EPSRC
Engineering and Physical Sciences Research Council

AMR
Tackling Antimicrobial Resistance

As part of the Cross Council Initiative in Antimicrobial Resistance (AMR) EPSRC launched a call in September 2014 to engage engineering and physical sciences (EPS) researchers with the AMR challenge and to develop networks within their institutions focussed on the four multidisciplinary themes identified in the AMR Cross Council Initiative. These networks will support people to build capacity and understanding which could lead to future research proposals.

Over £6M was made available to support institutional Bridging the Gap awards to enable institutions to undertake a range of people-focussed activities to facilitate interdisciplinary collaborations, funding for which can be difficult to find elsewhere. EPSRC expect that Universities will focus on the areas of the AMR research agenda that reflect their individual strengths. A key requirement will be the engagement of engineering and the physical sciences (including mathematical sciences and computer science) as part of the multidisciplinary networks.

Links:
http://www.mrc.ac.uk/research/initiatives/antimicrobial-resistance/
https://www.epsrc.ac.uk/funding/calls/bridgingthegapsepsamr/
http://gow.epsrc.ac.uk/NGBOViewPanelROL.aspx?PanelId=1-2H6XUI&RankingListId=1-2H6XW7

EPSRC: Bridging the Gap – EPS and AMR		
Grant Holder	**Institution**	**Title of Award**
Professor Andrew Pitt	Aston University	Aston Multidisciplinary Research for Antimicrobial Resistance: The AMR4AMR project

Co-Investigators

Summary

Antimicrobial resistance, the ability of microorganisms to overcome almost all of the antimicrobial treatments that we currently have, has been identified as one of the main challenges facing the 21st century, and it has become a critical problem across the globe, including in the developed world. Unless we step up our research efforts and find new approaches to deal with these bugs, it might not be long before we will find ourselves in a situation similar to times before the development of the penicillins, where simple infections turn out to have deadly consequences.

The reasons for the increasing resistance of organisms is many fold, and it is, therefore, going to take a concerted effort of researchers from many different areas to find long-term solutions; antimicrobial resistance presents a spectrum of complex and multifaceted questions, ranging in scope from fundamental scientific research at the horizons of disciplines through to the behaviour of individuals and society. While working across the conventional boundaries between the disciplines, interdisciplinary research, has become well established in the research world, it has not yet been applied in a concerted fashion to the problem of antimicrobial resistance.

Aston Interdisciplinary Research for Antimicrobial Resistance: the AMR4AMR project, will generate an active and vibrant research environment that will bring together researchers from across Aston, from disciplines like biology, the physical sciences such as physics and chemistry, pharmacy, engineering, mathematics and statistics, and other key areas like psychology, pharmacy practice, business and computer science, to focus holistically on the problem of antimicrobial drug resistance, and find new and innovative solutions. It is only by using a combination of approaches that we will transform the antimicrobial resistance landscape into a manageable and tractable problem.

Aston is a small and dynamic University, and AMR4AMR will enable us to very effectively bring together our world-leading researchers to identify and develop new ways of tackling the problems of antimicrobial resistance. To add substantial value to this, due to the size and organization of the University, we are uniquely placed to draw in research input from psychology, pharmacy practice, linguistics and our Business School, and we have a proven ability to work closely with businesses, all of which will inform the research and help to translate the science into solutions that can be used effectively in the real world.

Tackling the problem of antimicrobial resistance will bring many benefits; not only will it improve quality of life and provide safer environments in our hospitals and workplaces, it will bring financial benefits as the burden of antimicrobial resistance on our already strained health service is reduced. AMR4AMR will bring together researchers to work on a range of complementary and tailored solutions, such as smarter and cheaper methods for rapid identification of the microorganisms and their resistance, better drugs and smarter ways to deliver them, new materials for anything from implants, such as hip replacements, to better antimicrobial work-surfaces, medicines that are best suited to the patient, from paediatrics to pensioners, helping people to complete course of drugs (not doing so is a major cause of microbial resistance), and better ways of identifying were infections originate and how they spread. In the longer term this research will lead to the goal of "precision medicine", to identify the causes of disease at the molecular level, and to use targeted, combined therapies to address specific disease processes.

Through the generation of an environment that actively supports this interdisciplinary approach, new and innovative science and engineering, and better practices will be developed, and will provide the foundation for ensuring we stay one step ahead of the superbugs.

