Department of Life Sciences
Faculty of Natural Sciences

Presentation Handbook for the
MSc in Applied Biosciences and Biotechnology
Why a Master in Applied Biosciences and Biotechnology?

The biotechnology sector has grown rapidly in recent years and there are increasing career opportunities worldwide for experienced graduates who have been trained in advanced molecular biosciences, systems and synthetic biology and ‘omics’ technologies, together with exposure to career, business and innovation. Demand for these skills is predicted to increase sharply over the next decade due to investment in the “green economy”, notably in the areas of bioenergy and industrial biotechnology. The objective of this course is to provide postgraduates equipped with the required interdisciplinary skills in applied biosciences and biotechnology for this growing sector. In particular, the aims of MSc in Applied Biosciences and Biotechnology are:

- To equip graduates to pursue careers in bioscience and biotechnology either in industry or academic research.
- Produce graduates with an in-depth understanding of the core principles and methodologies underlying current biotechnological research
- To enable students to develop the transferable qualities and skills required for employment or research in the biosciences sector
- Produce bioscience graduates with training in relevant career, business and entrepreneurial skills.
- Provide a training in laboratory and research skills
- Meet the global need for graduates who can successfully contribute to the rapidly developing industrial biotechnology sector.

A multidisciplinary course, rich of translational skills.

The course is composed of three elements: a taught element, a tutored dissertation element, and a research element.

The taught element in weeks 1-27 includes lectures, seminars, practicals and tutorials in the fields of Bioinformatics, Computing, Systems Biology, Biochemistry and Molecular Cell Biology. It also includes a large component of practical lectures, including computer based practicals and training in laboratory skills.

The dissertation will be carried out in weeks 28-34. Each student will be paired to a faculty member within the Department of Life Sciences, working closely to produce a publication quality dissertation on a cutting edge theme of Biosciences or Biotechnology. At the end of dissertation term, students will have the chance to present their dissertation work at a conference.

Finally, a full time laboratory based research project will be carried out from week 35 to 52. For almost three months students will experience first hand how exciting and rewarding research life can be. Imperial College London consistently ranks among the top 10 Universities in the World and students will have a chance to experience and directly contribute to top class research in Biosciences, Biotechnology and more.

A fourth component of the course runs throughout all its length and it is one of the most unique feature of this Master: the “innovations talks”. Innovation talks are seminars held by entrepreneurs, policy makers, distinguished professors, from some of the leading firms, Universities and governmental organisations in the UK. In a series of seminars, students will meet and network with some of the most successful academics and entrepreneurs in the fields of Biotechnology and Biosciences. They will also learn about intellectual property, management and startups.
The Department of Life Sciences at Imperial College London

In 2014, the Department of Life Sciences at Imperial College London was judged by the British Government to be the top ranked university department in the UK for research intensity in Biological Sciences (see: [REF2014](http://www.timeshighereducation.co.uk/features/ref-2014-rerun-who-are-the-gameplayers/2017670.article)). The Department embraces the full breadth of modern life science activity and comprises one of the largest life science groups in Europe, with approximately 100+ academic staff, 180 research fellows and post-doctoral researchers, 200+ PhD students and 180+ Masters students. We have a vibrant and internationally leading research programme that spans levels of organisation from atoms to the biosphere, that strongly supports multidisciplinary collaborations and that actively fosters the development of new fields. The Department’s research and teaching activities are funded by a wide variety of research councils, charities and industries bodies, with the value of current external research grants totalling £70+ million. The department teaches two major undergraduate degrees in Biology and Biochemistry and a wide range of Masters-level courses aligned to the divisional strengths. The Department is based on two campuses: in South Kensington (Sir Alexander Fleming, Sir Ernst Chain and Flowers buildings) and Silwood Park near Ascot in Berkshire.

The South Kensington Campus

All of the MSc activities will be carried in the South Kensington Campus, the main research Campus of Imperial College London. The Campus is in the heart of 'Albertopolis' and is home to a huge range of architectural styles from the Edwardian Royal School of Mines building to the ultra-modern Norman Foster-designed Business School. There's plenty of green space too, including a beautiful landscaped square, with our famous Queen's Tower at one end.
Dates and Structure of terms

The MSc is a full time, 12 month course beginning in October and ending the last week of September.

Formal teaching and learning activities are scheduled between 09.00 and 18.00, Monday to Friday throughout the year, except when the College is closed for the holidays.

Taught modules run from October to mid-April and will be examined in January (one written exam) and April (two written exams). Dates will be confirmed when the relevant modules are underway.

Assessed course-work consists of a laboratory skills write-up, an essay and write-ups of innovations theme activities. Innovation theme activities will run from October to mid-July. The Tutored-Dissertation followed by the Mini-Conference will take place over a five-week period from the end of April and will finish with a viva. The laboratory-based Project will be undertaken from the beginning of June with the written report being submitted at the end of August. This will be followed by a project-related viva. The Exam Board will meet towards the end of September after the completion of exit vivas with external examiners.

Module summaries

Antibiotic Resistance

Antimicrobial resistance is a looming health challenge. This module will cover the biological basis of antimicrobial action and the different ways in which pathogenic microbes become antimicrobial resistant. We will discuss recent approaches to identify new kinds of antimicrobial compounds as well as recent work on how resistance arises and spreads within and between microbial populations. Students will present journal club papers and develop proposals for approaches to tackle this difficult problem.

