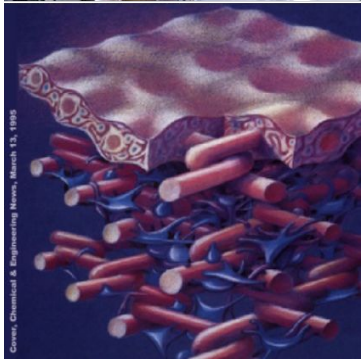
UCD Biomedical Engineering - ME in Biomedical Engineering

Dr Stephen Redmond
UCD School of Electrical and Electronic Engineering

Dr Eoin O'Cearbhaill
UCD School of Mechanical and Materials Engineering

Biomedical Engineering Programmes co-Directors

Biomedical Engineering



- Biomedical Engineering

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

- Wide variety of application areas

  Biosignal, bioimaging, and data analysis

  Biosensors, brain computer interfaces

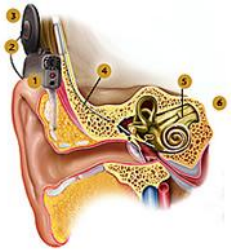
  Rehabilitation engineering, orthopaedics

  Biomechanics & sports performance

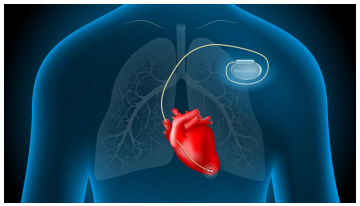
  Biomaterials, cell, and tissue engineering

  Medical device design

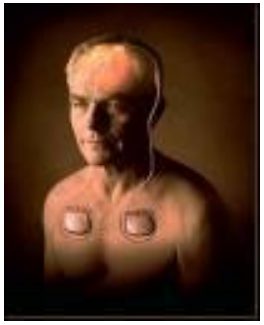
- Foundation in Electrical/Electronic or Mechanical Engineering



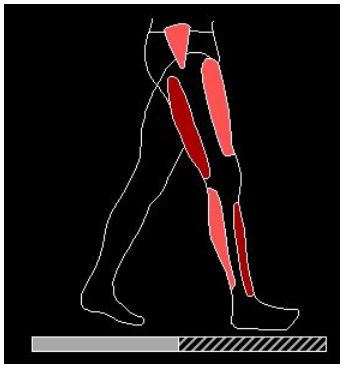
Cochlear implants



Pacemakers



Deep brain stimulation



Gait analysis

Artificial limbs

Rehabilitation robotics

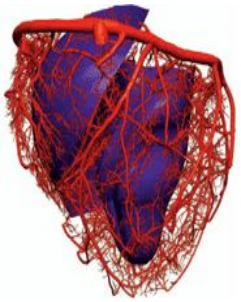
Biomedical Engineering

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

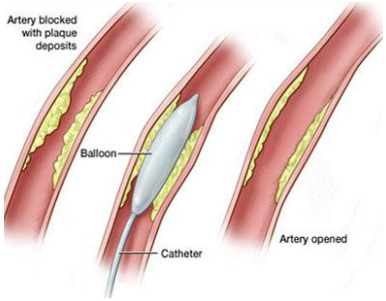
Hip implants

Biomedical signal processing

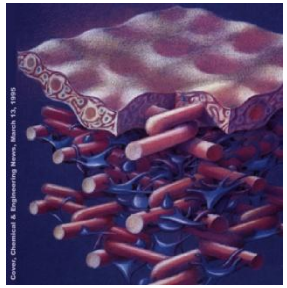
MR imaging



Physiological modelling



Angioplasty



Tissue engineering

Medtech in Ireland

Ireland continues to be a leading global hub for medtech

1st	1st	2nd	4th	4th	14th	450	12BN	75%
Ireland is the no. 1 exporter of contact lenses from the EU and globally.	Ireland is the no. 1 exporter of stents in the EU and globally.	Ireland is the 2nd largest exporter of medtech in Europe.	Ireland is the 4th largest exporter of artificial joints in the EU.	Ireland is the 4th largest exporter of diagnostic reagents from the EU.	14 of the world's global 15 medtech companies are in Ireland.	42,000 directly employed in medtech across 450 companies making it the largest employer of medtech professionals in Europe, per capita.	Annual exports of c.€12.6 billion.	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

