

Department of Chemical Engineering and Biotechnology Graduate Studies



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Welcome to the University of Cambridge Department of Chemical Engineering and Biotechnology



Chemical engineering and biotechnology have key roles to play in global issues such as the environment, sustainability, wealth creation and healthcare.

The mission of the Department of Chemical Engineering and Biotechnology (CEB) is to be world-leading in research and education in chemical engineering and biotechnology and their application to industry and healthcare. The strategic research themes for CEB are sustainable reaction engineering, product engineering and healthcare technologies. To succeed, we are committed to undertaking the highestquality, world-leading research in a vibrant, multidisciplinary environment, which shapes and defines the future direction of chemical engineering and biotechnology. A particular strength is the ability to research at the interfaces between chemical engineering and materials, chemistry, biology, physics and medicine to solve challenges facing

industry and society. The result is a unique multidisciplinary research environment where collaborations within the University and with external academic and industrial organisations flourish.

The lifeblood of CEB is its people and we strongly welcome the very best staff, students and researchers from around the world to become part of its mission. We are committed to promoting equality and diversity. Indeed, the diversity in the Department is a strength that facilitates the sharing of ideas and attracts international collaboration as we seek innovative solutions to global challenges in improving the quality of life, health and the environment.

We encourage exceptional and highly-motivated graduates from all corners of the world to consider our range of engaging and stimulating study opportunities. Our innovative research, underpinned by a dynamic enterprise culture, spans the wide range of disciplines embodied by modern chemical engineering and biotechnology. Our commitment is to apply research for the benefit of society. We would like you to be part of our success in achieving this.

Professor John Dennis Head of Department

Why study at CEB?

It is an exciting time to develop a career in chemical engineering and/or biotechnology and to apply your knowledge and skills to address the global problems faced by society today. Graduate study may lead to careers in areas as diverse as the control of carbon dioxide emissions to the development of new devices which seek to mimic biological organs and, as with many of our alumni, to leadership roles in academia and business across the globe.

The Department offers a unique environment in which to undertake postgraduate study. Students join a vibrant research community staffed by worldleading interdisciplinary research scientists, many of whom have strong business skills as well as a keen interest in the education of the next generation of researchers and innovators. CEB is a relatively large department housed in a new purpose-built building in West Cambridge. It is comprised of some 50 postdoctoral researchers and close to 200 postgraduate students. Individuals of almost 50 different nationalities bring a global perspective and diverse expertise, thus contributing to our world-class research output and reputation for academic excellence. Students enjoy close interactions with staff and fellow students and within and between research groups.

Research within the department is focused on key themes: Healthcare, Processes, Materials, Metrology, Modelling, Sustainability and Innovation. Research groups working in these specific research areas are listed on page 6. In the last UK Research Excellence Framework (REF 2014), 47% of the department's research activity was rated as world-leading (grade 4*) and 45% was rated as internationally excellent (grade 3*), placing CEB as the top ranked department in the country. Academic research undertaken here typically involves collaboration with other leading international universities and strong connections with industry. Research costs are supported in part by Government Research Councils and by a variety of industrial partners and multinational companies that invest in shared research interests and the application of emerging technologies.

The Department is widely acknowledged for its entrepreneurial achievements and the successful integration of multidisciplinary research, commercial exploitation and management training. CEB spin-off companies have brought a range of patented products to market, including a functional food, next generation glucose sensors, novel therapies for the treatment of cancer and the diagnosis of disease as well as recycling and environmental technology solutions.



Study options

Students are invited to apply for any research or taught postgraduate degree programmes at CEB. We offer three-year research-based programmes leading to the award of **PhD in Chemical Engineering or Biotechnology.** We also offer a one-year research-based course leading to the **MPhil in Chemical**

Engineering and Biotechnology; sometimes this may count towards the entry requirements for a PhD programme.

We offer three MPhil degrees containing taught components: the **MPhil in Advanced Chemical Engineering (ACE),** which includes a research component, and the **MPhil in Bioscience Enterprise (MBE).** Both are professional practice courses that provide training in business and management as well as science and technology.

The MPhil in Biotechnology is a new course starting in 2018.

The Department houses the EPSRC Centre for Doctoral Training (CDT) in Sensor Technologies and Applications. Students take a one-year taught course leading to the **MRes in Sensor Technologies and Applications** qualification, after which they go on to a three-year PhD research degree either in the Department or in another Department in Cambridge.

The University of Cambridge Graduate Admissions Office gives a full description of each of the courses, the entry requirements and funding opportunities on http://www.graduate.study.cam.ac.uk/ Please note that all of our courses are full time. Participants must demonstrate a fluent command of the English language.

