Cambridge Science Summer School

2012

Programme Director: Dr. Joyce Wong

The Cambridge Science Summer School offers a unique opportunity to experience a free academic environment which enables you to exercise the right of a scholar to unhampered passage in the interest of education. The University of Cambridge possesses a secular education system, not restricted by religion, whose teachings encompass not only science, but also philosophy, law, music, arts and humanities. We are very proud to be currently ranked top of the QS World University Rankings of over 600 global universities. Our summer programme will bring you into this intellectual community with highly motivated students representing many different nationalities, cultural backgrounds and industries to learn in a collaborative environment. Our aim is to stimulate academically brilliant students from Asia to participate directly in scientific research, working closely with senior faculty members and engaging in scientific discussion. We hope our progamme helps students to develop the right mindset for research and to learn how, through successful communication and collaboration, to turn hypotheses into practical success. We invite you to participate in cutting edge science by working alongside our best principal investigators from research-intensive departments at one of the oldest and finest universities in the world.

Applications are welcomed from students coming from overseas universities who can demonstrate proficiency in English. Competition for places is intense, so early application is advised.

"Formula for breakthroughs in research: Take young researchers, put them together, give them an unprecedented degree of freedom and turn up the pressure by fostering competitiveness."

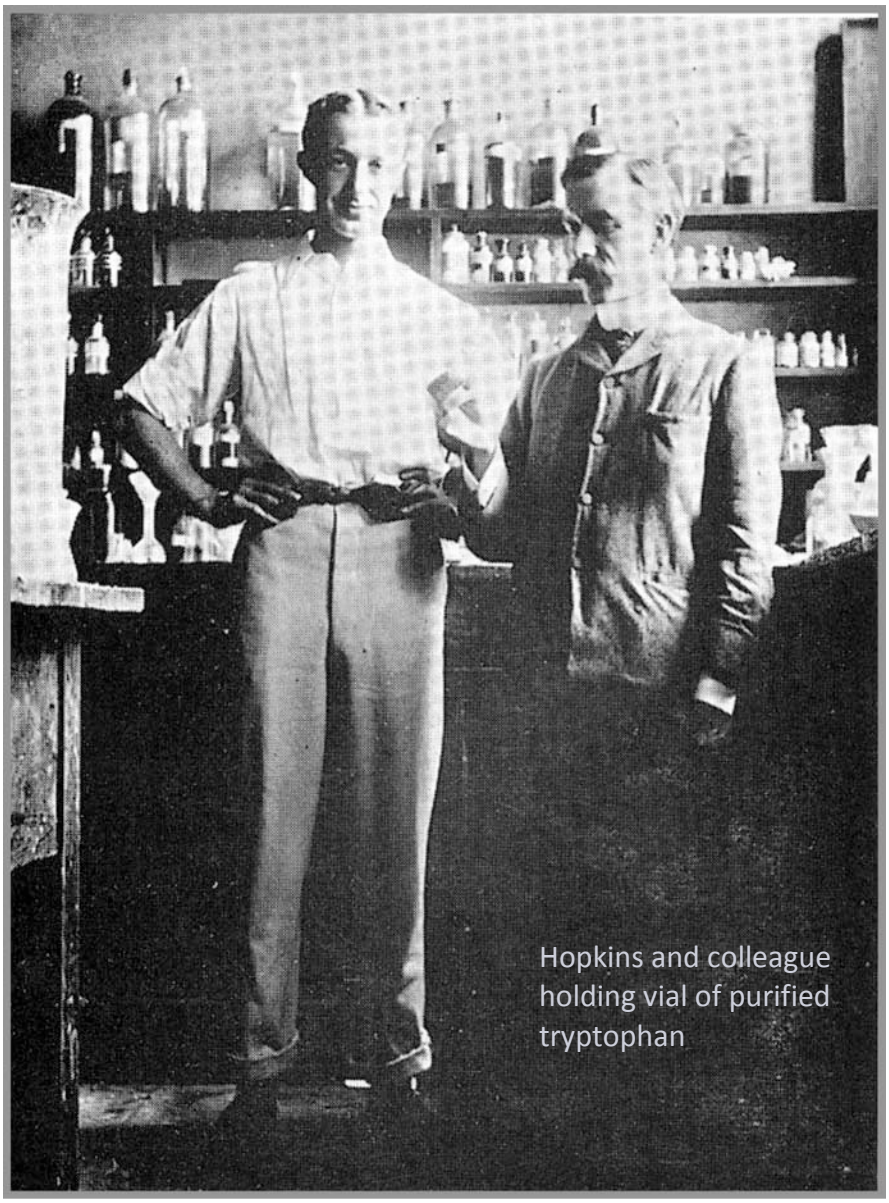
James Watson

"My goal is simple. It is complete understanding of the universe, why it is as it is and why it exists at all."

