

BSc in Medical Sciences with SURGERY & ANAESTHESIA

Introduction

This course focuses throughout on the scientific principles underlying surgical and anaesthetic practice - it is the *why* of surgery and anaesthesia, not the *how*. The practice of modern surgery and anaesthesia is becoming even more scientific and evidence-based. The course will focus on the science behind the scalpel. Students will be encouraged to critically evaluate scientific evidence from primary sources. It is not the aim of the course for students to memorise large amounts of information on the mechanics of how clinical procedures are performed. Rather, we anticipate that students will develop improved scientific understanding and analytical skills. Ideally, when introduced to a new surgical scenario they should be able to identify the likely physiological and pathological processes underlying the case, and the possible effects of interventions and how these would be assessed. The content of the modules is closely coordinated, so that there is integration without repetition.

This course will comprise three 5-week taught modules (see below) and either a research project or a specialist course (two 5-week modules).

Course Director and Head of BSc Year

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Course Administrator

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Aims and Objectives

Provide a course that will allow the students to develop an understanding of the important scientific principles that affect every aspect of surgery and anaesthesia from basic molecular mechanisms to the design and interpretation of surgical trials.

Content

- Regeneration, Repair and Cancer Control
- Perioperative Medicine
- Technology and Clinical Safety

Format of teaching

Teaching methods will include lectures, seminars, student presentations, discussions, debates, clinical demonstrations, practicals and tutorials.

Module 1: Regeneration, repair and cancer control

Module Director

Mr Duncan Spalding d.spalding@imperial.ac.uk

Module Leaders

Dr Sarah Blagden s.blagden@imperial.ac.uk
Dr Ana Costa-Pereira a.costa.pereira@imperial.ac.uk

Aims

This module aims to introduce new areas of knowledge that include stem cells, miRNAs and siRNAs and others such as immunotherapy and gene therapy. The first part of the module will focus on the physiological and pathophysiological responses following surgery and has three major components - healing and lack of healing; tissue regeneration and tissue compensation; cancer as a model of surgical success or failure.

Healing and lack of healing will concentrate on the failure to repair internal tissues following invasive surgery. It will include the mechanical and biological properties of the tissues and the interaction of these with the physiological status of the patient; the scientific considerations that underlie strategies to improve healing; some future prospects for improved post-surgery healing.

Content

- Tissue regeneration and compensation
- Healing and stem cells
- Cancer as a model of surgical success or failure
- Cancer stem cells
- Cancer immunotherapy
- siRNAs and miRNAs
- Gene Therapy

Module 2: Perioperative Medicine

Module Director

Dr Michael Wilson michael.wilson@imperial.ac.uk

Module Leaders

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Dr Istvan Nagy i.nagy@imperial.ac.uk
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Aims

The aim of this module is to provide a course on the mechanisms of anaesthesia and analgesia. Students will develop their understanding of anaesthesia and pain medicine from molecular biology, through central nervous system activity and into clinical applications. In particular links between laboratory and clinical research are made so that pharmacological targets for anaesthesia and analgesia can be identified and the safe use of drugs recognised in different population groups.

The aim of second part of module is to allow the student to develop an understanding of the importance of infection and immunity in the response to surgery, the ways in which these influence the healing process, whether beneficially or pathologically, and the rationales behind therapeutic and immunomodulatory interventions. Or, if you like, think of it another way - what will save more lives in the long-term, transplantation of pig organs into humans, or persuading Profs to wash their hands after every patient they examine?

Content

- Mechanisms of anaesthetic action
- Mechanisms of analgesic action
- Applied pharmacology
- Physiological Responses to Pain
- Laboratory & Clinical Studies of Pain Mechanisms
- Principles of Pain Management

- Sepsis and shock
- Peri and post-operative infections
- Transplantation biology

Module 3: Technology and Clinical Safety

Module Director

Dr Rajesh Aggarwal rajesh.aggarwal@imperial.ac.uk

Module Leaders

Dr Richard Abel r.abel@imperial.ac.uk
 Professor Justin Cobb j.cobb@imperial.ac.uk
 Dr Nick Sevdalis n.sevdalis@imperial.ac.uk

Aims

The aim of this module is to introduce an understanding of the use of engineering principles and technology to the practice of medicine. The use of engineering in medicine is frequently referred to as bioengineering. Since engineering, biology and medicine are all diverse, the subject of bioengineering is, by its very nature, varied and wide. Although in Imperial College we are lucky to be able to provide the right mix of skills to lead the way in many areas of bioengineering, there is no way the entire subject can be taught in a short module.