	Degree options	Description	Entry requirements	Duration
	MPhil Chemical Engineering and Biotechnology	Conduct fundamental and/or applied research in chemical engineering, chemical or biological science specialising in one of our declared research themes of Biotechnology, Measurement, Microstructure Engineering, Modelling and Processes.	A 1st class or high 2.1 honours degree in a relevant subject. Chemical Engineering, Biological, Physical or Life Science backgrounds are encouraged.	October – August
Research studies	PhD Chemical Engineering or Biotechnology	Conduct fundamental and/or applied research in Chemical Engineering, Chemical or Biological Science spanning across our declared research themes of Biotechnology, Measurement, Microstructure Engineering, Modelling and Processes. www.ceb.cam.ac.uk/phd	A 1st class or high 2.1 honours first degree or equivalent in a relevant subject. Chemical engineering, Biological, Physical or Life Science backgrounds are encouraged.	Three years Start in October, January or April
	MPhil in Advanced Chemical Engineering	Advanced Chemical Engineering with essential aspects of business administration. A five-month research project (not a taught element) complements the programme. www.ceb.cam.ac.uk/mphil	A 1st class or high 2.1 honours degree in Chemical Engineering or close equivalent.	October - August
Taught courses	MPhil in Bioscience Enterprise	Biotechnology and business professional practice course. Teaching covers the latest advances in biological and medical science, together with management, the ethical, legal and regulatory issues associated with bringing scientific advances to market. www.ceb.cam.ac.uk/mbe	A 1st class or 2.1 honours degree in Life or Physical Sciences, Medicine, Law, Economics or allied disciplines.	October - June
	MPhil in Biotech	 A full-time one year course in Biotechnology leading to the degree of Master of Philosophy. two compulsory elements, 'Principles of Biotechnology' and a practical component. Both of these elements will be assessed by coursework; six optional modules to be selected (examination by essay or coursework, or a combination of these). Two research projects, each assessed by a report of no more than 7,000 words and a presentation. www.ceb.cam.ac.uk/mphilbio 	Requirements Applicants should hold a 1st or a good upper 2nd class honours degree or equivalent. The course is currently aimed primarily at those who have a background in physical science or technology (such as Engineering disciplines, Physics, Mathematics or Computer Science).	Duration: October- June
Taught and Research	EPSRC Centre for Doctoral Training in Sensor Technologies and Applications Taught course and research studies MRes- PhD	Interdisciplinary one year MRes in sensor technologies and applications followed by three year PhD project in participating departments across Cambridge University. A programme of taught modules, individual and team research projects, research skills and entrepreneurship prepares students optimally for PhD research and professional leadership. www.cdt.sensors.cam.ac.uk	A 1st class or 2.1 honours degree in Life or equivalent in the natural sciences, engineering disciplines, computer science or medicine.	Four years Start in October

PhD Programmes and Research





Research Activities

'CEB' is one of the UK's leading research departments, ranking highly in both national and international University league tables. The department's research strategy responds to the global drive for 'sustainability', addressing the need for novel chemical engineering and biotechnology processes and materials.

Broadly, our work can be categorised in the following specialisms: **Healthcare, Processes, Materials, Metrology, Modelling and**

Innovation. Whilst we are committed to working at the interfaces of the underpinning science disciplines of engineering, chemistry, biology and physics, cross-collaborations between research groups working on sustainable processes, and the healthcare and materials development agendas are strongly encouraged. These interdisciplinary research activities are structured to provide novel solutions to the serious technical and economic challenges which affect most aspects of modern living.

The department is well-placed as a world leader within the wider strategic sustainability area, and our scientists engage with and make significant contributions to the University's initiatives on energy, food and healthcare, and collaborate actively with many external academic and industrial organisations. Working effectively with industry is a core strength of the department's teaching and research, as is progressing novel technologies through spinout companies and licensing agreements to ultimate launch of marketed products.

The pursuit of excellent research and the fulfilment of our responsibilities to participants in research, research users and the wider community require the maintenance of the highest standards of integrity. See the University's central research integrity website www.researchintegrity.admin.cam.ac.uk/ for more information.

CEB Research Impact

The Department of Chemical Engineering and Biotechnology (CEB) is committed to pursuing fundamental research of the highest quality, and is also a fertile ground for generating economic and societal impact from that research. The beneficiaries of such impact span the full value chain through industrial collaboration, clinical relationships and spin-offs/start-ups, supported by engagement and media activities to achieve scientific, health and engineering advances. Graduate students are actively encouraged to look for opportunities to exploit their research, and to publicise their work to a wider audience.

Research may impact new or existing processes or result in new products, so that impact may be driven through: 1) entrepreneurship, leading to spin-outs, also extending to social entrepreneurship, and including clinical outcomes; 2) industrial collaboration which recognises that by *improving* processes, existing companies may become more competitive, so innovative scientific solutions to critical problems are value-adding.

Industrial Collaboration



It has been historical strength in CEB, with on-going relationships and funding (eg Schlumberger Gould Research, ExxonMobil, BP,

BorgWarner, CEPSA, ENI, INEOS, SINTEF, LE/LINDE, Topsoe, Nestec, Pharrnas, DuPont) indicators of successful partnerships. Some highlights are: MEL Chemicals who are marketing CO2 adsorbents; elucidation of colloid stabilisation mechanisms in engine oils, enabling improved product manufacturing, being patented and developed by Infineum; die-flow characterisation methods for tungsten carbide pastes reducing testing times to one day for Ceratizit Austria GmbH, and supporting die design *in silico*. In some cases collaboration is coordinated through a third party: we are working with PCI (Guildford), a consultancy undertaking technical and economic work for the polyesters industry, to look at environmental impact of sourcing ethylene from Brazilian ethanol, rather than from petrochemicals. This is important in the context of "green" PET bottles.

