Navigating a ‘perfect storm’ of antibiotic resistance

Professor Ramanan Laxminarayan of Princeton University questions Professor Tim Walsh

I, Researcher
Ian Thomas talks robots with Professor Rossi Setchi

What made me curious?
Alison Goddard talks stardust with Dr Haley Gomez
Welcome to the second issue of Challenge Cardiff, the research magazine for Cardiff University.

The growing resistance to antibiotics is a worldwide problem and an area where Cardiff has leading research. Professor Tim Walsh has been working in India to help tackle a gene that he discovered, called NDM 1, which passes easily between types of bacteria called enterobacteriaceae such as E. coli and Klebsiella pneumonia. It makes them resistant to almost all of the powerful, last-line group of antibiotics called carbapenems and is widespread in India. In this issue Professor Ramanan Laxminarayan, senior research scholar and lecturer at Princeton University and director of the Center for Disease Dynamics, asks Professor Walsh what we can do to tackle this growing resistance and the role his research is playing.

Robotics is another fast developing area where Cardiff is playing a leading role as part of a pan-European project. In this issue Ian Thomas, chief executive of Age Cymru, quizzes Professor Rossi Setchi on how robots are helping older people live in their own homes for longer.

Elsewhere we continue our focus on what drives our academics or makes them curious. Earlier this year, Dr Haley Gomez was awarded an ERC consolidator grant to study the origins of cosmic dust in the Universe. She explains to Alison Goddard, Editor of *HE, what led to her interest in physics and astronomy and cosmic dust in particular.

Our news section updates you on our new Research Institutes and we carry a feature on our established and highly successful European Cancer Stem Cell Research Institute. We also bring you news of our £17.3m award to underpin a Compound Semiconductor Research Foundation, the first of its kind in the UK, with potential to become one of the leading clusters in Europe.

We hope that yet more of you will come forward with ideas to challenge our academics as a result of this second issue of Challenge Cardiff. The magazine is accompanied by a series of films and podcasts on our website. Please contact challengecardiff@cardiff.ac.uk if you would like to challenge our academics on an issue that matters to you.
Research news

Cardiff achieves top five place for research excellence

Cardiff University is now among the top five universities in the United Kingdom for the quality of its research and is also ranked second for impact. The results of the Research Excellence Framework, which were announced at the end of 2014 saw Cardiff rise 17 places on the quality measure, making it the fastest rising among the leading research universities of the Russell Group, climbing from 22nd in 2008.

The University set itself an ambitious target to come within the top ten UK universities when measured on quality, or grade point average (GPA). Professor Colin Riordan, Vice-Chancellor, said: “We are an extremely ambitious and innovative University and we are not afraid to set challenging goals. Achieving this outstanding result is a testimony to the excellence and hard work of all our staff. It is part of a very clear strategic vision for the University, one that will see our reputation rise globally to the benefit of Cardiff, Wales and the UK.”

New Research Institutes given the go-ahead

As part of its commitment to developing world leading research that has an impact in Wales, the UK and beyond, Cardiff University is establishing four new Research Institutes. They will bring together academics from a range of disciplines to tackle some of the major challenges facing society, the economy and the environment.

Building on the success of the four existing research institutes in catalysis, cancer stem cells, neuroscience and mental health, and sustainability, the new institutes will focus on crime and security, data innovation, energy systems, and systems immunity.

The Crime and Security Research Institute will draw together the best research to provide innovative and effective solutions to tackle crime and emerging threats to world security. Three specific areas of strength will be brought together: community policing and cohesion, evidence-based measures to help cut alcohol-related violence, and information and communications technology to help decision-making in complex situations, including security and defence applications.

The Data Innovation Research Institute will work with research groups from across the University that are undertaking big data intensive research projects. It will find new and better solutions to data management and analysis, using new technologies and will be at the forefront of big data science. Its main aim is to establish Cardiff as the leading university in the UK for big data research.

The Energy Systems Research Institute has been designed specifically to create an integrated energy systems approach. Drawing on diverse research expertise, the Institute aims to help meet the world’s increasing demand for energy in a sustainable and socially acceptable way.

The Systems Immunity Research Institute draws together knowledge and research expertise from across the University to develop and apply new ways of studying the body’s immune system. It will apply systems biology (big data and bioinformatic/mathematical approaches) to provide a holistic view of chronic disease progression, the control of infection and the mechanisms affecting our capacity to mount an effective immune response.

Innovative cameras will help to predict potential disorder

A £1m project to develop ‘smart’ cameras that sense violence on the streets is being developed by Cardiff University researchers. Computer science and violence experts are teaming up with technology specialists from Airbus Group to develop a system that will spot trouble brewing and guide police before anyone gets hurt. The study will develop imaging technology which will automatically alert CCTV operators when fights are detected on city centre cameras.

“Smart” CCTV already exists and can count people and identify cars. But the Cardiff project will go further by analysing night time crowds to provide ‘real-time’ alerts, helping to prevent serious injury and reducing costs to health services.

Professor Simon Moore, from Cardiff University’s Violence and Society Research Group, said: “Developing ‘smart’ camera technology that can pre-predict violence is a really cost effective way of helping police to do their jobs. Officers can’t monitor hundreds of city centre CCTV cameras all the time. By using imaging technology, officers will be alerted to violence ‘hotspots’ in real-time, helping to further reduce violence. It’s a great way of using technology to make the streets safer for all of us.”

The project is a partnership between Cardiff University, Airbus Group (formerly EADS) and the Welsh Government. Airbus is developing the technological infrastructure, while the Welsh Government is providing funding.

European funding boost for Cardiff

The University has secured funding for 26 projects totalling nearly £13m (£15.8m) under the European Commission’s Horizon 2020 programme in the first year of its operation. The new projects include four awards from the highly prestigious European Research Council (ERC) ‘Consolidator Grants’ scheme. This marks the first time any Welsh university has received four such grants in one round.

