UCD Biomedical Engineering

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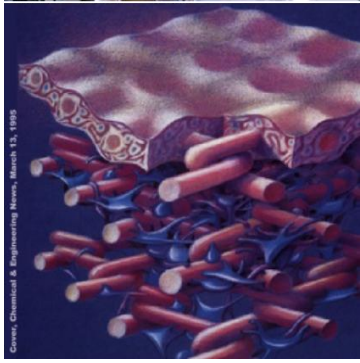
PhD Biomedical Engineering, UCD, 2021.
Lead Data Scientist, Danu Sports.

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

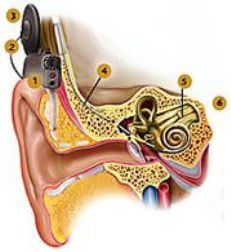
  Biomaterials, cell, and tissue engineering

  Medical device design

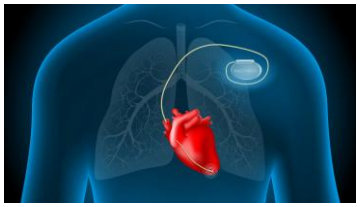
- Foundation in Electrical/Electronic or Mechanical Engineering

Biomedical Engineering

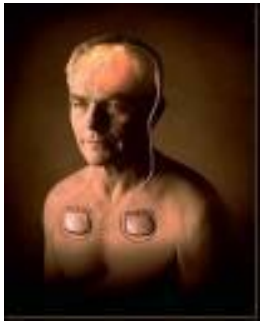
The application of engineering principles to understand, modify or control biological systems



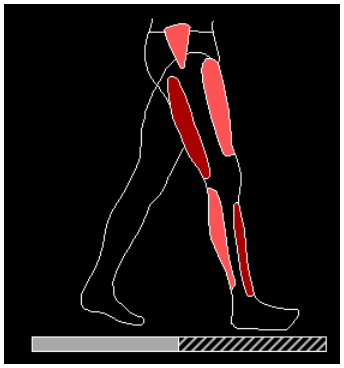
Cochlear implants



Pacemakers



Deep brain stimulation



Gait analysis

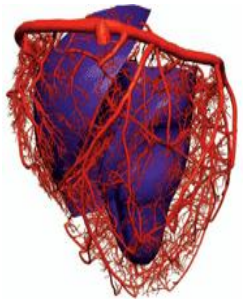
Artificial limbs

Rehabilitation robotics

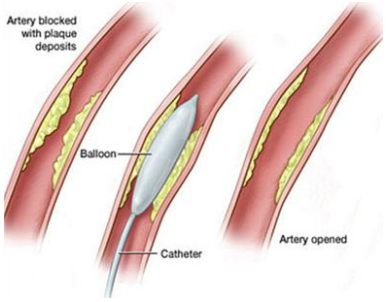
Hip implants

Biomedical signal processing

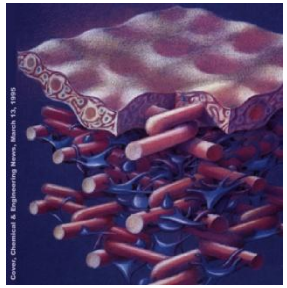
MR imaging



Physiological modelling



Angioplasty



Tissue engineering

Medtech in Ireland

Ireland continues to be a leading global hub for medtech

1st

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

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

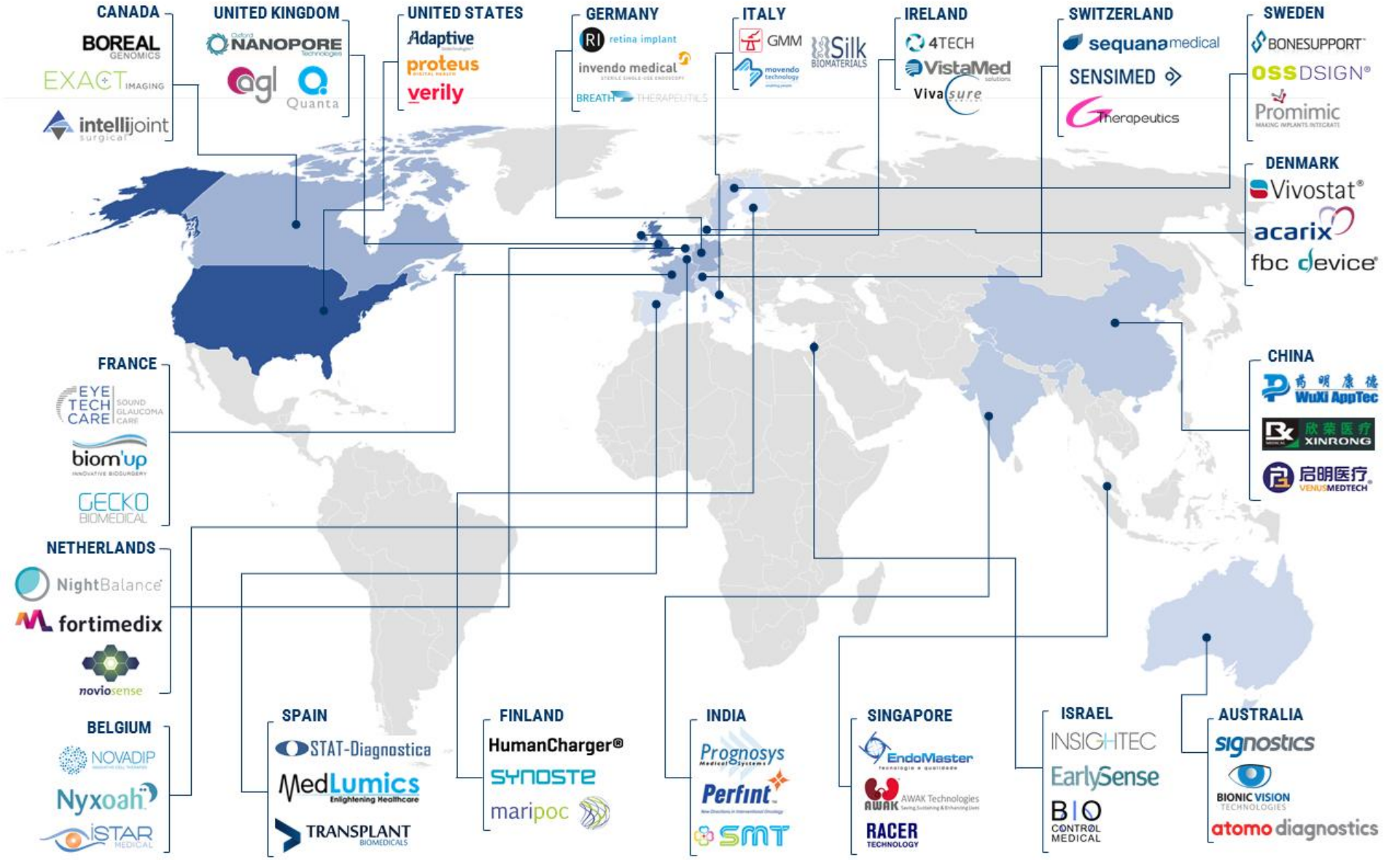
Medtech in Ireland

"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

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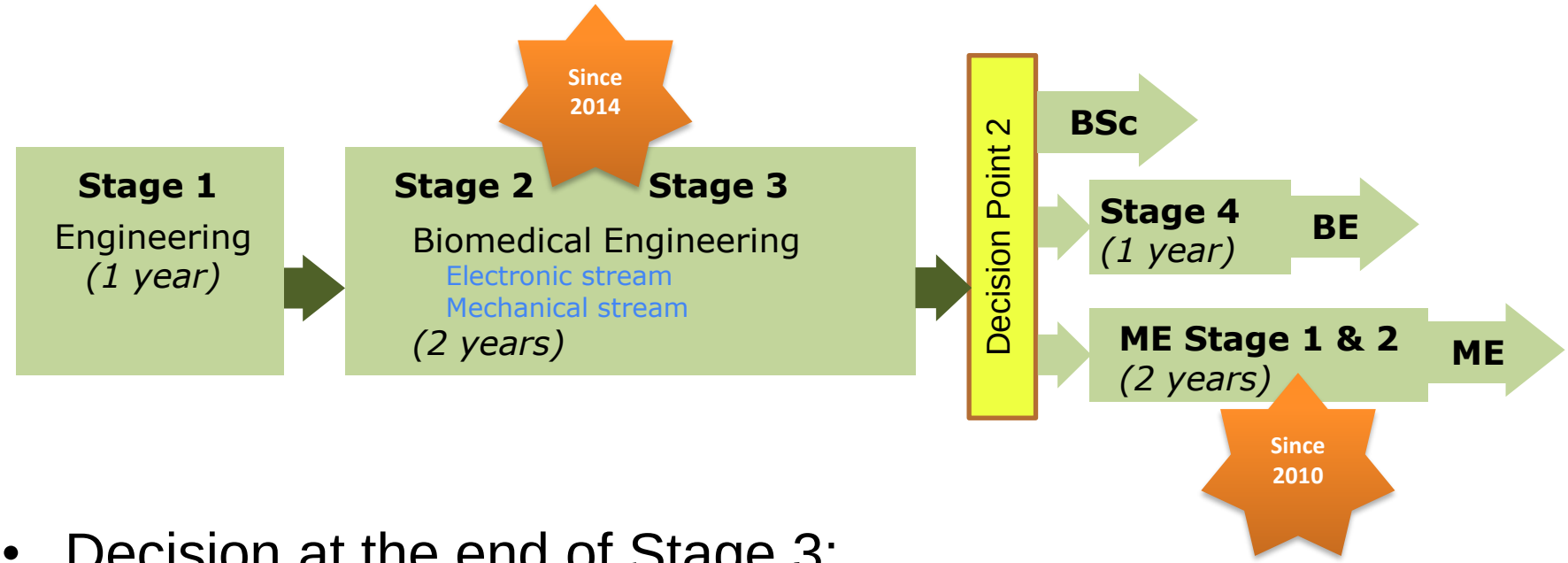
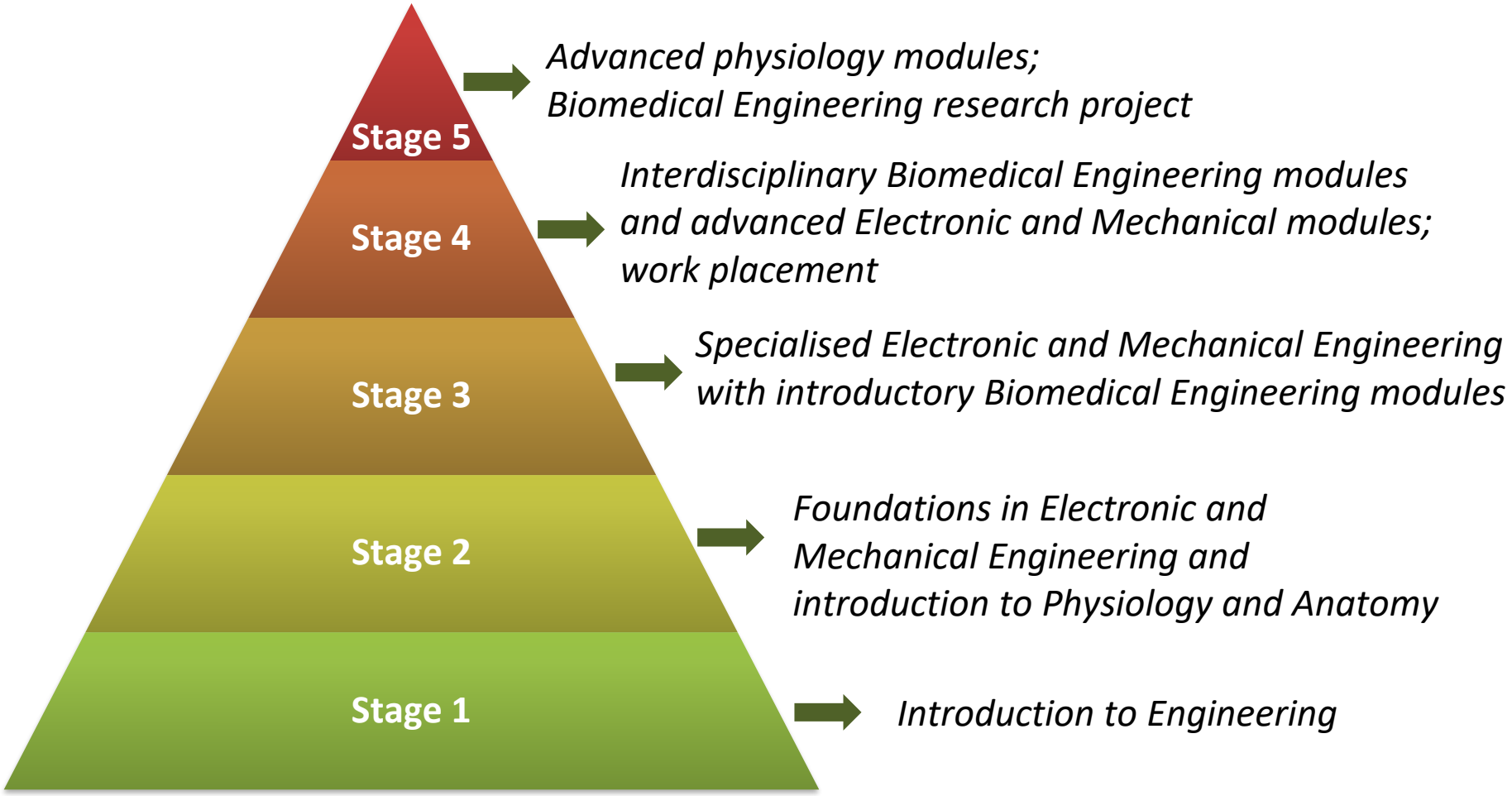
Biomedical Engineering pathways at UCD



