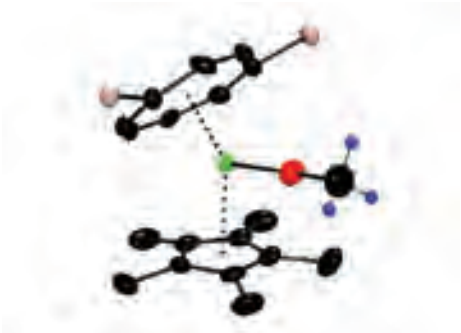
Chemistry



Essentials

Research programmes
MPhil, PhD Chemistry

Admissions requirements
For information on overseas qualifications that meet the admissions requirements, refer to pages 156-157

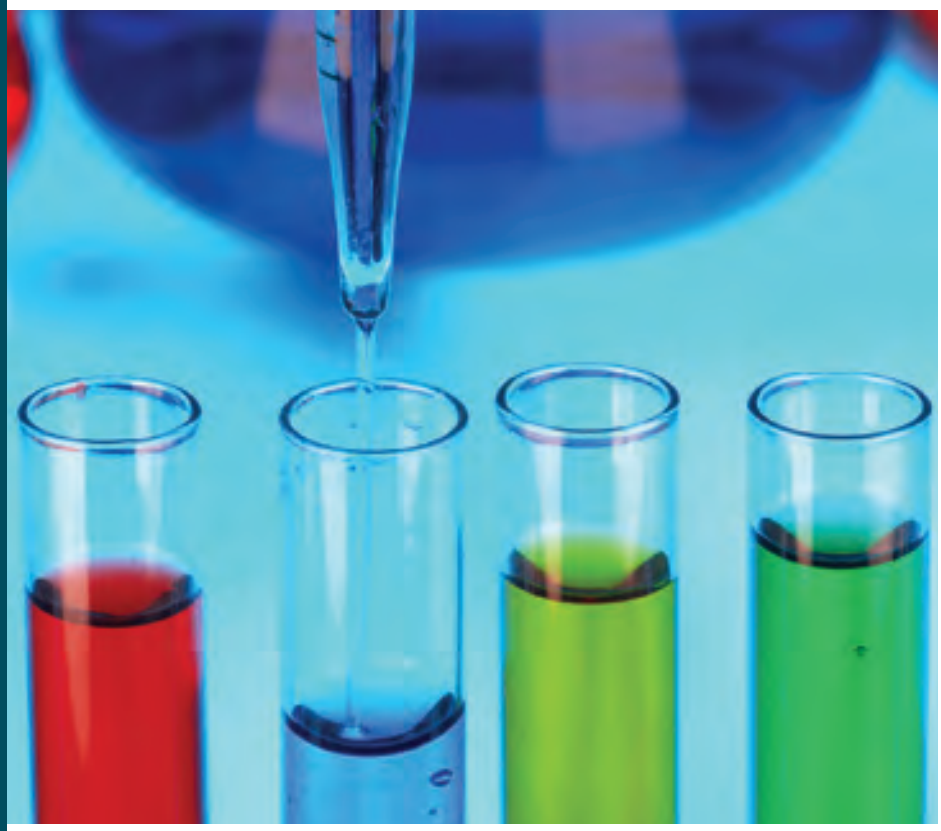
A first- or upper second-class undergraduate honours degree in chemistry or a related discipline

English language requirements
IELTS 6.5, with not less than 6.5 in Writing and 6.0 in the other sections. Internet TOEFL with 92 overall, with 21 in Listening, 22 in Reading, 24 in Speaking and 25 in Writing. For more information and alternative English language requirements, refer to page 156

Fees
Refer to pages 158-159 for information on fees

Further information
Chemistry, School of Life Sciences,
Deeptima Massey,
John Maynard Smith Building,
University of Sussex, Falmer,
Brighton BN1 9QG, UK
T +44 (0)1273 678057
E d.massey@sussex.ac.uk

