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Technologies

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The Manchester Institute of Biotechnology (MIB) is one of the leading biotechnology research institutes in the world. Focusing on advanced quantitative approaches to specific biotechnology challenges at the interface, the MIB enjoys a unique pluralistic and open research culture that is realised through a coherent and integrated research concept and the establishment of a unique multi- and inter-disciplinary community of researchers committed to working across discipline boundaries.

The MIB is based at the John Garside Building and houses over 500 research staff and students from 52 research groups from across The University of Manchester from the Faculties of Engineering and Physical Sciences, Life Sciences, and Medical and Human Sciences. With a strong emphasis on translational research, knowledge transfer and discovery through innovation our philosophy has placed us in a strong position to address a series of Grand Challenges that inform and are informed by our research at the molecular, systems and design levels as illustrated in our Discovery through Innovation Pipeline (Fig 1.0).

We pursue and are actively engaged in challenging research projects that enable us to make significant advances in science and engineering to benefit industry and society. Our track record in driving major interdisciplinary programmes in biotechnology has attracted more than £90M in external funding since MIB's inception in 2006 and our portfolio continues to grow substantially primarily through a “tightening” of our focus in areas of core strength (industrial biotechnology; synthetic biology; catalysis science; systems-based research; biomedical biotechnology; fuel and energy research), and supported by strategic recruitment to new leadership positions in the Institute.

Our research strengths are showcased in the ensuing pages defining our research Grand Challenges and showcasing a selected portfolio of projects that illustrate the diversity, quality and dynamism of our research teams. Our reputation as an international leader in the biotechnology field is evidenced with over 1400 publications, since 2009, in major journals and the impact of the Institute’s research is evident from a sustained commitment to the successful translation of basic science into commercial success.

As a leading industry-interfaced biotechnology institute we are proud to engage in technology transfers and have a number of strategic partnerships with companies from the chemical, biotechnology and biopharmaceutical sectors to translate research council funding into products and services for the betterment of all people and the environment across the globe.

Nigel Scrutton
Director

Harnessing the synergy of interdisciplinarity
Focusing on specific challenges in biotechnology the co-localisation of researchers from distinct disciplines generates interdisciplinary teams with unique capabilities.

Design promotes interaction
Reflecting the needs of interdisciplinary science, the MIB features open-plan, multifunctional laboratories and extensive specialist research facilities.

Discovery through innovation
Delivering internationally recognised programmes across all disciplines, with a strong emphasis on translational research, knowledge transfer and discovery through innovation.

Innovation in action
Advancing economic and societal development through knowledge generation and transfer. Enabling companies of all sizes to benefit from our research technology and expertise. Exploiting commercially significant innovation through licensing and the creation of spin-out companies.

The Manchester Institute of Biotechnology is committed to the pursuit of research excellence, education, knowledge transfer and discovery through innovation whereby a coherent and integrated interdisciplinary research community work towards developing new biotechnologies that will find applications in areas such as human health, the economy, food security, industrial transformations and the environment.
The University of Manchester

Our goal, outlined in the Manchester 2020 strategic plan, is to establish the University as a major centre for interdisciplinary research. The large scale and quality of our activity at Manchester sets us apart. We are able to combine disciplines and capabilities to meet both the challenges of leading-edge research and the external demands of society, business and other stakeholders.

The University of Manchester is one of the world’s leading centres for biomedical and biotechnology research that sits at the forefront of new discoveries in science and engineering. Research is at the heart of the University and the sheer scale, diversity and quality of our research activity is unrivalled in the UK. We have a distinguished history in research, innovation and enterprise stretching back over 180 years with many of the major advances of the twentieth century having been discovered at the University.

Our interactions carry responsiblity for several of the University’s key research priorities, working in areas where we have achieved or aspire to world-leading status. The Manchester Institute of Biotechnology was the first University-based, purpose-built interdisciplinary research institute of its kind in the UK. Through the establishment of multi-skilled interdisciplinary teams applying pioneering approaches to major global challenges in biotechnology, it has evolved into one of the leading biotechnology research institutes in the world.

We are committed to enhancing the lives of all people, through knowledge transfer and education and this is firmly embedded in the global challenges that constitute the unique research vision of the MIB whose role is integral to the advancement of the research mission of the University.

Professor Luke Georghiou
Vice President for Research

Expanding cross campus collaboration

We continue to develop collaborations across the University campus with current research grant funding aligned with 83 research groups from all four Faculties. Recent funding successes and applications endorse a closer alliance with other University of Manchester Institutes: Photon Science Institute, Manchester Institute of Innovation Research, and the Institute for Science, Ethics and Innovation. The development of our synthetic biology (SynBio) activity has developed closer alliances with members of the Faculty of Life Sciences and the Faculty of Engineering and Physical Sciences and with the Faculty of Life Sciences. Our interactions with the Faculty of Medicine and Human Sciences has developed significantly through the appointment of Professor Clare Mills, but also in the metabolomics area through Professor Roy Goodacre and in spectroscopy through Professor Peter Gardner. Our system modelling/text mining activities continue to assemble cross-faculty teams of researchers to deliver innovative research at the forefront of medical biotechnology.

Cross-disciplinary feasibility

There are numerous areas of research within the biological and biomedical field that require the ability to quantitatively analyse single cells and large cell populations. For example, metabolomic studies have the potential to yield understanding of complex disease processes, drug toxicity and cellular function whilst the development of innovative tools for accurate measurement of transcripts and proteins necessitates novel sample handling, data amplification and use of miniaturisation and microfluidics to assist with high throughput measurements to achieve sensitive detection.

In a programme funded by the EPSRC the MIB engaged in a suite of short-term speculative activities to consolidate the cross-disciplinary culture within the Institute. In one project, Professor Peter Gardner in collaboration with Professor Mark Dunne (FLS) differentiated four separate cell lines in pancreatic stem cells using FTR cell population imaging technologies. Following on from earlier work led by Professor John Vickers which utilised imaging Mass Spectrometry for 2D and 3D cellular characterisation in an Alzheimer’s study, Professor Roy Goodacre and Professor Nick LOCKYER will join a collaborative team of researchers from FLS led by Professor Alan Dickson that will seek to describe and understand the heterogeneity of stem cell populations at the molecular level. A stem cell model has been selected that has major significance in finding a potential cure for diabetes, but which also serves as a model for the general progression of stem cells towards a specific functional fate.

Stem cell fractionation using interactions with artificial matrices

There has been a recent explosion in interest in and potential applications of stem cells. Their potential for therapeutic medical applications is particularly exciting, with the real prospect of growing replacement tissue and bone to overcome a wide variety of disease conditions. Stem cells also have an important role in diagnostics, and have already shown promise in drug discovery research. To date, the key limitation to the exploitation of stem cells has been their scarcity. Furthermore, even when it is possible to source stem cells, there is still the formidable task of purification and sorting of the usable cells from cells that have differentiated into unusable types. Presently, stem cells are labelled with markers and then sorted one-by-one using very expensive instruments. Despite the very high speed of modern cell sorters the relatively small numbers obtained and the addition of labelling reagents mean that these methods are not suitable for widespread application of stem cell therapy. Stem cells have yet to find global application, because of their rarity. This project proposes to change the current stem cell sorting methods from low throughput one-by-one techniques to very high throughput alternatives that will be capable of sorting millions of cells simultaneously. The key to this will be the design of a series of filters that behave as smart sieves. The stem cells will be poured through new filters that will recognise the cells by their shape, size, flexibility and their chemical signature, without the addition of any extra reagents. A set of filters will be assembled, one on top of the other, to allow rapid screening of a mixture that contains both the valuable wanted stem cells, alongside less useful cells. This research programme will focus on the design of these filter stages, and use cutting edge science and technology to generate a completely new approach to stem cell purification. Specialist techniques such as microfluidics, nanotechnology, rapid microstructure prototyping will be combined with the latest ideas in cell biochemistry and cell bio-recognition to fulfil the primary objective of making it easier, cheaper and faster to harvest useful stem cells. The benefit to society will be huge, making the possibility of stem cell therapy a reality for everyone.

This is an EPSRC funded project involving partners from across the University, Professor Nick Goddard in collaboration with Professors Cathy Merry (Materials), Cay Kelly (FLS), Tony Day (FLS), Chris Ward (Dentistry) from The University of Manchester and Professors Steve Eichhorn from the University of Exeter and Peter Fielden from Lancaster University.
Beyond The University of Manchester we have a strong portfolio of national and international collaborations and networks with academics and industry. The diversity and quality of our research programmes is reflected in publications in major journals, with over 500 publications with over 280 research institutes from over 65 countries. The impact of the Institute’s research is evident from a sustained commitment to fundamental research institutes from over 65 countries. Our EU portfolio continues to grow, with current live awards in the region of €14 million, through collaborative research programmes and major EU training networks.

A number of EU and RCUK funded projects are tackling some of the key barriers to chemical manufacture in the 21st century. CHEM21 (Chemical manufacturing methods for the 21st century pharmaceutical industries) is a public-private partnership (PPP) that was launched at the end of 2012, led by Professor Nicholas Turner and GlaxoSmithKline. This is a €26.4 million project that brings together six pharmaceutical companies, 13 Universities and four SMEs from across Europe with the aim of developing sustainable biological and chemical alternatives to finite materials, such as precious metals, which are currently used as catalysts in the manufacture of medicines. CHEM21 will run initially for four years with funding from the Innovative Medicines Initiative. BIONEXGEN (Developing the next generation of biocatalysts for industrial chemical synthesis) is another flagship EU collaborative research project developing next generation biocatalysts for eco-efficient manufacturing processes in the chemical industry. This consortium consists of 17 institutions from university research groups, small and medium sized companies, to BASF, the world’s leading chemical company. Professor Nicholas Turner will also lead BIOOX (Developing processes for the chemical industry. This consortium consists of 17 institutions from university research groups, small and medium sized companies, to BASF, the world’s leading chemical company. Professor Nicholas Turner will also lead BIOOX (Developing processes for the chemical industry.

In Autumn 2014 will see the MIB and Photon Science Institute (PSI) host 12 early stage researchers (ESR) as part of a £3.6 million Innovative Doctoral Programme entitled “MAGnentic Innovation in Catalysis”, known as MAGIC. Manchester has partnered with three Universities (Tokyo, Freiburg, and Lund, Joseph Fourier in France, Edinburgh and Copenhagen) and five companies (A2, Bruker, TGK, Conformetrix, and SarDMICS) with each ESR closely linked to the international and industrial partners who will be actively involved in their research projects. DirectFuel is another FP7 funded project involving four Universities from across Europe and the US, together with Chemtex Italia and Photon Systems Instruments. This exciting project aims to develop photosynthetic microorganisms that catalyse direct conversion of solar energy and carbon dioxide to engine-ready fuels. In a separately funded project, a computational perspective is being undertaken by Professor Paul Popelier who is developing innovative QSPR models and expert systems for predicting toxicity of ionic liquids in the provision of safe green solvents for the future.

The Manchester Centre for Integrative Systems Biology (MCISB) is involved in SYNPOL (Biopolymers from syngas fermentation) working alongside 13 partners across Europe. This project aims to develop a platform integrating biopolymer production through modern processing technologies, with bacterial fermentation of SYNGAS, and the pyrolysis of high complex bio waste enabling the treatment and recycling of complex biological and chemical wastes and raw materials in a single integrated process.

In contrast, the Manchester Centre for Text Mining joins OSSMETER (Automated measurement and analysis of open source software) working with 8 partners on platform development that will support decision makers in the process of discovering, comparing, assessing and monitoring the health, quality, impact and activity of open-source software. The Linked2Safety project (Advancing clinical practice and data security in clinical research) brings together 11 partners to develop a secure framework to facilitate the efficient and homogenised access to shared distributed Electironical Health Records (EHRs) which would impact enormously across the healthcare sector.

The diversity of our research in the biomedical and healthcare arena received an EU funding boost with GlycoBioM (Tools for the detection of novel glyco-biomarkers) bringing together Europe’s leading scientists to study glycosylation. Hailing from Croatia (Genos), Denmark (UCPH), Germany (UKE and Galab), Ireland (NIHRT) and the UK (UNIMAN), the team is identifying new biomarkers and tools for detection and diagnostic screening which could be used to develop personalised treatment for cancer and related diseases.

For further details of our live portfolio can be found in the ensuing research pages.
International collaborations

Building links with China

Professors Eriko Takano and Nigel Scrutton have recently secured funding through a Synthetic Biology China Partnering Award, co-funded by the BBSRC, the Chinese Academy of Sciences (CAS) and the EPSRC to partner and develop long term fruitful relationships with Chinese scientists.

We have strong links with the National University of Defence Technology in China and currently host a number of their visiting scientists and PhD students.

In addition we have hosted events with two Chinese Universities (Hebei University of Science & Technology and Jilin University) to encourage scientific and teaching exchanges and collaborations. We continue to welcome a high proportion of overseas students and postdoctoral fellows to the Institute.

Brazil beginnings

In November 2012, academics representing the nine schools that comprise the Faculty of Engineering and Physical Sciences visited the top universities in Brazil to explore research synergies. MIB’s Dr Chris Blanford and Dr Neil Dixon, two members of the delegation, hosted a reciprocal visit in March 2013 to establish collaborations based on mutual strengths in industrial biotechnology and bioenergy. This has led to several joint funding applications and paper submissions.

