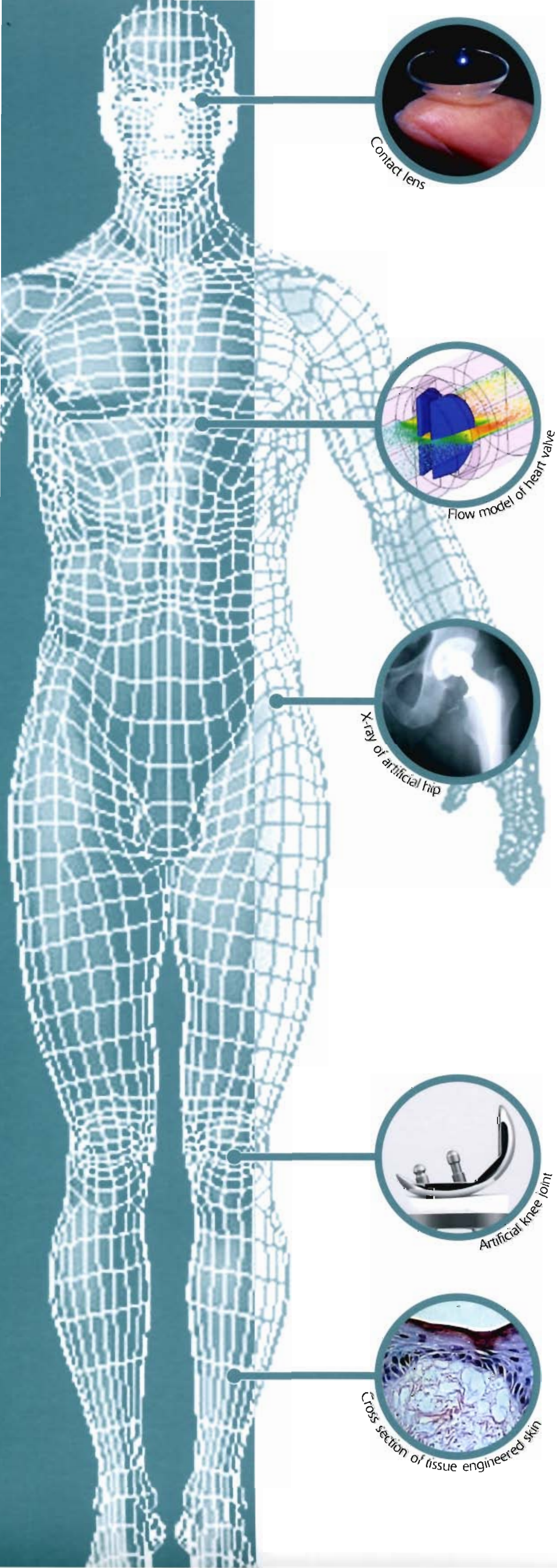
Bioengineering at Sheffield

Undergraduate Degree Courses

The University
of Sheffield



What is Bioengineering?

Bioengineering is a new field of engineering. It focusses on improving medical care and quality of life and creates new opportunities for industry. As the world population ages, costs and demands for healthcare are becoming critical. Bioengineering uses engineering expertise to analyse and solve problems in biology and medicine. Bioengineers develop innovative devices, implants, materials, processes, and informatics approaches for: the prevention, diagnosis and treatment of disease, for patient rehabilitation, and for improving health.

Bioengineering at Sheffield

The University of Sheffield offers two separate Bioengineering degrees:

Biomaterial Science and Tissue Engineering

This course merges materials science and engineering with human anatomy, physiology, biology and medicine. You will learn how natural and synthetic materials can be combined with cells and tissues for the repair, treatment and diagnosis of human disease and injury. The course provides an essential understanding of the mechanical, chemical and biological events that occur within body. Alongside this, you will learn about the inter-relationships between materials processing, structure, and properties. You will then discover how these subjects are applied in the development of engineered body parts.

Biomedical Engineering

This course is designed to give you a broad background in mechanical, electrical, materials and control engineering, whilst providing you with an understanding of the fundamental principles of anatomy and physiology. It will enable you to solve problems in a range of disciplines including bioinstrumentation; biomaterials; biomechanics; cellular, tissue and genetic engineering; clinical engineering; medical imaging; orthopaedic surgery; rehabilitation engineering; and systems physiology.

What do Bioengineers do?

As a Bioengineer you will be uniquely placed for an exciting career that involves working with living systems as well as applying advanced technology to the complexities of modern day medical healthcare.

Biomaterial scientists and tissue engineers work with a wide range of people including doctors, dentists, materials scientists, biomedical engineers, immunologists and clinical scientists. They develop new ways to repair or replace diseased and injured tissues in the body.

Biomedical engineers use a range of traditional engineering expertise to analyse and solve problems in biology and medicine, providing an overall enhancement of health care. They work in a wide range of capacities: designing instruments, devices, and software, bringing together knowledge from many technical sources to develop new procedures, or conducting research needed to solve clinical problems.