EPSRC: Bridging the Gap – EPS and AMR		
Grant Holder	**Institution**	**Title of Award**
Professor Maggie Smith	University of York	TARGeTED: Tackling Antimicrobial Resistance through Goal-orientated Thinking in the EPS Disciplines

Co-Investigators

University of York

Professor Martin Bees

Professor Susan Stepney

Dr Steven Johnson

Professor Thomas Krauss

Professor Anthony Wilkinson

Summary

Antimicrobial resistance (AMR) is a serious threat to human and animal health. The problem is multifactorial, spans across many disciplines and involves stakeholders from right across society's spectrum. Our belief is that by engaging researchers from different disciplines, we can ask new questions and develop new solutions to the AMR challenge. Scientists engaged in EPS can bring novel insights and innovative technologies to many aspects of the AMR challenge but there are barriers to their engagement with goal-orientated, inter-disciplinary research. We have identified the conditions that lead to successful inter-disciplinary research outcomes; receptiveness, understanding, communication, resources and networks. We have put together a programme of activities that will create the time and space for researchers from EPS to engage in thinking about the AMR challenge in such a way that they will be able to identify tractable problems that they can solve. To start with we will focus on areas of research excellence currently being conducted at the University of York that have not to date been applied to AMR research, but promise to provide new insights and innovative solutions. These areas are 'Novel tools for understanding and controlling bacterial behaviour' and 'Novel biosensors and diagnostics'. We recognize that a successful 'Bridging the Gap' programme will bring together collaborations between researchers not yet engaged with the AMR agenda and we have incorporated into our activities strategies to reach these people. The outcome will be an exciting community of inter-disciplinary researchers working on the challenges of AMR that are communicating, sparking ideas, writing papers and applying for further funding.

EPSRC: Bridging the Gap – EPS and AMR

Grant Holder	Institution	Title of Award
Dr Danish Malik	Loughborough University	Tackling Antimicrobial Resistance: An Interdisciplinary Approach

Co-Investigators

Loughborough University

Dr Emily Rousham

Dr Marc Kimber

Dr John Ward

Dr Sourav Ghosh

Project Partners

Assoc of British Healthcare Industries

Collegium Basilea

EMIDRN

Smith & Nephew

Hygiene Solutions

Infection Prevention Society (IPS)

NHS Lanarkshire

Royal Wolverhampton Hospitals NHS Trust

Southport & Ormskirk Hospital NHS Trust

University Hospitals of Leicester NHS Tr

Summary

The proposal aims to facilitate and encourage multidisciplinary research at Loughborough University (LU) into the healthcare environment (air, water and surfaces) and in community settings (e.g. nursing and care homes, low income countries with high population densities) as potential reservoirs for the transmission of antimicrobial resistant infectious agents. Hospital surfaces are a reservoir for transmission of antimicrobial resistant infectious agents, typically via contamination of the hands of healthcare workers. Staphylococci, C. difficile and Acinetobacter species have been shown to survive many months on high touch near-patient surfaces in healthcare environments. Recent epidemiological evidence suggests that patients admitted to rooms previously occupied by colonised patients have a higher probability of acquiring (i.e. is a risk factor for colonisation or infection) the same pathogen. Other studies have shown aerial dissemination of infectious agents, e.g. C. difficile spores, making it particularly difficult to eradicate infectious agents in hospitals. Despite a recent focus on performance management to improve the efficacy of cleaning and disinfection processes, published studies have demonstrated the presence of culturable indicator organisms (e.g. Methicillin-resistant Staphylococcus aureus and Vancomycin-resistant enterococci) post conventional "terminal disinfection" (i.e. upon patient discharge). Bacterial endospores (e.g. Clostridium difficile) are particularly resilient to routine disinfection treatments due to a variety of factors including use of insufficient, low concentration disinfectant, inadequate contact times etc .The Chief Medical Officer's report highlights issues such as poor design that limits cleaning, poor ventilation and poor water-supply management (risk of Legionella species and Pseudomonas aeruginosa). One of the problems of AMR is the length of time taken to identify pathogens (1-3 days) resulting in (i) potential spread of infectious agents; (ii) antibiotics given to patients unnecessarily 'just in case'. Rapid diagnostics would aid early detection and isolation of patients that would otherwise spread contamination. Photocatalytic self-cleaning surfaces could inactivate infectious agents landing on surfaces thereby breaking the link between contaminated surfaces and transmission through contact. Barriers and levers could be identified to improve hand-hygiene compliance whilst monitoring compliance in real-time using teletracking technology. Novel surface, air and water disinfection systems could be developed e.g. using atmospheric plasma technology. Natural ventilation systems could be designed to improve air quality and reduce dispersal of infectious agents in multi-bed wards. The proposal aims to focus on the following three AMR research themes: (i) Accelerating therapeutic and diagnostics development - Alternative approaches to treat resistant bacteria; New technologies for identifying resistant bacteria to underpin diagnostics development; Scale-up and manufacture of biotherapeutics; The effective delivery of existing antimicrobial agents (ii) Understanding the real world interactions - Understanding the role of the environment as a reservoir for AMR microorganisms and the transmission of infections in community and healthcare environments; Ways to manipulate the environment to prevent transmission (iii) Behaviour within and beyond the healthcare setting - Elucidate underpinning motivations for human behaviours relating to the spread of AMR infectious microorganisms in the healthcare environment and the community; Evaluate interventions to control/prevent the spread of resistant bacteria.