MIB researcher secures National Institute of Health grant

Dr Alexander P Golovanov from The University of Manchester has established a new and exciting collaboration with one of the world’s leading virology groups, led by Professor Rozanne Sandri-Goldin at the University of California-Irvine to jointly study the molecular mechanisms behind the critical protein interactions which lead to the herpes virus hijacking the cell.

Herpes simplex virus 1 (HSV-1) causes a wide range of diseases, from recurrent painful skin lesions to more serious conditions such as encephalitis.

Recently, studies here in Manchester led by Professor Ruth Itzhaki suggested that HSV-1 can be a risk factor in Alzheimer’s disease, and that antiviral drugs might be effective at slowing down its progress. Unfortunately, no effective antiviral treatment is currently available, which suppresses viral replication efficiently. Finding a ‘weak spot’ in the HIV, which can be targeted by the therapies of the future, would therefore make a significant breakthrough.

During the infection, HSV expresses and uses a key multifunctional protein called ICP27, which among other regulatory functions, helps the virus to hijack the cellular machinery which normally exports the cellular mRNA from the nucleus to cytoplasm. Instead this machinery is used to export viral mRNA. Earlier NMR studies performed in the MIB (Tunnicliffe et al, PLoS Pathog, 2011, 7(1), e1001244) established the first atomic-resolution structure of the complex between viral ICP27 and cellular mRNA factor.

This five-year project funded by the National Institute of Health (NIH) will look into further details of how the assembly of multicomponent complexes between viral and cellular proteins is organised and regulated, ultimately promoting viral replication. The identification of critical binding interfaces in these complexes may help to design new drugs, which will interfere with this complex assembly and HSV replication.

This collaborative project consists of two complementary parts: virology and in vivo studies will be conducted in the University of California Irvine, in Sandri-Goldin’s group, while high-resolution structural studies, mainly using NMR spectroscopy, will be conducted here in the MIB in Dr Golovanov’s group. What we learn about ICP27 mechanism of action may be helpful in developing drugs targeted at other herpes viruses such as KSHV, which causes cancer as these viruses also encode ICP27 homologues.
Degenerative disease researchers make breakthrough in bid to find treatment for Parkinson’s and Huntington’s

A significant breakthrough has been made by scientists at the MIB towards developing an effective treatment for neurodegenerative diseases such as Huntington’s, Alzheimer’s and Parkinson’s. The work, published in the journal Nature, was led by Nigel Scrutton, Professor of Molecular Enzymology, and details how an enzyme in the brain interacts with an exciting drug-like lead compound for Huntington’s disease to inhibit its activity, demonstrating that it can be developed as an effective treatment for neurodegenerative diseases.

New drug treatments for Alzheimer’s – adopting a drug repositioning strategy

Current drugs for Alzheimer’s can only delay symptoms for about six months, so new effective drugs are desperately needed.

Several thousand chemicals safely exert a change in the human body and are currently in use for treating medical conditions. Professor Andrew Dugird adopting the strategy of drug repositioning to find new drug treatments by testing to see whether any of these chemicals are beneficial for Alzheimer’s disease. There is precedence for this approach: Viagra and Rogaine treatment for hair loss were both found to have desirable side effects, though they were designed to treat other conditions. Old drugs that are effective in cellular models for Alzheimer’s disease can be rapidly progressed to clinical trials in humans, since many of the essential steps in drug development, such as toxicity testing in animals and people, have already been done.

A few hundred drugs have been tested but few show promise as drugs. It is possible to treat Parkinson’s disease and cancer, addiction, by Abbott Laboratories, but not tested for Alzheimer’s. Abbott Laboratories showed that A-77636 can enter monkey brains when taken orally, a crucial requirement for an Alzheimer’s drug. A new company, Phamarise, founded by Professor Andrew Dugird and Dr Farid Khan launched in 2012 will take A-77636 forward and test thousands of other known drugs. Hits found in cell culture will be examined to find out how they work and then tested in mouse models. A-77636 that are being developed by the global Huntington’s disease research team at University of Leicester, said: “This is a major move forward for the development of new KMO inhibitors. It is hoped that such compounds may ultimately be tested in clinical trials and prove beneficial for patients.”

Professor Sarah Tabrizi is the head of the Huntington’s disease research team at University College London’s Institute for Neurology. Commenting on the research, she said: “Unlocking the crystal structure of KMO is a real boost to our efforts to find treatments for this devastating disease. It provides a solid basis for the optimisation of inhibitor drugs Bx UPF 648 that are being developed by the global Huntington’s disease research community. KMO is one of our top drug targets, and the crystal structure is a significant step along our roadmap to clinical trials of KMO inhibitors in patients.”

Bacteria to shed light on new drug targets for inherited cancers BRCA1 and BRCA2

Working with colleagues at the University of Leicester and the University of Labor in Portugal, researchers identified the molecular structure of the enzyme lysine-5-monooxygenase (KMO), which is found in the human brain. It took five years for the team to establish the crystal structure of KMO – the first time its ever been done. The scientists then studied how the compound UPF 648 binds incredibly tightly to the enzyme to act as an inhibitor. Previous studies with animal models of neurodegenerative disease have shown that switching off the enzyme activity through drug binding should be effective in the treatment of brain disorders.

Professor Nigel Scrutton said: “UPF 648 works very well as an inhibitor of enzyme activity. However, in its current form it does not pass into the brain from the blood. The search is now on for related compounds that can both inhibit the enzyme and pass into the brain. Our research detailing the molecular structure of the enzyme now enables a search for new KMO inhibitors that are able to cross the blood–brain barrier. This provides real hope for developing drug therapies to target neurodegenerative diseases such as Huntington’s, Alzheimer’s and Parkinson’s diseases.”

Dr Flaviano Giorgini, the team’s neurogeneticist from the University of Lisbon, said: “This is a big move forward for the development of new KMO inhibiting drugs. It is hoped that such compounds may ultimately be tested in clinical trials and prove beneficial for patients.”

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New discoveries in biotechnology are applied to medical processes that can find applications in such areas as pharmacogenomics and drug production. The development of modern medicines requires an understanding of molecules and networks at the molecular and systems levels which involves imaging and spatial mapping of cell responses in health and disease and in response to drug challenges. Our research ranges from structural and dynamic modelling of potential drug targets and their interactions including establishment of early phase drug discovery pipelines through the challenges of systems mapping of the “virtual human”.

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In parallel, project members from The University of Manchester, in collaboration with the University of Liverpool, have been working on an analytical tool to capture and characterise glycan binding proteins which could eventually be used to pinpoint sugar biomarkers in diseases such as cancer.

This project has also progressed our understanding of diabetes, in particular the discovery of a novel glycan biomarker related to the disease, and the team expects to develop a system that will enable patients to check for maturity-onset diabetes of the young (MODY), a form of diabetes that is caused by mutations in a number of different genes.

The GlycoBioM project is truly a European success story, with partners from opposite ends of Europe all contributing to ground-breaking results. When the Croatian team found that certain glycans can predict the speed at which colon cancer will progress and that these results lead to better stratification for ovarian cancer, the team has made a significant contribution to help women with ovarian cancer. Apart from helping to develop new medicines at home, rather than having to visit hospital for lengthy infusions. The clinical need for underpinning research to support this pharmacology project has been met by the development of a new glyco-profiling method to reduce false-positive cancer diagnoses. This is expected to help women with ovarian cancer.

In order to further develop a new blood test for ovarian cancer, the team has made commendable progress in unravelling the complexities of breast cancer and has hoped that these results lead to better stratification of patients regarding the choice of the most appropriate therapy. This project also featured in the Royal Society Summer Exhibition – see Science and Society section.

Tackling the manufacture of concentrated protein medicines

Future trends in treating various chronic diseases with recombinantly-produced therapeutic proteins (such as monoclonal antibodies) require frequent and high doses of an active protein ingredient in a small volume of liquid (e.g. >10mg/ml) for subcutaneous (SC) injections using a prefilled syringe or auto-injection device. There is thus a need for underpinning research to support industrial development of new protein therapeutics for more convenient delivery of medicines to administer medicines at home, rather than having to visit hospital for lengthy infusions. The challenge for bioprocessing research is to dissolve the dose of protein required in a small volume to enable self-injection. The challenging project will be led by Dr Xue-Feng Yuan, Reader in Biochemical Physics in collaboration with MB colleagues Dr Robin Curtis and Dr Alexander Gobovanni from the School of Mechanical, Aerospace and Civil Engineering (SMACE).

Funded by the BBSRC, this project aims to develop methods for use by industry to screen protein formulations for viscosity and other flow properties, using small quantities of protein. This will enable methods for viscosity reduction to be developed. The team will apply comprehensive rheological characterisation, RheoChip rheometry, and advanced modelling as a platform, which can be used by industry to select the protein and formulation for development of the final dosage form, at an earlier stage than is possible today saving time and money in the development of many new protein medicines. The research will build on existing methods, which are already well established for rheological characterisation of water soluble polymers and BSA solutions, and adapt and apply them to the bioprocessing and injectability of high concentration protein biopharmaceutical solutions.

Dr Osman Blanch, Reader in Biophysics, has been working on an EPSRC-funded project with Dr Stavroula Balaban, a fluid dynamics engineer at UCL, to investigate the destabilisation of a protein structure in shear flow by changing protein-protein interactions during bioprocessing. The aggregation of protein therapeutics (biologics) is a major problem for the pharmaceutical sector and Dr Blanch and colleagues are developing Raman and infrared spectroscopies to understand the structural parameters governing their stability in order to solve this problem. In a related project, Dr Blanch is also working with Professor Annette Doig to develop these spectroscopic tools for detailed structural analysis of proteins and UCB Pharma are now supporting this research.

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World’s biggest ever study of food allergy gets underway

Up to 20 million European citizens suffer from food allergy, a disease that can be conquered, if critical steps are taken. However, management of both food allergy by patients and health practitioners, and allergies, by industry, is thwarted by lack of evidence to either prevent food allergy developing or protect adequately those who are already allergic. European Commission-sponsored research, known as the Integrated Approaches to Food Allergy and Allergy Risk Management (iFAAM), will set the stage for facilitating such research, known as the Integrated Approaches to Food Allergy and Allergy Risk Management (iFAAM), will set the stage for facilitating such intervention studies into food allergy from their application and new knowledge resulting from this will support more transparent producers. The evidence base and tools that will emerge from the Allergy and Respiratory Centre (represented by Unilever and Eurofins), and technology. The induction ceremony for new Fellows took place at the IUFoST* World Congress of Food Science and Technology, a distinguished group of professionals, known as the European Commission’s Toxicology Centre. The Manchester team will work with 38 partners including, industrial stakeholders (represented by Unilever and Eurofins), patient groups representing people at risk of severe allergic reactions from Germany, UK and Ireland and a risk manager and assessor group including the UK Food Standards Agency. The project will work closely with the clinical community, working in collaboration with the European Academy of Allergy and Clinical Immunology.

This study involves 38 partners and is headed by MB’s Clare Mills, Professor of Allergology, from the Allergy and Respiratory Centre of The University of Manchester’s Institute of Inflammation and Repair. Based in the Manchester Institute of Biotechnology, Professor Mills said: “This is a massive research project that will have far reaching consequences for consumers and food producers. The evidence base and tools that result from this will support more transparent precautionary “may contain” labelling of allergens in foods which will make life easier for allergy sufferers as they try to avoid problem foods.”

Developing a technological platform for the design of novel biomaterials

In a project that will contribute significantly to the field of healthcare technologies as well as biomaterials and tissue engineering research Dr Alberto Saiani, Reader in Molecular Materials, has received an EPSRC Research Fellowship to develop a technological platform for the design of novel biomaterials that can be used across a number of applications. The use of non-covalent self-assembly to construct materials has become a prominent strategy in materials science offering practical routes for the construction of increasingly functional materials for a variety of applications ranging from electronic to biotechnology. A variety of molecular building blocks can be used for this purpose such as de-novo designed peptides. With a library of 20 natural amino acids available it offers the ability to play with the intrinsic properties of the peptide such as structure, hydrophobicity, charge and functionality allowing the design of materials with a wide range of properties. The main challenge facing scientists in this field is being able to rationally design these peptides to gain control over the physical properties of the resulting self-assembled materials. This requires not only an in depth knowledge of the self-assembling processes at all length scales, but also a detailed understanding of the specific requirements of each application targeted. For example, injectable materials need to be developed for cell delivery while for drug delivery oral cavity sprayable systems could be required. For cell culture and tissue engineering the issue of adaptability of material properties is even more critical as depending on cell type, origin and intended behaviour, cells have very different requirements in terms of the environment, (i.e. material properties and functionality) in which they are placed. Finally, one other key element is the cost of these materials. When used as structural materials, as in hydrogels, the quantity of peptide required is significant.

Dr Saiani is currently developing this technological platform by furthering our understanding of the self-assembly process of these short peptides and designing novel responsive and increasingly functional materials for a new field of applications. Through engagement with academic and industrial end-users throughout the development process, the team will ensure that the materials designed will be relevant whilst exploring new potential fields of application.