Stephen Hawking

The origins of Cambridge can be traced back 3500 years to a farmstead located at the site of the present day Fitzwilliam Museum. When the Romans invaded Britain, they made use of the pre-existing settlement of the Belgic peoples, on what is now the Castle Mound, as their own fortress. They named this fortress Duroliponte, and it was perfect for defending the important river Cam against incursions from the Celtic natives to the North and West. After some 350 years, Duroliponte fell to the invading Saxons, a Germanic people that named the settlement Grantabrycge (literally: Bridge over the river Granta) and it became an important trade route North to the peoples of the marshland Fens. With the arrival of the Vikings, Grantabrycge quickly grew into a thriving market town, relocating from the Castle Mound on the river's left bank to the Quayside on the right. When the Vikings left, the Saxons took the town back, building St Bene't church in 1025, where it still stands on Bene't Street. In 1068, the invading Normans re-fortified the castle mound and began building anew. By this time, the town's name had evolved from Grantabrycge to Grentabrige or Cantebrigge (Grantbridge), reflecting the importance of its bridge over the river Granta. Cantebrigge eventually evolved to "Cambridge" and Granta to "Cam" (although the upper river is still affectionately referred to as "The Granta)." In 1209, students fleeing the unrest in Oxford settled in the then quiet and safe backwater of Cambridge, founding the University's first college – Peterhouse. From that day on, the University has grown progressively into a World Class academic institution that can lay claim to 88 Nobel Laureats - more than any other institution in the world. The present day Cambridge skyline is awash with the spires and towers that grace its many colleges, churches and research laboratories while down below is a world of quiet green quadrangles, bustling markets, modern shopping malls and, snaking through it all, the calm and beautiful river Cam.

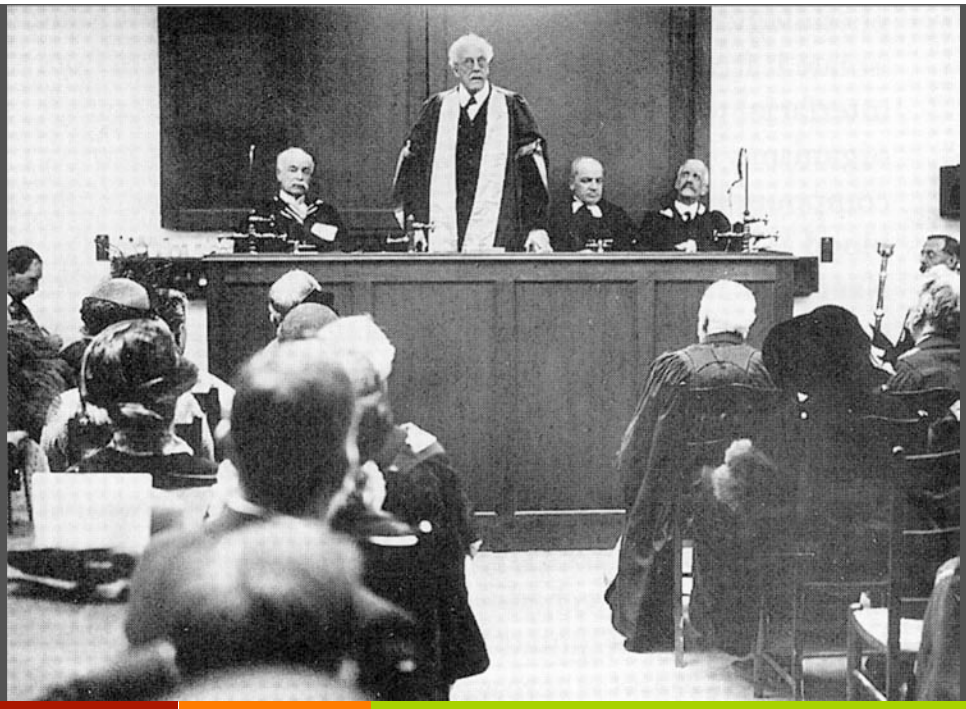
History of the Biochemistry and Pharmacology Departments