EPSRC: Bridging the Gap – EPS and AMR		
Grant Holder	**Institution**	**Title of Award**
Professor Timothy Leighton	University of Southampton	NAMRA - Network for Antimicrobial Resistance Action

Co-Investigators

University of Southampton

Professor Robert Read

Professor Rob Eason

Professor George Attard

Dr Yi Huang

Professor Robert Wood

Dr Emma Roe

Professor Jeremy Frey

Professor Bill Keevil

Dr David Voegeli

Project Partners

University Hospital Southampton NHS FT

IBM

Summary

Microbes continually evolve antibiotic-resistant strains despite the best efforts of biomedical scientists to combat them. This is taking us towards a future where routine operations and infections become high-risk, and where we cannot produce sufficient food globally (70% of antibiotics in the USA are used in animals for food production).

A new strategy is needed to combat Antimicrobial Resistance (AMR). This network will take world-leading Engineering and Physical Science (EPS) researchers and introduce them into a new Network for Antimicrobial Resistance Action (NAMRA). In a series of structured events, they will share their expertise with clinicians from the NHS, with biomedical scientists, and researchers from Health and Life Sciences. These people can tell the EPS researchers about the AMR problems that need tackling, and how any solutions must be designed to work in a real-world environment for use by healthcare workers, farmers, industry and the workplace. To help in this, the Network also includes leading researchers from Social and Human Sciences who can explain how AMR solutions must fit in with human behaviour, with Geographers who are experts in how distribution of the waters supply, and how livestock practices, affect AMR; with experts in the Legal and Ethical issues in developing new solutions to AMR for use in the wider world; and with experts in Business who research how supply chain issues affect AMR.

The EPS researchers have developed many world leading technologies, from the award-winning StarStream cleaning product, to surfaces that keep clean by mimicking shark skin. Such technologies were developed for other sectors (defence, nuclear etc.) and it is vital that such expertise be translated into the fight against AMR. Within NAMRA, the inventors can access the experts who understand AMR, and access laboratories and clinics to test the step-changing solutions they collaboratively identify. In return, world-leading work by current AMR researchers can be enhanced through NAMRA contacts to:

-engineer solutions;
-shape them for ready adoption by healthcare workers and others;
-set out the behavioural, ethical and legal framework for their adoption; and
-develop the business solutions so that, rather than staying on the laboratory bench, step-changing technologies can be fashioned into products that are available across the UK, and beyond.

The project begins with a 'Start-up' conference for attendees to share expertise and identify possible collaborators. Break-out sessions facilitate collaborative bids for NAMRA to fund 3-6 month projects to explore new ideas. One year in, a 'Community expansion' conference reviews the success of the collaborations to date, plans new collaborations, and invites AMR workers from across the UK, and representatives from NHS, Gov and local Gov, to discuss progress.