- 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



Stage 2 Biomedical Engineering modules

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

Options

Trimester	Module Code	Module Title	Credits	Level
		Option Modules*		
Spring	EEEN 20040	Electronic Circuits	5 Credits	level: 2
Spring	MEEN 20060	Mechanical Engineering Design I	5 Credits	level: 2
		In-Programme Electives		
Autumn	MEEN 20020	Manufacturing Engineering I	5 Credits	level: 2
Autumn	MEEN 20050	Heat Transfer	5 Credits	level: 2
Spring	BSEN20190	Intro to Carbon and Energy Footprinting	5 Credits	level: 2

* Rule for Options:	Select 1 of 2 in Trimester 2 (Spring)

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 modules

Trimester 1	Module Code	Module Title	Credits	Level
Autumn	ACM30030	Multivariable Calculus for Engineers II	5 Credits	level: 3
Autumn	ANAT20090	Medical Sciences for Biomedical Engineers	5 Credits	level: 2
Autumn	EEEN30160	Biomedical Signal Processing	5 Credits	level: 3
Autumn		Option x2	See rules	
Autumn		Elective	5 Credits	
Trimester 2	**Module Code**	**Module Title**	**Credits**	**Level**
Spring	EEEN30150	Modelling and Simulation	5 Credits	level: 3
Spring	EEEN30180	Bioinstrumentation	5 Credits	level: 3
Spring	MEEN30160	Biofluids	5 Credits	level: 3
Spring		Option x2	See rules	
Spring		Elective	5 Credits	

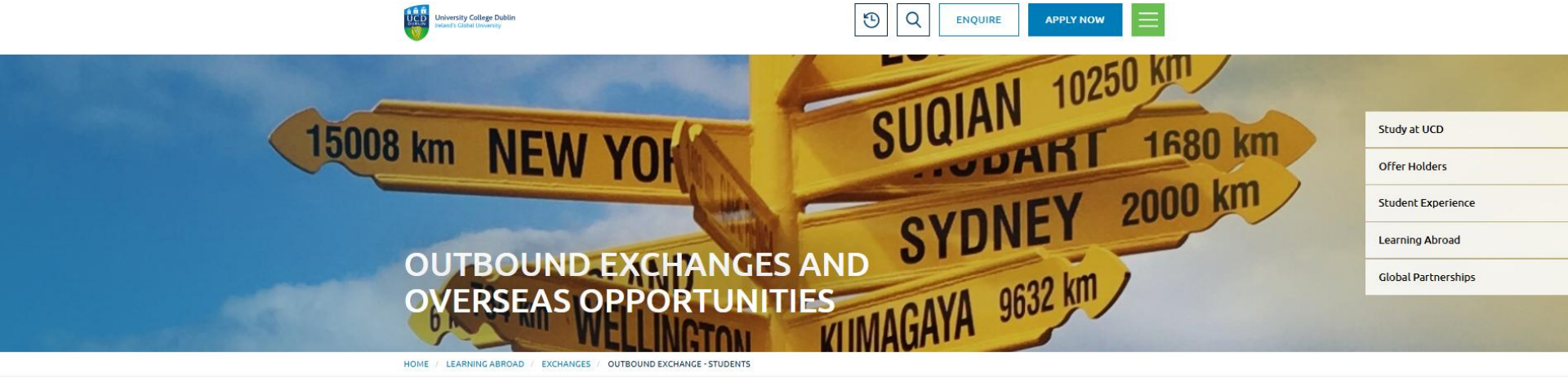
Bioelectronics stream "options"

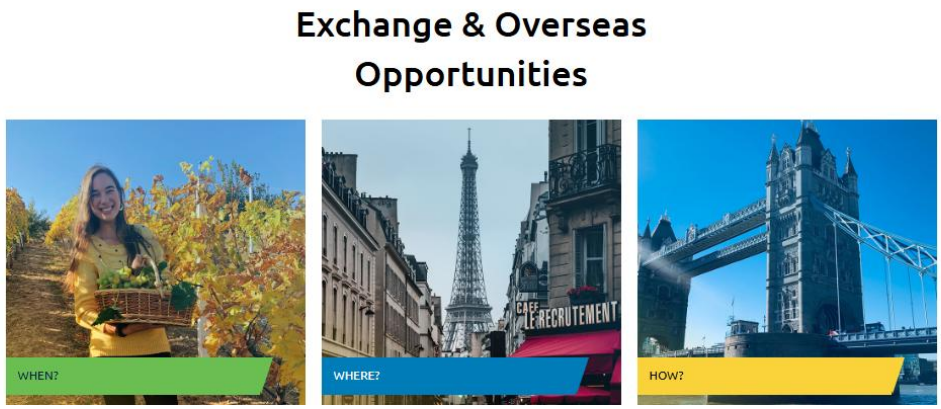
Trimester	Module Code	Module Title
Autumn	EEEN30020	Circuit Theory
Autumn	EEEN30110	Signals and Systems
Spring	EEEN30030	Electromagnetic Waves
Spring	EEEN30050	Signal Processing: Theory and Applications

Biomechanics stream "options"

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

Study Abroad (Stage 3)





Sample of previous host universities for Biomedical Engineering students

University of Auckland
University of Western Australia
McGill University
University of British Columbia
Georgia Institute of Technology
Purdue University
University of Illinois at Urbana-Champaign
University of Maryland
University of Miami
University of Virginia

Stage 4 Biomedical Engineering core modules

Trimester	Module Code	Module Title	Credits	Level
YEAR	EEEN30240	Professional Engineering Project	15 Credits	level: 3
Autumn	MEEN40600	Medical Device Design	5 Credits	level: 4
Autumn	MEEN40620	Biomechanics	5 Credits	level: 4
Autumn	MEEN40630	Biomaterials	5 Credits	level: 4
Autumn		Options x2	10 Credits	
Trimester	**Module Code**	**Module Title**	**Credits**	**Level**
Spring	MEEN41410	Tissue Engineering	5 Credits	level: 4
Spring	EEEN40070	Neural Engineering	5 Credits	level: 4
Spring	EEEN40350	Rehabilitation Engineering	5 Credits	level: 4
Spring		Options x1	5 Credits	

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 Regulatory Affairs in Science

Programme Steering Committee

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

A selection of modules…

ANAT20090 Medical Sciences for Biomedical Engineers

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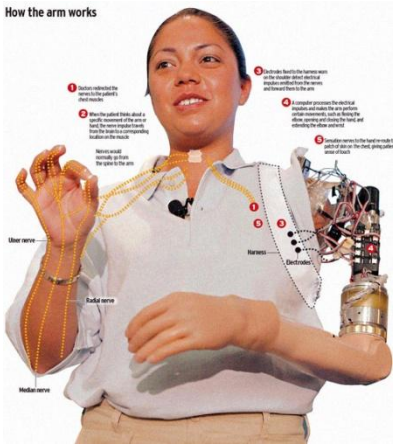
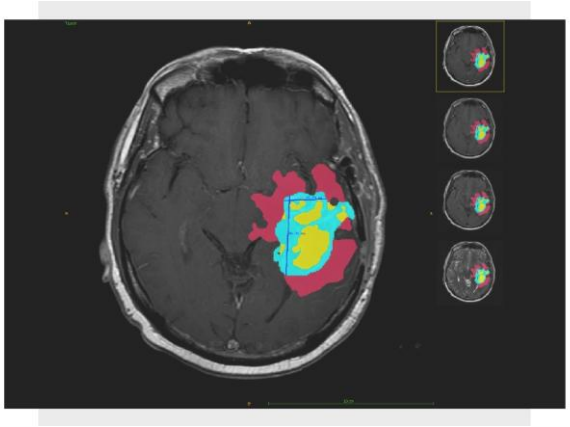
Bioelectronics stream