Plants and Animals Health

Plant and Animal Health teaching components:
Plant and Animal Health module will focus on major diseases and pests that impact global food security and natural ecosystems by threatening plant and animal health. Basic lectures will cover how plant and animal innate immunity functions at the molecular level, including molecular arms race between plants and pathogens as well as insights into genetic engineering of plants towards disease resistance.

Effector Biology Practical:
This module will involve a lab practical as an accessory component supporting the primary lectures. The practical will focus on activation of plant immunity by co-expressing virulence factors known as effectors secreted by the pathogens, and the plant immune receptors that recognize these effectors.

Neuroscience of Aging

As our society grows older, the impact of age-related cognitive decline will impose greater social and financial burdens on families, communities and on health & care providers. It has become apparent that the World is facing a crisis as health and social care budgets will be unable to cope with the increased demands of this changing demographic. One solution to this crisis is to develop effective preventative measures to reduce the number of people requiring health & social care in future. However, in order to meet this grand challenge, we need to better understand the reasons for age-related cognitive decline. Additionally, we need to understand the aetiology of diseases such as Alzheimer’s and Parkinson’s that lead to early dementia in our elderly population. This course discusses current theories concerning the neurological basis of cognitive decline as well as the mechanisms underlying neurodegenerative disorders such as Alzheimer’s Disease.
The course involves 12 hours of lectures beginning with introductory material on the basics of neuroscience. The course then deals with possible neuronal changes in the brain that could explain the inevitable age-related cognitive decline that we experience in older age. Additionally, we will discuss current theories that seek to explain the neurodegeneration associated with dementia and explore the possibility of developing rational therapies for the treatment or prevention of these devastating disorders.

During this course you will work as a committee to coordinate a journal club style meeting. This will involve selecting papers and organising them into a timetabled event where papers are presented and their importance discussed. You will need to organise presentations into designated research themes that complement the work discussed during the lectures.

**Biotechnology Entrepreneurship**

The Biotech entrepreneurship module will introduce basic concepts of entrepreneurship and provide an introduction to applications using biology, including both heterotrophic (sugar-driven) and autotrophic (sunlight-driven) biotechnology. The module also covers an introduction to the history of biotechnology and ends with a team exercise where students identify, research and present a potential business concept involving biology.

**Synthetic Biology**

This module provides an introduction to Synthetic Biology, explaining some of the components that are commonly used to engineer artificial gene circuits (e.g. transcription factors, inducible systems, CRISPR, etc.). This is presented in the context of simple network motifs and subsequent lectures explain the concepts behind modular Parts and how to assemble more complex DNA constructs. Various applications of synthetic network construction are discussed, from synthetic pattern formation - to emulate embryonic development - to gene therapy applications in humans. The latter includes how artificial transcription factors are being developed to treat Huntington's disease. Engineering in other biological systems, particularly non-model organisms is also introduced, with particular reference to the concept of portability between organisms.

This taught lecture material is complemented by a set of computer practicals on how to use Cell Designer (a tool to design and model biochemical networks) and, specifically, how to model transcription networks.

There is also an accessory activity on how to prepare a Grant Pitch; obtaining grant funding is an essential part of any academic career and students are guided to work in teams to prepare a grant proposal presentation. Finally, there are lectures on career, business and innovation to demonstrate how Synthetic Biology has industrial potential.

**Stem Cells & Regenerative medicine**

During these two weeks, we will discuss the fundamental principles of stem cell biology and regenerative biology as well as some of the exciting current research being done in these areas. The biology of stem cells will first be introduced and then discussed in greater detail by looking at what is known about these cells in several tissues such as the gut, skeletal muscles and brain. The relevance of stem cells to cancer and ageing will also be discussed. During the second half of the module, we will introduce regenerative biology and how it can inform regenerative medicine. We will draw on examples from several model organisms and discuss their possible clinical applications. The teaching will be a mixture of face to face seminars, question and answer sessions and student-led ‘research journal clubs’. You will then choose a topic from the teaching sessions that has interested you and in small teams with similar interests, produce a blog about research on this topic for your chosen audience. The learning that occurs during this work is impressive and I look forward to seeing what you create.
Insect Biotechnology

Insects have plagued humanity throughout history both as competitors in human nutrition and as vectors of diseases such as malaria. On the other hand, beneficial insects are economically important e.g. as pollinators. Insects are by far the most diverse group of organisms on earth. Powered by the rapid development of techniques in molecular biology and genomics past decades have witnessed the complete sequencing of many insect genomes from beneficial (honey bee or silkworm), vector (malaria mosquito) or pest insects (the red flour beetle or the pea aphid) and the efflorescence of genome editing tools for functional studies. In this postgenomic era insects have become important models in applied sciences with considerable economic potential. One focus of the module will be the use of genetic modifications for insect control for example the use of synthetic gene drives including the ethical aspects of this approach. Other activities include learning from/about companies in the field of insect biotechnology. Students will also foray into bioinformatic analyses and the curation of insect genomes.

Data Driven Biology

The lectures in the course will be divided into the following i) The protein component: Principles of protein structure and function. Annotation and prediction of protein structure, function and interactions. and ii) The DNA component: DNA sequence analysis; genome assembly and annotation. After the course the students will be familiar with principles underpinning protein and genomics bioinformatics including an awareness of contemporary research challenges. The student will have introduced to key software and databases. Recommended texts are A Lesk Introduction to Bioinformatics 4th ed Oxford University Press and A Lesk Introduction to Genomics 2nd ed Oxford University Press.

Academic team and contacts

AB&B MSc Course Director: Dr Giorgio Gilestro g.gilestro@imperial.ac.uk

Course Administration: Ms Annie Murphy annie.murphy@imperial.ac.uk