

CHALLENGE

CARDIFF



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



Navigating a 'perfect storm' of antibiotic resistance

Contents

03 A welcome from the Vice-Chancellor

04 Research news

A round-up of our research highlights

Challenge Cardiff



I, Researcher

08 *Ian Thomas talks to Professor Rossi Setchi about her work with robots*

11 Ain't misbehavin'

Claire Sanders interviews Professor Anita Thapar about her research into ADHD

14 Research's role in transforming child health

Liz Western talks to Professor Simon Murphy about how schools in Wales are tackling pupil health and wellbeing in a way that is unique in the UK

17 Antibiotic Resistance

Professor Ramanan Laxminarayan discusses the global problem of superbugs and antibiotic resistance with Professor Tim Walsh

20 Research impact

From sustainability to mental health, find out how our research is making an impact

24 What made me curious?

Alison Goddard asks Haley Gomez about what piqued her curiosity in astrophysics

26 Research Institute focus

European Cancer Stem Cell Institute

Cardiff achieves top 5 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.

Read more 04



05



Improving the health of teenagers

14



A selection of case studies on how research at Cardiff University is making a difference

Research impact **Read more 20**



Welcome to the second issue of Challenge Cardiff, the research magazine for Cardiff University.

The magazine places the users of research at its heart. After the publication of the first issue we encouraged users to come forward with ideas, challenges and questions. The response was gratifying and we have included as many of the ideas as we could in this issue. Others will appear in future issues.

Our cover story on tackling antibiotic resistance worldwide reflects Cardiff's standing as an international university. It reinforces our success in the 2014 Research Excellence Framework where we came fifth for research excellence and second for impact, meaning that our research changes people's

lives here in Wales, nationally and internationally.

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 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 pinpoint 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.

Fights on the street cost the taxpayer millions of pounds each year. The Home Office estimates that an average violence incident costs more than £33,000 in NHS and criminal justice costs, lost working hours, and the impact on victims.

The project grew out of original research work carried out by Kaelon Lloyd, a PhD student in the University's School of Computer Science and Informatics.

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

films and superconducting quantum devices. And Dr Mark Hannam will receive nearly £1.6m for his team's work on mapping gravitational waves from collisions of black holes. The fourth ERC Consolidator award of £1.5m was won by Professor Chris Chambers in the School of Psychology to research cognitive control training.

Horizon 2020 started on January 1st 2014 and will run for seven years. With a budget of just under €80 billion, it is the largest ever research and innovation funding programme in the EU.

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.



The funding will underpin the Compound Semiconductor Research Foundation – the first of its kind in the UK, with potential to become one of the leading clusters in Europe.

The Foundation, earmarked for the University's Innovation Campus, will drive the testing and development of ground-

breaking technology that lie behind products such as smart phones 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 2016-17 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 Cretu, 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 Landabasso, Corina Cretu's Chef 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 Cretu's Cohesion Policy reform agenda in line with better expending and effective impact on the ground."



Researchers discover asthma's potential root cause



Scientists 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), describe 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 the effectiveness of a class of drugs known as calcilytics in manipulating CaSR to reverse all symptoms associated with the condition. These symptoms include airway narrowing, airway

twitchiness and inflammation - all of which contribute to increased breathing difficulty.

"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 airway twitchiness, inflammation, and narrowing. Using calcilytics, nebulized directly into the lungs, 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-twelve patients respond poorly to current treatments. This significant minority accounts for around 90% of healthcare costs associated with the condition.

According to Cardiff Professor Paul Kemp, who co-authored the study, the identification of CaSR in airway tissue means that the potential for treatment

of other inflammatory lung diseases beyond asthma is immense. These include chronic obstructive pulmonary disease (COPD) and chronic bronchitis, for which currently there exists no cure. It is predicted that by 2020 these diseases will be the third biggest killers worldwide. Professor Riccardi and her collaborators are now seeking funding to determine the efficacy of calcilytic drugs in treating asthmas that are especially difficult to treat, particularly steroid-resistant and influenza-exacerbated asthma, and to test these drugs in patients with asthma.