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Bioengineering at Sheffield University

The University of Sheffield offers two separate Bioengineering degrees:

1. **BEng / MEng in Biomedical Engineering**
2. **BEng / MEng in Biomaterial Science & Tissue Engineering**

1. BEng / MEng in Biomedical Engineering (UCAS Code: BH81)

NB. All students on this course initially register for the four-year MEng programme (UCAS Code: BH81). At the end of Year two, you can choose to transfer to the three-year BEng course.

Our Biomedical Engineering programme draws on expertise from a number of departments in the University, including: Medical Physics and Clinical Engineering, Mechanical Engineering, Engineering Materials, Electronic and Electrical Engineering, Automatic Control and Systems Engineering and the Medical School. You need to have strong mathematical and physics-based skills to cope with the systems design aspects of this course. While the first two years of the MEng and BEng programmes have a common base, there are separate threads involving biomechanics and bioinstrumentation, and the opportunity to specialise in Years three and four of the MEng degree.

The **Biomedical Engineering** programme complements the **Biomaterial Science and Tissue Engineering** programme that we also run, but it has an emphasis on *engineering applications in medicine* as opposed to the application of *material devices in medicine*.

<table>
<tr><th>Qualification</th><th>Standard Entry Requirements</th><th>Subject Requirements</th></tr>
<tr><td>GCE/VCE A Levels</td><td>ABB</td><td rowspan="6">GCE A Level Maths (or equivalent) is essential. Physics to a minimum of AS Level is preferred; applicants without this subject may be considered if they are strong in Maths.

Students with A Level or AS Level Chemistry, Biology or CDT are encouraged to apply.</td></tr>
<tr><td>Two GCE A Levels plus two GCE AS Levels</td><td>AB+BB</td></tr>
<tr><td>Scottish Highers</td><td>AAAB - ABBB + AB-BB in Advanced Highers</td></tr>
<tr><td>Irish Leaving Certificate</td><td>AABBB - ABBBB</td></tr>
<tr><td>BTEC Level N</td><td>2 Distinctions + 1 Merit</td></tr>
<tr><td>International Baccalaureate</td><td>30-33 Points</td></tr>
</table>

2. BEng / MEng in Biomaterial Science & Tissue Engineering

NB. You can directly enter either the 3-year BEng or the 4-Year MEng stream, with the option to transfer to either programme at the end of Year 2.

MEng in Biomaterial Science and Tissue Engineering (UCAS Code: BJ8X) – 4 Years
BEng in Biomaterial Science and Tissue Engineering (UCAS Code: BJ89) – 3 Years

Biomaterial Science and Tissue Engineering is concerned with the materials used in medicine and dentistry, and how they interact with the human body. A major new area within this course is the subject of *tissue engineering* - where biomaterial scaffolds are made for growing complex arrays of cells in bioreactors to replace human tissues. The development of bioinformatics – the lab-on-a-chip – is a feature of both programmes. The **Biomaterial Science and Tissue Engineering** programme requires different skills to **Biomedical Engineering** – you will need to have a good background in chemistry. Human biology is taught within the course structure and is therefore not an entry requirement.

Qualification	Standard Entry Requirements	Subject Requirements
GCE/VCE A Levels	ABB (BJ8X) BBC (BJ89)	GCE A Level in two of Maths, Physics, Chemistry or Biology; or one at A Level and two at AS Level. Students with A or AS Level CDT are encouraged to apply.
Two GCE A Levels plus two GCE AS Levels	AB+BB (BJ8X) BB+CC (BJ89)	
Scottish Highers	AAAB – ABBB + AB-BB in Advanced Highers	
Irish Leaving Certificate	AABBB - ABBBB	
BTEC Level N	2 Distinctions + 1 Merit	
International Baccalaureate	30-33 Points	

The enclosed literature describes further aspects of both courses. If you are unsure about the acceptability of your particular qualification for either course, please ask. The Open Days that we run as part of the UCAS procedure will give clearer insights and more information on course content. Should you change your mind about which programme is more interesting, it is possible to change, as long as you have an appropriate background.

More information is available on both programmes via our Web Site at
http://www.shef.ac.uk/materials/prospective_ug/courses

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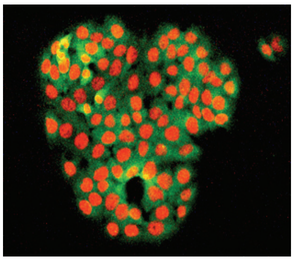
BEng/MEng in Biomaterial Science and Tissue Engineering

BEng – 3 year programme (UCAS Code: BJ89)
MEng – 4 year programme (UCAS Code: BJ8X)

What does biomaterial science & tissue engineering involve?

The aim of biomaterial science and tissue engineering is to improve human health through a variety of approaches. It combines our knowledge of materials science and human biology for repairing or replacing tissue. Human tissue may become damaged or diseased for a variety of reasons - this programme considers how tissues become damaged or diseased and what clinical strategies can be used for repair.

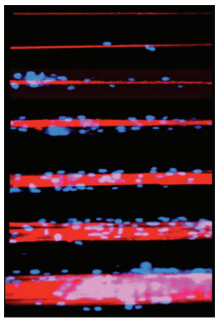
In particular, the use of biomaterials is studied, e.g. coronary stents, hip joints, contact lenses, vascular grafts, heart valves etc. We then study how biomaterials form scaffolds for engineering new tissues in the laboratory prior to transplantation. The success of this subject is founded on a breadth of expertise that is interdisciplinary and exciting to work in.