- Chemistry at Sussex was ranked in the top 15 in the UK in *The Guardian University Guide 2012, The Times Good University Guide 2012* and *The Complete University Guide 2011-12.*
- In the 2008 Research Assessment Exercise (RAE), 95 per cent of our chemistry research was rated as internationally recognised or higher, and over half rated as internationally excellent or higher.
- Recognition for past and present Sussex faculty has been outstanding. We are proud to have counted among our faculty two Nobel prize winners – John Cornforth in 1975 and Harry Kroto in 1996 – and nine faculty, of whom four are still active at Sussex, have been elected Fellows of the Royal Society.
- Chemistry has excellent facilities for synthesis and characterisation: advanced NMR suite, small molecule and protein x-ray diffraction, advanced mass spectrometry, single molecule fluorescence spectroscopy, together with access to national and international facilities for high-performance computing and neutron diffraction.



Research programmes

Chemistry at Sussex has a broad base spanning the traditional subdisciplines – inorganic, organic, physical and theoretical chemistry – each with an international profile, augmented by a strong bridge to the life sciences through medicinal chemistry and drug discovery.

Chemistry for energy and for health aligns with two of the the University's research themes Global Transformations and Environment and Health (for more information, refer to Research at Sussex on pages 7 and 10-11), and they are embodied within the structure of chemistry research as the two groupings:

Drug Discovery, Design and Synthesis (D^3S)
Within D^3S there are groupings focusing on:

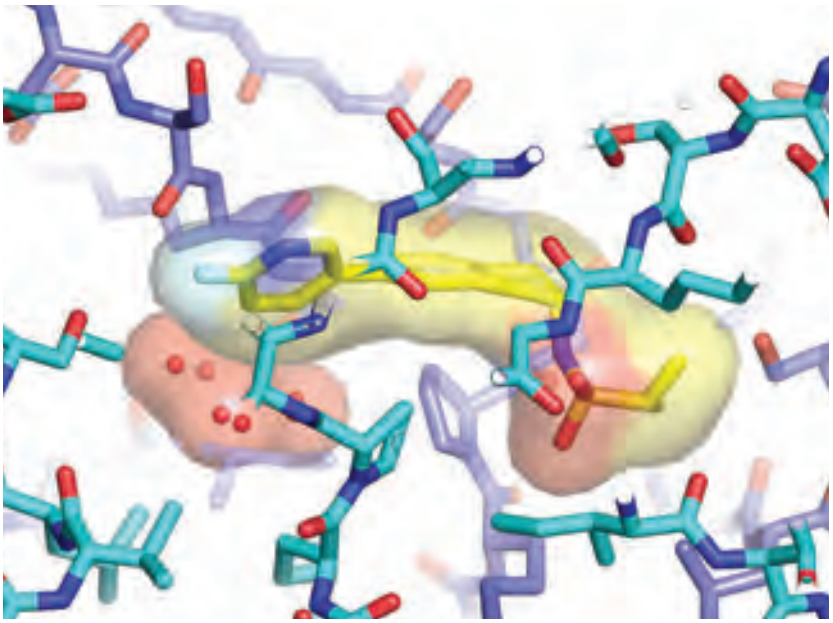
- medicinal chemistry of, and drug design for, oncology and neuro-degeneration
- total synthesis of pharmaceutically important natural products, including antibiotics and antifungals
- analytical chemistry for environmental health
- carbohydrates and sialic acids in molecular recognition and disease
- molecular dynamics for biologically important molecules
- physical chemistry methods for molecular photophysics, including cellular imaging with FRET, and advanced NMR techniques to study amyloid fibril formation.

Physical and inorganic chemistry also provide the underpinning technical capabilities in x-ray and neutron diffraction, NMR and mass spectrometry.

There is a strong underlying programme of curiosity-driven and opportunistic research, which either underpins the mission-oriented groups above or is spun out from them.