Calcilytics were first developed for the treatment of osteoporosis around 15 years ago with the aim of strengthening deteriorating bone by targeting CaSR to induce the release of an anabolic hormone. Although clinically safe and well tolerated in people, calcilytics proved unsuccessful in treating osteoporosis.

But this latest breakthrough has provided researchers with the unique opportunity to re-purpose these drugs, potentially accelerating the time it takes for them to be approved for use on asthma patients. Once funding has been secured, the group aims to be trialling the drugs on humans within two years.

"If we can prove that calcilytics are safe when administered directly to the lung in people, then in five years we could be in a position to treat patients and potentially stop asthma from happening in the first place," added Professor Riccardi.

The study was part-funded by Asthma UK, the Cardiff Partnership Fund and a BBSRC 'Sparking Impact' award.



I, Researcher

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.

Challenge Cardiff

IT: How did you go about shaping the project at the beginning with feedback from older people?

RS: The project involved a team of experts across several European countries. The partners included not only technical engineering experts such as our team at Cardiff, together with Fraunhofer IPA, Germany but also psychologists, sociologists, and healthcare professionals, along with companies such as Hewlett Packard, Robotnik and Profactor.

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 as monitoring and managing emergency situations, and helping with reaching, fetching and carrying objects that are too heavy or positioned in unreachable places. Tasks involving direct physical contact between the person and the robot were not included in the final solution.

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.

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.

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*.

IT: Do you have any plans to apply your research techniques to other issues?

RS: A related problem we work on with Professor Tony Bayer from the School of Medicine is early detection and diagnosis of dementia. The techniques we develop



are based on using the clock drawing test (CDT), which is a well-known cognitive assessment test for assessing patients' mental acuity by having them draw an analogue clock face. We have developed an intelligent system, which analyses clock drawings and assesses them as normal or abnormal, and could be used by clinicians for early detection of mild dementia. The classification accuracy of our tool is over 89%.

We have also published research on semantic life story books, which were developed for people who find reminiscence therapy helpful. Our system facilitates access and retrieval of stored memories used as the basis for positive interactions between elderly and young, and especially between people with cognitive impairment and members of their family or caregivers.

We are also working on developing an early response medical system that could save thousands of lives and prevent disabilities. The EmerEEG system is a portable medical device for the early diagnosis and treatment of traumatic brain injury (TBI). The idea is to bring TBI detection and early treatment methods to the scene of an accident.

IT: Are you looking for financial backers - or are you developing this as an 'open innovation' idea?

We are always looking for research funding. Our current research portfolio in the area of artificial intelligence and robotics includes work on intuitive interaction, artificial curiosity, computational imagination, and social robotics. The right financial backing can help us turn what might once have seemed like science fiction into today's cutting-edge innovations.

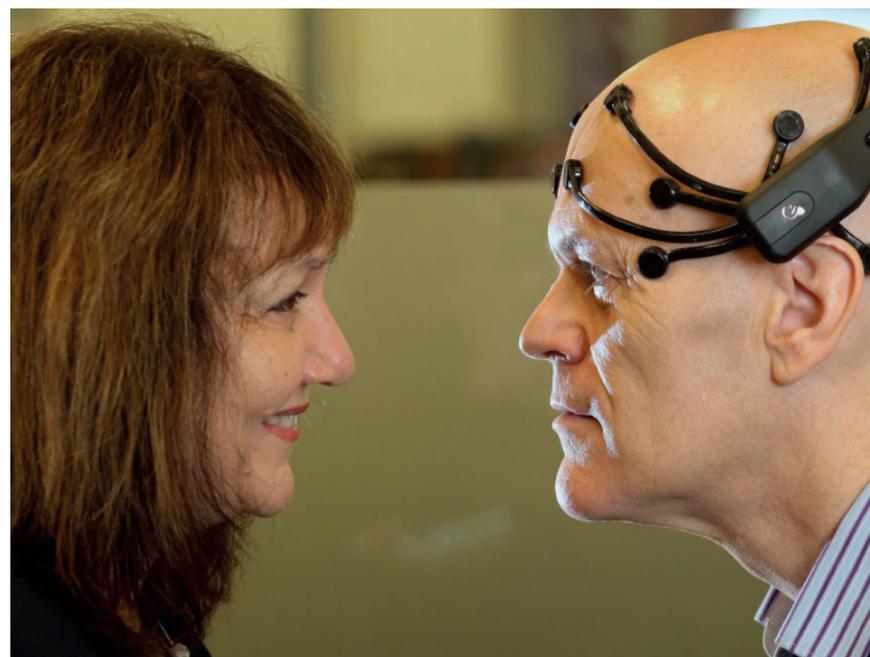
Ain't misbehavin'

