

Imperial College  
London

**WE ARE**

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**CHANGING  
LIVES**

**WE ARE**

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**THE DEPARTMENT  
OF BIOENGINEERING**

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**BIOMEDICAL ENGINEERING**

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**BIOLOGICAL ENGINEERING**

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**BIOMIMETICS**

# WE ARE

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# WORLD LEADERS

Imperial College London is one of the world's top universities. Specialising in science, engineering, business and medicine, it has been home to 14 Nobel Laureates, two Fields Medallists and four Crafoord Prize winners.







Imperial was ranked ninth in the QS world rankings (2016), and has an outstanding reputation for teaching and research. In the most recent Research Excellence Framework (2014), 91% of the academic staff submitted research judged either 'world-leading' or 'internationally excellent' – the highest percentage of any UK multi-faculty university.

1924

Sir Gilbert Walker, a Professor of Meteorology at the College, discovered the Southern Oscillation El Niño.

1928

Sir Alexander Fleming discovered penicillin, the world's first antibiotic.

SINCE THE COLLEGE'S FOUNDATION IN 1907, IM  
SCIENTISTS HAVE MADE INVALUABLE C



# A culture of innovation and discovery has characterised the College since its foundation in 1907, and our engineers, clinicians and scientists have made invaluable contributions to society over the past 100 years.

In 1924, Sir Gilbert Walker, a Professor of Meteorology at the College, discovered the Southern Oscillation El Niño; in 1928 Sir Alexander Fleming discovered penicillin, the world's first antibiotic, for which he was awarded the Nobel Prize in Medicine; and in 1971 Denis Gabor, a Professor of Applied Electron Physics at the College, won the Nobel Prize in Physics for his work on holography.

Today, Imperial College London is a thriving community of 14,000 students and 3,400 academic and research staff of the highest international quality – including 83 Fellows of the Royal Academy of Engineering and 72 Fellows of the Royal Society. Our main campus is based in the vibrant and culturally-rich area of South Kensington, with Hyde Park, the Natural History Museum, the Science Museum, the Victoria and Albert Museum, the Royal Albert Hall and the Royal Colleges of Art and Music just moments away.

## 1945

Sir Alexander Fleming received the Nobel Prize in Medicine for this work.

## 1971

Denis Gabor, a Professor of Applied Electron Physics at the College, won the Nobel Prize in Physics for his work on holography.

IMPERIAL ENGINEERS, CLINICIANS AND  
CONTRIBUTIONS TO SOCIETY

# WE ARE

# PIONEERS



**95%**  
OF THE DEPARTMENT'S RETURNED  
RESEARCH WAS JUDGED

★ ★ ★ ★  
WORLD LEADING

★ ★ ★ ★  
INTERNATIONALLY  
EXCELLENT

# Of all the engineering disciplines, none has the power to transform lives quite so dramatically as bioengineering. Our dedication to improving human health attracts the world's finest students and researchers, each keen to make a difference in this exciting and fast-developing field.

The Department of Bioengineering at Imperial College London is leading the bioengineering agenda both nationally and internationally, advancing the frontiers of our knowledge in the discipline's three main areas:

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Biomedical Engineering: Developing devices, techniques and interventions for human health.

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Biological Engineering: Solving problems related to the life sciences and their applications for health.

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Biomimetics: Using the structures and functions of living organisms as models for the design and engineering of materials and machines.

In the most recent Research Excellence Framework (2014), 95% of the Department's returned research was judged either 'world-leading' or 'internationally excellent', confirming our position as the leading Department in the UK. We're committed to building on this success, expanding both our basic and applied bioengineering research, and providing excellent training through our popular undergraduate, MSc, MRes and PhD programmes.

As befits a new and growing discipline, the Department's staff come from diverse academic disciplines including all main branches of engineering, physical sciences, life sciences and medicine, creating a rich collaborative environment. The interaction of our staff, along with colleagues across the institution, ensures our research benefits from both engineering rigour and clinical relevance.

The Faculty of Medicine at Imperial College London is one of Europe's largest medical institutions – in terms of its staff and student population and its research income. The Department of Bioengineering has strong links with the Faculty of Medicine and clinicians across the six teaching hospitals.

Housed in substantial purpose-built space within the historic Royal School of Mines and its adjacent Bessemer buildings, the Department boasts state-of-the-art laboratories, including 'wet labs' for cell culture, chemistry, histology, flow studies, biosensors and electrophysiology, biomaterials, molecular biology, and high throughput biological screening; as well as 'dry labs' for modelling, electronics, imaging and mechanics. The space has been designed to promote greater interaction among researchers – just what is needed for the interdisciplinary field that is modern bioengineering.



# WE ARE

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# BREAKING NEW GROUND

Research underpins all that we do.  
We focus on six core themes:

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Biomechanics and Mechanobiology

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Molecular and Cellular Bioengineering

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Detection, Devices and Design

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Implants and Regenerative Medicine

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Human and Biological Robotics

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Neural Engineering

These areas are connected and fluid, with staff and students working across more than one area, often at their interfaces.

## BIOMECHANICS AND MECHANOBIOLOGY

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**Mechanical forces shape the form and function of biological systems and regulate all manner of biological processes. The motion of joints, contraction of cells, and even the conformation of proteins are all governed by mechanical principles, which together define biological function in health and disease.**

**We seek to understand the pervasive role of mechanics in biology and medicine to answer the most pressing questions in health and disease. With specific interests in cardiovascular, musculoskeletal, ophthalmic and respiratory systems, we apply experimental, computational and theoretical approaches to understand how mechanical forces impact biological function at the molecular, cellular, tissue, organ and organism levels.**

## SELECTED ACHIEVEMENTS:

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A musculoskeletal dynamics model that contributed significantly to GB Rowing success at the 2004, 2008 and 2012 Olympics.

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A new biomechanically-based neuroprotective strategy in glaucoma.

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First evidence that mechanical forces external to the womb may influence skeletal development, suggesting a therapy for birth defects.