Rehabilitation Robotics



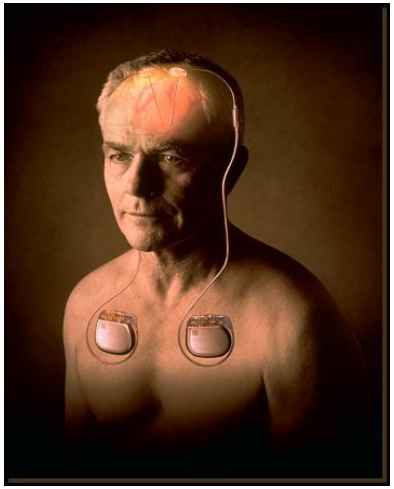
Biosensors & Actuators

Neuromuscular Stimulation



Machine Learning

Bioinstrumentation



Neural Engineering

A selection of modules…

EEEN40350 Rehabilitation Engineering

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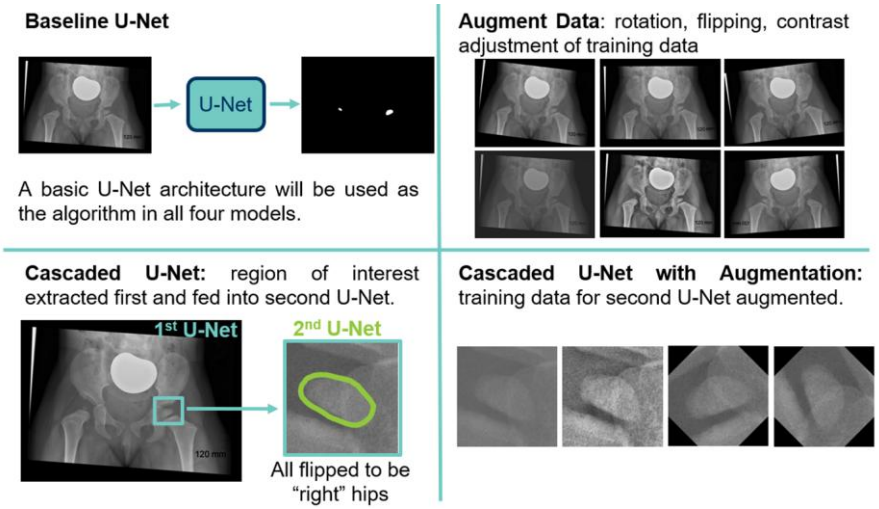
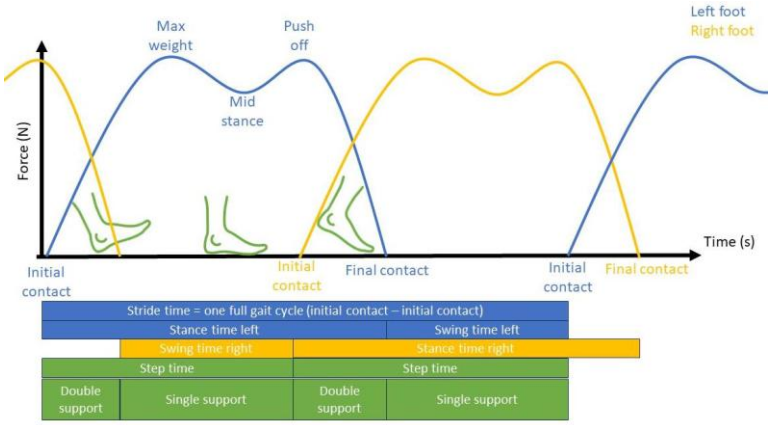
A selection of modules…

EEEN40720 Machine Learning for Engineers



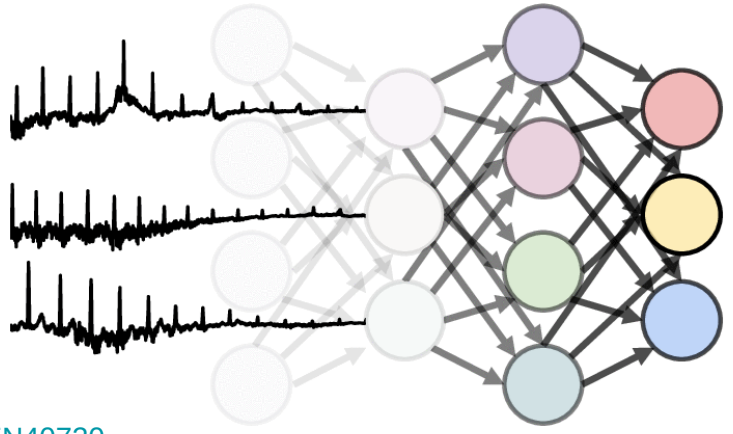
Biomedical applications, e.g. Gait, ECG, Sleep



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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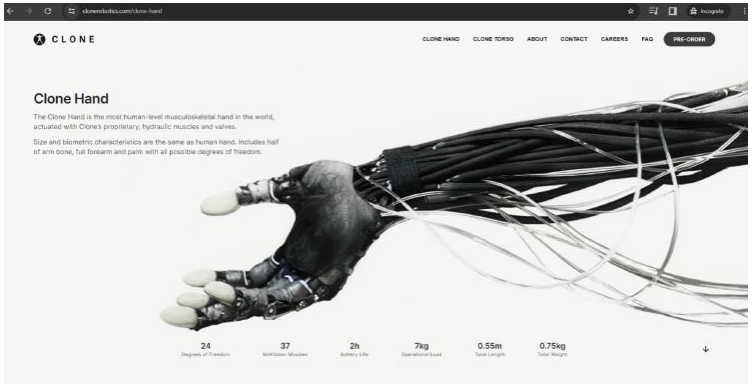
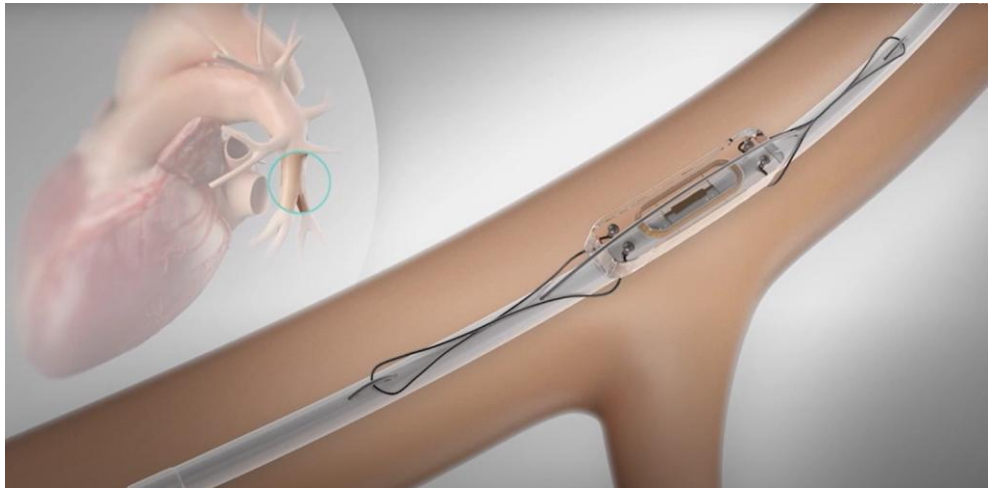
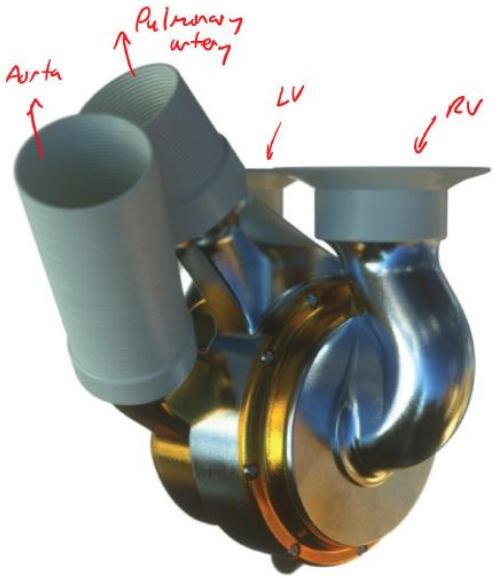
A selection of modules…

EEEN40730 Biosensors and Actuators







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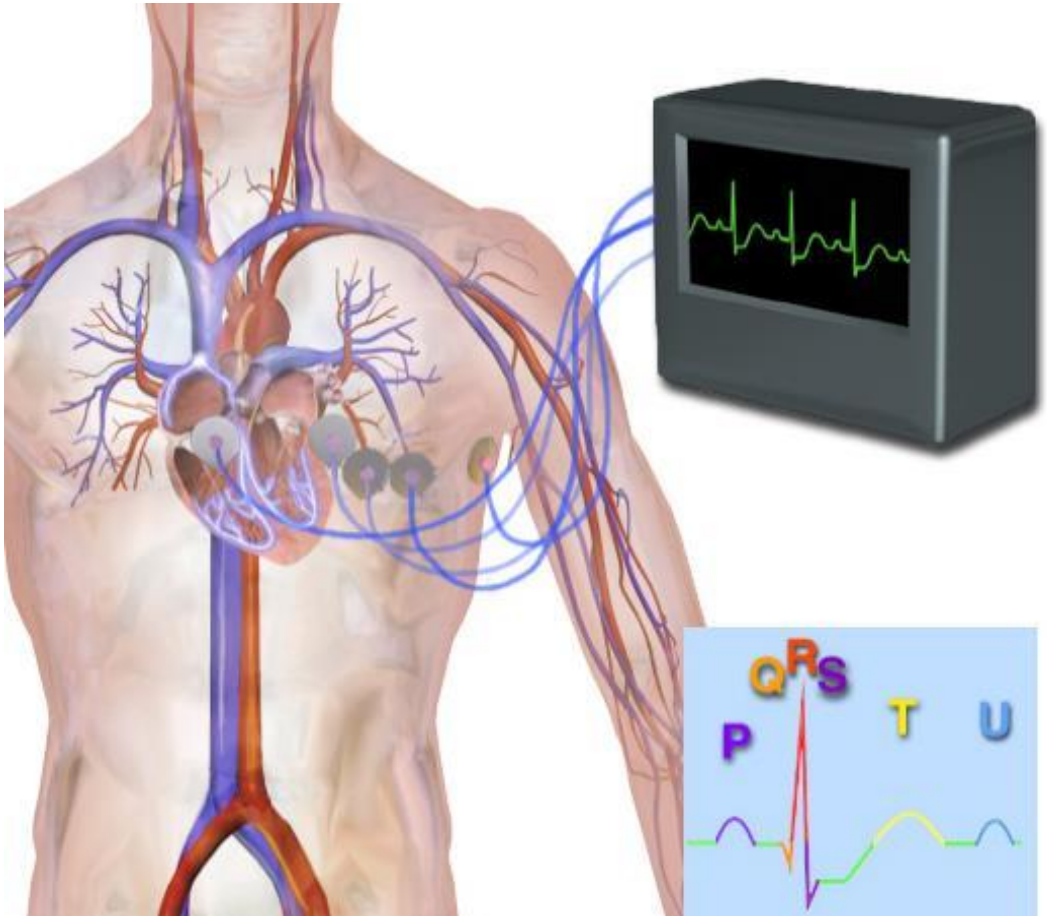
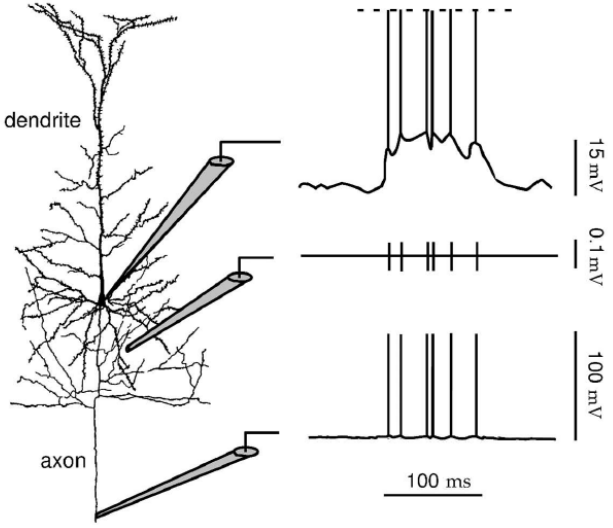
A selection of modules…