Claire Sanders has a daughter with severe ADHD who was 13 before she was diagnosed. Here she interviews Professor Anita Thapar about her research into ADHD and asks about the balance between genetic and environmental causes of the condition, and the treatments available.

For many parents the diagnosis of ADHD, or attention deficit/hyperactivity disorder, comes as a relief. This was certainly the case for us. Our daughter was a young teenager at the time and had undergone a series of tests at the Maudsley hospital in South London to try and understand what were widely described by teachers and health professionals alike as behavioural problems.

She finds it hard to concentrate, is often dreamy and tends to flit from one activity to another. Our daughter also suffers from frustration and outbursts of anger. She had been seen by an educational psychologist in primary school who thought she was just a little unfocused, and later referred for a brain scan to check for mild epilepsy - such were her lapses in concentration.

The diagnosis of ADHD made perfect sense. It helped us as a family to understand and support our daughter better. An adopted child, I had often attributed her lack of focus to a form of post traumatic stress disorder, the result of six years of neglect as a small child. But the doctors were clear that her ADHD predated this.



“There 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.”



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 wants to know what exactly ADHD is and, most importantly for her, will her children 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 hyper activity 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 focusses 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. “All 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 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. 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 find it 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 eight 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 left 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 lags behind the understanding of those with autism or schizophrenia. “I believe it does,” she replies. “There is evidence that the condition is both underdiagnosed and little understood in the UK and Europe more generally. In the States, there is under- and over-diagnosis.”

There also seem to me to be limited treatment options, certainly in the area of England where we raised my daughter. Indeed the mental health services are lamentable. It is also the area my daughter has most questions about. Prescribed Ritalin by the Maudsley she went through a transformation at school, with teachers commenting that for the first time she could make progress in class and that her

confidence grew. But the Ritalin and later Concerta had side effects.

“Why couldn't I sleep on it and why did I lose my appetite? Did it stunt my growth?”

Professor Thapar agrees that these are well known side effects of the drugs, which are only given in the most severe cases and have to be monitored carefully. There is limited evidence that growth can be stunted, although equally there is evidence that by coming off the drug for a couple of months children undergo growth spurts. “Studies do not show any long term impact on a child's eventual height”, she says.

My daughter stayed on the medication for two years before deciding the side effects outweighed the benefits. The situation was difficult as we had to travel to the Maudsley for monitoring the medication, and as we lived near Cambridge this was difficult.

I ask Professor Thapar why mental health support is so patchy across the UK, best practice and latest discoveries do not, in my experience, always make their way into GPs' surgeries. “This is one of the real challenges for academics like myself,” she says.

Professor Thapar oversees the content of child and adolescent psychiatry in the medical undergraduate curriculum here at Cardiff University, so hopefully the University is producing a new generation of young doctors that really understand the condition.

She is also the co-lead 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.

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 DECIPHer (Development and Evaluation of Complex Interventions for Public Health Improvement) and how this links to the School Health Research Network?