CEB benefits from the wider University, supporting exploitation through top class advisory, legal and financial support services within the University's Research, Technology Transfer and Corporate Liaison offices. Incentives are enhanced by generous IP returns for staff, and particularly students. More than 50 patents have been filed through Cambridge Enterprise (CE) since 2008. There are around 15 companies from CEB in the CE Equity Portfolio, with several others outside this, eq CMCL, Metrica.Bio, Agamatrix, Smart PM, BioBullets. Collectively, these companies have raised substantial City, Angel and VC funding and employ >600 people. With the exception of Prometic (market capitalisation ~\$400M) they remain privately owned and through these enterprises CEB continues to make on-going impact. AgaMatrix

started as an entrepreneurial venture in metrology in healthcare that has matured beyond an SME to have a multinational operation; Psynova is another example of entrepreneurship at the clinical interface and has been acquired by a multinational (now Myriad RBM). Psynova won the Medical Futures Innovation Award and was named top bioscience spin-out, Europe (2011). Enval was voted one of Europe's up and coming cleantech companies, shortlisted for the Environment and Energy Awards (2011), also winning Best New Technology prize at the National Recycling Awards and European ACES prize in the Materials/Chemistry category 2011.

Social Entrepreneurship aligns well with CEB sustainability agenda, with a number of emerging case studies. Eq. a novel manufacturing process for vaccine formulation and drug production based on natural product extraction in the Third World. The US Agency for International Development has nominated a grant through its 'Saving Lives at Birth' programme, to develop an innovative nipple guard for nursing mothers in HIV endemic regions and a novel heart valve design is being developed with a consultant heart valve surgeon at Papworth Hospital. Psynova is the 'youngest' addition to CEB's diagnostics legacy, with a test for Schizophrenia. Similar examples exist focussing on energy and the environment: eg Microwave Induced Pyrolysis, to process 2,000 tonnes of waste p.a. is driving up recycling rates through separation and recovery of high-value chemicals present in wastes (Enval). Other sustainable process solutions further exemplifying CEB's core skills are in the pipeline and effort will be invested in their maturation: eq, a software tool (SmartPM), optimally scheduling cleaning of heat exchangers in crude oil preheat trains, permits fouling mitigation; it is now under test by oil companies. CMCL, a business spin-out from CEB in 2008, is also now beginning to provide a conduit for impact with engineering software and technical solutions to automotive, materials, chemical and energy industries. Software has been exported to USA, Germany, Austria, Japan, Turkey and India.

The Department offers a one-year MPhil by research degree, which is formally known as the "MPhil in Chemical Engineering and Biotechnology".

The MPhil is a research degree, and the qualification may count towards the entrance requirements for Ph.D. study. Applicants may commence their MPhil studies with the intention of later applying to pursue the higher degree or may just come for an MPhil. Students progress their research projects under academic supervision for one year, and at the conclusion of their studies are examined by thesis and oral examination. Prospective students are invited to consider their research interests in the light of the specialisms of our senior academics and the department's on-going research activities.

Qualifications

Applicants will normally have studied chemical engineering, biological science, engineering, chemistry, applied mathematics, physics or a related subject at undergraduate level and have achieved the minimum of a high Upper Second Class Honours degree or equivalent international qualification.

Applications

Before making a formal application for this course, please consult the list below of groups that are able to take on 1-year research students; other academics/groups that are not listed will not accept applications for our MPhil in Chemical Engineering and Biotechnology course.

Information

The University Graduate Prospectus provides comprehensive information about the course, the admissions process, application deadlines, tuition fees and other costs. Occasionally studentships may be available for highly qualified applicants, covering tuition fees and where eligible also maintenance costs.

See a list of Chemical Engineering and Biotechnology Research Groups in the Department on www.ceb.cam.ac.uk/research/groups

See information on www.graduate.study.cam.ac.uk





MPhil in Chemical Engineering and Biotechnology



Liwei Cao I completed my BSc degree in Chemical engineering and Biotechnology at Tsinghua

University, China, and started the MPhil research in the Department in Cambridge in October 2015. As a member of the Sustainable Reaction Engineering group, I'm working on computational screening of palladium catalysed C-H bond activation reaction under Professor Alexei Lapkin's supervision. In this project, we aim to overcome the challenge of computational analysis of the feasibility of predicted novel transformation.

Over the course of this year as an MPhil research student, not only my research skills have been improved, but also my understanding of chemical engineering industry thanks to the several opportunities CEB has provided like the lunchtime career talks given by alumni in industry and the seminars given by well-known professors all over the world. I particularly enjoy the daily interactions with researchers using similar principle and tools in vastly different scenarios which is a constant source of stimulation and inspiration.

I have received a great amount of help and support with my research project both from my supervisor as well as the group members. The constructive feedback given has been extremely valuable and discussions truly productive, enabling me to get over the challenges and complete the work.

Overall, I have greatly enjoyed it so far, so much so that I have now applied for a PhD studentship in the department in order to continue this fantastic experience and carry on working on this interesting research project.

