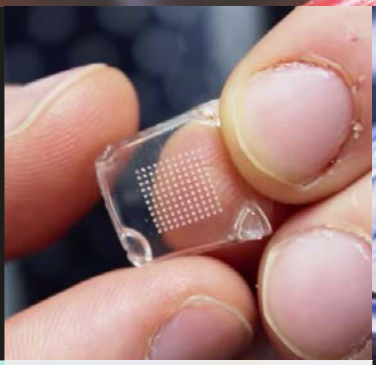
Queen's University Belfast

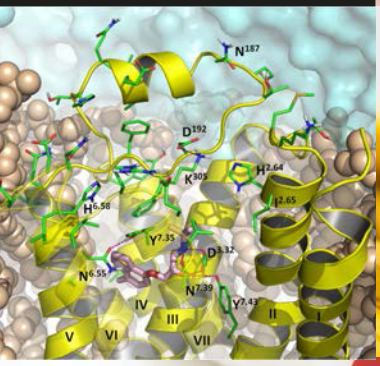
SCHOOL OF
PHARMACY

www.qub.ac.uk/pha

Research Prospectus

OUR RESEARCH





IS MAKING A DIFFERENCE.

We are exceptional


Our research environment has been rated as 100% World Leading
We are exceptional
Research Excellence Framework, 2015

FOREWORD FROM THE HEAD OF SCHOOL

PROFESSOR DAVID WOOLFSON

The School of Pharmacy at Queen's is one of the leading centres in the UK and internationally for education and research in pharmacy and the pharmaceutical sciences. As an academic research centre, our commitment is to improving the health of populations locally, nationally and internationally. Our research programmes span a wide range of scientific and professional disciplines, and are characterised by being multidisciplinary, internationally connected and, ultimately, relevant to patients.

In developing our research programmes, we have been driven by the belief that pharmacy and the pharmaceutical sciences are, and will continue to be, impacted by ongoing changes in societal attitudes to healthcare, a greater focus on intractable diseases and the continued challenges of early stage drug discovery. Target identification and validation, systems biology, the increasingly important interface between formulation science and engineering, a continuing interest in natural sources of drugs and a growth in the capabilities of enabling technologies are key drivers for change. Increasingly, we see that economic reality and ageing populations are lending traction to research aimed at securing the more effective use of existing drugs. Reflecting these realities, our research programmes increasingly demonstrate integration between the sciences and the clinic.

Translation and commercialisation of research, and the implementation of research-based health improvement initiatives, are essential if research is ultimately to benefit patients. The School of Pharmacy at Queen's has a long history of successfully developing new pharmaceutical and healthcare products, services and policies, either independently or in partnership with academic colleagues, industry or health providers.

> "The School of Pharmacy at Queen's has a long history of successfully developing new pharmaceutical and healthcare products, services and policies"

Whether in primary or secondary care pharmacy, or in the pharmaceutical sciences, our research seeks to make a positive contribution to the better prevention or treatment of disease. In this brochure, you will find descriptions of our research programmes as varied as novel delivery systems, new drug discovery approaches, new ways to fight infection, novel ways to make better use of existing medicines, and much more. We hope you enjoy reading about our work and that you might be inspired to join us in the quest for better health and a better quality of life for all.

FOREWORD FROM OUR DIRECTORS OF RESEARCH

Prof. Carmel Hughes
Director of Research
Pharmaceutical Science and Practice

The Pharmaceutical Science and Practice cluster is unique in its approach to research. The fundamental focus is on improving patient care, through spanning the application of the more traditional pharmaceutical sciences to evaluation of new services delivered in various settings. We are multidisciplinary in our ethos, with a strong track record in knowledge transfer. We are internationally connected and clinically engaged. All of this ensures that our research is relevant, timely and will make the greatest impact. Researchers within the cluster have links with industry, clinicians and policy makers. Work has led to important licensing agreements with pharmaceutical companies, the launch of new products, a major change in the approach to the management of infections and the implementation of new services for older patients living in care homes.

Prof. Chris Scott
Director of Research
Molecular Therapeutics

The Molecular Therapeutics cluster brings together diverse fundamental and applied research backgrounds in protease biology, targeted biologic therapeutics, nanomedicine and chemical biology. Our aim is simply to develop new therapeutic and diagnostic paradigms. We work closely with clinical and medical technology collaborators across the globe, both in academia and industry, to develop solutions for areas of unmet need; mainly cancer, pulmonary and infectious diseases. This approach has led to notable biopharmaceutical achievements. This includes the original development of ALM201, which has now entered clinical trials led by Almac Discovery Ltd., and the out-licensing of other antibody and DNA vaccine technologies to Fusion Antibodies Ltd., and Touchlight Genetics Ltd. One of the most exciting developments in the last 24 months has been the success of the ProAxsis Ltd., a spinout company that has led the development of a highly innovative diagnostic test for chronic airway disease. These achievements highlight the pedigree of our work, our excellent training environment, and our ethos towards translational science.

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ENGINEERED DRUG DELIVERY SYSTEMS FOR COMPLEX FORMULATION PROBLEMS

Name: Professor Gavin Andrews

Research Group: Pharmaceutical Engineering

Researcher profile: http://go.qub.ac.uk/gavinandrews

Professor Gavin Andrews is Chair of Pharmaceutical Engineering and has research interests in development of novel orally administered solid dosage forms and biomaterials. This involves the use of engineering techniques for controlled/ targeted delivery within the gastrointestinal tract and solubility enhancement of poorly soluble therapeutics and the use of multi-layer extrusion technology for manufacture of biomaterials and complex oral dosage forms. Gavin has secured funding from a wide range of sources, including the EPSRC, EU, The Wellcome Trust, SFI, NSF, DEL and The Royal Society (https://royalsociety.org/grants/case-studies/gavin-andrews/).

Gavin's research, which has a significant industrial focus, has been extensively sponsored by major multinational pharmaceutical companies and he has played a central role in technology transfer between academia and industry through funding from Innovate UK, Enterprise Ireland and Invest Northern Ireland. Gavin sits on the Editorial Advisory Boards of *Drug Development & Industrial Pharmacy*, *Journal of Pharmacy & Pharmacology* and *Journal of Pharmaceutical Sciences*. He has published his research widely in internationally peer-reviewed pharmaceutics journals and has been invited to present at leading national and international conferences.

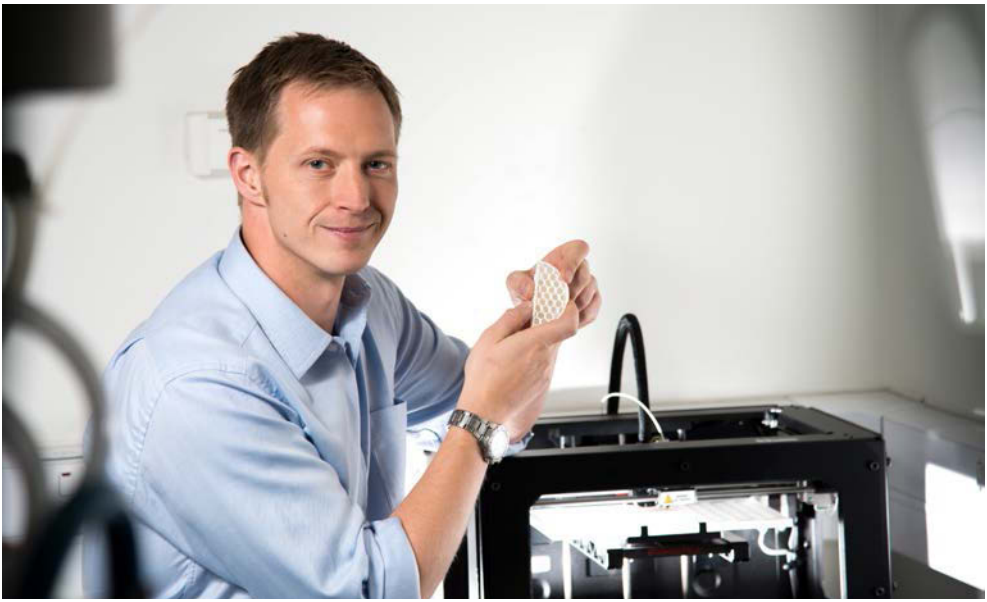
He has formed strong collaborative links with researchers in the UK, Europe and the United States, held a Royal Society Industry Fellowship with Astra-Zeneca from 2009-2014, is the current President of the UK & Ireland Controlled Release Society (www.ukircs.org) and is a member of the Academy of Pharmaceutical Sciences Expert Subject Group on Materials Science.

Gavin leads a dynamic research group that has its focus in pharmaceutical engineering with a specific emphasis on secondary processing. Research sits at the interface between pharmaceutical sciences and chemical engineering with the aim of challenging the traditional methods commonly used to manufacture oral dosage forms and drug delivery platforms. The group have a strong interest in emerging pharmaceutical manufacturing technologies and in understanding their inherent advantages and disadvantages. Ultimately, Gavin's group aims to design and manufacture both oral drug delivery and biomaterial products via a quality-by-design rather than quality-by-analysis approach. To date, focus has been on hot melt extrusion (HME) and more recently injection moulding (IM). Furthermore, they are interested in novel ways of producing intricate and fixed dose combinations. The general aim of Gavin's team is to better understand the capabilities of each process and to build an understanding of the interrelation between formulation and processing factors and the impact these have upon end product performance.

Interestingly, over the last 10 years there has been a significant drive towards continuous processing. HME and IM may be used for continuous production of high quality drug delivery products in a single step, whilst also permitting real time characterisation using process analytical technologies. Recent work in this area, included in The Royal Society Trustees' Report (https://royalsociety.org/~/media/about-us/reporting/2014-17-9-trustees-report.pdf?la=en-GB), involves the manufacture of solid dispersions and co-crystals to improve the dissolution rate of poorly water-soluble drugs, one of the major challenges in dosage form development. Gavin has also received considerable funding from Science Foundation Ireland and The Department for Employment and Learning (~£1M) to develop fixed dose combination products along with colleagues at Trinity College Dublin and Eli Lilly (USA). Moreover, the group has strong international links with major multinational pharmaceutical companies and universities (e.g., Eli Lilly, Astra Zeneca, Capsugel, Trinity College Dublin, University of Limerick, Purdue University, Rutgers University, Ghent University, CSOPS, SSPC) and has recently received $1.4M for a US-Ireland partnership to develop continuous manufacturing for nano-based drug products.

RESEARCH PARTNERS

- **Amebis**
- **Astrazeneca**
- **Capsugel**
- **GlaxoSmithKline**
- **King's College London**
- **Purdue University**
- **Gent University**
- **University of Ljubljana**
- **University of Helsinki**
- **Innopharma**
- **National Institute for Bioprocessing Research and Training**
- **Pfizer**
- **Rondol**
- **Rutgers University**
- **Trinity College Dublin**
- **University of Belgrade**
- **The University of Edinburgh**
- **University of Limerick**
- **Eli Lilly and Company**



ENGINEERING DRUG DELIVERY DEVICES OF THE FUTURE

Name: Dr Peter Boyd
Research Group: Advanced Manufacturing and Drug Delivery

Researcher profile: http://go.qub.ac.uk/peterboyd

Dr Peter Boyd is Lecturer in Pharmaceutical Engineering. He has a specialist interest in the manufacture of thermoplastic and thermosetting sustained and controlled release drug delivery devices using injection molding and additive manufacturing techniques. Peter has a track record in developing new dosage forms particularly in the area of vaginal drug delivery and in working with industry to bring laboratory-based research to the stage of clinical manufacturing.

One of Peter's key projects over the last six years, funded through the International Partnership for Microbicides with the National Institutes of Health (NIH) and USAID, has been the scale-up of a microbicide loaded dosage form for HIV prevention. A major focus of Peter's work has been the tech-transfer of this device to Contract Manufacturing Organisations in order to produce at a commercial scale. Peter's relevant knowledge of Chemistry, Manufacturing and Control (CMC) requirements and current Good Manufacturing Practice (cGMP) have helped to achieve a positive outcome for this project and in similar types of projects that he has completed with pharmaceutical companies over the last few years.

With research funding from the World Health Organisation (WHO), Peter has worked to develop adherence-monitoring strategies that could be applicable for use in clinical trials of vaginal dosage forms. He has been researching the use of vaginal ring technology for the application of neo-adjuvant chemotherapy and other applications in patient's suffering from cervical cancer.

A recent Medical Research Council (MRC) grant has been awarded to Peter to look at the use of 3D printing for the manufacture of drug delivery devices with a view to producing exquisitely customizable dosage forms that are tailored to the individual patient.

Peter says: "I'm focused on developing a platform technology which could have many applications but my particular interest would be implants for localised drug delivery. There's a large body of research that needs to be done but there is the potential for highly-personalised multi-drug delivery systems that were simply unimaginable 10 or 15 years ago."

In 2013, Peter sat on the Scientific Advisory Panel for Teva's "Vaginal Route of Administration" Scientific Symposium. Since 2013, he has been a member of the Population Council's Scientific Advisory Panel speaking on manufacturing issues associated with contraceptive development.

"There's a large body of research that needs to be done but there is the potential for highly-personalised multi-drug delivery systems that were simply unimaginable 10 or 15 years ago"

RESEARCH PARTNERS

- **International Partnership for Microbicides**
- **Medical Research Council**
- **The Wellcome Trust**
- **Population Council**
- **QPharma**
- **ProMed Pharma**
- **Star-Oddi**
- **World Health Organisation**

DISSECTING REGULATORY MECHANISMS WITHIN THE MICROENVIRONMENT

Name: Dr Roberta Burden
Research Group: Cell Biology and Microenvironment Research Group

Researcher profile: http://go.qub.ac.uk/robertaburden

Dr Roberta Burden's research group is primarily focused on dissecting the mechanisms by which the cellular microenvironment is regulated in both health and disease. Of particular interest is the role of proteolysis and chemokine biology in ageing and maladies such as cancer, cardiovascular disease and fibrosis. In recent years, the importance of dissecting the interactions between different constituents of the cellular microenvironment has been of increasing interest, in particular within the inflammatory milieu.

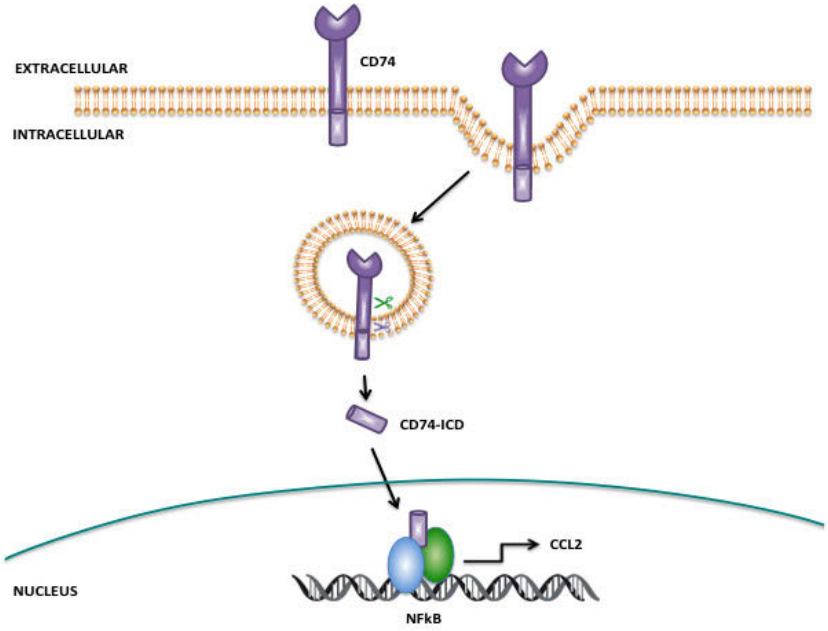
Roberta received a BSc degree in Biochemistry and a Masters degree in Medical Sciences before embarking on her PhD studies in Protease Biochemistry, focusing on the development of novel inhibition strategies for targeting cysteine proteases. Roberta's postdoctoral research was carried out in both academic and industrial laboratories, where the development and characterisation of novel therapeutics and their targets was the focal point of her research. Roberta was appointed as a Lecturer in Pharmacology in the Molecular Therapeutics research cluster within the School of Pharmacy at Queen's University Belfast in June 2012.

Recent work from her research group has focused on the cysteine protease Cathepsin S and the identification of novel mechanisms by which it can regulate the expression of pro-inflammatory chemokines such as CCL2. CCL2 is a potent mediator of macrophage recruitment to inflammatory sites in numerous diseases. Recently published work from Roberta's group has identified that Cathepsin S can transcriptionally

regulate CCL2 expression, which facilitates macrophage recruitment to inflammatory sites via the proteolytic processing of CD74. Cathepsin S facilitates the release of an intracellular domain fragment of CD74, which in turn activates the transcription factor NFkB and initiates the transcription of CCL2. *In silico* interrogation of human tumours confirmed the clinical significance of the relationship between Cathepsin S and CCL2 and work is now underway examining alternative inflammatory environments within which Cathepsin S regulates CCL2 and alternative mechanisms by which this effect is mediated.