Hopkins and colleague holding vial of purified tryptophan

The Cambridge University Department of Biochemistry has its foundations in the Sir William Dunn Institute of Biochemistry, a research institute endowed from the estate of Sir William Dunn, opened in 1924 and created for Frederick Gowland Hopkins (FRS, OM, Nobel Laureate) on the recommendation of Walter Morley Fletcher, first Head of the Medical Research Council. The institute underpinned the evolution of Hopkins's school of biochemistry, which dominated the emerging discipline of biochemistry through the 1920s and 1930s and trained many subsequent leaders in the field, including Nobel Laureates like Hans Krebs, Ernst Chain, Fred Sanger, Rodney Porter, Peter Mitchell and Tim Hunt. One of the Department of Biochemistry's most illustrious alumni was Joseph Needham, CH, FRS, FBA, also known as Li Yuese (李约瑟), who was not only a great biochemist but also an historian and the foremost British authority on China. Needham was the director of the Sino-British Science Co-operation Office in Chongqing from 1942 to 1946, making several long journeys through war-torn China, visiting scientific and educational establishments and obtaining for them much needed materials and supplies. He was acquainted with Zhou Enlai and numerous Chinese scholars, including the painter Wu Zuoren (吳作人), and the meteorologist Zhu Kezhen. Needham did more than any other Westerner to raise awareness in the West of the tremendous technological and scientific creativity of the Chinese culture.

Today, the department builds on those past giants and is a vibrant, world-class scientific community with an extremely wide range of scientific interests that includes plant biology (food security and biofuels), parasitology, bacterial genetics and pathogenesis, structural biology, cell and tissue biology, regulation of chromatin, DNA damage and control of gene expression, cancer and cardiovascular disease. While Biochemistry is one of the largest departments in Cambridge - with around 400 research and support staff - it is but a



Lord Balfour opening the Department of Biochemistry in 1924

component of the highly collegiate School of Biological Sciences that includes the departments of Pathology, Pharmacology, Genetics, Plant Sciences, Zoology, Veterinary Medicine, Physiology, Development and Neuroscience, as well as freestanding institutes such as the Sainsbury Laboratory, the Gurdon Institute and the Wellcome Trust Stem Cell Institute. We also have close links with other World Class Cambridge Institutes, including the renowned MRC Laboratory of Molecular Biology, the CR UK Cancer Research Institute, the Babraham Institute and the world famous Wellcome Trust Sanger Centre.

Working on the department's rooftops in 1933

The Cambridge Department of Biochemistry houses an internationally competitive research programme and state-of-the-art equipment and resources, including an 800MHz NMR facility, modern X-ray laboratories, core facilities for mass spectrometry and plasmon resonance, advanced services for protein and nucleic acid sequencing, and sophisticated mouse genetics. In collaboration with the Department of Genetics we have established a new Systems Biology Centre that encompasses array technologies, proteomics and informatics, as well as metabolomics. Members of the Department also participate in the new Wellcome Trust Centre for Stem Cell Research. These new developments underpin research in a range of different biological processes from molecular enzymology, through cell signalling and control of gene expression, to molecular microbiology, plant molecular biology and biofuel research, cancer and cardiovascular biology.

Right across from the Biochemistry Department's Sanger Building lies the Department of Pharmacology, another of the nine departments that together comprise the School of Biological Sciences and the largest department of Pharmacology in the United Kingdom. The Department is headed by Professor Peter McNaughton, a world expert on the molecular biology of pain.

The over-arching theme of research in the Department is to uncover the fundamental mechanisms that underlie important problems in Pharmacology. Major research areas of the Department include cellular neuroscience, systems neuroscience, cell signalling, ion and drug transport mechanisms, biomolecular imaging of molecular complexes and machines using atomic force microscopy and vascular biology. The Department is responsible for teaching students preparing for the medical and veterinary professions as well as students of natural science.