Medtech in Ireland

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

Medtech in Ireland

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

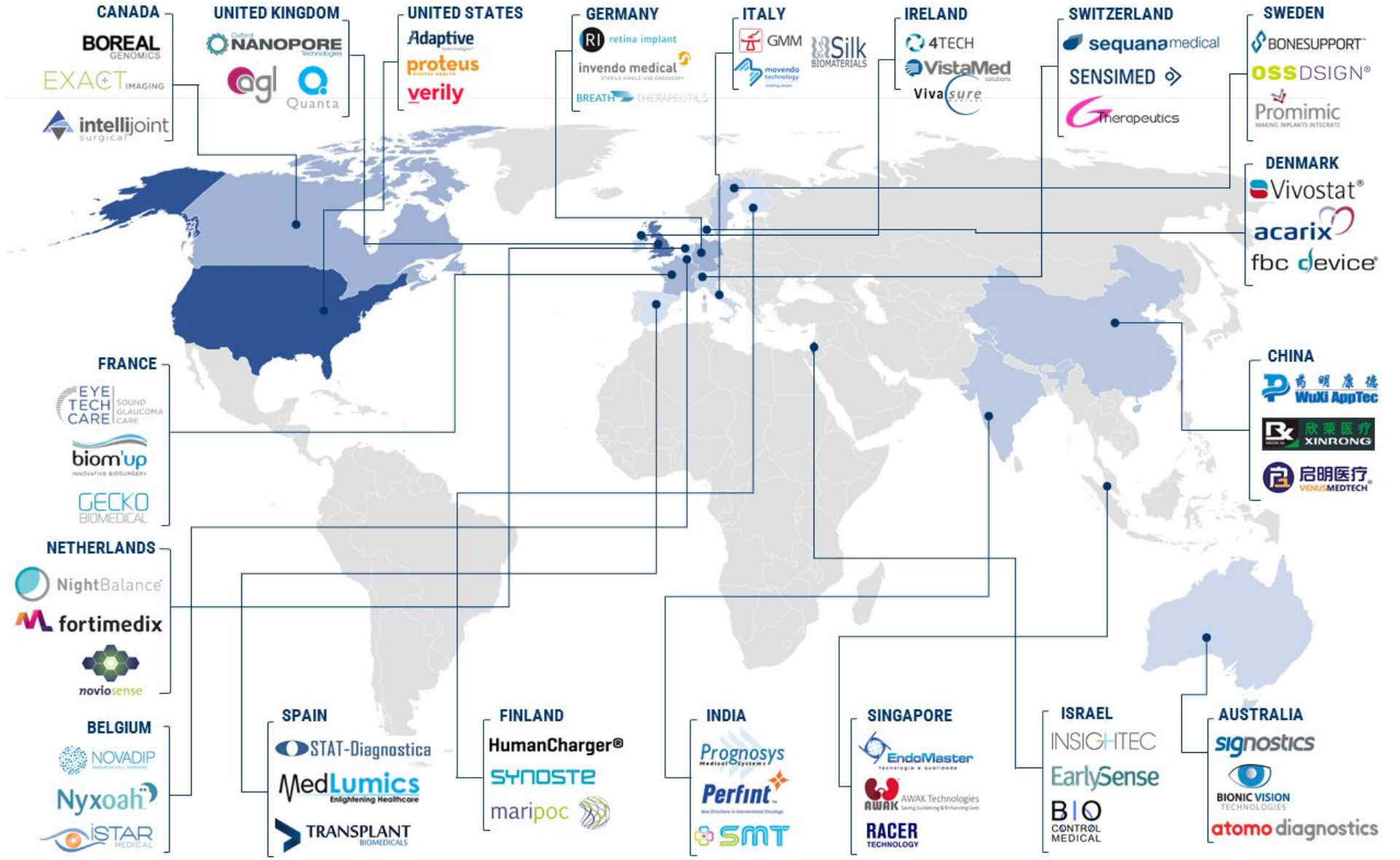
Medtech in Ireland

“450 companies
employing 42,000 people
to deliver €12.6 billion in medtech exports”