MIMIT celebrates 4 years

MIMIT (Manchester: Integrating Medicine and Innovative Technology) has celebrated its four year anniversary during which time it has developed 27 projects, requiring £3 million initial investment (project and infrastructure), based on 116 unmet clinical needs. To date projects have leveraged £4 million, 3 clinical research fellowships, numerous publications and patents. One of the first developments reached the market place mid-2013 and resulted in 1 licence agreement with a SME, £5m VC funding and 1% estimated net returns of £250m per annum. Royalty returns will be shared between the NHS, academia and inventors. Two other project have leveraged £6 million VC and £3 million Pharma investment between them and 9 projects have received UMP Proof of Principle investment to get them ‘investor ready’.

One of the early projects supported by MIMIT Phagenesis won Bionow Healthcare Project of the year 2012. Congratulations also went to Curtis Dobson, MIMIT Site Manager for the award of Biomedical Project of the Year 2012 to Micronsensor, a novel infection sensing technology.
**INDUSTRIAL BIOTECHNOLOGY**

Industrial Biotechnology (IB) is a set of cross-disciplinary technologies that use biological resources, such as algae, plants, marine organisms, fungi and micro-organisms, for the production and processing of chemicals, energy and materials. A multidisciplinary approach is essential to transform the traditional chemical and chemical-related sector to a more sustainable and competitive one which draws on disciplines such as organic and synthetic chemistry, biochemistry, molecular biology, enzyme kinetics, genomics, proteomics, bioinformatics and bioprocessing.

With major recent grant awards in Industrial Biotechnology and strategic participation in national and international forums over the past year, the widely recognised expertise in IB@MIB has seen major research programmes initiated.

**Rapid evolution of enzymes and synthetic micro-organisms for the development of industrial biocatalysts**

In collaboration with GlaxoSmithKline, one of the world’s largest pharmaceutical companies, this project seeks to develop an accelerated laboratory evolution platform for the rapid optimisation of biocatalysts for industrial application in target molecule synthesis.

*Expertise has been compiled from seven diverse research groups based at the MB, under the leadership of Nicholas Turner, Professor of Chemical Biology and Director of CoEBio3.* Leading other work packages within this grant are Professors Sabine Flitsch (glycomics), Roy Goodacre (metabolomics), David Leys (crystallography), Jason Micklefield (synthetic biology and biocatalysis), Nigel Scrutton (aromacymetry) and Dr Claire Evers (mass spectrometry, University of Liverpool).

By essentially mimicking the process of Darwinian evolution in the laboratory this interdisciplinary team will develop a new approach to engineering robust biocatalysts that will enable the optimisation of enzymes for industrial applications in a matter of weeks rather than the months it currently takes, resulting in a much greener approach to the production of a wide variety of products.

This ESM project is funded under the BBRC SiLoSa initiative in partnership with GSK.

**Biocatalytic tools for industry**

Professor Nicholas Turner will also lead BIONEXGEN (Developing a validated technology platform for the application of oxygen dependent enzymes in synthesis and transformation of alcohols), a collaborative FP7 project involving 11 partners from leading European companies and universities to develop new, eco-efficient, and safer manufacturing processes for the chemical industry and end-users. This programme will develop the tools for the implementation of biocatalysis to produce fine chemicals and fragrances, and fine chemicals. The aerobic biocatalytic oxidation reaction currently has the potential for the biggest impact on the future uptake of industrial biotechnology (IB) in Europe. Bioprocesses have the potential to overcome the hazardous nature and high environmental impacts of current chemical oxidation processes. Biocatalysis for oxidative chemical manufacturing processes can deliver a major advantage to the European chemical-using industries and the environment, and it is expected that this new technology platform will allow the rapid development of bio-oxidations as a routine technology for the IB industry and support the European knowledge based bioeconomy.

The four-year, €7.4 million project will be promoted by a dynamic public engagement and dissemination programme within the scientific community and the wider public, especially schoolchildren, to create extra value for the European Union.

**Directed evolution of enantiocomplementary malonate decarboxylases**

This project is led by Professor Jason Micklefield, in collaboration with Professors David Leys and Nicholas Turner, and is funded by BBIRC and BASF through the Industry Partnership Award (IPA) Scheme. The MB team used structure-guided directed evolution to create new malonate decarboxylase enzymes that can produce a wide range of carboxylic acids, which are particularly common intermediates in the manufacture of pharmaceuticals, agrochemicals and other valuable products. The new decarboxylase enzymes are also attractive because the substrates can be generated from malonic acid, a natural precursor derived from renewable sources (fermentation). The availability of chiral carboxylic acids, which are single enantiomers (one of two possible stereoisomers that are non-superimposable mirror images) of critical importance particularly for pharmaceutical production.

**Industrial chemicals of the monoterpenoid class realised through synthetic biology and pathway engineering**

In partnership with GSK, Professors Nigel Scrutton, John Gardiner, David Leys and Pedro Mendes have engineered bacterial strains to produce flavours and fragrances that belong to the monoterpenoid family of compounds using synthetic biology and enzyme engineering approaches.
**Bio- or ‘natural’ routes to the synthesis of these compounds significantly enhance their market value and this research will transform the industrial production of many products.** Synthesis by providing ‘natural’ routes to these compounds, avoiding problems associated with classical chemical synthesis. Bio-routes will reduce the environmental impact associated with classical synthesis and release industry from the constraints of limited availability from natural resources. This project is funded by the BBBSRC as part of the Industrial Partnership Award (IPA) Scheme.

**Pharmaceuticals and universities working together on multi million pound project**

Europe’s largest public-private partnership (PPP) dedicated to the development of sustainable pharmaceuticals was launched at the end of 2012 and is led by Professor Nicholas Turner and the pharmaceutical company GlaxoSmithKline. The introduction of biotechnology to the manufacturing processes for medicines will limit the drain on the world’s resources and have a lasting benefit on the environment. CHEM21 brings together six pharmaceutical companies, 13 Universities and four small to medium enterprises from across Europe in a £21 2 million project with the aim of developing sustainable biological and chemical alternatives to finite materials, such as precious metals, which are currently used as catalysts in the manufacture of medicines. CHEM21 will run initially for four years with funding from the Innovative Medicines Initiative. The project will establish a European research hub to act as a source of up-to-date information on green chemistry. It will also develop training packages to ensure that the principles of sustainable manufacturing are embedded in the education of future scientists.

**“Improving the sustainability of our drug manufacturing processes through collaborations such as CHEM21 will not only reduce our industry’s carbon footprint, but will provide savings that can be reinvested in the development of new medicines, increase access to medicines through cost reduction and drive innovations that will simplify and transform our manufacturing paradigm.”**

Dr John Baldesi
GlaxoSmithKline

**IBCarb - Glycoscience tools for biotechnology and bioenergy**

Professor Sabina Fitch, University of Manchester and Professor Rob Field, John Innes Centre

Carbohydrates constitute the largest source of biomass on Earth and their exploitation for novel applications in biorenewables, energy, food and health will be critical in moving away from dependence on hydrocarbons to develop sustainable biotechnologies and reduce GHG emissions, ensuring both energy and food security. Glycoscience is a broad term used for all research and technology involving carbohydrates, ranging from cell biology, human nutrition and medicine to carbohydrate-based materials and the conversion of carbohydrates to energy. The analysis, synthesis and biosynthesis of carbohydrates and their modification to industrial products are, therefore, central challenges in both industrial biotechnology and bioenergy. The last twenty years have seen a number of fundamental changes in the glycosciences generating a technology push with respect to carbohydrate synthesis and modification, enzymology and glycemic analysis. At the same time, there is a technology pull - great demand and opportunities in diverse areas such as biopharmaceuticals (8 out of 10 top selling drugs worldwide are glycoproteins), foods (prebiotics designed for the human gut microbes), pharming (targeting cell surface recognition and biosynthesis), materials (from biobenens polylactosacharides) or energy (digesting the indigestible). IBCarb is an interdisciplinary network that will allow for exploitation of opportunities presented by Glycoscience.

**Natural Products Discovery and Bioengineering Network (NPRONET)**

Professor Jason Micklefield, University of Manchester and Professor Barrie Wilkinson, John Innes Centre

Building on the UK’s established world-leadership in natural product chemistry, biosynthesis and microbiology Professor Jason Micklefield and Professor Barrie Wilkinson will lead this network, devising methods to activate the expression of biosynthetic gene clusters to discover novel natural products. Natural products are small molecules produced predominantly by microorganisms and plants that have inspired the development of many blockbuster drugs, including anticancer and immunosuppressive agents including most of the antibiotics in clinical use today. Natural products are also used in agriculture as herbicides, pesticides and fungicides to increase crop yields. In addition, bioengineering methods and synthetic biology tools will be developed to enable rapid structural diversification and optimisation of the most promising natural product molecules for therapeutic, agrochemical and other applications.

**“The networks will drive new ideas to harness the potential of biological resources for producing and processing materials, biopharmaceuticals, chemicals and energy. Each has a particular focus, such as maximising the potential of food waste and by-products to produce chemicals and biomaterials; unlocking the industrial biotechnology potential of microalgae; producing high value chemicals from plastics and making use of plant cell walls; harnecing the biosynthesis of natural product molecules for therapeutic, agrochemical and other applications.”**

David Willetts
Minister for Universities and Science

**Network in biocatalyst discovery, development and scale-Up**

Professor Nicholas Turner, University of Manchester and Professor John Ward (University College London)

This network aims to develop new tools to accelerate biocatalyst research, discovery and development. The network will provide the framework and coordination to allow research groups from industry and academia to easily access and develop a truly broad range of biocatalyst panels and technologies for screening whilst providing a pipeline through to scale-up, manufacture and commercial use of novel enzymes.

**“These networks bring together a number of internationally competitive, cross-disciplinary communities capable of undertaking innovative research that will attract further investment from the UK and abroad. They provide a new opportunity for the research community to make significant contributions to the UK’s biocatalyst-driven transformational bioscience into industrial processes and products; creating wealth and jobs; and delivering environmental benefits, such as CO2 reduction.”**

Dr Celia Caulcott
BBBSRC Executive Director, Innovation and Skills

**Working closely with industry to advance the field of chemical biology**

Funded by EPSRC, BBBSRC and MRC and with commitments from its 10 industrial partners, the Manchester Chemical Biology Network brought together more than 50 research groups from a range of disciplines across The University of Manchester to share expertise with industrial partners, including companies such as AstraZeneca, GSK and Pfizer. This collaboration between research groups provides a more effective platform to tackle the major challenges associated with the discovery of new drugs and other products of importance to human health and wellbeing, using expertise ranging from synthetic chemistry through to cell biology.
During the next two decades the chemical industry will undergo a major transformation. As both oil and natural gas begin to run out, there will be a growing need to switch from oil-based starting materials to those derived from biomass. Biotechnology-based processes will need to be developed to efficiently convert inexpensive raw materials to high-value products such as pharmaceutical drugs, cosmetics and fuels. From underpinning strategic research to the transfer of technology into the marketplace, The University of Manchester has a range of world-class activities supporting the need for solutions that can play their part in meeting the global energy challenge.

Our contribution to the energy agenda focuses in particular on the biological aspects of energy including fuel cells, solar energy and 2nd/3rd/4th generation biofuels. Research into alternative biofuels includes utilising biomass from both agricultural and marine sources to the development of novel biocatalysts. Fill your car with petrol or diesel today, and as oil begins to run out, there will be a growing need to switch from oil-based starting materials to those derived from biomass. Biotechnology-based processes will need to be developed to efficiently convert inexpensive raw materials to high-value products such as pharmaceutical drugs, cosmetics and fuels. From underpinning strategic research to the transfer of technology into the marketplace, The University of Manchester has a range of world-class activities supporting the need for solutions that can play their part in meeting the global energy challenge.

Bacteria making “oil”

Solutions that seek to reduce our dependency on fossil oil are being tackled by Professors David Leys, Andrew Munro and Nigel Scrutton who are working on a BBRC Industry Partnership Award with Shell combining state-of-the-art enzymology and laboratory evolution techniques with synthetic biology to make organisms produce “oil”, bypassing the need to drastically adapt oil-dependent processes. The team will focus, in particular, on production of linear alpha-olefins, a high value, and industrially crucial intermediate class of hydrocarbons that are key chemical intermediates in a variety of applications. At present, no “green” alpha-olefin production process is available, a situation which this project seeks to change.

Aquatic photobiology – exploring the potential

Biological fuel production is already a commercial reality with biology expected to contribute further towards fuel-production in both intermediate and future energy systems, particularly with the advancement in technologies that enhance economic sustainability.

Photosynthetic organisms are able to utilize water, CO2 and sunlight to directly synthesize fuel or chemical precursors - all in one-engineerable package capable of both self-amplification and internal self-repair. Terrestrial-grown plants however display poor overall solar energy conversion efficiency. Aquatic photobiology – cultures of photosynthetic cyanobacteria which are the hosts for alkane production

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SYNPOL – Biopolymers from syngas fermentation (SYNPOL)

SYNPOL is an EU FP7 KBBE collaborative project (Knowledge-Based Bio-Economy (KBBE)) involving 14 European partners from academia and industry. The basic idea of the SYNPOL project is the establishment of an integrated processing technology for the efficient synthesis of cost-effective commercial new biopolymers using the products derived from fermentation of SYNGAS generated from very complex feedstocks. This revolutionary project will see the establishment of a platform which integrates biopolymer production through modern processing technologies, with bacterial fermentation of syngas, and the pyrolysis of highly complex biomass (e.g., municipal, commercial, sludge, agricultural) enabling the treatment and recycling of complex biological and chemical wastes and raw materials in a single integrated process. R&D activities will be focused on the integration of innovative physico-chemical, biochemical, downstream and synthetic technologies to produce a wide range of new biopolymers, based on a number of novel and mutually synergistic production methods, and including an assessment on the environmental benefits and drawbacks related to the concept. The knowledge generated through this innovative biotechnological approach will not only benefit the environmental management of terrestrial wastes, but also reduce the harmful environmental impact of petrochemical plastics.