Energy and Materials Chemistry (EMC)
Within EMC there are groupings focusing on:

- experimental and theoretical organometallic chemistry: activation of small molecules, especially greenhouse gases, and catalysis for green synthetic chemistry, including polymerisation
- physical and theoretical chemistry: nanoscience of carbon for advanced applications, TiO_2 nanoforms (tubes, fibres and quantum dots) for photovoltaics and waste treatment, time-dependent density functional theory calculations underpinning photofragmentation experiments on solvation shells and density functional calculations on nuclear graphite in support of energy security and CO_2-free generation.



Recent thesis titles

A novel approach to iminosugars of biological interest

A photochemical approach towards the synthesis of gelsemine

Application of palladium N-heterocyclic carbene complexes in catalysis

Multidentate amide and cyclopentadienyl uranium and thorium complexes and related studies

Synthesis, characterisation and applications of novel nanomaterials

Theory of diffusion and plasticity in layered carbon materials

The structure, reactivity and spectroscopy of selected transitional metal complexes

The photodynamics of single quantum dots

Career opportunities

Our graduates have gone on to careers in Higher Education and research, and hold posts such as synthetic organic chemist, postdoctoral research fellow and university tutor.

Specialist facilities

Chemistry at Sussex provides a first-class environment for research and is superbly equipped. There are outstanding facilities for synthetic and preparative chemistry, bio-organic chemistry, structure determination, spectroscopic analysis, separation and elemental analysis.

State-of-the-art equipment has been obtained using Research Council special research grants and funding council funds, demonstrating our wholehearted commitment to research. Three state-of-the-art Varian nuclear magnetic resonance (NMR) spectrometers (400, 500 and 600 MHz) were recently installed. All have multinuclear capability and some are on open access to research students.

Chemistry has modern apparatus for chemical analysis, and other analytical services including mass spectrometry, nuclear magnetic resonance spectroscopy, and both gas and liquid chromatography. High-resolution mass spectrometers (Bruker FTMS, VG-AUTO SPEC) provide state-of-the-art facilities. The FTMS is equipped with HPLC, electrospray, MALDI, EI, CI, and MSMS facilities. Fast atom bombardment is available and there is a gas chromatography/mass spectrometry facility, also equipped with EI and CI modes. New GC-MS, HPLC-MS, MALDI and laser ablation-MS facilities have recently been installed in a Mass Spectrometry Centre serving chemistry, biochemistry and biology, along with a large investment in protein separation and mass spectroscopic analysis for proteomics research.

An ICP spectrometer also provides analysis for all elements at extremely low levels of detection. There is a recently installed HR GCMS (PRO-SPEC) facility.

There is a Nonius Kappa CCD diffractometer with an area detector for the accurate determination of crystal structures. The protein crystallography laboratory is fully equipped for all aspects of protein crystallography from protein purification and crystallisation through data collection and processing to model building and analysis, including a Rigaku RU-H3RHB rotating anode x-ray generator with Osmic Max-Flux optics, an RAXIS-IV++ image plate area detector and MSC X-Stream cryo system. Our facilities include a Stereoscan 420 scanning electron microscope with analytical x-ray capability and fluorimetry.

Theoretical and computational work is supported by a 64-processor farm with a mixture of 32- and 64-bit single and dual processors. Comprehensive storage and back up facilities are available for work with large data sets.

There are also facilities for differential scanning calorimetry, gel permeation chromatography, and optical microscopy with digital image analysis. In the laser spectroscopy laboratory there is a multi-frequency ion gas laser facility, and several diode pump solid-state lasers.

Technical support for research is available in all main areas. Access to all relevant journals is available, either online or through the School or the University Library.

Research interests by subgroup

Our main groupings are Drug Discovery, Design and Synthesis (D^3S) and Energy and Materials Chemistry (EMC). These groupings are supported by the subgroups listed below:

Inorganic chemistry

The University of Sussex is an internationally recognised centre of excellence in inorganic chemistry. Our longstanding reputation in synthetic organometallic chemistry is complemented by strengths in bioinorganic, polymerisation catalysis and physical inorganic chemistry.