EEN30180 Bioinstrumentation





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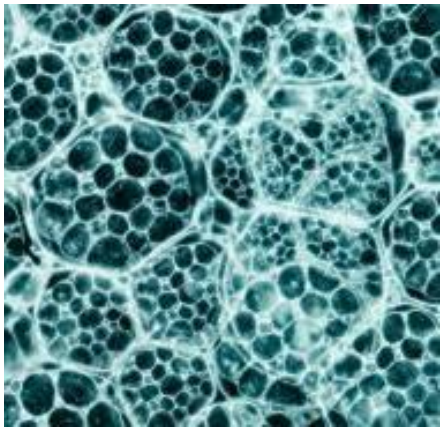
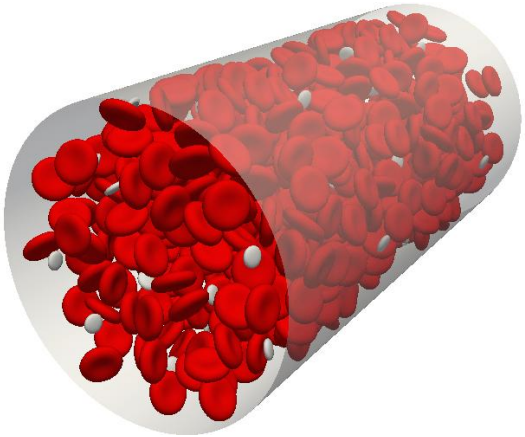
Biomechanics stream

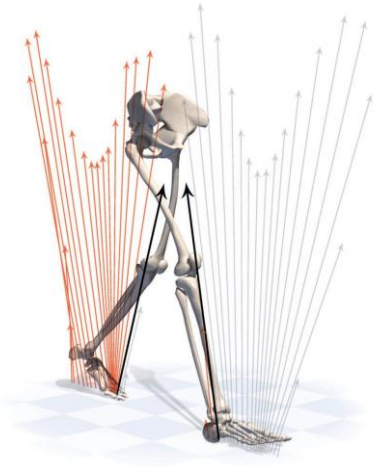
Medical Device Design



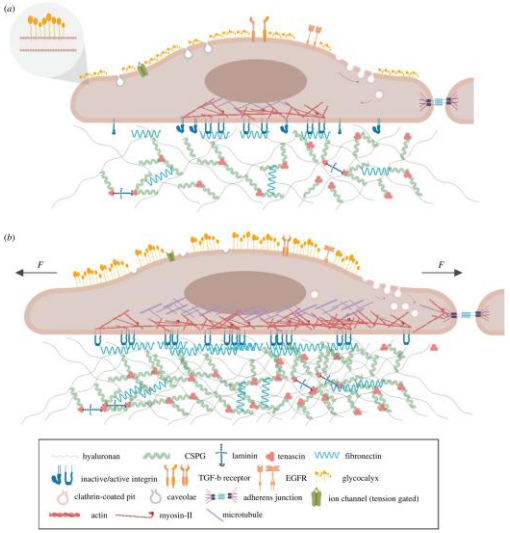
Biomaterials



Biofluids



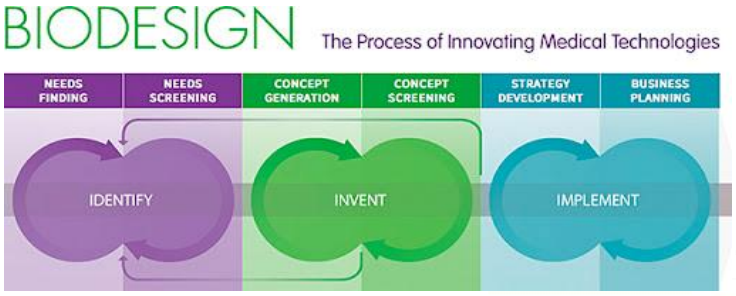
Movement Biomechanics



Tissue Biomechanics

A selection of modules…

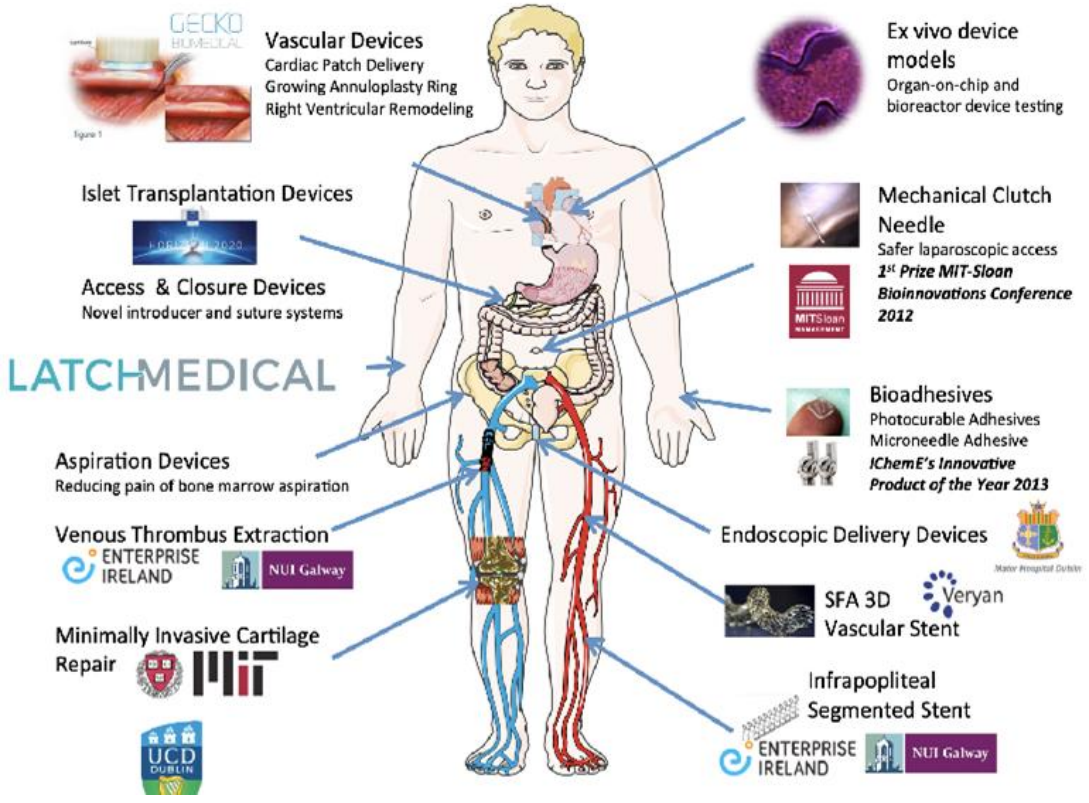
MEEN40600 Medical Device Design



I-Form Advanced Manufacturing Research Centre

cúram

AMBER



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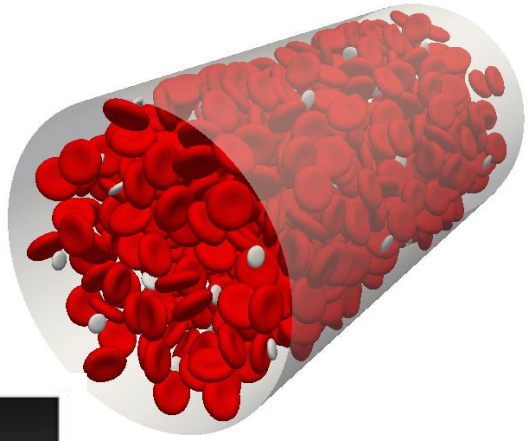
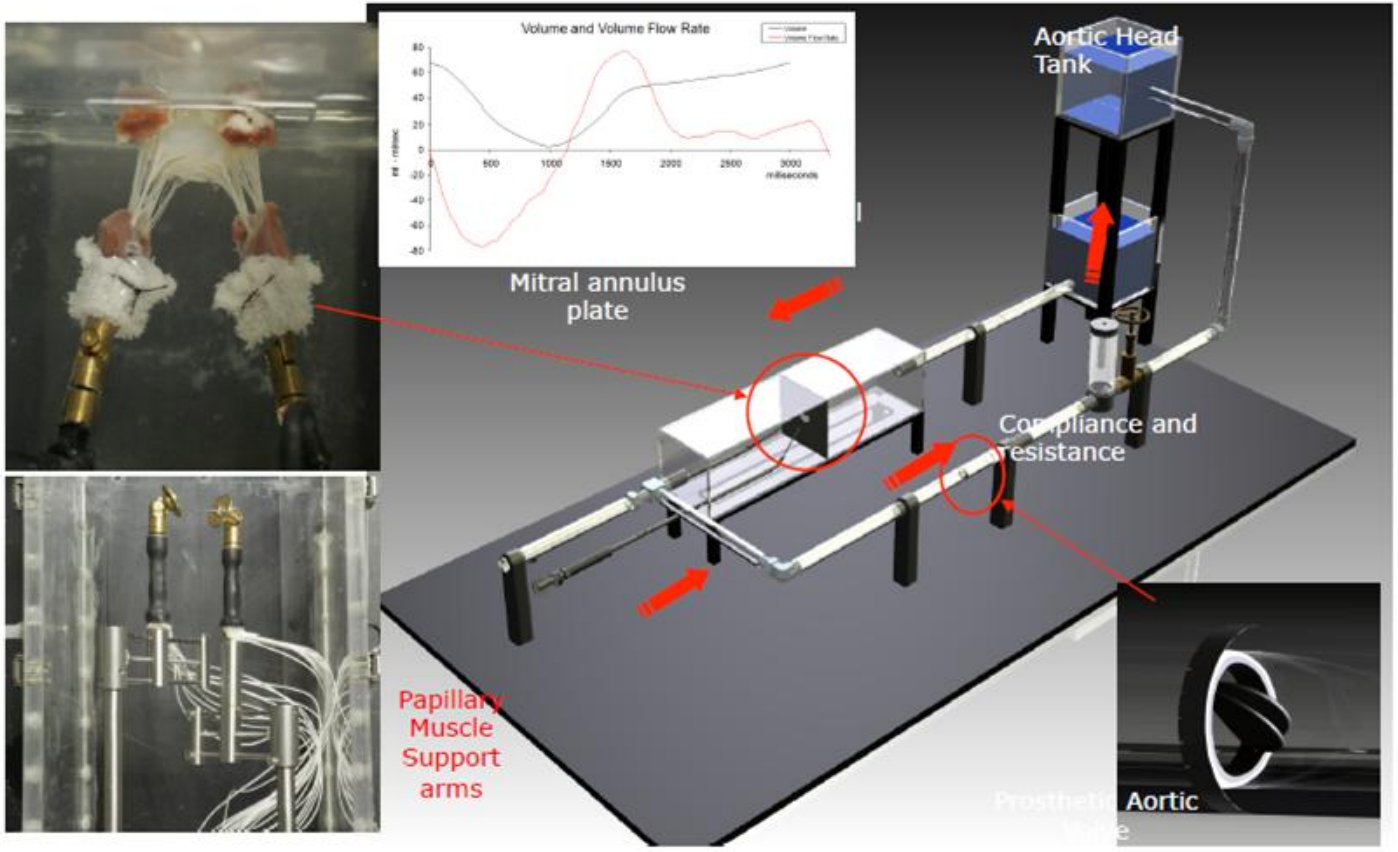
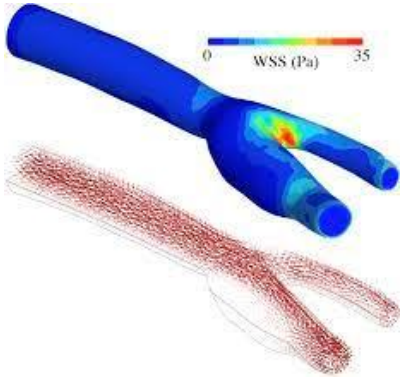
A selection of modules…