We will hold monthly meetings on particular AMR topics for smaller sub-groups within NAMRA. We will develop a Cognitive Computing facility to identify the knowledge gaps and possible fruitful areas of collaboration, working alongside the Steering Committee which performs its own assessment. We will also work hard to ensure that, after the two years of funding for NAMRA expires, we can sustain the network. Measures to do this include offering support, training and guidance:

-to ensure that interdisciplinary researchers do not 'fall into the cracks' between disciplines when publishing or applying for grants;
-to team-build an exhibit for public display on AMR, covering such issues as handwashing, biofilms and the use of antibiotics;
-identify and apply for sources of funding to continue their collaborations (incl. peer-reviewing proposals);
-to communicate their work to the public, via websites, school visits, Science Fairs;
-to the next generation of leaders in AMR.

The project ends with a 'Way Ahead' conference to ensure the good work continues after this funding ceases.

EPSRC: Bridging the Gap – EPS and AMR		
Grant Holder	**Institution**	**Title of Award**
Professor Matt Keeling	University of Warwick	Cross-scale prediction of Antimicrobial Resistance: from molecules to populations.

Co-Investigators

University of Warwick

Dr D Hollingsworth

Dr MJ Chappell

Professor MI Gibson

Dr NR Waterfield

Professor MJ Pallen

Professor M Turner

Professor TDH Bugg

Professor P Thomas

Professor PJ Sadler

Professor P Scott

Dr ND Evans

Dr JA Covington

Professor CG Dowson

Professor RA Roemer

Dr D Roper

Professor T McNally

Dr CJ Smith

Dr J Lewandowski

Dr E Fullam

Professor A Rodger

Dr M Polin

Dr V Kantsler

Summary

Antimicrobial Resistance (AMR) is a major threat to human health, dramatically reducing the effectiveness of drugs that have been a substantial component of medical treatment for decades. Traditionally the study of AMR has been led by Medical and Life Science researchers. However, we believe that to effectively halt the rise of AMR in the population requires the combined resources of Mathematical, Engineering, Physical, Chemical, Medical and Life Sciences, in highly interdisciplinary ventures. Moreover, we feel that the quantitative and predictive skills of EPSRC remit sciences are key to creating a step-change in the study of AMR in terms of: understanding mechanisms of AMR, prediction of potential novel antibiotic targets and methods to contain and control AMR spread.

We have identified five key areas of research in Warwick in which we already have interdisciplinary strengths and which will form key themes of our application:

1) Cell Wall Assembly. The assembly of the cell wall is one of the major targets for antibacterial drug action, and brings together key researchers in Chemistry and Life Sciences in addition to strong industry collaboration.

2) Bacterial Cell Division. Closely linked to the cell wall assembly proteins are the range of accessory proteins providing temporal interactions, force generation and regulatory capacity as well as substrate interactions for the PBPs that are necessary for bacterial cell division.

3) Antimicrobial Discovery. Identification of potential novel antimicrobial actions is a key element in combating the increase in AMR. Warwick is involved in the development of an unusually diverse range of novel antimicrobial systems, focusing on discovery, development and mechanism of potential targets.

4) Bacterial Genomics. Sequencing technologies, particularly high-throughput sequencing, have already made a considerable impact on medical microbiology. Warwick researchers are well placed to translate their experience into the understanding of AMR spread in health-care settings.

5) Public Health Epidemiology. An understanding of public-health is central to a wider understanding of how novel scientific discovery can be translated into applied health benefits. Mathematics, Life-Sciences and Medicine are all individually strong in this area.

In turn these subject areas are supported by Warwick's recognised expertise in mathematical modelling (both population and systems biology), imaging techniques and diagnostics.

This proposal has three main mechanisms through which the gaps between these subject areas will be bridged and productive interdisciplinary collaborations initiated:

1) Short term discipline-hopping fellowships. Utilising the highly successful and cost-effective fellowship model developed by the Warwick Institute of Advanced Study, we will recruit junior post-doctoral researchers to cross-departmental positions.

2) Focused cross-disciplinary meetings. Such meeting will take a variety of formats, but will form the natural interface between Warwick academics, industry and public-health researchers, and academics from other institutions. We intend to host vacation schools, problem-solving workshops and study-groups, together with larger research symposia. Potential early meetings could focus on "Passage Across the Cell Membrane", "Bacterial Cell Division" and "AMR in healthcare settings".

3) Visiting Fellowships. Although we believe Warwick is unique in the breadth of skills it supports, there are obviously many specialist areas where we simply do not possess the necessary expertise. To bridge this skills gap we will invite a select number of senior academics to short-term (3-6 month) visiting fellowships.