Biomaterials *– "are used to make prostheses, implants, and surgical instruments. They should not to provoke rejection by the body and can be natural (e.g. collagen, cellulose.) or synthetic (e.g. metallic, alloy, ceramic, polymer)"*

Tissue Engineering *- "combines biomaterial scaffolds with the growth of cells to construct functional tissues to replace or repair diseased or damaged body parts"*

What areas can biomaterial scientists and tissue engineers work in?



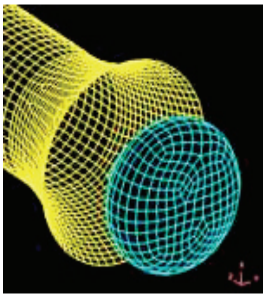
Biomaterial science and tissue engineering combines many clinical and scientific areas. Some of these specialities are outlined below, and you can readily work in any one of these:

- Tissue engineering of heart valves for patients with heart disease
- Growing new skin for patients with burns or leg ulcers
- Tissue engineering new bladders for patients with cancer
- Improving materials for dental reconstruction
- Tissue engineering cartilage for repairing diseased joints
- Designing bioreactors for replacing tendons injured by sports accidents
- Engineering chemical surfaces for growing nerve cells for spinal repair

Is this course for me?

If you enjoy science and its application to clinical problems then this degree is for you. You will typically be aiming at good A-levels in two or three of Maths, Physics, Chemistry and Biology (or equivalent). You must be confident in working across disciplines – for example combining your study in human biology with polymer chemistry for making tissue engineered nerves to treat spinal injuries. Indeed, if you are interested in working across more than one discipline then this is the degree for you.

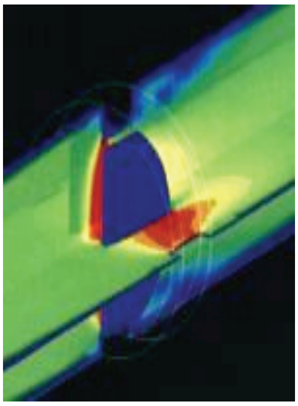
What areas of work are biomaterial scientists and tissue engineers involved in?



There are many areas depending on your interests – you may wish to specialise in biomaterials or in tissue engineering, so you could be developing synthetic materials to replace the biomechanical function of injured cartilage, or designing bioreactors for growing nerve cells. Whatever your interest, you will definitely work with a wide range of people including doctors, dentists, materials scientists, biomedical engineers and clinical scientists. You will be an expert in materials science with knowledge of the human body in relation to clinical therapies – and the ability to make new tissues in the laboratory.

What does the course involve?

The course provides you with a comprehensive understanding in the principles of human biology and of materials science for making medical devices and tissue engineered scaffolds. It covers how materials influence cellular biology and a detailed understanding of the principles, issues and practice of engineering tissues.



In years one and two, you learn about the fundamental aspects of materials science and human biology. This is then used as a foundation for introducing the area of tissue engineering in detail. We cover a range of topics including repair and replacement of hard and soft tissues, e.g. development of polymer composites for skin repair, the use of glass ceramics for bone defects, the use of cardiovascular valves for repairing hearts etc.

You also undertake major research project in your final year, working with staff involved in biomaterials and tissue engineering in the University or in the city hospitals. Current projects include engineering human skin, cartilage, nerve, bone, tendons and ligaments. These projects can focus on the design of new biomaterials or the application of tissue engineering.

The course is delivered by staff recognised internationally for their research at Sheffield University. They are all experts in subjects such as materials science, biochemistry, polymer chemistry, endocrinology, tissue engineering, anatomy, physiology and stem cell biology.

What are the career prospects for biomaterial scientists and tissue engineers?

This is a growth area, which aims to improve the quality of human life with parallel developments in the medical device and healthcare industries. You will be able to work in a number of areas - in industry, hospitals, universities, research, and government agencies. It really depends on you. In industry you might be working in product development. In hospitals and universities, developing entirely new areas of tissue engineering, or you might decide to work for a government agency where you could be involved in regulatory affairs.

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MEng or BEng in Biomaterial Science and Tissue Engineering?

There are two direct entry routes for Biomaterial Science and Tissue Engineering.

MEng Biomaterial Science and Tissue Engineering (UCAS Code: BJ8X)

The MEng course is intended for motivated students who wish to pursue careers in biomedical industries or in research and development. For entry to this course a student must have demonstrated a level of academic attainment during the first two years of the degree. The course builds upon the knowledge and skills obtained in the first two years of the course, introducing advanced techniques for the manufacture and characterisation of biomaterials and development of tissue engineered products. A group project is taken in the third year and an independent project in the fourth year.