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Demonstration that a corticosteroid drug mimics effects of high shear stress on endothelium, suggesting a new anti-atherogenesis strategy.

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A method to predict aneurysm rupture, now being developed by Philips for MRI systems.

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A study of respiratory blood splatter that determined the outcome of the UK's longest murder trial.

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First quantification of lymphatic valve behaviour under varying pressures that can be used to design biomechanics based therapies.



## MOLECULAR AND CELLULAR BIOENGINEERING

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**Molecular and cellular bioengineering focuses on the micro scale of cells and molecules.**

**Aided by a century of discoveries in cell biology, biochemistry and molecular biology, our research is (i) applying engineering methodology to the analysis, investigation and manipulation of biological systems; and (ii) applying engineering principles to the design and construction of new synthetic biological systems.**

**Our research encompasses mathematical analysis of molecular and cellular events and biophysical modelling of cell processes, as well as bottom-up design and construction of new biological molecules and customised cells.**

## SELECTED ACHIEVEMENTS:

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Use of nanotechnology to show that protein unfolding is a cellular mechanism for transforming mechanical stimuli into biochemical signals.

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The first design-led synthetic biology project using forward-engineering to go from libraries of biological parts via in silico models to working genetic devices.

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The development of biological AND, OR and NAND gates.

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A novel therapeutic approach using Peptide Nucleic Acids to regulate expression of disease-associated genes.

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The first mathematical model of activation-induced apoptosis, leading to a novel method for early diagnosis of immunological failure in HIV infected patients.

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The first mathematical model to reveal mechanisms in complex skin disease.

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The UK lead on the synthetic yeast genome project, enabling scientists to write the DNA sequence of yeast as well as read it.





## DETECTION, DEVICES AND DESIGN

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Physical and chemical measurements are of fundamental importance in clinical application and in understanding the underlying biology. Improvements in patient care can come about through identification of new markers of disease, rapid diagnoses and more frequent or continuous monitoring, in the hospital, the clinic or ideally in the home.

The enabling technology for these exciting developments ranges from molecular probes to whole measurement systems, and encompasses chemical sensors and biosensors, low power circuits for data processing and wireless transmission, and novel real-time signal processing.

## SELECTED ACHIEVEMENTS:

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Development of rapid sampling microdialysis for monitoring brain injury in hospitals worldwide.

The first demonstration of large molecule delivery to localized areas of the brain, using ultrasonically-activated microbubbles.

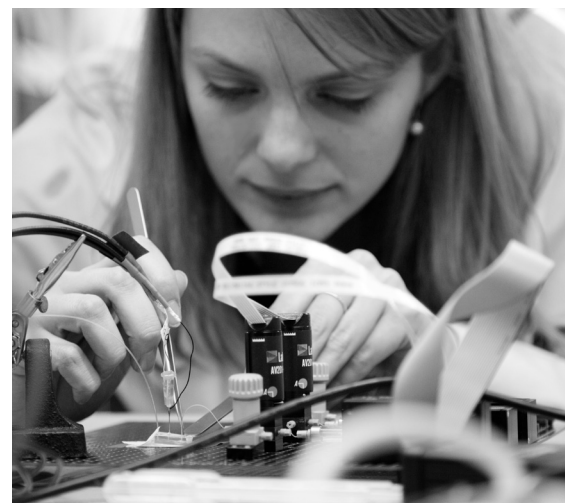
A multi-probe bipolar radiofrequency device reducing blood loss in liver resection, which has saved around 1000 lives.

Novel methods for electronically steering and focusing ultrasound therapy, in clinical trial for solid tumour ablation.

An endoscopically delivered bipolar radiofrequency catheter capable of ablating malignant tissue, now in production.

The world's highest dynamic range and lowest power consumption circuit mimicking the basilar membrane, suitable for bionic ear/cochlear implants.

The first technique for imaging elasticity of deep tissues using optical detection.



## IMPLANTS AND REGENERATIVE MEDICINE

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**Substitution, scaffolding or splinting is needed for tissues that are not able to self-renew; this may be due to ageing and diseases of ageing, trauma or degenerative conditions.**

**In this research area, the Department focuses on the technologies and clinical applications of providing substitute tissues (both synthetic and natural) and/or cells for implantation into the body, or promoting tissue remodelling for the purpose of replacing, repairing, regenerating, reconstructing or enhancing function.**

**We focus on the biology, biochemistry, biomechanics, design and manufacture of structures for artificial materials, bioactive materials, surface modification, delivery systems and smart implants that respond to the changing environment.**

## SELECTED ACHIEVEMENTS:

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Quantification of the mechanical effect of knee meniscus replacement, leading to a novel implant design now licensed to a company.

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A novel approach involving selective mechanical reinforcement of the infarct zone that dramatically improves cardiac function after heart attack.

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Developed novel approaches to tissue engineering that are likely to prove very powerful in the engineering of large quantities of human mature bone for autologous transplantation as well as other vital organs such as liver and pancreas, which have proven elusive with other approaches.

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Developed bioactive nanomaterials, nanocomposites and hydrogels for musculoskeletal and cardiac tissue regeneration.

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Using live cell Raman spectroscopy and multivariate analytical techniques to study cell differentiation/tissue engineering, heart valve calcification and toxicological studies.

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Create new testing protocols for pre-clinical orthopaedic implants leading to multiple joint replacement designs.

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Novel methods to control cell behaviour through nanoscale engineering of material surfaces including monolayer protected metal, nanotubes and other nanotopographies/nanochemistries.