The School of Physics and Astronomy secured three of the four ERC Consolidator awards to fund work by young researchers. Dr Haley Gomez will receive over £1.4m to probe the evolution of dust throughout cosmic time. Dr Oliver Williams, will receive nearly £2.2m to lead research into the superconductivity of diamond

Cardiff to be home to UK’s first compound semiconductor research foundation

A £17.3m award that will put Cardiff University at the cutting edge of semiconductor technology was announced by the UK Government in March.

Breaking technology that lies behind products such as smartphones and tablets, powering change across sectors including healthcare, biotechnology and mass communications.

The award adds to £12m already pledged by Welsh Government to support the Foundation. The funding will strengthen bonds between Cardiff-headquartered IQE plc, the leading global Compound Semiconductor wafer supplier, and the University.

Cardiff is one of seven outstanding university research projects to receive over £100m from UK Research Partnership Investment Fund (UKRPIF) in 2015-17 to drive innovation and growth.
GW4 goes from strength to strength

The GW4 Alliance of Bath, Bristol, Cardiff, and Exeter, continues to go from strength to strength.

In the latest round of funding from its Building Communities Programme, GW4 has committed over €450,000 to establish cross-institutional research communities. The programme brings together academics with complementary expertise from across the four universities to build communities focused on major research or societal challenges.

The 12 successful projects cover areas including data science, pay equality, musculoskeletal research, Alzheimer’s disease, and neurological and psychiatric disorders. This latest round of funding brings the Alliance’s total investment in grassroots research communities to over £1m.

Through the new Collaboration Lifecycle programme, GW4 aims to maximise the research activities of its research communities by providing them with support to run bespoke events facilitated by an external consultant. GW4 also looks to be a major intellectual stakeholder in the Cardiff Capital Region city deal announced by Chancellor of the Exchequer, George Osborne, in his most recent budget, and in the prospective Great Western Cities region announced by the leaders of Bristol, Cardiff, and Newport councils.

Looking to the future, the Alliance hopes to run a series of public events in Cardiff from September which will be released online as podcasts, and a major event in the European Parliament at the start of 2016.

Academic to advise EU Commissioner

A senior University academic has secured a prestigious role to advise the European Commissioner for Regional Policy, who is responsible for a €351 billion budget to boost the standard of living in some of Europe’s poorest cities and regions.

Kevin Morgan, Professor of Governance and Development, has become a special adviser to Corina Crețu, who is responsible for one third of the EU’s total budget as she seeks to reduce economic and social inequalities.

EU regional policy supports job creation, competitiveness, economic growth, improved quality of life and sustainable development to create a European Union “where people in all our regions and cities can realise their full potential”.

Mikel Landabaso, Corina Crețu’s Chief de Cabinet, welcomed Professor Morgan’s appointment. He said: “Kevin’s research work on regional innovation systems, green growth and the link between multi-level governance and development trajectories, coupled with his hands-on experience in the field, understanding policy makers’ concerns and limitations, makes him a precious asset for Commissioner Crețu’s Cohesion Policy reform agenda in line with better expanding and effective impact on the ground.”

Researchers discover asthma’s potential root cause and a novel treatment

Cardiff scientists have identified the potential root cause of asthma and an existing drug that offers a new treatment.

Published in Science Translational Medicine journal, University researchers, working in collaboration with scientists at King’s College London and the Mayo Clinic (USA), describes the previously unproven role of the calcium sensing receptor (CaSR) in causing asthma, a disease which affects 300m people worldwide.

The team used mouse models of asthma and human airway tissue from asthmatic and non-asthmatic people to reach their findings.

Crucially, the paper highlights their findings.

“Our findings are incredibly exciting,” said the principal investigator, Professor Daniela Riccardi, from the School of Biosciences. “For the first time we have found a link between airways inflammation, which can be caused by environmental triggers - such as allergens, cigarette smoke and car fumes – and airways twitchiness in allergic asthma.

“Our paper shows how these triggers release chemicals that activate CaSR in airway tissue and drive asthma symptoms like airways tightening, inflammation and narrowing. Using calcilytics, rebout DNA directly into the lung, we show that it is possible to deactivate CaSR and prevent all of these symptoms.”

Dr Samantha Walker, Director of Research and Policy at Asthma UK, who helped fund the research, said: “This hugely exciting discovery enables us, for the first time, to tackle the underlying causes of asthma symptoms. Five per cent of people with asthma don’t respond to current treatments so research breakthroughs could be life changing for hundreds of thousands of people.

“If this research proves successful we may be just a few years away from a new treatment for asthma, and we urgently need further investment to take it further through clinical trials. Asthma research is chronically underfunded; there have only been a handful of new treatments developed in the last 50 years so the importance of investment in research like this is absolutely essential.”

While asthma is well controlled in some people, around one-in-two patients respond poorly to current treatments. This significant minority accounts for around 90% of healthcare costs associated with the condition.

The study was part-funded by Asthma UK, the Cardiff Partnership Fund and a BBSRC ‘Sparking Impact’ award.
How a professor’s work with robots brings hope to older people

No longer something we read about in books or watch in science fiction films, robots are increasingly having a practical role in 21st century society. A pan-European project involving a team of researchers from Cardiff University is looking at how robotics can help people with disabilities to have a better quality of life and to keep them connected to friends and family. The project is not just about technical innovation but also involves the ethical and social aspects of the role of robotics in assisted living.

Interested in how robots are providing support to older people living in their own homes, Ian Thomas, Chief Executive of Age Cymru came to see Professor Rossi Setchi to find out more about the project. He started by asking her how she got involved in robotics research.

