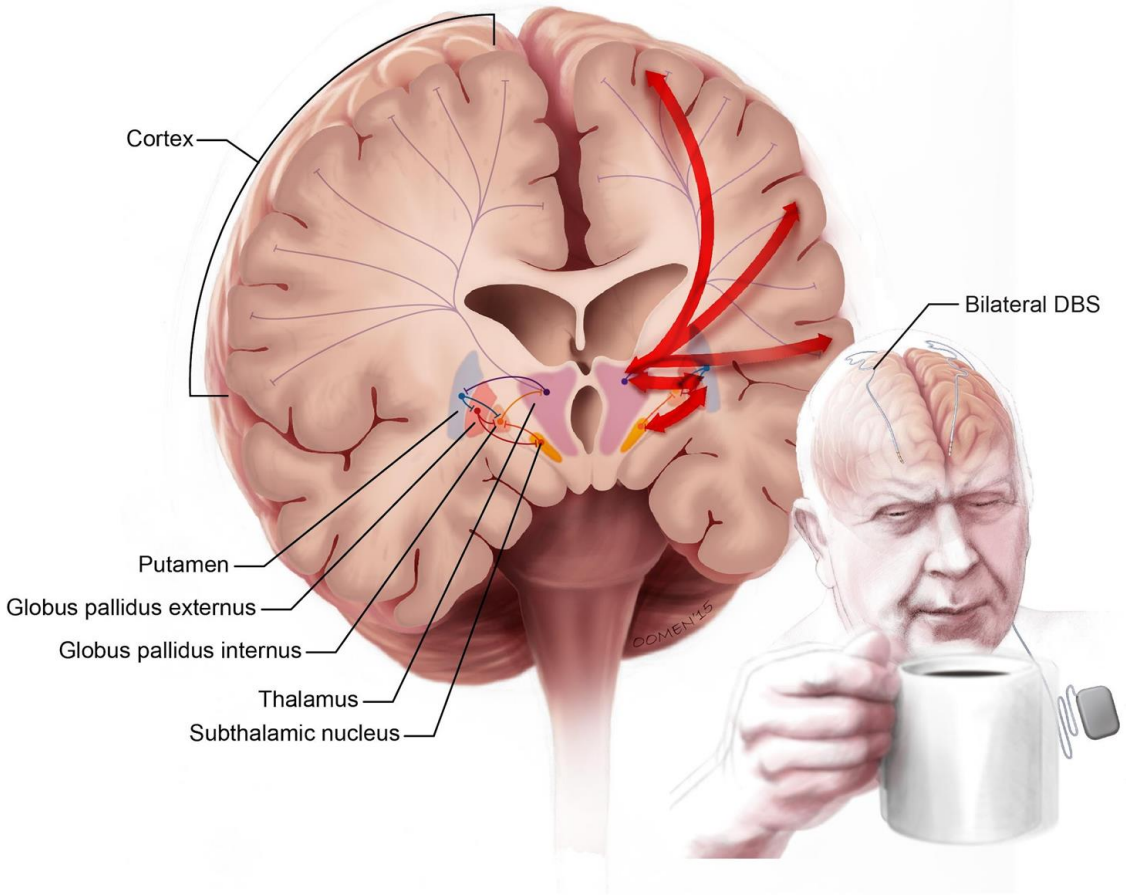


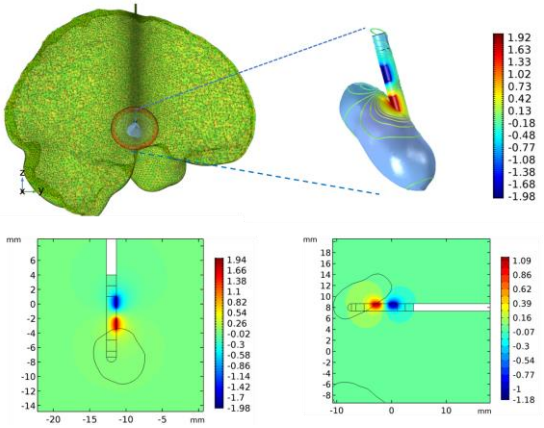




Relevant Modules:
Neural Engineering

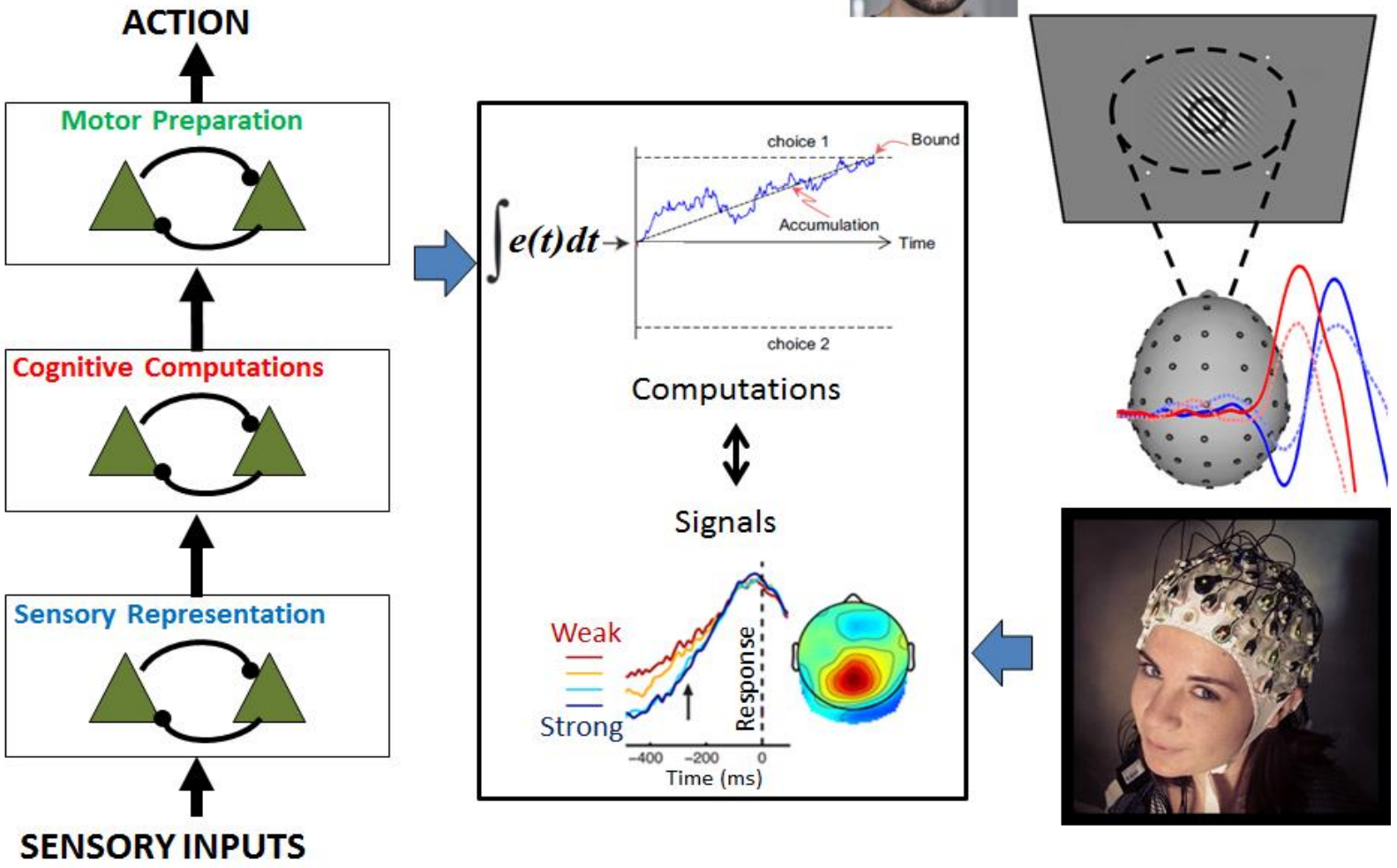
Sample research areas:
Deep brain stimulation