The course seeks to develop:-

- an appreciation of recent developments in tissue engineering
- communication and teamwork skills
- understanding of the limitations of biomaterials and reasons for failure
- advanced analytical and problem solving skills
- a knowledge of biomaterial characterisation, selection and design
- an awareness of industrial practices
- understanding of the regulatory control of biomedical materials and devices

BEng Biomaterial Science and Tissue Engineering (UCAS Code: BJ89)

The BEng course is intended for students who want to graduate with a Bachelors degree in Engineering after three years and do not wish to study for a further one year towards a Master degree in Engineering. The final year of study for the B. Eng degree is very similar to the third year of the M. Eng. programme. The major difference is the opportunity to undertake an independent research project in the third year. Overall, this course builds upon the knowledge and skills obtained during the first two years of the course, but has a particular emphasis on preparing graduates for a broad range of industries in healthcare, biomaterials or engineering. Alternatively, graduates may decide to opt for higher degree training.

This course seeks to develop:-

- an appreciation of tissue engineering
- management, communication and team skills
- understanding how biomaterials fail
- biomaterial characterisation selection and design
- awareness of industrial practices
- independence in investigative research

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What Courses do I take in Biomaterial Science and Tissue Engineering?

Year 1 core modules

Human Anatomy and Physiology
Structure & Bonding of Materials
Functional Materials
Industrial Awareness & Computing
Materials in Medicine & Dentistry

Biology and Chemistry of Living Systems
Materials Science
Microstructure & Mechanical Properties
Mathematics

Year 2 core modules

Physiology of the Neural & Endocrine System
Cell & Molecular Biology
Structural Chemistry & Crystallography
Deformation of Materials
Structural Characterisation
Principles of Materials Processing

Physiology of the Musculoskeletal System
Materials & Biomaterials Practicals
Materials for Biological Applications
Fracture Mechanics & Corrosion
Materials Selection, Design & Reverse Engineering

BEng

Year 3 core modules (80 credits)
Individual Research Project
Tissue Engineering
Management for Bioengineers
Seminars in Bioengineering
Functional Polymers & Surface Analysis

+ elective modules

MEng

Year 3 core modules (70 Credits)
Tissue Engineering
Group Bioengineering Project
Management for Bioengineers
Seminars in Bioengineering
Functional Polymers & Surface Analysis

+ elective modules

Year 4 core modules (70 credits)
Bioengineering Research Project
Scientific Writing

+ elective modules

What Elective Modules can I choose in Biomaterial Science & Tissue Engineering?

YEAR 3 – For BEng and MEng routes.

MAT 216	Materials Science
MAT 328	Solidification & Thermomechanical Processing
MAT 333	Metals
MAT 334	Composite Microstructures & Strong Reinforcing Fibres
MAT 336	Advanced Structural & Chemical Analysis
MAT 373	Surface Degradation & Protection
MAT 413	Chemistry of Silicate Materials
MAT 482	Structures & Properties of Glasses

YEAR 4 – MEng route

MAT 317	Advanced Thermodynamics & Kinetics
MAT 328	Solidification & Thermomechanical Processing
MAT 337	Advanced Glasses & Ceramics
MAT 339	Failures & Case Studies
MAT 348	Fracture Mechanics & Heat Transfer
MAT 373	Surface Degradation & Protection
MAT 388	Enterprise, Creativity & Innovation

As courses are constantly being developed by departments contributing to the degree, students can apply to take courses from any engineering departments at the relevant level. These applications are dealt with on a case by case basis in consultation with the relevant departmental member of the Board of Studies.

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BEng/MEng in Biomaterial Science and Tissue Engineering

BEng – 3 year programme (UCAS Code: BJ89)
MEng – 4 year programme (UCAS Code: BJ8X)

Module Descriptions

YEAR 1

AMA154 Mathematics 1 (Materials) - This module is part of a series designed for particular groups of Engineers. Each module aims to reinforce students' previous knowledge and to develop new basic mathematical techniques needed to support the engineering subjects taken at levels 1 and 2. They also- provide a foundation for the level 2 mathematics courses in the appropriate engineering department.

AMA155 Supplementary Mathematics (Materials) - This module is part of a series designed for particular groups of Engineers (see module title). Each module aims to reinforce students' previous knowledge and to develop new basic mathematical techniques needed to support the engineering subjects taken at levels 1 and 2. They also provide a foundation for the appropriate mathematics courses in Level 2.

MAT107 Introduction to Human Anatomy and Physiology - This half-module introduces students to the language and study of anatomy and attempts to focus learning around a number of new topics that are core to the Cell and Human Biology element of the degree courses Biomaterial Science and Tissue Engineering and Biomedical Engineering. These topics are placed in the context of whole body and look in detail at the structure (anatomy), and function (physiology) of the musculoskeletal system and other basic tissue types. Considerable emphasis is placed on practical experience and developing an increased level of understanding of the structure and function of the human body rather than on learning by rote.

MAT115 Structure and Bonding of Materials - The course is designed to give an insight into the fundamental nature of matter from atomic structure to the configuration of ions and atoms in crystalline materials. The course will start with a review of atomic orbital theory, leading to an understanding of the nature of bonding in metals and ionic crystals. The crystalline structure of metals will be discussed, introducing concepts such as close packing of atoms and unit cells. The underlying principles which control the crystal structure of simple ionic compounds will also be presented. The lectures will be reinforced by three practical classes.

