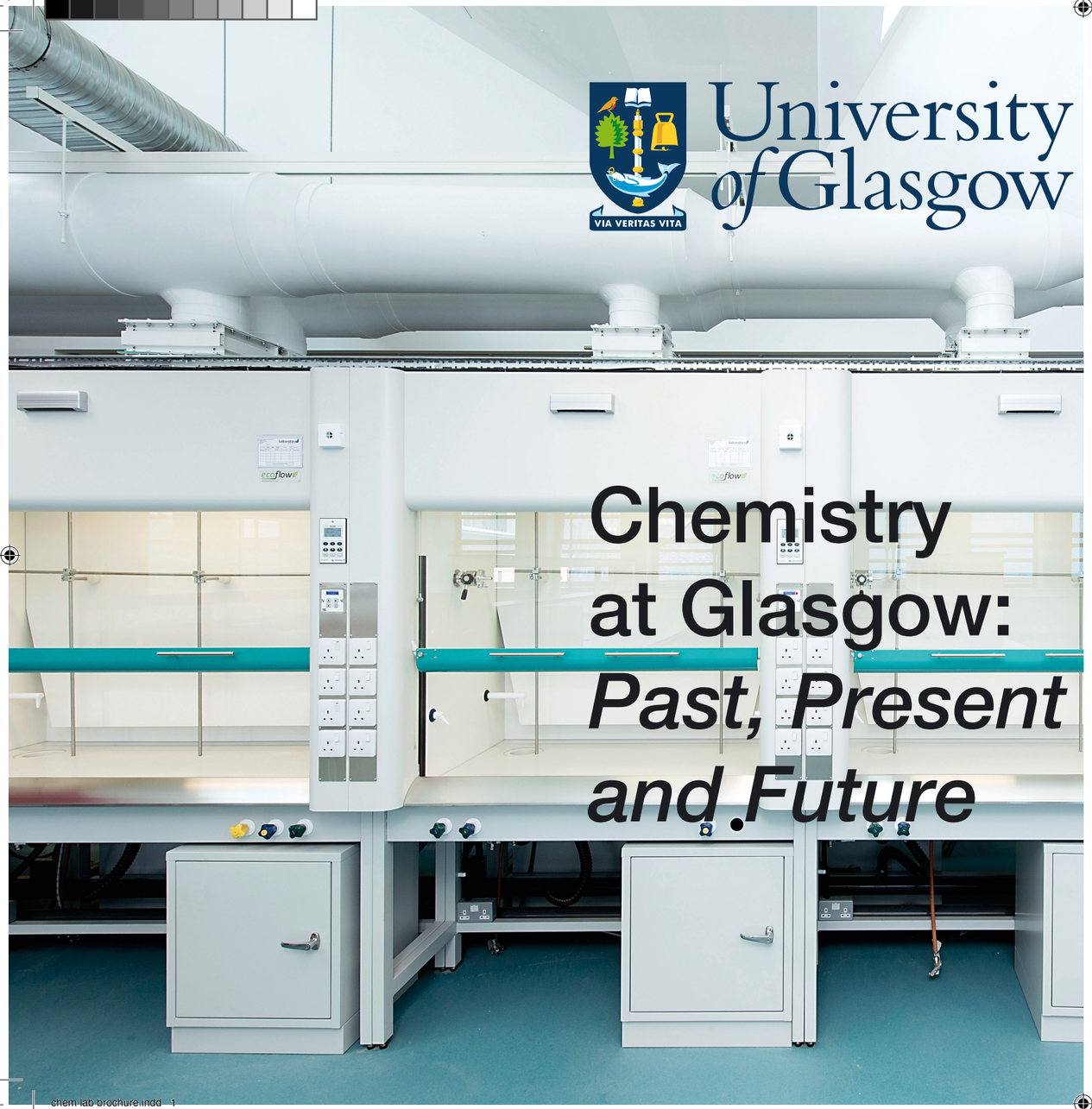


University of Glasgow

VIA VERITAS VITA

Chemistry at Glasgow: *Past, Present and Future*

Programme

Welcome at the “Chemistry at Glasgow: Past, Present and Future” event celebrating the renaissance of chemistry at the University of Glasgow and offering a perspective on the future direction of the School of Chemistry. The programme for the afternoon will be:

2:00 pm:	Prof Stephen Clark (Head of the School of Chemistry) – Welcome
2:10 pm:	Dr Robert Anderson (former Director of the British Museum in London) – The 250-year history of chemistry at the University of Glasgow
2:40 pm:	Award ceremony and unveiling of the ACS plaque for Frederick Soddy
2:50 pm:	Dr Philip Ball (Author, science journalist, and former Nature editor) – The role of water in biology
3:20 pm:	Coffee and tea break
3:50 pm:	Prof Herbert Waldmann (Director of the Max Planck Institute for Molecular Physiology, Dortmund)
4:20 pm:	Prof Robert Liskamp – Inaugural Lecture
5:30 pm:	Informal reception and tour of the Laboratory for Chemical Biology