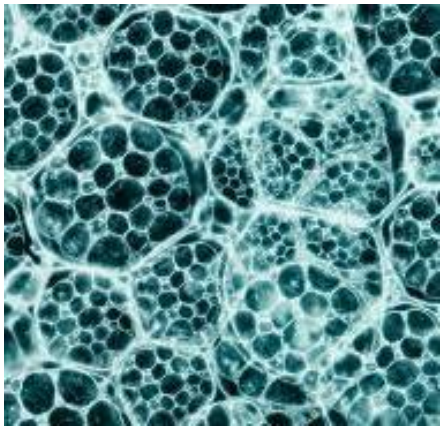
Sample research areas:
Cognitive Neural Systems

PI: Simon Kelly

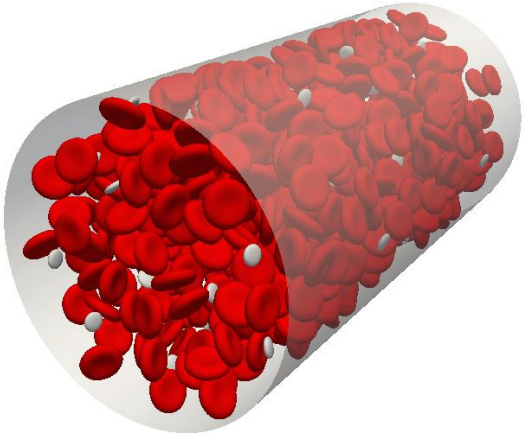


Biomedical Engineering at UCD: Biomechanics

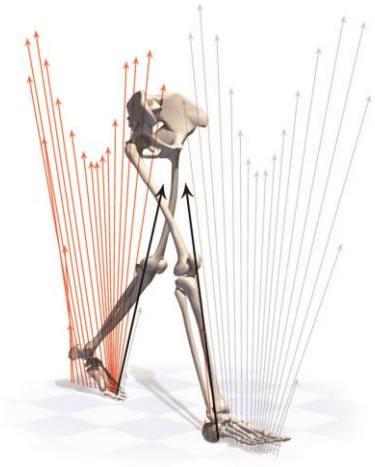
Medical Device Design



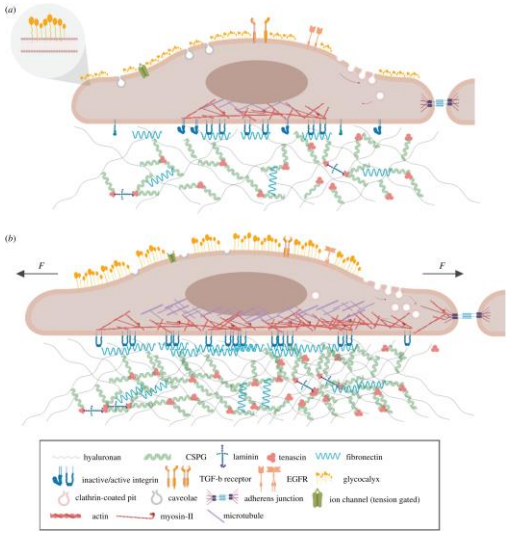
Biomaterials



Biofluids



Movement Biomechanics



Tissue Biomechanics

Biomedical Engineering at UCD: Medical Device Design

Dr. Eoin O'Cearbhaill

Relevant Modules:
Medical Device Design
Biomechanics II

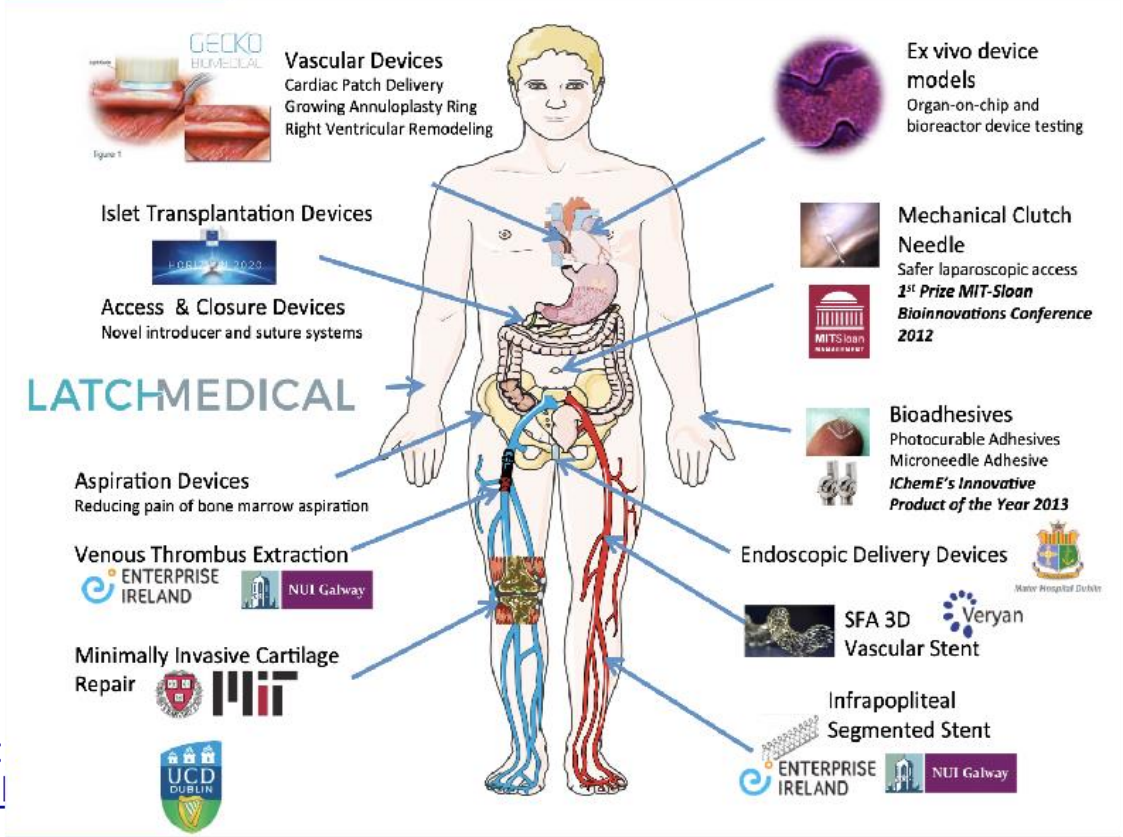
I-Form Advanced Manufacturing Research Centre

