BSc Medical Sciences with Biomedical Engineering

Programme Overview 2022-23

The Department of Bioengineering
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1. Welcome from the Programme Director

Dear students,

Welcome to Bioengineering! I am delighted to be able to introduce you to the Department and to the intercalated BSc Medical Sciences with Biomedical Engineering programme. I hope to meet you in person in the future, as a student of this exciting programme, which is entering its fifth year for 2022-23 entry.

Bioengineering is a dynamic and growing discipline, which brings together engineering, medicine, life sciences and physical sciences. Our interdisciplinary research is ground-breaking and has had a demonstrable impact in healthcare and fundamental biomedicine. Find out more about our research in the next section of this guide or on our website.

We believe there is a great deal of benefit in introducing collaboration between medics and engineers at an early stage of the curriculum. You will gain a very different perspective on medicine and healthcare through developing your engineering knowledge; you will develop new learning techniques; you will build invaluable networks; and you will be well placed to contribute to the medical profession, whether through a conventional route or in one of the closely related industries.

The Department of Bioengineering is known for being welcoming, dynamic and lively. We take great care of our students and really value their contribution, both inside and outside the classroom. Our staff are dedicated to ensuring all our students have a challenging, interesting and supported experience, both academically and pastorally - so do make the most of their expertise throughout the programme.

Scientific medicine revolutionised the practice of medicine in the 20th century; engineering is already revolutionising 21st century medicine. Exploitation of the astonishing developments in robotics, biomechanics, sensing, imaging, neuroscience, biomaterials, regenerative medicine, synthetic biology, and artificial intelligence will require a new way of working.

Our new intercalated programme will equip you with a solid foundation in the engineering underpinning of modern medicine, provide collaborative research opportunities at the cutting edge, enable long-term collaboration and new career opportunities. This will stand you in excellent stead to contribute to the cutting-edge of healthcare innovation in the future.

We hope that you will be excited by this opportunity and will successfully apply to the programme. If you have any queries about the programme or would like to find out more, please do get in touch with us.

With very best wishes,

Firat

Dr Firat Guder
Programme Director
2. Introduction to the Department of Bioengineering

What is Bioengineering?
Biomedical engineering is a discipline that advances knowledge in engineering, biology and medicine, and improves human health through cross-disciplinary activities that integrate the engineering sciences with the biomedical sciences and clinical practice. It includes:

- The acquisition of new knowledge and understanding of living systems through the innovative and substantive application of experimental and analytical techniques based on the engineering sciences.
- The development of new devices, algorithms, processes and systems that advance biology and medicine and improve medical practice and health care delivery.

The term "biomedical engineering research" includes not only the relevant applications of engineering to medicine but also to the basic life sciences.

About the Department
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:

a. **Biomedical engineering:**
Developing devices, techniques and interventions for human health.

b. **Molecular bioengineering:**
Solving problems related to the life sciences and their applications for health.

c. **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. 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, MD(Res) and PhD programmes.

Research
Our research is highly interdisciplinary and involves extensive collaborations with departments from all faculties in the College and leading London hospitals, as well as international universities and research centres.

Because of its cross-disciplinary nature, the research is best reflected in terms of themes:
- Biomechanics
- Neural engineering
- Detection, devices, design
- Implants and regenerative medicine
- Molecular and cellular bioengineering
- Human and biological robotics
Studying
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. The Department of Bioengineering offers opportunities to study at both undergraduate and postgraduate levels. We are committed to the highest quality teaching and learning, and to our students’ Imperial experience both inside and outside of the lecture theatre.

Industrial links and careers
The Department of Bioengineering works with industry partners from start-up companies to global corporations in the UK and internationally in a wide range of projects. Our work with partners includes:

- **Research Collaborations.** Working with industry partners on the development of new biomedical and bioengineering technologies.
- **Student projects, placements and internships** in the UK and internationally
- **Events and training**
- **Translation of new science into applications and** products which impact on wider society.
- **Consultancy work** to help companies solve engineering and science problems.