Laboratory for Chemical Biology

The Laboratory for Chemical Biology contains 20 fume hoods and has direct access to all state-of-the-art (single, multiple, microwave) peptide synthesis, purification (normal and reverse phase prep HPLC, flash chromatography systems), and characterisation equipment (ES-MS with ion-trap). It has equipment for binding/interaction studies (ITC, FRET, plate reader) and facilities for microbiological work and tissue culture are adjacent to the central lab.

The layout of the lab is such that the large write-up space is very accessible and nearby, but still quiet with individualised workplaces. North facing roof windows throughout the lab (including the write-up space and equipment lab) allow a maximum of daylight to enter. Together with the bright colour scheme, it is a very desirable place to work and spend many hours.

Research in our school

Research in the School of Chemistry is carried out under the heading of five research sections: Heterogeneous Catalysis, Chemical Biology Molecular Medicine & Synthetic Biology, Complex Chemical Systems, Dynamics & Structure, and Nanoscience & Materials. In this brochure, we highlight some of the “biology inspired” chemistry research in our school.

Chemical biology

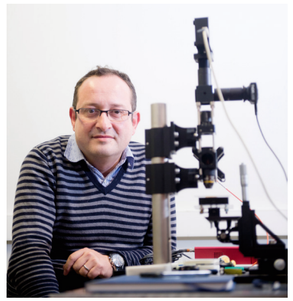
In the group of **Prof Rob Liskamp**, Chemistry is applied as a powerful “enabling” science in Chemical Biology facilitating developments in biology and the medical sciences. Core to chemistry is the design and creation of molecules allowing us to obtain insights in biological processes including diseases such as cancer, infections, and autoimmune diseases leading to new approaches of treatment. It requires a multidisciplinary effort where chemical biologists, cancer researchers, physicists, and structural chemists are collaborating. Despite enormous advances, vaccines for malaria, HIV, and hepatitis C are still not available while resistance against antibiotics is increasing. We are developing chemo-synthetic vaccines based on essential parts of proteins of a virus. Using molecular evolutionary approaches, we are developing a new generation of smaller (synthetic) antibodies for treatment of inflammation, infections, and cancer.

Proteins ‘ring like bells’

As far back as 1948, Erwin Schrödinger—the inventor of modern quantum mechanics—suggested that quantum mechanics and coherent ringing might be at the basis of all biochemical reactions. Researchers in the group of **Prof Klaas Wynne** have shown this to be correct. Using lasers, they have been able to measure the vibrational spectrum of the enzyme lysozyme, a protein that fights off bacteria. They discovered that the entire protein rings like a bell with a frequency of a few terahertz or a million-million hertz, which could be responsible for the transfer of energy across proteins. The experiments show that the ringing motion lasts for only a picosecond or one millionth of a millionth of a second, which is just perfect for the most efficient reaction.

Chiral plasmonics nanomaterials

A new type of material called *chiral plasmonic nanomaterials*, which is composed of gold nanostructures, enables light to be bent and twisted in ways impossible with traditional glass lenses. This offers the chance to detect unprecedented nanogram amounts of biological material such a viruses or toxins. A team of chemists and engineers led by **Dr Malcolm Kadodwala** have invented a cheap plastic-based chiral plasmonic nanomaterial that they are developing into new medical diagnostic technologies. They are currently, working with colleagues at the Beatson Cancer Research Laboratory on rapid multiplex screening of protein–protein interactions relevant to the diagnosis and treatment of a variety of cancers.

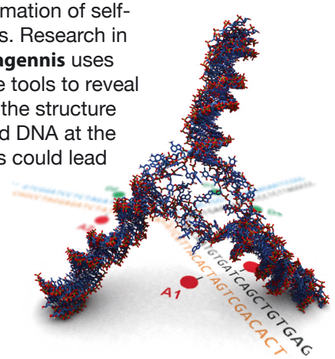


Molecular imaging agents

Many diseases are poorly diagnosed and treated due to a lack of understanding at the molecular level. One approach in gaining a better insight into disease mechanisms is the design of non-toxic, molecular imaging agents that can bind with high affinity and high selectivity to a targeted biological receptor. The challenge is to generate functionalised molecular tracers that can produce insightful images of a specific disease. Work in the group of **Dr Andy Sutherland** has led to the development of one-pot, multi-bond forming tandem reaction processes that allow the rapid assembly of functionalised drug-like molecules. Used in combination with novel transition metal catalysed labelling techniques has allowed the generation of new, non-toxic molecular imaging agents for a range of neurological disorders and diseases such as cancer.