RS: My interest in robotics started with reading science fiction: Isaac Asimov, Arthur C. Clarke and Ray Bradbury, among others. The word “robot” itself comes from a work of fiction written 95 years ago, Karel Čapek’s play ‘RUR’. As a teenager, I never thought the future was so close and that during my lifetime I would be able to interact with robots which appear to have emotions. This happened in 2013 in Japan, at the Aging Societies in Europe and Japan Conference in Tokyo where we presented our robotics project and could interact with robots developed in Japan for assisting elderly people with dementia. The future looked very different many years before that, when I was a student at Moscow Technological University. At that time, the challenges were about developing flexible manufacturing technologies using electronics, IT and robotics. This period is now called the third industrial revolution. It is particularly exciting that we are now living through yet another industrial revolution, one inspired by developments in cyber-physical systems and artificial intelligence. Our focus is on this fourth industrial revolution, which connects people, machines, physical objects, everything from industrial equipment to everyday objects that range from medical devices to automobiles.

IT: Robotics has been around for decades, and attempts have been made before to use machines, which help with independent living. What makes your project different?

RS: Robotics technology can be deployed in a wide range of areas; some are more challenging than others. For example, industrial robotics is well established in large-scale manufacturing industries with high levels of automation. The attempt to use machines that help with independent living is a much more recent development. What makes our project different is the emphasis on improved human-robot interaction, better situational awareness and semi-autonomy. In general, robot autonomy is realised by its ability to navigate independently in the environment and in cooperation with humans or other robots. The view advocated in our project is that semi-autonomy is a safer mode of operation. This allows robots to operate in an autonomous way when completing well-defined tasks but they are controlled remotely by humans in more challenging situations.

IT: Social barriers and isolation present some of the biggest challenges faced by older people. Can a robot really help people stay in touch with family and friends?

RS: The project, which was led by Cardiff University, was initiated by a researcher at the School of Engineering, Dr Renxi Qiu, who was in the habit of Skyping his elderly parents abroad when he was suddenly unable to reach them due to a switch being turned off. He then started thinking of how he could address this kind of problem remotely, and the idea for the project was born. Based on the concept of “a butler in the house”, the robot is controlled via the internet, like a Skype-type application that in addition to enabling communication, can scan the environments and move around to bring objects, turn on switches, and open doors. The current generation of robots are human size and have two arms, one of which can hold a tray and the other which can move objects.

The robot has three different interfaces for different user groups: (i) an applet on a smart phone which is used by the person needing assistance, (ii) a tablet application which can be used by family or friends which can scan the environment if something is wrong, and (iii) a PC-based application, which is for the use of the emergency services. These interfaces can be switched off by the user at any time to protect their privacy.

Trials have already been carried out with several user groups in Germany, Spain and Italy, all of whom have been very positive and accepting of the new technology. The robot does help people stay in touch.
Across several European countries, the project involved a team of experts in computer science, engineering, sociology, and healthcare. Feedback from older people and their carers about the perceived usefulness and acceptability of the robots was incorporated in the next design cycle.

The success of the project is due to the attention to the user requirements and the extensive evaluation of the final solution involving end-users. The focus group was composed of 60 elderly people and family members who care for them from Italy, Spain and Germany. The study of the user requirements helped to define our scope and hypotheses for research. The project brought our ideas to the attention of policy makers at two important events, the Aging Societies conference, organised by the European Commission, the Delegation of the European Union to Japan, and the EU-Japan Centre for Industrial Cooperation, looked at ways to help and provide for the ageing societies in Europe and Japan. The second event was held at the House of Lords.

In addition, our research was reported in the annual UK Department of Health R&D report on assistive technology for disabled and older people and included as an example of a success story by Kay Swinburne MEP in her report EU Funding for Research and Innovation.

More research has to be done on the semantic interpretation of the environment, spoken commands, and human behaviours. More work is needed on developing effective strategies for semantic reasoning in the presence of environment or task uncertainty, and developing the ability to work interactively and collaboratively with people.

IT: When do you hope to turn this into an idea that works in the real world?
RS: Researchers at Fraunhofer IPA and our industrial partners are turning this research into applications for the real world. Several of our algorithms were implemented in the current generation of Care-bot Robots. The project brought our ideas to the attention of policy makers at two important events in Japan and the UK. The project was invited to participate in the Aging Societies in Europe and Japan conference in Tokyo. The conference, organised by the European Commission, the Delegation of the European Union to Japan, and the EU-Japan Centre for Industrial Cooperation, looked at ways to help and provide for the ageing societies in Europe and Japan. The second event was held at the House of Lords.

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IT: Do you have any plans to apply your research techniques to other issues?
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IT: What’s been your greatest challenge working on this project?
RS: In terms of project management, the greatest challenge when working with 12 partners from Europe is system integration and developing a common vision. With regard to research in robotics in general, the greatest challenge is the need for cognitive robots to be able to reason about their own performance, assess their current state, predict human intentions, and develop behaviours that satisfy ethical standards and safety.
When I explained to her that I had this opportunity, through my work at Cardiff University, to challenge a world leading expert on ADHD, she immediately came up with a list of questions.

First, she wanted to know exactly how ADHD is defined, and most importantly for her, will her child have it? It is a question that vexes her as she has found the condition debilitating, making school hard and employment almost impossible.

Professor Thapar, who was awarded the prestigious Ruane Prize for Outstanding Achievement in Child and Adolescent Psychiatric Research last year, explains that there are strict criteria covering the diagnosis of ADHD. These include very severe problems with concentration that are significantly out of proportion to a child’s age or developmental level. They also include hyperactivity and restlessness, as well as impulsiveness. “These symptoms have to be present in more than one setting,” she says. “So a child that is just disruptive at school but can concentrate at home, would not be considered to have ADHD. The symptoms have to be severe enough to impair other functions, such as learning, and their onset is in early childhood.”

The contribution of genetic risks to ADHD is one of the main focuses of Professor Thapar’s research. A practising clinician, she established and runs a well-regarded clinical service for children with complex neurodevelopmental and psychiatric disorders and was made the first Professor in Child and Adolescent Psychiatry in Wales in 1999. She vividly recalls a particular family who attended her clinic in the 1990s. “At five of the children had ADHD,” Professor Thapar says. This triggered her interest and she has subsequently worked on research projects that have found that large, rare chromosomal deletions and duplications contribute to ADHD risk and overlap with autism and schizophrenic risks.