Amanda Chen



I graduated summa cum laude with a B.S. in Biomedical Engineering from the University of Rochester (Rochester, NY, USA) in Spring

2014 and enrolled in the MPhil in Chemical Engineering and Biotechnology course in Fall 2014. As a member of the BioScience Engineering Group, I worked on the development and characterisation of adjuvanted liposome vaccines under the supervision of Professor Nigel Slater and in collaboration with industry partners, Zoetis, Inc. My work was funded by the International of Institute Education (Whitaker Fellowship) and Phi Beta Kappa. We had previously demonstrated that certain combinations of lipids within a liposome formulation enable the highly effective delivery of liposome vaccines to cells. However, such formulations have to date only been prepared at laboratory scale and methods are required whereby they can be manufactured in sufficient quantities for clinical trials and eventual marketing. Such methods must enable the formulation of liposome vaccines with the active pharmaceutical ingredient/antigen in high yield, due to the high cost of both the active ingredient and the lipids involved in the formulation, and result in a thermally stable formulation in which liposomes undergo negligible agglomeration and degradation. Thus, the efforts in this project were focused primarily on the identification of improved liposome manufacturing methods, which were validated in large animal models. Throughout the course of my MPhil research year, I benefited greatly from the academic freedom granted by independent research. Additionally, my project gave me the invaluable experience of managing international collaborations across academia and industry. Following the completion of my degree, I started my PhD studies in the department of Biological Engineering at the Massachusetts Institute of Technology (Cambridge, MA, USA).







Course Overview

This unparalleled one-year, fulltime

taught Master's programme is for those seeking the advanced skills required by companies in which rapid change and interdisciplinary working is now standard practice. The MPhil ACE starts in the autumn of each year. The course is unique because: • Candidates receive an

education

both in advanced aspects of Chemical Engineering and in essential areas of business administration, such as technology policy, company formation, finance and management, global economics and sustainable development;

- There are opportunities to develop
- professional problem-solving skills;

and

• It offers conventional research experience at a leading academic institution.

Content

Students combine advanced chemical engineering studies with

essential aspects of business administration. A wide range of science-based elective courses is also available. A five-month research

project complements the programme.

Michaelmas and Lent Terms

Students take two advanced chemical engineering modules and

eight other modules from a list of core chemical engineering and engineering/business subjects. The taught material enhances basic knowledge on chemical engineering fundamentals, as well as offering experience of

other science and business based disciplines. The modules are assessed by both examination and written coursework.

March – August

During this period, students undertake a full-time research project within the department. The research may include industrial collaboration. The project is assessed by seminar and dissertation.

Programme Objectives

The programme sets ambitious educational objectives for its students, including the development of:

• An advanced understanding of fundamental areas of chemical engineering;

• An understanding of essential areas of business administration, e.g. finance and management, technology policy, company formation and structure, global economics and sustainable development;

• Technical problem solving skills, including time management, teamwork and leadership abilities, whilst interacting with colleagues in order to obtain information effectively and define optimal outcomes and solutions; and

• The ability to define, organise and undertake a research project, with possible extensive industrial collaboration, within a specified period of time and to present it as a dissertation and seminar.

Compulsory modules

Numerical Methods Data Analysis

Core Chemical Engineering

Advanced Transport Processes Pharmaceutical Engineering Rheology and Processing Computational Fluid Dynamics

Fluid Mechanics and the Environment Interface Engineering Optical Microscopy Optimisation Healthcare Biotechnology Bionanotechnology Biophysics

Engineering/Business modules Contaminated Land and

Waste Containment

Sustainable Development Nuclear Power Engineering Present and Future Energy Systems

Biosensors

Biomimetics

Entrepreneurship

Business Innovation in a Digital Age

Management of Technology Strategic Management International Business

Please note the modules may change from year to year.

Teaching and Learning Methods

Students participate in lectures, small group teaching (supervisions), tutor-led seminars and demonstrations, technical projects, case studies and research projects.

Assessment

The assessment of taught modules involves a combination of some or all of the following:

Coursework – individual or group

- Class participation
- Written examination
- Presentations individual or group

To gain the MPhil degree, students are expected to pass satisfactorily both main elements of the course, namely:

- Formal taught modules
- Research project

Entry Requirements

The MPhil cohort is made up primarily of students with a good first class honours degree in Chemical Engineering. The extent of the course requires students who are very highly motivated, innovative, able to work efficiently both on their own and in a team and who have high levels of perseverance. Applicants need to demonstrate a high level of commitment and

"The M.Phil in ACE programme istailored to provide students with advanced and durable skills that will enable them to cope with the demands faced by chemical engineers. We expect ACE studenst to be very committed, highly motivated and to manage their time effectively in order to deliver top quality materials."

Dr Sarah Rough Programme Manager Sir1002@cam.ac.uk





Course Overview

The MPhil in Bioscience Enterprise (MBE) programme is a taught science, technology and business course intended for those who have the ambition to found technology companies or take up leadership, executive, or consultancy roles in the life science sector.