CURAM

AMBER

Ongoing Projects

- Focused on the development of medical devices, with a particular emphasis on platform technologies
- Offering smart ways of delivering next-generation diagnostics and therapeutics through minimally invasive approaches.
- https://scholar.google.com/citations?user=lcQZxKEAAAAJ&hl=en



nature COMMUNICATIONS

nature biomedical engineering

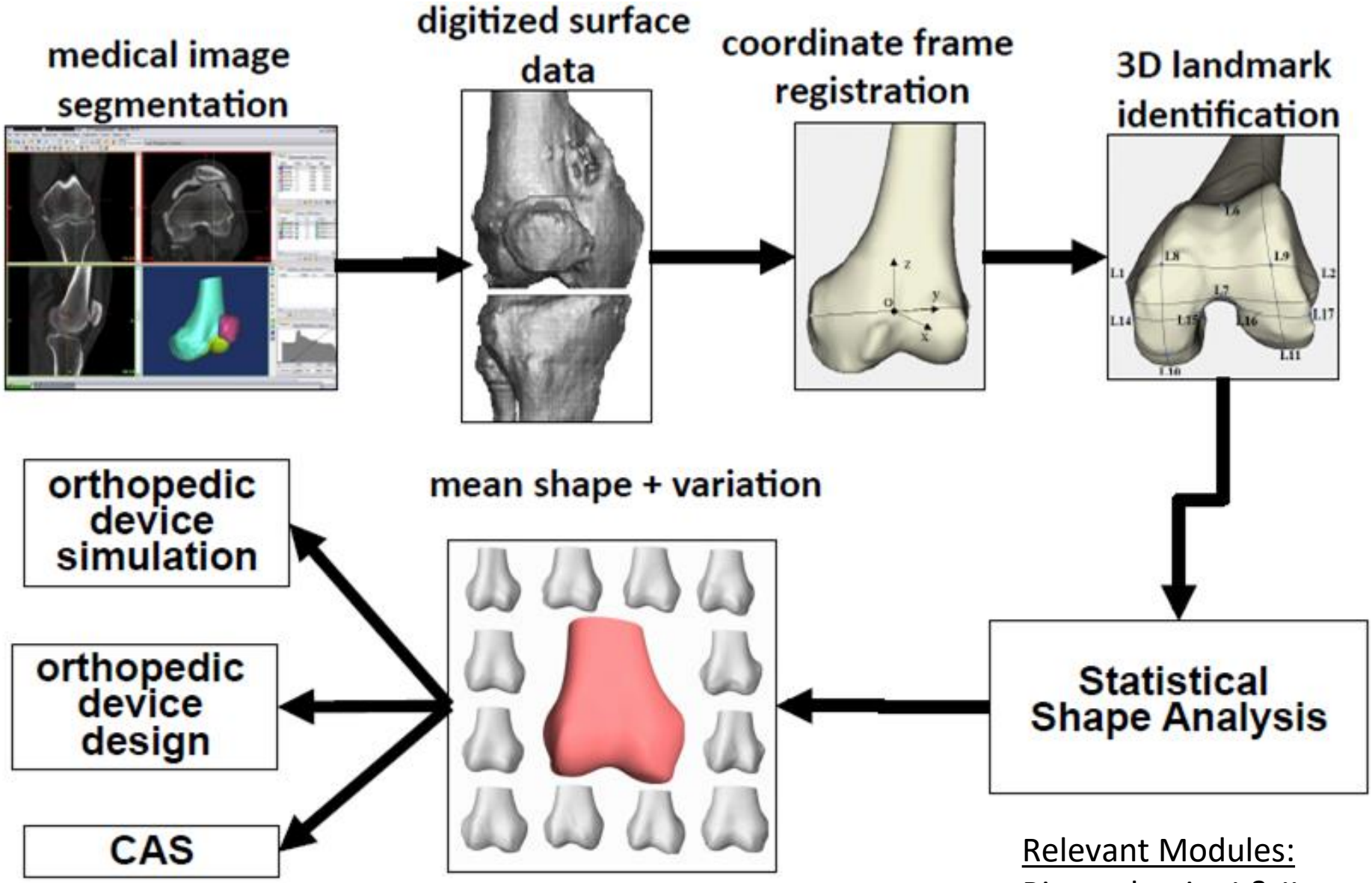
ADVANCED MATERIALS

Science Translational Medicine

Acta BIOMATERIALIA
Structure-Property-Function Relationships in Biomaterials

Microsystems & Nanoengineering
www.nature.com/micronano

Orthopaedic Biomechanics

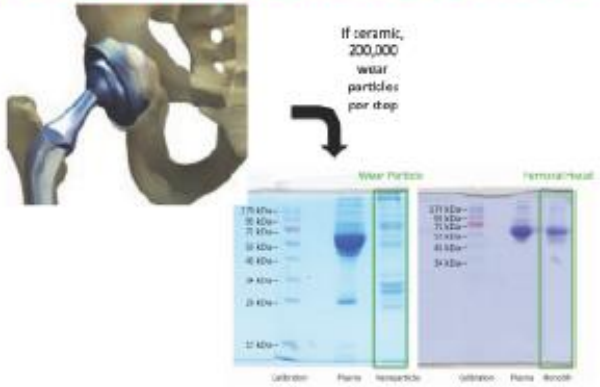


Relevant Modules:
Biomechanics I & II

Biomedical Ceramics & Metals (K Stanton)

Orthopaedic and dentistry examples . . .