In 2010 a study co-authored by Professor Thapar found evidence of a genetic link with ADHD by analysing DNA samples from 366 children diagnosed with ADHD, aged 5 to 17, and 1,047 without the condition. The researchers found the children with ADHD were more likely to have certain small segments of DNA either duplicated or missing than the other children. “This does not mean though,” Professor Thapar stresses, “that any child your daughter may have will automatically have ADHD. There are no single gene responsible for the condition and environmental factors also play a part, although it is very hard to say what these are. The best advice is to have a planned pregnancy, not to smoke and to eat and live healthily.”

Professor Thapar explains further. “We have come a long way in terms of understanding genetic risk but it is still very hard to understand environmental ones. They are likely to be factors in the prenatal and early postnatal environment and there is a link with prematurity and low birth weight. In medicine we know that smoking causes lung cancer; for example. But we do not have that clear evidence of specific types of environmental causation for ADHD.”

A question that has also perplexed me as a parent is why it took so long for our daughter to be diagnosed. Did the fact that she is a girl make a difference?

“It is certainly true that far fewer girls are diagnosed with ADHD than boys,” says Professor Thapar. “In the general population we estimate that there are three to four boys with ADHD for every one girl. In the clinical setting the ratio is nine to nine boys for every one girl.” She argues that there is some evidence that ADHD presents differently in boys from girls, with girls less prone to hyperactivity and more prone to inattention. As a parent I also feel that there is a lot of stigma associated with the condition. It is as if you are making excuses for your children, somehow seeking to explain away their bad behaviour by using a convenient label.

“This is one of the most difficult areas for people with ADHD,” agrees Professor Thapar. “It is a medical condition, a disorder if you like. It is not simply a ‘bad’ behaviour issue and yet it is often treated as such.”

She argues that if undiagnosed there is evidence that ADHD leads to problems with employment, relationships and even to prison as those with untreated ADHD can be impulsive and quick to anger and are judged harshly. Recent research from Sweden shows that those on medication for their ADHD were more likely to stay out of prison than those not being treated.

I ask Professor Thapar if public understanding of ADHD has improved over time. “This is one of the most difficult areas of the medical curriculum here at Cardiff University, to challenge a world leading expert on ADHD, she immediately came up with a list of questions. It is as if you are making excuses for your children, somehow seeking to explain away their bad behaviour by using a convenient label. This is probably the most striking message that I take away from this interview for my daughter.”

She is also the co-leader for the forthcoming 6th edition of Rutter’s Textbook in Child and Adolescent Psychiatry. It is also why she gives interviews like this and talks to the media. My daughter is 22 now and struggling to find work or a fulfilling way of passing her time. I wish that there were employment opportunities for her, ones that took account of her condition. ADHD is associated with low self-esteem and in my daughter’s case, she was labelled for years as having behavioural problems that were in fact a medical condition.

Research undertaken by one of Professor Thapar’s colleagues shows that in the last 50 years the rate of behavioural problems in the general population has gone up, but the rate of ADHD has stayed the same. “There is really good evidence from studies showing that poverty, parenting and adversity do lead to poor behaviour. ADHD is different.”

This is probably the most striking message that I take away from this interview for my daughter. Since that diagnosis nine years ago we have understood that she has a condition, or a disorder. She is not wilfully misbehaving. The research here at Cardiff spells that out unequivocally. The challenge, however, is to manage the symptoms in a society that shows little tolerance or understanding.

“Therapy is no single gene responsible for the condition and environmental factors also play a part, although it is very hard to say what these are.”
Research’s role in transforming child health

Schools in Wales are tackling the health and wellbeing of pupils in a way that is unique in the UK. Improving the health of teenagers can be notoriously difficult but Cardiff researchers are succeeding in gathering vital information from them and working with a network of schools to develop effective approaches. This puts Welsh schools ahead of the rest of the UK in such collaborative working.

Liz Western works on the frontline of efforts to improve the health of schoolchildren as part of the Public Health Wales team in Pembrokeshire. Her work with the Welsh Network of Healthy School Schemes dovetails with a Cardiff University project which provides evidence to schools to help them improve pupil health and wellbeing. The School Health Research Network, a partnership with Welsh Government, Public Health Wales and Cancer Research UK, includes about one third of all secondary schools in Wales. Liz challenged the University’s Professor Simon Murphy on how the research can improve children’s lives.

LW: Can you tell me about the work that you do at DECIphr (Development and Evaluation of Complex Interventions for Public Health Improvement) and how this links to the School Health Research Network?

SM: DECIphr is one of the five UK Clinical Research Collaboration public health centres of research excellence and we focus on developing and evaluating complex interventions to improve children’s and young people’s health and wellbeing. There are particular challenges in our area about generating an evidence base for what works so it’s important we collaborate with partners in practice, policy makers and the public to get evaluation studies done, and SHPN (School Health Research Network) is a natural extension of that.

LW: Why did you choose to focus on secondary schools?

SM: We were slightly pragmatic in the sense that we had a partnership with Welsh Government in our pilot study. They were conducting their Health Behaviour in School-Aged Children survey within secondary schools so we linked the launch of the network to that. In many ways, it’s a lot easier to research with older children and young people. The measures are a little more valid and reliable and they’re more cognitively able to fill in questionnaires and responses.

There are key health issues for that particular group, in particular substance misuse, the onset of alcohol use, and the potential for the onset of smoking behaviour. One particular issue that has come out for us with this round of feedback reports is issues of mental health and self harm. One of our network events for schools was particularly well subscribed because they wanted to look at that issue. Saying that, our next ambition is to move the network into primary schools, and there will be particular challenges of how you ask younger children about their health. It’s likely we will focus more on diet and physical activity issues which are more pertinent to that age.