SM: DECIPHer 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 SHRN (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.



“If I had to sum it up, it would be that schools felt that they were being researched *with* rather than *on*. It’s very much a partnership with schools, local authorities and Public Health Wales, so that together we’re setting the research agenda.”

Navigating a ‘perfect storm’ of antibiotic resistance

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



Professor Ramanan Laxminarayan discusses the global problem of superbugs and antibiotic resistance with Professor Tim Walsh

LW: We work in a climate that’s data driven, do you believe in the adage that what gets measured gets done and, if you do, how would you like to see schools using these reports?

SM: I think that’s right. It’s becoming even more of an issue with reduced resources and having to make decisions about where they are used. If we are able to provide evidence which shows some effect through the evaluation studies we will conduct in the network, but also long-term monitoring of data, of programme implementation, all those things are useful for securing resources. I think the linking of health and attainment data is going to be the key one because that will open up a lot of doors in securing or maintaining resources and investment.

How schools should use the reports? I think probably the health action groups are a good way forward in doing that. Ultimately they should use them in the best way they see fit. There should be some sort of flexibility around it. We have got an event where we

are pulling together all the different schools so they can share best practice. One of the ideas is that the partner schools in particular areas might work together to identify ways that work for them.

LW: How would you hope that the setting up of the network will impact on school health research?

SM: If I had to sum it up, it would be that schools felt that they were being researched *with* rather than *on*. It’s very much a partnership with schools, local authorities and Public Health Wales, so that together we’re setting the research agenda. The best research questions are the ones that are developed in collaboration with the very people that the research affects, so the young people themselves, the teachers and the parents.. We also get better interventions that we produce together and stronger studies in research ready schools, because if academics are dreaming them up on their own, they’re not going to fly when you get to the chalk face.

LW: How would you like to see the network develop over the next five years?

SM: The ideal is having something like clinical research networks and evidence-based medicine. I know that doesn’t always happen in the way that it’s supposed to, but it’s a model that I would like to see within schools so that you would have more research practitioners, so people that understood evidence could apply it to practice more. You would have research specialist schools that could be areas of innovation and piloting of innovation, and research and evaluation become an integral part of everyday practice. That’s a whole big cultural change. It’s going to take a little while but within Wales we have the context, we have the partnerships and the infrastructure that really can make that happen so it’s exciting times for the future of the network.

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 had 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 and upgraded 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.



“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.”

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 carbapenems (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 another issue altogether and sometimes, for example, we came under enormous pressure to dampen down the impact of our studies, which I am grateful to say we never did.

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 unnerved by international and external pressures.

What inspired you to work globally, and not just in the UK?

I have never seen my work as UK or European-centric. Maybe this is due to my upbringing; I have a Dutch-Australian wife, my mother’s side of the family is Spanish, my dad grew up in Iran, one of my daughters is Chinese and I grew up in Tasmania. I couldn’t care less about national identity and view nationalism as having a negative impact on societies and communities. Nor does it have a place in science.

Fortunately, working on antibiotic resistance provides a perfect opportunity to work with many international groups. In the UK, all

recent antibiotic resistance mechanisms have been imported, usually from Asia, and thus it makes perfect sense to undertake studies in that part of the world where resistance is most prevalent. What is present in Asia will undoubtedly reach our shores.

Our research group has 22 active international collaborations from Brazil to China and Libya to Iraq. Our recent research programme, BARNARDS, is the first of its kind to be funded by the Bill and Melinda Gates Foundation. It addresses the clinical burden of infections and antibiotic resistance on infants in Pakistan, Bangladesh, South Africa, Nigeria and Rwanda. I would like to believe that what we have started will be merely the beginning of something truly powerful and, maybe, historic.

In terms of research into drug resistance, whose work most inspires you and why?

To answer this question, I will choose one deceased and one living.