## HUMAN AND BIOLOGICAL ROBOTICS

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**Human and Biological Robotics is an emerging research area that uses the framework of robotics to understand the control principles evolved by biological sensorimotor systems, and apply this knowledge to create novel robotic devices that can truly help humans.**

**Like robots, animals rely on a large variety of sensors, require a neural control system, use actuators or muscles, and are constrained by their mechanical structure. We do not view each of these components in isolation, but as part of a continuous perception-action loop; we consider them as parts of a system that integrates biomechanics and neural control. This systems level approach will advance our understanding of fundamental principles in neuroscience and biomechanics. It will also drive the development of novel sensors inspired by their biological counterparts, versatile robots with novel capabilities, and robotics tools to augment humans.**

## SELECTED ACHIEVEMENTS:

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Four-dimensional in vivo X-ray microscopy analysis of blowfly flight motor control

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First decoding of the neural response of the auditory brainstem to running speech, which can be used for verifying the fittings of auditory prosthesis

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The first interface that uses a combination of free muscle transplant and targeted muscle re-innervation to provide control signals for bionic substitution of hand function in humans

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The first robotic controller able to adapt, like humans, to unstable interactions typical of tasks with tools

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The first application of sparse filtering in neuroscience, to characterise the auditory system's selectivity to natural stimuli





## NEURAL ENGINEERING

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Neural Engineering is an established field comprising the development and application of advanced technology for the study of the brain, as well as the utilisation of advances in neuroscience for further improvements in technology.

Neural Engineering is a rapidly growing area in which the Department is taking a leading role, as evidenced by the recent recruitment of several experimental and computational neuroscience academic staff members and the creation of the Centre for Neurotechnology and Centre for Doctoral Training in Neurotechnology for Life and Health.

## SELECTED ACHIEVEMENTS:

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A new conceptual framework explaining how cortical neurons process information about sound location.

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First demonstration that our brains can optimally trade off sensory and movement uncertainty, used at Moorfield's Eye Hospital to assess neurological development.

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Demonstration that visual processing depends on an animal's locomotor and nutritional state.

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A new framework for understanding how the brain learns a seemingly infinite amount of movement skills, now used in rehabilitation devices.

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Novel analysis of how frequencies <4 kHz can be detected by the inner ear, leading to a new active microphone design.

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First multiphoton imaging of sensory-evoked calcium signals in many neurons simultaneously.

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Use of models from condensed matter physics to decode larger patterns of neural activity than previously possible.

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The first robotic controller able to adapt, like humans, to unstable interactions typical of tasks with tools.



# **WE ARE**

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# **LEADING INTER- DISCIPLINARY RESEARCH**

The Department manages the cross-faculty Institute of Biomedical Engineering on behalf of Imperial College London. The Institute comprises a number of research centres, each drawing together engineers, medics and scientists to apply their extensive expertise to create revolutionary progress in medical diagnosis and treatment. Examples of these Centres include:

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The Royal British Legion Centre for Blast Injury Studies

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Centre for Neurotechnology

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Synthetic Biology Hub

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Musculoskeletal Medical Engineering Centre

THE ROYAL BRITISH LEGION  
CENTRE FOR BLAST INJURY  
STUDIES AT IMPERIAL  
COLLEGE LONDON

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The Centre for Blast Injury Studies is the first collaboration of its kind in the UK. Supported by charitable funding from the Royal British Legion, it brings together civilian academics from divergent fields; engineering, shock physics and biology, and serving military doctors, for an unparalleled approach to the study of blast injuries.

Roadside bombs and improvised explosive devices were the signature weapon of the Iraq and Afghanistan conflicts. Improvements in both personal protective equipment and early medical care during the campaign resulted in increased survival rates after severe blast injury. As a consequence, it is vital that we learn all we can about the effects of these devices and the injuries they cause in order to continue the improvements in protection, mitigation, treatment and recovery.

The Centre's specialists work collaboratively, developing highly innovative platforms and technologies to assess the effects of blast at a molecular, cellular, organ and whole systems level. The aim is to develop a rigorous scientific approach to investigating the effects of blast on the human body to better understand the unique debilitating pathologies associated with those kinds of injuries. The centre leadership is drawn from academia (Professor Anthony Bull) and clinical leadership from the military (Professor Col Jon Clasper) and managed by Dr Emma Burke.





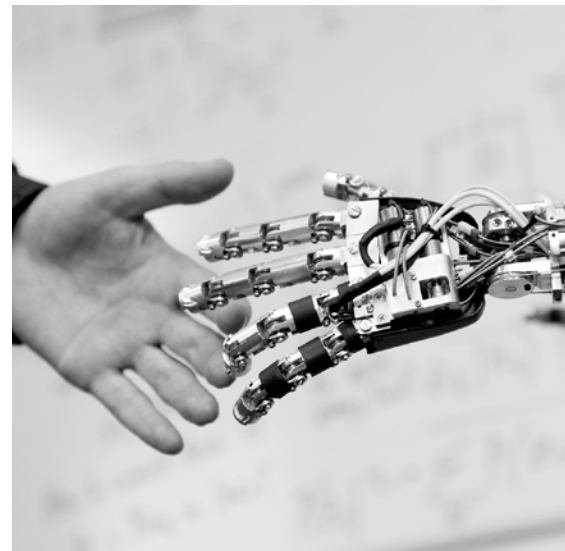
**The Centre for Neurotechnology fosters collaborative research at the interface of neuroscience and engineering across the Faculties of Engineering, Medicine and Natural Sciences, with satellite groups at Oxford and the Crick Institute.**

**Brain-related illness affects more than two billion people worldwide, and is having an increasing impact on healthcare resources. The challenge now is to find ways to reduce this burden on society. We use novel technological approaches to improve our understanding of how the brain works, and to develop new therapeutic strategies to treat its disorders, in order to address this challenge.**

The Centre hosts the EPSRC Centre for Doctoral Training in Neurotechnology for Life and Health (the CDT), which offers a unique training programme, created by Imperial College in collaboration with partners in industry and the charity sector. Working in multidisciplinary teams, CDT students undertake 4 years of training which allows them to develop and harness new technologies for understanding and treating brain disorders.

The centre is led by Dr Simon Schultz (Engineering), and co-Directors Professor Paul Matthews (Medicine) and Professor Bill Wisden (Natural Sciences).