MAT116 Materials Science: Where to/How fast? I - This unit introduces the basic concepts of Thermodynamics (Where to?) and Kinetics (How fast?) required to understand the synthesis, stability and long-term performance of materials. We illustrate the use of Thermodynamics in understanding solids, liquids, gases, synthesis and processing methods. Kinetics provides an introduction to homgeneous (gas-gas, liquid-liquid) and heterogeneous (solid-solid) reactions and their application in, for example, corrosion, polymer synthesis and vapour deposition.

MAT125 Functional Materials I - The course introduces a) the optical properties of materials and their applications and b) the shapes of molecules in relation to their function. The optical properties considered will include absorption, emission, refraction and diffraction, leading to applications such as coloured materials, lenses, optical fibres, light sources, and sensors, and their role in the photonics revolution. The second part of the course will consider the factors, including temperature, that control the shapes of simple and complex molecules and their packing in the solid state. These concepts will be applied to the development of, for example, stiff fibres and liquid crystals

MAT136 Microstructure and Mechanical Properties - This unit deals with the principles underlying microstructure formation in metallic and non metallic materials and their solidification, deformation and heat treatment are covered in some detail. Types of mechanical behaviour are discussed and the application of different tests to determine mechanical properties is described.

MAT158 Industrial Awareness and Computing Skills - This unit provides a sound foundation in IT skills that will be useful throughout the rest of the degree course, together with industrial visits and training in communication skills. You will use standard computer packages to learn key skills such as word processing, use of spreadsheets, databases and the internet, and you will gain some programming experience. This module includes a week-long tour of biomaterials and materials companies which will provide you with an insight into the biomaterials industry. You will be expected to take part in debates and complete a presentation on one of the visits.

MAT167 Materials in Medicine and Dentistry - This course is taught by Professors Paul Hatton and Ric Van Noort from the School of Clinical Dentistry. Its aim is to introduce undergraduate students to the widespread use of biomaterials and medical devices in the treatment of human disease, and to understand both the property-use relationships in medical devices and the fundamental limitations of biomaterials in the body.

MAT181 Biology and Chemistry of Living Systems - MAT181 builds on the knowledge gained in MAT107 and expands the range of biological systems covered that are core to the Cell and Human Biology element of the courses Biomaterial Science and Tissue Engineering and Biomedical Engineering. The following are included: the internal workings of the cell (no genetics); cell/tissue response to injury and materials; (some) conditions that may lead to need of tissue replacement. These are placed in the context of the whole body anatomy and physiology. Specific disease processes are studied in detail, for example, tumorigenesis. Six practical classes cover light microscopy, electron micrographs, cell staining and cell culture.

YEAR 2

AMA154 Mathematics I (Materials) - This module is part of a series designed for particular groups of Engineers (see module title). Each module aims to reinforce students' previous knowledge and to develop new basic mathematical techniques needed to support the engineering subjects taken at levels 1 and 2. They also provide a foundation for the level 2 mathematics courses in the appropriate engineering department.

OR

AMA250 Mathematics II (Materials) - This module is part of a series of second-level modules designed for the particular group of engineers shown in brackets in the module title. Each module consolidates previous mathematical knowledge and develops new mathematical techniques relevant to the particular engineering discipline.

MAT204 Materials and Biomaterials Practicals - This unit comprises practical laboratory classes tailored specifically for students studying Tissue Engineering. 50% of the module consists of the most relevant Materials based practicals for this subject (SEM, X-ray diffraction, spectroscopic methods, polymer processing) and 50% consists of an introduction to biochemical and cell biological analytical methods (SDS-PAGE electrophoresis and immunofluorescence microscopy).

MAT205 The Physiology of the Musculoskeletal System - This unit builds on the introduction to anatomy, physiology, and cell and molecular biology given in MAT107 and MAT181, and uses the principles learnt in these modules to study the functioning of the musculoskeletal system in detail. The interactions between the various components (muscle, bone, tendon, joints and skin) of the musculoskeletal system are emphasised, with particular stress on the fact that biological systems do not exist in isolation.

MAT206 The Physiology of the Neural and Endocrine Systems - This unit takes a functional approach to understanding the workings of the human body in health and disease, in order to develop an awareness of the 'systems' nature of human physiology. The material covered concentrates on the endocrine and neural systems and their roles in other structures in the human body.

MAT209 Cellular and Molecular Biology -This unit provides an introduction to biochemistry and molecular biology that builds on the anatomy, physiology and cell biology learnt at Level 1. It starts with the chemical components of living cells and progresses by understanding how simple chemicals become macromolecules and, in turn, form lipids, proteins and nucleic acids. How macromolecules form individual components of a living cell such as the membrane, chromosomes and mitochondria is also covered. The essential functions of the cell including metabolism DNA replication and genetic transcription are then discussed. Finally, how a complex of cells can form a tissue is examined***.***

MAT215 Structural Chemistry and Crystallography- The purpose of this module is to provide you with the scientific background necessary to understand crystal structure of inorganic and polymeric materials. You will learn about unit cells, symmetry, fractional atomic coordinates and close packed structures. The main inorganic structural families will be taught, with examples of direct correlations between crystal structures and physical properties. The relationship between chemical structure, molecular organisation, microstructure and physical properties of polymers in the solid state will be explained, with parallels drawn between synthetic polymers and biopolymers. You will also be told about different methods of microstructural investigation.