In its first phase (funded to £6M by the BBRC and EPSRC) the Manchester Centre for Integrative Systems Biology (MCISB) prepared a complete toolbox from computational analyses through experimental approaches to data handling and organisation. The results of this early research can be found in a set of web resources and in the most recent issue of Methods in Enzymology devoted to Systems Biology by the MCISB. The MCISB continues to be involved in two Biotechnology Research Industry Club (BRIC) projects funded by the BBRC (on protein production in various microorganisms using various feedstocks), as well as by a large number of other BBRC and EU grants under the leadership of Professors Hans Wetterhoff, Pedro Mendes and Dr Jacob Snoep.

IONTOX Safe green solvents for the future

In silico predictive chemometric models for selected toxicity endpoints of ionic liquids (ILs) are a modern addition to the world of chemical compounds, deployed in areas ranging from electrochemistry, over organic synthesis, to cleaning, extraction and separation technology. Their unique negligible vapor pressure, non-flammability, enhanced thermal stability and outstanding solvation potential make them green solvents but their toxicity needs to be understood and controlled. Reliable toxicity prediction can only be achieved through computational means. Quantitative structure-property relationships, known as QSPR, solve the problem created by stringent environmental regulations and costly and time consuming experimental determination. This EU International Incoming Fellowship will see Professor Paul Popelier develop eco-toxicological models for ILs in silico, obeying OECD principles, based on available toxicity data against various endpoints.
Considering the ever growing interest in ILs, truly predictive QSPR models will be highly advantageous in designing the desired ILs. This project combines complementary expertise in physicochemical parameters rooted in quantum chemistry and rigorous chemometrics. Professor Popelier aims to establish collaboration with experimental toxicologists at The University of Manchester for experimental validation of the developed models delivering innovative QSPR models and expert systems for predicting toxicity of ILs, ready for European regulatory purposes.

**Enzymes for energy conversion**

Fuel cells are electrochemical devices that directly convert chemical energy into electrical energy. These function like a battery but have the reactants like hydrogen and oxygen fed from outside the cell. These devices frequently rely on expensive platinum-group metals to speed up the energy conversion process. Some metal-containing enzymes such as hydrogenases and multicopper oxidases carry out the same functions as efficiently as the precious metal catalysts and use small amounts of abundant elements such as iron, nickel and copper.

Dr Christopher Blanford’s recent EPSRC fellowship work focused on exploiting multicopper oxidases to create miniature components for portable fuel cells that could be used to power consumer devices like mobile phones. Two of the key challenges to adapting biological catalysts to replace inorganic ones are immobilising the enzymes to have the most efficient possible transport of reactants, products and electrons, and maximising the longevity of these immobilised enzymes.

Dr Blanford and his group have discovered numerous biomimetic surface modifications, essentially using the enzyme’s natural partners to orient the macromolecules for efficient electron transport while preserving their activity for months. As part of the group’s research into rational electrode surface modification, they discovered a unique copper configuration that could be adapted to produce more efficient fuel-cell enzymes in common expression systems like E. coli.

The group also use an electrochemical quartz crystal microbalance (EQCM) to test how real-world usage conditions affects the longevity of fuel cell electrodes. While the enzymes remain viable for days when a constant output is required, rapidly varying the electric current extracted from the electrodes could diminish their lifetime to minutes. The group found that these destructive effects can be mitigated by limiting the electrode’s output potential.
In the wake of the human genome project, microbiology is currently undergoing a major transition: we are now capable of obtaining a comprehensive molecular view of the entire cellular circuitry of our microbes of interest, followed by an equally comprehensive re-engineering of their cellular functions, called Synthetic Biology. Synthetic Biology aims at the rational design of biological systems and living organisms using engineering principles, to achieve new useful functions in a modular, reliable and predictable way. It has the potential to drive a new industrial revolution in biotechnology, with applications in many sectors, including healthcare, sustainable energy, green chemistry, pharmaceuticals, novel materials and bioremediation. It requires cutting-edge research at the interface of biology, engineering, chemistry and computing science. The Manchester Institute of Biotechnology has assembled one of the strongest interdisciplinary teams with world-class expertise in all areas in a single state-of-the-art facility.

SynBio@MIB - Synthetic Biology advancing synthetic biotechnology

Through active collaborations with a large variety of industry partners the Centre for Synthetic Biology of Sustainable Chemicals and Natural Products (SYNBIOSCHEM) at the MIB is harnessing the power of synthetic biology to propel chemicals/natural products production towards ‘green’ and more sustainable manufacturing processes, and boost UK research capacity by stimulating innovation with industry and other key stakeholders in the chemicals/natural products sector.

Major EU funded projects in synthetic biology include BIONEXGEN, BIOINTENSE and BIOOX focused on developing the next generation of biocatalysts for industrial chemical process.

Strategic links in this field have been developed with a number of SMEs as well as large global companies through regular Industry Days hosted at the MIB bringing together academia and industry in focused groups to explore future perspectives in synthetic biology. In addition we have links with international Centres of Excellence including the Austrian Centre for Industrial Biotechnology (ACIB), CSIRO biofuels cluster in Australia, SynBio in the US (multi-university SynBio Centre), Beijing Genomics Institute and the Chinese Academy of Sciences as well as several SynBio centres across Europe.

Emerging societal, ethical, and regulatory challenges associated with this rapidly advancing new technology are addressed in close interaction with social scientists and economists across The University of Manchester.

MIB-based synthetic biology researchers


Associated researchers

Andrew Balmer, School of Sociology Sarah Chan, Faculty of Life Sciences Philip Shapira, MIB

We actively link across campus with network partners as part of a wider synthetic biology strategy.

Industry stakeholders-partners

We have an established track record of leadership in industry and stakeholder collaborations in the chemicals/natural products sectors including:

- ACIB, AustZeneca, BASF, Bayer, Bruker, CalSi, Charmwood Consulting, Codexis, Dr Reddy’s, Evolva Biotech, GleeceSmithKline, Janssen, Orion, Lonza, Merck, Pfizer, Reaxa, Synthace, Syngenta, Shell, Syngate, Unilever and many more.

EU science and training programmes in symbio

We enjoy ‘hub status’ for major EU science and training programmes in this sector, including the Innovative Medicines Initiative award CHEM 21 (ICEM), EU training networks (MAGIC, PAPITY) and EU FP7 consortia awards (DIRECTFUEL, BIONEXGEN, AMBIOCAS, BIOINTENSE; SUPRABIO).

Networks

BBSRC Natural Products Discovery and Bioengineering Network (NPRONET) led by Jason Micklefield (MIB, UoM) and Barrie Wilkinson (John Innes Centre).

Pipeline to discovery

Technology Platforms

TP1 Rapid identification of components and accelerated directed evolution for SynBio

TP2 Bioengineering technologies and chassis design

TP3 Metabolomics, analytical science and metabolic engineering platforms

TP4 Computational systems biology, bioinformatics and genomics

Our research

We have a strong portfolio of current research grants in the region of £42M and state-of-the-art facilities underpinning our research in synthetic biology with world leading programmes in biocatalysis (CalBioChem), systems biology (MCBiB) and protein redesign, structure and mechanism (MCMC) as well as leading science technology programmes embedded in the wider MIIB@M research portfolio. These projects are already providing SynBio solutions to the green manufacture of fine chemicals, therapeutic small molecules and new routes to biofuels.

The Centre of SYNBIOSCHEM integrates expertise across several knowledge themes including: biosynthesis pathway refactoring; system modelling and primary metabolic pathway engineering, chassis (host) and end-product yield optimization. These activities are supported by cutting-edge Technology Platforms that are integrated to deliver outcomes in these knowledge themes and ultimately assembled to deliver new sustainable production prototypes for chemicals and natural product synthesis.

The Technology platforms support integrated work programmes involving (but not exclusively) the following discipline areas:

-computational and systems modelling of prototypical pathways in engineered chassis; pathway/biocatalyst control (e.g. orthogonal regulatory circuits, ribozymes); chassis engineering (e.g. yeast, bacterial) for robust and high yield industrial producers; informatics and genomics/metagenomics to facilitate building block discovery; enzyme engineering and evolution to generate new biocatalytic module libraries; robotics for accelerated host optimization and refactoring; metabolomics/analytical science supporting chassis optimization and intermediate/product analysis; pathway refactoring/assembly comprising assembly of building block modules, pathways and regulatory components.

These technology platforms are integrated through iterative (n) cycles of (circuit design—computational modelling—experiment—data analysis—modelling—redesign). These cycles will be implemented at different levels, within individual platforms as well as between platforms, to establish a semi-automated and integrated pipeline for the discovery and re-engineering of biocatalysts building blocks and engineered pathways/cells.
Exploiting natural product assembly line genomics and synthetic biology for discovery and optimisation of novel agrochemicals

Harnessing world leading expertise in natural product synthesis this project brings together Jason McKechnie, Professor of Chemical Biology (Bristol), Professor Elias Fouquenet (Macquarie), Peter Leadlay (Cambridge) and Russell Cox (Bristol) to develop a platform technology that can exploit the potential of microbes for the production of useful compounds for uses in agriculture and medicine.

Many microorganisms produce beneficial compounds for human health by forming a fungus with most microbes having the capacity to produce many more compounds than are actually observed. If their full potential can be activated then it could provide new compounds for the testing of medicines and agricultural chemicals.

This grant funds an ambitious programme to rapidly sequence the genomes of 40 microorganisms with the known ability to produce potential compounds that benefit agriculture. The team will work with partners in the international agrochemical company Syngenta to develop these as new herbicides, insecticides and fungicides, while partners at the biotechnology company Biopika will focus on compounds with uses in human medicine.

This £5M project is funded under the BBSRC SLoLa initiative in partnership with Syngenta and Biopika.

Development and application of next generation synthetic biology tools

Dr Dixon seeks to develop novel protein production and metabolic engineering tools and demonstrate the applications of these novel synthetic biology tools in the context of the bioprocessing industry. Although biopharmaceuticals offer many health benefits along with substantial commercial opportunities, their production remains a significant technical challenge. Dr Dixon will develop and demonstrate four important flavours of a novel gene co-expression technology, to allow microbial protein products to be produced more effectively, along with the potential to provide a simpler and more efficient manufacturing process.

Additionally, these co-expression technologies will be used to optimise a number of multisite co-expression challenges, helping to guide metabolic engineering efforts leading to improved bioprocessing efficiencies, with the potential to reduce both drug development times and manufacturing costs. Dr Dixon has also been awarded a Technology Strategy Board (TSB) feasibility grant entitled ‘Rapid Engineering of Cellular Factors’ working alongside collaborators from UCS and Synacta to advance the industrial application of synthetic biology. This is a collaborative R&D project, with the goal of demonstrating the rapid creation of bacterial cellular factories, for fine chemical production that is both economically and environmentally sustainable, based on industrial biotechnology, and advanced synthetic biology and bioprocesses.

Engineered compartments for monoterpenoid production using synthetic biology

TERPENOSOME is led by Professor Enrico Takano, and together with Professor Nigel Scrutton and Dave Matthews, is a project that will investigate the biosynthesis and bioengineering of tlypocopeptide antibiotics of the ramoplanin and endusacidin family. The tylopilopeptides are highly potent antibiotics which have considerable clinical potential, with ramoplanin having entered phase III clinical trials. The team will develop alternative synthetic biotechnological approaches to enable the rapid structural diversification of this class of antibiotics, providing access to large numbers of tlypocopeptide variants with potentially improved antiinfective activities, for subsequent development with industrial partners.

The new biosynthetic insights will be used to guide the development of biosynthetic strategies aimed at altering the glycosylation, halogenation and lipidation patterns, as well as the amino acid sequence of the tylopilopeptides. The bioengineering methodologies developed here will be used to engineer a wide range of derivatives for other promising classes of antibiotics as well as other natural product variants for alternative therapeutic and agrochemical applications.

In a complementary project, funded by the TSB, Professor Enrico Takano aims to use synthetic biology as a key technology to discover and develop new antibiotics overcoming common problems associated with antibiotic discovery from natural sources, such as poor understanding of the antibiotic producer, poor growth characteristics, reproducing poor yield and lengthy delays to market. Demuris Ltd, an SME with expertise in natural products discovery has identified a promising broad-spectrum antibiotic but it is produced in low quantity. In collaboration with Credo, a large chemicals company with established routes to market, the team will fully unlock the potential of this promising broad-spectrum antibiotic using synthetic biology approaches.

Biotechnology and biosynthetic gene cluster refactoring will be used for optimum expression and for introducing additional diversity of the chemical structure. The optimized biosynthetic machinery will then be introduced into Demuris’ optimised production host for maximum yield required for commercialisation. In addition, the methods established in this work will be utilised for the activation of novel tlypilopeptide clusters identified from the genome-sequence of the broad-spectrum antibiotic producer and the products identified and characterised for potential industrial applications.