MEEN30160 Biofluids







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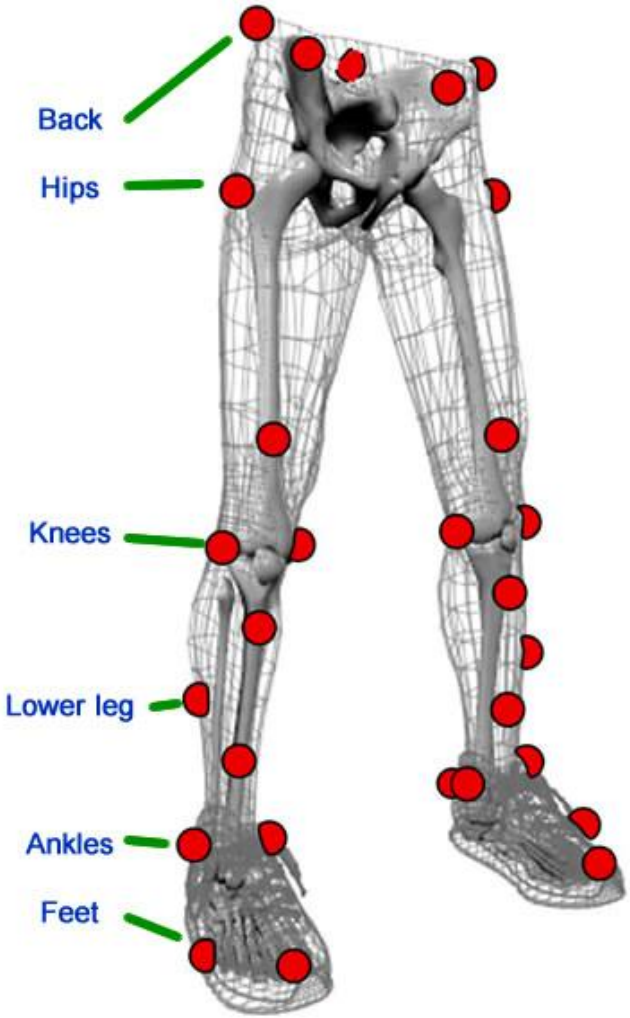
A selection of modules…

MEEN40620 Biomechanics



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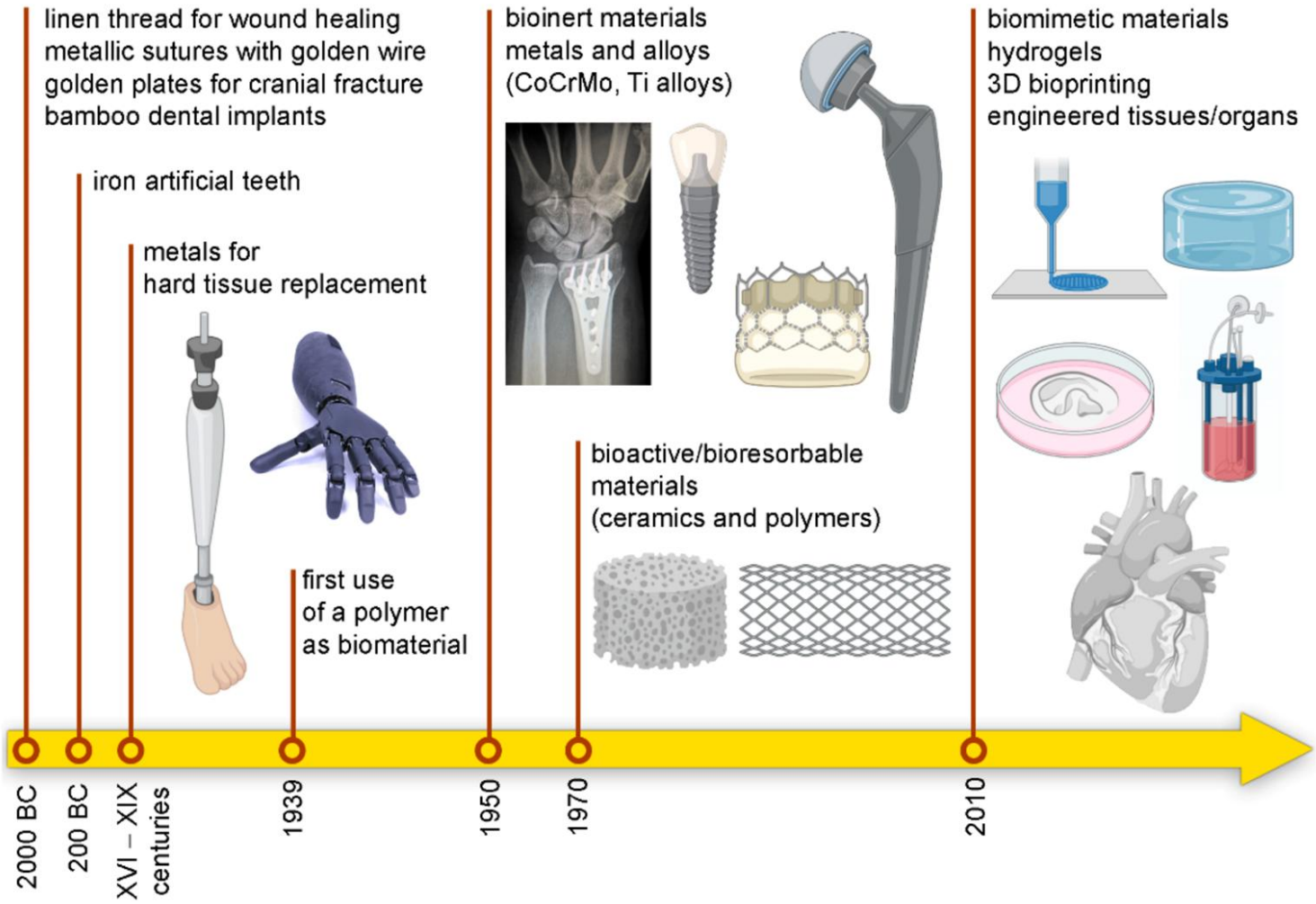
A selection of modules…

MEEN40630 Biomaterials



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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.'

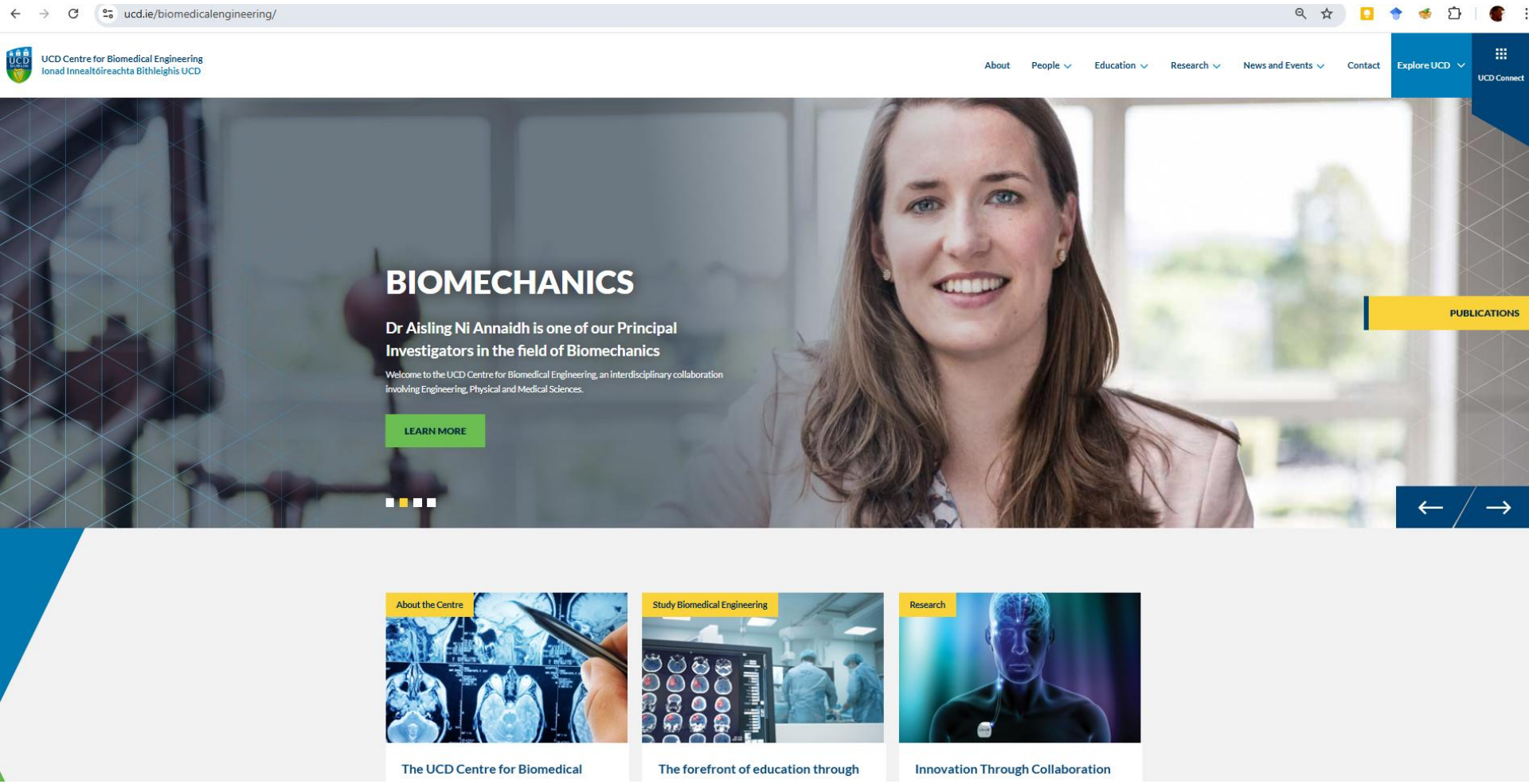
Boston Scientific

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.