MAT236 Deformation of Materials - The course describes the plastic deformation of metals, polymers and inorganic materials, indicating the fundamental mechanisms that give rise to sample strain in response to applied stress or arising from thermally induced effects. The deformation mechanisms are related to microstructure and processing and the implications for design are considered.

MAT245 Principles of Materials Processing - This course considers processing of both metallic and non-metallic materials by melting, including fundamentals of melting. A range of topics will be considered including processing of glasses and polyphase materials, container and float glass manufacture, sol-gel technology in production of materials, processing of glass composites, devitrification of glasses and processing of glass ceramics, glass and ceramic fibres.

MAT246 Materials Selection, Design and Reverse Systems Engineering - This unit builds an understanding of the inter-relationship between selection, materials processing, product design and product performance to develop a holistic approach to optimum selection of materials for engineering and industrial applications. Topics examined include the methodology of design, methods of materials and process selection, risk assessment, and product liability. Case studies, unified life cycle cost engineering and design for recycling are also discussed.

MAT255 Structural Characterisation - The aims of this unit are to provide you with an introduction to and understanding of some of the most important methods of structural characterisation of materials. The techniques covered are: scanning and transmission electron microscopy, X-ray structural analysis and spectroscopy. By the end of this unit you should have an understanding of the scientific principles behind each of these techniques and a basic knowledge of how to use them.

MAT272 Fracture Mechanics and Corrosion - Part 1 - Introduction to heterogenous reactions via wet and dry corrosion. Positive and negative effects of corrosion and their relationship to other phenomena. Thermodynamics of oxidation and transport in oxide scales. Parabolic, linear and logarithmic rate laws. Examples of the oxidation of pure metals and alloys. The electrochemical nature of aqueous corrosion, Faraday's law, Nernst equation. Standard electrode potentials, cells, polarisation, Tafel equation. Examples taken from industrially relevant materials and reference to everyday life discussed. Part 2 - Why do materials not achieve their theoretical strengths? The effects of flaws - Inglis, Griffith and Irwin approaches. What happens at real crack tips - plasticity and how limited plasticity may be incorporated in LEFM. Incorporation of cyclic loading and environmental effects into our analysis.

MAT315 Materials for Biological Applications - A wide variety of materials are used in tissue culture, biochemical analysis and bioengineering. This module outlines the most commonly used materials and introduces a range of advanced materials for specialised applications. The key properties of these substances will be detailed along with the selection of materials on the basis of performance and cost.

YEAR 3 MEng

MAT300 Tissue Engineering Approaches to Disease and Failure of Living Systems - This module will extend knowledge on basic human anatomy and physiology and explore tissue engineering and biomedical engineering approaches to address problems of disease, failure and old age in body systems. Generic technologies of relevance to tissue engineering such as gene therapy and stem cell introduction will also be included.

MAT308 Research Seminars in Bioengineering - This module is divided into two components. In the first section seminars and workshops will be given on various aspects of bioengineering by a number of invited industrial and academic speakers. Students will then be asked to undertake further research in two of these topics. In the second component, groups of students will select topics from a given list of controversial and topical issues in bioengineering to research and present to the class in both a written and oral format.

MAT316 Surface Modification for Biomaterials - Surface modification is critical to the development of a vast number of biomaterials from hip implants to DNA arrays. Theories and methods used to alter the chemistry and topology of a surface will be outlined and their relevance to biological applications discussed. Topics covered include microfabrication, self assembled monolayers, graft polymerisation, plasma treatment, protein immobilization and biomimetic surfaces.

MAT338 Functional Polymers and Surface Analysis - Functional polymers: this course will cover electroactive polymers (electronically and ionically conducting), light-emitting and liquid crystalline polymers, as well as liquid crystals for displays, and novel nanostructured organic materials, including block-copolymers and dendrimers. Surface analysis: The most commonly employed surface analytical techniques will be described, including contact anale analysis, XPS, SIMS and AFM. The module will outline the principles and operation of these techniques and briefly detail how to interpret data obtained from them.

MAT381 Management for Bioengineers - This module introduces students to a number of the fundamental concepts of engineering project design and management with particular emphasis placed on the specific problems that need to be addressed when working in biological environments. Topics to be covered include GLP, GMP, international standards, regulatory affairs, legal and ethical issues, intellectual property and project planning.

MAT372 Group Projects in Bioengineering - In this module, students will develop individual research project proposals and then work as a team to develop a select number of these as grants applications suitable for research councils or as industrial proposals suitable for seed funding or venture capital. The emphasis of this module will be on students developing skills in project planning, group communication and management, enterprise and transfer of research into the industrial environment.

YEAR 3 BEng

MAT300 Tissue Engineering Approaches to Disease and Failure of Living Systems - This module will extend knowledge on basic human anatomy and physiology and explore tissue engineering and biomedical engineering approaches to address problems of disease, failure and old age in body systems. Generic technologies of relevance to tissue engineering such as gene therapy and stem cell introduction will also be included.