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

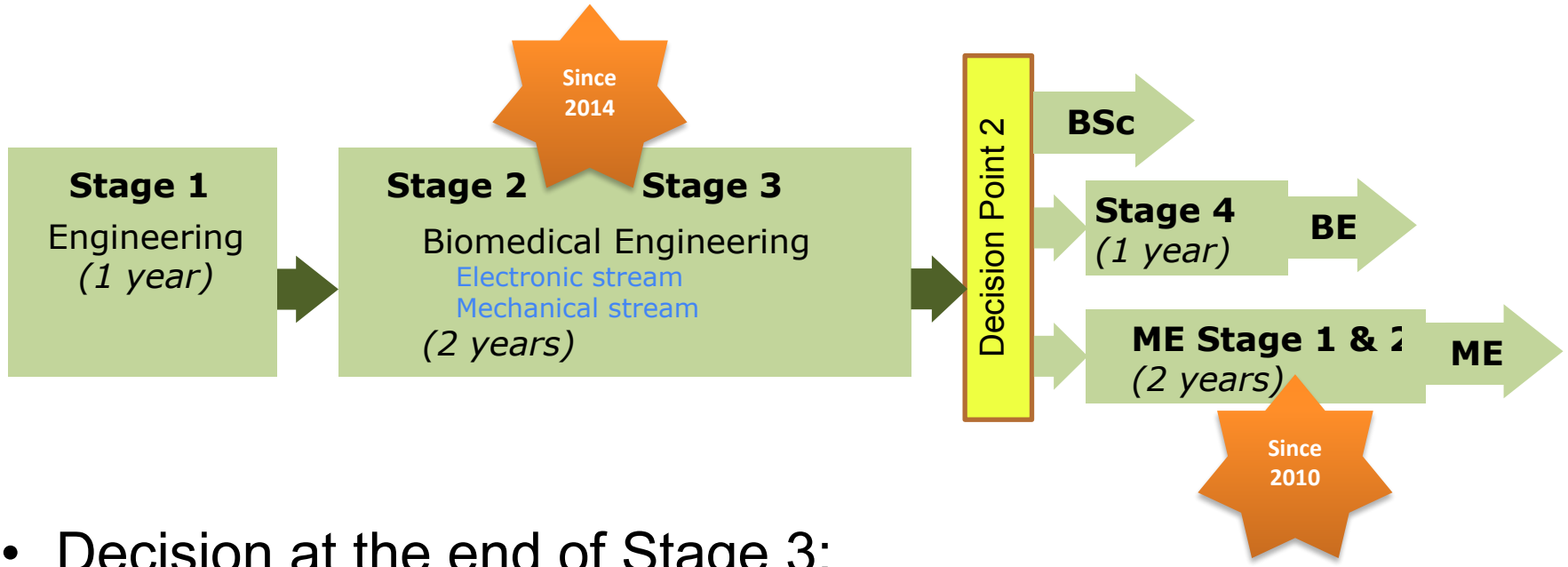
MOST WELL-FUNDED MEDICAL DEVICE COMPANIES ACROSS THE GLOBE

As of 5/4/17



CBINSIGHTS

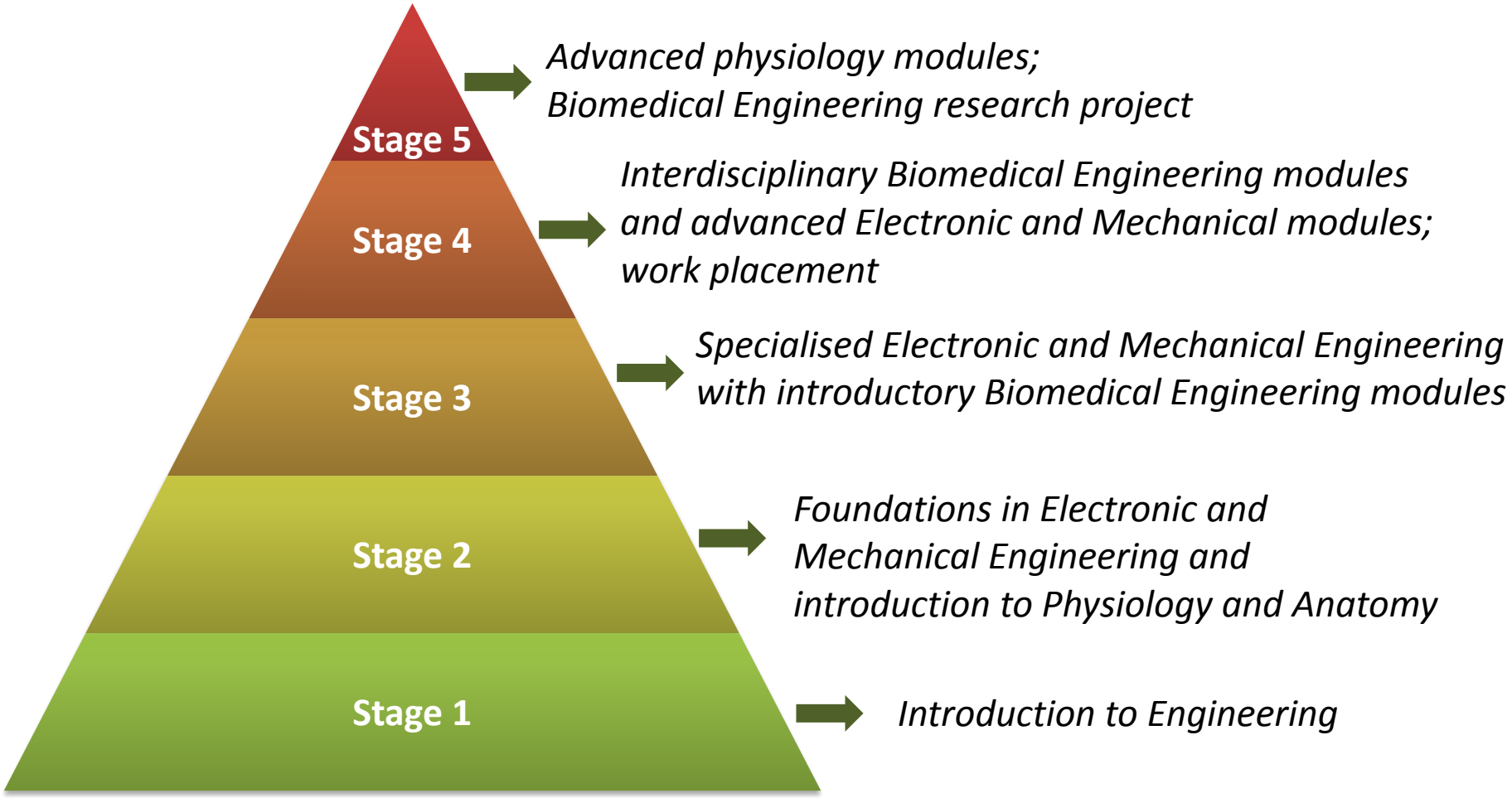
Biomedical Engineering pathways at UCD



- Decision at the end of Stage 3:
  1. Graduate with **BSc** (Engineering Science)
  2. Progress to Stage 4 of **BE in Biomedical Engineering**
     - Or, if eligible (weighted GPA ≥ 2.8):
  3. Progress to Stage 1 of **ME Biomedical Engineering** programme

BSc: Bachelor of Science
BE: Bachelor of Engineering
ME: Master of Engineering

UCD Biomedical Engineering programmes



UCD Biomedical Engineering
Master of Engineering Degree

ME Biomedical Engineering	
Duration: 2 years	
Workload: 120 credits	
Entry: GPA greater than 2.8 in Biomedical/Electronic/Electrical/Mechanical Engineering	
Accredited by Engineers Ireland	
6-8 Month Professional Work Experience and 25 credit research 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

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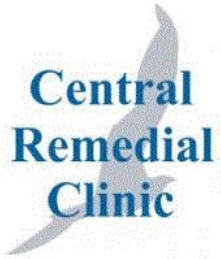
http://www.ucd.ie/biomedicalengineering/

ME Biomedical Engineering Year 1

Core Modules	
ANAT40010	Medical Sciences for Biomedical Engineers (unless already taken)
MEEN40620	Biomechanics
MEEN40630	Biomaterials
EEEN40660	Experimental Design and Statistics for Engineers
MEEN40600	Medical Device Design
1 or 2 Modules From Below or Equivalent **Option Modules**	
EEEN30160	Biomedical Signal Processing
EEEN40010	Control Theory
PHYS30010	Cardiovascular Physiology
PHYC40940	Bio-inspired technologies
EEEN40580	Optimisation Techniques
MEEN30030	Mech. Eng. Design II
MEEN40020	Mechanics of Fluids II
MEEN40030	Manufacturing Engineering II
PHYC40430	Nanomechanics

ME Biomedical Engineering Year 1

Semester 2 : 30-Credit Professional Work Placement
January – August



Employer testimonials (work placements)

'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

ME Biomedical Engineering Year 2

Semester 1		Semester 2	
MEEN40610	Research Project / Thesis	MEEN40610	Research Project / Thesis
EEEN40750	Research and Professional Skills for Biomedical Engineers		
EEEN40730	Biosensors & Actuators		
3 Modules From Below or Equivalent		**3 Modules From Below or Equivalent**	
EEEN40720	Machine Learning for Engineers	**Biomedical Engineering option modules (choose min. of 2)**	
PHYS30010	Cardiovascular Physiology	EEEN 30180	Bioinstrumentation
EEEN40130	Advanced Signal Processing	EEEN40350	Rehabilitation Engineering
COMP47460	Machine Learning	MEEN41160	Musculoskeletal Biomechanics and Mechanobiology
EEEN40300	Engineering Entrepeneurship	EEEN40070	Neural Engineering
EEEN40580	Optimisation Techniques for Engineers		
MEEN30030	Mechanical Engineering Design II	**Option modules**	
MEEN40020	Mechanics of Fluids II	CHEN40470	Cell Culture and Tissue Engineering
MEEN40030	Manufacturing Engineering II	MEEN40040	Materials Science and Engineering III
MEEN40050	Computational Continuum Mechanics I	MEEN30010	Applied Dynamics II
MEEN40060	Fracture Mechanics	COMP40400	Bioinformatics
MEEN40070	Advanced Metals/Materials Processing		
MEEN40080	Technical Ceramics		
MEEN40160	Kinetics & Thermodynamics of Materials		
MEEN40170	Mechanics of Solids III		
CHEN40790	Bio-material Interactions		

For new entrants to Biomedical Engineering…

ANAT20090 Medical Sciences for Biomedical Engineers

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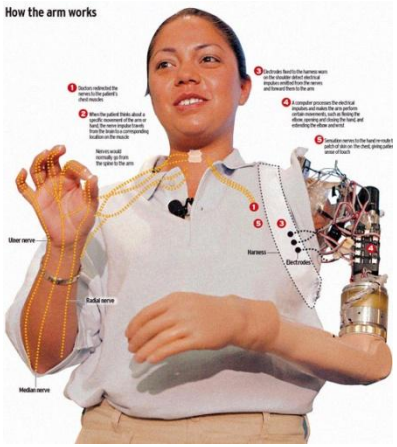
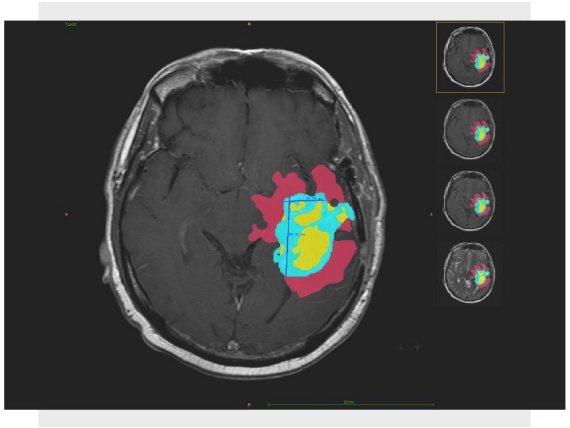
Bioelectronics Modules