Life in the Departments and the University of Cambridge

Undergraduate and graduate teaching remain our highest priorities – imparting both scientific knowledge and the passion for science that we all share. Cambridge was the crucible for experimental science in the 17th century and we preserve that tradition of free thought, fierce independence, creativity, free discussion and exchange of ideas and, above all, of academic community. We believe that the best science comes from supporting individuals and building a collegiate community of enquiring minds. This important social aspect of science in Cambridge is nurtured by the University's college system, which provides not only accommodation but also a sense of belonging to an intellectually diverse community on a small, village-like scale. A Summer spent in Cambridge doesn't just train you in science, it teaches you how to think about scientific problems, ask critical questions, generate testable hypotheses, plan experiments, interpret the data and discover how things work. *En passant*, you will be exposed to thought leaders and towering intellects from every walk of human endeavour.

"What is known for certain is dull."

Max Perutz

"A Summer in Cambridge is also an investment. Science is an intensely social enterprise, forged through friendship and mutual respect. Our Summer Programme will provide unparalleled opportunities to meet, socialize and work with eminent scientists. We hope that your experiences and the relationships you establish will lead you to return to us in the future, rejoining our community as our future Masters and Ph.D. students."

Professor Gerard Evan

"Through art and science in their broadest senses it is possible to make a permanent contribution towards the improvement and enrichment of human life and it is these pursuits that we students are engaged in."

Fred Sanger

Who is who?

(but not a complete list of research groups)

Professor Gerard Evan, Ph.D., F.Med.Sci, FRS is the Sir William Dunn Professor of Biochemistry in the University of Cambridge and head of the Department of Biochemistry. He is one of the world's foremost experts on oncogenes – the genes that drive the development of cancer – and on tumour suppressors – the genes that prevent cancers. He is best known for his work on the enigmatic Myc oncoprotein, whose deregulation is implicated in the majority of human cancers: in particular, for his discovery that oncogenes like Myc that drive deregulated cell growth also trigger cell death – an inbuilt tumour suppressor programme that is corrupted in all cancers. His approach is unique – he used switchable genetics to turn off and on specific cancer genes in tissues *in vivo* and uses these models to identify novel targets for anti-cancer drugs. From 1999-2009, he was the Distinguished Professor of Cancer Research at the University of California, San Francisco, returning in 2009 to head the department of Biochemistry at Cambridge. Professor Evan's contribution to cancer research have been widely recognized: he is an elected member of the European Molecular Biology Organisation and a fellow of the UK Academy of Medical Sciences, the European Academy of Sciences and the Royal Society.
http://www.nature.com/nature/journal/v455/n7213/full/7213xiiia.html
http://www.cancerquest.org/gerard-evan-interview

Professor Peter Leadlay, Ph.D., FRS, is the Herchel Smith Professor of Biochemistry in the University of Cambridge. His research concerns the natural pathways for biosynthesis of antibiotics and how they can be altered to produce tailored novel therapeutics. His current interests are in the synthetic biology, the genetics and bioengineering of natural product biosynthetic pathways, identification of novel cellular targets for natural products, and genome mining for novel biosynthetic enzymes and pathways, and synthetic biology. Peter studied Chemistry at Oxford, then at ETH Zürich and joined the Biochemistry Department in Cambridge in 1979. He is a recipient of various awards including the American Chemical Society Remsen Award (2006), a Chaire Internationale de Recherche "Blaise Pascal" held at Institut Pasteur Paris (2003-2004), and the Smets Chair at Louvain/Leuven (2009). He was elected a Fellow of the Royal Society in 2000. He is co-founder of the Cambridge-based biotech company BIOTICA.

Professor George Salmond, Ph.D., ScD, FRSA, FSB is Professor of Molecular Microbiology in Cambridge University and a Professorial Fellow of Wolfson College, Cambridge. George's work is focused on virulence in bacterial pathogens of animals and plants, how bacteria send and receive signals between each other to govern their behaviour ("quorum sensing"), the regulation and biosynthesis of secondary metabolites (including antibiotics and anti-cancer molecules), and exploitation of bacterial viruses in molecular genetics and biotechnology. George is also a Governor of the John Innes Centre and the Scottish Crop Research Institute, and was International Secretary and Member of Council of the Society for General Microbiology and Member of Council of the Federation of European Microbiological Societies. In 2011, George was awarded the 2011 Colworth Prize Lecture by the Society for General Microbiology, awarded biennially "for an outstanding contribution in an area of applied microbiology".
http://www.bspp.org.uk/profiles/salmond.php