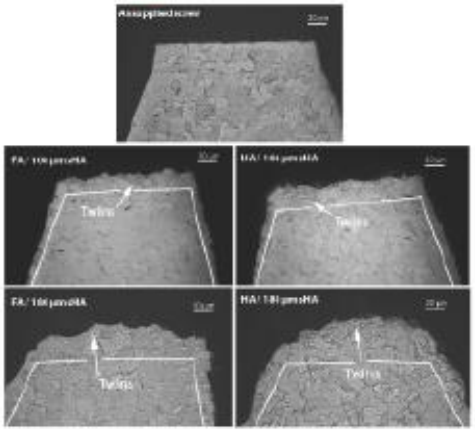
Protein adsorption on wear particles



DePuy
ENBIO
stryker
Queen's University Belfast
QUEEN MARY

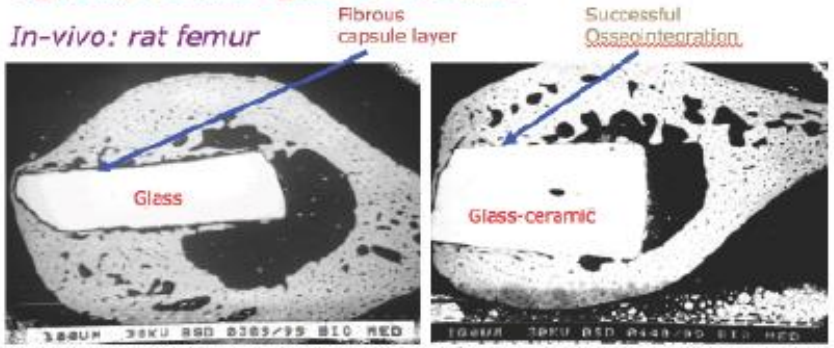
Nano-toughening for dental cements

Coating of Ti dental screws



Apatite-mullite glass-ceramics

In-vivo: rat femur

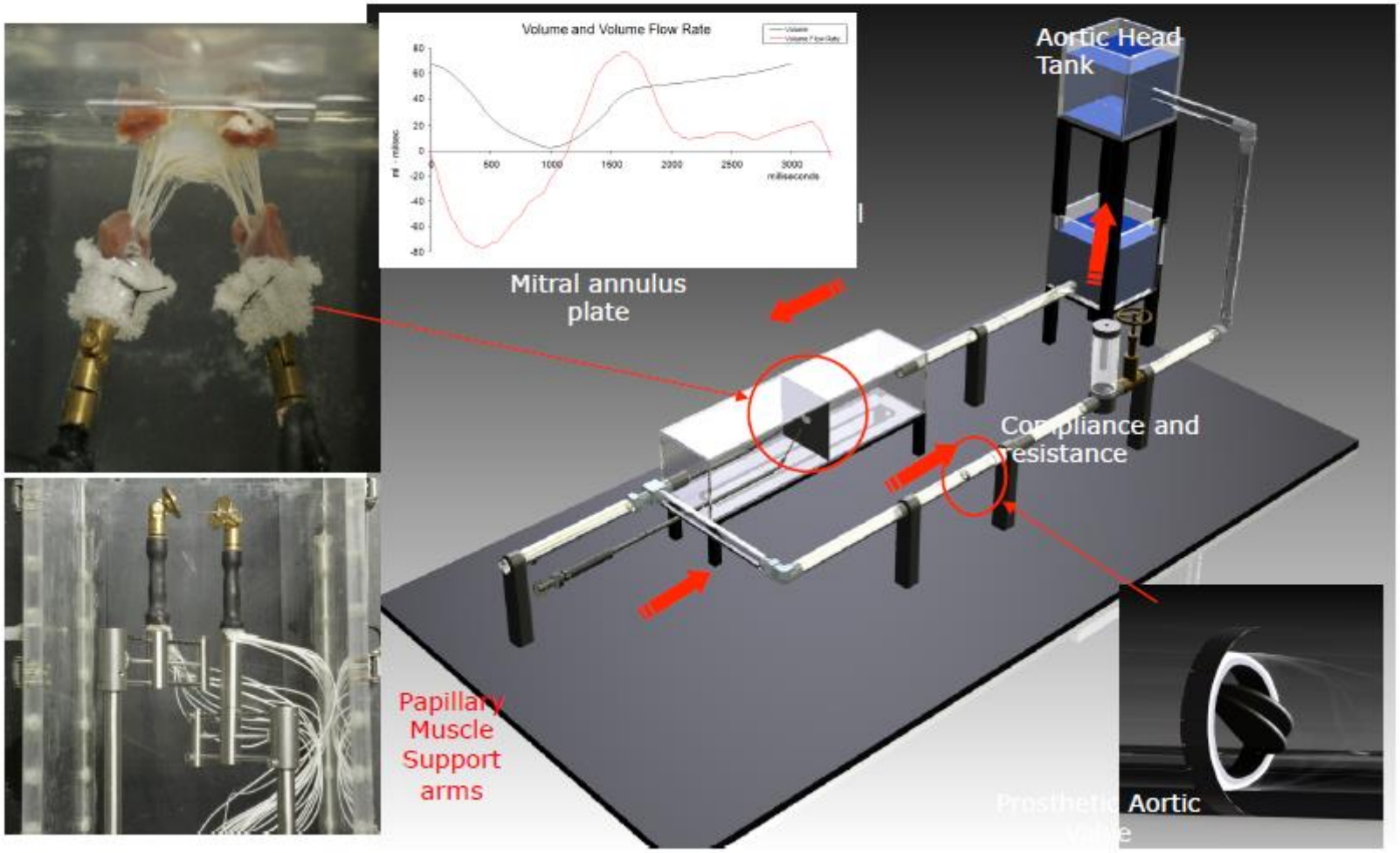


C. O. Freeman, I.M. Brook, A. Johnson, P.V. Hatton, R.G. Hill, K.T. Stanton, " Crystallization modifies osteoconductivity in an apatite-mullite glass-ceramic", *J. Mat Sci: Materials in Medicine* 14 (2003) 985-990