Rehabilitation Robotics



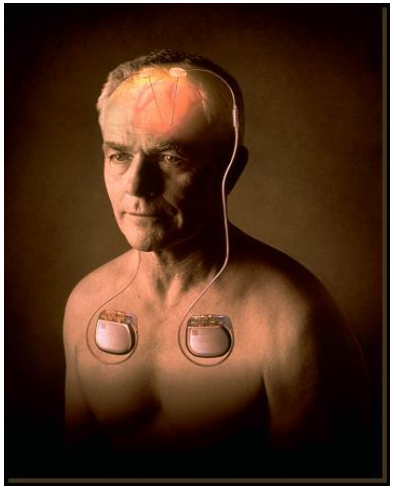
Biosensors & Actuators

Neuromuscular Stimulation



Machine Learning

Bioinstrumentation



Neural Engineering

A selection of modules…

EEEN40350 Rehabilitation Engineering

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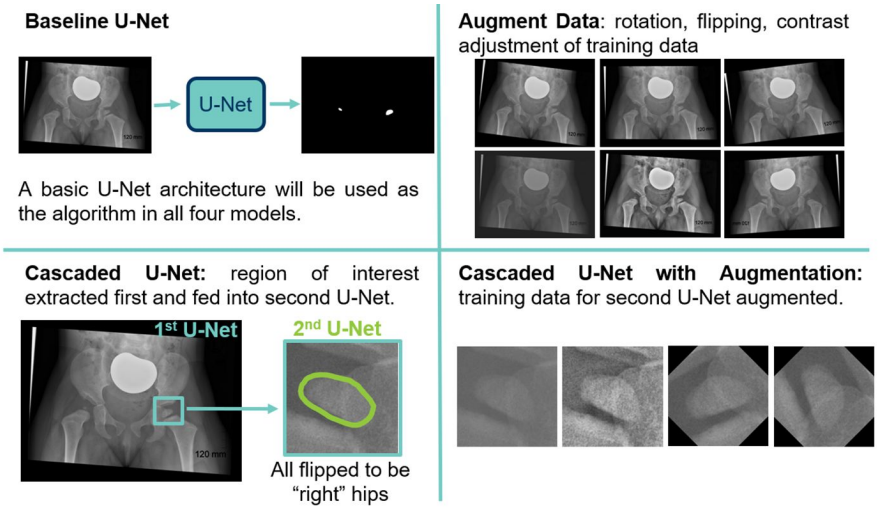
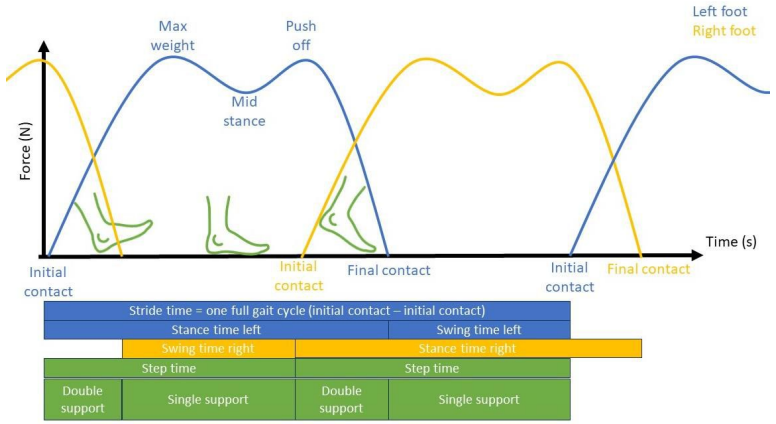
A selection of modules…

EEEN40720 Machine Learning for Engineers



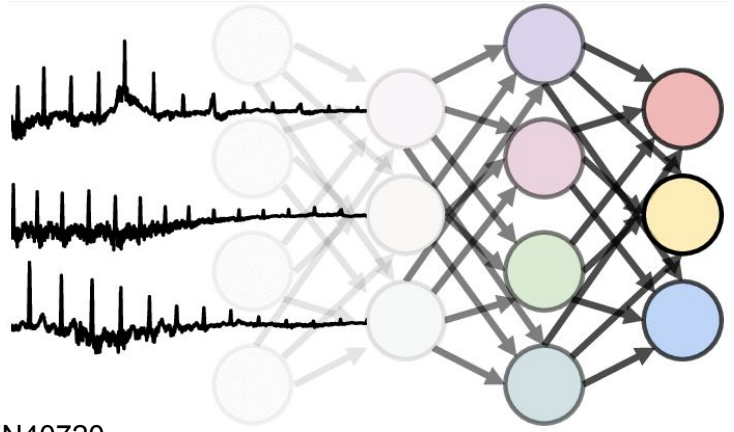
Biomedical applications, e.g. Gait, ECG, Sleep



Understand how to apply ML methods to engineering problems.

Deep understanding of a range of machine learning algorithms.

Best practice methods in training, testing and evaluating ML models.



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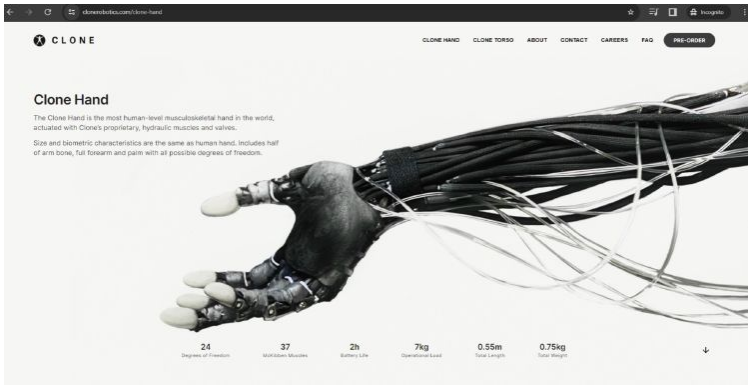
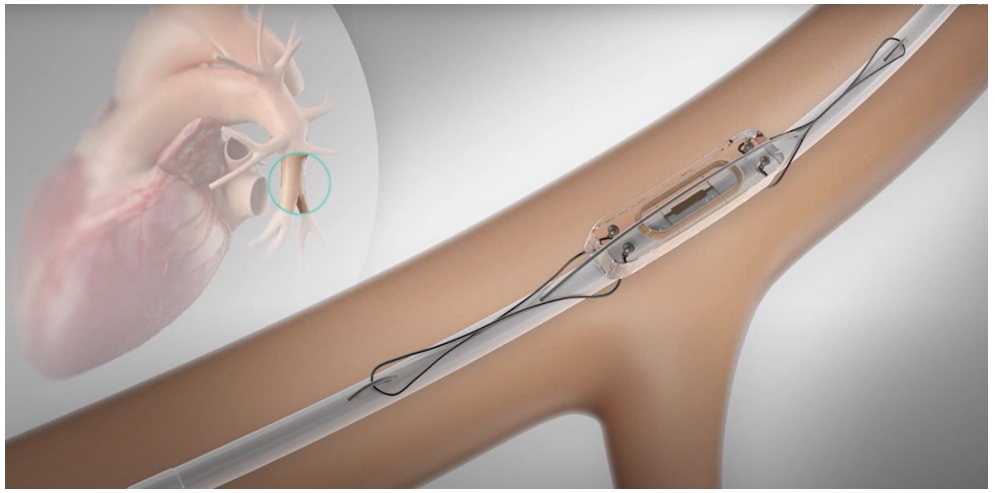
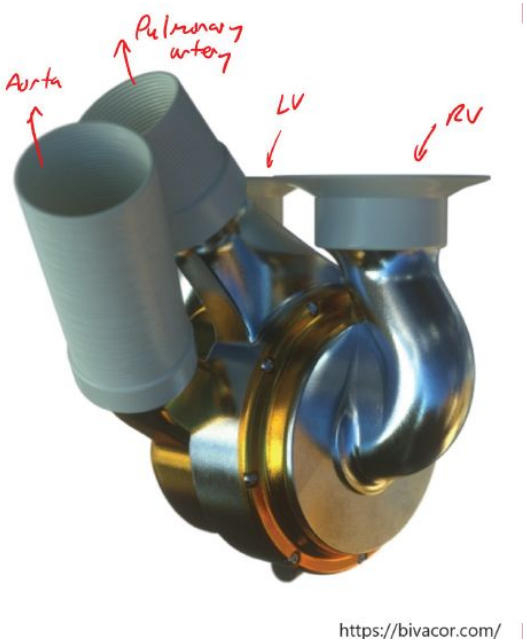
A selection of modules…