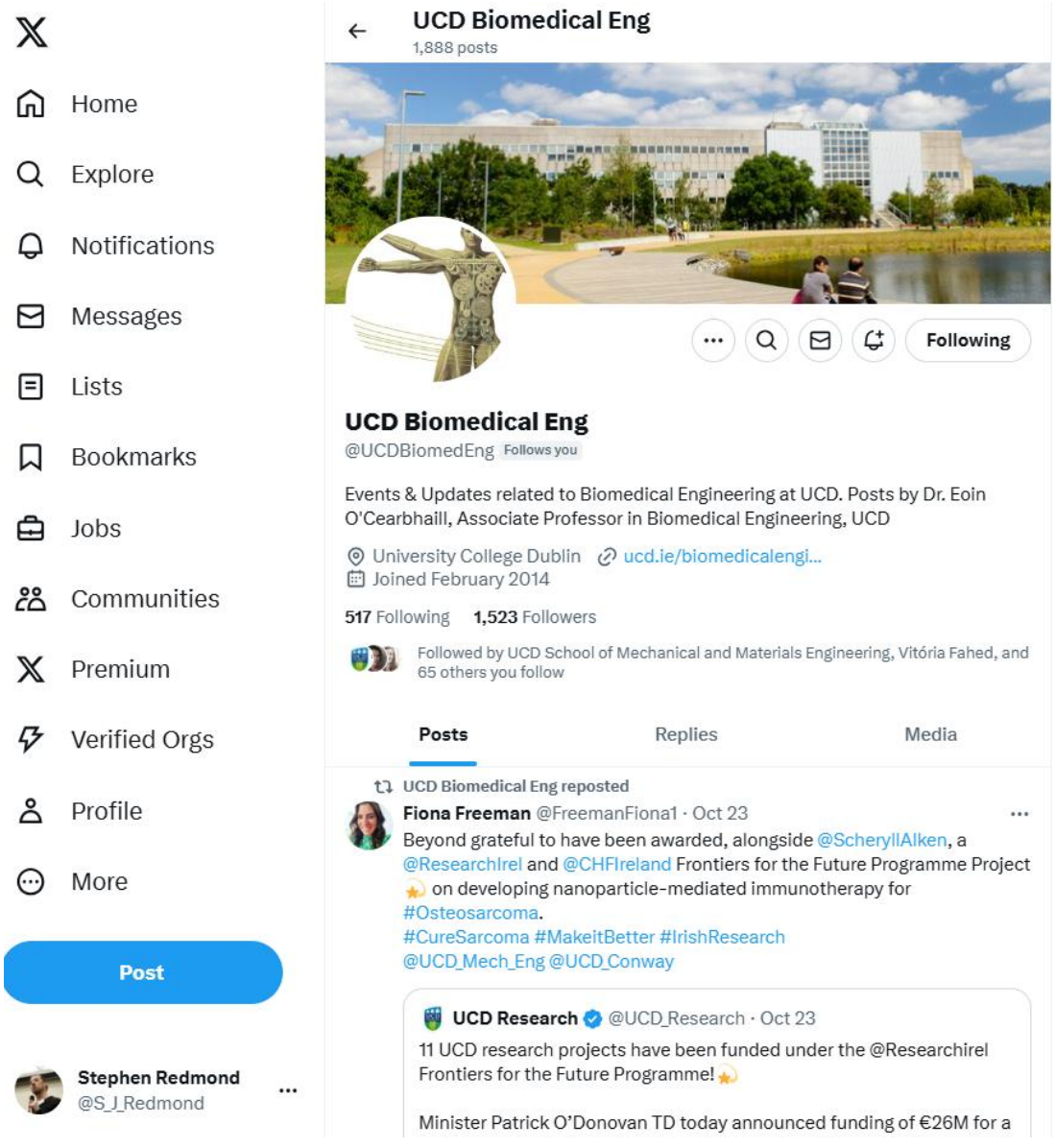
UCD DUBLIN

UCD Centre for Biomedical Engineering



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

UCD Biomedical Engineering Twitter



@UCDBiomedEng

UCD Biomedical Engineering

Questions?

UCD Biomedical Engineering

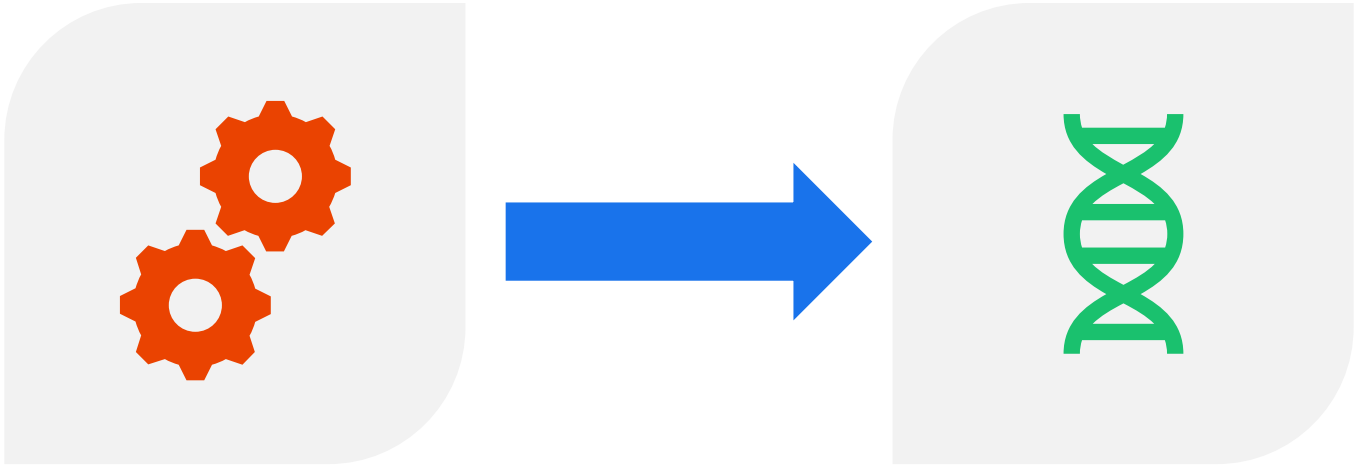
The perspective of students, past and present!...

GRACE CARRAGHER

GRACE.CARRAGHER@UCDCONNECT.IE

Biomedical Engineering Through Mechanical Engineering

What did I do?



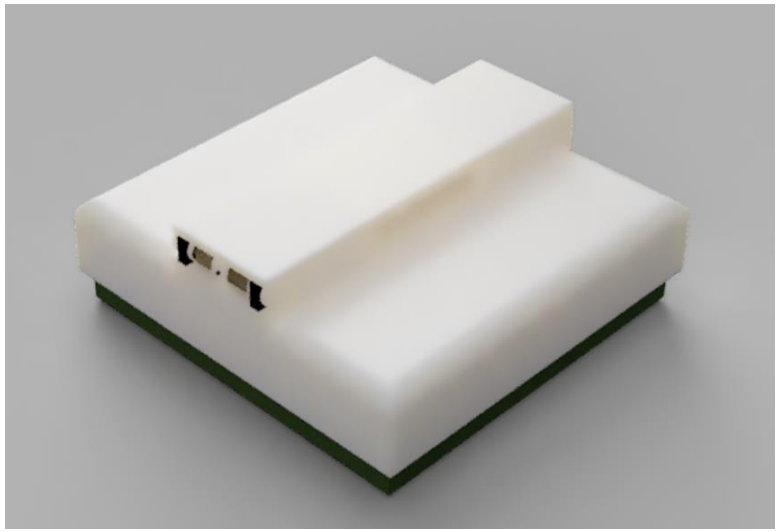
MECHANICAL ENGINEERING
UNDERGRADUATE DEGREE

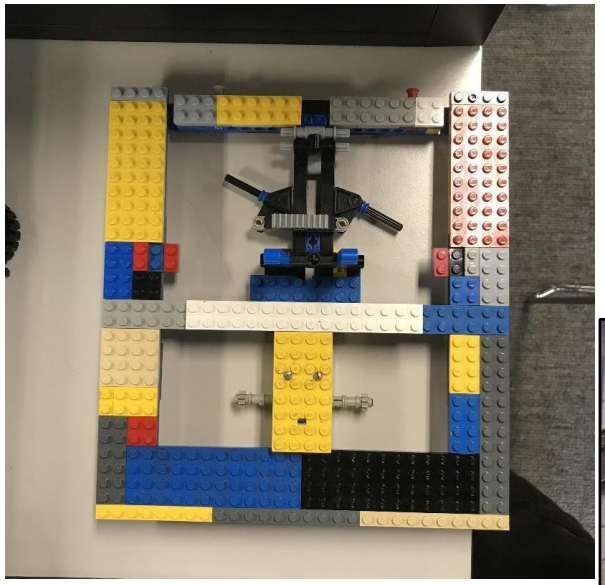
BIOMEDICAL ENGINEERING
MASTERS

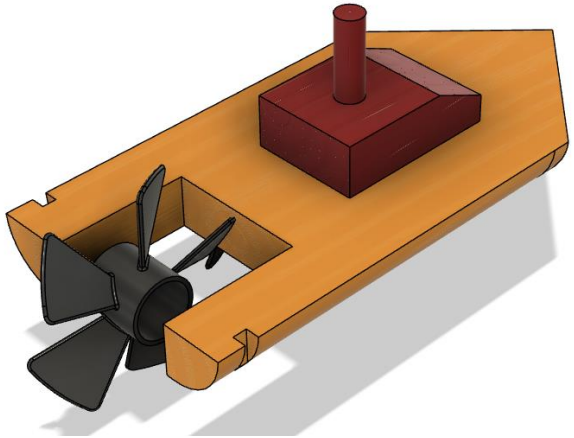
Decision Time for You

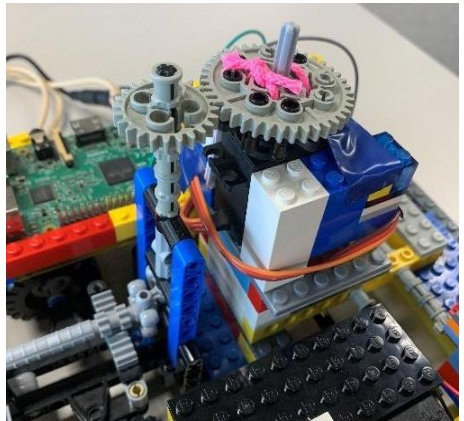
- What do you enjoy about college?
  - Electrical..
  - Mechanics..
  - Energy..
  - Biomedical..
- What industry would you like to see yourself working in?
  - Medical Devices
  - Prosthetics
  - Automotive
  - Electronics