The module will include an introduction to basic engineering terms and principles and apply them to the design of implants, fracture fixation methods, and the biomechanics of movement and function. It will also focus on how new technologies are applied to surgery, how they are designed, their advantages and limitations, and how they are integrated into clinical practice. Imperial College is a pioneer of new surgical technologies and clinical safety, and this module will draw heavily on this expertise. The main areas will be imaging techniques, minimally invasive surgery and clinical safety.

Content

- The design of medical implants and the body's response to them
- Materials influence on implant success from mechanical and physiological impact
- Biodynamics of human performance
- Imaging techniques
- Robotics
- Minimally invasive surgery
- Implementation of new techniques to clinical practice
- Safety of surgery and new technology

Modules 4 and 5

Projects

A wide variety of projects will be offered from the research groups within the Division of Surgery, Oncology, Reproductive biology and Anaesthetics

Past BSc Project Titles in Surgery and Anaesthesia

- Use of checklist in improving postoperative handover
- The normal human hip
- A survey of the prevalence of fatty degeneration in the spinal muscles of patients presenting with low back pain
- Does mental practice enhance surgical performance in the Operating Theatre?

- The everlasting hip replacement
- Comparison of the acquisition of basic laparoscopic skills of junior surgeons with and without open surgical experience
- Investigation of tumour-peritoneal interactions in the pathogenesis of peritoneal metastases using a novel in vitro peritoneal model.
- Patient Specific Virtual Reality Endovascular Simulation
- Investigating normal knee joint locking using electromyography and dynamometry
- Mechanisms of pulmonary monocyte recruitment in ventilator-induced lung injury
- Comparison of plain radiographic and CT methods for the measurement of the position of artificial knee joint components
- Co-registration of Hip 3D CT scan with 3D wear patch position scan of the same hip
- A matter of life and death: The role of R1H Asparaginyl Hydroxylase in promoting cellular proliferation in disease
- The effects of energy drinks on central fatigue; a magnetic brain stimulation study
- The use of siRNA to identify new kinases that phosphorylate
- Understanding the mechanism of xenon neuroprotection using electrophysiology and molecular biology
- Anaesthetics inhibit γ -secretase activity and hence negate the effect of inflammation on beta-amyloid deposition in the CNS
- Surgery and society: the impact of deprivation on outcome in arthroplasty
- Hip imaging gender differences
- The balance between apoptosis and proliferation in colorectal cancer: Relative roles of HIF transcription factors in Caco-2 cells
- The development of laparoscopic skills in surgical trainees
- Among five noble gases, only xenon and argon attenuates OGD-induced human kidney cell death in vitro
- Taste Sensitivity in Bariatric Surgery Patients
- Anteromedial gonarthrosis: defining a global epidemic
- Patello-femoral patho-anatomy
- The role of reactive oxygen species signalling in β 2 integrin activation and tumour necrosis factor alpha release from monocytes
- NAPE-PLD expression in dorsal root ganglia
- 360 degree Assessment of Surgical Performance in Crisis Simulations

- Haematopoietic stem cells and impact on tumour cell growth
- Anaesthetics cause GABAergic, glutamatergic, dopaminergic and cholinergic neuronal cell death equally at the brain developing stage
- Extracellular matrix remodelling in the prostate of mice with defective collagen internalisation receptors
- Cost Effectiveness of Surgical Simulation
- Understanding the mechanism of xenon neuroprotection using electrophysiology and molecular biology
- Designing and validating a simulation for gastroschisis and application of a pre-formed silo
- Organ viability assessment in the preservation period during transplantation utilising rapid sampling microdialysis
- Fabrication of hierarchical fibrous structures for use as an articular cartilage scaffold
- Renal tubular/vascular injury after kidney transplantation
- Why anterior cruciate ligaments rupture
- Neurocognitive functional changes after renal transplant
- Validation of the ventriloscope for cardiovascular examination
- The relationship between the physical and functional presentation of patients with osteoarthritis at the knee joint undergoing surgical intervention
- What are the long term failure mechanisms of MoM hips
- Comparison of Body-Worn Sensor Systems for Measuring Balance and Activities of Daily Living
- Interactions between the corticospinal and vestibular systems in the control of the neck musculature
- Characterisation of burn injury-evoked phosphorylated extracellular signal-regulated kinase
- Longitudinal analysis of MRI of patients with ASR and non-ASR metal-on-metal hips
- Comparison of learning curves in SILS and standard laparoscopic cholecystectomy
- To determine the level of exposure to anaesthetic gases in the operating theatre using selected ion flow tube-mass spectrometry (SIFT-MS)
- Endovanilloid-induced desensitisation of TRPV1
- Design and Validation of a Vascular Surgery Error Capture Checklist
- A perfect hip
- Expression of steroidogenic enzymes and receptors in normal, malignant and