Dr Kathryn Lilley, MA, Ph.D. is University Reader in quantitative Proteomics at the Department of Biochemistry and director of the Cambridge Centre for Proteomics, which is part of the Cambridge Systems Biology Centre. Her research uses advanced proteomic technologies to ascertain where proteins are located within cellular structures and how their flux over time and variation in post-translational state may be monitored in a high throughput manner. To do this, she is developing quantitative proteomics techniques for use in conjunction with membrane proteins, organelle proteomics and protein trafficking, as well as novel experimental strategies and methods for statistical analysis of quantitative proteomics data.
http://www.rsc.org/Publishing/Journals/cb/Volume/2008/6/interview_with_kathryn_lilley.asp

Professor Geoffrey Smith, FRS FMedSci FIBiol is Professor and Head of the Department of Pathology, University of Cambridge and a Principal Research Fellow of the Wellcome Trust. He is a virologist whose research focus is poxviruses – notably vaccinia virus the vaccine used to eradicate smallpox – with a particular interest in how these viruses interact with the host cell and the host immune system. He gained his Ph.D. working on influenza virus at the National Institute for Medical Research, London and then moved for a post-doctoral fellowship to the USA, working at the National Institutes of Health, where he developed vaccinia virus as an expression vector and pioneered the development of genetically engineered live vaccines. He then established his own research group at the University of Cambridge (85-89) before moving to the Sir William Dunn School of Pathology in the University of Oxford (89-2000) and then to Imperial College London in 2000. He was appointed Professor of Pathology in Cambridge in 2011. Professor Smith is a Fellow of the Royal Society, the Academy of Medical Sciences, and the Institute of Biology. He is also President of the International Union of Microbiological Societies and Chairman of the WHO Advisory Committee for Variola Virus (smallpox) Research. In 2005 he was awarded the Feldberg Foundation Prize in Medical and Biological Science and elected a Founding Member of the European Academy of Microbiology. In 2011 he was elected a member of the German National Academy of Sciences, Leopoldina.

Dr Luca Pellegrini, BSc., Ph.D. is University Lecturer in the Department of Biochemistry whose work is centred on Structure-Function Analysis of Molecular Mechanisms for DNA Repair – in particular, the enzymes and sensors that monitor, sense and repair double strand breaks in DNA. Faithful inheritance of genetic information is essential to cellular life and requires the accurate replication of the genome and the repair of any DNA lesion that might block replication or alter the encoded message. The ultimate goal of his research is to define atomic structure and mechanism of action of the macromolecular assemblies responsible for signalling and processing of DNA DSBs and, to do this, he uses the full range of structural biology and biophysical techniques.

http://www.bio.cam.ac.uk/~lp212/

Professor Paul Dupree, MA, Ph.D., is professor of Biochemistry in the University of Cambridge. His research is focused on understanding the biosynthesis and function of polysaccharide components of the plant cell wall, in particular the biosynthesis of xylans and glucomannans in different plant species. This research underpins development of renewable materials, most notably the generation of biofuels from plants. After completing his PhD thesis in the Department of Plant Sciences in Cambridge, he moved in 1991 to Heidelberg as a Royal Society Research Fellow at the European Molecular Biology Laboratory. There, he studied the mechanisms of movement of proteins within animal cells. He returned after three years to Cambridge to start a new project on the subcellular organisation of plants and was appointed as a Reader in the Department of Biochemistry from January 1995. Paul was made Professor in 2010.

http://www.bio.cam.ac.uk/~dupree/

Professor Stephen Jackson, Ph.D., F.Med.Sci, FRS, is the Frederick James Quick Professor of Biology in the Department of Biochemistry, School of the Biological Sciences at Cambridge University, UK, and a Senior Group Leader in the Wellcome Trust/Cancer Research UK Gurdon Institute of Cancer and Developmental Biology in Cambridge. Through his earlier research into transcription by eukaryotic RNA polymerases II and III, Steve discovered the DNA-dependent protein kinase, which led him into the field of DNA repair and DNA-damage signalling – a field in which he has made many, important contributions. Steve has received several prizes including, Eppendorf European Young Investigator of the Year (1995), the Tenovus Medal (1997), the Biochemical Society Colworth Medal (1997), and the Anthony Dipple Carcinogenesis Young Investigator Award (2002). He is an elected member of the European Molecular Biology Organization (EMBO), and a fellow of both the Academy of Medical Sciences and the Royal Society.