The first of these is Andrei Dmitrievich Sakharov, a Russian physicist and Nobel Peace Prize Winner who sadly died in 1989. During his outstanding career, often in exile, he wrote the works *Reflections on Progress, Peaceful Coexistence, and Intellectual Freedom, 1968* where he offers the following: “[...] *intellectual freedom is essential to human society – freedom to obtain and distribute information, freedom for open-minded and unfearing debate and freedom from pressure by officialdom and prejudices. Freedom of thought is the only guarantee of the feasibility of a scientific democratic approach to politics, economics and culture*”. These words became an inspiration for me during the media storm surrounding our NDM-1 studies in India.

The second is to whom I affectionately regard as my surrogate father, Professor Fernando Baquero, from Madrid. He is an outstanding philosopher and scientist, and has explored the evolution of antibiotic resistance and the factors that really drive it. Despite being blessed with a brain the size of Pluto and one of the global-leading thinkers on antibiotic resistance, he is a diligent student of history, languages and art. And perhaps, more importantly, he is unfailingly gracious, humble and generous – a lesson for us all.

Are you optimistic that developed and developing countries will together be able to tackle multi-drug resistance before it gets entirely out of hand?

Britain’s Chief Medical Officer, Sally Davies, and Prime Minister David Cameron have championed the message of antibiotic resistance across Europe and leading from the front. Will it help? Probably. Will it solve the problem of multi-drug resistance? No.

In responding to a globally critical scenario, for the first time in decades, there is now increased political traction and with it funding into the front end of the problem i.e. antibiotic development. However, it seems particularly pointless, and even wasteful, to develop a new group of precious drugs if they are going to be used like sweets in other parts of the world.

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 sanitation, 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, medical tourism 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 avant garde; 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.

Research impact

Cardiff 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



There's a critical need for accurate and reliable models to predict the movement of floodwater, and its contents. NASA's Earth Observatory estimates two billion people are likely to be vulnerable to flooding by 2050. Research from Cardiff is already helping predict flood risk, from Somerset to Kuwait and from Romania to the Philippines.

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 now 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 end of life decision making

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 vegetative 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 at the University of York, gave a multi-dimensional view of the profound challenges for service-users, care-providers and policy makers, and identified gaps and tensions in clinician-family communication, media representation and the surrounding public, legal, professional and policy debates.

It influenced the Royal College of Physicians' working party revising the College's treatment



guidelines. It generated interest from stakeholders, including medics and policy experts; informed new training materials and prompted changes in thinking among clinicians.

This on-going research has been turned into a half-hour programme

on BBC Radio 3 and was cited in the House of Lords report on the Mental Capacity Act 2005, supporting recommended change. It was a runner-up in the research impact category at the Guardian University Awards 2015.

Transforming The Mabinogion

Regarded by many as one of Wales' greatest contributions to European literature, The Mabinogion is a rich mix of Celtic mythology and Arthurian romance captured by anonymous authors in 11 tales.

Its translation into English by Professor Sioned Davies has not only enhanced public understanding of the text but has led to new performances and inspired a series of modern stories.

Her detailed re-examination of the text has enabled modern audiences to understand how it

would have been understood by medieval listeners and, crucially, performed. A rich collection of explanatory notes and indices has helped to enhance the reader's understanding of this ancient text.

Professor Davies' translation has led to a revival of the practice of telling the *Mabinogion* by contemporary storytellers, encouraged by a series of highly successful workshops. In addition, Seren Books commissioned award-winning authors to reinvent the original stories in a series entitled *New Stories from The Mabinogion*, inspiring such stories as *White Ravens* by Owen Sheers and

The Meat Tree by Gwyneth Lewis. The translation has also been the source for children's books such as Margaret Isaac's *Arthur and the Twrch Trwyth* (2012) and Daniel Morden's *Tree of Leaf and Flame* (2012).

In addition, the translation has been used to develop tourism trails such as the Twrch Trwyth Trail in Cwmaman. A *Mabinogion* web portal and mobile app is being created in collaboration with the Pembrokeshire-based SME Writemedia Partnership to guide users to designated *Mabinogion* sites.