Relevant Modules:
Biomaterials

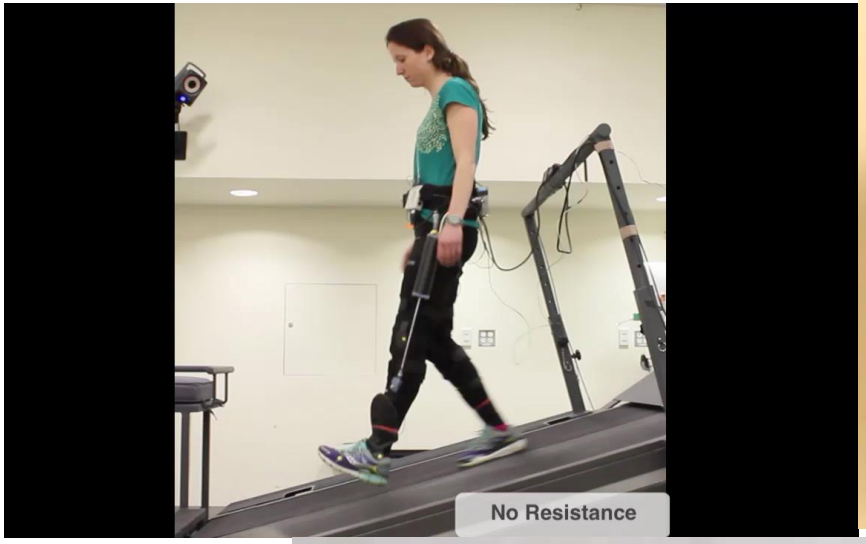
Heart Valves - Dr. Malachy O'Rourke

Left Heart Simulator

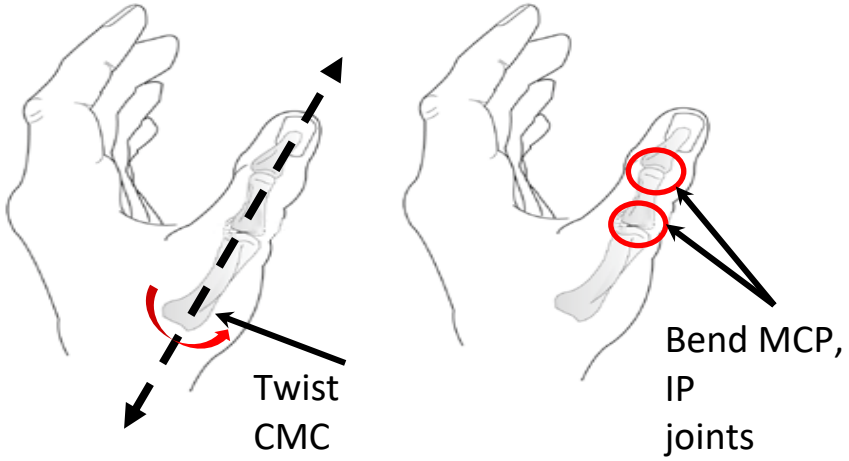


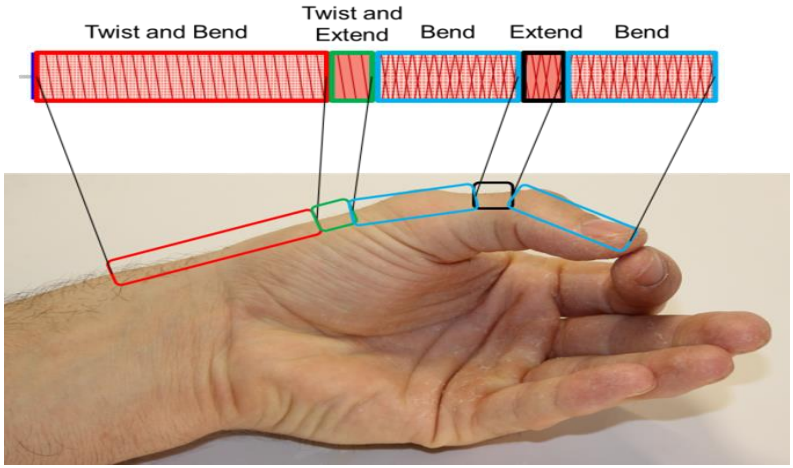
Relevant Modules:
Biofluids

Soft & Wearable Robotics



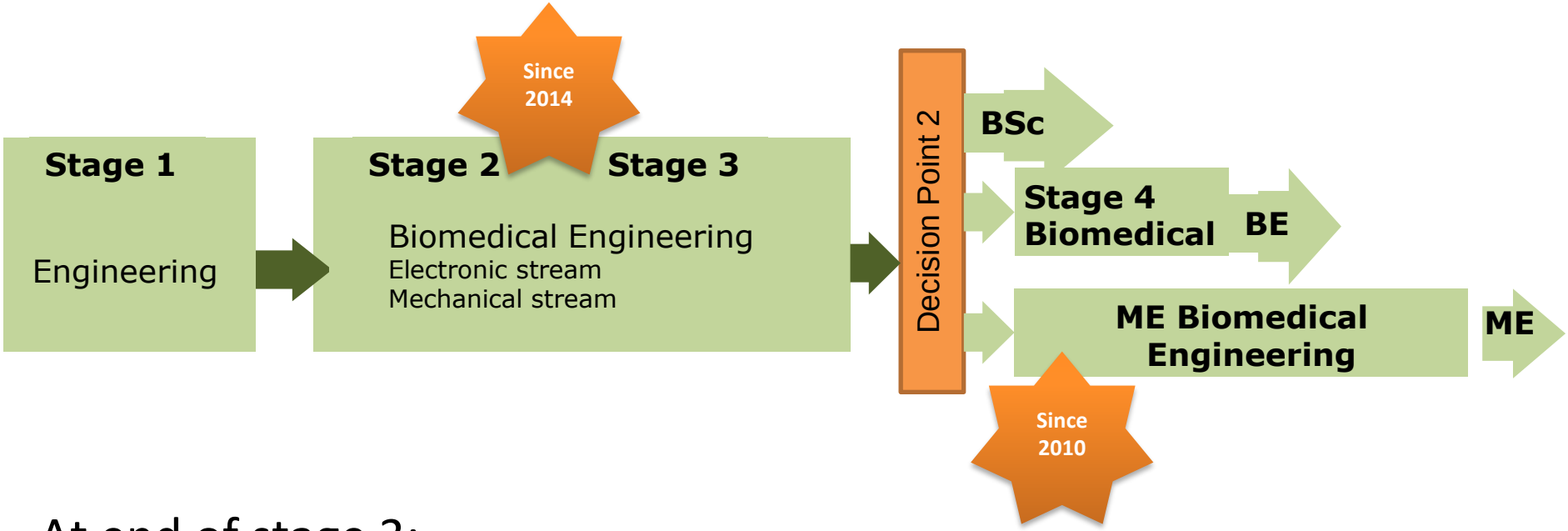
<u>Relevant Modules:</u>
Rehabilitation Engineering





Maeder-York, Clites, Boggs, Neff, Polygerinos, Holland, Stirling, Galloway, Wee, Walsh (2014) “Biologically inspired soft robot for thumb rehabilitation” *Design of Medical Devices Conference*, MN.

Biomedical Engineering Paths at UCD



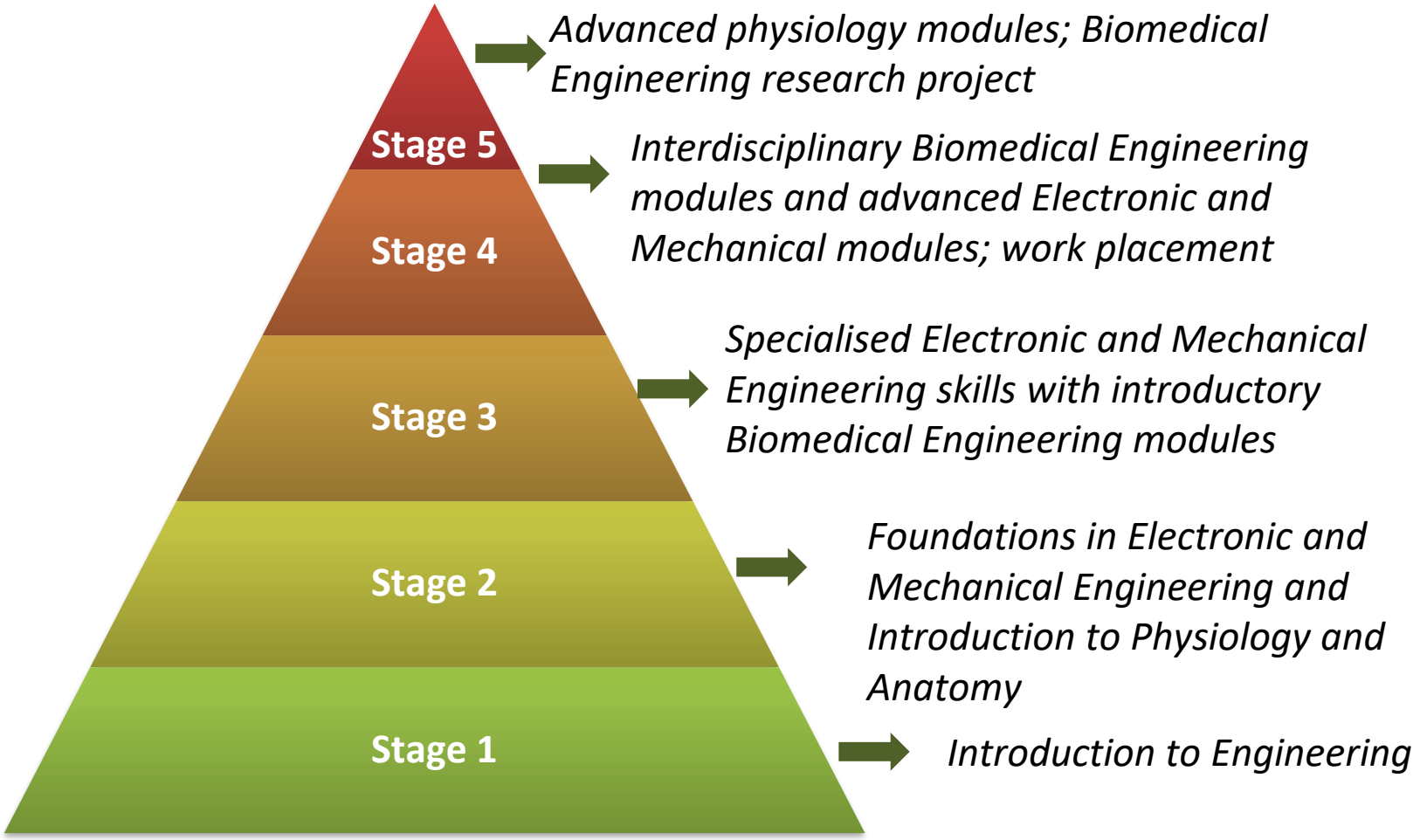
At end of stage 3:

- graduate with BSc (Engineering Science)
- progress to stage 4 of BE in Biomedical Engineering

Or, if eligible (weighted GPA ≥ 2.8):