http://www.ecancermedicalscience.com/tv/video-by-category.asp?play=747&cid=2&scid=92&q

Professor Peter McNaughton, Ph.D. is Sheild Professor of Pharmacology and Head of the Cambridge Department of Pharmacology. His research is focused on the neurobiology of pain sensing. Pain is unique amongst sensations in that it increases with prolonged exposure, a process known as sensitization. His laboratory uses a range of electrophysiological and molecular biological approaches to understand the molecular and cellular basis of pain sensation. He was born in New Zealand, where he studied Physics at the University of Auckland, then took a Rhodes scholarship to study in Oxford and decided to change to the field of cardiac electrophysiology for his PhD, which he completed, in 1974. Since then, he has pursued research imainly on the cellular basis of the detection of sensations. He was a lecturer in Physiology at the University of Cambridge from 1978 to 1991,moving to London in 1991 to take up a post as Head of the Department of Physiology at King's College London. In 1999 he returned to Cambridge. He is also Wolf Professor of Pharmacology at Christ's College.

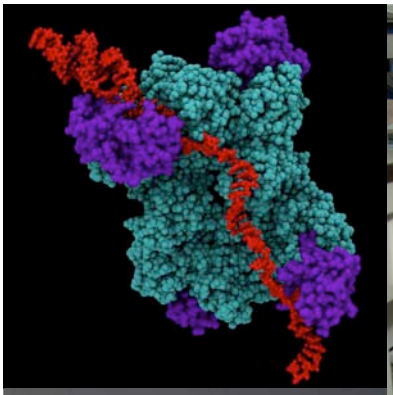
http://www.thenakedscientists.com/HTML/articles/columnists/people/peter-mcnaughton/

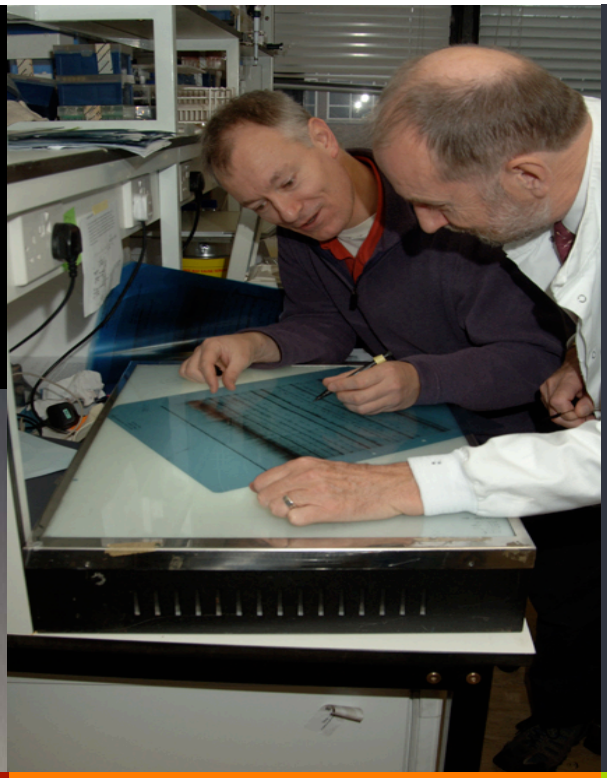
Dr Lora Heisler, Ph.D. is University Lecturer in Pharmacology and a Wellcome Trust Senior Fellow, whose work is focused on the mechanisms underlying the pathophysiology of obesity and type 2 diabetes. Her laboratory investigates the basic neurophysiology of appetite, body weight, and insulin action by examining the neurocircuitry of neurotransmitter and neuropeptide systems, and further, how these systems interact within the brain and periphery. Using complementary genetic, pharmacological, and neuroanatomical approaches, they investigate how perturbation or stimulation of components of these pathways affects energy homeostasis in an effort to identify new treatments for obesity and type 2 diabetes. The ultimate goal of her research is to elucidate the neuroendocrinology of energy homeostasis and neural influences on peripheral metabolism, in order to define novel therapeutic targets for obesity and type 2 diabetes.