Studies encompass most of the main group elements, transition metals, and f-block metals, eg lanthanides, Th, and U (Geoff Cloke). Organometallic research is directed towards the synthesis and structural characterisation of highly novel compounds, including for example low coordinate phosphorus (Ian Crossley), the development of new ligands and preparative methods, the activation of small molecules (especially 'greenhouse gases'), and homogeneous catalysis (Martyn Coles, Robin Fulton, Eddie Viseux), supporting the EMC grouping.

Research in the inorganic materials area focuses on low-dimensional magnets and conductors (John Turner), and extended one- and two-dimensional arrays of metal containing polymers (Martyn Coles). Bioinorganic research (Robin Fulton) encompasses studies of lead toxicity, water soluble metallo-drugs, and novel sensors.

Recent highlights include:

- reductive coupling of CO and activation of CO_2 by U(III) mixed sandwich complexes
- synthesis of rare 3-coordinate group 14 complexes that are capable of facile activation of carbon dioxide
- a new class of cationic phosphines incorporating bicyclic guanidine substituents, and their application in coordination chemistry and catalysis
- synthesis and structures of dense phase magnetic fluorides that are archetypes for low dimensional magnets and superconductors.

Organic chemistry

The strong presence in organic chemistry has resulted in the discovery and control of reactive organic intermediates that produce new and incisive synthetic techniques. The aim is to control stereochemistry in organic synthesis (Robin Fulton, Phil Parsons, Eddy Viseux).

Biologically important molecules and their medicinally important synthetic analogues are targets (Phil Parsons), including sialyl and carbocyclic neuraminic acid mimetics (Hans Streicher).

Recent highlights include the total synthesis of galbonolide B, alkene cross metathesis for nitroalkenes and the double [3+2] photocycloaddition reaction and tools for the characterisation of influenza virus neuraminadases. There are important new initiatives in medicinal chemistry (Simon Ward) and drug design.

Physical chemistry

Experimental physical chemistry develops techniques in laser science, single molecule spectroscopy and FRET – Förster Resonance Energy Transfer (Mark Osborne), mass spectrometry (Alaa Abdul-Sada), NMR (Iain Day), and nanoscience (Qaio Chen) to apply to problems in EMC and D³S.

Highlights within D³S include the use of FRET to elucidate multiple mechanisms for the regulation of ribonucleotide reductase by Spd1, and the use of NMR to follow the effects of Alzheimer's A_β Aggregation state.

Within EMC, nanostructured MO_X semi-conductors are being developed for photo-catalysis and photovoltaics. A recent highlight of fundamental work in the area of photocatalysis is the demonstration that electrons trapped at the surface of TiO_2 affect the surface chemistry.

Theoretical and computational chemistry

Interests span the development of time-dependent density functional theory methods, the analytical solution of the three body problem and modelling radiation damage in graphite to the interactions between proteins and nucleic acids.

Theoretical chemistry

Theoretical chemistry covers molecular, solid-state and biological systems. Within EMC, a prime focus is the activity in carbon science at Sussex initiated by Sir Harry Kroto, with applications to energy research (Malcolm Heggie).

The most important source of low CO_2 power generation in the UK is the fleet of graphite moderated nuclear reactors (AGRs and Magnox). Density functional theory calculations are applied to understand the processes by which neutron damage causes changes in shape and strength in the graphite. Highlights in this area include identification of the fundamental cause of the Windscale nuclear accident (stored energy in graphite), low-energy routes for the Stone-Wales transformation in fullerenes, and the science of buckling and folding graphene.

Fundamental experimental studies of ion solvation are key to understanding the behaviour of ions in solution in living things and in the environment. In a collaboration with the University of Nottingham, we are supported by time-dependent density functional calculations (Hazel Cox). Highlights of this work are the first UV photo-fragmentation studies of dication Mn and Zn complexes.