- enter ME programme in Biomedical Engineering

UCD Biomedical Engineering Programmes



Stage 2 Biomedical Engineering Core modules

NBS1_S2	Biomedical Engineering Stage 2			
Core				
Trimester	**Module Code**	**Module Title**	**Credits**	**Level**
Autumn	MATH 20290	Multivariable Calculus for Engineers	5 Credits	level: 2 (Inter.)
Autumn	EEEN 20020	Electrical & Electronic Circuits	5 Credits	level: 2 (Inter.)
Autumn	MEEN 20010	Mechanics of Fluids I	5 Credits	level: 2 (Inter.)
Autumn	PHYS 20040	An Introduction to Physiology	5 Credits	level: 2 (Inter.)
Autumn	EEEN 20010	Computer Engineering I	5 Credits	level: 2 (Inter.)
Autumn		**Elective**	5 Credits	
Trimester	**Module Code**	**Module Title**	**Credits**	**Level**
Spring	EEEN 20030	Engineering Electromagnetics	5 Credits	level: 2 (Inter.)
Spring	STAT 20060	Statistics and Probability for Engineers	5 Credits	level: 2 (Inter.)
Spring	MEEN 20040	Mechanics of Solids I	5 Credits	level: 2 (Inter.)
Spring	MEEN 20030	Applied Dynamics I	5 Credits	level: 2 (Inter.)
Spring	MEEN 20070	Materials Sci & Eng I	5 Credits	level: 2 (Inter.)
Spring		**Option**	5 Credits	

Stage 2 Biomedical Engineering Option modules

Trimester	Module Code	Module Title	Credits	Level
Option Modules				
Spring	**EEEN 20040**	Electronic Circuits	5 Credits	level: 2 (Inter.)
Spring	**MEEN 20060**	Mechanical Engineering Design I	5 Credits	level: 2 (Inter.)
In-Programme Electives				
Autumn	**MEEN 20020**	Manufacturing Engineering I	5 Credits	level: 2 (Inter.)
Autumn	**MEEN 20050**	Heat Transfer	5 Credits	level: 2 (Inter.)

Rule for Options:	Select 1 of 2 in Trimester 2

Students intending to pursue the Mechanical Engineering stream of Biomedical Engineering MUST select "MEEN20060 Mechanical Engineering Design I" as their Stage 2 Option.
Students intending to pursue the Electronic Engineering stream of Biomedical Engineering MUST select "EEEN20040 Electronic Circuits" as their Stage 2 Option.

Stage 3 Biomedical Engineering Core modules

Core			
Trimester	**Module Code**	**Module Title**	**Credits**
Autumn	ACM30030	Multivariable Calculus Eng II	5
Autumn	ANAT20090	Med. Sciences for Biomed.Engin	5
Autumn	EEEN30160	Biomedical Signal Processing	5
Autumn		Elective	5
Trimester	**Module Code**	**Module Title**	**Credits**
Spring	EEEN30150	Modelling and Simulation	5
Spring	EEEN30180	Bioinstrumentation	5
Spring	MEEN30160	Biofluids	5
Spring		Elective	5

Stage 3 Biomedical Engineering Option modules

NBS1_S2	Bioelectronics stream	
Module Code	**Module Title**	**Trimester**
EEEN30020	Circuit Theory	Autumn
EEEN30110	Signals and Systems	Autumn
EEEN30030	Electromagnetic Waves	Spring
EEEN30050	Signal Processing: Theory and Applications	Spring

NBS1_S2	Biomechanical stream	
Module Code	**Module Title**	**Trimester**
MEEN20020	Manufacturing Engineering I	Autumn
MEEN30090	Materials Science and Engineering II	Autumn
MEEN30010	Applied Dynamics II	Spring
MEEN30020	Mechanics of Solids II	Spring

ENQUIRE APPLY NOW

OUTBOUND EXCHANGES AND OVERSEAS OPPORTUNITIES

- Study at UCD
- Offer Holders
- Student Experience
- Learning Abroad
- Global Partnerships
- Covid-19 FAQs
- UCD's Ukrainian Response

HOME / LEARNING ABROAD / EXCHANGES / OUTBOUND EXCHANGE - STUDENTS

Exchange & Overseas Opportunities

Any questions? Say "Hi" to start!

Stage 4 Biomedical Engineering Core modules

Core				
Trimester	**Module Code**	**Module Title**	**Credits**	**Level**
YEAR	EEEN30240	Professional Engineering Project	15 Credits	level: 3 (Degree)
Sem 1	MEEN40600	Medical Device Design	5 Credits	level: 4 (Masters)
Sem 1	MEEN40620	Biomechanics	5 Credits	level: 4 (Masters)
Sem 1	MEEN40630	Biomaterials	5 Credits	level: 4 (Masters)
Sem 1		Options x 1	5 Credits	
Trimester	**Module Code**	**Module Title**	**Credits**	**Level**
Sem 2	CHEN40470	Cell Culture & Tissue Engineering	5 Credits	level: 4 (Masters)
Sem 2	EEEN40070	Neural Engineering	5 Credits	level: 4 (Masters)
Sem 2	EEEN40350	Rehabilitation Engineering	5 Credits	level: 4 (Masters)
Sem 2		Options x 2	5 Credits	

UCD Biomedical Engineering Taught Masters Degree

ME Biomedical Engineering	
2 Year degree	
120 Credit	
GPA greater than 2.8 in Biomedical/Electronic/ Electrical or Mechanical Eng.	
Accredited by Engineers Ireland	
6-8 Month Professional Work Experience and 25 credit project	
Sample modules: Neural Engineering Rehabilitation Engineering Machine Learning For Engineers Biosensors & Actuators Biomechanics & Mechanobiology Cell Culture & Tissue Eng	Medical Sciences for Biomedical Engineers Biomechanics Biomaterials Medical Device Design Experimental design and statistics Bioinformatics Regulatory Affairs in Science

ME Biomedical Engineering Year 1

Semester 2 : 30-Credit Professional Work Placement

January – August

‘Also, just a note that we were blown away by the quality of the applications from UCD this year - it was very tough choosing between them at both interview and offer stages. The UCD students really stand out from the other candidates (and we had applicants from all over Ireland and around Europe).’

Shimmer Technologies

‘It’s rarely I feel the need to go into writing on feedback directly to Universities in relation to student placements we receive here in Boston Scientific, in fact this will be the first time. However, in the case of your Masters students who have just finished placements with us here in the past few weeks…, I feel the need to specifically highlight that these students were of a stand-out nature and not only developed considerably themselves during their placements, but contributed very well to our business – in fact to the extent that they will leave a vacuum behind them now that they have returned to college…As is the case with students of the standard, they are fast learners, very intelligent, constantly ask the right questions and always bring new perspectives. In addition to this, however, what really made these students stand-out for me was their level of enthusiasm, engagement, perseverance, thoroughness, ability to integrate within the team and their strong work ethic.’