Research in the Centre spans multidisciplinary topics at the interface of engineering and neuroscience, but is broadly structured along a number of technology and health themes. Technology themes include: Microelectronics, devices & biosensors; Optical & genetic neurotechnology; Computational modelling & data analysis tools; Neuroprosthetics & neural interface technology; Robotics & human-machine interaction; Imaging. Health themes include: Diagnostics & clinical monitoring; Electroceuticals; Brain repair & neuroregeneration; Brain circuits in health & disease; Rehabilitation & augmentation; Lifelong health & well-being.



## SYNTHETIC BIOLOGY HUB AT IMPERIAL COLLEGE LONDON

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# The Synthetic Biology Hub at Imperial College London is comprised of five 'branches' which together create a centre of excellence for synthetic biology in the UK.

- The Centre for Synthetic Biology and Innovation
- SynbiCITE
- The Foundry - Consortium with NUS, Berkeley and Imperial College London
- Frontiers Engineering
- The Flowers Consortium

Synthetic biology at Imperial College London continues to grow and CSynBI is now a leading centre of excellence with a network of research teams and innovation and knowledge centres. CSynBI is proud of the scale of its activities, which range from education to world-leading research to industrial applications. It influences strategy and spearheads engineering in synthetic biology. It is leading the way in automating the production of interchangeable genetic elements. Development of these elements is critical if we are to scale up synthetic biology processes such that we can make a real impact in the big challenges facing society.

The Centre for Synthetic Biology and Innovation is the academic branch of the Hub, undertaking basic research into developing new tools for synthetic biology such as biological part libraries, CAD software, computational models and automation. SynbiCITE, the Innovation and Knowledge Centre, based at Imperial aims to bridge the gap between academia and industry to speed up developments in new synthetic biology technologies. This is complemented by the DNA Synthesis and Construction Foundry, a facility that is establishing a common framework to build DNA by using an automated robotic system. The hope is that synthetic biologists will be able to scale up the volumes of DNA produced to more easily test their new function. Developing standard operating procedures and protocols are essential for reproducibility and reliability. Including new technical standards Dicom-SB and synBIS information system. This is further complemented by Frontiers Engineering, an initiative which is facilitating the transition from oil-based to bio-based process feed stocks.



# The Musculoskeletal Medical Engineering Centre (MSk MEC) brings together researchers from across Imperial College London focussed on the discovery and application of new technologies to improve the understanding, diagnosis and treatment of musculoskeletal disorders, such as osteoarthritis.

Formerly the Centre for Medical Engineering Solutions in Osteoarthritis Centre of Excellence funded by Wellcome Trust and EPSRC, the Centre's membership includes over 100 researchers across different technology and application themes, and represents a strong and diverse interdisciplinary collaboration of engineers, scientists and clinicians.

Imperial researchers at the MSk MEC have a strong track record of translating their research to maximise impact, commercially through spin-outs and licenses to patented technologies and know-how, and non-commercially through pioneering improved clinical practice and providing access to software and databases. Research within the centre covers five main themes: Musculoskeletal Dynamics; Implant Design and Testing; Tissue Engineering and Regenerative Medicine; Surgical Technology and Rehabilitation, Sports and Human Performance.

Key research leaders include Professor Anthony Bull (Engineering), Professor Justin Cobb (Medicine), Professor Molly Stevens (Engineering), Professor Andrew Amis (Engineering) and Dr Jonathan Jeffers (Engineering).



**WE ARE**

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# **AT THE HEART OF INDUSTRY**

**The breadth and depth of the Department's research is reflected in the diversity of our sponsors, the success of our spin-out companies, student start-ups and the generosity of our benefactors.**



## RESEARCH SPONSORS

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Air Force Office of Scientific Research  
Allergan Inc.  
Arthritis Research UK  
Arthrotek  
Assistance Foundation  
Biotechnology and Biological Sciences Research Council  
Birth Defects Foundation  
BrightFocus Foundation  
British Heart Foundation  
British Skin Foundation  
Cerebra Foundation  
Clothworkers' Foundation  
Defence Science and Technology Laboratory  
Department of Health  
Department of Trade and Industry  
Dutch Heart Foundation  
Engineering and Physical Sciences Research Council  
European Union  
FH Muirhead Trust  
Fight for Sight Foundation  
Find a Better Way  
Fresenius KABI  
Furlong Foundation  
Garfield Weston Foundation  
Gatsby Charitable Foundation  
GB Rowing  
GE Healthcare  
Gillette Management LLC  
GlaxoSmithKline UK  
Google  
Henry Smith Charity  
Howmedica  
Human Frontier Science Program  
Imperial Innovations Ltd  
Johnson & Johnson Sante Beaute France SAS  
JRI orthopaedics  
Leverhulme Trust  
Limbs & Things Ltd  
MDi  
Medical Research Council  
Medic Vision Ltd  
Microsoft Research Ltd.  
Ministry Of Defence  
National Institutes of Health  
National Institute for Health Research  
National Science Foundation  
Nuffield Foundation  
Riken  
Rosetrees Trust  
Royal Academy of Engineering  
Royal Centre for Defence Medicine  
Royal Society  
Scientifica Ltd  
Symbionix Ltd  
Smith & Nephew  
Stroke Association  
Stryker Osteonics  
Surgical Science Ltd  
The Royal British Legion  
The Royal Society of New Zealand - Rutherford Foundation  
Tyco Healthcare  
UK Sport  
US Air Force  
Wellcome Trust

## SPINOUT COMPANIES

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**Cortexica Vision Systems Ltd** —  
technology for brand visibility management.

**Dynamic Therapeutics Ltd** —  
devices to deliver improved long-term oxygen therapy using intelligent feedback control.

**HeliSwirl Technologies Ltd** —  
SMAHT (small amplitude helical technology) devices, which increase the efficiency of industrial fluid flows.

**Hydra Polymers Ltd** —  
branched architecture polymeric materials to aid product efficacy, function and environmental profiles.