Professor Colin Taylor, BSc., Ph.D. is Professor in the Department of Pharmacology at the University of Cambridge who also studies the roles of inositol trisphosphate (IP3) receptors in generating intracellular calcium signals, as well as the structural determinants of IP3 receptor behaviour using techniques like single particle analysis of images collected by electron microscopy, and how calcium signals are decoded.

http://www.phar.cam.ac.uk/research/taylor/taylorresearch.html

Dr Florian Hollfelder, M.Phil., Ph.D.,is University Reader in Chemical Biology at the Department of `biochemistry in Cambridge and Director of Studies in Natural Sciences at Trinity Hall. His group's research is focused on quantitative and mechanistic questions at the chemistry/biology interface, involving low- and high-throughput approaches. His interests range from synthetic biology through to the design of microfluidic "lab-on-a-chip technologies. Florian was educated at the Technical University of Berlin and Cambridge University. His postdoctoral work at Harvard Medical School focused on the biosynthesis and action of the natural antibiotic microcin B17. After a formative stay at Stanford University in California working on free-energy relationships in enzymes he joined the Chemistry Department of Cambridge University to work on enzyme models and physical-organic chemistry. Florian is coordinator of several EU-funded trans-national collaborative initiatives, including the EU New and Emerging Science and Technology project (MiFem) on biological experiments in microdroplet reactors, and several Marie-Curie networks working on the directed evolution of functional proteins and protein-protein interactions.
http://www.thenakedscientists.com/HTML/content/interviews/interview/959/





Which research subject is the most challenging area for you?

Cancer and cell signalling
Infectious diseases
Biochemistry
Structural biology
Neurobiology

Cancer and cell signalling

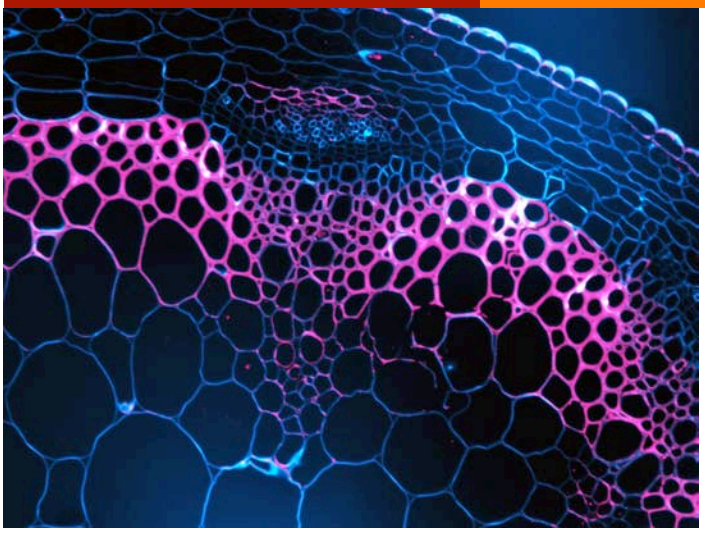
Cell signalling deals with how information is transferred between different cells and transduced within each cell: in effect, such signals indicate to the cell whether it should divide, differentiate, move or die. Cancer is a disease where such signalling is corrupted: cells divide when they shouldn't, stay alive when they should have died, fail to differentiate appropriately and move around the body establishing colonies in other tissues. Members of the Cancer and Cell Signalling group use a variety of cell and animal-based systems to explore how signaling works in normal and cancerous cells and tissues. Students will employ a wide variety of cell and molecular biological techniques, including cell culture, protein and nucleic acid chemistry, cloning and protein expression, protein purification, mass spectrometry and, in certain laboratories, magnetic resonance imaging, advanced microscopy, histopathology and generation of genetically engineered mice. Laboratories focused directly on cancer also employ various of genomic and proteomic tools with which to identify and map mutations in signalling pathways.