Pastoral care
We want you to be happy and successful during your time in the Department. We are renowned for being a friendly and welcoming Department so if you do have problems or want to talk to someone please do come and see us. If we can’t help with your problem then we will help you find someone who is able to help you.

**Personal Tutors**
Your Personal Tutor is usually a member of academic staff who is allocated to you for the duration of your course to offer help and support with academic or personal issues. They will also follow your progress throughout the course to help keep you on track to succeed.

**Senior Tutor**
The Department’s Senior Tutor (Dr Claire Higgins) has overall responsibility for the academic and pastoral care of undergraduate students in the Department. If for any reason you are not comfortable speaking to your Personal Tutor you can arrange to speak with the Senior Tutor instead.

**Academic Tutor**
The Department’s Academic Tutor (Mr Martin Holloway) assists with the administration of programmes, provides academic support to students, delivers teaching and lectures, and provides invaluable pastoral support.

**Student Office**
The Student Office is located in RSM 3.21c. Our role is to support all the teaching activities of the Department – that includes helping students and academics with a range of queries on a number of topics, such as:

- Student admissions
- Administration of UG, PGT, and PGR programmes
- Administration for exchange and visit students
- Examinations
- Timetabling
- Delivery of programmes
• Coursework and assessment deadlines
• Administration of the Department Teaching Committee and Staff-Staff Committee
• Student feedback
• Teaching policies and procedures
• Quality assurance
• Implementation of new degree programmes

Typically, your first port of call for most queries would be either your Personal Tutor or the Student Office. We are here to help you so please do pop in if you have any queries. We also love to hear your suggestions on how to improve things – such suggestions can be made formally through the student reps and Student-Staff Committee, or informally by dropping in and having a chat.
## 3. Provisional dates for the academic year 2021-22

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<th>Term dates</th>
<th>College closures</th>
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<td><strong>Autumn term:</strong>&lt;br&gt;1 October 2022 - 16 December 2022</td>
<td><strong>Christmas/New year:</strong>&lt;br&gt;24 December 2022 – 02 January 2023 (College reopens on 03 January 2023)</td>
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<td><strong>Spring term:</strong>&lt;br&gt;7 January 2023 - 24 March 2023</td>
<td><strong>Easter Holiday:</strong>&lt;br&gt;06 April 2023 – 12 April 2023 (College reopens on 13 April 2023)</td>
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<td><strong>Summer term:</strong>&lt;br&gt;29 April 2023 - 30 June 2023</td>
<td><strong>Early May Bank Holiday:</strong>&lt;br&gt;01 May 2023</td>
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<td><strong>Spring Bank Holiday:</strong>&lt;br&gt;29 May 2023</td>
<td><strong>Summer Bank Holiday:</strong>&lt;br&gt;28 August 2023</td>
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You can also find useful information about key dates on the following website: [http://www.imperial.ac.uk/admin-services/registry/term-dates/](http://www.imperial.ac.uk/admin-services/registry/term-dates/) and the College Year Card here: [www.imperial.ac.uk/estates-facilities/security/id-cards/](www.imperial.ac.uk/estates-facilities/security/id-cards/)
4. Key contacts

For your year of study on the BSc Medical Sciences with Biomedical Engineering programme, you will be part of our community. We hope all students, regardless of programme, will actively engage with the Department and contribute to Departmental activities such as seminars, public engagement, and outreach activities.

As such, you will get to know many members of staff, but below are some of the key people who will be able to help you if you have any queries or difficulties.

Dr Sarah Owenson  
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Departmental Safety Officer
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k.keating@imperial.ac.uk
5. Programme overview

Introduction
This programme will provide you with an education in engineering as applied to healthcare challenges, and position you well for interdisciplinary careers at the forefront of healthcare innovation.

Content
The programme is delivered across three terms, and will comprise online pre-sessional learning, core modules, elective modules and a group research project. You will be able to specialise by choosing some elective modules to suit their individual interests. Throughout the year, collaboration with other bioengineering students is encouraged - specifically in the group research project, where medics and bioengineers work together to produce original research relating to real-world challenges.