LW: It’s a really challenging time for schools. Why do you feel they should make health and wellbeing a priority and how can the network better engage, or help us to engage, with schools that are harder to reach?

SM: It’s always a challenge to get schools to take health seriously because a lot of the key drivers, and all the league tables, are around educational attainment. I think in Wales we’re particularly lucky when you look across other parts of the UK because we’ve got a context which supports the importance of health. You can see that in the fact that health and wellbeing is one of the criteria that Estyn (the inspection body for schools in Wales) look at in their inspection or the recent [Professor Graham] Donaldson Review of the curriculum which emphasised health and wellbeing as being a key part of that. We also have a public health infrastructure, which helps to deliver the Welsh Network of Healthy School Schemes. All those things are largely absent in England so we’re ahead of the game.

I think it’s up to us to demonstrate the value of health to schools, and one of the things that the network is going to be able to do is to link health activities to longer term educational outcomes through our data linkage programme. Once you’ve got good evidence which shows that there is a potential relationship between having a healthy child in school and a healthy school environment and educational performance, then we have made the argument and you are more likely to get the hard-to-reach schools on board.

LW: The Welsh Government’s Health Behaviour in School-Aged Children survey (HBSC) is a really valuable source of comparable information at a national level over time, but how have you made this relevant at a school level and what do you see as the potential at a local authority or scheme level?

SM: We were doing a pilot this year, so we were testing out some of the processes involved in the School Health Research Network. We used the HBSC survey as an opportunity to collect data in our initial pilot schools. We used the data to provide the schools with a tailored health profile, so on all the major health outcomes associated with their pupils, be it mental health and wellbeing, experiences of bullying, smoking, alcohol use, diet, physical activity, we were able to tell each school what their school population looked like. We then benchmarked it against the national average so they could see where they were doing well and where they had some sort of distance to travel. Within that report, we also let them have information on recommended approaches to address some of those issues, and also links to various support services including Public Health Wales where they could seek further support and guidance.

From the feedback we’ve had it seems like the schools really appreciate those reports. In terms of how we hoped they would use them, I think many of the schools have been using them with all the different communities within the school, so often they have set up school health action groups and that would involve teachers, pupils, sometimes parents. Then they look at the report and decide what the most important health issues are to them and decide how they are going to address them.
Navigating a ‘perfect storm’ of antibiotic resistance

After 72 years of use in humans, antibiotics are becoming impotent.

In 1943, bacterial infections that had been death sentences — from battlefield wounds, industrial accidents and childbirth — suddenly could be cured in a matter of days, thanks to the mass production of penicillin. Other new antibiotic treatments would soon follow, and like some miracle drug they would go on to cure previously deadly infections.

But in the same way science evolved to tackle bacteria, bacteria have quickly evolved to develop defences against a range of antibiotics. Misuse and over-prescription have both played their roles in speeding up the rampant march of antibiotic resistance, which in the UK alone now causes 5,000 deaths annually. The issue lies with bacterial enzymes called beta-lactamases, which are able to conquer antibiotics such as penicillin.

In 2009, Professor Timothy Walsh’s team from the School of Medicine discovered a new type of antibiotic resistant bacteria called New Delhi Metallo-beta-lactamase (NDM-1), which has spread more rapidly across the globe than any other type of antibiotic resistance. His group then discovered that NDM-1 has significantly contaminated the Indian environment and traces of the bacteria were also identified in overseas patients being treated in UK hospitals.

Professor Walsh’s team’s work on NDM-1 resulted in a UK-wide Department of Health call to ensure that mandatory screenings were conducted on all patients arriving from overseas hospitals. Europe, South Africa and Canada also enhanced their control measures as a direct consequence of his research. Here, Princeton University lecturer, Professor Ramanan Laxminarayan, who also directs the Center for Disease Dynamics, Economics & Policy in Washington DC and New Delhi, talks to Professor Walsh about his research and what chance we have of overcoming what is fast becoming a global crisis.

“...
Tell me a bit about your research with antibiotic resistance and why it is becoming such a global problem.

Our work can be broadly divided up into three main areas: Understanding how antibiotic resistance genes spread throughout bacterial populations, and how that affects their ability to cause disease; determining the impact of antibiotic resistance in low-middle income countries; and helping to develop and assess the activity of new antibiotics.

The reason why the issue of antibiotic resistance has become so topical is that we are now experiencing infections that are untreatable - even common infections. The real game-changer came when we began to see the emergence of resistance to carbapenem (a ‘last resort’ compound, similar to penicillin) which then spread across the world. At this point, the time bomb started ticking. I’m pleased to say our early publications on NDM-1 were very much instrumental in raising global awareness of this critical clinical problem.

Can you tell me some of the lessons you’ve learned in how to communicate with policymakers?

Due to our discovery of NDM-1, we have had a lot of experience dealing with the media, government officials and research funders. The important message is to keep communications simple and always be honest. Have just three or four key points to communicate. As my old boss in London used to say: “Flash, tell ‘em once, tell ‘em twice, tell ‘em thrice”. Data are data and it does not lie; how you interpret that data is your battle. As my old boss in London used to say: “Flash, tell ‘em once, tell ‘em twice, tell ‘em thrice”. Data are data and it does not lie; how you interpret that data is your battle.

There is a tendency for policy makers, particularly in the UK, to be far too politically correct. In doing so they are nervous about singling out nations that have disproportionately contributed to the rise of antibiotic resistance. I believe it is important to be transparent and not be undermined by international and external pressures.

What inspired you to work globally, and view nationalism as having a negative impact on societies and communities?

I couldn’t care less about national identity. My dad grew up in Iran, one of my daughters was brought up in the UK, one of my daughters was brought up in the UK, and one of my daughters was brought up in the UK. I have a Dutch-Australian wife, I have a Dutch-Australian wife, and I have a Dutch-Australian wife.