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MAT245 Principals of Materials Processing - This unit will discuss fundamental scientific principles underlying the processing of materials via solid, liquid and vapour phases, including surface/interface energies, wetting and dihedral angles, capillary forces, flow and rheology, deformation and mixing. These concepts will be applied to ceramics (mixing shape forming, sintering), glass (melting, mixing, float process, fibre manufacture), metals (extraction, casting, deformation processing), polymers (flow and shape forming, injection moulding, extrusion). Production of thin films and coatings (PVC, CVD) and single crystals (e.g. Czochralski Si) will also be considered along with the technology of joining and surface treatment.

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MAT356 Literature Survey and Project - The project is chosen from a list drawn up by staff within the Biomaterials and Tissue engineering group. It is an original research investigation carried out individually under the supervision of one or more members of the academic staff. Students carry out a Literature Survey involving the reading of original papers and review articles in Learned Society Journals and Conference Proceedings. This document will be due at the end of week 4. Most projects involve extensive laboratory work, which will be completed prior to the end of Semester 1. The assessment of the project includes a verbal presentation on the work carried out before staff and other students and a written dissertation, which is due prior to Easter.

YEAR 3 MEng and BEng OPTIONS

MAT216 Materials Science: Where to? How Fast II? - This unit builds on the introductory course MAT116. The thermodynamics component will focus on the processes and technologies involved in the making of steel. Running alongside the operational aspects, the fundamental and relevant thermodynamic and kinetic principles of blast furnace operation, and the oxygen and electrical steel making processes will be discussed in some detail. The kinetics part will focus on oxidation and wet corrosion using examples from aerospace, chemical and oil industries. The course starts from first principles dealing with mass transport in ionic lattices and finishes with oxidation processes in engineering alloys. The mixed potential theory will be developed to explain the kinetics of wet corrosion.

Solidification and Thermomechanical Processing - The principles governing solute redistribution and front morphology in solidification from melts are set out and applied to microsegregation and solidification microstructure formation and control. The interaction of metallurgical and mechanical variables in determining microstructural evolution in high temperature solid metal shaping processes is explored.

MAT333 Metals - To review present understanding of the mechanisms of solute redistribution and microstructure formation by solidification from the melt, to review the principles involved in the design and development of advance metallic materials and to illustrate how microstructural change during processing of materials can be modelled. The module will include the following subjects: fundamentals of solute partitioning and redistribution in freezing processes; eutectic and deudritic growth; competitive growth and formation of grain structure in ingots and castings. Advanced light and directionally solidified alloys for aerospace; metal matrix composites for automotive applications; metallic glasses and nanocrystalline alloys for magnetic applications. Methods of quantifying phase propositions , grain size and particle size distributions for optical and lectron microscopy are presented.

MAT334 Composite Micromechanics and Strong Reinforcing Fibres - To provide an understanding of the mechanics of laminated composites. To consider the micromechanical and damage accumulation mechanisms which apply to continuous fibre composites and cross-ply laminates. To introduce laminate theory and angular dependence of strength and modulus.

MAT336 Advanced Structural and Chemical Analysis - This module will introduce and develop an understanding of the basic operating principles of a range of advanced spectroscopies and chemical analysis techniques, including Synchrotron Techniques, Neutron Scattering, XAFS, NMR, Mossbauer and Impedance Spectroscopy.

MAT373 Surface Degradation and Protection - Review of electrochemical nature of corrosion of metals, standard electrode potentials and kinetics. Definition of polarisation and investigation of corrosion properties. Forms of corrosion and the different methods of corrosion control. Consideration of the mechanical and chemical properties that can be influenced and controlled by surface engineering techniques, their respective capabilities and the properties of the coated or treated surface that they can be used to produce.

MAT413 Chemistry of Silicate Materials - This course provides an introduction to the materials science of cement and concrete. The initial twelve lectures introduce different types of cement and their reaction with water in setting and hardening. Manufacture of ordinary Portland cement, the phases formed and how these react with water and contribute to strength, as well as uses of cement, are all discussed.

MAT482 Structure and Properties of Glasses - This course considers structural features of noncrystalline oxide materials, comprising glasses and polyphase glass-based composite materials. A range of topics will be considered including structural features of silicate and phosphate noncrystalline systems, production methods, viscous flow, ionic conductivity, diffusion, ion-exchange, hydrolysis, and performance of noncrystalline and polyphase materials used as confining barriers and implants in aqueous media.

YEAR 4 MEng

MAT317 Advanced Thermodynamics and Kinetics - This unit comprises two components: 1) This component builds on the thermodynamics and kinetics modules MAT116 and MAT216. It will cover introductory statistical thermodynamics, showing how the properties of macroscopic systems can be related to molecular properties. Classical statistical mechanics will then be introduced along with computer simulation methodology such as molecular dynamics, Monte Carlo and energy minimisation. Examples relevant to materials science will be covered. 2) This component deals with concepts relevant to the structure and energetics of surfaces and interfaces in metallic and other materials, and their relation to properties and behaviour in processing and service. It also provides information on the techniques used to control these properties, and hence enhance the in-service performance of the surface or interface. By the end of this section, a student should be able to demonstrate an appreciation of the factors governing structure and energetics of heteregeneous surfaces and interfaces, and a knowledge and understanding of how interfacial energetics influences annealed microstructures and properties, and performance of materials and their respective capabilities.