China Partnering Award

Professors Enrico Takano and Nigel Scrutton have secured funding through a Synthetic Biology China Partnering Award, co-funded by the Biotechnology and Biological Research Council (BBSRC), the Chinese Academy of Sciences (CAS) and the Engineering and Physical Sciences Research Council (EPSRC) to partner and develop long term fruitful relationships with Chinese scientists. The funding is provided for up to four years and it is anticipated that the partnerships will lead to new joint grant applications and high impact research.

Professors Enrico Takano and Nigel Scrutton will collaborate with Professor Lien Zhang at the Chinese Academy of Sciences Institute of Microbiology to establish cooperative research on the use of synthetic biology approaches for production of high-value fine chemicals.

STREPSYNTH: Rewiring the Streptomyces cell factory for cost-effective production of biomolecules

Professor Roy Goodacre is bringing his expertise to bear on STREPSYNTH, an EPSRC funded project involving 16 partners and led by Professor Anastassios Economou (Katholieke Universiteit Leuven, Belgium).

STREPSYNTH aims to establish a Streptomyces-based new industrial production platform (SNIP) for high value added biomolecules.

Streptomyces lividus was chosen as a bacterial host cell because it has already shown itself to be highly efficient in extracellular production of a number of heterologous molecules that vary chemically, has a robust tradition of industrial fermentation and is fully accessible to genetic intervention. In setting up SNIP the consortium choses two classes of biomolecules with obvious immediate industrial value and application: heterologous proteins (industrial enzymes, biopharmaceuticals, microbial enzymes, diagnostics) and small molecules (antiparticles and indolocarbazoles) useful for multiple industrial purposes (biopharmaceuticals, additives, food technology, bioenergy).

It is envisioned that SNIP is a modular platform that can be repurposed for diverse future applications. Professor Goodacre is very excited to be involved in this novel synthetic biology. His role is to develop a metabolomics and fluxomics toolbox which aims to establish standardisation procedures for robust metabolomics and for 13C- and 15N-based fluxomics in Streptomyces lividus T424.

“Synthetic biology is an exciting new field with enormous potential to bring benefits to people around the world in all sorts of ways, for example producing better antibiotics or manufacturing low carbon fuels. Co-funded initiatives such as this scheme will see British and Chinese scientists learning from each other’s expertise and benefitting from the globalisation of excellent science.”

Professor Douglas Kell, Chief Executive of BBSRC

“We at CAS attach great importance to international collaboration. The idea of this programme is to put the best minds together. Together our scientists and those from the UK can advance this field more efficiently. In the process of their cooperation, I hope they will further strengthen their linkages and collaboration, and tackle bigger challenges for the needs of mankind.”

Cao Jinghua, Deputy Director-General of Bureau of International Cooperation of CAS

“EPSRC is pleased to be part of this joint international call which demonstrates the wide scope for synthetic biology to create impact in many academic fields. It has the potential to create new solutions to address pressing global challenges, such as the need for new fuels, better waste management and new medicines.”

Professor David Delpey, Chief Executive of EPSRC

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Professor David Delpey, Chief Executive of EPSRC
MIB iGEM team take Best Undergraduate Human Practices Award at the World Championships Jamboree

For the first time in history an undergraduate team from The University of Manchester competed in the International Genetically Engineered Machine competition (iGEM), the world’s premiere UG Synthetic Biology competition. Student teams are given a kit of biological parts at the beginning of competition. We are very proud of what the team has achieved – the Manchester iGEM team is the only first-time undergraduate team to win the award without the benefit of building on the experience of earlier teams from the same university. This makes their achievement all the more amazing.

The team involves first-year to last-year students working very closely together. Professor Eriko Takano (Team Leader) and Rainer Breitling.

Along with 60 other teams from across Europe the Manchester iGEM team presented their project at the regional iGEM Jamboree held in Lyon on 11 – 13 October 2013 gaining gold medal status and Best Undergraduate Human Practices Award which they went on to win at the World Championship Jamboree in Boston.

“Student teams are given a kit of biological parts at the beginning of competition. We are very proud of what the team has achieved – the Manchester iGEM team is the only first-time undergraduate team to win the award without the benefit of building on the experience of earlier teams from the same university. This makes their achievement all the more amazing.”

Professor Eriko Takano
Team Leader, iGEM.
models with explicit time delay, providing a mechanism for easy calculation of summaries of entire simulations and groups of simulations and incorporating a new feature that will allow researchers, for the first time, to be able to navigate the entire history of a model, such that the reasons for changes that took place are formally identified, as well as decisions on the model structure. The project will also improve and extend the software’s interoperability and standards compliance to allow bioscience researchers to freely exchange data and models.

COPASI (Complex Pathway Simulator) is based on the GEPASI simulation software (General Pathway Simulator) that was developed in the early 1990s by Professor Pedro Mendes. It is the result of an international collaboration between the University of Manchester (UK), the University of Heidelberg (Germany), and the Virginia Bioinformatics Institute (USA). The initial development of COPASI was funded by the Virginia Bioinformatics Institute, the Klaus Tschira Foundation, the BBSRC and EPSRC. Professor Pedro Mendes has received additional funding from the BBSRC to maintain and develop this important resource.

Study maps human metabolism in health and disease

Scientists from the MB working with researchers from Cambridge, Edinburgh, Berlin, Reykjavik and San Diego among others have produced an instruction manual for the human genome that provides a framework to better understand the relationship between an individual’s genetic make-up and their lifestyle. The team have mapped 65 different human cell types and half of the 2,600 enzymes that are known drug targets in order to produce the network model, providing the most comprehensive model yet to explain why individuals react differently to environmental factors such as diet or medication. Pedro Mendes, Professor of Computational Systems Biology commented: “This research is the second, important stage of our understanding of the human genome. If the sequencing of the human genome provided us with a list of the biological parts then our study explains how these parts operate within different individuals. It provides a network mapping all the small molecule transactions that define what goes on with these so-called metabolites in human biochemistry. The results provide a framework that will lead to a better understanding of how an individual’s lifestyle, such as diet, or a particular drug they may require is likely to affect them according to their specific genetic characteristics. The model takes us an important step closer to what is termed ‘personalised medicine’, where treatments are tailored according to the patient’s genetic information.”

Douglas Kell, Professor of Bioanalytical Science at the MB said: “To understand the behaviour of a system one must have a model of it. By converting our biological knowledge into a mathematical model format, this work provides a freely accessible tool that will offer an in-depth understanding of human metabolism and its key role in many major human diseases. It offers the most complete model of the human metabolic network available to date to help analyse and test predictions about the physiological and biochemical properties of human cells. Pharmaceutical drugs get into cells by ‘hitchhiking’ on the transporter proteins that normally serve to move small molecules around. An area of particular interest is thus the incorporation into our metabolic network map of knowledge of pharmaceutical drug transport.”

Dr Nicolas Le Novère, from the Babraham Institute in Cambridge (UK), said: “This is a model that links the smallest molecular scale to the full cellular level. It contains more than 8,000 molecular species and 7,000 chemical reactions – no single researcher could have built this alone. Having large collaborations like these, using open standards and data-sharing resources, is crucial for systems biology.”

**SYBIL provides insight into skeletal diseases**

SYBIL (Systems biology for the functional validation of genetic determinants of skeletal diseases) is a large scale collaborative project that brings together a complementary group of world-class scientists, disease modelers, information technologists and industrialists. The overall concept of this project is to functionally validate genetic determinants of common and rare skeletal diseases to gain a mechanistic understanding of disease processes and age-related changes, and to develop new and validated therapeutic targets.

Rare skeletal diseases (RSDs) are an extremely diverse and complex group of diseases that primarily affect the development skeleton. There are more than 450 unique and well-characterised phenotypes that range in severity from relatively mild to severe and lethal forms. Although individually rare, as a group of related orphan diseases, RSDs have an overall prevalence of at least 1 per 4,000 children, which extrapolates to a minimum of 225,000 people in the 27 member states and candidate countries of the EU.

Dr Jean-Marc Schwartz will lead one of the work packages and, alongside Professor Roy Goodacre, provide the core qualitative and metabolomic data and over 11 years in systems biology analyses for the consortium. Dr Jean-Marc Schwartz will lead one of the work packages and, alongside Professor Roy Goodacre, provide the core qualitative and metabolomic data and over 11 years in systems biology analyses for the consortium. Roy has over 18 years experience in mass spectrometry (MS), advanced data analysis applied to spectroscopic, mass spectrometric and metabolic data and over 11 years in vibrational spectroscopy. He has published over 180 peer-reviewed papers and has co-edited books on metabolic profiling and systems biology. He is the Editor-in-chief of the journal Metabolomics and on the editorial board of the Journal of Analytical and Applied Physics. Finally, he is a founding director of the Metabolomics Society and director of the Metabolic Profiling Forum.

**Perfecting drug combinations to combat severe diseases and conditions**

A multidisciplinary team of researchers, led by Professor Douglas Kell, have found a way of identifying ideal drug combinations from billions of others which would prevent inflammation from occurring. The findings, published in Nature Chemical Biology, could be the first step in the development of new drug combinations to combat severe diseases and conditions.

Most non-infectious disease, such as cancer, stroke and Alzheimer’s are worsened by inflammation, which is the body’s natural defence mechanism. Inflammation has evolved to help fight infection but can also be very damaging in long term disease, prolonging suffering and ultimately risking premature death. After a stroke, the body reacts to the injury as if it were an infection, causing further damage. By blocking the inflammation, the chances of survival or higher quality of life following a stroke are thus greatly enhanced. This can be achieved by quickly and effectively identifying combinations of drugs which can be used together.

Existing ‘cot-blocking’ stroke drugs are only effective if administered within three hours after the stroke – often very difficult to achieve as people are often unaware they are having a stroke – and even then do not completely solve the problem, often leaving sufferers with serious disabilities.

However, using ideal drug combinations the researchers suggest they can block inflammation and therefore greatly reduce the damage caused by non-communicable diseases such as stroke. Although the researchers have initially concentrated on stroke, they believe the process can be applied to all drugs and for a huge variety of diseases. The team developed an evolutionary computer program which rapidly sifted through nine billion different combinations of potential drugs.

Sorting and testing 50 drug combinations at a time using robotics in the laboratory, the scientists were able to find effective combinations and then refine them as many times as necessary to find ideal combinations. Ultimately, they hope this will lead to the development of tailored therapies for treating inflammation.

Another advantage of choosing ideal drug combinations is that it allows patients to take smaller doses, which reduces potential toxicity concerns.

**Erythrocyte and fibrin imaging for disease diagnosis**

In a separate study, Professor Douglas Kell has shown that unliganded iron is responsible for a large number of degenerative and inflammatory diseases. In collaboration with Prof Nidia Pretorius (University of Pretoria, South Africa), he has now shown that this is made by unusually abundant morphologies of fibrin - the protein responsible for blood clotting - and or red blood cells. Work is in progress to use these kinds of measurements for the rapid, cheap, and minimally invasive diagnosis of the severity of such diseases and the effectiveness of their treatment.
The National Centre for Text Mining (NaCTeM) provides text mining systems and infrastructure at large scale

NaCTeM has developed text mining tools, resources and services to support the automatic extraction of information and knowledge from the growing amount of literature in an efficient, manageable and comprehensive manner at large scale. Applications areas include: drug discovery, chemistry, systems biology, clinical trials, public health, medical historical archives, newswire analysis, pathway reconstruction and advanced search systems. NaCTeM, led by Professor Sophia Ananiadou and Dr John McNaught, is a fully sustainable text mining centre. It has been funded by BBSRC, MRC, AHRC, Wellcome Trust, NH and industrial partners.

PathText: reconstructing pathways with evidence from text

To understand complex biological systems in detail we need to incorporate knowledge scattered over millions of scientific publications. Using conventional means, pathway model reconstruction and maintenance is a manual and expensive curation process due to new discoveries. However, PathText links pathway models with textual evidence by combining and ranking relevant information from the literature using text mining methods. PathText integrates and ranks the evidence from text using a number of text mining tools and services including the identification of reactions, genes, proteins and metabolites in their semantic context, from text automatically. NaCTeM’s interoperable text mining infrastructure links the text analysis components and text mining workflows with an annotation environment to further support curators in their task.

PathText currently links CellDesigner with NaCTeM’s text mining services FACTA+ (mining direct and indirect associations between concepts and bio-processes), KLEIO (advanced semantic faceted search based on bio-entities) and MEDE (semantic search based on bio-processes). Novel methods such as automatic event and biological process recognition from text have facilitated this task.

This project was led by Professor Sophia Ananiadou in collaboration with Professor junichi Tsujii, Professor Douglas Kal, and Professor Hiroaki Kitano (Systems Biology Institute, Japan). It was funded by BBSRC.

Text mining interoperable software platforms

Interoperability, text mining processing, and annotation are supported by Argo, a Web application for analysing (primarily annotating) textual data. The workbench supports the combination of elementary text-processing components developed by the centre to form comprehensive processing workflows. It provides functionality to manually intervene in the otherwise automatic process of annotation by correcting or creating new annotations, and facilitates user collaboration by providing sharing capabilities for user-owned resources.

The workbench builds upon a previous, standalone application (J-Compare) that currently hosts over 100 text-processing components. Argo benefits users such as text analysts by providing an integrated environment for applying text mining techniques to enrich health (MOH) reports (1848-1972), by applying text mining techniques to enrich these data with semantic annotations. The project plans to extend its impact to the following sectors: public health, public policy, publishing, media and libraries, with a view to ensuring sustainability and wider uptake of methods and technologies.