Within D³S, rational design of medicinal compounds is supported by molecular dynamic calculations of interactions between proteins and nucleic acids and of the structure and dynamics of DNA (Peter Varnai). A recent highlight is the identification of helical chirality as the link between local interactions and global topology in DNA.

Research interests by faculty member

Current research interests of supervising faculty are listed below, together with their primary research group allegiances in brackets. For more information, visit **www.sussex.ac.uk/lifesci/people/chemistry**

Alaa Abdul-Sada (EMC) Mass spectrometry and its application in chemistry of the environment. Analytical application of different mass spectrometry.

Qiao Chen (EMC) Advanced materials technology for green energy. Sub-molecular imaging of molecular recognition events and chemical reactions. Metal oxide, semiconductor and metal substrates.

Professor Geoff Cloke (EMC) Synthesis of novel, highly reactive organo-transition metal and f-element complexes. Small molecule activation (CO, CO_2) by uranium(III) complexes.

Martyn Coles (EMC) Synthesis/coordination chemistry of cationic phosphorus compounds. Bulky alkyl ligands to stabilise reactive main group complexes. Main group compounds for catalysis.

Hazel Cox (EMC) Theory of the chemical and physical properties of gas-phase TM complexes. Implementation and use of time-dependent density functional theory for spectroscopy.

Ian Crossley (EMC) Synthesis and study of d-block and main-group organometallics with non-classical reactivities and electronic properties. Design and synthesis of novel amphiphilic chelates and low-coordinate phosphorus compounds.

Iain Day (D³S/EMC) Development of pulse sequences for hyperpolarised NMR methods. Application of diffusion ordered NMR spectroscopy and novel time-resolved NMR experiments to the formation of amyloid fibrils.

Robin Fulton (EMC) Lead (and group 14 analogue) alkoxides/hydroxides and their viability as nucleophile or base. Synthesis of main group materials and development of new chiral catalysts

Professor Malcolm Heggie (EMC) Computer modelling of solids and large molecules. Mechanochemistry. Layered materials. The Matter Compiler: synthesis in the scanning probe microscope. Graphite and novel carbons.

Shane Lo Fan Hin (EMC) Development of experiments for the enhancement of chemical education.

Mark Osborne (D³S/EMC) Development of ultra-sensitive laser spectroscopic techniques to detect, image and manipulate single molecules. Application of single-molecule technologies to the study of the photophysics of molecules and cellular imaging.

Professor Philip Parsons (D³S) Synthesis of molecules (galbonolide B, antifungal; lactonamycin, anti MRSA; herbimycin, anticancer) involving cascade reactions, organometallic reagents and cycloadditions.

Professor Louise Serpell (D³S) Refer to the Biochemistry subject entry on page 48.

Hans Streicher (D³S) Carbohydrate (bio)-chemistry and synthesis of carbohydrate mimetics. Carbohydrates and sialic acids in molecular recognition processes and related diseases.

Darren Thompson (D³S) Refer to the Biochemistry subject entry on page 48.

John Turner (EMC) Reactivity in TM and main group molecules. Small targets (C_nH_m, H_2, O_2, N_2) with TM systems containing electronically non-innocent amides. Novel dense phase fluorides with low-D magnetism.

Peter Varnai (D³S) Computational studies of structure and dynamics of biological molecules in collaboration with experiments such as NMR and single-molecule FRET spectroscopy. Rational design of molecules for medicine and biotechnology.

Eddie Viseux (D³S) Novel multidisciplinary methodologies for synthesis. Natural product synthesis. Novel manganate reagents to oxidise allylic and propargylic alcohols. Green chemistry.

Professor Simon Ward (D³S) Medicinal chemistry and drug discovery. Research in oncology, neurodegeneration and infectious diseases synthesising molecules and characterising in biophysical and biochemical assays to identify novel drug candidates.