**Medermica Ltd** —  
diagnostic and sensor technology development for laboratory and healthcare applications.

**Orthonika Ltd** —  
soft tissue replacements for the knee.

**Veryan Medical Ltd** —  
design and manufacture of novel implantable vascular grafts and stents.

**Visbion Ltd** —  
software and hardware for the acquisition, storage, archive and display of medical images.

## STUDENT START-UPS

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**Blocks** —  
modular smart watch which records physiological measurements.

**Customem** —  
biological membranes for the removal of contaminants in water, including heavy metals.

**Dentally** —  
dental records software.

**GripAble** —  
mobile assessment & rehabilitation for arm disability

**MeVitae** —  
online recruitment website.

**Neurofenix** —  
a medical device company dedicated to make upper limb rehabilitation for stroke patients engaging and available for everyone.

**Koniku Inc** —  
neuron-based sensors.

**StentTek** —  
a novel catheter system for minimally invasive vascular access which is advancing dialysis treatment.

## MAJOR BENEFACTORS

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The Bagrit Trust  
The Charles Hayward Foundation  
The Michael Uren Foundation

# WE ARE

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# ADVANCING HEALTHCARE

The Michael Uren Biomedical Engineering Research Hub will house research into new and affordable medical technologies, helping people affected by a diverse range of medical conditions. The hub will accommodate a clinical facility providing patients with direct access to innovations in healthcare. Laboratory and office spaces will enable interdisciplinary, translational research initiatives at the interface of biomedical sciences and engineering. Research undertaken in the hub will include research into a range of cancers, manufacture and research into a range of medical devices, regenerative medicine research and cardiovascular technology.



## MICHAEL UREN OBE

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A pioneering biomedical engineering centre will be built at the new Imperial West Research and Innovation campus thanks to an unprecedented £40m gift from Michael Uren OBE and his foundation. The Institute of Biomedical Engineering's (IBME) Biomedical Engineering Research Hub will be the home of new translational centres in biomedical engineering, fostering interdisciplinary research and collaboration between the Faculties of Engineering, Medicine and Natural Sciences at Imperial College London.

# WE ARE

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# WORLD RENOWNED

## A SPIRIT OF COOPERATION

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The multidisciplinary nature of bioengineering has led to extensive collaborative research nationally, within the EU and further afield, both informally and through established consortia. Collaboration with prestigious British and overseas research institutes includes: MIT, Harvard, Caltech, the National University of Singapore, Stanford, ETH Zürich, Carnegie Mellon, Princeton, Cambridge, Eindhoven, Columbia and Max Planck Institutes.

The Department has hosted extended stays of numerous academic visitors from Canada, China, Denmark, Germany, Israel, Italy, Japan, Singapore, Switzerland, Ukraine and the USA.

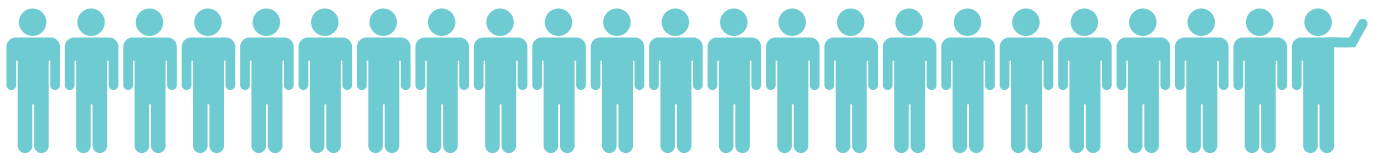
Industrial collaborations exist with major bioengineering companies such as: Stryker Osteonics, Howmedica, Smith & Nephew, JRI, MDi, Arthrotek, Medic Vision Ltd, Limbs & Things Ltd, Symbionix Ltd, Surgical Science Ltd and Allergan Inc.



## A CULTURE OF ACHIEVEMENT

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**Our staff are recognised for academic leadership (e.g. honorary degrees from other institutions, prizes and medals); national science contributions (e.g. fellowships of the Royal Academy of Engineering) and achievements in public life (e.g. the Order of the British Empire for services to healthcare).**



Fellowships and Honorary Fellowships include the Institute of Physics and Engineering in Medicine, the International Academy for Biomedical Engineering, the American Institute of Medical and Biological Engineering, the American Society for Mechanical Engineers, the International Academy for Medical and Biological Engineering, The Royal College of Surgeons, the Royal College of Physicians, the Institute of Materials, Minerals and Mining, the Institution of Mechanical Engineers and the Association for Research in Vision and Ophthalmology. Our three Fellows of the Royal Academy of Engineering (Professors Kitney, Stevens and Bull) reflect international standing of the Department, and of the discipline.

Staff are involved at the highest levels of mainstream professional bodies and learned societies. Current and recent positions include chairs of the Royal Academy of Engineering/Royal Society of Medicine Inquiry into Systems Biology, the RAEng Engineering Policy Committee, Institution of Mechanical Engineers Engineering in Medicine and Health Division, President of the Bioengineering Society and membership of the Biofluids Technical Committee of the ASME, the World Council of Biomechanics, and committees of the British Society for Cardiovascular Research, the British Atherosclerosis Society, the International Society of Vascular Biology, the Medical Physics Group Committee of the Institute of Physics, the

IEEE BIOCAS Technical Committee, the IEEE CNNA Technical Committee, the BBSRC Strategic Board, the Journal of Biological Engineering International Advisory Board, the International Advisory Board of Analytical Abstracts, the Materials Research Society, the Institution of Mechanical Engineers Council, the Institution of Mechanical Engineers Technical Strategy Committee, the IEEE Technical Committee on Haptics, the American Physiological Society, The Physiological Society, the BSI Technical Committee SV/2/5, the National Committee of the British Neuroscience Association and the Programme Committee of the Organisation for Computational Neurosciences.

# Bioengineering's potential to improve tomorrow's world has made it one of the fastest growing fields in science and engineering, and number one for job growth prospects.

Its unique position at the interface between life science and engineering puts bioengineering at the forefront of human development. The discipline has three vital roles to play in creating a better tomorrow:

First, future healthcare will depend heavily on current bioengineering research into engineered replacement tissues and new devices. These include artificial retinas and cochleas for the blind and deaf, rehabilitation and assistive devices for the disabled, stents and grafts to open or replace blocked blood vessels, body scanners that can image cellular and molecular events, and other advanced diagnostic equipment.