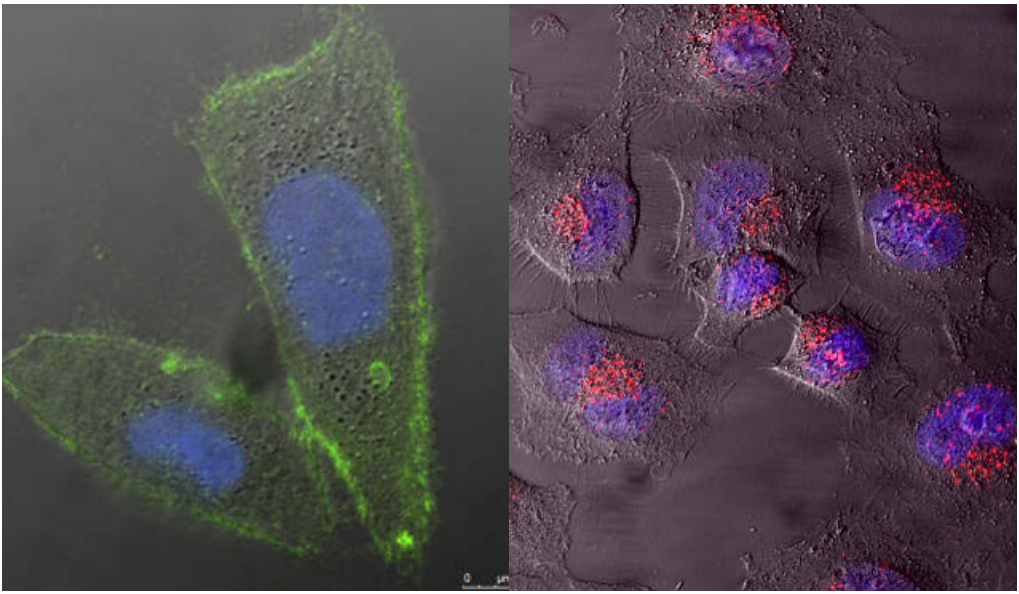
From the interrogation of the CatS-CD74-CCL2 axis, further work has focused specifically on the role of CD74 in tumourigenesis. CD74 is a type II glycoprotein normally expressed within the endo-lysosomal system, however numerous studies have now identified expression of this protein on the surface of tumour cells. Work currently being undertaken within Roberta's research group is focused on delineating the role of this protein in tumourigenesis, in particular within a subclass of brain tumours known as gliomas. This work has identified a novel role for the protein in mediating therapeutic responsiveness in gliomas and studies are now focused now on delineating the molecular mechanisms by which this is mediated.

Image below: CCL2 is transcriptionally controlled by the lysosomal protease cathepsin S in a CD74-dependent manner. *Wilkinson et al. Oncotarget. 2015* © all rights reserved.



RESEARCH PARTNERS

- University College Dublin
- Jacobs University Bremen
- Brainwaves Northern Ireland
- The University of Edinburgh



INVESTIGATING UBIQUITIN SPECIFIC PROTEASES AS TARGETS IN HUMAN DISEASE

Name: Dr James Burrows

Research Group: Ubiquitin Specific Protease Group

Researcher profile: http://go.qub.ac.uk/jamesburrows

The Work carried out by Dr James Burrow's research group focuses upon ubiquitin specific proteases (USPs) and their functions and potential role in disease, to assess their potential as therapeutic targets. In particular, James and his team have focused upon USP17 and its potential as a target for cancer therapy.

James' group have shown that USP17 expression is induced by activation of many important receptors such as Epidermal Growth Factor Receptor (EGFR) and Chemokine Receptor Type 2 and 4 (CXCR2/4), and is required for cellular processes important in cancer such as cell cycle progression and cell migration. Most recently, James has demonstrated that USP17 expression is required for the initiation of clathrin-mediated endocytosis (CME), a process vital for the internalisation and signalling of many important receptors such as EGFR, MET and ERBB2. This is a novel and extremely important observation, as it indicates the induction of USP17 expression by receptor activation initiates CME of these receptors and that targeting USP17 could potentially block their proper internalisation, signalling, and thus, function.

James and his group have also demonstrated that USP17 regulates the activity of the protease Ras Converting Enzyme 1 (RCE1). RCE1 is an important enzyme required for the processing and proper activation of a range of proteins known as 'CaaX' proteins and which include the proto-oncogene Ras. He has shown that RCE1 has a novel isoform which is deubiquitinated and specifically regulated by USP17. This is first indication that ubiquitination plays a role in the regulation of RCE1, a poorly understood integral membrane protease.

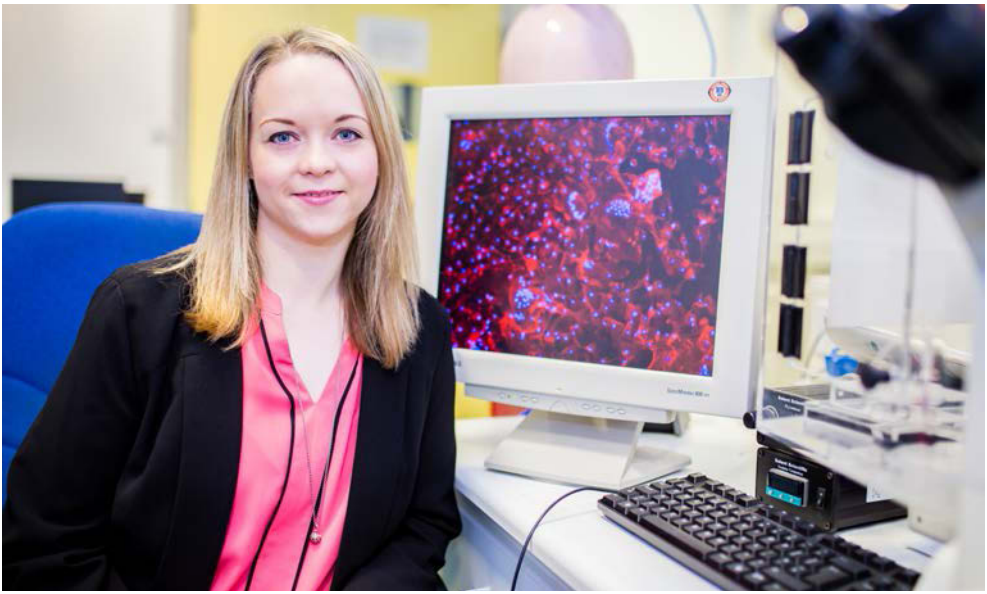
James' research group has also shown that USP17 is over-expressed in a range of tumour tissues and they are currently assessing USP17 as a potential cancer therapeutic target, as well as further determining how USP17 contributes to the regulation of RCE1 and CME.

Finally, the team are also currently pursuing a new project where they are assessing the potential of targeting bacterial proteases which contribute to host immune evasion as an alternative to antibiotics.

> "USP17 expression is induced by activation of many important receptors such as EGFR and CXCR2/4 and is required for cellular processes important in cancer such as cell cycle progression and cell migration"

RESEARCH PARTNERS

- **Feinberg School of Medicine, Northwestern University**
- **Trinity College Dublin**
- **Wellcome Trust Sanger Institute**
- **Queen's University Belfast Centre for Infection and Immunity**



MEDICAL DEVICES AND THE SHIFTING PARADIGM OF BIOCOMPATIBILITY

Name: Dr Louise Carson
Research Group: Bioactive Biomaterials and Infection Control

Researcher profile: http://go.qub.ac.uk/louisecarson

Since ancient times, mankind as engaged in the exploitation of biomaterials. As far back as 1065 – 740 BC, wooden and ivory prosthetics have been found in Ancient Egyptian tombs. However, it was during the 20th century when implantable medical devices became a cornerstone of modern medical and surgical practice. Devices such as joint prostheses and cardiac pacemakers are commonplace in modern healthcare, and have contributed a great deal to improving clinical outcomes for patients.

The successful outcome of the implantation of biomaterials is strongly dependent on the properties of the material. 'Biocompatible' is a catchword to describe a material with the ability to exist in contact with tissues of the human body without causing an unacceptable degree of harm. As biomaterials are now becoming used in increasingly complex scenarios (such as tissue engineering, biosensors, and drug delivery), there is potential for host tissue reactions to seriously impede the development and clinical application of these new technologies. A shift in the biocompatibility paradigm is seeing the traditional concept that implanted materials should be 'ignored' by the body replaced by the idea that materials should interact with tissues in a desired and beneficial manner.

Dr Louise Carson's research focuses on the Foreign Body Response (FBR), an inflammatory process that can limit the implanted device's overall biocompatibility, function, and even structural integrity. To date, no biomaterial has been developed with the ability to prevent the FBR, nor is the process fully understood.

It appears that a key stage in the cellular events

occurring during the FBR is the adherence of macrophages to the material surface, and their subsequent fusion into large multinucleate Foreign Body Giant Cells (FBGCs), the histological hallmark of the FBR. If the process of macrophage fusion and FBGC formation is attenuated, it may be possible to limit the FBR and thereby improve material biocompatibility.

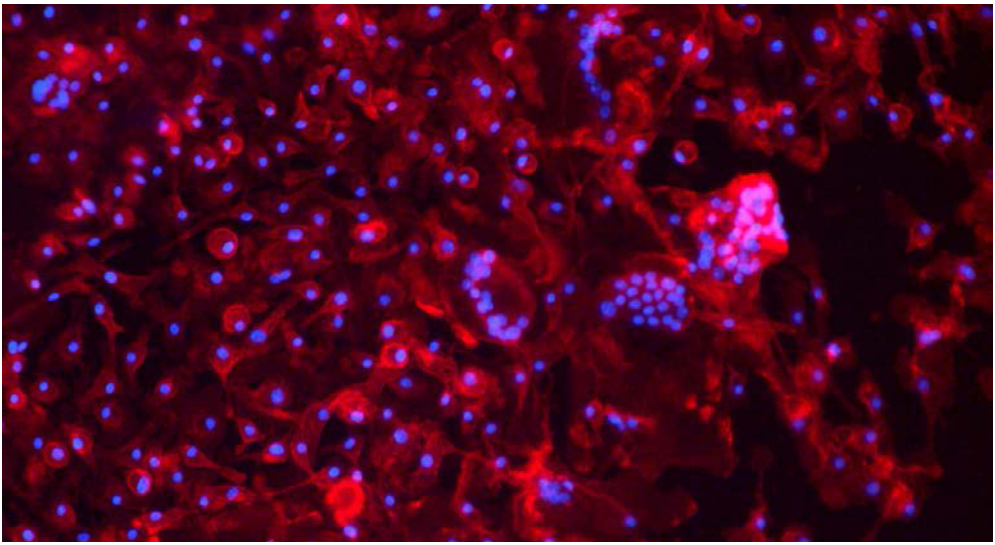
Louise has explored several approaches to impede FBGC formation, including;

• The design biomimetic materials that incorporate natural polysaccharides resembling the extracellular matrix. The concept here is to disguise, or camouflage, the surface of the material from the body's immune system, reducing the likelihood of a detrimental tissue reaction

• Development of materials with intricate microscopic surface patterns that can reduce the motility of adhered macrophages, thereby limiting the degree of FBGC formation

• Understanding the role of proteases in FBGC formation and selectively inhibiting proteases that are instrumental in macrophage fusion

The ultimate goal of Louise's work is to see this fundamental research translated into clinically applied biomaterials and medical devices to improve health outcomes. The technology already exists to manufacture the next generation of "smart" medical devices, such as tiny, intricate biosensors for disease monitoring (an example of which is implantable glucose sensors for real-time blood glucose monitoring in the management of diabetes). However, clinical trails of these new technologies have proved disappointing as the devices stop working within weeks of implantation due to the FBR. By developing our understanding of the FBR and exploiting this to design materials with improved biocompatibility, the vast potential for implantable devices in disease management could be realized.



RESEARCH PARTNERS

- **Engineering and Physical Sciences Research Council**
- **The Royal Society**
- **Society for Applied Microbiology**
- **University of Calgary**
- **Yale University**

DETERMINING THE APPROPRIATENESS OF PRESCRIBING

Name: Dr Janine Cooper

Research Group: Primary Care Research Group

Researcher profile: http://go.qub.ac.uk/janinecooper

Dr Janine Cooper is a Lecturer in Pharmacy Practice, having previously read for a Master's degree in Pharmacy and a Ph.D. in epidemiology at Queen's University Belfast. Janine's research focuses on pharmacy practice and pharmacoepidemiology, and she has worked on a range of studies from observational epidemiology to cluster randomised controlled trials. Janine has a particular interest in inappropriate prescribing, multimorbidity and polypharmacy.

According to Janine, "Prescribing for patients with two or more long-term conditions, or multimorbidity, is now common practice in primary care and is often associated with the use of multiple medications, or polypharmacy, which increases the risk of potentially inappropriate prescribing. However, polypharmacy may be necessary in many conditions, and the appropriateness of prescribing may be assessed using explicit prescribing criteria".

Over the past number of years, Janine has been looking at medication use in the ageing population. She says: "There has been a paucity of research in potentially inappropriate prescribing in middle-aged adults, despite approximately one-third of this age-group living with multimorbidity. This population is particularly important as it represents a group which will be the focus for health provision in the future".

Along with colleagues in the Royal College of Surgeons in Ireland, Trinity College Dublin and Queen's University Belfast, Janine developed

a set of explicit criteria for middle-aged people known as PROMPT (PRescribing Optimally in Middle-aged People's Treatments). In PROMPT, each criterion includes a statement about prescribing, for example, about doses, duration or medications to be avoided under certain conditions, and the rationale for this type of prescribing being potentially inappropriate.

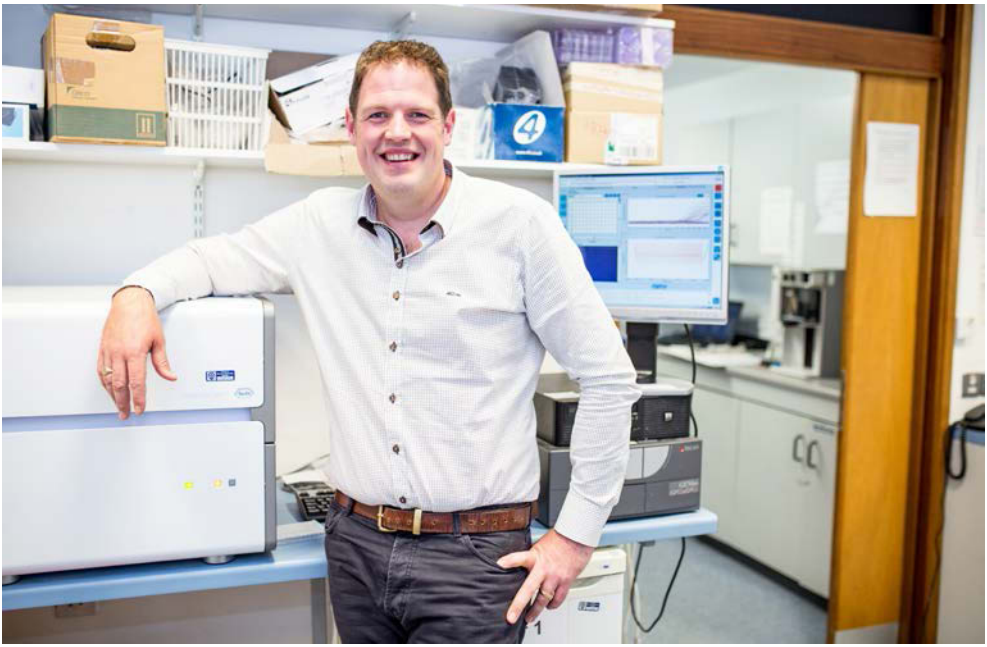
In a recent study, these criteria have been applied to datasets from the Enhanced Prescribing Database in Northern Ireland and the Primary Care Reimbursement Service database in the Republic of Ireland to determine the prevalence of potentially inappropriate prescribing. "Our study found that potentially inappropriate prescribing is common amongst middle-aged people and that polypharmacy was most strongly associated with potentially inappropriate prescribing". This work showed that the most frequent prescribing issues in this age group were the use of strong opioids without a laxative, long-term proton pump inhibitors above maintenance dose and long-term benzodiazepines.

Janine will be developing her research programme with further observational studies on multimorbid patients prescribed polypharmacy. Janine says: "Further work is needed, particularly to investigate health care outcomes, such as hospital admissions and medication-related problems, which may help to inform interventions to improve prescribing practices in this age group".

> **"There has been a paucity of research in potentially inappropriate prescribing in middle-aged adults, despite approximately one-third of this age-group living with multimorbidity"**

RESEARCH PARTNERS

- **Health Research Board Centre for Primary Care Research**
- **Royal College of Surgeons in Ireland**
- **Trinity College Dublin**



MOLECULAR AND PHYSICAL MODULATION OF RADIATION SENSITIVITY

Name: Dr Jonathan Coulter

Research Group: Experimental Therapeutics

Researcher profile: http://go.qub.ac.uk/jonathancoulter

Dr Jonathan Coulter joined the School of Pharmacy in June 2012, with a central research theme of developing novel therapeutics to increase tumour cell radiation sensitivity. This stems from the fact that at least 75% of all cancer patients receive radiotherapy as part of their treatment, with almost 60% of those patients treated with curative intent. The development of novel radiosensitising strategies has the potential to markedly improve these statistics while concurrently reducing dose-limiting toxicity to surrounding healthy tissue.