Watching single DNA molecules

The double helix is the iconic form of DNA but this unbranched form is not the active one *in vivo*. Instead, it is branched DNA molecules that are key intermediates in genetic duplication and repair of DNA damage. Branched DNA is also widely used for nanoscience and nanotechnology in the formation of self-assembled nanostructures. Research in the group of **Dr Steven Magennis** uses cutting-edge fluorescence tools to reveal unique information about the structure and dynamics of branched DNA at the single-molecule level. This could lead to potential drug targets, new design strategies for synthetic biology, and the development of programmable DNA machines and circuits.

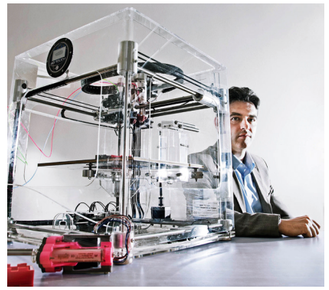


Catalysts reducing carbon dioxide

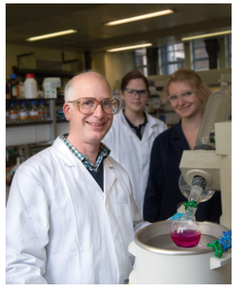
The group of **Dr Mark Symes** aims to design and synthesise new catalysts for the reduction of nitrogen oxides and carbon dioxide, based on the enzymes that undertake these conversions in nature. In doing so, we will make catalysts that are more selective for particular products and that lower the amount of energy required for these transformations. Key reactions that are being investigated include the reduction of carbon dioxide to methanol, the reduction of nitrogen to ammonia, and the coupling of methane to give longer chain hydrocarbons.

Evolving inorganic systems

One target of the group of **Prof Lee Cronin** is the development of ‘inorganic biology’, that is, a biological system beyond the naturally occurring ‘organic biology’ found on planet earth. Not only does this have ramifications for the origin of life on earth, elsewhere in the universe, but the realisation of a living system assembled from the bottom up would also lead to a range of new technologies. We allow complexity and information transfer between systems to bootstrap the assembly of systems capable of exhibiting evolutionary dynamics. This new experimental approach not only requires developments in information theory, but automation of experiments, robotics, and evolutionary programming. Success could mean new hints to the origin of life on earth as well as the possibility of developing new types of artificial life based upon chemistries not found in biology today.



Oxidative Stress



How do we age? Can degeneration be prevented or reversed? How should we treat heart attacks, diabetes, and stroke? These are some of the questions that the group of **Dr Richard Hartley** is answering using chemical biology. Oxidative stress interests him because it is involved in neurodegeneration, cardiovascular disease, diabetes, and the process of ageing. It is complicated because the reactive oxygen species (ROS) that cause oxidative stress are also vital for cell signalling. The ROS are made in the mitochondria, which are the powerhouses of the cell. However, no one could quantify the ROS that were being made or knew what caused overproduction in disease. What is more, drugs were needed both to stop ROS overproduction and to clean up the damage they cause. The Hartley group have developed small molecules that go to the mitochondria and report what is going on there as well as a molecular mop that cleans up the molecular garbage generated in diabetes.

Green strategies for energy storage

The declining availability of fossil fuels and our ever-increasing global energy demands make developments in energy storage capabilities of vital importance. Researchers in the group of **Dr Serena Corr** are tackling this issue with work focussing on developing new ‘green’ routes to nanoparticles that can act as the active material in Li-ion batteries. We have developed faster routes to electrode nanoparticles using energy and time efficient microwave synthetic approaches and we also employ environmentally friendly and sustainable materials in our syntheses.

Robert Anderson giving his talk with a slide of Soddy in the background.

Prof Anton Muscatelli (Principal & Vice-Chancellor of University of Glasgow) with Robert Anderson, unveiling the HIST ACS plaque.

Professor J. Stephen Clark FRSE and Robert Anderson with the plaque.

Robert Anderson with the plaque.

Attendees:
Back row (left to right) Prof J. Stephen Clark FRSE, Prof Robert Liskamp (University of Glasgow), Herbert Waldemann (Head of the Department of Chemical Biology at the Max Planck Institute of Molecular Physiology, Dortmund and Professor of Biochemistry, Technische Universität Dortmund);.
Front row (left to right) Dr Philip Ball (science journalist and writer), Prof Anton Muscatelli (Principal & Vice-Chancellor of University of Glasgow), Dr Robert Anderson

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