Secondly, an engineering approach to understanding body systems that perform classical engineering functions – such as the joints (mechanical articulation), the cardiovascular and respiratory systems (fluid transport and exchange), and the nervous system (computation and information transmission) – will lead to new insights into the normal function and disease of these systems, and new approaches to treatment.

Thirdly, the study of biological systems will lead to new technical solutions in applications such as sensing, information processing and low power circuitry, where biology has evolved highly effective and efficient answers to common engineering problems.

As a result of these key roles, there is an increasing demand, both in industry and the public sector, for healthcare specialists, engineers, scientists and managers who are trained in bioengineering. Indeed, in 2013, CNN Money ranked biomedical engineering ahead of all other subjects for employment potential, basing its findings on a 10-year forecast for the US Bureau of Labor Statistics.

Imperial's bioengineering graduates are well equipped for employment in the growing industrial sector devoted to healthcare, as well as in hospitals, clinics, research institutes, and government or other public organisations concerned with the design and regulation of medical materials and equipment. The multidisciplinary nature of our course also ensures that graduates are welcomed in the industrial, commercial and consulting areas, where analytical and problem solving skills are useful for a wide range of applications.

A substantial number of our graduates follow research careers, both in industry and in academia. Students who are successful in gaining entry to graduate schools of medicine will eventually qualify with both engineering and medical degrees and be ideally qualified to enter a range of medical specialities including cardiology, orthopaedics, radiology and surgery.

# WE ARE

# CREATING FUTURES



IN THE 2017  
GUARDIAN  
UNIVERSITY LEAGUE  
TABLE FOR GENERAL  
ENGINEERING

## UNDERGRADUATE COURSES

The Department offers two MEng undergraduate degrees and an intercalated BSc for medical students. The MEng Biomedical Engineering takes a top down approach, providing a broad foundation in physics, mathematics, engineering and biomedical science and then progressing to applying the quantitative aspects of engineering analysis and design to biomedical problems. The MEng Molecular Bioengineering develops a bottom up understanding of the links between molecules, cells, tissues, organs and limbs generating function, health and disease within a bioengineering context.

## MODULES INCLUDE:

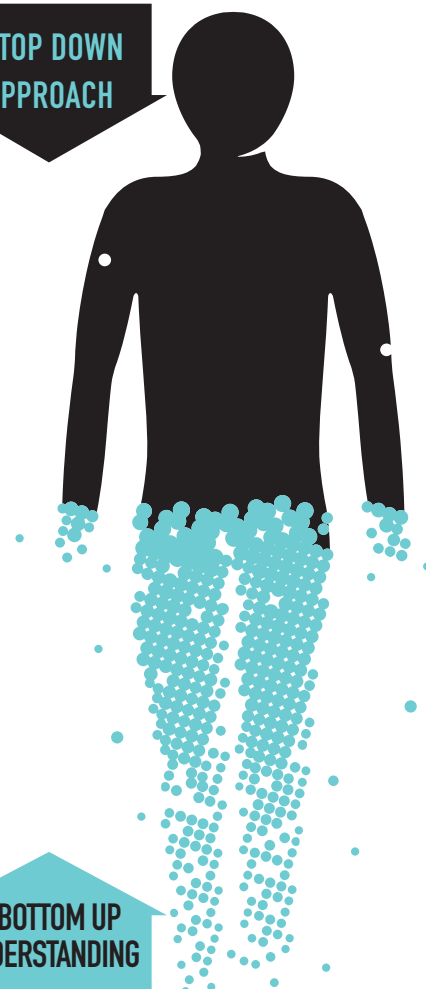
### MEng Biomedical Engineering

- Biomechanics
- Computational Neuroscience
- Biomedical Imaging
- Physiological Monitoring and Data Analysis
- Signals and Systems
- Physiological Fluid Mechanics
- Human Centred Design of Assistive and Rehabilitation Devices

### MEng Molecular Bioengineering

- Molecules Cells and Processes I and II
- Analytical Sciences
- Control Systems
- Modelling in Biology
- Advanced Synthetic Biology
- Molecular Bioengineering Design Project
- Tissue Engineering and Regenerative Medicine

A TOP DOWN  
APPROACH



The MEng Biomedical Engineering degree has been accredited by the Institution of Mechanical Engineers, the Institution of Engineering and Technology, the Institute of Physics and Engineering in Medicine and the Institute of Materials, Minerals and Mining.

## INTERCALATED DEGREE

From 2017 the Department will offer an intercalated degree for medical students. The BSc Medical Sciences with Biomedical Engineering is a one year programme for fourth year medical students to develop biomedical engineering skills relevant to their future clinical career.

As part of the programme the medical students will work with the third year Bioengineers on a group project. A great opportunity for students to experience the benefits of interdisciplinary working first hand.

More information about the programmes offered in the Department of Bioengineering is available on our website.

A BOTTOM UP  
UNDERSTANDING



## MSc COURSES

At the postgraduate level, the Department offers two, one-year taught MSc programmes in Biomedical Engineering, and in Human and Biological Robotics. The MSc in Biomedical Engineering meets the growing need to teach graduates about the physical and engineering techniques that are being applied both to clinical medicine and in medical research. Students tailor the programme to their own interests by selecting one of four available streams: Biomaterials & Tissue Engineering, Biomechanics & Mechanobiology, Medical Physics & Imaging or Neurotechnology. The MSc in Human and Biological Robotics has a unique focus on engineering methods to investigate human and animal sensing and sensorimotor control, and the design of biomimetic systems and assistive devices for humans. The programme builds an understanding of robotics for humans and society, service and social robotics, rehabilitation technology, as well as machine vision, artificial intelligence and machine learning. Both MSc programmes include core and elective modules, which enable students to focus on specific areas of interest whilst developing a breadth and depth of engineering knowledge.