EEEN40730 Biosensors and Actuators







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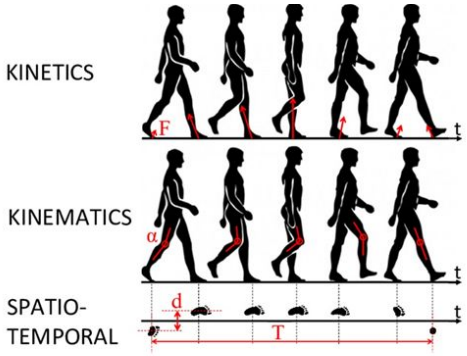
Wearable sensors:

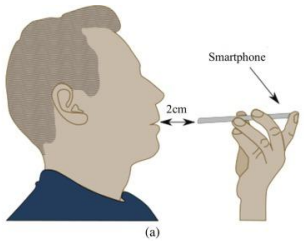
EEEN40730 Biosensors & Actuators
EEEN40070 Neural Engineering
EEEN40720 Machine Learning for Engineers

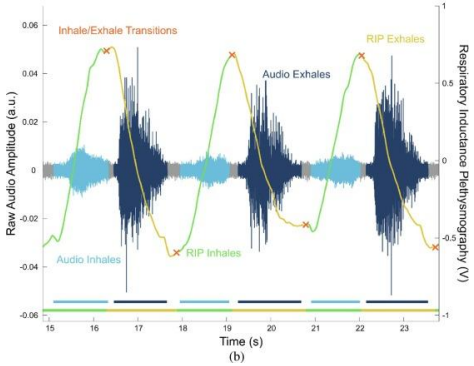
Gait / Movement



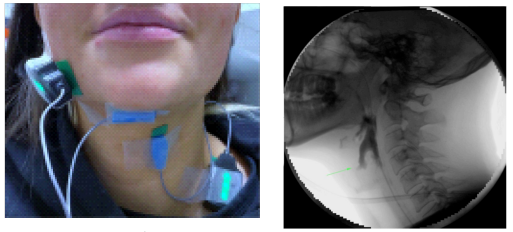
A Symbolic Approach to Human Motion Analysis Using Inertial Sensors: Framework and Gait Analysis Study by Anita Pinheiro Sant'Anna

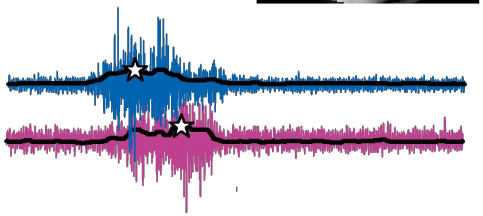
Respiration



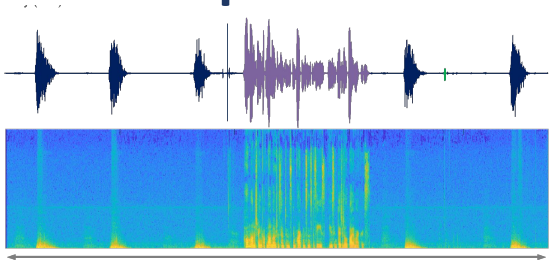


Swallowing





Speech



Sleep

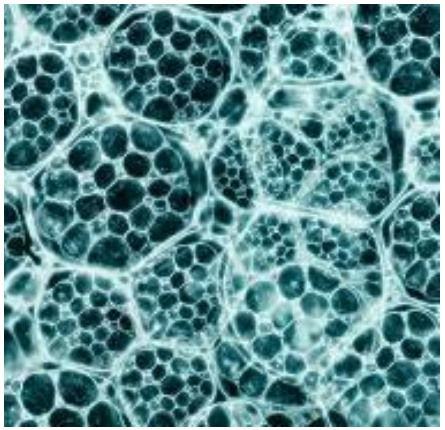
ST. VINCENT'S UNIVERSITY HOSPITAL
Elm Park