MAT328 Solidification and Thermomechanical Processing - The principles governing solute redistribution and front morphology in solidification from melts are set out and applied to microsegregation and solidification microstructure formation and control. The interaction of metallurgical and mechanical variables in determining microstructural evolution in high temperature solid metal shaping processes is explored.

MAT337 Advanced Glasses and Ceramics - This knowledge aims to build on the knowledge acquired by students in the first two years of the course in the areas of ceramics and glasses. In the first part, the students will examine in depth three systems that exemplify standard ceramics, electro-ceramics and engineering ceramics, considering the relationships between processing and properties. In the glasses component, the principles underpinning the production and properties of the more common commercial systems will be explained.

MAT339 Failures and Case Study - The failures analysis component of the module introduces students to the general methodologies involved in carrying out a failure analysis. This will be achieved by formal lectures, case studies (eg on gas turbines or aerospace components) and failure analysis practicals. The module will also examine how improvements in design, manufacturing and inspection procedures can lead to failure prevention. The case studies are designed to simulate the kind of team work that could be required of graduates in industry. They aim to increase students' knowledge of applications of engineering materials, and their ability to work in a group to cooperate and collaborate efficiently and effectively.

MAT348 Fracture Mechanics and Heat Transfer - This module introduces students to fracture mechanics and heat transfer. In the fracture mechanics part topics covered in some detail include linear elastic fracture mechanics, cyclic fatigue and stress corrosion. A brief introduction to elastic-plastic fracture mechanics is also included. The heat transfer part of the course is intended to develop an understanding of the basic physics of conductive, convective and radiative heat transfer and its relevance to materials processing. To this end, the course concentrates on 'simple' analytic approaches to heat transfer problems.

MAT373 Surface Degradation and Protection - Review of electrochemical nature of corrosion of metals, standard electrode potentials and kinetics. Definition of polarisation and investigation of corrosion properties. Forms of corrosion and the different methods of corrosion control. Consideration of the mechanical and chemical properties that can be influenced and controlled by surface engineering techniques, their respective capabilities and the properties of the coated or treated surface that they can be used to produce.

MAT388 Enterprise, Creativity and Innovation - This course examines the concepts of Creativity, Innovation and Enterprise in general, as individual themes and proceeds to look into their interrelationships, with particular emphasis on the organisational culture required to sustain the flow of ideas and the role of leadership in successfully driving through an idea from its conception to the final marketable product or system. It provides the student with the essentials of business, managment and entrepreneurship. Problem solving methods and techniques are explored, particularly the themes of problem definition, idea generation, solution selection and implementation. These are supported by practical workshops and two case studies in creative innovation. Furthermore, real life case studies are used to illustrate the concepts

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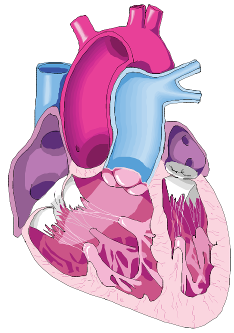
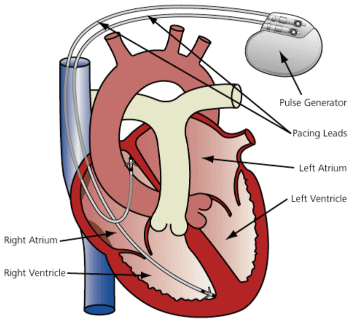
How to Mend a Broken Heart
A Bioengineers Approach

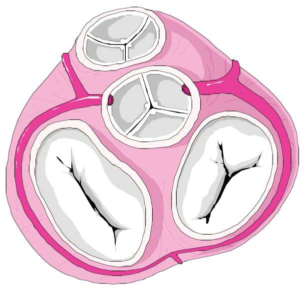


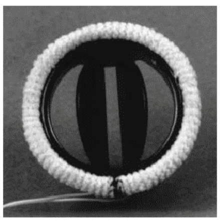
- The heart is a pump, designed to push blood around the body.
- Blood pressure keeps blood supply to our fingers, toes and brains
- The movement of the heart muscle and thus the beating of our heart is regulated by an electrical system.



- When the electrical system in the heart fails or is disrupted, the heart cannot beat properly.
- Pacemakers are often implanted to assist the heart's electrical system
- The pacemaker monitors the heart and can adjust the electrical signals being sent through the heart muscle, ensuring that the pumping of the heart is optimised

- The heart contains 4 valves that separate each of the 4 chambers of the heart.
- Blood pressure and the pumping of blood into the body is achieved by closing off each of the chambers in a specific order.
- If the valves start to leak, pressure cannot be built up.
- Faulty heart valves can be replaced with artificial valves.





Mechanical Heart Valves:

- Mechanical heart valves are designed to replace the heart valve
- using a leaflet system that opens and closes in response to pressure.
- They are made from a range of metals (titanium) and polymers.
- Patients with these valves need to take blood thinning drugs.

Tissue Heart Valves:

- Tissue valves are made from the tissue of animals that are stretched onto a polymer or metal frame.
- The material is chemically treated to ensure it won't degrade or infect the patient.
- Over time these materials tend to harden & don't close

Department of Engineering Materials

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