## RESEARCH DEGREES

We offer an MRes in Bioengineering which provides an opportunity to develop research and analytical skills related to bioengineering. The MRes in Medical Device Design and Entrepreneurship focuses on the intricate and unique field of medical device development and the key entrepreneurship and management skills required to get the device to market, from concept to business planning and market emergence. Through our Centre for Neurotechnology we also offer an MRes in Neurotechnology which leads into the Centre for Doctoral Training PhD programme.

The PhD programme attracts outstanding students from a variety of academic backgrounds. The Bioengineering Doctoral Training Programme offers doctoral-level training in cutting-edge and interdisciplinary projects while providing students with the opportunity to develop the skills they need to tackle research challenges in a collaborative environment. Students studying for a PhD in bioengineering are encouraged to interact with researchers working in different areas and may be co-supervised by academics from other departments.

## EXCELLENCE IN EDUCATION

The Department of Bioengineering is committed to the highest quality teaching and learning, and to our students' Imperial experience both inside and outside of the lecture theatre. Imperial and the Department have a range of mechanisms in place to achieve excellence in this.

The Department has a number of external examiners who ensure that the standard of the degrees awarded is comparable to other UK universities as defined by the QAA national benchmarks. They oversee that justice is done to every single student.

The Department has a Staff Student Committee, which serves as platform for discussion of students' experiences, feedback and suggestions.

A student representative sits on the Departmental Teaching Committee to ensure that student views are heard and acted upon.

College wide initiatives include the personal tutor system, College tutors, deans, counsellors, residential wardens, and disability advisors.

Staff in the Department have received prestigious awards, including Awards for Teaching Excellence in Engineering education.



IMPERIAL  
COLLEGE

A THRIVING  
COMMUNITY

14,000  
Students

3,400  
Academic and research  
staff of the highest  
international quality

83  
Fellows of the Royal  
Academy of Engineering

72  
Fellows of the  
Royal Society

14  
Nobel Laureates

2  
Field Medallists

4  
Crafoord Prize Winners

# WE ARE

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# DEVELOPING CHAMPIONS

## SPORTS INNOVATION CHALLENGE

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The London 2012 Paralympic Games shone a spotlight onto the life-changing impact that well-engineered sporting equipment can bring to people with disabilities.

At Imperial, we're challenging our engineering students to make new strides in this inspiring field through the Sports Innovation Challenge – for which students must design, build and implement equipment or technology that makes a tangible contribution to Paralympic sport.

This flagship project has been integrated into the existing engineering curriculum, giving second year undergraduate bioengineering students the opportunity to tackle real world problems and help make a healthy lifestyle more accessible to those with disabilities. Our projects to date include:

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Cycling: students designed an EMG (muscle electrical signal)-operated gear change mechanism for upper-limb amputee cyclists.

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Throwing: students developed a prosthetic for lower-limb amputees allowing rotation at the foot during a throwing movement.

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Sailing: students built a navigational communications and control suit to give sensory feedback for visually or aurally impaired athletes.

A limited number of extended research projects are also available to individual MEng students in the final year, and groups of MEng students in their third year. Working under the guidance of the academic staff, students have eight months to design, manufacture and test their concept before a demonstration and assessment.



**WE ARE**

**BIOENGINEERS**

The Department attracts a broad spectrum of professors, lecturers and researchers, all committed to the advancement of bioengineering.





## PROFESSOR ANTHONY BULL

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Professor Bull is the Head of Department of Bioengineering and Director of the Institute of Biomedical Engineering at Imperial College London. An Imperial trained mechanical engineer, Anthony's interest in biomechanics began as a student, where he concentrated on musculoskeletal biomechanics in arthritis, sport and, following, trauma. Anthony has played a major role in the development of bioengineering in the UK, and continues to lead on a number of national initiatives in addition to his role at Imperial. In 2014, he was recognised as a Fellow of the Royal Academy of Engineering. Professor Bull led the creation of the Royal British Legion funded Centre for Blast Injury Studies, and continues to lead the Centre as Director working closely with academic colleagues across Imperial and with military medical colleagues from across the UK armed forces.



## PROFESSOR JAMES E MOORE JR

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Professor Moore is the Bagrit and Royal Academy of Engineering Chair in Medical Device Design in the Department of Bioengineering. A trained mechanical engineer, Jimmy began researching biomechanics in the US as a student, concentrating on blood flow patterns and how they relate to disease formation and treatment. In 2013, he was granted a prestigious Wolfson award for his pioneering work on “vascular biomechanics and medical device development”. With the new MRes in Medical Device Design and Entrepreneurship, Jimmy is combining his experience in medical device development with his passion for entrepreneurship in order to train the next generation of engineers to bring innovative new devices to the market. In 2014 Professor Moore was appointed Director of Research for the Department.





## PROFESSOR MOLLY STEVENS

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Professor Stevens is Professor of Biomedical Materials and Regenerative Medicine and the Research Director for Biomedical Material Sciences in the Institute of Biomedical Engineering at Imperial College. She joined Imperial in 2004 after Postdoctoral training in the laboratory of Professor Robert Langer in the Chemical Engineering Department at the Massachusetts Institute of Technology (MIT). In 2010 she was recognised by The Times as one of the top ten scientists under the age of 40 and in 2013 she was elected Fellow of the Royal Academy of Engineering. She has a large and extremely multidisciplinary research group of students and postdocs/fellows. The Stevens group uses transformative bioengineering approaches that will overcome severe limitations in current materials in two main areas, namely 1) Biosensing and 2) Regenerative Medicine. A key focus is on understanding and engineering the biomaterial interface using innovative designs and state of the art materials characterisation methods. In 2016 Professor Stevens was awarded the Clemson Award for Basic Research from the Society for Biomaterials.