The Dublin Neurological Institute at The Mater Misericordiae University Hospital

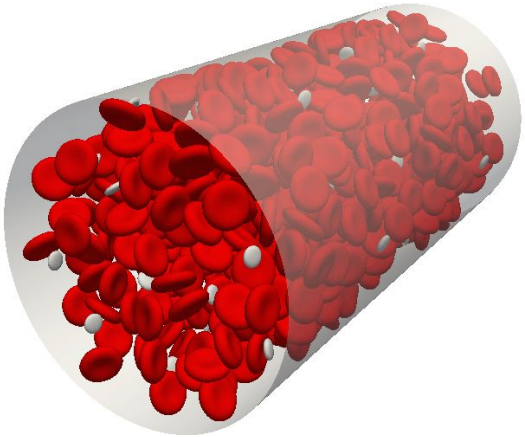
THE DNI

Biomechanics stream

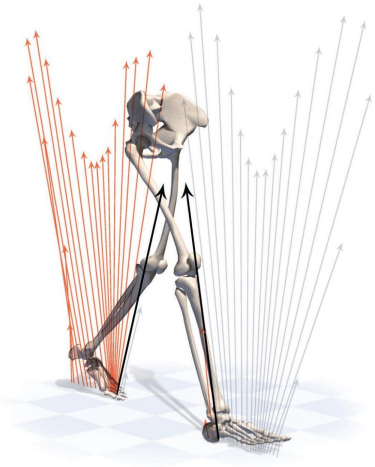
Medical Device Design



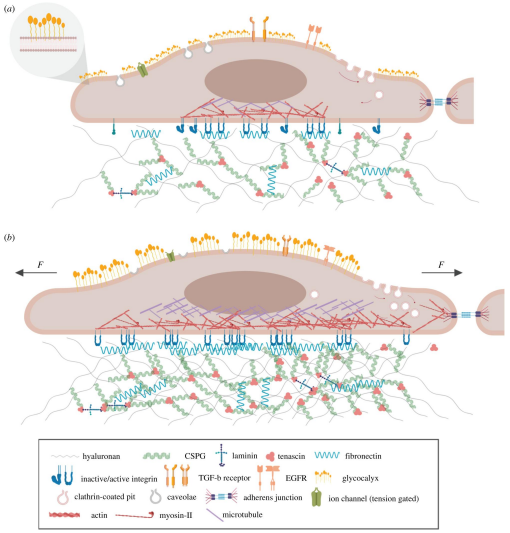
Biomaterials



Biofluids



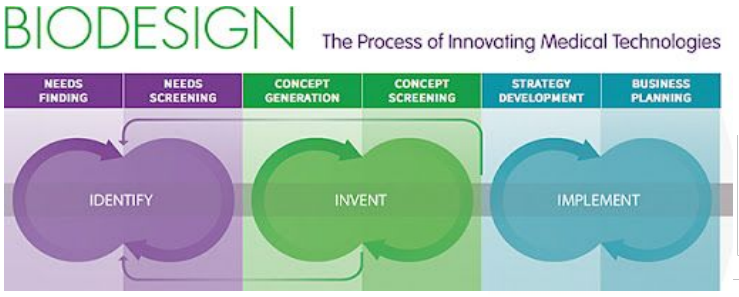
Movement Biomechanics



Tissue Biomechanics

A selection of modules…

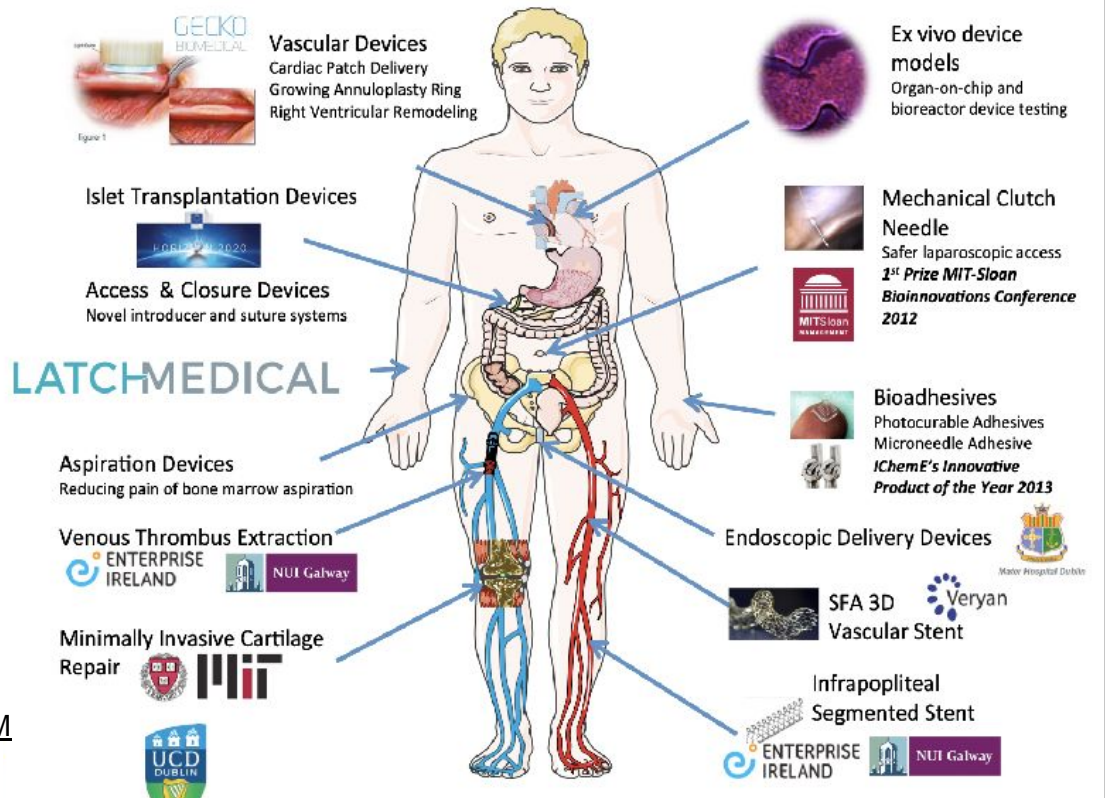
MEEN40600 Medical Device Design



I-Form Advanced Manufacturing Research Centre

cúram

AMBER



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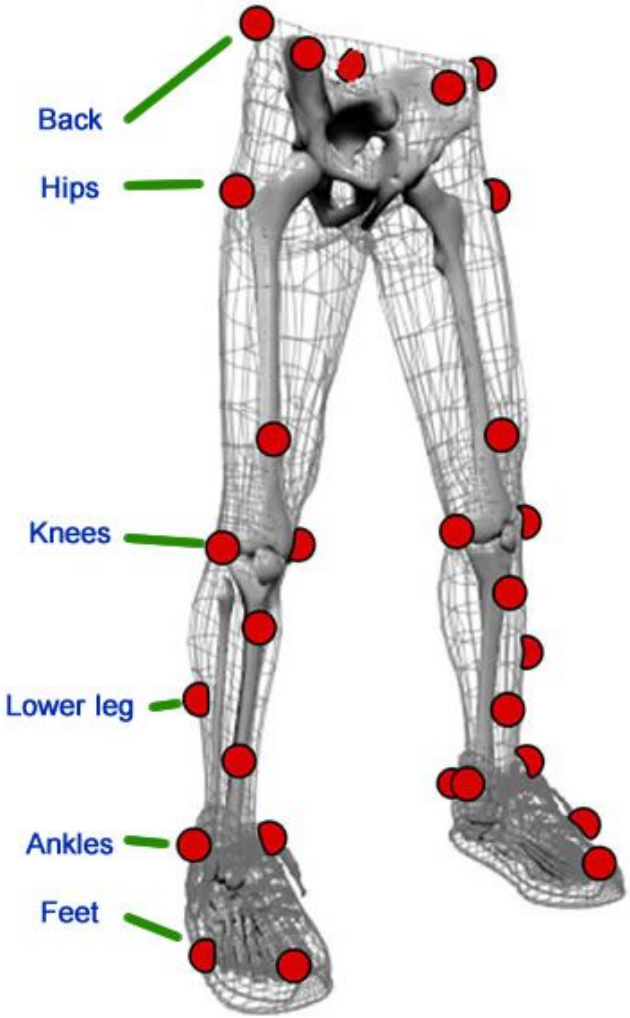
A selection of modules…