The programme will begin with a course of pre-sessional learning to build up your skills in mathematics and programming to enable you to engage with the engineering content of the programme. In the autumn term, you will study several core modules including a bespoke double module 'Fundamentals of Biomedical Engineering', to ensure you develop a deep understanding of core concepts. In the autumn and spring terms you will be able to specialise in areas of interest through elective module choices. You will also engage in substantial original research in collaboration with bioengineers through a group research project taking place throughout the academic year. The programme will culminate with final examinations, submission of remaining coursework and group project presentations.

Pre-sessional learning
To ensure that you have the required mathematics and programming knowledge, you will be expected to undertake some compulsory guided study before commencing the programme. This is important because although many of you will be able mathematicians, you may not have used these skills for some time, and will need to be apply to apply them in an engineering context from the beginning of the degree programme. You may or may not have experience with programming; the pre-sessional learning will introduce computational thinking and simple programming, which will help you a great deal with the rest of the programme.

Note that the pre-sessional learning is taught entirely through the College’s online learning environment (Blackboard) and so access to the internet is essential for completing the pre-sessional learning. You will have access to experienced members of staff who will support your learning and assist with any queries, either via live tutorials or via booked personal e-appointments. Your engagement and progress on the pre-sessional module will be monitored to ensure appropriate support is provided.

The pre-sessional learning programme will be delivered over six weeks, during August and September before the programme starts, though the material is normally made available from the start of July. There will be approximately 5 hours of guided learning per week. You will also be able to access videos of lectures and demonstrations, regular formative online quizzes to enable self-assessment, and self-directed learning opportunities. Therefore in total is expected that you will complete around 30 hours total of guided study, and it is expected that you will also dedicate adequate additional independent study time to ensure you are confident with the
material prior to the start of term. The amount of independent study required will depend on your background and aptitude for mathematics and programming.

The pre-sessional training will not contribute to final degree grades but individual feedback will be provided following diagnostic tests early in the academic year and used to identify potential gaps in knowledge which may need to be addressed.

Programme Structure
This intercalated programme runs over three terms, for one academic year. The number of hours of learning and teaching, and hours of independent study vary from module to module. Students are also expected to undertake pre-sessional learning for approximately six weeks prior to the start of the course, to ensure they have the required background knowledge and skills to enable them to make good progress on the intercalated programme.

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<tr>
<th>Period</th>
<th>Modules</th>
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<tr>
<td>August-September 2021</td>
<td>• Online pre-sessional learning</td>
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<td>Autumn Term</td>
<td>• Fundamentals of Biomedical Engineering</td>
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<td>• Probability and Statistics for Bioengineering</td>
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<td>• Journal Club</td>
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<td>• Group Research Project</td>
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<td></td>
<td>• 1-2 elective modules (to a total of 5 across the whole year)*</td>
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<tr>
<td>Spring Term</td>
<td>• 3 – 5 elective modules (to a total of 5 across the whole year)*</td>
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<td></td>
<td>• Group Research Project</td>
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<tr>
<td>Summer Term</td>
<td>• Group Research Project</td>
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*Note that not all combinations of elective modules may be possible due to timetabling constraints, and electives have to be chosen within guidelines.

Entry requirements
The programme is available to medical students both from Imperial College London and from other institutions.

Students are required to be registered on a General Medical Council (GMC) recognised MBBS degree (or equivalent). Students must have successfully completed the first two years of that programme. No break in studies is permitted between the programme at the other institution and the beginning of the programme for the BSc degree.

Intercalating students need to demonstrate that they are likely to receive a 2.1 or 1st by supplying an academic transcript from their home institution. It is expected that applicants received at least a 2.1 in their second year of study.

All applicants will normally be required to have achieved a minimum of Grade ‘B’ at A-Level in Mathematics, or equivalent.