4) Pump Priming. This will be open to all Warwick researchers and will be used to increase Warwick's capacity and capability to undertake world-class, innovating and exciting research in AMR.

EPSRC: Bridging the Gap – EPS and AMR

Grant Holder	Institution	Title of Award
Professor Jamie Hobbs	University of Sheffield	Sheffield antimicrobial resistance network – SHAMROK

Co-Investigators

University of Sheffield

Professor Simon Foster

Dr Simon Jones

Professor Sheila MacNeil

Professor David Dockrell

Summary

The introduction of antibiotics in the 1940's revolutionised healthcare and underpinned medical advances through the rest of the century, but little over 70 years later we now face increasing instances of antimicrobial resistance that threaten many life-saving treatments. Problems with developing new innovative solutions to these challenges come from areas as diverse as a lack of understanding of the fundamental science explaining the mode of action of antimicrobials, to understanding clinical bottlenecks in the development of new treatments. If we are to be successful in developing new treatments and maintain our current precarious position in winning the war against bacterial infection, we need to understand and address these challenges fully. To do this will require innovative approaches that draw in expertise and cutting-edge methodology from the physical sciences and engineering, working in partnership with biologists and clinicians. The University of Sheffield has world-leaders in bacterial research, from microbiology to vaccine development and clinical practice, and a proven track record of close collaboration between Biologists, Medics, Chemists, Physicists and Engineers to address these problems. However, looking more widely the University has considerably more to offer through encouraging and developing new research collaborations that will fully engage those in Engineering and the Physical Sciences with the potential to help circumvent bottlenecks and problems.

This project aims to develop a framework to nurture and develop new research opportunities to augment those already in place as part of our internationally leading Imagine: Imaging Life and Florey Institutes. We will build an expansive, cross Faculty network that will focus on the EPSRC defined challenges we are best placed to address: the development of physical and physicochemical tools for understanding bacteriology and the host response ("Tools for understanding bacteriology"); and the development of new surfaces, dressings, and tissue engineering related approaches for preventing infections and delivering antimicrobials ("Improved drug delivery strategies for antimicrobials" and "Smart surfaces and dressings to prevent infection"). A series of focussed workshops, discipline hopping research and short proof-of-concept research projects will deliver new collaborations and solutions to a worldwide problem. We will aim to both take advantage of obvious synergies and to actively search deeper for new opportunities, making the most of our existing expertise to catalyse truly transformative activities that are unconstrained by traditional discipline boundaries.

EPSRC: Bridging the Gap – EPS and AMR

Grant Holder	Institution	Title of Award
Professor Adrian Mulholland	University of Bristol	BristolBridge: Bridging the Gaps between the Engineering and Physical Sciences and Antimicrobial Resistance

Co-Investigators

University of Bristol

Dr KME Turner

Dr MB Avison

Dr J Spencer

Dr ME Barbour

Dr AM Seddon

Professor J Tavare

University of Bath

Professor RS Trask

Cardiff University

Professor T Walsh

Summary

Antimicrobial (antibiotic) resistance (AMR) is a major and growing problem in many areas of medicine. AMR has been recognised as one of the most important challenges facing the UK. The availability of effective antimicrobial compounds underpins much of modern health care, making possible invasive surgical procedures and aggressive chemotherapeutic regimes that would otherwise be compromised by unacceptable risk of bacterial infection. Within this broad area, the increasing prevalence of resistant Gram-negative bacteria as causes of healthcare associated infections, the lack of new agents effective against these organisms, and the consequent requirement to stimulate antibiotic development, are all highlighted in the recent report of the UK Chief Medical Officer.

Physical scientists, engineers and mathematicians can make potentially transformative contributions to tackling AMR. Unleashing this potential requires new ways of interdisciplinary working, and bringing together researchers from these disciplines with counterparts from biology and human and animal medicine. We will achieve this by the following specific objectives:

(1) A wide range of networking activities to build new interdisciplinary research communities

(2) Pump-priming projects in, and across, three distinct strands we have identified, building on EPS research strengths, aligned with AMR strategy, to foster transformative research to combat AMR

(3) Training activities (training EPS researchers in biomedical methods and models and vice versa), to aid EPS researchers in understanding AMR and equip biomedical researchers to apply EPS methods, effectively training a new generation of researchers to tackle the problems of AMR