MEEN40620 Biomechanics



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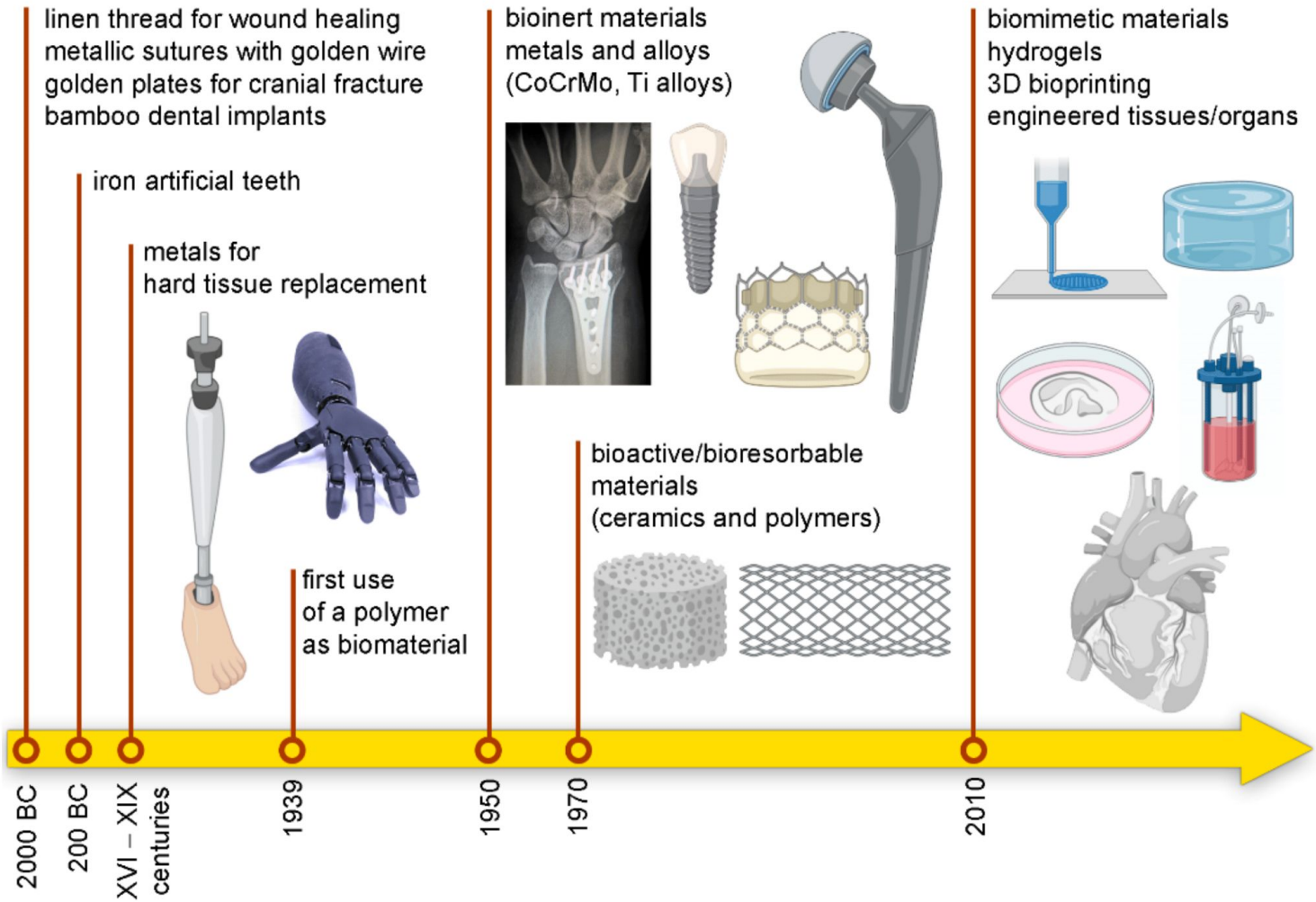
A selection of modules…

MEEN40630 Biomaterials



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Sample of Recent ME Projects

Sample ME Projects (2024/2025)

- Development and characterisation of biopolymer-doped electro-spun scaffolds.
- EEG signatures of perceptual decision making—moving from two to multiple alternatives.
- Experimental Analysis and Design of Aortic Valve Systems.
- Design of an apparatus and testing protocol for evaluating the device body interface of prostheses and orthoses.
- Design of a bespoke diffusion assay for microneedles.
- Estimating energy expenditure in elite athletes to monitor relative energy deficiency in sport (REDS).
- A computational design tool for soft orthoses and harnesses.
- Accuracy of Thin-Walled Parts Relative to Build Plate Recoater.
- Microstructure-informed mechanical behaviour of pancreatic tumours.
- Sense of agency for myoelectric control.
- Optimizing Lipid Nanoparticle Formulations for RNA Therapeutics A High-Throughput Approach.
- Development and Validation of a Perfusable Organ-on-Chip Device for Drug Testing.
- Longitudinal analysis of acoustic speech biomarkers in Huntington's disease.
- Testing of a novel robot for gait rehabilitation based on a recumbent bike design.
- Effect of fatigue on lower limb biomechanics of repeated jumping in male soccer players.
- Using Machine Learning Tools to Automate Signal Quality Control for Large Dataset Study.
- Design of a novel growth modulation device for treating knee deformities in children.
- Investigating oropharyngeal muscle activity in obstructive sleep apnea.
- Examining EEG signals of sensorimotor decision formation during learning of myoelectric control.
- Applying machine learning to automate segmentation of different tissue types.
- Optimize the development of a microfluidic device using different 3D bioprinting techniques.
- Investigating the effect of tongue position on maximum tongue force using different tongue training devices.
- The biaxial material properties of skin.
- Unravelling Meniscal Development: A MultiModal Analysis of Structural and Biomechanical Changes from Birth to Adulthood.
- Deriving individually-specific EEG indices of motor preparation for assessment of decision making.
- Estimating brain strain in extreme sports related traumatic brain injuries.
- Design of adaptive controllers for deep brain stimulation.
- Achilles tendon – its age-related changes and potential clinical utility in men.
- Evaluation of STING expression in Osteosarcoma tumours.
- Predictive simulations of lower-limb cycling rehabilitation.
- A Platform for Assessing the Brain Processes behind Driver Decisions in Urban Mixed-mode Traffic.

UCD DUBLIN

Engineering World Health

UCD Engineering World Health

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 30 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:

Study

Outreach Programmes

Bridges and Bytes – The Student Voice on AI and Assessment

Undergraduate Programmes

Postgraduate Programmes

Doctorate PhD Programmes

APEP International Programmes

Engineering International Programmes

Student Blogs

Oisin Wade - Chemical & Bioprocess Engineering

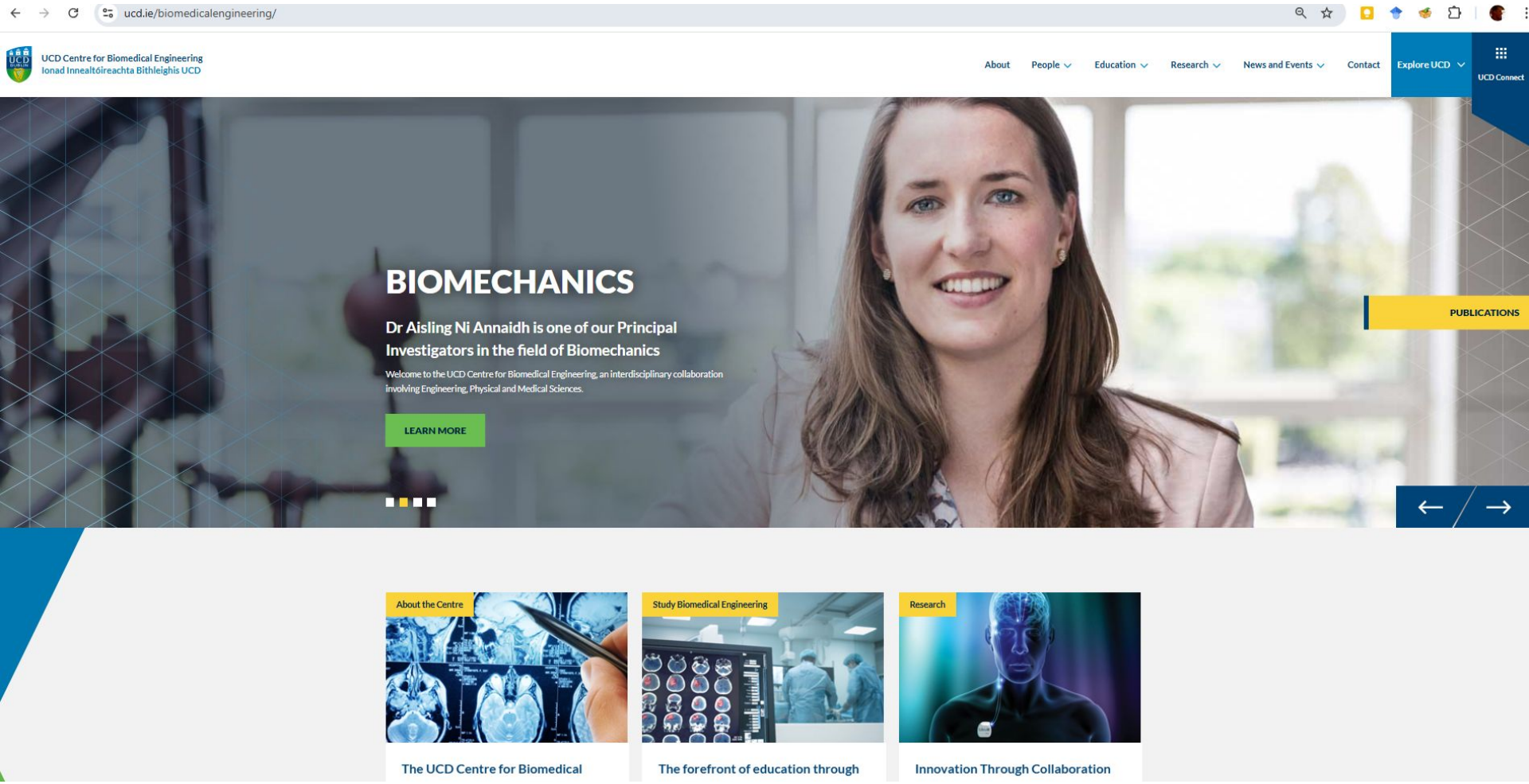
Daisy Odunze - Environmental Technology

Ahmed Ashfaq - Chemical Engineering

Becoming Engineers Without Borders from 2025!

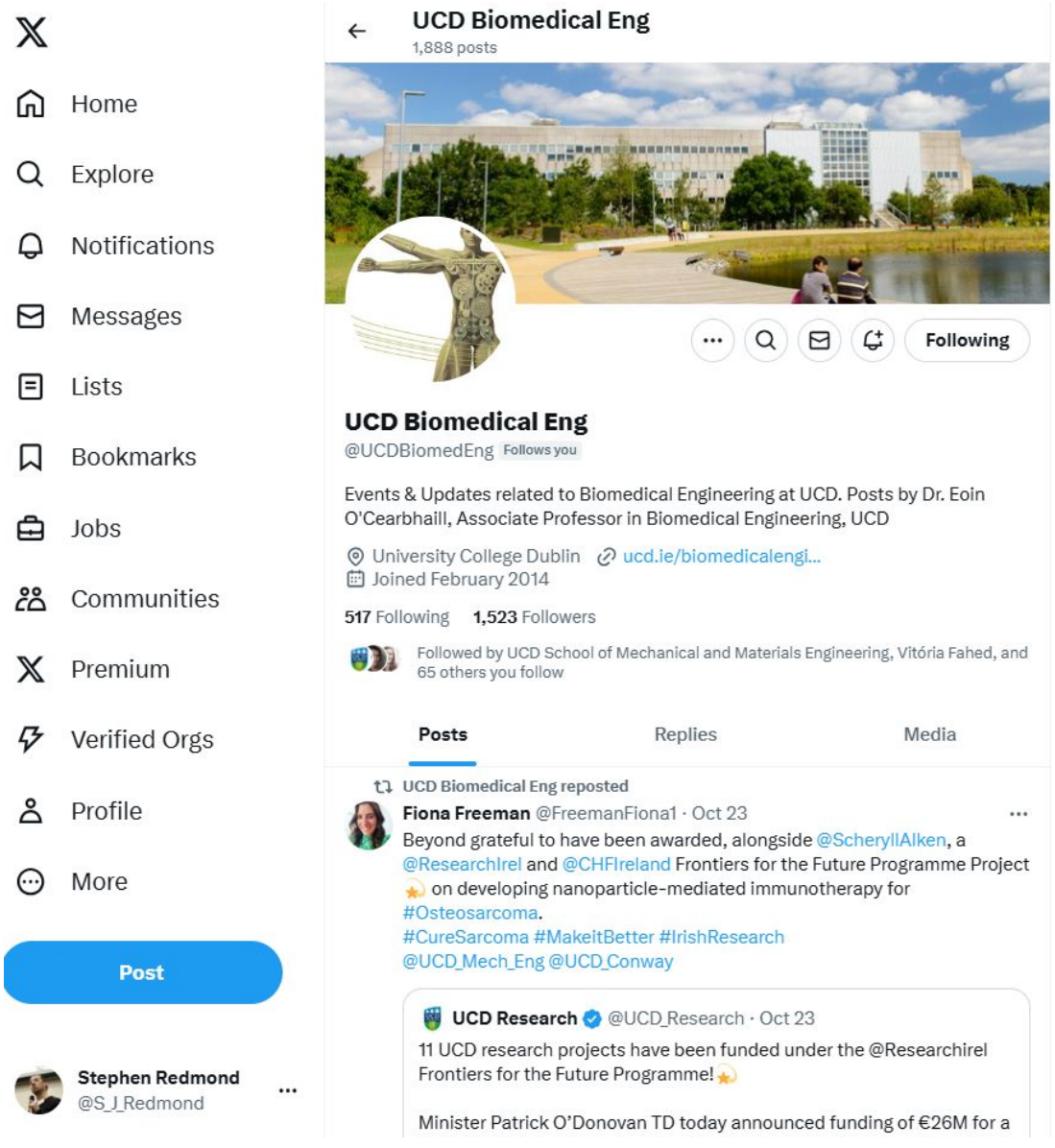
https://www.ucd.ie/eacollege/study/studentblogs/ucdengineeringworldhealth/

UCD Centre for Biomedical Engineering



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

UCD Biomedical Engineering Twitter/X



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Questions?