Open Source Software receives funding boost

This EU FP7 funded project will see NaCTeM working with 8 partners across Europe on OSSMETER which aims to extend the field of automated analysis and measurement of Open Source Software, and develop a platform that will support decision makers in the process of discovering, comparing, assessing and monitoring the health, quality, impact and activity of open-source software. To achieve this, OSSMETER will compute trustworthy quality indicators by performing advanced analysis and integration of information from diverse sources including the project metadata, source code repositories, communication channels and bug tracking systems of Open Source Software.
Tackling early cognitive decline – a text mining perspective

Critically only 50% of people with dementia ever receive a diagnosis that could lead to them receiving medical care and support. Professor John Kaare is collaborating with Professor Alessia Panni and Dr Ilona Sidi from FMHS as part of a joint programme, with Lancaster University and King’s College, London to look at novel ways in which data and text-mining techniques, combined with adaptive user interfaces, may enable sufferers’ new opportunities for self-referral. Funded by the EPSRC, the project is entitled SAMS: Software Architecture for Mental Health Self-Management.

By exploiting novel data and text mining techniques, combined with adaptive user interfaces, SAMS will validate thresholds by non-intrusively examining changes in people with established cognitive dysfunction and mild Alzheimer’s disease and begin to explore the potential for technology-enhanced detection of early cognitive dysfunction. Patterns of computer use and content analysis of e-mails, such as forgetting topics, expressions of concern, emotion, etc., will be analysed and coupled to feedback mechanisms to enhance users’ cognitive self-awareness, enabling them to self-reflect themselves for expert medical advice.

This project is supported by the EPSRC, Dementias Neurodegenen Network (DNDNN), The Alzheimer’s Society, Microsoft Research, the University of British Columbia and Johns Hopkins University School of Medicine.
Professor Perdita Barran joins MIB

Perdita graduated from The University of Manchester with a degree in Chemistry with Industrial Experience in 1994. She went on to obtain a PhD in Chemical Physics in 1998 from Sussex University under the supervision of Professors Tony Stace and Sir Harry Kroto. Following postdoctoral appointments in the UK and USA she was awarded an ERCB Advanced Research Fellowship to study “The Structure and Energetics of Peptides and Small Proteins” which she took up at the University of Edinburgh where she helped to establish a Centre of Proteomics (SIRCAMS).

Since 2009 she has published 38 papers with five currently in review. She has a total publication list of 70 peer reviewed papers (over 900 citations, in Factor 23). This impressive output spans work on the fundamentals of Ion Mobility Mass Spectrometry, including instrument development all the way to its application to biomedical problems. Barran has communicated 2 book Chapters, and an entry for the European Encyclopaedia of Biophysics (2012). Perdita was awarded The Disty Memorial Prize for Innovation in Separation Science in 2005, and the Joseph Black award from the Royal Society of Chemistry 2009 for her significant developments in the field of mass spectrometry and separation science, especially ion mobility techniques. Recently she was appointed as an Editor of the International Journal of Mass Spectrometry.

Adopting a combined experimental-computational approach

Many advances in medicine, biology, chemistry and materials science of the last few decades owes much to the structural information that has been obtained for proteins and nucleic acids by X-ray crystallography and NMR spectroscopy, and which has revolutionised our view of how life works. Unfortunately, these techniques are far too difficult to apply to the main class of biomolecules - carbohydrates.

Despite carbohydrates constituting over half of the biomass of our planet and performing an almost limitless number of roles in our systems, we don’t really understand how they work in the same way that we do for proteins and DNA. The lack of definitive data means there is considerable debate as to how we even define structure in carbohydrate polymers. In order to understand the molecular principles that govern their assembly, organisation and interactions with other molecules which requires alternative approaches to studying carbohydrate structure.

Paul Popelier, Professor of Chemical Theory and Computation has joined forces with Dr Ewan Blanch, Reader in Biophysics and a Raman spectroscopist on an EPSRC funded project to develop a combined computer modelling and spectroscopic lab-based approach to characterising the structures of carbohydrates, from simple sugars to key carbohydrate polymers known to be involved in regulating biological functions generating a uniquely concise new tool for glycochemistry. The team will be combining high level quantum chemistry calculations, molecular dynamics simulations and highly detailed Raman spectra to develop and validate novel computer modelling tools that will provide new insights into many other areas of research, such as protein-ligand interactions and DNA-drug molecule binding.

Although the resulting development of new computational tools will be focused on the structures and behaviour of carbohydrates, the end product will also be widely applicable to all other biomolecules, particularly proteins and nucleic acids.

Secondary Ion Mass Spectrometry (SIMS)

SIMS is developed and used for the analysis and imaging of chemical and biological systems, including advanced materials, single cells and biological tissue. The aims involve novel insights into the chemical and spatial organisation and function of these systems at the molecular level. Nick Lockyer and Professor John Vickerman are developing applications of SIMS in areas involving the characterisation and classification of cells and tissue at the molecular level. They are also working closely with industry to develop new instrumentation and analytical protocols to advance SIMS applications in biosciences.

Forensics and archaeology

ZadMS - short for ZooArcheology by Mass Spectrometry – is a pioneering new technique called “collagen fingerprinting” which uses the persistence and slow evolution of collagen as a molecular barcode to read the identity of bones. The method, developed by Dr Mike Buckley during his PhD, uses a well-established approach, peptide mass fingerprinting, allied to high throughput Time of Flight Mass Spectrometry. Bones are identified by differences in the mass of the peptides which arise as a result of sequence differences between species.

Discovery of detailed genotype of a historic strain of M. tuberculosis

The study of ancient DNA enables the prevalence of diseases in past populations to be determined by analysis of skeletons for the presence of pathogen DNA. In a recent study of Mycobacterium tuberculosis (MTB) published in PNAS, Terry Brown, Professor of Biomolecular Archaeology, together with researchers from York and Durham, have obtained the detailed genotype of a historic strain of M. tuberculosis from a female adolescent buried sometime between 1840 and 1911 in a crypt in Leeds, England through the use of pioneering new methods based on next generation sequencing.

M. tuberculosis is the second deadliest infectious agent worldwide, yet little is known about the bacterium’s historic genetic variations and how such historic strains have evolved over time. The genotyping of historic strains of M. tuberculosis could enable comparisons between strains from different geographic locations and time periods, and may yield clues about the pathogen’s evolutionary history. The group are particularly interested in linking strain variations to changes in TB virulence during the medieval period, when Britain became increasingly urbanised. They are also comparing strain data for TB in Europe with similar results from the Americas, the latter helping us to understand why many native Americans died of TB after first contact with Europeans even though strains of TB had been endemic in the New World for many years prior to contact. The Brown group have worked on several diseases, including malaria and syphilis, and most recently on tuberculosis and leprosy.

Palaeobiodiversity and vertebrate evolution

Recently, Dr Mike Buckley was approached by Dr Natalia Rybczynski, a vertebrate palaeontologist with the Canadian Museum of Nature to identify bone fragments dating from three- and a-half million years ago. By extracting minute amounts of collagen, the dominant protein found in bone, from the fossils and using chemical markers for the peptides that make up the collagen, a collagen profile for the fossil bones was developed. Dr Buckley then compared the profile to 37 modern mammal species, as well as that of a fossil camel found in the Yukon. The collagen information, combined with the anatomical data, demonstrated that the bone fragments belonged to a giant camel as the bone is roughly 30% larger than the same bone in a living camel species.

“...This is the first time that collagen has been extracted and used to identify species from such ancient bone fragments. The fact the protein was able to survive for three and a half million years is due to the frozen nature of the Arctic...” This has been an exciting project to work on and unlocks the huge potential collagen fingerprinting has to better identify extinct species from our preciously finite supply of fossil material.”

Dr Mike Buckley
Royal Society University Research Fellow
“This project will provide a new dimension to our understanding of early European agriculture and also inform work on the impact that future environmental change could have on the sustainability of modern cereal cultivation.”

Ribs from the female adolescent skeleton 4006 from St. George’s Crypt, Leeds. Bone formation possibly indicative of pulmonary TB is visible on the surface of the ribs within the area indicated by the boxes.

Terry Brown, Professor of Biomolecular Archaeology

I became fascinated with the natural world when I was very young. I began my research career studying the effects of metal pollution on microorganisms and the tolerance that some plants display to high concentrations of toxic metals. I then became excited by DNA and worked on mitochondrial genes in fungi in order to learn the new (in those days) techniques for gene cloning and DNA sequencing. I contributed to the discovery of the mitochondria Group 1 introns and to work that described the base-paired structure of these introns. I then became interested in ancient DNA and was one of the first people internationally to carry out DNA extractions with bones and preserved plant remains. This work has required close collaboration with archaeologists, both in Manchester and elsewhere, and has led to my current interests in the origins of agriculture, genetic profiling of archaeological skeletons, and the evolution of disease.

Fingerprinting food

MBR researchers using MALDI-TOF-MS and chemometric approaches have found new applications as a fast and accurate viable bacterial detection and quantification method for routine use in the milk and meat industry. Major food adulteration and contamination events seem to occur with some regularity, such as the widely publicised adulteration of milk products with melamine and the recent microbial contamination of vegetables across Europe for example, and more recently the horsemeat scandal, which has rocked consumer confidence in the food supply chain. With globalisation and rapid distribution systems, these can have international impacts with far-reaching and sometimes lethal consequences. These events, though potentially global in the modern era, are in fact far from contemporary, and deliberate adulteration of food products is probably as old as the food processing and production systems themselves. Professor Roy Goodacre’s critical review “Fingerprinting food: current technologies for the detection of food adulteration and contamination” features on the inside cover of the September 2012 edition of Chem Soc Rev. This review first introduces some background into these practices, both historically and contemporary, before introducing a range of the technologies currently available for the detection of food adulteration and contamination. These methods include the vibrational spectrosopic: near-infrared, Raman, NMR spectroscopy, as well as a range of mass spectrometry (MS) techniques, amongst others. This subject area is particularly relevant at this time, as it not only concerns the continuous engagement with food adulterers, but also more recent issues such as food security, bioterrorism and climate change. It is hoped that this introductory overview acts as a springboard for researchers in science, technology, engineering, and industry, in this era of systems-level thinking and interdisciplinary approaches to new and contemporary problems.

ADAPT – Life in a cold climate: the adaptation of cereals to new environments and the establishment of agriculture in Europe

Professor Terry Brown has recently secured significant funding from the European Research Council to explore the concept of the advance of agriculture were caused in order to understand whether pauses in the rate at which agriculture became productive enough to support long term population growth.

Combining genome sequencing and transcriptome profiling with ecological niche modelling of a large collection of historic varieties of barley and wheat landscapes collected from different parts of Europe, this project aims to identify regions of Europe where early crops underwent evolutionary adaptation in response to local environmental conditions. These data will then be compared with archaeological information on the rate at which agriculture spread through different parts of Europe, in order to understand whether pauses in the advance of agriculture were caused by the need for crops to undergo genetic adaptation to the new environments into which they were being taken. The Brown group will also compare with demographic data on early farming communities, which suggest that in some regions an initial increase in population size was followed by rapid decline, possibly indicating that further genetic adaptation was needed before crops became productive enough to support long term population growth.

Raman spectroscopy and cells: lighting up sub-cellular research

Raman spectroscopy is a physicochemical method based on the interaction of light with matter. In Raman scattering a molecular vibration yields light of a different wavelength. This enables a very powerful and non-invasive analysis of the chemical and structural information of a sample; indeed one can use this to measure protein structure and posttranslational modifications. Moreover, it is highly sensitive and when coupled with atomic force microscopy (AFM) has exquisite spatial resolution (<20 nm). In the MIB we are developing Raman to analyse cells and their components and this has recently been facilitated via three new approaches: (i) optical trapping of eukaryotic cells using Raman tweezers; (ii) coupling in situ cell growth facilities within the instrument so that drugs and metabolites can be mapped within cells; (iii) the very recent acquisition of an AFM-Raman system which shall be developed for tip enhanced Raman spectroscopy (TERS) imaging, following on from our pioneering work in bacterial surface enhanced Raman scattering (SERS).

Bruker & MIB — investing in the future of NMR Spectroscopy

Nuclear Magnetic Resonance (NMR) spectroscopy is an essential platform technology for research in the life and chemical sciences and currently makes a major contribution to UK research priorities such as ageing and infectious disease characterising biemolecular structure, function and dynamics. Our capabilities in NMR have expanded rapidly with the purchase of an 800 MHz instrument from Bruker. This addition to our facility, which currently houses 400 MHz, 500 MHz and 600 MHz instruments, will open up a substantial number of new research programmes focusing on the structures and dynamics of complex macromolecular systems. Our commitment to developing methods and technologies in the area of magnetic resonance spectroscopy is shared by Bruker UK Ltd who has committed 4 fully funded studentships to the MIB.

“Bruker has long maintained an interest in structural biology with active collaborations in various research projects into method development and applications across an array of technology including the development of the National EPR Centre. Our company ethos and commitment to knowledge advancement is shared by the MIB and we are very excited to be directly involved in the training of young scientists through our sponsorship of four MIB-Bruker studentships aimed at developing a strong strategic partnership with MIB that will ultimately generate new discoveries and innovations.”