The University of Bristol is exceptionally well placed to build and deliver new engineering and physical science research into AMR, combining as it does international excellence across all of these fields. The University of Bristol houses world-leading research in the physical sciences, mathematics, computer science and engineering, much of which is EPSRC-funded. Bristol is also a thriving centre for basic biomedical, clinical, veterinary and community health research, with studies into AMR as a key strength. AMR is a strategic priority at the University of Bristol through our Infection and Immunity research theme and with support from the Elizabeth Blackwell Institute (EBI) for Health Research, we have already begun building connections across these interdisciplinary communities. This Bridging the Gaps project will exploit the potential opportunities that exist across a wide range of outstanding EPS researchers, including those who have never previously felt their research was relevant to AMR. By ensuring that EPS researchers are core members of interdisciplinary research activity, we will identify and seed new approaches to analyse, mitigate and ultimately overcome AMR. UoB houses world-leading research in materials science, engineering, synthetic biology, physics, maths/statistics, nanoscience and chemistry, all with significant EPSRC funding. UoB currently has the 6th largest EPSRC portfolio of any UK University, with in excess of £200M in live grants. Bristol is also a thriving centre for biomedical, clinical and community health research (within Clinical Sciences, Veterinary Sciences, Cellular and Molecular Medicine and in our NHS Trust partners, UoB has the fifth largest active portfolio of grants classified by EPSRC as relevant to the Healthcare sector, totalling approx £30M), in which studies of AMR form a key part. UoB has an outstanding track record of success in developing new interdisciplinary collaborations to address major societal challenges with the EBI, which was formed in 2012 for this express purpose. The EBI is ideally placed to help building interdisciplinary capacity in AMR, and has an existing governance mechanism for open and transparent deployment of this type of funding.

EPSRC: Bridging the Gap – EPS and AMR		
Grant Holder	**Institution**	**Title of Award**
Professor John King	University of Nottingham	Bridging the Gaps: Systems-level approaches to antimicrobial resistance

Co-Investigators

University of Nottingham

Dr RL Gomes

Professor TM Fromhold

Professor R Bayston

Professor P Barrow

Professor C Alexander

Professor RE Sockett

Professor CER Dodd

Professor M Searle

Dr J Twycross

Summary

The problem of antimicrobial resistance (AMR) is an increasing challenge, not only in the context of healthcare but also in, for example, food safety and agriculture. The prevalence of resistant bugs such as MRSA has received widespread media coverage and the problems relating to resistance are now more widely recognised than ever before, as is the importance of developing new approaches, particularly given the increase in issues associated with multidrug resistant species. The current proposal seeks to drawn on wide-ranging applicable expertise in engineering and the physical sciences that, in collaboration with biological-science researchers, clinicians and industry, offers hitherto unexploited opportunities to contribute significantly to addressing these very significant challenges.

We shall accordingly deliver a programme of activities that promotes new interdisciplinary collaborations across traditional boundaries between engineering, the physical sciences and the biological sciences. The University of Nottingham has an outstanding history of such discipline-bridging activities, as well as of research relevant to AMR, and will bring this experience to bear upon the challenge of AMR.

The primary mechanism for promoting new research collaborations will be that of themed Sandpits, building on the success of the Mathematics-in-Medicine Study Groups pioneered by the University in 2000 (and subsequently spawning the Mathematics-in-the-Plant-Sciences Study Groups and others). In these, presenters from the biological sciences, clinical medicine or industry will describe issues that could benefit from new approaches drawn from engineering and the physical sciences; intensive brain-storming work on these topics will identify the skills needed and establish the relevant cross-disciplinary teams; seed funding will then be provided for the most promising projects identified. While the process is now well-established, the outcomes of such workshops are very far from predictable and the aggregation of the range of disciplines outlined above should ensure that innovative approaches come to the fore. Other mechanisms will include Challenge Days (modifying the successful approach of the Industry Challenge Days held by the Business School to ensure that research developments align with the needs of potential end users), discipline-hopping secondments, speed-networking sessions, cross-disciplinary workshops (focussing on specific methodologies, to enhance further the opportunities for identifying potential crossovers between research fields) and annual showcases in the form of a launch event and a concluding 'forward-look' workshop. These activities will be augmented by a Visiting-Scholar programme whereby leading experts in complementary areas will contribute their expertise to the initiative.