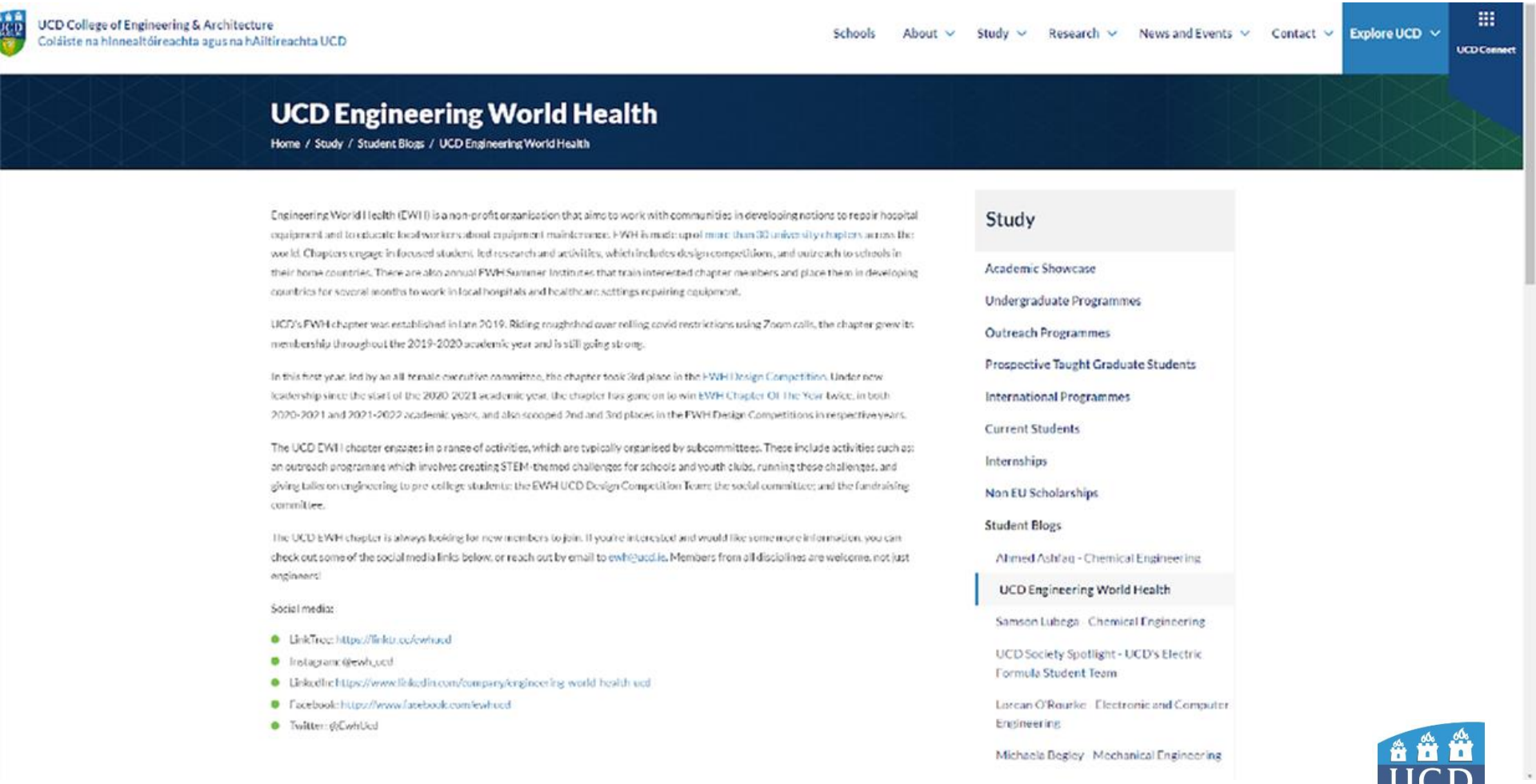
Boston Scientific

Sample ME Projects

- Finding the correct model for sensory-motor translations in the brain
- Crush strength testing of mussel shells considering fish jaw anatomy
- Probing the brain mechanisms of multisensory detection
- Deep brain stimulation of axons and branching collatorals
- Computational modelling of directional electrodes for deep brain stimulation
- The Three Dimensional Soldering of an Implantable Heart Sensor for a Closed Loop Circuit
- Adhesive patch for an on-body injector device.
- Achilles tendon – its age-related changes and potential clinical utility in men
- How do the zones of articular cartilage emerge over postnatal development?
- One- and few-shot learning with deep neural networks for medical image analysis
- Can decision neuroscience help to make our roads safer?
- Simulation of unprotected Vs protected head impact events during professional rugby tackles.
- A continuous measure of decision processing to monitor changes of mind
- Design of a device to measure oropharyngeal force: tongue protrusion.
- Does a Mobile bearing Polyethylene spacer really matter in Total Ankle Replacement?
- EEG signals of sensorimotor decision formation under varying neuromuscular demands
- Identification of novel speech-biomarkers in Huntington's disease
- Can sutures share the load?
- How do the mechanical properties of the meniscus develop over time?
- Longitudinal analysis of sleep and physical activity in Huntington's disease.
- Characterisation of biomaterials to understand their influence on organ-on-a-chip devices.
- Design and development of an organ-on-chip model of pancreatic cancer metastasis
- Design of scale up microfluidic chips for the synthesis of polymer nanoparticles
- Computational Medical Imaging: Analysis of multimodal brain MRI data sets in type I & II diabetes
- EEG signals of sensorimotor decision formation in the learning of complex myoelectric control
- Sense of agency for myoelectric control
- Does finger pad skin slip inform grip force control?
- Assessing new methods for separating sensory, cognitive and motor processes in EEG
- Biomechanical Considerations of Menstrual Cups
- Biomechanics & pathophysiology of traumatic spinal cord injury
- Instrumented pedals for rehabilitation robotics and athletic training
- Predictive modelling of lower-limb cycling rehabilitation
- Optimisation of the External Cable Assembly for ProVerum Medical Minimally Invasive Expander Imaging and Delivery System in the Treatment of Benign Prostatic Hyperplasia
- Design of a novel growth tethering device for treating limb deformities in children
- Non-invasive Ultrasound Thrombus Disruption
- Motor unit coherence in Type 1 diabetes
- Using AI in predictive simulations of gait

UCD DUBLIN

UCD Engineering for World Health



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UCD Engineering World Health

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Engineering World Health (EWH) is a non-profit organisation that aims to work with communities in developing nations to repair hospital equipment and to educate local workers about equipment maintenance. EWH is made up of more than 80 university chapters across the world. Chapters engage in focused student led research and activities, which includes design competitions, and outreach to schools in their home countries. There are also annual EWH Summer Institutes that train interested chapter members and place them in developing countries for several months to work in local hospitals and healthcare settings repairing equipment.

UCD's EWH chapter was established in late 2019. Riding roughshod over rolling covid restrictions using Zoom calls, the chapter grew its membership throughout the 2019-2020 academic year and is still going strong.

In this first year, led by an all female executive committee, the chapter took 3rd place in the EWH Design Competition. Under new leadership since the start of the 2020-2021 academic year, the chapter has gone on to win EWH Chapter Of The Year twice, in both 2020-2021 and 2021-2022 academic years, and also scooped 2nd and 3rd places in the EWH Design Competitions in respective years.

The UCD EWH chapter engages in a range of activities, which are typically organised by subcommittees. These include activities such as: an outreach programme which involves creating STEM-themed challenges for schools and youth clubs, running these challenges, and giving talks on engineering to pre college students; the EWH UCD Design Competition Team; the social committee; and the fundraising committee.

The UCD EWH chapter is always looking for new members to join. If you're interested and would like some more information, you can check out some of the social media links below, or reach out by email to ewh@ucd.ie. Members from all disciplines are welcome, not just engineers!