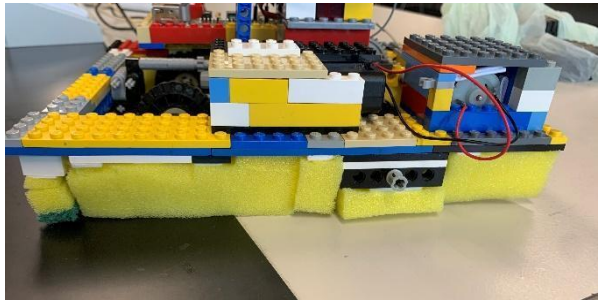
Mechanical Engineering

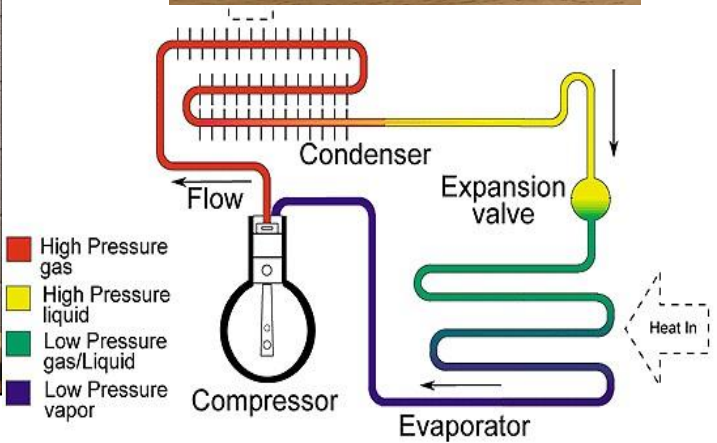










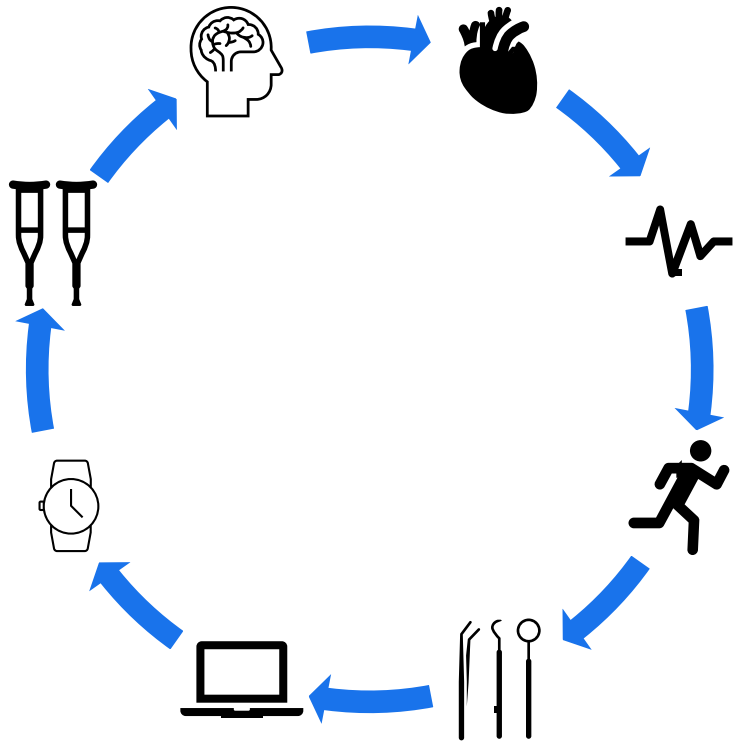


Australian National University

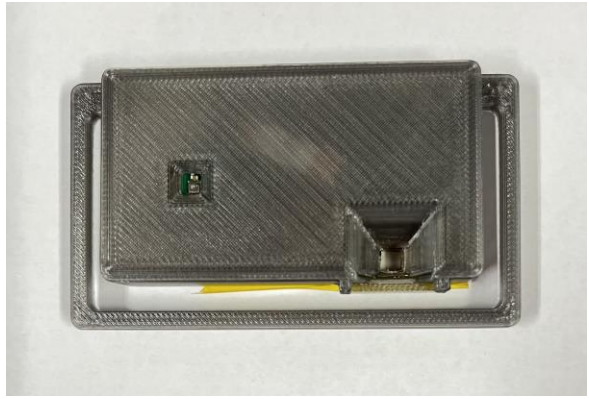
Medtronic – Internship

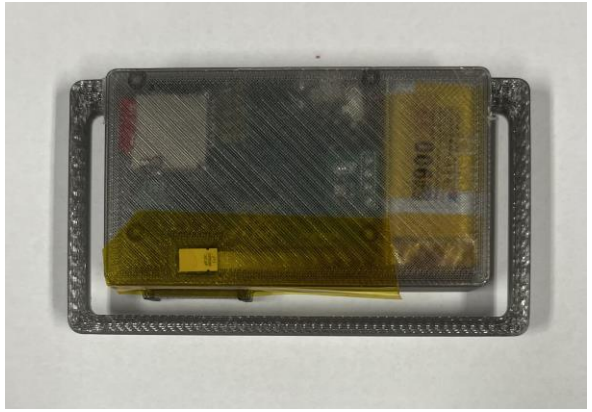
- Automation Engineering
  - Design
  - Testing
  - Documentation
  - Shipping

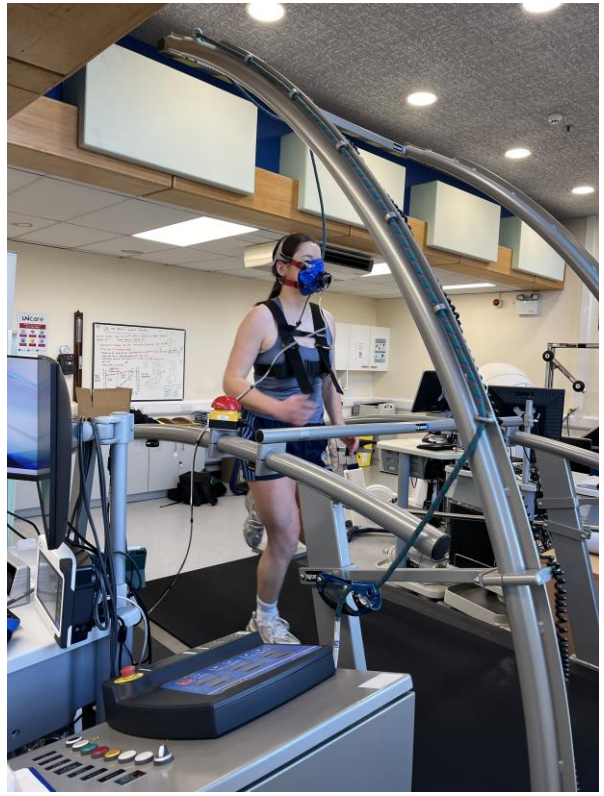
Biomedical Engineering Masters



Biomedical Engineering Masters







Thanks for listening!

Any questions?

Ask me now or feel free to email me

grace.carragher@ucdconnect.ie

BIOMEDICAL ENGINEERING STAGE 1

Ben O'Callaghan, PhD

17 February 2025

BACHELORS & EXCHANGE

- Engineering Omnibus
  - No Biomedical undergrad
  - Chose modules from electrical/electronic/mechanical/health sciences to suit Biomedical
- 3rd Year – Non-EU Exchange – National University of Singapore (NUS)

MODULES STUDIED

Functional Anatomy and Kinesiology

Neural Engineering

Image Processing for Engineering

Biomaterials

Rehabilitation

Medical Device Design

Biomedical Signal Processing

Science of Human Performance

Nanomechanics

Bioinstrumentation

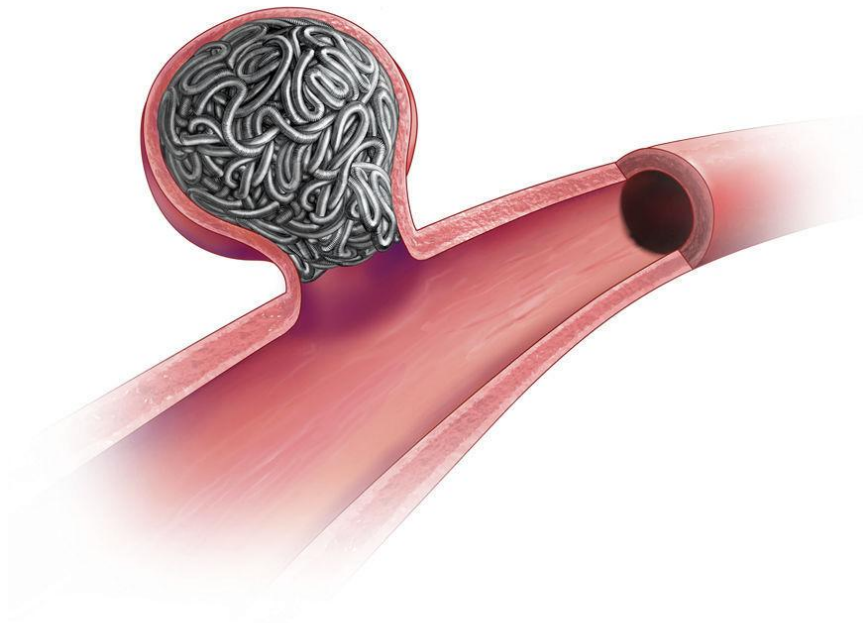
Tissue Engineering

Biomechanics

ME PROJECT

- A ROBOTIC KNEE BRACE FOR REHABILITATION FOLLOWING STROKE

stryker®
Neurovascular



stryker®
Neurovascular

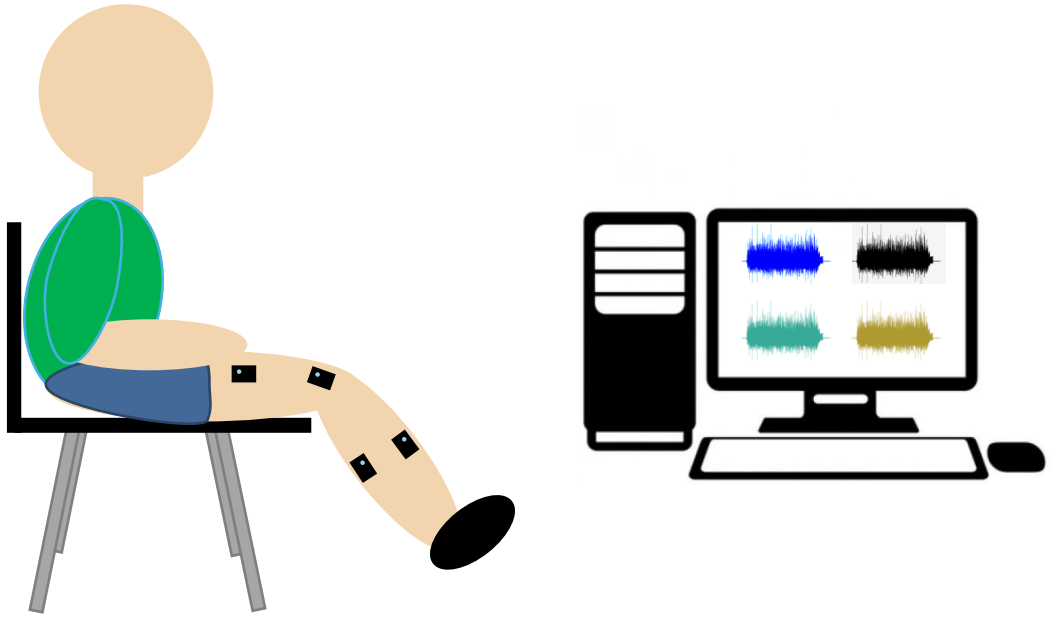
- Manufacturing Engineer responsible for:
  - 4 Production lines
  - Ensuring high quality of product
  - Increase yield (reduce scrapped products)
  - Machinery/equipment maintenance and updates
  - Ensuring compliance with manufacturing procedures