What is present in Asia will undoubtedly reach our shores. Therefore, above all else, what we crave is international accountability and transparency. Up until now, we have had precious little of that. International antibiotic stewardship programmes are a must. As is capacity building in low-middle income countries underpinned with sustainability programmes to examine the burden of infections and antibiotic resistance. Additionally, unless we address the desperate plight of global sanitisation, super-drug resistance will continue to spread like wildfire throughout impoverished communities.

What part of the world is most likely to be the most important source of new infectious diseases?

If I were a betting man my money would be on South Asia. This part of the world has produced many of the world’s new mechanisms that bacteria employ to resist or destroy antibiotics. It has brewed up a perfect storm, the effects of which will be felt in every country. Environmental industrial pollution, unchecked antibiotic usage, poor sanitation, a dysfunctional health service, and a blissful unawareness of the problem, are some of the factors that have created this perfect storm. Regrettably, these are not quick-fix issues and changing them will take an enormous amount of time; and time is the one thing we do not have.

If you could choose one power to solve a global health problem, what would it be?

I would roll out our beloved NHS across the entire planet. It has many critics and often those criticisms are roundly justified. However, it was the NHS that was vital in reducing the level of UK MRSA rates from 40% to less than 8% in fewer than 20 years, an unrivalled success story that has been conveniently forgotten about. So my magic wand is to create a global NHS. The challenge, however, will be to keep it free of privatisation pervasion.

What advice would you give to Tim Walsh, 20 years younger?

If I were to change one thing, I would tell the young Tim Walsh to be braver and more adventurous; to pursue studies that are politically provocative. We often complain about not being able to reach the general public and yet, quite frankly, that is because our research is rightly perceived as boring. Create a stir and people become interested - a lesson I have only come to appreciate in the last five years.

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Research University researchers make a positive and lasting impact around the world by working across disciplines to tackle major global challenges.

Saving lives and safeguarding water

Researchers in the Hydro-environmental Research Centre in the School of Engineering recognised the need for more accurate models to predict flood risk and water quality levels for a range of extreme events. Led by Professor Roger Falconer, they integrated and refined existing models to give more accurate solutions for dam breaks and embankment breach flows. The refinements also led to the ability to simulate the effects of flooding in urban environments.

They developed the new widely-used hydro-environmental numerical model called DIVAST - Depth Integrated Velocities and Solute Transport. It is based on an earlier hydrodynamic version of DIVAST also developed by Professor Falconer. DIVAST is used by major organisations around the world on large-scale projects and, in particular, for mitigation planning against national and international risks associated with floods and water quality.

In Romania the models have been used to map flood risk over 700km of the Siret River and its major tributaries, following a major event in 2005 resulting in fatalities. In the Philippines the research is helping to map potential flood risk scenarios across the country. The models have also been used to show the viability of Sabah Al Ahmad Sea City - a major coastal waterway development in Kuwait.

Improving the response to victims of violence

According to annual figures from the Crime Survey for England and Wales (CSEW), each year approximately 1.2m female victims and 700,000 male victims disclose experiencing domestic violence.

Dr Amanda Robinson conducted a series of inter-related research projects, which extended key insights into the best responses for victims of domestic and sexual violence. She found that multi-agency partnerships are essential for improved service provision; that victims require independent support from specialist providers; and that high-risk victims require a distinctive form of service provision.

The first multi-agency risk assessment conference (MARAC) was held in Cardiff and now each year over 280 MARACs operate across the UK, responding to more than 74,000 high-risk cases of domestic violence with an associated 54,000 children.

The provision of services for victims of domestic and sexual violence has changed quite considerably during the past decade, and the evidence produced by Dr Robinson’s research has played a key role in these developments. Service delivery for victims of domestic and sexual violence is becoming more holistic, efficient, and effective both in the UK and beyond.

Three of the seven policy local databases, created and interpreted differently by many scientists. No uniform, agreed catalogue existed.

Professor Alex Gray and his team at the School of Computer Science & Informatics conducted research on the distributed data management infrastructure and associated tools for creating the Catalogue of Life. This research has led to an infrastructure that incorporates tools for preparing the catalogue and for maintaining its consistency.

Research impact

The work of Professor Jenny Kitzinger and her team in the Risk, Science, Health, and Media research group in the School of Journalism, Media and Cultural Studies, stimulated debate about the treatment of people in vulnerable and minimally conscious states.

The research included reviewing existing literature and mapping out issues and gaps from a humanities/social science perspective. The team analysed media reporting, examined the use of technologies and carried out interviews both with clinicians and over 50 families, focusing on decision-making about serious medical treatments. They also carried out an in-depth interview/ focus group study in three specialist neurological units - examining experiences of long-term care provision.

This research, conducted in collaboration with colleagues in the University of York, gave a multi-dimensional view of the profound challenges for service-users, carers, experts, informed new training materials and prompted changes in the way nurses and doctors provided care to patients in a large acute hospital in the north of England. The team also analysed the experiences of patients with brain injuries and their families and sought to understand how research on these issues can be made more accessible to patients and carers.

The Catalogue of Life

This federated database is the most complete set of species data anywhere in the world, comprising 1.6m entries. It is utilised by governments across the globe for nature conservation, import control and predicting the effects of climate change.

The catalogue is endorsed by the international VOS Co-operative, an umbrella organisation of local databases, the International Union for Conservation of Nature (IUCN), the Convention on International Trade in Endangered Species (CITES), the Convention on Biological Diversity, the Convention on Migratory Species, and similar bodies. The catalogue is utilised by governments across the globe for nature conservation, import control and predicting the effects of climate change.

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Cities and buildings of the future

The two key programmes are HTEB, a simulation software that predicts the thermal energy performance of buildings under varying weather conditions, and EEP, a software that offers a comprehensive urban modelling tool for planning and designing new urban developments, predicting energy use, CO2 emissions and the potential for collecting solar energy.