One key research strand involves the characterisation of gold nanoparticles as novel radiosensitising agents that exhibit a low toxicity potential. These desirable properties are tempered by the fact that clinically unfeasible concentrations of gold are required to generate significant radiosensitation. To address this, Jonathan's group, in collaboration with Dr Dorian Dixon at the Nanotechnology and Integrated BioEngineering Centre (University of Ulster), have developed co-functionalised gold nanoparticles that prevent agglomeration under physiological conditions, while simultaneously promoting nanoparticle internalisation. Using this strategy, we have reduced the radiosensitising concentration of gold nanoparticles 20-fold, and have elucidated key biological mechanisms underpinning their efficacy.

Jonathan was recently awarded Prostate Cancer UK funding to develop a second-generation gold nanoparticle based on this technology. In this

project, ionising radiation will be utilised both as a primer (low dose) to induce specific expression of a target receptor on prostate tumor cells, and in a therapeutic context post nanoparticle exposure. Gold nanoparticles will be co-functionalised with stabilising polymers and biologically active, antagonistic pepducins known to inhibit activation of the PI3K/Akt pro-survival pathway. Jonathan anticipates that this approach will provide a tumour-targeting strategy, while providing both physical and molecular approaches to augment radiation sensitivity.

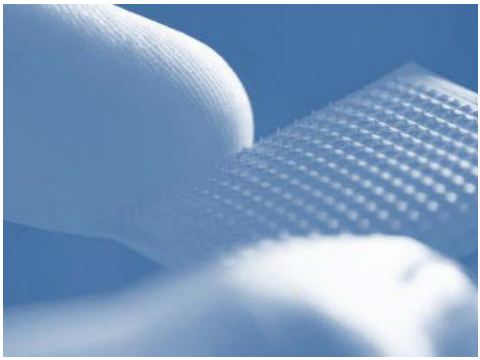
In a separate project, Jonathan's team are supporting data acquisition for the MEDIC network consortium on an EPSRC funded project entitled: "Improving patient outcome by integrating the generic with the personal". This multi-centre project involving University of Cranfield, Imperial College London, University of Nottingham, University of Stirling and Queens' University aims to determine the potential of radiation/drug/nanoparticle interactions using predictive mathematical models of combination therapies, validated alongside experimentally derived measurements. This is being developed in the first instance using glioblastoma as the treatment exemplar, with the long-term objective of establishing a generic modelling framework adaptable to a range of tumours and combined therapies.

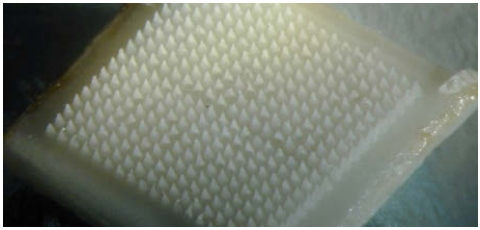
Recently, Jonathan has developed an interest in the contribution of cancer stem cell-mediated radioresistance and treatment failure. Specifically, he aims to develop gold nanoparticles targeted to these sub-populations using an anti-angiogenic and anti-stem cell peptide, ALM201, that targets this population of cells. This was developed by Professor Tracy Robson from the School of Pharmacy, and is now in phase I/II clinical trials. Although at an early stage this work is supported by collaborations with world leading experts including Professor Robert Bristow (University Health Network, Toronto) and Professor Norman Maitland (York Cancer Research Unit).

Jonathan has published widely on subjects including nanoparticle and gene therapy radiosensitisation, given invited presentations at conferences and seminars both nationally and internationally, and has been supported by funding from the EPSRC, Cancer Research UK and Prostate Cancer UK.

RESEARCH PARTNERS

- **Prostate Cancer UK**
- **Engineering and Physical Sciences Research Council**
- **University College Dublin**
- **Ulster University**
- **University Health Network – Ontario Cancer Institute**
- **Cancer Research UK**
- **The University of York**





MAKING DIFFICULT-TO-DELIVER MEDICINES AN OFFER THEY CAN'T REFUSE

Name: Professor Ryan Donnelly
Research Group: Microneedles

Researcher profile: http://go.qub.ac.uk/ryandonnelly

As a Pharmacist, Professor Ryan Donnelly has a keen interest in formulating medicines from drug substances so that they can be safely, conveniently and efficiently administered to patients. With many new drug substances not being suitable for oral administration and injections associated with numerous problems, Ryan's work has focused on the use of microneedle arrays to bypass the gastrointestinal tract and deliver medicines into the body across the skin. Microneedle arrays are minimally-invasive systems comprised of hundreds of tiny needles, less than 1 mm high, formed on a flexible patch.

The microneedle patches, which can range from the size of a phone sim card to the size of a mobile phone, are applied to the skin like a normal medical plaster. Bypassing the skin's *stratum corneum* barrier allows virtually any type of drug substance to be delivered for local or systemic effect. What makes Ryan's system special compared to competitor platforms is that the microneedles are made of biocompatible hydrogels that are not toxic to the human body and are removed from skin after use, completely intact.

"Microneedles are a great way of delivering vaccines, peptides, proteins and other biotech-derived drugs in a minimally-invasive way, painlessly and without drawing blood. As the microneedles are in contact with the interstitial fluid just under the skin surface, they are also a useful method to indirectly monitor medicines, biomarkers and metabolites in the body."

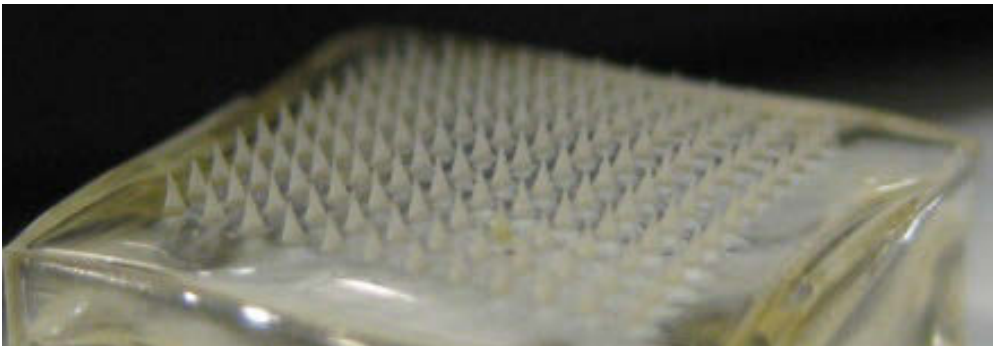
The market for delivering drugs across the skin is

worth around US $32Bn a year, but that's with just 20 drugs. If just a few new compounds could be demonstrated as safe and effective, new markets could be opened worth hundreds of millions, each and every year. There are many potential benefits for different patient groups. Some people are scared of needles, and a microneedle patch may be much more acceptable. Conventional needles are also subject to costly disposal methods, and can be reused, whereas Ryan's microneedle patches become soft upon first insertion and so cannot be used again, or inserted into another person by accident, or maliciously.

Ryan's research has been extensively funded by the UK Research Councils, in particular BBSRC, charities and, increasingly, the pharmaceutical and medical devices industries. Critical to future success and patient benefit will be Ryan's partnership with Lohmann Therapie-Systeme AG, the world's largest transdermal patch manufacturer, who will manufacture products derived from Ryan's technologies for third party customers who will then market the products.

Still at a relatively early stage of his career, Ryan has authored over 350 peer-reviewed publications, including 5 patent applications, 4 textbooks and approximately 140 full papers. He has been an invited speaker at numerous national and international conferences. Ryan is the Editor-in-Chief of *Recent Patents on Drug Delivery & Formulation* and a member of the Editorial Advisory Boards of *Pharmaceutical Technology Europe*, *Expert Review of Medical Devices* and *Journal of Pharmacy & Bioallied Sciences* and is a Visiting Scientist at the Norwegian Institute for Cancer Research, where he is an Associate Member of the Radiation Biology Group. His work has attracted numerous awards, including BBSRC Innovator of the Year in 2013, the GSK Emerging Scientist Award in 2012 and the Royal Pharmaceutical Society Science Award in 2011.

> **“Microneedles are a great way of delivering vaccines, peptides, proteins and other biotech-derived drugs”**



RESEARCH PARTNERS

- **Action Medical Research**
- **Arthritis Research UK**
- **Biotechnology and Biological Sciences Research Council**
- **Engineering and Physical Sciences Research Council**
- **Invest Northern Ireland**
- **LTS Lohmann Therapie-Systeme AG / IIS Innovative Injektions-Systeme GmbH & Co. KG**
- **Medical Research Council**
- **The Wellcome Trust**

microRNA MEDIATED MECHANISMS OF DISEASE

Name: Dr Fiona Furlong
Research Group: Experimental Therapeutics

Researcher profile: http://go.qub.ac.uk/fionafurlong

Dr Fiona Furlong's research interests stem from her desire to translate the functional role of microRNAs (miRNAs) in normal cellular physiology and disease into diagnostics and therapeutics. Fiona received a BSc and PhD from University College Dublin (UCD). Following a short period researching as a postdoctoral scientist she was competitively awarded the Irish Cancer Society post-doctoral career development fellowship in 2008 to develop her independent research group.

She joined the School of Pharmacy in August 2012, where she currently conducts research into the role of the miR-433 microRNA in chemoresistant ovarian and breast cancer among a number of other disease associated microRNAs.

Fiona has led the field in describing the cell cycle effects of miR-433. In her first publication on miR-433, she demonstrated that miR-433 negatively regulated the mitotic arrest deficiency protein 2 (MAD2) which abrogated spindle assembly checkpoint (SAC) responses in cancer cells. As the expression of miR-433 is highly deregulated in a number of cancers and associated with poor patient survival, this data highlighted a very important consequence of how miR-433 can compromise the cell cycle in which aberrant miR-433 expression may mediate resistance to chemotherapy.

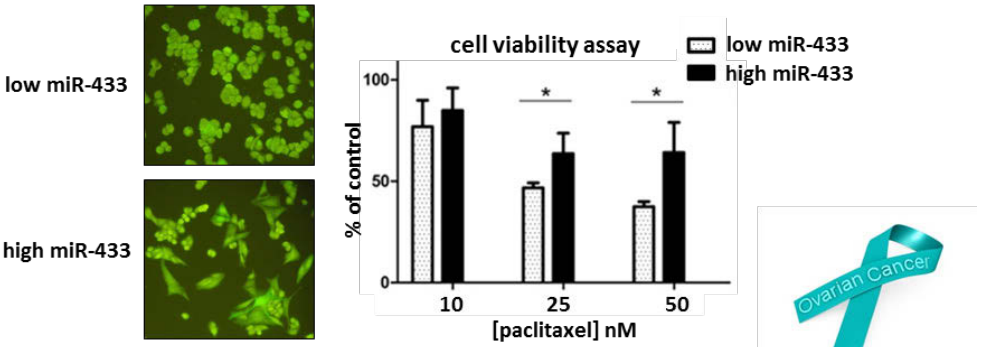
Her group subsequently demonstrated that miR-433 expression induced cellular senescence arising from a functional inactivation of the retinoblastoma protein (Rb) by a mechanism which involved the downregulation of another cell cycle protein, CDK6, by miR-433. Mechanistic studies are also ongoing to characterise how higher miR-433 expression may be linked to

the population of stem-like cells which remain following selective pressure from culture in high doses of chemotherapy. The characterisation of the functional role of miR-433 that underpins the survival of cells exposed to chemotherapy may lead to the discovery of a mechanism to reverse this chemoresistant phenotype.

These *in vitro* functional studies of microRNAs are also supported by immunohistochemical (IHC) analyses of protein expression in patient samples in which Fiona has collaborations in the UK, Ireland and the USA. A critical component of the research in Fiona's lab is the application to the clinic. Previous work highlighted how loss of the miR-433 target protein, MAD2, was a significant and independent marker of poorer survival in patients with ovarian cancer. Her on-going studies involve the analysis of a number of the miR-433 target proteins in patient formalin fixed and paraffin embedded (FFPE) tissue samples and functional studies of primary cell cultures isolated from resected tumour samples and tumour ascites. These studies set the stage for the development of a diagnostic biomarker test of chemoresistance.

Lastly a Health Research Board (HRB) funded project led to the discovery of several other microRNAs associated with driving chemoresistance. Work is ongoing to develop the research of these microRNAs to levels already achieved for the miR-433 microRNA. While Fiona predominantly researches miRNAs associated with aberrant expression in cancer cells, the recent publication of the role of miR-433 in renal fibrosis has renewed her interests in this condition. Fiona spent a short time researching Diabetic Nephropathy leading to a number of publications on this disease. Future work will see her expand her research to include a variety of disease backgrounds and cell contexts.

The image shown below indicates the differences in behaviour exhibited by tumour cells which are either highly expressive of miR-433, or express small amounts of this microRNA. © *Cancer Medicine*. All rights reserved.



Weiner-Gorzel, K., et al. Cancer Med, 2015. 4(5):745-58

RESEARCH PARTNERS

- Health Research Board
- University College Dublin
- Trinity College Dublin
- Northern Ireland Biobank
- The Gurdon Institute
- Johns Hopkins University
- Marie Curie
- Imperial College London

PUSHING BIODISCOVERY BOUNDARIES IN THE BATTLE AGAINST BIOFILM

Name: Professor Brendan Gilmore
Research Group: Biofilm and Infection Control Group

Researcher profile: http://go.qub.ac.uk/brendangilmore

Professor Brendan Gilmore's primary research interests have been in the role played by proteolytic enzymes (proteases) in the progression of diseases. However, following appointment to Queen's University Belfast and a sabbatical visit to Prof Howard Ceri's Biofilm Research Group at the University of Calgary, his research focus shifted to understanding and controlling the process of biofilm formation.

Biofilms are fascinatingly complex communities of bacteria, attached to surfaces and embedded within a matrix of self-produced extracellular polymeric material, often referred to as slime. Bacteria within these communities converse and cooperate through a process known as Quorum Sensing. These bacterial cities represent the predominant mode of growth of bacteria in both the natural environment and during chronic infections. Importantly, when bacteria form biofilms (as they do in between 60-80% of chronic, persisting or recurring bacterial infections) they become exceptionally difficult to treat, since they resist normal immune clearance mechanisms and exhibit elevated tolerance to antibiotics – often requiring up to 1000-fold more antibiotic to kill compared to bacteria living in suspension.

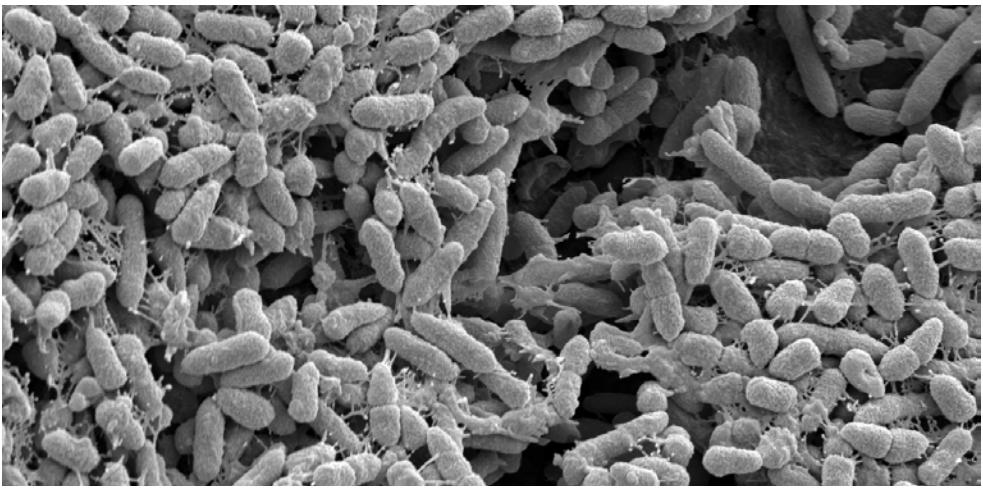
Therefore, research in Brendan's group aims to tackle the problem of biofilms in two main ways (i) development of efficient methods to control or eradicate biofilms and (ii) discovery of new antibiotic or quorum sensing inhibitor compounds capable of either destroying biofilms or increasing their sensitivity to conventional antibiotics. The former work has led Brendan to research the application of non-thermal 'cold'

plasmas for biofilm eradication. Non-thermal plasmas are gases, which are partially ionized under the influence of an electric field, giving rise to a powerful cocktail of reactive oxygen and nitrogen species, capable of rapidly destroying bacteria. This successful, multidisciplinary work is currently in the early stages of the commercialization process and Brendan's hope is that this technology can be used to treat patients with chronic topical infections, as well as hospital and other surfaces which act as a reservoir of infectious agents.

Discovery of new antibiotic and anti-infective agents has become one of the most pressing issues in healthcare in the face of burgeoning antibiotic resistance. Brendan's group are involved in a major biodiscovery programme, where they are discovering new antimicrobial agents from ancient bacteria and archaea isolated from a salt mine in Northern Ireland. These halophiles are not only being mined for antibiotic discovery, but also for the discovery of novel enzymes for use in the pharmaceutical industry.

Finally, Bacteria growing in biofilms utilize proteases for regulation of the biofilm matrix and interactions with the host and are a key target therefore for the design of highly specific protease inhibitors which are capable of modulating the process of biofilm formation. In our previous work we have shown that targeting a specific protease from Pseudomonas aeruginosa, lasB, not only reduced the amount of extracellular matrix (slime) produced by the biofilm, but resensitized the bacteria within to conventional antibiotics, reducing the amount of antibiotic required to destroy the biofilm. Brendan's group are using specific protease inhibitors to tease apart the regulatory mechanisms that control biofilm formation, in the search for new drug targets.