All students follow the same syllabus during the first two terms of this intensive nine-month professional-practice programme. Teaching covers the commercial exploitation of the latest advances in biotechnology together with the business and management skills associated with bringing scientific opportunities to market. There is particular emphasis on entrepreneurship and understanding how companies are created, funded, and developed. Learning is based on real business scenarios, and lectures and case studies are frequently delivered by senior company executives. Science syllabus: Small molecule biopharmaceutical drug development; medical devices, diagnostics; agribiotech.

Business syllabus: Product and company valuation; partnerships and alliances; healthcare economics; finance; regulatory affairs; technology and innovation management; 'I have thoroughly enjoyed my Cambridge experience in the past year. The MBE programme provided me with discipline-specific knowledge, transferable business and management skills and a comprehensive understanding of the global healthcare industry. The professional network I developed through this programme will continue to benefit my career pursuits in the future.'

Celine Zeng, MBE student

marketing; strategy; intellectual property and corporate law.

Students have numerous opportunities to apply their skills and the principles learned, for example, when working in teams on a consulting project and in developing a plan for a concept company. During the third term students are engaged on an internship with a life science company where they are responsible for a defined business project and



collect data and analyse it as the basis of a dissertation.

The MBE course offers participants an unparalleled educational experience with access to leading scientists, entrepreneurs, and academics and the life science business network. The department is unique in its practical and successful approach to bio-entrepreneurship and is widely acclaimed for the excellence of its science and business graduates.

Assessment

Whilst there are no formal examinations, attainment is assessed throughout the course with emphasis on learning through problem-solving and teamwork in the research, preparation and delivery of presentations and project reports. Written submissions include science and technology papers, various short reports and critical appraisals, a client briefing paper and a dissertation. Students are encouraged to participate in extracurricular enterprise activities including regional and national business competitions and are required to submit a business plan as one of the course assignments.

International Perspective

Students are encouraged to gain an international perspective of the life sciences business sector in recent years and have planned visits to Boston in the USA, Basle Switzerland and Shanghai in China amongst other destinations have been planned and led by the students in recent years. The costs associated with optional overseas extracurricular activities and miscellaneous expenses incurred in the UK are not included in the course fees.

Entry Requirements

Applicants usually have a background in the biological, medical, or physical sciences or have experience in the financial or legal sectors. A strong interest in pursuing a business career in the life sciences, and a fluent command of English are essential. A higher degree or postgraduate experience in an academic or business environment is highly advantageous.

For further information please visit the website or contact the course administrator:

Tel: +44 (0)1223 766337 Email: biosci@ceb.cam.ac.uk Website: www.ceb.cam.ac.uk/mbe



MPhil in Biotechnology

Overview



The M.Phil. in Biotechnology is a full-time course based in the Department of Chemical Engineering and Biotechnology. Other Departments within the University contribute by teaching some of the modules and hosting research projects.

The programme aims to:

- Provide students with advanced technical knowledge of biotechnology;
- Provide students with practical skills in biotechnology;
- Provide training in research in biotechnology;
- Produce graduates with a fundamental understanding of biotechnology who will go on to be leaders in the biotechnology industrial sector.

Learning Outcomes

Successful students should be able to:

- Demonstrate an advanced technical knowledge of biotechnology;
- Show proficiency in biotechnology practical work;
- Show awareness of modern bioanalytical

techniques and their limitations;

• Undertake a research project which requires an understanding of techniques and published literature, originality in the application of

knowledge, and some degree of self-direction.

- Communicate by writing formal reports and by giving oral presentations;
- Manage tasks and work to deadlines.

Teaching Methods

Students will be taught through lectures, small group teaching, training workshops, practical classes (both laboratory and computational) and research projects (both as an individual and as part of a team).

Students will be based in the Department of Chemical Engineering and Biotechnology, but attend some programmes in other parts of the University.

There is an annual intake of around 10 students selected through a highly competitive application process.

A summary of the proposed 2018-19 course is found below (subject to change). Full synopses will be published later in the year.

Programme Structure

The programme contains the following elements.

1. Compulsory taught class

A course on "principles of biotechnology" (32 lectures) will be taught in Michaelmas term. It will include lectures on cell biology, synthetic biology, systems biology, and bioanalytical techniques. This course will count as two modules.

2. Compulsory practical class

A compulsory laboratory course on fundamental techniques in biotechnology will be taught in Michaelmas term. It is planned that this includes computer-based cloning experiments (6 hours), wet-laboratory experiments (10 hours), and practical demonstration sessions ($12 \times 2\frac{1}{2}$ hours).

The practical demonstration sessions will expose students to advanced biotechnology techniques such as liquid-phase chromatography, cell transfection with fluorescent proteins, AFM, mass spectrometry, NMR, optical microscopy.

3. Optional modules

Students will select six modules from a list chosen from new and existing MEng and MPhil courses within the Department and University. The following is a possible list of optional modules:

- Bionanotechnology (CEB)
- Biophysics (CEB)
- Healthcare biotechnology (CEB)
- Optical microscopy (CEB)
- Biosensors (CEB/CUED)
- Biomimetics (CUED)
- Molecular modelling (CUED)
- Cellular & molecular biomechanics (CUED)

- Systems biology (DAMTP)
- Synthetic and executable biology (Biochemistry)

The list of available modules will be published by Notice in the Reporter in the Easter Term preceding the course.