The School has distributed HTEB free of charge to many companies worldwide. Swiss architects Kopitsis Bauphysik have used HTEB in dynamic simulations of more than 100 buildings over the past 15 years, including Switzerland’s first zero energy office EMPA EAWARE.

EEP can be linked to Google Sketchup, a popular design tool, and helps city planners and other professionals make fundamental decisions on energy performance at early concept design stage. The framework was used to produce the energy consumption guidelines for the Pearl, an artificial island of residences for 40,000 people off Qatar. The latest version of EEP was used to provide low carbon plan guidance for the Ba’nan District project in Chongqing, China.

A legal framework to unite a faith

His analysis compared the laws of the 44 autonomous churches in relation to governance, ministry, doctrine, liturgy, ritual, ecumenism, property and finance. The pioneering study uncovered similarities and differences between systems, and proposed a set of shared legal principles to unite the Anglican Communion’s 44 autonomous churches and their 80 million members.

The research led to a statement of the principles of canon law compliance by its churches, and a covenant for adoption by its churches to regulate their relations. The two documents - Principles of Canon Law Compliance by the Churches of the Anglican Communion, and the Anglican Communion Covenant - have global reach. They are designed to enable Anglicanism to maintain communion between churches, and provide ‘house rules’ on divisive issues. Professor Doe’s work has led to the establishment of the Anglican Communion Legal Advisers Network and contributed to a change in perception, posture and practice in global Anglicanism.

The link between cannabis use and schizophrenia

In an analysis of existing research, Dr Stan Zammit and colleagues in the Medical Research Council Centre for NeuroPsychiatric Genetics and Genomics in the School of Medicine, examined the complex relationship between cannabis use and its long-term effects on mental health, in particular its influence on the risk of schizophrenia.

Before this research was carried out, cannabis was known to cause acute, short-term psychotic states but there was insufficient evidence supporting a relationship between cannabis and chronic psychotic disorders, such as schizophrenia.

Dr Zammit and his team discovered that individuals who used cannabis regularly had a substantially increased risk of schizophrenia compared to those who did not use the drug. The research has transformed international policy and framed the debate on cannabis use. It has influenced the UK’s Advisory Council on the Misuse of Drugs classification review, and was used to support statements made by the White House Office of National Drug Control Policy (ONDCP) in the US.

Understanding Englishness

The analysis found a growing emphasis on Englishness, with increased support for England to be recognised in the governing structures of the UK and dealt with as a distinct ‘unit.’

People who identified strongly as English were more likely to support an English parliament or English votes for English laws. The research stimulated widespread public and media debate on the status of England within the United Kingdom, including coverage across all main national quality newspapers and broadcasters.

The research directly influenced the final report of the McKay Commission, which examined the consequences of devolution for the House of Commons, and it influenced the Labour Party’s constitutional thinking.

Valuing Victorians: sharing 19th century illustrations

Professor Julia Thomas, Professor David Slipit and Dr Anthony Mandal from the School of English, Communication and Philosophy developed the Database of Mid-Victorian Illustration (DMVI), which used bespoke software tools to harness literary research and create a tagged ‘image bank’.

The database was developed on a project funded by the Arts and Humanities Research Council in which the team’s groundbreaking work in illustration studies was used to add valuable ‘mark ups’ to the images, such as geographical location, historical context and relationships between pictured characters.

Illustration was everywhere in the Victorian period but in the modern digital age, illustrations accompanying 19th century literary texts have been largely forgotten.

Following on from this work, Professor Thomas gained further funding from the AHRC for the Lost Visions project. Working with colleagues at the School of Computer Science and Informatics, Lost Visions aimed to make more historic illustrations than ever before available to the public in a searchable form.

Launched at the end of March, The Illustration Archive for the first time makes fully searchable over a million illustrations from 68,000 volumes of the British Library’s collection of works of literature, philosophy, history and geography.

Before 2008-9, the worldwide Anglican Communion had no global legal framework for its 44 autonomous churches and their 80m members.

Historically, the Communion maintained mutual ‘bonds of affection’ on the basis of shared beliefs. Cardiff researchers sought to develop a set of shared principles to bring member churches together and reduce disputes.

Work by Professor Norman Doe in the Law School first identified the need for a framework of ‘house rules’ for the Communion.

Research impact

Global demand for sustainable, low carbon energy buildings has increased. Improved energy efficiency in buildings is considered to be capable of reducing global emissions by at least 1.8 billion tonnes of CO2 (United Nations Environment Programme).

Modelling programmes developed by Professor Philip Jones in the Welsh School of Architecture are helping architects and planners to simulate the performance of buildings, large-scale developments and retrofit projects at an early stage.
As a child growing up in Barry, Dr Haley Gomez enjoyed English and drama as well as the intellectual challenge associated with the sciences. When her girls’ school couldn’t offer A-level physics, she transferred to the nearby boys’ school to pursue her interests. Now she is a senior lecturer in astrophysics, being an active member of various research council committees and referees for other fellowship applications. Yet she makes time to continue her expertise with her flair for communication to inspire pupils and teachers in Welsh classrooms. She oversees the UK part of a €3.6m EU-funded project to bring astronomy research into secondary schools and to develop new training methods for teachers. She also leads a Welsh Assembly National Science Academy project to improve science in primary schools that is focused particularly on girls in poorer communities.

“I work with a team of outreach staff to improve physics in schools, particularly for girls who don’t see university as being within their reach. What made me curious? What made me curious?”

As our interview draws to a close, Haley reflects on what she has learned from her experiences of working and studying. What advice would she give to her 16-year-old self clutching a dog-eared copy of Masters of Time? “I may get a bit too involved with the science and I feel that I have failed when I cannot solve a problem. Pushing yourself helps you to work hard but, if I could go back in time, I would advise my younger self not to take it too personally when things don’t work out,” she says.