Brendan's world leading research on biofilm control was recognized by the award of the 2013 Royal Pharmaceutical Society Science Award for his contributions to the field. He has authored over 100 peer reviewed publications and patents, an the pre-eminent text book *Hugo & Russell's Pharmaceutical Microbiology (8th Ed)*, a core text in Schools of Pharmacy worldwide.



RESEARCH PARTNERS

- **Biotechnology and Biological Sciences Research Council**
- **Engineering and Physical Sciences Research Council**
- **Invest Northern Ireland**
- **Beaufort Marine Biodiscovery**
- **Society for Applied Microbiology**

HALO - INVESTIGATING INFECTION IN CHRONIC LUNG DISEASE

Name: Dr Deirdre Gilpin
Research Group: Halo Group

Researcher profile: http://go.qub.ac.uk/deirdregilpin

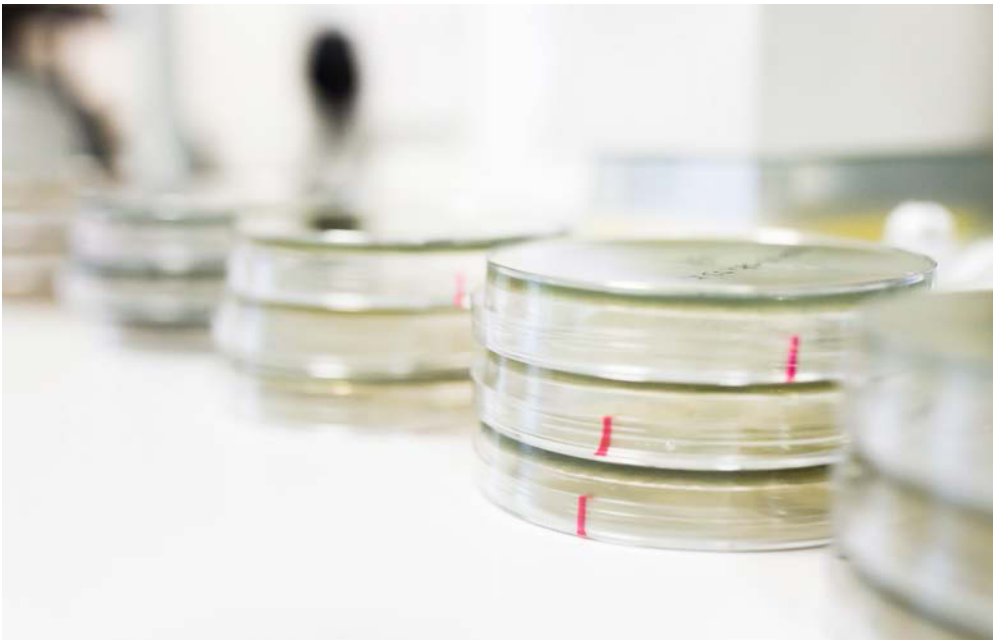
Respiratory infection in chronic lung diseases such as COPD, CF and bronchiectasis represent major, and often underestimated, healthcare challenges. Understanding the composition and function of lung bacteria in the pathogenesis of chronic disease will help to alleviate or cure chronic lung disease and, in the face of increasing resistance rates, help to use antibiotic reserves more wisely.

The Halo research group, led by Dr Deirdre Gilpin, is a multidisciplinary research group, comprising pharmacists, scientists, and clinicians with a clear translational focus. The group's overarching aim is to develop laboratory findings into new clinical and therapeutic approaches. Deirdre's group have been at the forefront of identifying the wide range of bacteria in the lungs of both healthy people and those with chronic respiratory conditions, using a range of traditional culture and cutting edge next generation sequencing technologies. Increasingly, their work is determining how the lung environment affects the function of these bacteria. Two key areas of research are:

• **Chronic MRSA infection in CF:** this is associated with declining lung function and increased mortality in people with CF. This project will look for changes in MRSA, from first identification, as it develops into a chronic infection, and relate this to changes in the patient. Understanding how chronic infection is established may help Deirdre and her team identify markers which might indicate transition to chronic infection, and help design treatment strategies which could prevent or subvert its onset.

• The effect of cigarette smoke and electronic cigarette vapour on key pathogens in COPD: It is well known that cigarette smoke has a damaging effect on the lungs, but there is very little known about cigarette smoke or electronic cigarette vapour on lung bacteria. Current research is currently focussing on how cigarette exposure might affect bacterial virulence, influence antibiotic resistance and development of chronic infection.

Deirdre's research group has also developed a range of DNA and RNA based methodologies which allow us to characterise bacteria at a genetic level. These include DNA fingerprinting techniques to help determine similarities between bacteria from a range of sources, and also rapid identification techniques. This has formed a key component of a new €50 million Europe-wide project to develop new drugs that to improve the lives of people with CF and bronchiectasis (inhaled Antibiotics in Bronchiectasis and Cystic Fibrosis). Together with her industrial (Novartis and Basiliea) and academic partners across Europe, Deirdre's team will pioneer the use of these novel molecular tools in clinical studies.



RESEARCH PARTNERS

- **Randox Laboratories Ltd**
- **Stragen Pharma SA**
- **Basiliea Pharmaceutics Ltd**
- **Novartis Pharma AG**
- **US Cystic Fibrosis Foundation**
- **European Commission: Innovative Medicines Initiative**
- **University of North Carolina at Chapel Hill, North Carolina**
- **University of Washington, Seattle**
- **University of Alabama**
- **University of Marseille**
- **Cardiff University**
- **Royal College of Surgeons in Ireland**
- **Stragen Pharma SA**

THE IMPORTANCE OF PEDAGOGY IN PREPARING PEOPLE FOR THEIR CHOSEN CAREER IN PHARMACY

Name: Dr Maurice Hall

Research Group: Pharmaceutical Science and Practice

Researcher profile: http://go.qub.ac.uk/mauricehall

Following on from his doctoral work in nanoscience and nanotechnology, and new academic role in the University some years ago, Dr Maurice Hall began to diversify and specialise in educational research. Maurice, a Lecturer (Education) and registered pharmacist, has a keen interest in pedagogy. He particularly enjoys investigating new forms of teaching, learning and assessment, and hopes that his research in this area will inform educators and the pharmacy profession.

His initial work was conducted with colleagues from the Northern Ireland Centre for Pharmacy Learning and Development (NICPLD), a key pharmacy educational body in Northern Ireland. It centred on determining the online continuing professional development (CPD) needs of pharmacists in Northern Ireland. He also was involved in a similar study that explored pharmacists' opinions on various types of teaching methods on offer to them (namely live workshops, print-based or eLearning formats of material).

Other studies that Maurice has conducted (in collaboration with Dr Lezley-Anne Hanna) focus on feedback provided to pharmacy students, given its association with improved academic performance and patient safety. Maurice clarifies

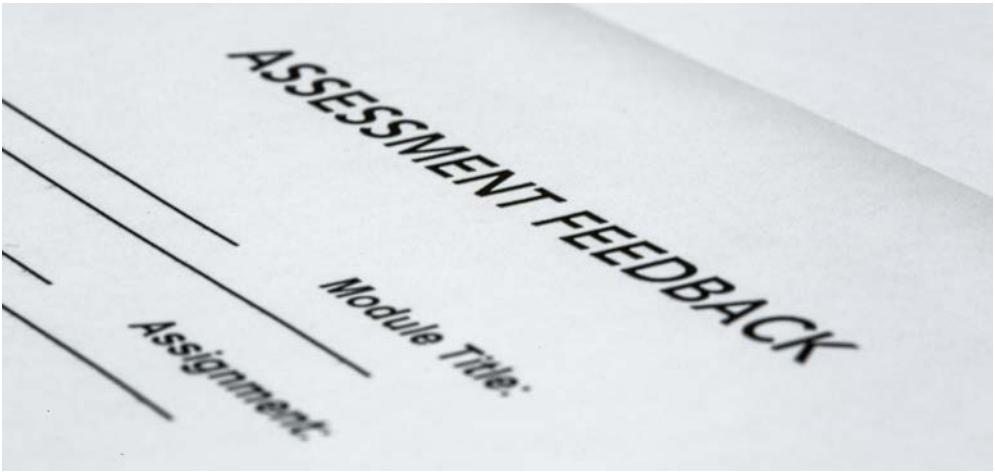
that "student dissatisfaction with feedback is a well-documented problem among higher education establishments. By doing this work, we found that students considered various components within the pharmacy program to be exemplary with regard to feedback provision. This presents a great opportunity for dissemination of good practice across the School and beyond."

Moreover, they are concerned with professionalism and its adoption by pharmacy students and to date have conducted research to ascertain students' attitudes to this in the context of various common behaviours such as drinking alcohol and social media use. According to Maurice: "participants definitely appear to consider themselves primarily as students rather than as future pharmacists bound by a professional code. Indeed, some of the findings relating to alcohol intake are of particular concern, from both an academic and personal health perspective. However, from our research on social media, conducted several years apart, it seems that the education we are currently providing about this topic is having a positive influence on students' online behaviour." Most recently, Maurice has investigated pharmacy students' perceptions of risk and patient safety. He explains that "similar to our other work, it appears that gender and level in the pharmacy degree influence students' perceptions of

> "Student dissatisfaction with feedback is a well-documented problem among higher education establishments"

risk. Additionally, international students seem more cautious than students from the British Isles. Again, these are factors that educators should be aware of when designing courses and assessments."

In tandem to the work outlined above, Maurice has supervised numerous MSc students; this research encompasses investigating the role of the pharmacist in medicines adherence for patients with chronic conditions such as asthma or chronic obstructive airways disease (COPD).



RESEARCH PARTNERS

- **Queen's University Belfast Scholarly Educational Research Network**
- **Northern Ireland Centre for Pharmacy Learning and Development**

PREPARING FUTURE PHARMACISTS TO BE SAFE AND EFFECTIVE HEALTHCARE PRACTITIONERS

Name: Dr Lezley-Anne Hanna

Research Group: Pharmaceutical Science and Practice

Researcher profile: http://go.qub.ac.uk/lezleyannehanna

Dr Lezley-Anne Hanna is passionate about education. Her philosophy, as an experienced pharmacist and Senior Lecturer (Education), is to develop and deliver teaching of the highest standard that meets the needs of the pharmacy profession and the University. Ultimately, she wants to "ensure that future pharmacists are equipped with the knowledge and skills required to be safe and effective healthcare practitioners".

It was only after completing her doctoral work in evidence-based practice that Lezley-Anne gained a greater appreciation that all aspects of her practice should be informed by evidence, which spurred her to start conducting research with undergraduate students. According to Lezley-Anne, "having an awareness of students' attitudes and opinions facilitates a richer reflection on current teaching methods". Initial work that she (and one of her collaborators, Dr Maurice Hall) conducted centred on gaining pharmacy students' opinions on the feedback provision within the degree programme. Lezley-Anne considers this area to be very important and explains that "there is evidence to suggest that feedback can have positive effects on learning and achievement and helps students maintain an interest in the subject. Also, if feedback is not provided within healthcare disciplines then patient safety may be compromised as mistakes can go undetected, there is no positive reinforcement for good performance, and ultimately the appropriate level of competence may not be achieved".

Lezley-Anne subsequently won educational awards for feedback provision and contributes to the School's high National Student Survey (NSS) score in this area. To aid with recruitment and retention, she has also investigated why students choose to study pharmacy as a career and the transition from secondary to higher education.

Furthermore, following the introduction of a code of conduct for UK undergraduate pharmacy students, and the growing emphasis placed on professionalism within pharmacy, Lezley-Anne and Maurice conducted research to ascertain students' attitudes and usage of alcohol, smoking and social networking sites. She considers that the work "has revealed many interesting findings. For example, it seems that male students are prepared to engage in riskier behaviour than female students." They also conducted other work to determine goal orientations of pharmacy students and whether there was an association between these and academic performance. "Again, differences were noted. High performers were more likely to be female than male, and the mean score for work avoidance was significantly greater for males than for females. From these findings it seems that we need to take a closer look at our teaching methods and adapt these if required to ensure that key messages are being delivered effectively to all students." Recently, Lezley-Anne has been investigating the empathetic ability of pharmacy students, due to the growing realisation that empathy is a key component of the patient–healthcare professional relationship as it may improve patient satisfaction and contribute to optimal clinical outcomes.

In tandem, Lezley-Anne continues to progress her doctoral research on evidence-based healthcare and over-the-counter consultations; she co-supervises a PhD student who is conducting work in this area.

> "having an awareness of students' attitudes and opinions facilitates a richer reflection on current teaching methods"

RESEARCH PARTNERS

- **Queen's University Belfast Scholarly Educational Research Network**
- **Northern Ireland Centre for Pharmacy Learning and Development**

RESEARCH FOCUSED ON PHARMACY EDUCATION AND PREPARING STUDENTS FOR PRACTICE

Name: Dr Sharon Haughey

Research Group: Clinical Pharmacy

Researcher profile: http://go.qub.ac.uk/sharonhaughey

Dr Sharon Haughey qualified as a pharmacist in 1999 and joined the School in 2001 as a part-time Lecturer (Education) in Pharmacy Practice. During the start of her time at the School, Sharon facilitated an 18-month project developing a continuing professional development (CPD) system for pharmacists in Northern Ireland within the Northern Ireland Centre for Pharmacy Learning and Development (NICPLD) in 2004/2005. After completion of this project, Sharon returned to the School as a full-time Lecturer (Education) in 2005.

Sharon's research was initially centred on CPD for pharmacists and initial publications and conference contributions were directly related to her PhD in developing a CPD portfolio and evaluation system specifically for pharmacists.

Following the completion of her PhD, Sharon has continued to develop her knowledge and expertise in the areas of reflective practice and assessment methods. Sharon has developed a particular interest in OSCEs (objective structured clinical examinations). She has collected data from students exposed to this type of assessment in order to gain an understanding of how we can improve the process and support students.

With the move towards an integrated MPharm degree across the UK, Sharon has also established an interest in integration and has completed research projects looking at integrated assessment and Criterion Referenced Assessments (CRAs). Working together with colleagues in the Pharmacy Practice and Teacher Practitioner teams at the School of Pharmacy has proven to be beneficial in exploring all areas of pharmacy education.

Other areas of research which Sharon has an interest in include:

- Simulation and experiential learning
- Work based learning
- Inter-professional learning
- Pharmacist prescribing

Overall, Sharon's research in education aims to find ways to improve the student experience and help prepare students for the world of work and patient care. This involves looking at how students learn in practice with patients (placements), simulated environments and at an inter-professional level. Collaboration with expert patients, placement providers, stakeholders, clinical practice teams and colleagues in the Schools of Medicine, Nursing and Law here at Queen's has been crucial in developing the MPharm course.

> **"This research in education aims to find ways to improve the student experience, and help prepare students for the world of work and patient care"**

RESEARCH PARTNERS

- **Northern Ireland Centre for Pharmacy Learning and Development**
- **Association for Simulated Practice in Medicine**
- **Pharmacy Law and Ethics Association**
- **Scholarly Educational Research Network**

FROM OBSERVATION TO INTERVENTION

Name: Professor Carmel Hughes
Research Group: Primary Care Research Group

Researcher profile: http://go.qub.ac.uk/carmelhughes

Much of the work undertaken by Professor Carmel Hughes' group is focused on how we can improve the use of medicines in older people. The use of medicines in older people has been described as arguably the single most important health care intervention in the industrialised world, and older people, (conventionally assumed to be aged 65 years and older), are the biggest consumers of medicines.

However, much of Carmel's work has shown that some of the medicines prescribed for older people are not appropriate, and patients may not take the medicines as intended by the prescriber. So, Carmel's approach in much of her research is to observe and explore the process of prescribing and the taking of medicines, and then to try and develop approaches or interventions which can bring about improvements.

In her observational work, Carmel uses large databases such as the Northern Ireland Enhanced Prescribing Database (EPD) which contains anonymised information on all prescriptions dispensed in Northern Ireland, and the Clinical Practice Research Datalink (CPRD) which contains very extensive clinical information, including medicines prescribed, in a representative United Kingdom sample of patients. These databases allow Carmel and her team to explore what is being prescribed, and sometimes, to follow what happens to patients.

In order to try and understand prescribing and the use of medicines, Carmel's team undertake interviews or focus groups with doctors, pharmacists and patients, where they are asked for views and opinions. The information obtained is often very helpful in allowing Carmel to see why certain medicines are prescribed, what works well, and what works less well, and what might

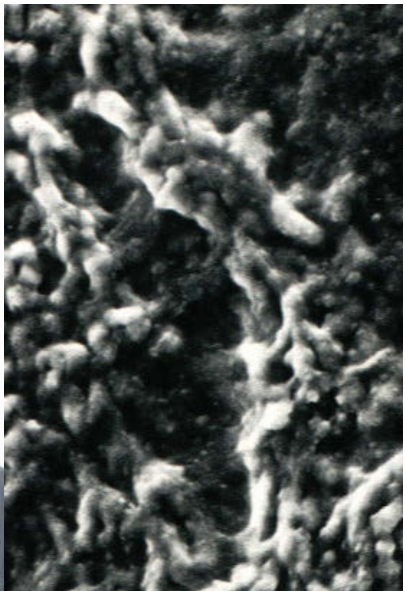
work better in the future.