Additional information
This document provides a brief overview of the intercalated programme. For further details, it is important that when you join the programme, you ensure you read (in full) the programme handbook, the programme regulations and any relevant Departmental or College policies and procedures.
6. Assessment

Examinations and coursework
Each module will be assessed through coursework, practical work, or written exams; or a combination of some or all of these.

The main examination periods in the Department are December/January and May/June.

Coursework deadlines within the Department are monitored to ensure that you do not have an unreasonable workload at any one time.

Rules of progression
To successfully pass the programme, a student must:
• Achieve an overall aggregate mark of at least 40%
• Achieve a pass in the mastery assessment for relevant modules
• Achieve a mark of at least 40% in each module

Final degree classifications:
• First – a student must achieve an aggregate mark of 70%
• Upper second – a student must achieve an aggregate mark of 60%
• Lower second – a student must achieve an aggregate mark of 50%
• Third – a student must achieve an aggregate mark of 40%
7. Overview of modules

Full module descriptors can be accessed on the Department of Bioengineering’s website at https://www.imperial.ac.uk/bioengineering/admin/current-ug/intercalated-bsc/ or you can contact the Student Office for more information.

Pre-sessional learning: mathematics and programming (core)
This pre-sessional study module is designed to build students’ confidence and abilities in core mathematical concepts and programming to prepare for the formally assessed modules. The content is designed to: (i) revise those aspects of A-level (or equivalent) mathematics that will be built upon in mechanics and electrical engineering and to (ii) provide an introduction to computational thinking and simple programming.

BE3-HFBE Fundamentals of biomedical engineering (core)
This course will provide basic principles of mathematics, computational thinking, basic electrical and mechanical engineering required for other courses in the intercalated Biomedical Engineering programme.

BE3-HPSFB Probability and Statistics for Bioengineering (core)
This module ensures that all students acquire a solid foundation in probability theory as well as the statistical knowledge and skills required for the bioengineering programme.

BE3-MJCLUB Journal club (core)
The aim of the course is for students to read and discuss key journal articles relevant to the course. Students will relate their reading and research to the group projects which they will undertake through their intercalated year, e.g. exploring clinical aspects of their group project through a literature review, prior to working on developing an engineering solution to the problem.

By the end of the course, students will be able to:
• Read journal articles and extract the important information
• Write a critical review (referee report) on the article
• Understand the structure and writing style of high impact journal articles

Each week, students will read and review relevant journal articles individually. During the scheduled sessions, students will be required to take turns to present a summary and critique of specific papers to the rest of their group, which will be followed by a question and discussion session. Students will also take turns writing a critical review of the papers discussed each week, to be submitted the following week. All students should engage with the discussion of papers regardless of if it is their turn to present or write a critical review.

Group research project (core)
This project gives students an opportunity, in collaboration with undergraduate students from the Department’s other undergraduate programmes, to define a problem, devise engineering solutions and evaluate experimental data. This project will help students to develop important project management skills, enable them to develop skills to work in a multi-disciplinary environment, and hone their written and oral communication, and presentation skills. The project will be closely linked to the Journal Club module which students study as part of the programme, as this will give them an opportunity to explore a related research area in detail from a clinical perspective before developing an engineering-based solution in their group projects.

It will give students an opportunity to apply the knowledge learned in the rest of the course to current research problems, and research an area of deep interest to them. Students will be supervised by a member of academic staff from the Department or potentially elsewhere in the Faculty of Engineering, as agreed on a case-by-case basis.
Elective modules
Please note all electives modules are subject to change for the 2021-22 academic year. Students should also note that rules will apply to module selection which must be adhered to.

Advanced physiological monitoring and data analysis (elective)
The module will focus on core aspects of biological and clinical measurement.
• Data handling and fitness for purpose (statistics of measurement)
• Sampling (using microdialysis, microfluidics)
• Biopotential measurement - particularly patch clamp measurement
• Chemical measurement in cells and in vivo: sensors and biosensors and detection methods
  o Electrochemical sensors
  o Bioassays

Principles of Biomedical Imaging (elective)
This module will explain how images of the human body can be obtained using different forms of penetrating radiation. It will also provide a detailed explanation of how the imaging modalities of CT, X-ray, MR, US and optical imaging work.