4. Research components

The following is a list of the research components of the course.

- Individual Research Project (January-May). These projects will be hosted within one of the participating departments.
- Team Research Project (June-August). This project involves the whole cohort undertaking a research project set by an industrial company.

5. Skills components

There will be a series of compulsory workshops on transferable skills and on research skills.

Participating Departments:

CEB along with support from Engineering, Biochemistry, Applied Mathematics and Plant Sciences.

Industrial Partners:

Medimmune, Synthace, Astra Zeneca and INVISTA.

"The MPhil programme in Biotechnology is a new exciting opportunity in which worldleading scientists are brought together to deliver a one-year MPhil degree, which combines an in-depth multidisciplinary scientific programme", Dr Gabi Kaminski MPhil Director

For further information please visit

www.ceb.cam.ac.uk//mphilbio or email Dr Gabriele Kaminski Schierle on gsk20@cam.ac.uk



EPSRC Centre for Doctoral Training in Sensor Technologies and Applications (CDT)

Course Overview

The Sensor CDT is a four year MRes + PhD programme which aims to provide an interdisciplinary, research focused, training programme to those aspiring to become leaders in the field of sensor innovation. The interdisciplinary nature of the MRes year allows students to advance and expand their knowledge base, and to explore new interests in adjacent scientific and engineering disciplines. A holistic approach guides the course from the physical concepts of sensing, to the interpretation and

management of sensory data, through to the development of applications, preparing the students optimally for their PhD research.

After passing the MRes course students continue towards a three year PhD project in a sensing related area. The PhD projects are interdisciplinary in nature, with supervisors from two different departments or research areas. Some PhD projects are carried out in collaboration with industry. Students are encouraged to develop their own PhD projects together with their supervisors.

Each year about 10-15 students are admitted to the course which has a strong emphasis on team-driven research and peer-to-peer learning. The student cohorts are supported by a mix of academic and industrial mentors, with the development of research, team-building and leadership skills being at the heart of the programme. The Sensor CDT is supported by world leading expertise and infrastructure from 20 participating departments across the University, and from a consortium of leading sensor industries, ranging from SMEs to global corporations.

Content

Year 1 MRes

The MRes year consists of an intensive programme of taught modules and research projects covering a large area of sensor technologies and applications, including optical sensors, bio-chemical sensors, microscopy and image analysis, sensor networks, medical applications, civil infrastructure and environmental monitoring. A series of laboratory practicals exposes the students to the research facilities and people across the University. Activities around project management, scientific writing and entrepreneurship provide valuable skills for a successful PhD project. Students typically decide on their interdisciplinary PhD project by the middle of the MRes year – after having sampled the opportunities Cambridge University has to offer in the area of sensing. Taught components:

• "Principles of Sensing" foundations course, delivered by experts from different fields in sensor technologies and applications across Cambridge University.

• Laboratory practicals.

• Four elective modules, providing specialised sensor related knowledge from subject areas such as engineering, physics, biology, chemistry, biochemistry, computer science, materials and medicine.

• The exact modules offered are subject to change. Module choices will take into account students' backgrounds and interests.

• Entrepreneurship: a business skills course, run by the Judge Business School, focused on developing a technology idea into an enterprise venture.

Research components:

• Guided Sensor Design Project: a technical project to design a sensor from concept to working device, carried out individually and in small groups.

CDT Sensors Technology and Applications



"The Sensor CDT programme has provided a unique opportunity to explore and indulge in cutting edge research, while being surrounded by bright, like-minded people and with experts in my fields of interest within effortless reach. The skills and experience gained so far are key for pursuing a successful PhD and future career." Farah Alimagham

• Mini-Research Project: an individual 2.5 months research project, spanning two departments or in collaboration with industry.

• Sensor Team Challenge: an industrially motivated 3 months research challenge that the entire cohort works on collectively, supported by mentors from industry and academia.

Research skills, outreach and industry links:

• Workshops and seminars on transferable skills such as project management, scientific writing and communication, programming and error analysis.

• Talks by speakers from industry, providing a commercial and industrial perspective on sensing.

• Showcasing MRes and PhD projects at Cambridge Science Festival or the Sensor CDT Sensors Day conference.

• Teaching sensor related topics to other researchers, students or the general public.

Years 2-4 PhD

After successfully passing the MRes course and being accepted onto their PhD project students conduct research in a sensing related area under the supervision of a primary supervisor associated with the Sensor CDT. Students will be registered in the Department of their primary supervisor. The project is interdisciplinary in nature, with a second supervisor coming from a different University department or industry. Sensor CDT students are in a position to develop their own tailored PhD project based on their knowledge and contacts acquired during the MRes course.

Throughout the PhD project Sensor CDT students are supported through cohort events such as research workshops and conferences as well as skills sessions and networking meetings.

Assessment

Assessment of the MRes taught modules is a combination of reports, presentations, coursework and exams, depending on the choice of options. The MRes research components are assessed by a combination of written reports and presentations. Progression from MRes to PhD requires students to pass the MRes course, successfully defend their PhD project proposal and be accepted by their PhD supervisor. The PhD project is assessed through a PhD thesis and viva.