Jeremy Lea
Bruker UK Ltd.
Robots are already part of the pharma industry’s development process, but could they ever take over completely?

Ross King, Professor of Machine Intelligence, and his colleagues have spent a decade developing Robot Scientists – machines designed to automate the discovery of scientific knowledge.

The King group built two Robot Scientists. “Adam” was designed to understand how the components of cells work together (functional genomics) and is the first machine to have discovered some novel scientific knowledge. New Robot Scientist “Eve” is designed to automate drug screening and design. Eve has been applied to the discovery of leads for neglected tropical diseases such as malaria, African sleeping sickness, Chagas disease etc.

The motivation for our work is partly philosophical and there is a strong view that holds that we do not fully understand a phenomenon unless we can replicate it: “What I cannot create, I do not understand” (Richard Feynman from “The Universe in a Nutshell”). Automating science is an excellent test bed for AI as it involves formal reasoning with interaction with the real-world. However the most important motivation is that we wish to make scientific research cheaper and more cost-effective.

Ross King
Professor of Machine Intelligence

INNOVATION IN ACTION

The MIB pursues and is engaged in challenging research projects that enable us to make significant advances in science to benefit industry and society. Through innovative research, we can help you advance your business, solve technical problems, improve your processes, develop new products and build the technical capabilities of your staff. We understand the importance of adapting the approach to meet the needs of the project.

There are a number of ways for commercial businesses to benefit from the academic expertise fostered in the MIB. We run a successful programme of networking events with industrial partners and other stakeholders that focus on developing practical strategies to create short-term, mid-term and long-term relationships for mutual benefit. Our partnerships range from collaborative research programmes to joint studentships and instrumentation-technologies development across the chemical, biotechnology and biopharmaceutical sectors.

Collaborations
We actively engage with a wide range of companies from large pharmaceutical to smaller SMEs. Existing partnerships include companies from the chemical, biotechnology and biopharmaceutical sectors as outlined in our research portfolio including Bruker, BASF, GSK, Novartis, Shell, Siemens, Solvay, Syngenta and Unilever.

We offer an unrivalled environment that presents opportunities for placements in industry across a variety of research disciplines. Our portfolio of industrially sponsored postgraduate studentships includes Bruker Ltd, Lonza, Unilever, AstraZeneca, Tgk, Christech, Shell and GlaxoSmithKline.

We also host European biotechnology training networks in Industrial Biotechnology including FiFifty and BIOTRAINS, for the support for the chemical manufacturing industries and MAGIC (MAGnetic Innovation in Catalysis).

Benefits of collaborative research with MIB include:

• the cost effective trialling and testing of products, drugs and compounds using University facilities and expertise
• the development of close long-term relationships with academic staff to build a relevant and comprehensive portfolio of research and expertise needed to meet your company’s specific needs.
• the transfer of innovative techniques and practices from the laboratory to the manufacturing process
• the direct licensing of innovative technologies and processes
• the accessing of government and European Union funds for academic research that would be out of reach for purely commercial projects
Technology Transfer
The University of Manchester Intellectual Property Limited (UMIP) assists in the commercialisation of any innovative technologies and processes that may be derived from collaborative research. UMIP has over a 20 year history of Intellectual Property (IP) commercialisation and works closely with MB to ensure that any IP is fully developed to maximise technology transfer.

In the FY2012-13 the MB has secured over 31 invention disclosures which represents a 48% increase from the previous year and filed 1 priority patent and 2 new licences.

For further details of collaboration and partnership opportunities please contact:

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Biotechnology YES 2012 - MB team triumphs in National competition to be the biotechnology stars of the future

Members of Jason Micklifield’s research group secured a place in the final of a national competition to find the entrepreneurial bioscientists of the future. Matthew Styles, Anna-Winona Struck, Sarah Shepherd, Brian Law and James Leigh formed team Enzmax and beat off stiff competition from 377 competitors across 82 teams in five regional workshops held in October and November in the Biotechnology Young Entrepreneurs Scheme (Biotechnology YES) 2012 competition. The team flew the flag for Manchester in December at the UK finals held in London. Although the team did not scoop the top prize, which went to Calvitium Solutions, they won the category for “Best consideration of IP strategy” sponsored by Potter Clarkson.

Enzmax have a proprietary platform technology, known as Enzmax SHIELD™, which they use to deliver cost-effective solutions for maximising the performance of enzymes in industrial biotechnology.

Spin-out companies

CAX, known as Conformetrics, founded by Dr Andrew Almond, is focused on the optimisation of drug discovery and design using NMR-based technology to accurately solve bioactive three-dimensional molecular structures. Conformetrics Ltd and AstraZeneca signed a research collaboration agreement under which Conformetrics’s proprietary NMR-based technology will be applied across AstraZeneca’s pre-clinical therapeutic pipeline to enhance lead discovery and hit identification.

Pharmakure, founded by Professor Andrew Doug and Dr Farid Khan, launched in 2012 to explore new Alzheimer treatments through the screening of existing drugs. Pharmakure is a new drug discovery company focused on Alzheimer’s disease through the discovery of new uses for old drugs, offering great promise for delivering new therapeutic options to patient care.

PeptiGelDesign was founded in 2013 by Drs Aline Miller and Alberto Sanui. A technological platform has been developed based on the fundamental understanding of the self-assembly of oligo-peptides across the length scales. This allows the design of biocompatible and biodegradable hydrogels with tailored mechanical properties and functionality for a range of biotechnological applications. These hydrogels are composed of an entangled network of elongated fibres that mimic the structure of extra cellular matrix. Their mechanical strength can be tailored to span those of a large range of human tissues. Moreover the hydrogels can be functionalised with multiple biologicals and pharmaceuticals. These novel materials are therefore suitable and proven as drug delivery vehicles, scaffolds for cell based therapies and assays as well as tissue engineering, thereby enabling the next generation of therapeutic treatments. This research is now being commercialised through the spin out PeptiGelDesign Ltd.

Research Centres

Centre of Excellence in Biocatalysis, Biocatalysis and Biocatalytic Manufacture (CoEBio3)

Development of new biocatalyst-based processes to meet the changing needs of industry in the next 10-20 years. CoEBio3 will train graduate and postdoctoral scientists such that they possess the necessary combination of skills in chemistry, biology and engineering needed to support these changes.

Peptide Gel Design is the spinout of the University of Manchester's Innovation Centre (UMIC).

CoEBio3 is a state-of-the-art, co-located centre bringing together the expertise of researchers from all four Faculties of the University of Manchester, building strong links with industry to develop courage and deliver. The centre is led by Professor Andrew Doug, stage of the way to open the centre in 2014.

Manchester Centre for Biophysics and Catalysis (MCBC)

MCBC is a state-of-the-art, cross-disciplinary platform technology centre integrating biophysical, structural, and computational methodologies to address contemporary problems in catalysis and the dynamical properties of biological macromolecules. By going beyond simple structure determination of biological molecules, MCBC is driving the new “dynamics determines function” paradigm through temporal analysis of dynamic transitions relevant to biological function and catalysis from the femtosecond to second timescale.

National Centre for Text Mining (NaCTeM)

The National Centre for Text Mining (NaCTeM) is the first publicly-funded text mining centre in the world. The Centre provides text mining services in response to the requirements of the UK academic community leveraging the UK e-Science framework, grid technology, relevant standards and ONT-UK middleware.

Michael Barber Centre for Collaborative Mass Spectrometry

The Michael Barber Centre for Collaborative Mass Spectrometry is a leading research centre devoted to developing mass spectrometry based technologies and their application to biological problems. Professor Parvati Banr, Waters Chair in Mass Spectrometry has recently taken up the post of Director.

Manchester Centre for Innovative Systems Biology (MCoISB)

The MCoISB provides a hub for cutting-edge systems biology research pioneering the development of new experimental and computational technologies and skills necessary for the development of quantitative Systems Biology, and their exploitation.

Manchester: Integrating Medicine and Innovative Technology (MIMIT™)

MIMIT™ uses its unique Innovation Development Process™ to scope unmet healthcare needs and accelerate the development of new healthcare technologies, thereby enabling new technologies to reach patients faster and more effectively.

www.mcbc.is.manchester.ac.uk

www.mcoisb.org

www.mimit.org.uk

www.nactem.ac.uk

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www.mccb.is.manchester.ac.uk

www.mobic.org.uk
The University of Manchester has established a number of prestigious interdisciplinary Research Institutes in addition to existing specialist research centres and groups. Research institutes incorporate the acknowledged research strengths across the University into core research priorities. Researchers in the MIB have strong links with the following institutes:

Institute for Science Ethics and Innovation
www.isei.manchester.ac.uk

Cancer Research UK Manchester Institute
www.cri.uk.manchester.ac.uk

Research Facilities
We have an impressive range of specialist research facilities in the MIB which are maintained by dedicated experimental officers offering flexible and tailored use of our facilities, ranging from walk-in service to formal collaborations. Services and equipment are available to all University of Manchester researchers and external users from academia and industry.

Protein Science – an integrated approach
The Protein Science Facility at the MIB provides protein production services and access to cutting-edge biophysical equipment, which can be used to study many different chemical and biological processes over a range of timescales and temperatures. The facility is actively involved in a wide range of research topics and has contributed to a number of publications in a broad range of high impact journals. The facility has developed the use of advanced spectroscopic tools to study catalytic, binding, structural and dynamical processes in biological macromolecules including advanced fluorescence techniques; Circular Dichroism (CD) spectroscopy; electrochemical approaches to probe redox properties of biological molecules using potentiometry apparatus; Fourier Transform Infra-Red (FTIR) spectroscopy; thermal stratiﬁcation calorimetry (ITC) and surface plasmon resonance (SPR).

Manchester Protein Structure Facility
Enquiries Dr Colin Ley
colin.ley@manchester.ac.uk
Tel: +44(0)161 306 5185

X-ray crystallography utilizes X-ray diffraction by single protein crystals to elucidate three dimensional structures at atomic resolution. The technique plays a pivotal role in understanding how individual amino acids interact with small molecule ligands and cofactors. The facility provides a complete service pipeline, taking you from purified protein to crystal structure. Meeting the often rate limiting challenge of crystallogenesis are two complimentary high throughput nanofluidic dispensing robots (Mosquito & Phoenix) allowing rapid screening and optimisation. The facility also houses two rotating anode X-ray generators and associated data collection equipment. These in-house facilities are further supplemented with regular synchrotron access.

Manchester Protein Expression Facility
Enquiries Dr Eddie McKenzie
edward.a.mckenzie@manchester.ac.uk
Tel: +44(0)161 306 4710

The facility provides a comprehensive resource for the high level expression and scale-up production of recombinant proteins. Currently we offer a choice of four expression systems: bacteria, pichia, insect and mammalian cells. Depending on particular needs we are able to provide either small scale production facilities for biochemical analysis and antibody production or larger scale production for structural studies. Equipment includes: a 10 litre wavebag (GE Healthcare) for insect cell scale up.

Nuclear Magnetic Resonance (NMR)
Enquiries: Dr Matthew Cliff
matthew.c1clf@manchester.ac.uk
Tel: +44 (0)161 306 4229

NMR Magnetic Resonance (NMR) spectroscopy is one of the principal techniques used to obtain physical, chemical, electronic and structural information about molecules. It is a powerful technique that can provide atomic resolution information on the topology, dynamics and threedimensional structure of molecules in solution and the solid state. The breadth and quality of information attainable from NMR measurements makes it unique among spectroscopic tools.

In March 2012 the MIB took delivery of a new 800 MHz Bruker NMR spectrometer, along with upgrades to existing 600 and 500 MHz spectrometers. These new additions to our facility will open up a substantial number of new research programmes focusing on the structures and dynamics of complex macromolecular systems.

We have close links with Bruker who have contributed four 4-year fully funded industrial PhD studentships. MIB has both state-of-the-art high magnetic field strength instruments, and more economical lower field instruments.

Computational Chemistry
Enquiries: Linus Johannisson
linus.johannisson@manchester.ac.uk
Tel: +44 (0)161 306 4559

Simulation of protein function and dynamics using computational methodologies including protein dynamics & conformational change (MD simulations); free energy calculations (umbrella sampling, metadynamics); ligand binding ( docking, metadynamics) and catalytic mechanisms (QM & QM/MM calculations).

Mass Spectrometry
Enquiries: Dr Nick Lockyer
nick.lockyer@manchester.ac.uk
Tel: +44 (0)161 306 4479

SIMS is developed and used for the analysis and imaging of chemical and biological systems, including advanced materials, single cells and biological tissue. The aims involve novel insights into the chemical and spatial organisation and function of these systems at the molecular level.

Nick Lockyer and John Vickerman are developing applications of SIMS in areas involving the characterisation and classification of cells and tissue at the molecular level. They are also working closely with industry to develop new instrumentation and analytical protocols to advance SIMS applications in biosciences.

Mass Spec@Manchester
Mass spectrometric research has a long and rich history at The University of Manchester. In this network we attempt to bring together the experience and expertise of these researchers under one umbrella.
POSTGRADUATE AND TRAINING

The MIB offers a unique environment to carry out multidisciplinary research with open-plan laboratory and write-up areas designed to promote open communication between researchers from diverse and hybrid scientific backgrounds. Home to over 250 PhD students and 80 MSc students we endow our interdisciplinary investigators with the key skills to enable them to work successfully across the disciplinary interfaces at the forefront of biotechnology.