From these database observations and findings from interviews and focus groups, Carmel can then develop new approaches or interventions to assist with prescribing and medicines' taking, which are then tested in randomised controlled trials (RCTs). Some of the interventions which she has developed have proved very successful. One intervention was tested in nursing homes for older people, and Carmel found that older people were much less likely to get medicines they didn't need if a pharmacist reviewed their medical and prescribing history and spoke with residents' doctors. This pharmacy service is now being used in nursing homes in Northern Ireland.

Carmel's current research projects are continuing to focus on prescribing for older people who live in their own homes, and those who live in nursing homes. She has been part of a research partnership involving the University of East Anglia, the University of Leeds and Aberdeen University, which has received a large grant (£2 million) from the National Institute for Health Research (NIHR). This grant will allow Carmel's team to investigate if pharmacists rather than doctors can undertake the prescribing role in nursing homes. Pharmacists, provided that they have undertaken further training, can become prescribers, so Carmel's team are interested in whether they can use their skills in the nursing home setting, and perhaps have an impact on residents' lives. Carmel's most recent grant from the NIHR, will explore a new approach to improving the prescribing of antibiotics in nursing homes.

RESEARCH PARTNERS

- **Newcastle University**
- **The Alzheimer's Society**
- **Brown University**
- **City University London**
- **The Dunhill Medical Trust**
- **Northern Ireland Health and Social Care Board**
- **McMaster University**
- **Health Research Board**
- **Queen Margaret University**
- **University of Massachusetts Medical School**
- **University of Leeds**
- **The National Health Service National Institute for Health Research**
- **National University of Ireland, Galway**
- **Royal College of Surgeons in Ireland**
- **University of Aberdeen**
- **The University of Auckland**
- **Warwick University**
- **University of East Anglia**



ENGINEERING THE CLINICAL PERFORMANCE OF BIOMEDICAL IMPLANTS

Name: Professor David Jones
Research Group: Biomedical Devices Research Group

Researcher profile: http://go.qub.ac.uk/davidjones

One startling view of the future has been presented by The Royal Academy of Engineering. It has been that has stated that at some stage everybody will have a medical device/biomedical implant of some kind, be it something as simple as a contact lens at one level to a dialysis catheter, designed for someone whose kidneys have failed."

Such a vision is of enormous professional relevance to Professor David Jones. "My interest is primarily in the design of medical devices that are resistant to microbial infection and the associated biological implications. This is the big problem in all medical devices. No matter where you put it or what it is, there is that possibility." Furthermore, nowadays many medical implants are co-designed as drug delivery systems and this has increased the complexities associated with their design and function. In addition to ensuring that the mechanical function of the device is maintained, drug release from the device must be optimised to ensure that the outcomes of treatment/performance are achieved. This is a second key co-interest of David's reseach programmes.

Research in this area is multidisciplinary and resides at the interfaces of engineering, material science and the pharmaceutical sciences. The nature of the David's research group reflects this diversity and adds to the overall personal and scientific development of research staff within this group. David's academic experiences reflect this diversity. A Pharmacist by training, he has also a degree in Mathematics and Statistics and is both a Chartered Engineer and Chartered Chemist. The ethos of the research group is that by different, complementary disciplines working together, we will successful provide

solutions to the problems associated with the use of implanted medical devices and drug delivery systems.

More specifically, David's research group is primarily concerned with the control of infection (and related phenomena) on ocular (contact lenses, intraocular lenses), urinary (urethral catheters, ureteral stents, continuous ambulatory peritoneal catheters) and respiratory (endotracheal tubes) devices. Research in the group has additionally focused on the design of novel bioactive material platforms that may be easily implanted and retained within body cavities, notably the oral cavity, for the treatment of infection and inflammatory diseases.

Examples of biomaterial strategies that have been successfully used to enhance the clinical performance within the above clinical scenarios include:

- Interpenetrating polymer network systems with enhanced mechanical and controlled drug release properties
- Hydrogel coatings for urethral catheters with enhanced lubricity (to aid insertion and removal)
- Hydrogel coatings of endotracheal tubes that may be used to entrap nebulised antimicrobial agents to produce infection-resistant materials *in situ*
- Electrically conductive biomaterials as infection-resistant biomaterials and for responsive drug delivery applications
- Bioactive implants in which drug diffusion and release may be engineered through manipulation of the solid state of the bioactive agent through complexation, amorphous dispersion formation and ion-pair formation
- Stimulus sensitive bioactive implants that undergo rheological structuring following implantation and in so doing provide controlled and prolonged drug release at the site of administration. These systems include platforms that preferentially adhere to mucosal surfaces within the body (mucoadhesive systems).
- The application of advanced processing methods to manufacture and optimise medical device and bioactive implant performance, notably multilayer hot melt extrusion and injection moulding.

The various research programmes in this group have been/are currently funded by the UK Research Councils, government sources and the Pharmaceutical/Medical Device Industries. Since 1994, over thirty PhD students have graduated from the research group and have found employment within the Pharmaceutical and Medical Device Industries, Academia and the Health Service. Commercialisation of the research from this group has been performed, with the sales of one award-winning, medical device currently exceeding £1M.

This image shows a three-layered extruded catheter, with drug contained within the middle (dark) layer. Controlling both the processing parameters and the thicknesses and chemical compositions of the layers results in the ability to fine-tune drug release across the inner and outer layers. In so doing, a greater resistance to microbial biofilm formation is achieved. This example of biomaterial modifcation typifies the work of David's group, which aims to significantly improve the performance of these devices using sophisticated modifcation techniques.

RESEARCH PARTNERS

- **Engineering and Physical Sciences Research Council**
- **Biotechnology and Biological Sciences Research Council**
- **Invest Northern Ireland**
- **The Royal Society**

THERMAL STABILITY AND TARGETED DELIVERY THROUGH FORMULATION OPTIMISATION

Name: Dr Vicky Kett

Research Group: Kett Group for Thermal Stabilization and Mucosal Delivery

Researcher profile: http://go.qub.ac.uk/vickykett

The overarching aim of Dr Vicky Kett's research group is to improve the effectiveness of drugs though optimization of pharmaceutical formulation. They achieve this through making delivery more targeted and improving stability. Targeted delivery of drugs improves the response and reduces the amount of drug required. This cuts cost, potential for side effects, and build-up of resistance toward drugs such as antibiotics.

Also, improving stability simplifies manufacture, storage and supply considerations.
Biotech therapeutics are often prohibitively expensive and very sensitive to temperature. Formulations are required that enable them to be delivered in a more targeted manner and improve their thermal stability.

Antibiotics require targeted delivery to reduce the dose required, thus reducing cost, side-effects and antimicrobial resistance.

Targeted delivery including needle-free delivery and thermal stability also offer the ability to improve the availability of vaccines and drugs to people in the developing world where temperature and cost considerations are often essential.

Vicky's team use drying technologies in a variety of ways to design pharmaceutical formulations, including lyophilized products and inhaled powders. Insights gained from fundamental research have been used to improve freeze-drying methods for commercial formulations including antibiotics, hormones and vaccines.

Vicky's team have also developed a range of formulations that are able to stabilise sensitive drugs such as vaccine and DNA and improve their uptake across biological barriers including mucosal tissue and biofilm. This has led to the development of the Vaccinetab technology developed for vaccines, and the Stabilitab product suitable for a wider range of target molecules and delivery routes. Both technologies are able to stabilize drugs without refrigeration. and are amenable to a range of presentations and delivery routes. Indeed, Vaccinetab went on to win the Invent 2015 "Health and life" award.

Examples of formulations developed by the group include:

- Freeze-dried tablets for mucosal (nasal, sublingual and vaginal) administration of material including HIV vaccine and microbicides
- Targeted delivery of antibiotics for cystic fibrosis treatment
- Nanoparticles for targeted delivery of protein and pDNA

Fundamental research carried out by the group has probed the mechanisms of protein protection during freeze-drying using thermal analysis techniques (DSC, MTDSC and isothermal microcalorimetry) as well as neutron scattering in collaboration with colleagues at the Rutherford Appleton Laboratory.

Vicky and her colleagues also use thermal techniques to characterise amorphous, polymorphic and cocrystal systems. Vicky is chair of the Royal Society of Chemistry Thermal Methods Group. She lectures on training courses for thermal analysis and freeze-drying and is co-editor of the 2nd edition of *Principles of Thermal Analysis and Calorimetry*.

Dr Vicky Kett and some of her research team

RESEARCH PARTNERS

- **Actavis**
- **Agri-Food and Biosciences Institute**
- **Cancer Research UK**
- **Engineering and Physical Sciences Research Council**
- **Invest Northern Ireland**
- **Science & Technology Facilities Council Rutherford Appleton Laboratory**
- **University of Bologna**
- **University College London**
- **University of Geneva**
- **The Wellcome Trust**

HARNESSING THE BUILDING BLOCKS OF LIFE TO ENGINEER INNOVATIVE THERAPIES

Name: Dr Garry Laverty
Research Group: Experimental Therapeutics

Researcher profile: http://go.qub.ac.uk/glaverty

Research has come full circle for Dr Garry Laverty. A School of Pharmacy graduate, Garry returned to Queen's University in October 2012 following two years working within the biotech industry. Garry and his group are focusing on the creation of novel therapies based on the natural building blocks of life, utilising a range of biomolecules including: carbohydrates, lipids, proteins, and nucleic acids, with the potential to revolutionise healthcare.

In 2014, Garry's research hit the headlines worldwide. His group developed a peptide-based gel, derived from the building blocks of natural tissue, which selectively eradicates the most drug resistant "jelly-like" biofilm forms of superbugs such as MRSA, *Pseudomonas aeruginosa* and *Escherichia coli*. Garry outlines: "This technology holds great promise in preventing the most serious of superbug infections which are responsible for increased resistance to standard antimicrobial therapies and patient suffering worldwide".

He continues: "Our peptide-based molecules are particularly exciting as they have the potential to resolve the current lack of antimicrobials in clinical development. They attack infection by targeting multiple microbial sites, rather than at a single target as is the case with most marketed antibiotics. Therefore the likelihood of resistance developing is extremely low. The design of these biomolecules can be also modified in our laboratory to tailor their properties and function to a particular purpose, for example to vary their antimicrobial spectrum of activity and potency or to enable attachment to the surface of medical devices such as catheters and hip replacements to prevent infection".

Such diversity has allowed Garry to expand the potential scope of applications for these molecules to other fields including their use within stimuli-responsive drug delivery; tissue engineering and regenerative medicine; wound healing, inflammation and cancer, in the hope of further medical breakthroughs. Garry's research has taken him across the globe including a placement with the world-leading nanomaterials group (the Xu group) at the School of Chemistry, Brandeis University, USA. Garry spent a research sabbatical there in 2013 funded by Queen's University research support package for new academic staff and highlights the important contribution it has had in his relatively short career as a researcher. "The ability to travel to a new group, in a different country, at such an early stage in my career was very important in my development as a researcher and academic. Learning new skills is paramount in being able to ask and answer important scientific questions".

Garry uses his previous experience working in a biotechnology company to foster links with the pharmaceutical industry for a variety of projects including the development of novel drug formulations for human and veterinary sectors. "It is important to engage with industry, healthcare professionals and patients as this will ultimately reduce the barriers for translating these technologies clinically. As a qualified pharmacist working within research you are in a unique position, having knowledge of both the drug development process and the expectations of patients. The School of Pharmacy provides me with the perfect environment to engage purposefully in such activities".

> **"The School of Pharmacy Provides me with the perfect envorinment to engage purposefully in my activities"**

RESEARCH PARTNERS

- **Brandeis University**
- **University of Pavia**
- **Biochemical Society**
- **Society for Applied Microbiology**
- **The Royal Society**
- **The University of Birmingham**

SEX, DRUGS AND RINGS

Name: Professor Karl Malcolm

Research Group: Drug Delivery Research Group

Researcher profile: http://go.qub.ac.uk/kmalcolm

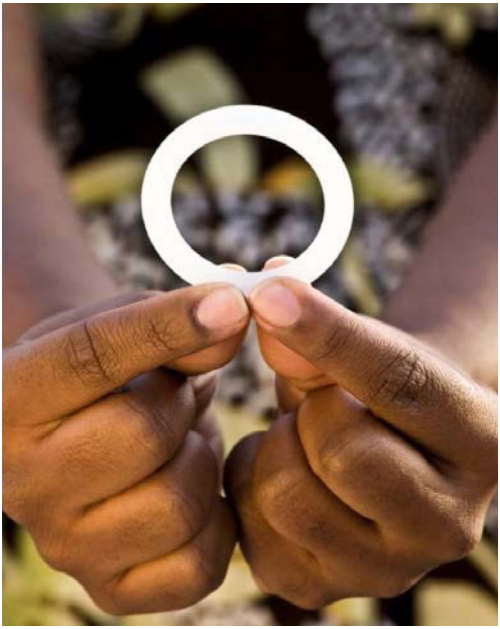
Professor Karl Malcolm's research is primarily focused on developing pharmaceutical products for improving the sexual and reproductive health of women. For the past fifteen years, Karl's research team has helped spearhead the development of HIV microbicides – products that women administer vaginally to provide protection against sexual transmision of human immunodeficiency virus (HIV).

Many of the HIV microbicides initially tested in the clinic comprised simple water-based gels containing antiretroviral compounds, which required either daily administration or application immediately before sex. However, women struggled to adhere to the prescribed use regime for these gels, and, as a result, clinical studies show compromised efficacy. Back in 2002, Karl first promoted and demonstrated the feasibility of developing long-acting vaginal rings for continuous and controlled release of antiretrovirals. Their ability to be used covertly without the knowledge or co-operation of the male partner, the relatively high user acceptability and the expectation of increased user adherence in long-term use suggest that a microbicide-releasing ring against HIV will challenge existing sexual norms within many developing world cultures by empowering women to take control of their own sexual health. In fact, a vaginal ring releasing the antiretroviral compound dapivirine – developed by Karl's research team in partnership with the International Partnership for Microbicides (IPM) – is presently the most advanced microbicide product currently in development. Two Phase III clinical studies have recently been completed in Africa, and, if the results prove

successful, the dapivirine-releasing ring will be the first microbicide product to reach market. Karl says, 'Hopefully, most of the impact from this work has yet to come. There's so much interest and goodwill about a ring device that a woman could use to offer round-the-clock protection against HIV infection.'

Karl's work was recently honoured at Queen's University, when he became one of the winners of the first Vice-Chancellor's Impact Awards. He and his multidisciplinary team are now working on new ring devices which, in addition to offering protection against HIV infection, also combine hormonal contraception and protection against other sexually-transmitted diseases. "I expect that the struggles and difficulties we had in developing a ring for HIV prevention are likely to be multiplied many times over for these more complex, multi-purpose rings. But we're ready for the challenge ahead." Other ongoing activities within Karl's research portfolio include the development of novel ring devices with in-built temperature sensors to more accurately monitor user adherence, the development of long-acting injectable MPT formulations, and development of vaginal ring devices for controlled release of protein-based microbicides.

An internationally renowned researcher, Karl publishes his work in top journals within the fields of pharmaceutics and health sciences. Reflecting on his career to date, he explains: "One of the keys to great innovation in the pharmaceutical field is collaboration; I've been very fortunate to work with and be inspired by some great people, organisations and companies."



"I expect that the struggles and difficulties we had in developing rings for HIV prevention are likely to be multiplied many times over for these more complex, multi-purpose rings. But we're ready for the challenge ahead"

RESEARCH PARTNERS

- **Medical Research Council**
- **International Partnership for Microbicides**
- **The Wellcome Trust**
- **Population Council**
- **World Health Organization**

DEVELOPING INNOVATIVE SOLUTIONS FOR THE DETECTION AND INHIBITION OF DISEASE-RELATED PROTEASES

Name: Dr Lorraine Martin

Research Group: Biomolecular Sciences

Researcher profile: http://go.qub.ac.uk/lorrainemartin

Dr Lorraine Martin has a long-standing interest in the role of proteases in health and disease. In normal physiology these enzymes play important physiological roles. Their activity however, requires tight control by natural inhibitors which if unbalanced, can lead to significant problems. Many active proteases are therefore important biomarkers of disease as well as direct targets for drug development across all sectors including respiratory and cardiovascular disease, cancer and infection.

Translational research has always been a passion for Lorraine, who feels that there is nothing more rewarding than seeing work in the lab have impact on the ability to treat and manage disease. Her first post-doctoral position was through a Knowledge Transfer Partnership with PPL Therapeutics, Edinburgh, the biotechnology company behind "Dolly", the cloned sheep. Lorraine played a pivotal role in clinical trials of a transgenic human protease inhibitor, alpha1 antitrypsin, in cystic fibrosis (CF). "It was a privilege to work with the CF community during this time. It was clear then that CF and other lung diseases, such as COPD, would be a primary focus of my future research".

A Senior Lecturer within the School of Pharmacy, Lorraine has continued to focus on active proteases as biomarkers of disease and potential therapeutic targets. A major programme of work, funded by the CF Trust, is the targeting of channel activating proteases (CAPs) as a means to regulate the epithelial sodium channel (ENaC), dysregulation of which contributes to airways

dehydration in CF. This work has also included an important drug discovery element. "Our compound not only hydrates airways cells but increases mucociliary flow, which is essential to keep the airways free of infection. This strategy could provide a novel treatment for CF, independent of CFTR mutation, preventing the significant lung damage that results from chronic cycles of infection and inflammation, with potential impact on quality of life as well as life expectancy".