Entry Requirements

Applicants should hold a first or upper second class honours degree or equivalent in the natural sciences (e.g. biology, chemistry, physics); engineering disciplines (e.g. electrical, mechanical); computer science or medicine. An innovative approach to problem solving and well developed technical skills are essential. You should possess an openness to learning new skills which might lie outside the field of your undergraduate degree and a willingness to work in a cross-disciplinary research setting.

For further information please visit the website or contact:

Dr Oliver Hadeler, Programme Manager admin@sensors.cam.ac.uk www.cdt.sensors.cam.ac.uk

Graduate Student Experiences

Fergus Richie Sensors CDT



I'm Fergus, a student in the 2015 cohort of the Sensor CDT, specialising in the measurement and analysis of cellular biomechanics. I started out doing the engineering degree here in Cambridge,

which gave me a lot of flexibility in how I progressed through the course. In much the same way, the Sensor CDT encouraged me to explore the range of options in my specialism before I wrote my PhD proposal, which has meant that I've got a much clearer picture of what I'll be doing next year than I otherwise might have had.

The course is a mixture of modules from departments within the university, which helped in bring me up to speed on topics that had previously escaped my attention, and projects organised within the Sensor CDT, which focussed on the practical applications of the theory to the construction of sensors in the real world. This experience has been invaluable, and the structure of the course has allowed me to learn skills that I would never have had the opportunity to learn otherwise.

My PhD will focus on measuring the material properties of living tissue, where I'll be able to use all the skills and experience I've gained this year to contribute to our understanding of the structures and dynamics that make up multicellular organisms.

Aazraa Oumayyah Pankan

PhD student in the Electrochemical and Micro Engineering Group



I am a final year PhD student in the Electrochemical and Micro Engineering Group, working with Dr Adrian Fisher. My research is in the bioenergy area, focusing on electricity production using photobioelectrochemical systems, with photosynthetic microorganisms acting as biocatalysts. One part of the project involves developing novel anode materials for biophotovoltaic platforms, while the other part includes improving biohydrogen production for use in a photo-microbial fuel cell. My PhD is supported by the Cambridge Trust.

My experience at CEB has been an enriching one, professionally as well as personally. You have the opportunity of being in the driving seat of your research, which helps develop a panoply of skills, as you have to oversee so many aspects of a project. The structure of the Department allows easy interactions with other researchers and sharing of facilities, which helps establish collaborations. CEB staff are extremely friendly and helpful; they play a major part in making the research go smoothly.

I was lucky to meet people at CEB who have become my close set of friends, which makes the experience much more enjoyable. The tearoom is a key social space, where we catch up on each other's activities.

Santiago Lago Biotechnology PhD



I completed my undergraduate degree in Neuroscience at the University of Edinburgh, specialising in the genetics of Bipolar Disorder, and have a Master's degree in Biotechnology and

Biomedicine from the University of Malaga Prior to starting my PhD, I worked for five years as a research assistant in the biotech industry at Novasite Pharmaceuticals in San Diego and Vivia Biotech in Madrid. I focused on the development of novel screening assays for drug discovery, personalised medicine and toxicity prediction in disease indications including haematological cancers, diabetes and obesity.

My motivation for initiating a PhD was the desire to apply my previous experience in the biotech industry in an attempt to provide new solutions for the treatment of neuropsychiatric disorders. The Bahn research group are world leaders in the field of biomarkers for neuropsychiatric disorders, and are credited with having developed the first bloodbased diagnostic test for schizophrenia. We are currently developing a novel platform for high throughput functional exploration of patient cells *ex-viv*o for biomarker and drug target discovery and have plans to commercialise our findings.

Jelena Renić MPhil Chemical Engineering (ACE)



Originally from Croatia, I completed the BSc in Chemical Engineering at Villanova University in the US. I started the MPhil ACE in October 2013 and have greatly enjoyed it so far.

My future plans include working in industry for some period of time before pursuing a PhD and thus this course is ideal for me. MPhil ACE provides a unique mixture of technical and business/management modules alongside a research project. The core and elective modules cover a wide variety of topics, from biopharmaceuticals to nanotechnology, so students can choose what they find most interesting.

I am particularly enjoying rheology, which was initially daunting, but the lecturers are extremely passionate and are able to keep the students engaged. Overall I find the academic staff easily approachable and very helpful. I am excited to soon start my research project with one of them.

However, the aspect of this course that I enjoy the most is the chance to interact with my amazing fellow students. The MPhil is a small group of diverse students who completed their previous degrees in different parts of the world. Some are planning to pursue a PhD in chemical engineering while others are applying for a job with consultancy companies. Our next challenge is a team consultancy project, which will definitely be an enjoyable experience with such a brilliant group of people.

Fergus Kennedy MPhil in Bioscience Enterprise (MBE)



I joined the MPhil Bioscience Enterprise immediately after graduating from my first degree in Biology at the University of Oxford. Whilst at Oxford I had become deeply involved in the

biotechnology and entrepreneurship, winning the national Telegraph STEM Awards healthcare category with my own solution to improve rural vaccination rates in low resource settings. This experience gave me aspirations to leave the laboratory, and follow a career into business innovation where I could satisfy my broad scientific curiosity and create new solutions to global healthcare problems.