“I was awarded an ERC consolidator grant to study the origins of cosmic dust in our Universe. Cosmic dust is responsible for halving half of all starlight since the Big Bang from telescopes like Hubble. This obscured starlight is re-emitted in a region of the electromagnetic spectrum that is still relatively unexplored. The Herschel Space Observatory provided a unique opportunity to resolve this using the 90% of dust too cold to be detected before as previous telescopes were designed to detect light at shorter wavelengths. Data from only a small fraction of the largest survey of the sky carried out with Herschel has been exploited. During the next five years I aim to unravel the dust and gas content of galaxies over cosmic time by using this rich dataset.

“I will produce the first statistical census of dust in galaxies, tracing dust to earlier cosmic epochs than previously possible. I aim to go all the way back to when the universe was only half its age. The ERC award is a fantastic opportunity to have long-term support to reach these goals. It will allow me to build a large group of students and postdoctoral assistants to tackle these problems and will make a real difference to the field. To be one of the 392 researchers awarded a Consolidator grant this year is a huge privilege and best of all, there are three of us who received this award in the School of Physics and Astronomy at Cardiff University, so we can all support each other during the next five exciting years.”
Research Institute focus

European Cancer Stem Cell Research Institute

Five years ago scientific opinion was divided on the existence of stem cells. Today there is a growing consensus that these cells provide vital clues to the development of cancers and their treatment. Cardiff University is poised to take treatments to a new and personal level.

Cancer is the most common cause of death in the UK. Although five-year survival rates for many tumour types are slowly improving, we still do not have effective therapies for all tumours and we still do not properly understand the processes that underlie resistance to therapy and tumour relapse. Furthermore, for some tumours (such as some of the pancreas) our understanding of how to treat patients is so limited that they are currently virtually untreatable. There is a plethora of unmet clinical needs relating to better cancer diagnosis and treatment.

The European Cancer Stem Cell Research Institute was set up to tackle these challenges by focusing on the concept of the ‘cancer stem cell’. The Institute is the only centre in Europe completely focused on cancer stem cell research. With the support of its patron, Sir Terry Matthews, it was launched on the international stage via a major scientific conference held at the Celtic Manor Resort, Newport in July 2013. Two years on, it is recognised as an internationally renowned ‘Centre of Research Excellence’, having gained leading national status as the Cancer Research UK Cardiff Centre in a highly competitive funding round.

The Institute’s main focus - the ‘cancer stem cell concept’ - is a high risk/high gain research area complementary to, but quite distinct from, existing basic research and clinical strengths within Cardiff University. Cancer stem cell research was regarded as ‘high risk’ back in 2010. At that time the scientific field was split into two clinical strengths within Cardiff University.

The Institute’s main focus - the ‘cancer stem cell concept’ - is a high risk/high gain research area complementary to, but quite distinct from, existing basic research and clinical strengths within Cardiff University. Cancer stem cell research was regarded as ‘high risk’ back in 2010. At that time the scientific field was split into two camps: those advocating the existence of cancer stem cells and those opposed to this concept. However, there have been significant changes over the last five years -

“One of the Institute’s key goals is therefore to develop novel therapies that target the cancer stem cell”

Professor Alan Clarke

Professor Alan Clarke said: “Conventional therapies are, on the whole, successful at reducing tumour size, but may lead to relapse of the tumour if the cancer stem cells are also not killed. One of the Institute’s key goals is therefore to develop novel therapies that target the cancer stem cell and then (critically) use these in conjunction with conventional approaches to coincidentally ‘de-bulk’ the tumours and kill the cells that would drive relapse.”

The Institute provides a state-of-the-art research environment for senior academics, research fellows and postgraduate students to interact. New early-career research fellows have been recruited to work alongside world-leading teams in basic biomedical science and drug development to create a UK-based hub of research excellence to target cancer.

There has been rapid technological development in the Institute’s capacity to extract and indefinitely grow cancer stem cells in a laboratory setting which is revolutionising the utility of these cells. This is now opening up possibilities for the development of tailored therapy (known as ‘stratified’ or ‘personalised’ medicine) which is predicted to change the landscape of both research and therapy over the coming years. The cancer stem cell concept offers a new approach to the treatment of cancer that has wide-ranging implications. The challenge for the Institute is to tackle these issues and, ultimately, the objective is to transform the survival rates for patients suffering from a range of cancer types.


The ten research teams and their themes

1. Professor Alan Clarke - Studying the relationship between stem cells and cancer
2. Dr Matt Smalley - The different behaviour of cells within an individual tumour in response to therapy, including whether cancer stem cells can be continually formed over the life of a tumour
3. Dr Neli Rodrigues - Haematopoietic stem cells (rare cell types harboured in adult bone marrow) and cancer stem cells in leukaemia
4. Dr Richard Clarkson - Targeting the causes of metastatic disease - identifying novel therapeutic strategies to eliminate or modify the cancer cells responsible for the spread of tumours around the body
5. Dr Joaquin de Navascues - Neutral competition during intestinal homeostasis (how the intestine maintains its equilibrium) and repair and its impact in early tumour formation
6. Dr Liming Gui - Uncovering the similarity between early embryonic development and the initiation of cancer
7. Dr Catherine Hogan - Understanding how tumours initially establish themselves and colonise within normal tissues
8. Dr Lee Parry - Understanding the interactions that link the environment, via diet and gut bacteria, to cancer
9. Dr Gail Gaskell - Exploring the origin and evolution of cancer stem cells in primary and metastatic skin cancers and their role in disease recurrence
10. Dr Florian Stiebzelgruber - Understanding molecular mechanisms that allow cancer cells to regrow into new tumours after therapy, particularly in cancers of the brain (glioblastoma)
To find out more about the impact of our research go to www.cardiff.ac.uk/research

To request a copy of Challenge Cardiff in large print format contact Laura Hodges on 029 2087 0298, email HodgesL1@cardiff.ac.uk

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