Lorraine has also led the commercial exploitation of the patented ProteaseTag™ technology to develop a range of novel products to detect and quantify active protease biomarkers. Initially funded by a Proof of Concept (Invest Northern Ireland) award, this programme soon secured further support from the MRC and the CF Foundation In 2013, Lorraine co-founded and became CEO of ProAxsis Ltd and later that year won the overall, highly competitive Northern Ireland Science Park's (NISP) Connect 25K Award. ProAxsis has since secured significant investment from QUBIS Ltd. and NetScientific plc., a London-based, transatlantic investment company specialising in healthcare technologies. In addition, ProAxsis was one of the first companies across Europe to win a prestigious Horizon 2020 SME instrument award (2014). ProAxsis is also showcased in the recently published MRC Outputs, Outcomes and Impact Report 2014/15 (https://www.mrc.ac.uk/successes/outputs-report/industry-interactions-and-other-collaborations/)

The first-in-class ProteaseTag™ product for the detection of active neutrophil elastase, a biomarker of chronic airways disease, is now on the market and a number of pharma customers have been secured. ProAxsis is also developing a point of care test for use in the proactive management of CF and COPD.

Lorraine says, "We identified a need for novel tools to measure disease-related proteases and are really delighted with the success of ProAxsis to date. We are currently in a phase of rapid growth and are excited at the prospect of expanding opportunities for collaboration and co-development across a number of diseases".

RESEARCH PARTNERS

- **Beaumont Hospital**
- **AstraZeneca**
- **Cystic Fibrosis Trust**
- **Dundalk Institute of Technology**
- **Cystic Fibrosis Foundation – Therapeutics**
- **Medical Research Council**
- **Invest Northern Ireland**
- **University of Leeds**
- **Mologic**
- **Microarrays, Inc.**
- **Our Lady's Children's Hospital, Crumlin**
- **Royal College of Surgeons in Ireland**
- **Ulster University**
- **The University of North Carolina at Chapel Hill**
- **University of Dundee**

ProAxsis

THE SCHOLARSHIP OF TEACHING & LEARNING AND PREPARING STUDENTS FOR PRACTICE

Name: Dr Paul J. McCague
Research Group: Pharmaceutical Science and Practice

Researcher profile: http://go.qub.ac.uk/paulmccague

Dr Paul McCague graduated with a Master of Pharmacy degree from Queen's in 2008, and following pre-registration training returned to the School of Pharmacy at Queen's to complete a PhD in the Clinical and Practice Research Group. Paul held lectureships in the Schools of Pharmacy at University College Cork and Liverpool John Moores University before returning to the School of Pharmacy at Queen's to take up position of Lecturer in Pharmacy Education in September 2015.

He has undertaken the Postgraduate Certificate in Teaching & Learning in Higher Education and the Postgraduate Diploma in Teaching & Learning in Higher Education. Paul is also involved in pharmacy education post-registration and works with the Irish Pharmacy Union Academy to develop and deliver courses for pharmacists to help facilitate their continuing professional development.

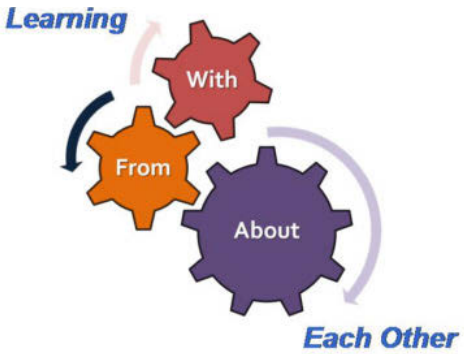
Paul's PhD thesis is entitled "The Unlicensed Use of Extemporaneously Prepared Paediatric Medicines in the Community and Hospital Setting", with this doctoral work involving both quantitative and qualitative methods of research. Paul continues to have an interest in the field of medicines use in children. As part of his research, Paul has collaborated with local schools as well as the Royal Belfast Hospital for Sick Children, Alder Hey Children's Hospital, Wirral Women and Children's Hospital, Cork University Hospital and the Mercy University Hospital Cork.

Paul has a keen interest in interprofessional education (IPE) and simulation based learning (SBL). IPE is defined as "when two or more

professions learn with, from and about each other to improve collaboration and the quality of care". Paul works with staff and students from the Schools of Pharmacy, Medicine, Nursing and Law in the development and delivery of these sessions. SBL provides students with the opportunity to demonstrate their clinical skills, competencies and behaviours in a simulated environment. Paul has been involved in research studies examining views of students and other key stakeholders on these types of learning. Paul has a strong commitment to research-led teaching and the Scholarship of Teaching and Learning (SoTL). He has disseminated numerous educational initiatives at national and international conferences as well as publication in peer reviewed journals. Paul's work on SoTL enables the sharing of good practice and serves as a useful feedback mechanism from students & staff in order to continually refine and advance the curriculum.

> **"SoTL enables the sharing of good practice and serves as a useful feedback mechanism from students & staff in order to continually refine and advance the curriculum"**

Paul has supervised numerous MSc students in areas such as views of stakeholders on the use of generic medicines and medicines reconciliation on discharge from secondary care. He has experience of locum work in both hospital and community pharmacy settings over the past six years and is a Member of the Royal Pharmaceutical Society. Paul continues to maintain practice contact through regular locum work which helps to enrich and contextualise his teaching.



RESEARCH PARTNERS

- **Irish Pharmacy Union Academy**
- **Alder Hey Children's NHS Foundation Trust**
- **University College Cork**

DELIVERY SYSTEMS FOR NANOMEDICINE

Name: Dr Helen McCarthy

Research Group: Experimental Therapeutics

Researcher profile: http://go.qub.ac.uk/helenmccarthy

For the last 10 years, Dr Helen McCarthy's research team have focused on the development of non-viral delivery systems for nanomedicine. These biomimetic systems are designed to overcome the extra and intracellular barriers, so that the macromolecular payload can be delivered at the destination site in order to exert the optimal therapeutic effect.

Helen has designed and patented a peptide delivery sequence, termed RALA, which consists of arginine/alanine/leucine/alanine repeats that result in a hydrophobic and hydrophilic region facilitating interaction with the lipid bilayers enabling transport of DNA, RNA and other phosphate based compounds, endosomal disruption and importantly, increased biological activity. Helen's team have consistently demonstrated that RALA condenses these macromolecules into nanoparticles that are stable and highly functional both in vitro and in vivo. Helen's research team are also developing a number of 2nd and 3rd generation multifunctional delivery systems.

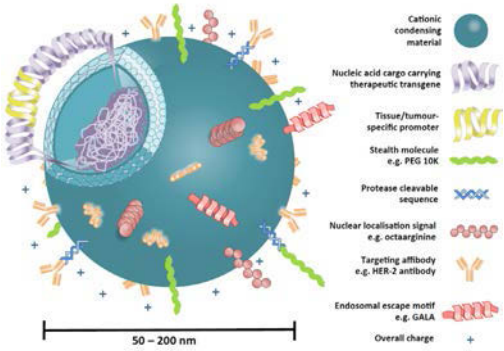
Ongoing projects include the development of a transcriptionally targeted nanomedicine for the treatment of highly aggressive RUNX2-positive tumours. Expertise in nitric oxide biology has enabled Helen's group to deliver the cytotoxic and radio-chemo sensitising iNOS transgene under the control of the human osteocalcin promoter (hOC) using the RALA peptide. The transcription factor largely responsible for activating this promoter is the master transcription factor RUNX2. With funding from Cancer Research UK, Helen & Professor Tracy Robson have compiled overwhelming evidence to support the further development of RALA/hOC-iNOS nanoparticles as a viable therapeutic approach. Most crucially though, RALA/hOC-iNOS demonstrates exquisite potency at delaying tumour initiation, reducing tumour burden and enhancing survival in models of highly aggressive metastatic

breast and prostate tumours.

In another project, Helen and Professor Ryan Donnelly from the School of Pharmacy have created a unique platform technology for DNA vaccination. It is well known that DNA vaccination is a highly potent strategy, because it activates both a prophylactic and therapeutic response, allowing the patient's immune system to actively seek and destroy the target. The "problem" is that there is no effective delivery system to transport DNA to immune cells to generate an immune response. The "solution" to this problem is in the two-pronged approach of Helen's system. Firstly, a peptide has been designed to protect DNA from degradation and ensure delivery to the nucleus. Secondly, the use of dissolvable polymer microneedles in a transdermal patch will ensure that the Peptide/DNA nanoparticles reach the high antigen presenting cell population in the skin to evoke maximum effect. Using DNA that codes for several tumour-associated antigens specific to a particular cancer, Helen's group can create a highly potent targeted DNA vaccine. She has applied these vaccines to cervical cancer and prostate cancer, and has licensed this technology to her industrial partners Touchlight Genetics. The development of this technology holds great potential as a state of the art new targeted treatment for antigen expressing cancers.

A further project within Helen's portfolio, seeks to improve the outlook for patients suffering from serious bone fractures. Each year, more than 2.2 million patients undergo bone graft procedures to resolve these traumas, at a global cost of $2.5 billion. Fractures cause pain, reduce function, induce disability and result in a lesser quality of life. The inevitable increase in incidence of skeletal tissue damage highlights the imperative 'need' to develop innovative strategies for efficacious regenerative biomaterials. Helen's (in collaboration with Professor Nicholas Dunne from the Queen's University School of Mechanical and Aerospace Engineering) "solution" is to develop an injectable thermo-responsive hydrogel (TH) loaded with nucleic acid and ceramic nanoparticles (NPs) designed to augment the regeneration of bone tissue at fracture/metastatic sites using a minimally invasive surgical approach. This will provide significant benefit to patients, clinicians and government decision-makers alike.

Helen has published widely, holds several patents on delivery systems in the nanotechnology area and has given numerous invited conference presentations. She has also collaborated extensively both nationally and internationally.



This schematic of a multi-functionalised vector for therapeutic transgene delivery details Helen's novel approach to biomimetic delivery systems, leading to the improved outlook for patients suffering from a range of life-threatening conditions

RESEARCH PARTNERS

- **Prostate Cancer UK**
- **Touchlight Genetics**
- **Invest Northern Ireland**
- **Gent University**
- **Medical Research Council**
- **Cancer Research UK**
- **Trinity College Dublin**
- **Colorado State University**
- **Rutgers University**

SHEDDING LIGHT ON MORE EFFECTIVE BIOMEDICAL DEVICES

Name: Professor Colin McCoy
Research Group: Biomaterials Chemistry

Researcher profile: http://go.qub.ac.uk/colinmccoy

Professor Colin McCoy has long been fascinated by light, and how it can induce chemical reactions which can be harnessed for medical applications. According to Colin, "light is easy to control, you can switch a light on or off. What's less easy to control is how drugs move around, what dose a patient is actually getting, or how a device behaves when it's in place."

This realisation has led to Colin and his team to work on the development of numerous light-triggered systems, which operate in a range of ways, from the release of a drug at the place and time it's needed, through to using light to bring about chemical changes which are both economical by industrial standards, but offer untold benefits to the end user.

One way in which Colin is making a difference via his groundbreaking work is the use of light to prevent infections taking hold in implanted medical devices. One such device, known as an endotracheal tube, has been in Colin's sights for a long time, and he's making strides in the improvement of their antimicrobial performance.

"There was no technology out there which could control and prevent infection effectively within these devices. The answer came from what we already knew about applying light to bring about the delivery of various drugs". In fact, the technology developed by Colin and his group can not only prevent infection of these devices, saving countless lives every year, but can also prevent the occurrence of antimicrobial resistance, which is a current healthcare crisis.

In addition to these more obvious applications, Colin's work has applications within other areas of healthcare where there is a critical need for infection-free surfaces which don't generate resistant organisms. This has led to the development of PhOx Technology, an umbrella organisation which offers products including a high-level disinfectant technology, known as Illumicide. These products offer the disinfection of surfaces at efficacies greater than current techniques, without the need for chemicals which can lead to the damage of the device, or the harm of the patient or healthcare professional during the sterilisation process. As Colin states, "being able to stop these infections will save huge amounts of money for the NHS, but, more importantly, it will save lives".

Colin's interests aren't exclusive to the use of light to prevent infection, however, with another project seeking to find new ways to improve the use of devices known as intermittent urinary catheters. These devices, which are often used by patients with reduced bladder function at frequencies of up to ten times a day, can bring about the development of complications, infections and severe pain within the urinay tract, not to mention constant discomfort for the user. Another of Colin's proprietary technologies, known as Uroglide, is a novel coating technology, which can be used in conjunction with currently existing device maufacturing processes, to prevent these issues, and greatly improve users' quality of life. Colin says: "Uroglide is a coating that's cheaper than the industry standard, yet stays wetter for longer, is more slippery, and adheres strongly to the catheter." In fact, the potential of this coating is so great, that Colin's team recently received funding for the project from the Royal Academy of Engineering to the tune of £80,000, which will assist with its commercialisation.

In addition to these projects, Colin is the author of more than 100 peer-reviewed publications and patents in journals including *Nature*, the *Journal of the American Chemical Society*, *Pharmaceutical Research*, *Bioconjugate Chemistry* and *Chemistry of Materials*. He is also a Fellow of the Royal Society of Chemistry and serves on the editorial board of *Journal of Pharmacy and Pharmacology*.

RESEARCH PARTNERS

- **Science Foundation Ireland**
- **Action Medical Research**
- **The Wellcome Trust**
- **Engineering and Physical Sciences Research Council**
- **The Royal Society**

IMPROVING THE USE OF MEDICINES

Name: Professor James McElnay

Research Group: Clinical and Practice Research Group

Researcher profile: http://go.qub.ac.uk/jamesmcelnay

Professor James McElnay has had a long standing research programme on improving the use of medicines, with a particular interest in making sure that patients receive the right medicine, at the right dose, at the right time. His work has spanned different diseases and age groupings, but has focused on safe and effective medicine use in children and also in adults with multiple conditions, requiring multiple medicines. His aim is to bring forward pharmacy-based solutions to ensure improved medicine safety and effectiveness.

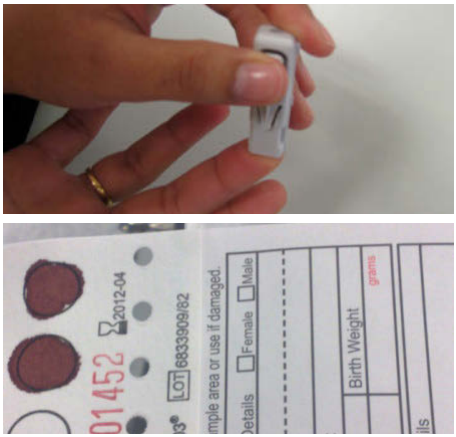
It is well documented that about half of the medicines prescribed by general practitioners and dispensed by community pharmacists are either not taken at all, or not taken at the directed dosage, i.e. patient adherence to prescribed medicines (and indeed lifestyle advice) is far from optimal. It has been stated (by the World Health Organisation), for example, that "the degree of medication non-adherence is so great on the health of the population, more people worldwide would benefit from efforts to improve adherence than from the development of new medical treatments." This poor adherence, coupled by the inappropriate prescribing of medicines (often more medicines prescribed than is required), means that the use of medicines is generally poor, leading to sub-optimal patient outcomes.

Work within Professor McElnay's research group involves the development and evaluation of novel approaches to improve the use of medicines, within both primary care and hospital settings. Having developed new approaches to improve

medicine use, James' team use a range of methods to look at outcomes. These vary from laboratory based methodologies, through clinical outcomes to measures of health-related quality of life. His laboratory has over recent years pioneered the use of dried blood spot sampling, which involves a single drop of blood collected on absorbent paper, to measure patient 'exposure' to medicines that have been prescribed for them. Although he first developed this approach for pharmacokinetic studies, his group are increasingly using the methodology in adherence and in pharmacoepidemiology research.

The adherence work to date has focused on children who are of course dependent on their parents for managing their medicines. His new research in that latter field also involves IT approaches to help children get the best advantage from their medicines, e.g. improved inhaler use in asthma. James also leads a research initiative across Northern Ireland which is examining the impact of home 'telemonitoring' in which patients monitor their own clinical outcomes at home, e.g. blood pressure, with this information being made available to healthcare providers via the internet.

Hospital based research has also focused on medicines management challenges in that setting. Working with colleagues at the Antrim Area Hospital, a new process for managing medicines has been developed (Integrated Medicines Management) which has been shown to decrease the length of hospital stay and also help prevent re-hospitalisation through ensuring that medicines being received on discharge from hospital are optimised and that the patient has been counselled on how to use their medicines effectively post discharge.



Using the approach which Professor McElnay has developed with his team, one drop of blood is all that is required to assess medication use.