In addition to the traditional UK doctoral training programmes we host a number of EU training networks (P4FIFTY, Biocatalysts and MAGIC). Students join a vibrant and dynamic international community of researchers and students from across the EU and around the world including China, Egypt, Saudi Arabia, India, Pakistan, UK, Mexico, Chile and Thailand amongst others. We offer an unrivalled environment that presents opportunities for placements in industry across a variety of research disciplines with a growing number of research students industrially funded through Bruker UK Ltd, Lonza, Cypex, Unilever, UCB Pharma, AZ, Tgk, Conformetrix, and SarGimics with each ESR closely linked to the international and industrial partners who will be actively involved in their research projects.

In the search for new enzymes and biocatalysts, high-throughput screening methods for catalysis have a key role and they are necessary for screening libraries generated either from sampling the biosphere or from diverse generation methods. The technique suitable for HTS must be rapid and cost effective and reflecting the desired functions.

The MIB team has successfully developed new fluorescence based HTS methods for several biocatalytic reactions. This HTS method will be used to screen bacterial, plant, fungal (and their mutants) P450 libraries for hydroxylation activity against a set of standard compounds which have to give specific reaction with human P450s. Another aspect of MIB efforts will be to develop P450s active in both conventional organic solvents and also alternative ones (such as fluorinated solvents) providing engineering solutions for large scale application to be investigated. The adaptation of existing HTS methods is associated with synthesis and testing new potential substrates.

“MAGIC” brings Marie Curie success to Manchester

The MIB and Photon Science Institute (PSI) have secured a Marie Curie FP7 IDP training network grant worth 3.4 million euros. The four year grant entitled “Magnetic Innovation in Catalysis”, known as MAGIC, will see the MIB and PSI host 12 Early Stage Researchers (ESR’s) who will be appointed to three-year PhD training programmes. Hosted at the MIB and PSI this project will see Manchester partner with six Universities (Tokyo, Freiburg, Lund, Joseph Fourier in France, Edinburgh and Copenhagen) and five companies (AZ, Bruker, Tgk, Conformetrix, and SarGimics) with each ESR closely linked to the international and industrial partners who will be actively involved in their research projects.

The concept of team-based activity is well founded across research groups in MIB-PSI and will enrich the training experience bringing multiple skills embedded in these teams to MAGIC programmes. These novel methods will transform current experimental capabilities and will be applied to a range of important biological catalysts to probe the mechanistic importance of coupled motions and quantum physico-chemical effects. Innovative physical sciences magnetic resonance techniques (NMR and EPR) will be developed and implemented in a life sciences context to contrast studies of enzyme mechanisms and catalysis, and ultimately rational design.

“Our aim is to train the future generation of leading investigators of biological catalysis/enantioselectivity with a view to developing new enabling technologies that can advance physical understanding of catalysis and mechanism. Collaborative research projects will explore the mechanistic details of enzyme systems by adopting innovative, versatile and unique experimental techniques to probe the contributions of motions across multiple spatial and temporal timescales and quantum chemical effects. In turn these novel methods will transform current experimental capabilities and will be applied to a range of important biological catalysts to probe the mechanistic importance of coupled motions and quantum physico-chemical effects.”

Professor Nigel Scrutton
Director

“MIB has a reputation for pushing the boundaries in technology development and innovation. I was delighted to join the MIB as it promotes interdisciplinary, challenge oriented science that is supported by an outstanding structural biology infrastructure.”

Claudio Santos
Ph.D Biochemistry, 2nd Year Bruker Studentship

“The MIB is an exhilarating environment in which to carry out research. I relish associating with peers from around the world, and the up-to-date facilities mean the research undertaken here is of the highest quality. I also believe that the integration of different experimental approaches provides a key advantage over other competing groups and institutions.”

Alex Geddes
Ph.D Biochemistry, 2nd Year Bruker Studentship
BIOTRAINS – leading the green chemical training push

The ‘European biotechnology training network for the support of the chemical manufacturing industries’ (BIOTRAINS) programme brings together microbiologists, enzymologists, chemists, engineers and process development experts involved in the training of the next generation of scientists who will develop green manufacturing methods for the chemical industry. Led by Professor Nicholas Turner, Director of the Centre of Excellence for Biocatalysis, Biotransformations and Biocatalytic Manufacture (CoEBio3: www.coebio3.org), this four-year project involves eleven partners from academia and industry who will recruit and train research fellows and another six industrial partners who are offering placement training that is expected to make a major contribution to efforts to replace traditional chemical manufacturing – reliant on highly toxic chemicals and solvents – with so-called ‘white biotechnology’. The term covers the manufacturing of chemicals, alternative energy and biomaterials and has the potential to enable economies to become less dependent on fossil fuels by employing the power of natural biocatalysts and modern manufacturing techniques to deliver safer and less environmentally damaging industrial methods. It is a term used mainly in Europe for the application of nature’s catalysts, such as enzymes and cells, in biotechnology for industrial purposes. The use of the word ‘white’ distinguishes it from other biotechnologies such as ‘red’ (medicinal) and ‘green’ (plant) biotechnology.

We work closely with the University Public Engagement team, Manchester Museum and the Museum of Science and Industry (MOSI) to deliver events and activities including the Manchester Science Festival and National Science and Engineering week. We continue to host students as part of the Nuffield Bursary Placement Scheme enabling students to work alongside professional scientists, technologists, engineers and mathematicians. In particular the scheme encourages from schools in difficult social circumstances, and students who do not have a family background of higher education or STEM professions.

On Friday 9 November 2013 the MIB opened its doors to 200 A-A/S students from 12 schools/colleges from across the North of England providing them with a unique opportunity to visit a world class interdisciplinary research institute. Students witnessed and participated in a number of activities throughout the day including interactive research stands followed by guided tours of the research laboratories with an opportunity to talk with researchers about their work. MIB postdocs and research students developed a number of laboratory demonstrations that covered topics as diverse as NMR, protein expression and robotics. A variety of interactive stands showcased the rich array of MIB research from the developing enabling technologies (including micro fluidics, nanotechnology and spectroscopy/spectrometry), protein science and genomics through to systems and computational biology.


Tour demonstrations included: Protein Structure | Mass spectrometry | NMR | Protein Expression | Robotics | Enzyme reactions.

The University of Manchester is committed to the discovery and dissemination of knowledge and seeks to lead on public engagement in all forms, providing expertise in public discourse and policy development, listening to the wider community, and involving the public in its work.

"... a distinctive feature of the University is its commitment to a social responsibility agenda. This ethos is embedded in our outreach activity at the MIB and we are committed to engaging with our wider community with the aim of increasing awareness, interest, and understanding of science and hopefully inspiring the next generation of scientific leaders."

Dr Rosalind Le Feuvre
MIB’s Research and Planning Manager
The stand demonstrated how the study of carbohydrates such as sucrose, starch, pectin and alginate can help improve many aspects of our lives from producing renewable energy and materials to generating new medicines. How cell sugars interact with foreign molecules have applications in a variety of areas, including improving human fertilisation therapies, developing anti- flu medicines and diagnostic tools, and creating new anti-cancer treatments. Identifying the difference in glycosylation between cells can help scientists distinguish between epidemic, seasonal and bird flu and develop the correct therapies for flu outbreaks. As the glycosylate also differs between individuals, it provides a method for producing advanced diagnostic tools for personalised medicines.

One of the main exhibition activities was focused on cell surface sugars and visitors were encouraged to build a cell surface sugar array. This activity was very popular and designed to highlight and directly promote the GlycoBioM work. As part of the exhibition the team also commissioned a three minute animation which provided an introduction and overview of the whole area of carbohydrate science. This video has since had over 700 views. They were also successful in the Royal Society Games Jam competition with their game, ‘Cell Invaders’, which was voted the best game at the exhibition and won £2,000 worth of development and is now available to download on PC and iPad.

“it was very exciting to be selected to exhibit at the Royal Society and we very much enjoyed interacting with the students. Our exhibit demonstrated how the study of these sugars can help improve many aspects of our lives from producing renewable energy and materials to generating new medicines. Understanding the glycosylate and its interaction with other molecules will provide a wide range of opportunities for the development of new foods, medicines and healthcare treatments”

Sabine Flitsch
Professor of Chemical Biology
Faculty of Engineering and Physical Sciences

School of Chemical Engineering and Analytical Science

CURTIS, Robin - weak protein-protein interactions, protein aggregation, bioprocessing, biomolecular thermodynamics.

De VISSER, Sam - computational studies of enzyme mechanism and function.

GARDNER, Peter - vibrational spectroscopy of bio and biomedical systems.

GODDARD, Nick - microfluidics; sensors (electrochemical/optical); high throughput platforms; microexposures (electrochemistry); multiphase microfluidics; micro- and nano-fabrication.

MILLER, Alina - application of physical principles to mimic, manipulate and improve biomolecular self-assembly to create materials for regenerative medicine.

POPELIER, Paul - predictive modelling of structure and dynamics from first principles; drug design; chemical insight from modern wave functions.

KEANE, John - development of clinical decision support systems (DSS) and analytics of multi-modal (structured, semi-structured, unstructured, image) data for bio-health applications.

HENCHMAN, Richard - biomolecular structure and dynamics.

POPELIER, Paul - computational enzymology & protein modelling.

WESTERHOF, Hans - integrative systems biology.

YUAN, Xue-Feng - philosophy of complex fluid/soft matter such as biofluids and biomaterials in living system; quantitative rheological and structural characterization under physiological conditions; integrated multiple scale modelling.

School of Chemistry

BARRAN, Perdita - mass spectrometry, instrument development and R&DMS fundamentals.

FLITSCH, Sabine - glycosciences and biocatalysis.

GARDNER, John - carbohydrate chemistry/chemical biology, biocatalysis, dendrimer synthesis and heterocyclic biocatalytic chemistry.

GOODACRE, Roy - integrative ‘omic analyses and vibrational spectroscopy for understanding biological systems.

HENCHMAN, Richard - biomolecular structure and dynamics.

POPELIER, Paul - predictive modelling of structure and dynamics from first principles; drug design; chemical insight from modern wave functions.

KEANE, John - development of clinical decision support systems (DSS) and analytics of multi-modal (structured, semi-structured, unstructured, image) data for bio-health applications.

KELL, Douglas - development and application of novel analytical methods at the interface between postgenomic biological systems, quantitative bianalytical science and machine learning, with a special emphasis on evolutionary computing and systems biology.

LOCKER, Nick - imaging Mass Spectrometry (IMS), instrument development.

MICKLEFIELD, Jason - chemical biology and synthetic biology.

WONG, Lu-Shin - combining chemical biology and nanotechnology applications in the life sciences: Biocorruption and surface chemistry towards nanoscale protein arrays.

School of Computer Science

ANANIADOU, Sophia - biomedical text mining, information extraction, terminology management, semantic interoperability of resources.

KING, Ross - interface between computer science and biology/chemistry.

MCNAUGHT, John - text mining.

MENDES, Pedro - computational systems biology.

RENACID, Goran - text mining and automatic knowledge structuring (ontologies, concept maps) in life sciences and health-care.

School of Materials

BLANFORD, Chris - sensitive measurements of protein-surface interactions in electrocatalytic enzymes.

SAIANI, Alberto - understanding the chemical architecture - thermodynamics - structure - physical property correlations in complex polymeric systems.

School of Mechanical, Aeronautical and Civil Engineering

BARTOLO, Paolo - biomaterials and computer-aided design of scaffolds for tissue engineering.

MUTCLIFFE, Mike - computational biology & protein modelling.

ROY, Kailash - membrane mechanics and biomechanics.

YUAN, Xue-Feng - philosophy of complex fluid/soft matter such as biofluids and biomaterials in living system; quantitative rheological and structural characterization under physiological conditions; integrated multiple scale modelling.

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Douglas Kell honoured in Queen’s New Year’s Honours 2014
Professor Douglas Kell CBE MS DPhil FSB FLW FAAAS
Chair in Bioanalytical Science

Douglas Kell was awarded a CBE for services to science and research in the Queen’s New Year Honours 2014. He has been a pioneer in many areas of computational biology and experimental metabolomics, including the use of evolutionary, closed-loop methods for optimisation. He also contributed to the discovery of the first bacterial cytokine, currently on trial as part of a vaccine against tuberculosis.

Douglas studied at Oxford University focusing on the development and exploitation of novel methods for the study of (mainly microbial) bioenvironments. He was awarded a Personal Chair at the University College of Wales (now Aberystwyth University) in 1992 and from 1998-2002 was Director of Research of the Institute of Biological Sciences. He co-founded Aiber Instruments, that received the Queen’s Award for Export Achievement in 1998.

In 2002 he accepted an RSC/EPSRC-funded Chair in Bioanalytical Sciences at UMIST. From 2005-2008 he was Director of the Manchester Centre for Integrative Systems Biology at The University of Manchester. From 2008 until 2013 he was Chief Executive of the Biotechnology and Biological Sciences Research Council (BBSRC).

He has a Doctor of Science Honoris Causa from Cranfield University (2011), and is a Fellow of the Learned Society of Wales (2012), of the American Association for the Advancement of Science (2012), and of Aberystwyth University (2013). He has published over 400 scientific papers with >18,000 citations in WoK (H-index 72). In Google Scholar H=83 and citations >26,000.

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