Social media:

- LinkTree: https://linktr.ee/ewhucd
- Instagram: @ewh_ucd
- LinkedIn: https://www.linkedin.com/company/engineering-world-health-ucd
- Facebook: https://www.facebook.com/ewhucd
- Twitter: @EwhUcd

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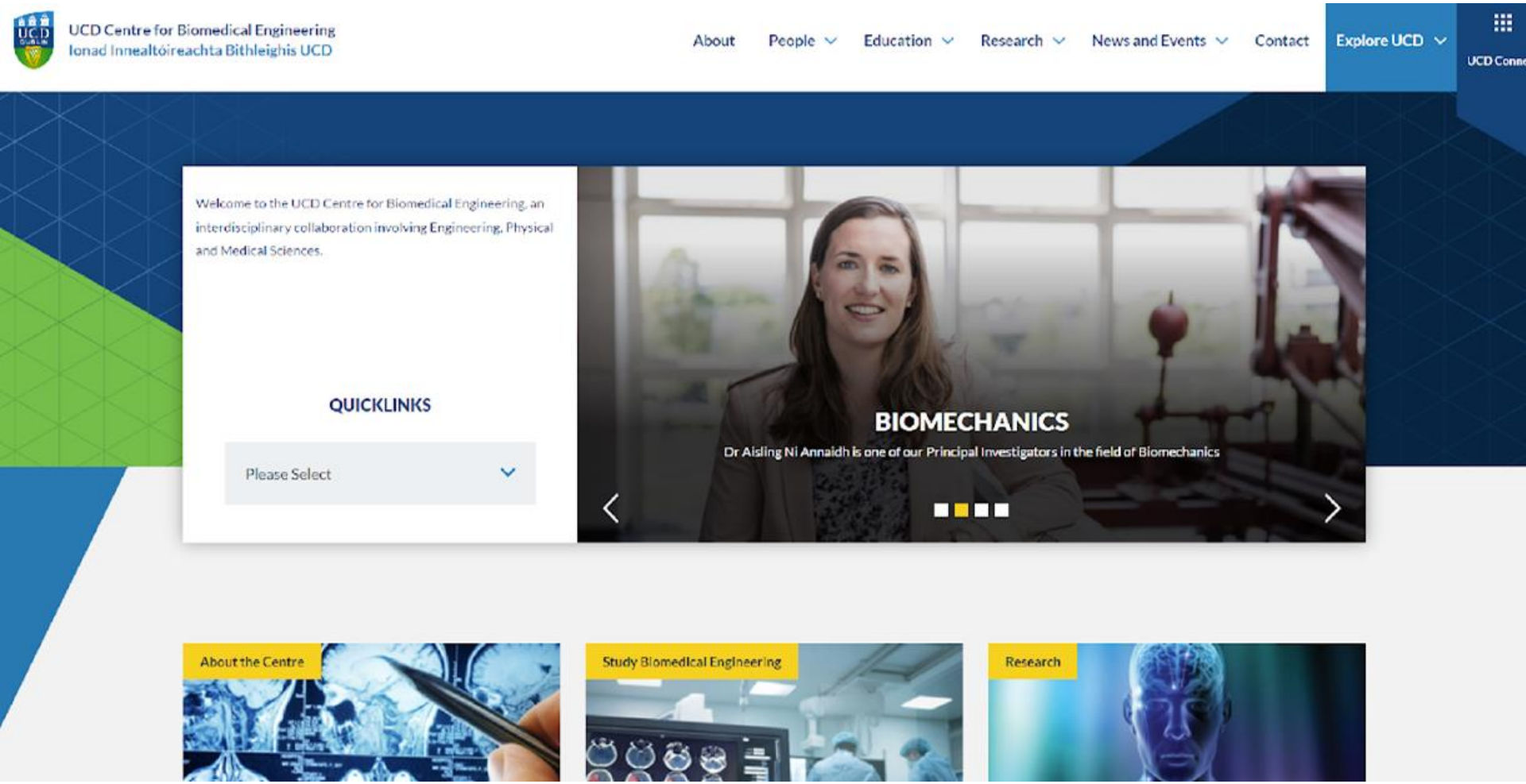
- Internships
- Non EU Scholarships
- Student Blogs
  - Ahmed Ashfaq - Chemical Engineering
  - UCD Engineering World Health
  - Samson Lubega - Chemical Engineering
  - UCD Society Spotlight - UCD's Electric Formula Student Team
  - Lorcan O'Rourke - Electronic and Computer Engineering
  - Michaela Begley - Mechanical Engineering

https://www.ucd.ie/eacollege/study/studentblogs/ucdengineeringworldhealth/

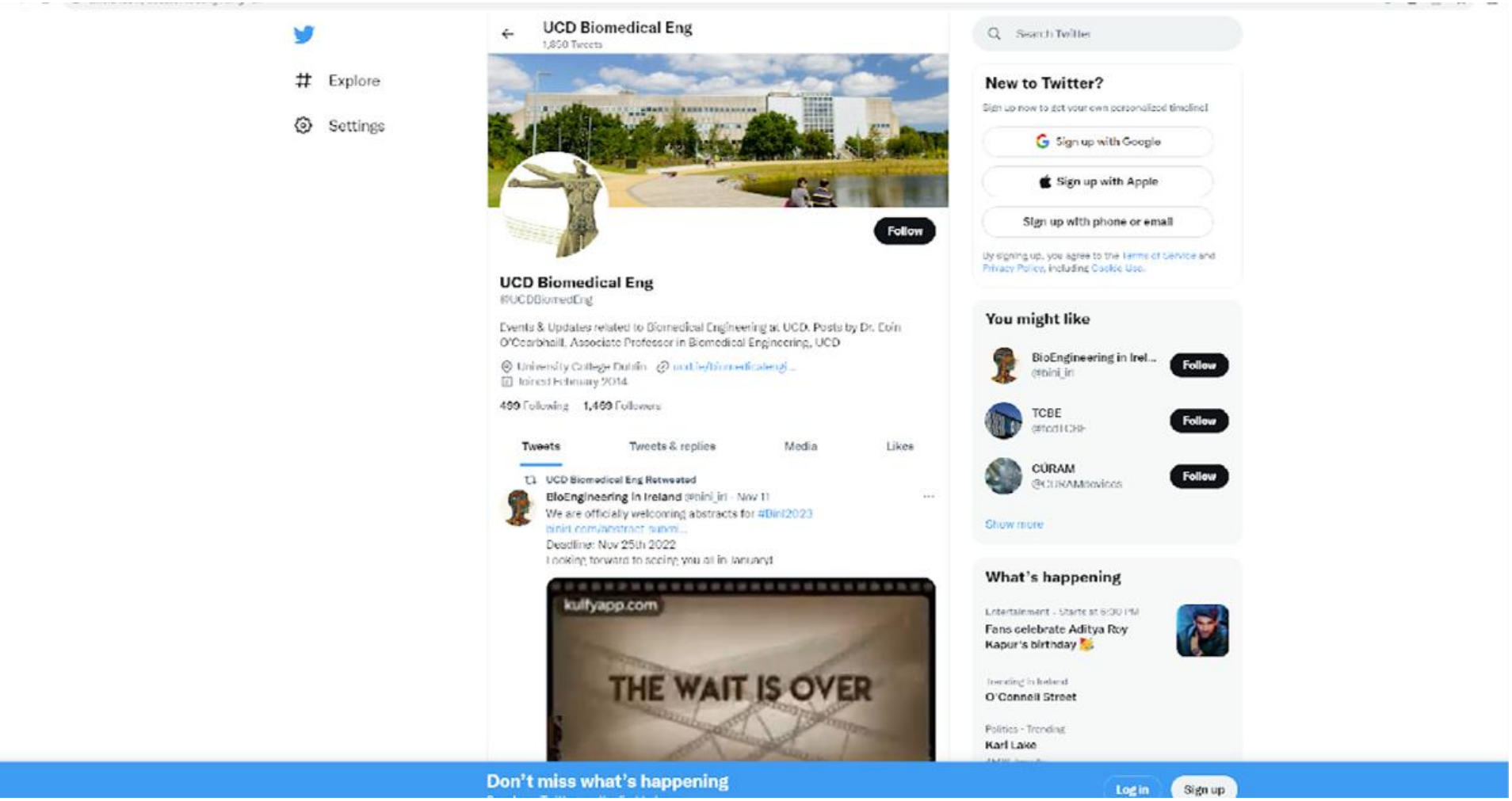
UCD Biomedical Engineering Centre

http://www.ucd.ie/biomedicalengineering/



UCD Biomedical Engineering Twitter

@UCDBiomedEng



UCD Biomedical Engineering

Questions?