Image processing (elective)
This module will provide students with a substantial introduction to digital image processing relevant to image analysis. It will also provide students with appreciation of aspects of computation in interpreting or “parsing” images, as well as introducing students to some of the biomedical, clinical and research applications of image processing and computer vision.

Medical device certification (elective)
This course is aimed at teaching key information and skills needed by professional engineers in the development of medical systems and devices; specifically in the preparation of a project for CE certification (or regulatory approval in the appropriate environment)

It has two components:
• Product Development for medical devices
• Safety, hazards and safe working practices

Orthopaedic biomechanics (elective)
The objectives of this course are to understand the basic mechanics of the musculoskeletal system. The course will cover the structure and function of the musculoskeletal tissues (bone, cartilage, muscle, tendon, ligament), the mechanics of the tissue (or tissue’s response to mechanics), diseases and injury of the tissues, and clinical treatments.

Biomimetics (elective)
Mankind has always mimicked nature. Fishing nets, airplane wings, sonar, computer viruses and artificial intelligence are just a few of a long list of examples where nature has inspired technological applications but many functional principles developed during evolution still remain to be discovered. Understanding these principles may help scientists and engineers to solve outstanding technological problems.

Biomimetics is a new interdisciplinary field that is growing quickly and seeks to explore, appreciate and make use of nature’s solutions at different organisational scales ranging from molecular to systems levels.

Advanced Physiological Monitoring and Data Analysis (elective)
The module will be an advanced level module that will focus on four core aspects of biological and clinical measurement.

1. Data handling and fitness for purposes - Normality of experimental data, types of error
2. Methods for selective and sensitive detection - Electrochemical sensors and biosensors
3. Sampling Biomolecules form the human body - Blood, Sweat, Tears, Urine, Saliva
4. Invasive chemical measurement in tissue and cells. - concentration in tissue, measurement methods, interpretation of data

Tissue engineering and regenerative medicine (elective)
This module will introduce fundamental concepts of normal tissue development, then discuss how researchers have used this information to imitate nature in a lab setting, engineering cells and tissues that may be used to model diseases, treat disease, or develop drugs.

Medical device entrepreneurship (elective)
Lecture topics will include: intellectual property, funding, regulatory issues, incubators, technology transfer, and case studies.

Bioengineering Approaches to Cancer (elective)
This module will provide students with an understanding of the fundamental biological and biophysical processes involved in cancer and the application of bioengineering to better understand and manage the disease.

Neuroscience (elective)
The aim of the course is to introduce students to the key principles and methods of neuroscience, covering multiple levels of organisation, from molecules to behaviour.

Cellular and Molecular Mechanotransduction (elective)
Topics include: Introduction to Mechanobiology; The cytoskeleton in cells; Main molecular signalling pathways involved in cell biomechanics; Subcellular structures and molecules relevant to mechanobiology; Mechanosensing, mechanotransduction, and mechanosignalling; Techniques for mechanical manipulation of cells; Mechanotransduction across different length scales; Cellular mechanotransduction; Molecular mechanotransduction; Mechanotransduction in health and disease; Biomechanics of stem cells; Biomechanics of pancreatic cancer; Biomechanics of liver cancer; Biomechanics of breast cancer.

Biomedical Instrumentation (elective)
To develop and shape the students’ ability to translate a set of bioengineering/biomedical specifications into a practical and robust instrumentation architecture.

*Note that module descriptors are only produced for the given academic year and as such changes may be made from one year to the next. The above information relates to the 2021-22 academic year.
8. Useful links

Websites

- Faculty of Medicine Intercalated BSc programme website: https://www.imperial.ac.uk/medicine/study/undergraduate/intercalated-bsc-programme/
- Department of Bioengineering website: http://www.imperial.ac.uk/bioengineering

Policies

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Other useful information and support services:

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