Infectious diseases

Infectious diseases kill millions of people a year around the world. To the organisms that cause such diseases, we are just an unusually rich ecosystem for them to invade, explore and propagate. However, we have defenses: immune and inflammatory processes that have evolved to stifle such invaders. This, in turn has triggered an evolutionary "arms race" in which the bugs and our defenses try to outflank each other. Members of the infectious disease group study how invading pathogens invade and spread in our bodies and how our bodies attempt to stop them. Students will engage in projects using state-of-the-art microbial genetics, isolation and purification of novel antibiotics and antibacterial agents, mutagenesis and bacterial biochemical pathway manipulation, analysis of bacterial transport protein structure and function, analysis of bacterial population dynamics, and genetics and genomics of trypanosomes.

Biochemistry

Biochemistry is the discipline that seeks to understand how the chemical processes in living organisms interact and, together, build a self-sustaining and replicating organism. However, contemporary biochemistry is not limited to merely the chemistry of life but has overlapping ties to structural biology, cell biology and cell signalling. Members of the Biochemistry group study diverse areas – how tissues are organized, how structures of large complexes within cells are linked to their functions, plant biochemistry and the reprogramming of plants to generate biofuels, how life evolved and, even, how it might be redesigned. Students will employ a wide variety of techniques and technologies, including classical biochemical analysis of polysaccharides and proteins, isolation and purification of cells and their constituents, sophisticated cell and tissue imaging and microscopy, RNA biochemistry, cloning, chemical biology and microfluidic technologies (lab-on-a-chip).



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Structural Biology

Life would be impossible without large macromolecules: nucleic acids harbour our genetic information while proteins mediate most of the structural, catalytic and dynamic processes that underpin biology. Structural biologists attempt to understand how the unique 3-dimensional structures of macromolecules dictate and explain their functions. An understanding of how biological processes work at the molecular level also underpins our ability to develop drugs that modulate or interfere with those processes when they go wrong and cause disease. Students will deploy the full range of biophysical tools, including cloning, protein expression and purification, X-ray crystallography and NMR spectrometry, computational biology to resolve and dock molecular structures, surface plasmon resonance to explore protein interactions, mass spectroscopy and proteomics.

Neurobiology

Neurobiology is the discipline that seeks to understand how our brain works: how we think, how our nerves communicate and sense information. More than any other discipline, neurobiology deals with how the whole (the brain) is greater than the sum of its parts (the nerves that make up the brain). Members of the neurobiology group explore these extremes: how nerve cells (neurons) function and interact at the molecular and cellular level, how we perceive various nervous signals such as pain, and how ensembles of neurons conspire to generate behaviour and thought. Students will be involved in projects that explore detailed ultrastructure of neurons and synapses, others that investigate the biochemistry of neurotransmitters and the cell biology of how they are stored and released, the dynamics of signalling fluxes in neurons, delineating the neural circuitries that regulate behaviour, and the molecular biology and histopathology of neural degenerative diseases. Students will employ a wide range of cell and biochemical techniques, including electrophysiology, advanced confocal imaging and dynamic microscopic imaging of ion and signal fluxes within cells, fluorescence energy transfer, atomic force microscopy to examing the ultrastructure of ion channels and ionotropic receptors, mass spectroscopy and bioenergetics. Some will also gain experience in neuroanatomy and histopathology.

Extras: Supervisions, English lessons and Evaluation

Students can also apply to take supervisions, choosing their preferred supervisor to student ratio, in which an individual student meets with a postdoctoral researcher or professor once a week to work on a series of research-based papers, or a longer dissertation, in the student's research area. The cost for such supervisions is not included in the programme fee. For 1:1 supervisor to student ratio is charged at £50 per student per hour, for 1:2 supervisor to student ratio is charged at £30 per student per hour and for 1:3 is charged at £25 per student per hour. If you are interested in taking extra supervisions, please tick this option and circle the preferred option of supervisor to student ratio in the application form.

We can also help you to arrange extra English classes outside the departments if you feel this will help you to improve your proficiency in English. Please select this option in the application form and contact us for further details.

An evaluation fee of £50 is charged for the assessment of a scientific report if you would like to write at the end of the programme. This report is strictly restricted to 1500 words and no longer than 10 pages including diagrams, graphs, tables and bibliography and will be assessed and critiqued by the head of the Biochemistry Department (Professor Gerard Evan). In this way you can evaluate your progress and understanding. Please tick this option in the application form if you would like to write a scientific report for evaluation at the end of the programme.