PHD – ELECTRONIC ENGINEERING (UCD)

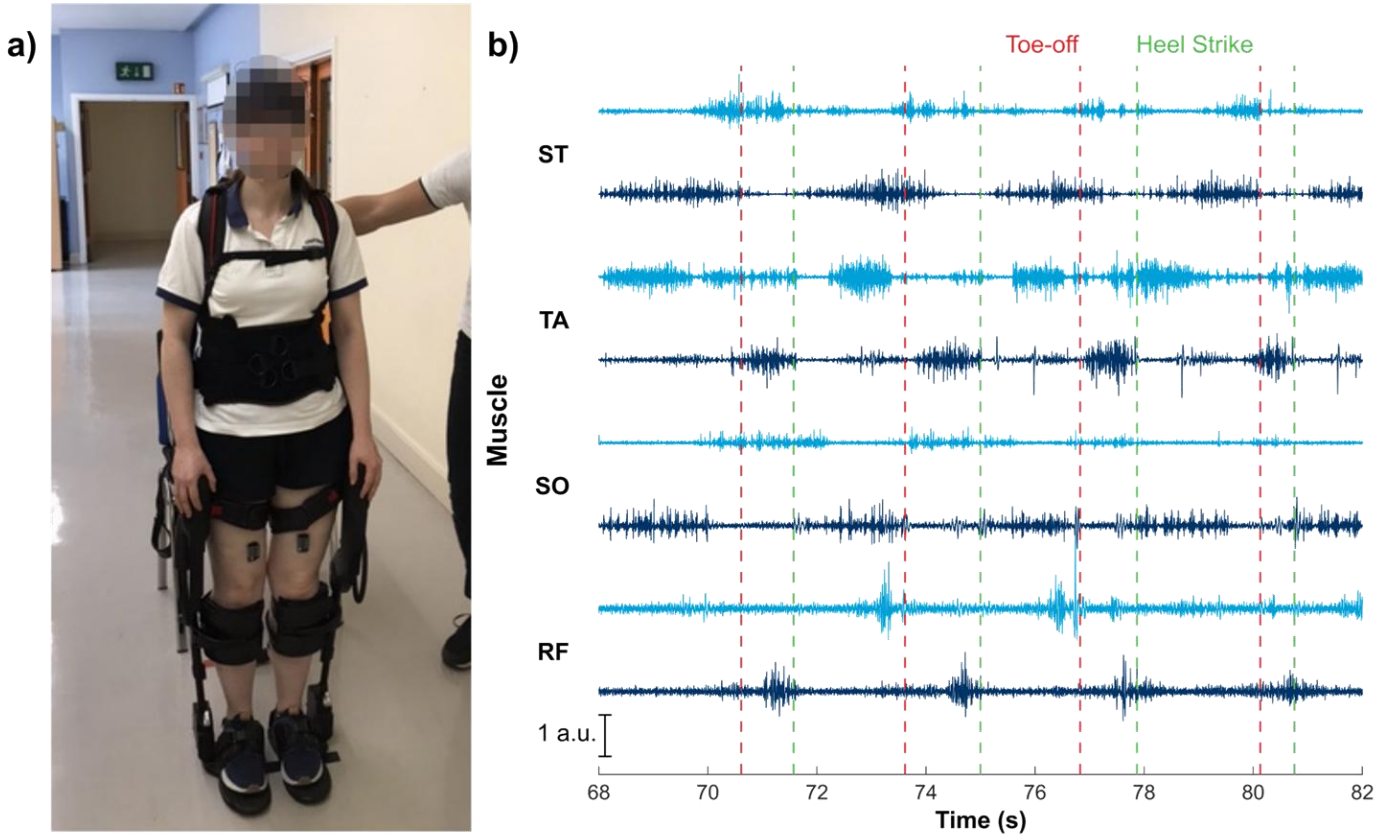
- Assessment of therapeutic interventions for neurological disorders
  - Wearable sensors (accelerometers)
  - Electromyography

- Development of algorithms to quantify features of:
  - Movement (kinematics)
  - Muscle activation

ELECTROMYOGRAPHY (EMG)

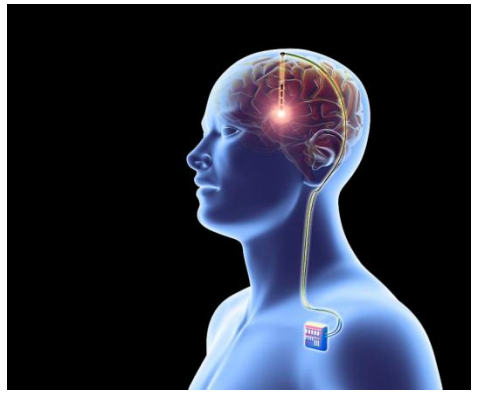


STROKE – EXOSKELETON STUDY

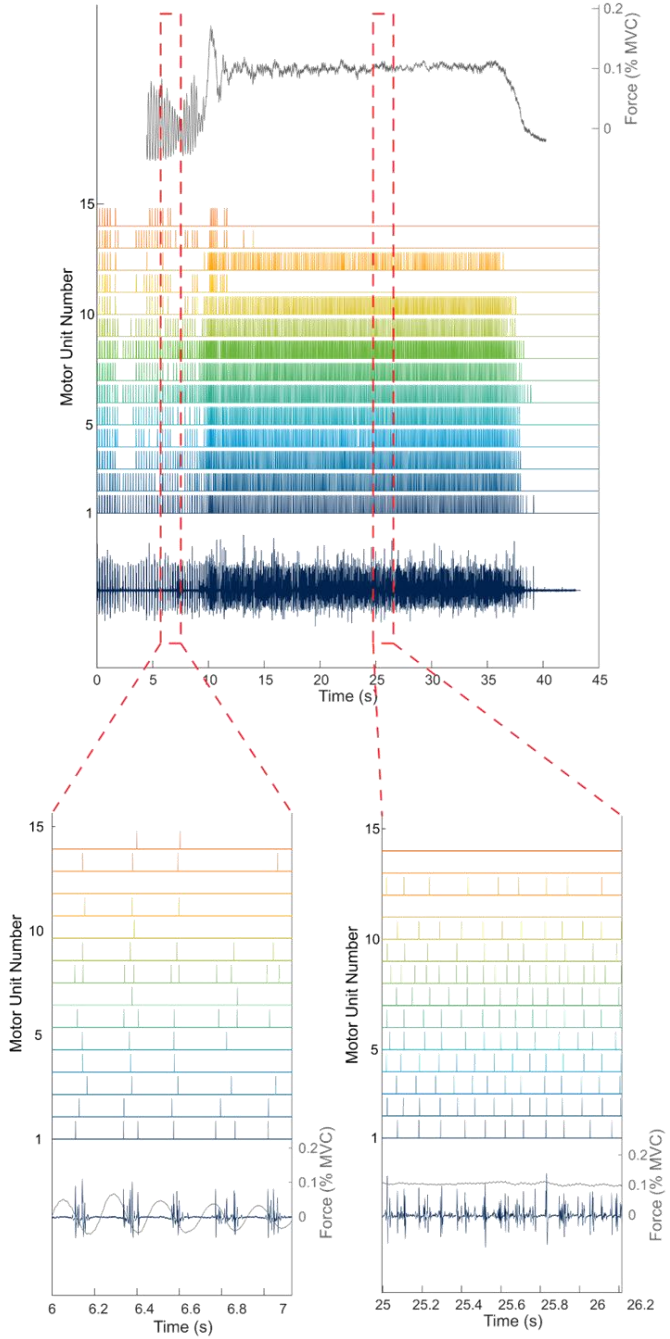


PARKINSON'S AND DEEP BRAIN STIMULATION

- Electrical stimulator implanted in Basal Ganglia
- Parameters tuned in real-time by physician



DBS ON



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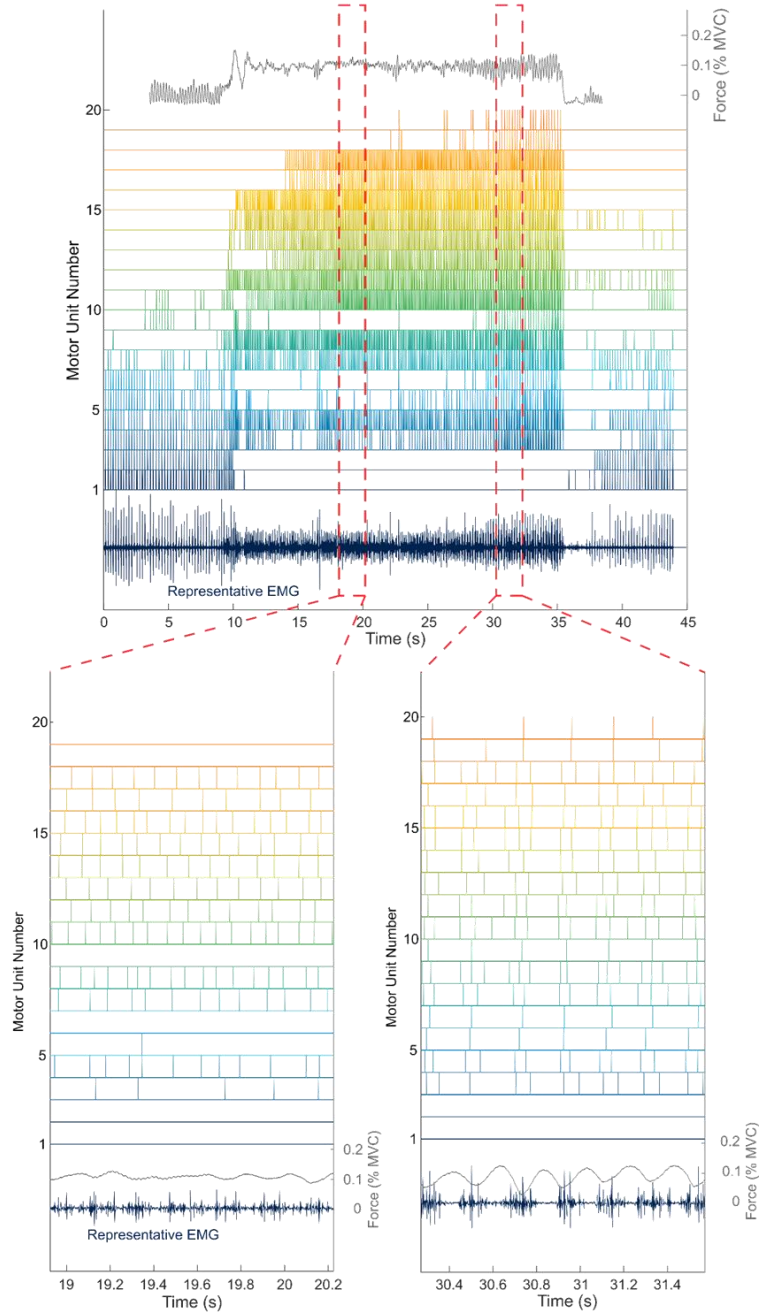

DANU

DANU

Reducing the physical, emotional and monetary costs of injury in sports

ANY
QUESTIONS