## DR TOM ELLIS

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Dr Ellis is a reader in synthetic genome engineering in the Department. He obtained his PhD in Pharmacology from the University of Cambridge with a thesis examining a class of drugs that bind directly to DNA sequences, and investigating their use as synthetic gene expression regulators that target critical promoter elements of genes. Before joining Imperial in 2009, Tom worked in industry at a drug-discovery biotech and in academia in USA and Cambridge. He will be leading the UK contribution to the synthetic yeast genome project – an international collaboration to synthetically reproduce the yeast genome.



## DR NIAMH NOWLAN

Dr Nowlan is a senior lecturer in the Department. Her research focuses on developmental mechanobiology, with particular emphasis on skeletogenesis: the study of how mechanical forces induced by prenatal movements affect bone and joint formation before birth. In July 2013, Niamh was awarded an ERC Starting Grant, worth €1.5m, for a five-year project to research the importance of prenatal movements for normal joint shapes.





## DR REIKO TANAKA

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Dr Tanaka joined Imperial College London in March 2009 as an EPSRC Career Acceleration Fellow in the Department of Bioengineering and has been promoted to a Lecturer in January 2012.

With her special interest in regulatory mechanisms in biological systems combined with her background in engineering systems and control theory, Reiko aims to search for fundamental rules and mechanisms of biological control from the viewpoint of control, and to make a decisive contribution to systems medicine and biology. Since most diseases are caused by malfunctioning of various regulatory mechanisms, understanding of common control design principles helps to identify key mechanisms to investigate and to propose and answer clinically/biologically relevant questions that could not be posed without it.



## DR ANIL BHARATH

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Dr Bharath is a Reader in Image Analysis, and an Associate Director of Imperial's Institute for Security Science and Technology. He holds a degree in Electrical & Electronic Engineering from UCL, and obtained a PhD from Imperial College London, from the Department of Electrical & Electronic Engineering. Anil's main research interest is the analysis of visual data, including new algorithms and system architectures. In 2008, he co-founded Cortexica Vision Systems, a company that applies spatial neuronal models, expressed through the use of two-dimensional, complex wavelet decompositions, to visual searches, both at video rates and on mobile devices. In 2014 Anil was appointed Director of Postgraduate Research.





## PROFESSOR MARTYN BOUTELLE

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Professor Boutelle is a Professor of Biomedical Sensors Engineering. Trained at Imperial College London, Martyn gained a PhD in electrochemistry with John Albery FRS in the Department of Chemistry, before moving to Physiology at the University of Oxford, where he worked in the interdisciplinary area of in vivo monitoring of the brain using electrochemical sensors. Martyn's main research interests are the role of spontaneous brain depolarisations in the maturation of brain injury, and methods of monitoring brain health using microelectrodes and microdialysis. Martyn works in collaboration with surgeons to clinically monitor the brain. In 2014 Martyn was appointed Deputy Head of Department and appointed Director of Courses in 2015.

## CONTACT INFORMATION

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[www.imperial.ac.uk/bioengineering](http://www.imperial.ac.uk/bioengineering)

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 facebook/imperialbioeng

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## GENERAL ENQUIRIES

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## ACADEMIC STAFF

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Professor Anthony Bull  
Professor of Musculoskeletal Mechanics,  
Head of Department

Dr Benjamin Almquist  
Lecturer

Dr Anil Bharath  
Reader in Image Analysis

Professor Martyn Boutelle  
Professor of Biomedical Sensors Engineering  
Deputy Head of Department

Professor Etienne Burdet  
Professor of Human Robotics

Dr Paul Chadderton  
Lecturer

Dr James Choi  
Lecturer

Dr Claudia Clopath  
Lecturer

Dr Armando Del Rio Hernandez  
Senior Lecturer

Dr Robert Dickinson  
Senior Lecturer

Professor Emmanuel Drakakis  
Professor of Bio Circuits and Systems

Dr Tom Ellis  
Reader in Synthetic Genome Engineering

Dr Aldo Faisal  
Senior Lecturer - Joint appointment with  
Department of Computing

Professor Dario Farina  
Professor of Neurorehabilitation

Dr Rylie Green  
Senior Lecturer

Dr Firat Guder  
Lecturer

Dr Claire Higgins  
Lecturer

Dr Angela Kedgley  
Lecturer

Professor Richard Kitney  
Professor of Biomedical Systems Engineering

Dr Andrei Kozlov  
Lecturer

Professor Robert Krams  
Professor of Molecular Bioengineering

Professor Holger Krapp  
Professor of Systems Neuroscience

Dr Sylvain Ladame  
Senior Lecturer

Dr Chiu Fan Lee  
Lecturer

Dr Huai-Ti Lin  
Lecturer

Dr Nick Linton  
Clinical Senior Lecturer

Dr Spyros Masouros  
Lecturer

Professor James Moore Jr  
The Bagrit & RAEng Chair in  
Medical Device Design

Dr Niamh Nowlan  
Senior Lecturer

Dr Danny O'Hare  
Reader in Sensor Research

Dr Tom Ouldrige  
Royal Society University Research Fellow

Dr Darryl Overby  
Reader in Cellular Biomechanics

Dr Tobias Reichenbach  
Lecturer

Dr Simon Schultz  
Reader in Neurotechnology

Dr Guy-Bart Stan  
Reader in Engineering Design  
for Synthetic Biology

Professor Molly Stevens  
Professor of Biomedical Materials  
and Regenerative Medicine - Joint appointment  
with Department of Materials

Dr Reiko Tanaka  
Lecturer

Dr Mengxing Tang  
Reader in Biomedical Imaging

Dr Jennifer Tweedy (nee Siggers)  
Senior Lecturer

Professor Peter Weinberg  
Professor of Cardiovascular Mechanics

For the most up-to-date list of our academic staff,  
please go to  
[www.imperial.ac.uk/bioengineering/people/staff](http://www.imperial.ac.uk/bioengineering/people/staff)

## RESEARCH FELLOWS

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Dr Hari Arora  
Dr Alister Bates  
Dr Amanda Foust  
Dr Peter Hellyer  
Dr Christina Warboys

## SENIOR RESEARCH INVESTIGATORS

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Professor Colin Caro  
Professor Kim Parker  
Professor Robert Schroter