RESEARCH PARTNERS

- University of Tartu
- University of Liverpool
- Liverpool Women's NHS Foundation Trust
- University of Missouri-Kansas City
- The Small Businesses Research Initiative
- Arthritis Research UK
- St. George's University of London
- The Association of the British Pharmaceutical Industry
- Northern Ireland Health and Social Care Public Health Agency – Research and Development
- World Health Organization

SCALABLE SYNTHESES OF NATURE-LIKE VITAMINS AND PROBES OF METABOLIC PATHWAYS

Name: Professor Marie Migaud

Research Group: John King Laboratory- Biological and Medicinal Chemistry

Researcher profile: http://go.qub.ac.uk/mariemigaud

For the past 15 years, Professor Marie Migaud's laboratory has developed efficient syntheses of pyrimidine, purine and nicotinamide riboside analogues and derivatives, of sugar-diphosphonucleoside and dinucleotide derivatives and of bisphosphonates.

These compounds are designed to be chemical probes and/or modulators of enzymes to investigate metabolism-related diseases, such as diabetes, ageing, inflammation, neurodegeneration and cancer. Marie's group has also led the field of atom-efficient phosphorous chemistry using ionic liquids, and was the first to take advantage of mechanochemistry and employ phosphorus reagents with notoriously difficult solubility and stability profiles to access high-value nucleoside phosphoramidites.

The work of Marie and her team has secured long-term support from Merck KGaA and led to more recent research interests from companies such as GlaxoSmithKline. Marie's group's expertise in manipulating the profile of reagents

has led to the development of efficient syntheses of advanced nucleo(s/t)ides and the generation

> These compounds are designed to be chemical probes and/or modulators of enzymes to investigate metabolism-related diseases, such as diabetes, ageing, inflammation, neurodegeneration and cancer

of a wide range of chemical tools to explore the metabolic pathways of B-vitamins.

Critically, Marie's portfolio includes the design of short synthetic sequences poised for scale-up. This work has attracted substantial support from the US nutraceutical company, ChromaDex Inc. Additionally, her synthetic work complements and enables a number of national and international research programs related to the field of NAD(P) and B-vitamin biology, conducted in collaboration with biochemists, biologists, nutritionists, oncologists and virologists, and which encompass research priority areas ranging from Healthy Ageing and Cancer to Food and Product Security and Sustainable Manufacturing.

RESEARCH PARTNERS

- University of Pennsylvania
- University of Pittsburgh
- The University of Eastern Piedmont Amedeo Avogadro
- University of Birmingham
- Chromadex
- Cytec
- GlaxoSmithKline
- University of Hamburg
- Nestlé Institute of Health Sciences
- The University of Sheffield
- Merck
- Oregon Health and Life Science University
- University of St. Andrews
- University of Bergen
- The University of Iowa
- University of Oxford
- University of South Alabama
- Warner Chilcott

LIFE AND DEATH: IMPROVING CARE FOR PEOPLE WITH ADVANCED DISEASES

Name: Dr Carole Parsons
Research Group: Pharmaceutical Science and Practice

Researcher profile: http://go.qub.ac.uk/caroleparsons

Dr Carole Parsons is interested in the prescribing and use of medicines in advanced disease as patients approach the end of life. She acknowledges the difficulties involved in conducting research at this time in people's lives. "People are particularly vulnerable at the advanced stages of disease and as they approach the end of their lives, so it is vitally important that any work we do is undertaken sensitively and ethically. However, it is also crucial that we do undertake this kind of research rather than shying away from it because of the potential benefits to patients and their families at an extremely difficult time".

Carole and her team have a particular interest in people who are in the advanced stages of dementia. Carole says "Patients with advanced dementia nearing the end of life do not always receive adequate palliative care. They may experience a high level of symptoms, receive less optimal pain control, undergo more burdensome interventions and receive less palliative care than patients with other end-of-life conditions. They have been referred to as the "disadvantaged dying". As a result, Carole's aim is to conduct research that ultimately improves the care these patients receive.

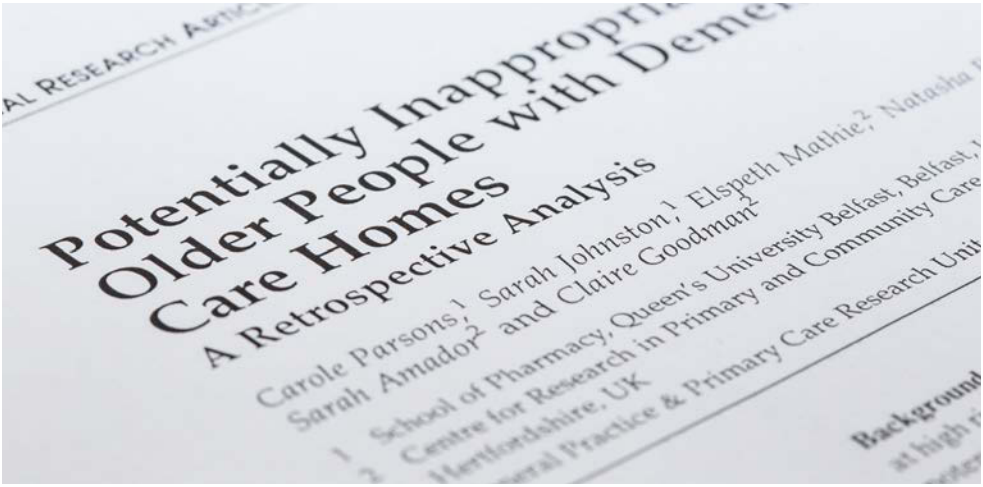
Carole has been involved in work examining the prevalence of pain among community-dwelling patients and nursing home residents with dementia, and has studied the ways in which medications are discussed, decided upon, managed and administered to people with advanced dementia, from the perspectives of healthcare professionals, carers and families.

These studies led to a successful application for funding to the tune of £320,000 from the Health and Social Care Research and Development Division of the Public Health Agency in Northern Ireland and the Atlantic Philanthropies to investigate pain recognition, assessment and management in people with advanced dementia who are nearing the end of life. The outcome of this research will be the development and subsequent pilot of an intervention to improve the way that pain is assessed and managed for people dying with dementia in primary, secondary, hospice and nursing home care settings.

Carole is also interested in the appropriateness of prescribing for nursing home residents with advanced dementia as they approach the end of life and how prescribers make decisions and communicate with the families of people with advanced dementia regarding medication use. As a Cochrane Fellow, she is undertaking a Cochrane Systematic Review to evaluate the evidence regarding withdrawal or continuation of drug treatments for dementia (cholinesterase inhibitors and memantine).

> **“Our aim is to conduct research that ultimately improves the care these patients receive”**

Carole has authored more than 50 peer-reviewed publications. She is a member of the Executive Committee of the Northern Ireland Palliative Care Research Forum and the Clinical Management Group of the Northern Ireland Clinical Research Network for Dementia. She also serves on the editorial board of the *International Journal of Gerontology and Geriatric Medicine*.



RESEARCH PARTNERS

- **Health and Social Care Research and Development Division, Public Health Agency**
- **The Atlantic Philanthropies**
- **Alzheimer's Society**
- **BUPA Foundation**
- **Centre for Ageing Research and Development in Ireland**

EXPLOITING IMMUNOPHILIN PROTEIN BEHAVIOUR TO CREATE TARGETED ANTI-CANCER THERAPIES

Name: Professor Tracy Robson

Research Group: Experimental Therapeutics

Researcher profile: http://go.qub.ac.uk/tracyrobson

For the last 10 years, research carried out by Professor Tracy Robson and her team has focused on the contribution of a novel anti-tumour protein, FKBPL, to tumour growth, angiogenesis, metastasis and cancer stem cell signalling; this has led to the generation of a therapeutic peptide, based on FKBPL, which is now in cancer clinical trials.

FK506 **B**inding **P**rotein **L**ike - FKBPL, is a novel member of the immunophilin protein family; which have wide-ranging roles in a host of diseases. Tracy has previously shown that FKBPL is associated as a co-chaperone within HSP90 complexes, critical for regulating steroid receptor signalling, particularly glucocorticoid receptor the androgen and oestrogen receptor (ER). In the latter studies she found that FKBPL mutations are linked to male infertility and that FKBPL has a role in ER signalling, where it correlates with response to tamoxifen in breast cancer patients. Since then she has demonstrated in a meta-analysis of 3277 patients from five breast cancer cohorts that FKBPL levels were a significant and independent predictor of breast cancer specific survival (HR=1.25, 95% CI 1.07-1.45, p=0.004), indicating superiority over current prognostic markers and highlighting its potential as a future prognostic biomarker and predictive marker of response to endocrine therapy.

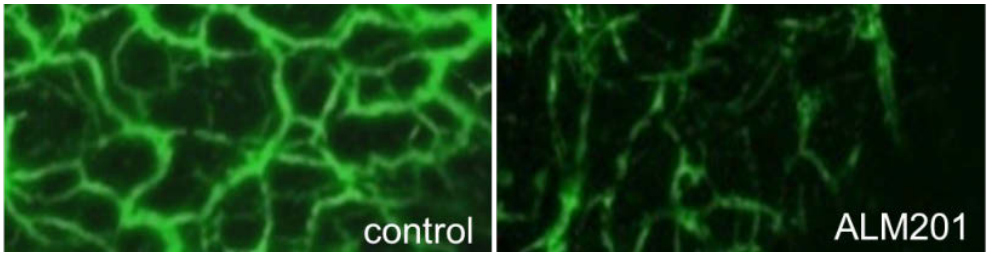
In a separate study, Tracy and her team identified an extracellular role for FKBPL as a secreted anti-angiogenic protein that inhibits blood vessel development. The team demonstrated that peptide derivatives based on its active

anti-angiogenic domain, are potent inhibitors of angiogenesis, dramatically halting tumour growth by targeting CD44 on actively migrating endothelial cells, inhibiting migration and vessel formation. In partnership with Almac Discovery, Tracy's research group has led the development of therapeutic peptides (AD-01 and ALM201) based on FKBPL's active anti-angiogenic domain. Due to robust efficacy and an excellent safety profile, ALM201 has now entered phase I/II cancer clinical trials (EudraCT number: 2014-001175-31). FKBPL's ability to bind CD44 also allows targeting of CD44-rich cancer stem cells offering a novel approach to overcoming treatment resistance and tumour spread, enhancing clinical utility. Importantly, this provides a first-in-class peptide-based therapy for targeting tumour angiogenesis/ cancer stem cells by an entirely different pathway to those agents currently approved.

More recently, a clearer understanding of FKBPL's physiological role was achieved by developing FKBPL deficient mouse models. FKBPL's critical role in angiogenesis was supported by the group's inability to generate an FKBPL knockout mouse; embryonic lethality occurred prior to E8.5. Furthermore, whilst Fkbpl heterozygotic mice (FKBPL+/-) developed normally, embryos showed some vasculature irregularities; vessels were more angiogenic and yet less robust and leaky, suggesting vascular dysfunction. Vascular irregularities have been associated with a variety of pathological conditions. Presently, Tracy and her team are continuing to characterise these mice for other conditions associated with vascular irregularities.

Tracy has published widely, holds several patents on both therapeutic and diagnostic approaches in the cancer area and has given numerous invited conference presentations. She has obtained significant research grant income from industry, BBSRC, MRC, Cancer Research UK, Breast Cancer Now, Prostate Cancer Charity, Prostate Cancer Research Foundation and Invest NI. She has also collaborated extensively both nationally and internationally.

Tracy and her group have developed a novel therapeutic peptide in collaboration with Almac Discovery (ALM201), which inhibits tumour angiogenesis (shown in green, below). It's now in Phase I/II clinical trials.



RESEARCH PARTNERS

- **Almac Discovery**
- **University of Birmingham**
- **The University of Warwick**
- **Ontario Institute for Cancer Research**
- **Breast Cancer Now**
- **University College Dublin**
- **The Beatson Institute for Cancer Research**
- **The University of Manchester**
- **Biotechnology and Biological Sciences Research Council**
- **Medical Research Council**
- **National Institutes of Health**

DEVELOPING NEXT GENERATION TARGETED PRECISION MEDICINE

Name: Professor Christopher Scott
Research Group: Nanomedicine Research Group

Researcher profile: http://go.qub.ac.uk/christopherscott

The laboratory of Professor Chris Scott is interested in the development of novel experimental therapeutics. To date, Chris and his team have an established track record in developing new strategies to targeting different classes of drug target, including proteases and cell surface receptors.

Chris' team have previously worked with local industry to develop therapeutic antibody candidates such as Fsn0503 with Fusion Antibodies Ltd. More recently, they have turned their efforts to development of nanomedicine for the treatment of cancer, infectious disease and inflammatory conditions such as sepsis and Acute Respiratory Distress Syndrome (ARDS).

A key focus of the group is the development of targeted nanomedicines, using agents such as antibodies to develop novel strategies for the development of antibody drug conjugates (ADCs) which is currently one of the hottest areas in drug development. It is the hypothesis of the Nanomedicine Research Group in this research that to improve the localisation of drug to the site of disease will simultaneously enhance therapeutic effects and reduce toxic side effects.

Chris' lab is highly interdisciplinary, bringing together students and researchers with backgrounds in molecular biology, pharmaceutics, medicinal chemistry and enzymology. They collaborate extensively with both basic scientists and clinicians across the University and internationally. Chris' work is funded extensively through RCUK, NIH, Royal Society and from collaborations with industry.

RESEARCH PARTNERS

- The National Institutes of Health
- Research Councils UK
- The Royal Society

BRINGING COMFORT TO PATIENTS SUFFERING FROM EYE DISEASE

Name: Dr Thakur Raghu Raj Singh

Research Group: Ocular Drug Delivery

Researcher profile: http://go.qub.ac.uk/thakursingh

Dr Thakur Raghu Raj Singh is Lecturer in Pharmaceutics in the School of Pharmacy, Queen's University Belfast. He has obtained his PhD in Drug Delivery from School of Pharmacy, Queens University Belfast (2009), M.Sc in Pharmaceutical Sciences from University Science Malaysia (2006) and B. Pharm from Jawaharlal Nehru Technological University, Hyderabad, India (2002).

Thakur's research interests are in the design and physicochemical characterisation of advanced polymeric drug delivery systems for ocular, transdermal and topical applications. Thakur has authored over 100 scientific publications, including 40 full papers and two books with Wiley-Blackwell. He has also been an invited speaker at a number of national/international meetings. He is currently an Editorial Board member of the I*nternational Journal of Pharmacy*, *Chronicles of Pharmacy* and *Science Domain International*. He is also a Scientific Advisor to the Editors of the *Journal of Pharmaceutical Sciences*. He is a reviewer for at least 18 other international scientific journals. Raj also teaches extensively to MPharm, MSc, and BSc students here at the School of Pharmacy.

Thakur's aspirational research programme is primarily focused in developing novel methods of drug delivery which will be of global benefit in treating the world's major eye diseases such as Age-related Macular Degeneration (AMD), Diabetic Retinopathy, Diabetic Macular Edema – these are all very challenging to treat. Patients have to see their doctor almost monthly to get an injection into the eye. Repeated Injections in the eye can cause problems. There are chances of infection, of bacteria from the surface of the eye getting in, increase in eye pressure, patient

discomfort and adherence. Furthermore, the patient needs antibiotic drugs as well as the medicine itself which is very expensive to provide.

Thakur's research team is working on numerous drug delivery platforms to address current challenges in order to address growing demand for better delivery systems to effectively treat eye diseases. For example, Thakur's research group has developed implants using liquid material which turns solid after being injected. The solid implants are capable of controlling the drug release from two months to at least six months so it's one injection every four or six months, not every month.'

He is also working on injectable-size solid implants composed of biocompatible and biodegradable polymeric materials. And there is research into longer-lasting eye drops for Glaucoma. Glaucoma is the second leading cause of blindness, which is expected to affect up to 80 million people by 2020. 'At the moment there are problems here too. How do you get the dosage right? And when you blink – most of the drug is gone.'

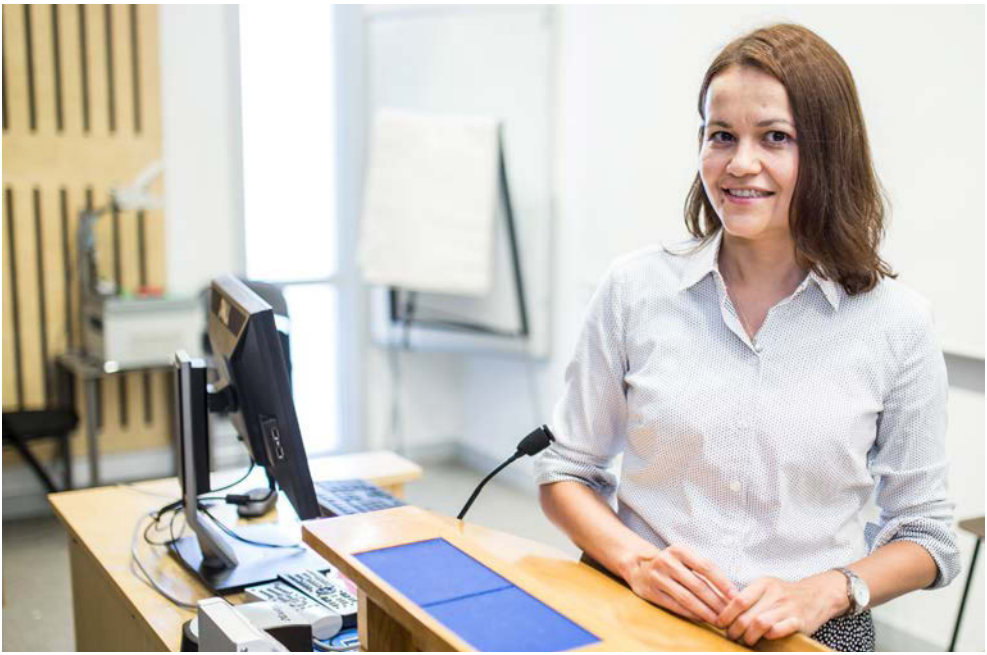
There are major global collaborators, including the Ulster University in Belfast, Moran Eye Centre at the University of Utah, and the University of Loughborough.