resistant breast cancer

- Online rapid sampling microdialysis for the in-vivo detection of anastomotic leakage
- Development of a new serological test for metastatic bone disease
- Growth and development of fetal trabecular tissue
- Neuropharmacological enhancement of skill acquisition
- Optimal properties of lower gastrointestinal tissue in health and disease
- Effectiveness of motion analysis for determining technical skills during endovascular tasks
- Role of Toll-like receptor-7 in arterial injury
- Optimal properties of upper gastrointestinal tissue in health and disease
- Optimal visualisation of the acetabular columns
- The interrogation of intra-operative decision making systems in trainee and expert surgeons using functional near infra-red spectroscopy (fNIRS)
- The impact of severe sport on the female hip
- Role of monocyte-endothelial interactions in a mouse two-hit model of ischaemia-reperfusion injury

What do the students think of the BSc in Surgery and Anaesthesia?

'With the fast moving pace of technology and molecular biology, a sound understanding of the science behind and the future of surgery and perioperative medicine is a must for tomorrow's doctors.

It is very difficult to generalise the day in the life with this BSc, except to say that every day provided new and exciting challenges.

The Surgery and Anaesthesia BSc provides a uniquely broad perspective across 3 challenging and rewarding modules. The first, regeneration, repair and cancer control, looks in detail at the spectrum of current and cutting-edge palliative and curative, surgical, targeted and personalised treatments for cancer and end stage disease, and the emergence of stem cells as a versatile tool for regeneration. We had the chance to observe cutting-edge research being presented by leaders in their field by attending a symposium and conference in the fields of stem cell research and hepatobiliary surgery respectively.

The second module, perioperative medicine, explores the advances in the treatment of inflammatory and neuropathic pain, the mechanisms of anaesthesia and the impact of surgery and the inevitable perioperative inflammation in critically ill patients. The Harefield experience provided a rare insight into the novel therapeutic applications for end stage heart and lung disease at a world-renown transplant centre.

The final module consolidates the thrust of innovation and the opportunities and pitfalls of bringing an idea from bench to bedside whilst ensuring patient safety remains a top priority. This requires a holistic approach, looking not only at the technologies themselves but also the implications for the training and selection of 21st century surgeons and the management of the hospitals they work in with the advent of new technology based methods of learning.

The module also explores the wide base of home-grown and world-leading innovation in minimally invasive technologies that will define the future.

With the hectic pace and intensity, the need for camaraderie and social bonding cannot be greater. This year has seen the intake of a geographically diverse group of students from throughout the UK providing opportunities for not just networking but also lasting friendships. The ethos of teamwork has persisted during the year with plenty of opportunities to share ideas and socialise in dinners, dances and for those of a sporting disposition, 5-a-side football and dodgeball. The creation of hoodies specifically designed for surgery BSc students is testament to the great working environment between every member of the BSc.

Overall I feel the course has given me the ability to understand the evidence-base behind the treatments and procedures we routinely subject our patients to and will undoubtedly help me to make sound decisions and promote progress in the best interests of the health of my patients.'

'Rigorous, challenging, a right hoot! Probably sums up Surgery & Anaesthesia BSc nicely. Everyone has something to say about the BSc – Is it hard? Can I get a first? Can I get published? Is it worth it? All very reasonable questions and the answer to all of those is a resounding YES.

Surgery BSc is probably quite self-selective but the aim of the following is to show the rest that it has something for everyone. It is a fantastically diverse BSc bringing together topics from other BSc's and is taught by world class lecturers; never before have I been so enthused and stimulated.

A brief run-through of the modules:

- Module 1 – Regeneration, Repair, Cancer. Based at the Hammersmith hospital. Predominantly molecular biology of cancer and stem cells. A number of symposia are arranged culminating in writing a journalistic article about the research presented.
- Module 2 – Perioperative Medicine. Based at Chelsea & Westminster Hospital. Anaesthetics, pain neuroscience, inflammation and its immunology, and cardiorespiratory aspects of surgery. A trip to the Harefield Heart Hospital is the highlight of this module. You get to play with artificial heart pumps and listen to cutting edge research in the field.
- Module 3 – Technology & Clinical Safety. Based at Charing Cross & St Mary's. Current technology and materials science comprises the orthopaedic section of this module. Emerging technology such as NOTES and imaging techniques as well as safety in surgery are based at the academic surgery unit at St Mary's.

Projects – the research groups that teach each module offer a range of projects so you can participate in areas which interest you as you progress through the course. I decided to do the History of Medicine course and completed my thesis on Plastic Surgery & Burns Disasters in the 1980's.

An outstanding BSc, well run and you will acquire basic skills which will stand you in good stead for any career you wish to pursue.'