Funding from the programme will be assigned in competition to multidisciplinary projects judged on their research excellence and their capacity to contribute to addressing AMR challenges. The programme's Strategy Group will be responsible for assessing applications and for monitoring progress; the activities outlined above are specifically designed (in particular by bringing together researchers from diverse disciplines) to ensure that the research ideas developed are highly innovative and that the associated projects have the required mix of research expertise. The programme will be very explicitly outward-facing, drawing extensively on input from clinicians, industrialists and other potential end users, as well as interacting with complementary research elsewhere. In combination with the excellence and innovation of the research developed, such collaborations will ensure the sustainability of the initiative.

EPSRC: Bridging the Gap – EPS and AMR

Grant Holder	Institution	Title of Award
Professor Richard Curry	University of Surrey	Novel Strategies to Detect and Mitigate the Emergence of AMR in Zoonotic Pathogens

Co-Investigators

University of Surrey

Professor RM La Ragione

Professor J McFadden

Professor RA Dorey

Project Partners

National Physical Laboratory

Royal Surrey County Hospital NHS F Trust

University of Sao Paolo

Veterinary Medicines Directorate

Summary

Antimicrobial resistance (AMR) is one of the most critical challenges facing science in the 21st century. For decades we have benefited from the widespread availability of drugs to treat a variety of conditions using antibiotics with penicillin becoming one of the most recognizable drugs in terms of public awareness. However, through the natural evolution of pathogens, accelerated by the over-use of antimicrobial drugs, the effectiveness of current treatments to such interventions is reducing. Indeed the emergence of pathogens which are fully resistant to antimicrobial drugs, though limited, is becoming an increasing trend. As a direct result of the serious implications and threats this poses the UK has established a 5-year AMR challenge to researchers, mirrored internationally, to address these issues.

In considering AMR it is important that the risk to human health from the emergence of AMR in livestock is also recognized and addressed. The use of antibiotics in this context is also widespread, and the emergence of AMR is occurring as seen in human pathogens. Given the food chain, and environmental factors such as waste treatment and run-off, there is significant risk that this may offer a pathway for the translation of AMR pathogens from animals into humans.

Much of the study into AMR and its emergence has naturally been undertaken by researchers within the life sciences. However, researchers within the engineering and physical sciences (EPS) have for many years contributed strongly to the development of life and medical sciences through the development of new characterization tools, advanced mathematical modelling techniques, and through the development of increasingly smart sensors to give a few examples. There is therefore significant scope for engaging EPS researchers directly with addressing the AMR challenges with the aim of accelerating the development of new techniques and tools for identifying and addressing the problem.

This project will create a space in which we will bring together researchers from the EPS community, including many leaders of their field, with those directly tackling AMR research challenges in the life sciences. We will do this through the creation of a Collaborative Hub for Advancing Interdisciplinary Research (CHAIR) at the University of Surrey. This CHAIR will be based in the newly established School of Veterinary Medicine, providing a neutral space to engage with researchers from across the EPS Departments within the University. To support and facilitate collaborations focused on addressing the AMR challenges we will run a series of integrated seminars, workshops and networking events which will lead to 'sandpits' at which researchers will work to propose short collaborative projects. Successful projects will then be eligible to apply to receive further funding with the aim of generating full research proposal submissions to funding bodies on the AMR challenges. We will also provide support in terms of research time to short projects, funds for short-term missions to support researcher interaction and information exchange, and network formation.

A series of researcher development and training activities will be offered in collaboration with the University's Researcher Development Programme. We will also closely engage with a number of strategic partners including the Defra Animal and Plant Health Agency, the Veterinary Medicines Directorate (VMD), The National Physical Laboratory (NPL), The Royal Surrey County Hospital, and internationally at North Carolina State University (USA) including supporting a short-term visiting appointment, and Universidad Sao Paulo (Brazil). This will significantly extend the potential impact of the activities we will support and provide new opportunities for wider collaboration.