Thakur is also a co-founder and director of Re-Vana, a university spin-out company. Re-Vana is a drug delivery company focused on the development and commercialisation of revolutionary gel-based long-acting injectable drug delivery platform to treat chronic eye diseases. Re-vana has won the local 'Life and Health' category award of 'INVENT 2015' and Mass Challenge UK Silver Award in 2015.

> "I'm trying to reduce the burden to the health care system. I'm inspired to do something excellent to benefit patients and society"

RESEARCH PARTNERS

- **Re-Vana**
- **Loughborough University**
- **Ulster University**
- **Moran Eye Center – University of Utah Healthcare**
- **Singapore Eye Research Institute**



COMPUTER PREDICTIONS TO BOOST PRECLINICAL DRUG DISCOVERY

Name: Dr Irina Tikhonova

Research Group: Molecular Modelling

Researcher profile: http://go.qub.ac.uk/irinatikhonova

The main focus of Dr Irina Tikhonova's research efforts is to facilitate understanding drug target interactions and function employing computational tools and, using the gained knowledge, to develop novel computer-aided drug design strategies. In collaboration with pharmacologists and medicinal chemists, she also immediately translates her computational protocols and predictions to identify functionally important residues in proteins and pharmacologically useful compounds. The current targets of Irina's interests include the G protein-coupled receptors (GPCRs) with diabetes, obesity, schizophrenia and ischaemic heart disease applications, and enzymes involved in malaria and cystic fibrosis.

The biased agonism of GPCRs, where in addition to a traditional G protein signaling pathway a GPCR promotes intracellular signals though beta-arrestin, is a novel paradigm in pharmacology. Clinically, GPCR biased signaling has been linked to side effects of several drugs. We have recently explored the structural context of biased agonism on the example of beta-2 adrenergic and cholecystokinin receptors using molecular dynamic simulations of the receptors with biased and unbiased ligands. We have predicted ligand-specific side chain reorganization in the functional NPxxY motif of helix 7 in the beta-2 adrenergic receptor *(Biochemistry, 2013, 52, 5593-603)*.

In collaboration with a pharmacology lab in France we confirmed the importance of helix 7 and identified a sulphur-aromatic interaction

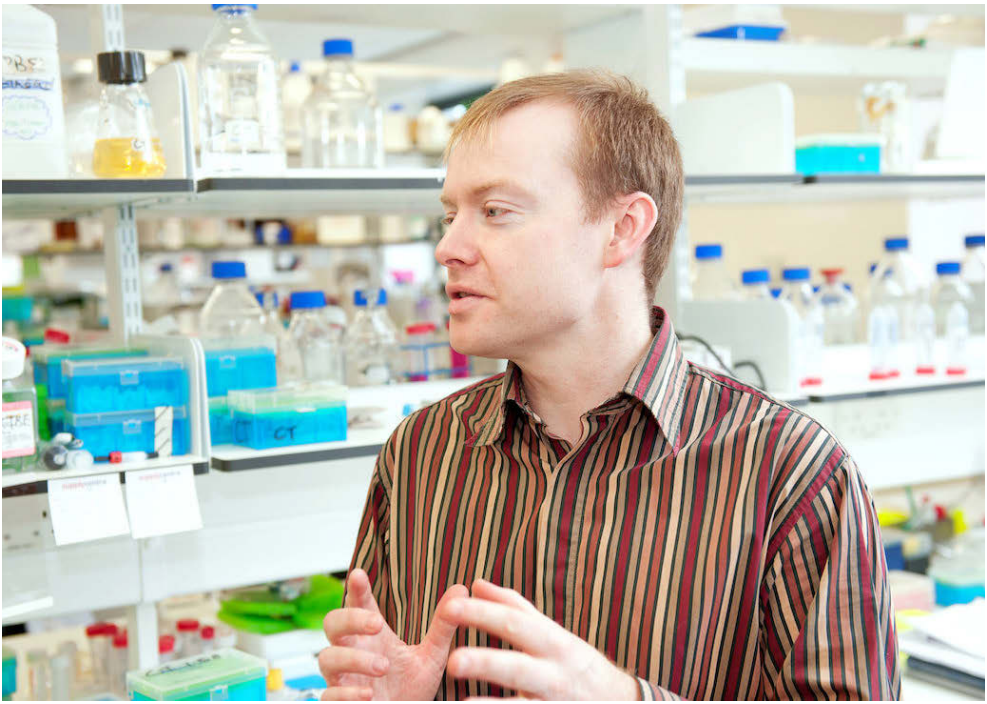
that stabilize the beta-arrestin active state of the cholecystokinin receptor *(J Am Chem Soc, 2013, 135, 2560-73)*. Understanding the network of interactions induced by biased ligands and the subsequent receptor conformational shifts will lead to development of more efficient drugs.

Another research topic at present is to structurally characterize the allosteric and orthosteric sites of the free fatty acid receptors (FFAs) and identify novel selective small molecule binders, thus providing the groundwork for novel therapies of immune and metabolic disorders. Our bidirectional, iterative approach, including computational modelling, site-directed mutagenesis and compound synthesis has helped to delineate key residues for ligand recognition and identify novel selective modulators *(Mol Pharm, 2011, 80, 163-173; J Biol Chem, 2011, 286, 10628-40 and FASEB J, 2012, 26, 4951-65)*. This project we run in collaboration with researchers from Scotland, Germany and Denmark. Using our FFA homology modelling experience, a strategy to model a GPCR, which is phylogenetically distant from GPCRs with the available crystal structures, is proposed *(BMC Structural Biology, 2015, in press)*.

We also work on improving and developing novel computational protocols to integrate chemistry, biology and medicine of drug targets. Our current research focus here is to develop methodologies to incorporate protein flexibility in computer-aided drug design using cutting-edge physics-math-based computational methods. Recently, we have developed a protocol involving molecular simulations, probe mapping and Tanimoto similarity measurements to rationalize selective polypharmacology of antipsychotic drugs targeting the bioaminergic receptor family *(J Chem Inf Model, 2013, 53, 1761-74)*. In addition, our current investigations concern allosteric regulation, drug resistance and drug sequential binding.

RESEARCH PARTNERS

- **French Institute of Health and Medical Research**
- **University of Bonn**
- **University of Southern Denmark**
- **University of Glasgow**
- **The University of Sheffield**
- **Enamine**
- **The Royal Society**
- **The Wellcome Trust**
- **University of Padua**



HALO - INVESTIGATING INFECTION IN CHRONIC LUNG DISEASE

Name: Professor Michael Tunney
Research Group: Halo Group

Researcher profile: http://go.qub.ac.uk/michaeltunney

The Halo Research Group is a multidisciplinary research group based at the School of Pharmacy. The group is jointly led by Professor Michael Tunney, from the School of Pharmacy and Professor Stuart Elborn, from the School of Medicine, Dentistry and Biomedical Sciences at Queen's. Their laboratory is a world class centre of excellence which aims to develop the next generation of treatments, diagnostic tools and standards of care in order to alleviate or cure respiratory infection.

Their multidisciplinary team of research staff includes pharmacists, microbiologists and other clinicians. All are dedicated to working together to push the boundaries of scientific and clinical discovery. Their goal is to translate these advances into new clinical and therapeutic approaches that will ultimately improve the lives of patients with CF and other respiratory diseases.

Research focuses primarily on the improved detection and treatment of lung infection in patients with respiratory diseases such as cystic fibrosis (CF), non-CF bronchiectasis and chronic obstructive pulmonary disease. Using a combination of specialist microbiology techniques and DNA fingerprinting methods, Michael and his team have identified that a much wider range of bacteria may cause respiratory infection in patients with these diseases than was previously thought.

They have also discovered that bacteria which do not require oxygen to live may be present in the airways. The team's current research programme is designed to:

- Establish the role of these organisms in causing infection and damage in the lungs of patients with respiratory disease

- Determine why these bacteria develop resistance to antibiotics used to treat infection

- Evaluate the efficacy of antibiotics and other agents under low oxygen conditions which mimic conditions in the lung and;

- Examine whether changes in antibiotic treatment to target a wider range of bacteria present in the lungs result in improved clinical outcomes for patients

The group are also leading a €50 million, 5-year Europe-wide, project to develop new drugs that could improve the lives of patients with CF and bronchiectasis. The iABC (inhaled Antibiotics in Bronchiectasis and Cystic Fibrosis) consortium, which is made up of industry partners Novartis and Basilea and world-leading lung specialists from across Europe, will develop new 'inhaled antibiotics' to manage chronic lung infection, the main cause of disease and death in patients with these conditions.

RESEARCH PARTNERS

- **University of Michigan**
- **Innovative Medicines Initiative**
- **University Hospital Heidelberg**
- **Aix-Marseille University**
- **University of Naples Federico II**
- **Basilea Pharmaceutica**
- **Cystic Fibrosis Foundation**
- **Seventh Framework Programme**
- **Health and Social Care Board Public Health Agency – Research and Development**
- **Katholieke Universiteit Leuven**
- **Leibniz University of Hanover**
- **Novartis**
- **Stragen Pharma**
- **Helmholtz Centre for Infection Research**
- **Randox**
- **National Health Service National Institute for Health Research**
- **Queensland Institute of Medical Research**
- **Royal College of Surgeons Ireland**
- **University College Cort**
- **University of Washington**
- **Engineering and Physical Sciences Research Council**

RESEARCH FOCUSED ON COMPETENCE IN CLINICAL PHARMACY SKILLS AND PREPARING STUDENTS FOR PRACTICE

Research Group: The Northern Ireland Teacher Practitioner Team

Researcher profile: http://go.qub.ac.uk/TPTeam

The Teacher Practitioner (TP) Team are a network of pharmacists based across Hospital Trusts in Northern Ireland and both Schools of Pharmacy in Northern Ireland. The Team are led by the Team Leader, Dr Roisín O'Hare, who is based in the Southern Trust. All of the TPs work in clinical practice as well as teach therapeutics and clinical pharmacy skills at the University and Hospital sites throughout the MPharm course. The TPs co-ordinate, design and deliver hospital clinical placements in every year of the MPharm as well as design and deliver high stakes Objective Structured Clinical Examinations (OSCEs) for third and fourth year of the same course.

Their research areas of interest include understanding and evaluating the student experience on experiential hospital placements, looking for ways to improve critical thinking and reflection during placements and university based teaching, understanding student perceptions of professional socialisation and how we can influence this as well as student views on preparedness for OSCE.

Goal 1 - Create a collaborative culture for research and development:

- Develop and maintain pharmacy practice research links between the Trusts and the School of Pharmacy.
- Liaise with colleagues in the School of Pharmacy to support research into clinical education delivered at both University and Trust sites.
- Develop and support inter-disciplinary links to increase pharmacy involvement in ongoing research in the Trust.

Goal 2 - Promote research and scholarship:

- To liaise with clinical staff in order to assist with the identification and supervision of undergraduate and postgraduate projects.

Goal 3 - Develop an effective infrastructure for research and development

- Develop and implement clear research policies and procedures.
- Ensure the TP Team are supported to develop and maintain research skills including qualitative

and quantitative research methods.
• Ensure the TP Team are provided with adequate support for practice research e.g. ORECNI and research governance applications.
• To promote the publication and presentation of research undertaken at both Trust and University sites.

THE TP TEAM

Name: Dr Roisin O'Hare

Dr Roisin O'Hare has worked as a clinical pharmacist in hospital in orthopaedics, general medicine and then cardiology for over 10 years. She was one of the founding members of the Teacher Practitioner Team in 2007 and has led the Team since then. In her role as Team Leader she works across both Queens University in Belfast as well as the University of Ulster at Coleraine and also as a clinical pharmacist in Cardiology in the Southern Trust. She completed her Doctor of Practice in both clinical and educational practice with a research project based on the introduction of Objective Structured Clinical Examinations (OSCEs) into the School of Pharmacy at QUB.

Roisin has an ongoing interest in this area and has collected data to try to understand how to improve the support provided for students undertaking these assessments. Roisin's other research interests include evaluation of educational techniques which improve both learning at the University site and experiential whilst on placements. Roisin is also involved in postgraduate education supporting pre-registration students and newly qualified hospital pharmacists on the Foundation Programme. She is a co-author and assessor of Advanced Therapeutics for qualified pharmacists on the Advanced Practice programme as well as the distance learning MSc in Clinical Pharmacy.

Name: Dr Joanne Brown

Joanne worked as a community pharmacist prior to returning to the School of Pharmacy at Queen's to complete her PhD. She has worked as a hospital pharmacist in dispensary and clinical roles in Care of the Elderly, General Medicine and Gastroenterology for over 10 years. She is also involved in postgraduate education supporting newly qualified hospital pharmacists on the Foundation programme and Advanced Practice programme. In this role she works between the Schools of Pharmacy and the Northern Trust.

Name: Mrs Kathryn King

Kathryn has worked as a clinical pharmacist in Cardiology, Respiratory and Gastroenterology for over 20 years. She studied and worked in England for 14 years, managing the pharmacy service to the Medical Directorate in trusts in Coventry and then Birmingham before moving back to Northern Ireland in 2003. She has worked as a member of the Northern Ireland Medicines Governance Team and joined the Teacher Practitioner team in 2007. She is also a pre-registration pharmacist tutor, a foundation programme co-ordinator and participates in the teaching and assessment of other postgraduate diploma and Masters courses in the region.

Name: Miss Sara Laird

Sara has worked as a rotational clinical pharmacist in general medicine, general surgery, orthopaedics, paediatrics and Intensive Care. Subsequent posts held include working in Accident & Emergency, Acute Medical Unit and providing an Integrated Medicines Management service to a cardiology ward. She joined the regional Northern Ireland Teacher Practitioner Network in 2008. In her role as Teacher-Practitioner, she works between Queen's University Belfast, Ulster University and the pharmacy department, Craigavon Area Hospital. University roles include assisting with the delivery of quality assured clinical skills teaching during hospital placements, and student assessment. Trust roles include working as a clinical pharmacist in general medicine, supporting pre-registration trainees, Foundation Programme and Advanced Practice pharmacists.

Name: Mrs Aine Liggett

Aine has worked as a clinical pharmacist in hospital in orthopaedic surgery and also general medicine. In 2011 she joined the Northern Ireland Medicines Governance Team until taking up this post in July 2015. In her current role as a Teacher Practitioner Pharmacist she will work between the School of Pharmacy at QUB and the South Eastern Trust (Ulster Hospital, Lagan Valley Hospital) where her clinical area will be in acute medicine.

Name: Mrs Janet Magee

Janet worked as a clinical pharmacist in general surgery and ICU in the legacy NHSST before becoming a GP practice pharmacist, and then a member of the NHSCT team of Medicines Management advisers. She has worked as an independent prescriber, in a general medical practice, providing patient-centred care to respiratory and mental health patients. Janet was a founding member of the MPharm course at Ulster University. In her role as TP, she works across both Queen's University and Ulster University, and also

as a clinical pharmacist, and lead pharmacist for the safer management of controlled drugs in the WHSCT. She is also involved in post-graduate education supporting pre-registration pharmacists undertaking their pre-registration training in the WHSCT, and has developed and delivered training on behalf of NICPLD.

Name: Ms Fionnuala McCullagh

Fionnuala initially worked in community pharmacy followed by two years working with an Essential Drug Programme in West Africa, gaining experience in healthcare education and HIV. She has since worked in hospital pharmacy for over ten years in a variety of clinical specialties including emergency admissions, stroke and renal medicine. Fionnuala developed a number of national learning programmes whilst working with the Centre for Pharmacy Postgraduate Education (CPPE) – topics include heart failure, antibacterials, and medicines reconciliation. She joined the Teacher Practitioner team in 2010 as the first with a particular link to the University of Ulster course. Fionnuala supports postgraduate education in her workplace as a pre-registration tutor, and a facilitator and mentor for the Foundation Programme for pharmacists. She co-developed and now co-facilitates the educational skills module for pharmacists undertaking the Advanced Practice course in NI.

Name: Ms Fiona O'Neill

Fiona started her career in community pharmacy and, after eight years, took a year-long sabbatical to Australia where she worked in hospitals in Sydney. After her return to Northern Ireland, she moved into the hospital sector. She was the clinical pharmacist for the Royal Jubilee Maternity Service for six years, moving to the Medicines Governance Pharmacist role in the South Eastern Trust in 2009. In 2011 she took the post of Teacher Practitioner Pharmacist. She is also the Pharmacy audit convenor and leads the pharmacy teaching for the medical assistantship in SEHSCT. She has developed written and e-learning courses for NICPLD.

Name: Mrs Louise Shephard

RESEARCH PARTNERS

- **Scholarly Educational Research Network**
- **United Kingdom Clinical Pharmacy Association**
- **Guild of Healthcare Pharmacists**
- **Pharmaceutical Society of Northern Ireland**
- **Royal Pharmaceutical Society**

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