The MPhil Bioscience Enterprise has served as my bridge from life sciences academia to business. I have most enjoyed the opportunities to work alongside real companies with exciting science, such as helping Cambridge-based Owlstone Medical understand the Chinese market for their remarkable technology which detects lung cancer from breath, and developing my own strategy for global biotech MedImmune to use their existing drugs to treat rare diseases.

In addition to developing practical skills in finance, law, regulation and product development, I have most enjoyed the incredible variety of entrepreneurial opportunities available to me through societies and workshops with industry leaders. This includes developing my own projects, co-founding the digital diagnostic start-up OpFix after winning entrepreneurship competitions in Cambridge.

Central to the MBE experience is the fantastic diversity of the students. My class of 26 included over twelve nationalities, comprised of consultants, scientists, venture capitalists, bankers and lawyers all at different stages of their careers. Not only did this diversity create an amazing mix of ideas, but developed into a truly global network that will help my personal and professional development for years to come.

How to Apply







How to Apply

In order to study for a graduate course in Chemical Engineering or Biotechnology at the University of Cambridge you must formally apply to Graduate Admissions. More information about the application process is available from Graduate Admissions website: www.admin.cam.ac.uk/offices/ gradstud

The Colleges

Graduate students at Cambridge are members of the University and also members of a College. The collegiate system creates an environment in which you will meet people from other disciplines and participate in a wide variety of cultural, sporting and social activities.

Colleges provide accommodation, meals and other amenities. Facilities vary but typically include student common rooms, libraries, laundry and computing facilities. Sports facilities such as rowing, rugby, football, cricket, athletics, squash, tennis and badminton are usually available.

Each student is assigned a graduate tutor who is responsible for their welfare and in addition supports all manner of graduate activities and interactions between students and college fellows.

Funding

The costs of tuition, College fees and maintenance, and advice on applying for scholarships and bursaries are given in the Graduate Admissions section of the University website: www.admin.cam.ac.uk/students/ gradadmissions/prospec/studying/ funding

Prospective students may be eligible to apply for funding from the UK Research Councils, Cambridge Trusts, Gates Cambridge Trusts and various other charitable organisations. In all cases the scholarship are highly competitive and the awards are usually subject to eligibility restrictions, on the basis of academic qualifications or nationality. The deadlines for making applications for financial support are often set many months in advance of the start of the course. Students are advised to check these details as soon as they decide to make an application.

Students may also support their studies through personal savings, family contributions and loans. The Carpe Diem Enterprise Trust has made available a limited number of tuition bursaries for the MPhil in Bioscience Enterprise programme, application for which is made through the department.

Please note that there are very few funding opportunities open to students who have already started their course. However, colleges may invite their graduates to apply for funds for travel, conferences, research abroad, child care or computing expenses and in cases of hardship. Please check individual college websites for detailed information.

Careers

In 2015 The Careers Office reported that the unemployment rate for our first-degree students has been the

lowest seen for ten years at 2.6%.

The University Careers Service provides resources information about vacancies and arranges specialist workshops and events. They can help you research the right opportunities and provide you with information about applications and interviews. For more details visit www.careers.cam.ac.uk

You can also download the latest Careers Guide from www.careers.cam.ac.uk/guide.asp

Equality and Diversity

The University's diversity plays a key role in sustaining its academic excellence. It is fully committed to equality of opportunity, promotes an inclusive culture and values diversity. Talented applicants from any country and of any race, religion or group are encouraged to apply. Admission is determined only by performance and personal merit. More information on www.equality.admin.cam.ac.uk

Student Welfare

Advice and support for students and their dependents in Cambridge are available through the Department, Graduate Union and University Counselling Service.

University of Cambridge and Environs

Cambridge is a great place to be a student. If you have an image of Cambridge, it is probably one of ancient buildings, immaculate green lawns and people punting down a willow-fringed river. This is an accurate image - the city is stunningly beautiful and small enough to retain its community

atmosphere.

Bustling streets, theatres, cinemas, cafes and restaurants, Cambridge also has a thriving central market and a good range of shops. Green spaces and parks with cows grazing on the meadows are a feature of the city. The countryside is nearby with pleasant walking and cycle routes from the city centre to villages such as Coton and Madingley. Further afield, visit Ely to see the magnificent cathedral and absorb the unique and mysterious atmosphere of the Fens.

In addition, Cambridge is Europe's largest technology cluster. Around 57,000 people are employed by the more than 1,500 technologybased firms in the area, which have combined annual revenue of over £13 billion. The University is a major employer, technology provider, and a source of knowledge and skills in the region.

Cambridge has good road and rail connections to the rest of the UK, and London is only 50 minutes away by train. The city is also within easy reach of all London's international airports, and there is a direct 30 minute rail link to London Stansted Airport.

Information about the city and cultural events is available on the official tourism website www.visitcambridge.org

For the student perspective about studying in Cambridge visit the Graduate Union website www.gradunion.cam.ac.uk





CEB Teaching Consortium of Companies



For more information on the CEB Teaching Consortium visit www.ceb.cam.ac.uk/undergraduates/teaching-consortium

CDT Sponsors







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CEB Focus

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