EPSRC: Bridging the Gap – EPS and AMR		
Grant Holder	**Institution**	**Title of Award**
Professor Chris Toumazou	Imperial College London	Engineering, Physical, Natural Sciences and Medicine Bridging Research in Antimicrobial resistance: Collaboration and Exchange (EMBRACE)

Co-Investigators

Imperial College London

Dr P Georgiou

Professor A Armstrong

Professor AH Holmes

Summary

This project consists of a two year programme which aims to bridge the gap between Engineering, Natural Sciences and Physical Sciences and AMR Research. The purpose of the programme is to try and engage these disciplines in multidisciplinary research which is important and relevant in tackling the catastrophic threat that antimicrobial resistance poses. The programme is principally designed to develop a cohort of interdisciplinary research fellows who through the programme, will develop a unique set of hybrid research skills, a positive attitude to multidisciplinary research and the ability to communicate across traditional academic boundaries. We aim that these individuals will become the potential future leaders in multidisciplinary research into AMR. Supporting this main aim, are a range of activities designed to bridge the gaps between disciplines, encourage researchers in different disciplines to engage in collaborative AMR research while also providing valuable learning experiences for the fellows. Activities include developing a virtual network for AMR research, organising conferences and seminars, a sandpit exercise and supporting pump-primed AMR projects.

EPSRC: Bridging the Gap – EPS and AMR

Grant Holder	Institution	Title of Award
Professor Steven Bell	Queen's University of Belfast	Building the Queen's University of Belfast AMR Network (QUBAN)

Co-Investigators

Queen's University of Belfast

Professor JA Bengoechea

Professor JS Elborn

Professor CP McCoy

Professor WG Graham

Professor BF Gilmore

Dublin City University

Dr N Dunne

Summary

Antimicrobial resistance (AMR) is becoming a serious health issue since the number of bacteria which are resistant to existing antibiotics is rising faster than the supply of new antibiotics. This proposal aims to encourage researchers from Engineering and Physical Sciences in QUB to engage with the AMR problem by bringing them into contact with specialist AMR researchers who are primarily located in the Schools of Biology and Medicine, Dentistry & Biomedical Science (MDBS) and are much more familiar with the issues surrounding AMR. They can also provide a clinical perspective. This will form the basis for a new Queen's University Belfast Antimicrobial Network, QUBAN. The network will focus on the Research Councils' Theme: "Accelerating Therapeutic and Diagnostics Development". We have already identified 33 researchers from across six Schools/Centres in QUB who will be obvious members of QUBAN but we anticipate, and will actively promote, further engagement from other researchers within these Schools and from the wider research community in the University. There are exciting possibilities for using our expertise in advanced materials and processing to develop novel approaches to combating AMR through use of microbicides that are not based on small molecule drugs, these range from photogenerated electrons to cold plasmas. Similarly, modifying surfaces can help in preventing infection while sensors can be used to detect infection at the early stages. There is strength-in-depth in all these areas within QUB.

QUBAN is designed to promote interdisciplinary working through a series of activities that will run throughout the 24 month duration of the programme and beyond. Important among these are the Sandpits which are planned in Months 3 and 14. The Month 3 event will be the first major forum where we will bring together interested parties from across the University to develop novel research ideas away from everyday distractions. Funding for Proof-of-Principle studies to take these projects to the level where they will be sufficiently advanced for external grant application funding will be available. This will be complemented by a parallel funding mechanism which will be an open call for smaller grants and will cover anything from buying out laboratory supervision to free up time for writing grant applications through to travel or small items of equipment. Researchers at all levels, including PDRAs and PhD students will be encouraged to become involved in QUBAN. There is a planned seminar programme but we also envisage funding short (three month) discipline-hopping visits to laboratories in other Schools/Faculties by PhD students and "Dragon's Den" competitions for PDRAs.

The programme will be driven forward by the two PIs along with a Technical Management Group who will prioritise applications for funding the Proof-of-Principle proposals arising from Sandpit events and also help to set the scientific direction to the Seminar series, poster sessions and Sandpits. In addition, we will have a high level Steering Committee who will help to set the strategic direction of the Network. This Committee will be Chaired by Prof James McElnay, the University's PVC for Research and have 3 other senior academic members. Prof Rafael Canton (University Hospital Ramon y Cajal, Spain) a world leading expert on AMR, Prof Duncan Graham (Director of the Centre for Molecular Nanometrology, Strathclyde) a leading proponent of application of physical sciences to healthcare problems, and Prof Chris Hardacre (Head of School CCE, QUB) who has extensive experience in coordinating multicentre research grants. The Steering Committee will review progress every six months against targets, outputs/pathways to impact, publications and any IPR issues that may arise, ensuring the successful investment and delivery of the BTG award.