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 provided 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 94,000 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 objectives listed in the 2008 UK Government report 'Saving Lives, Reducing Harm, Protecting the Public' used evidence from Dr Robinson's research. The impact of Dr Robinson's research can also be observed in the most significant pan-European policy document to come out on this topic for decades: the Council of Europe's 2011 *Convention for Preventing and Combating Violence Against Women and Domestic Violence*.

The Catalogue of Life



The loss of biodiversity is an issue of global concern, and has prompted global campaigns to halt the rate of species extinction.

A major hurdle in any initiative was the lack of any form of definitive list of the world's species. Species data were scattered across hundreds of 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.

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 UN Convention on Biodiversity (CBD). It is the world's most authoritative source of peer-reviewed information about the names (Latin scientific names and common names) of the world's species of plants, animals, fungi and micro-organisms.

Its coverage has extended from 600,000 species in the late 1990s to 1.6m species now. It was used in the preparation of the IUCN (International Union for the Conservation of Nature) Red List to check information about species being added to the endangered species list.

Cities and buildings of the future

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 Phillip 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.

The two key programmes are HTB2, 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 HTB2 free of charge to many companies worldwide. Swiss architects Kopitsis Bauphysik have used HTB2 in dynamic simulations of more than 100 buildings over the past 15 years, including Switzerland's first zero energy office EMPA EAWAG.



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 master plan guidance for the Ba'n'an District project in Chongqing, China.

A legal framework to unite a faith



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.

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 common to its churches, and a covenant for adoption by its churches to regulate their relations. The two documents - Principles of Canon Law Common to 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

Led by Professor Richard Wyn Jones, researchers at the Wales Governance Centre worked with the University of Edinburgh and the Institute for Public Policy Research (IPPR) to study the place of England and Englishness in the UK through the 'Future of England Survey', first conducted by YouGov in July 2011. There have now been three 'Future of England Survey' reports, the latest of which was launched in October 2014.

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

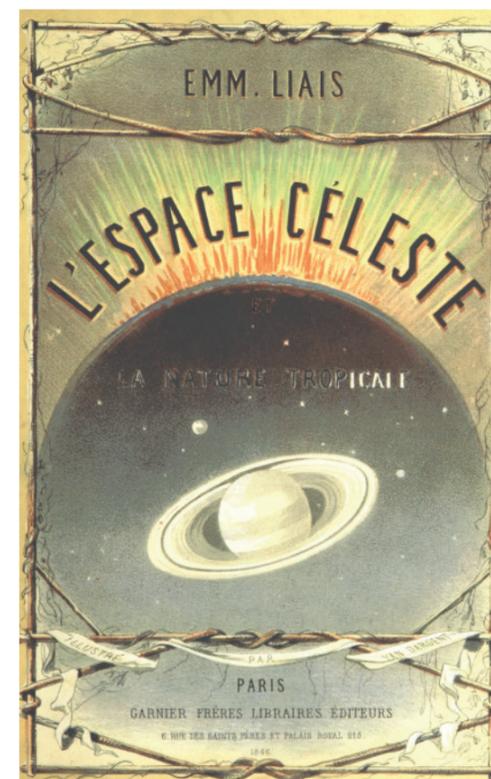
Illustration was everywhere in the Victorian period but in the modern digital age, illustrations accompanying 19th century literary texts have been largely forgotten.

Professor Julia Thomas, Professor David Skilton 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 ground-breaking 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.

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.



What made me curious?

Alison Goddard, Editor of *HE, spoke to Haley Gomez about what piqued her curiosity in astrophysics and fired her ambition to communicate its findings.

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 the School of Physics and Astronomy, she retains her flair for communication: she is also head of public engagement and outreach at the School. When she's not conducting research into stellar dust or lecturing in astrophysics, she's inspiring the next generation of pupils and teachers in Welsh schools.



by Philippa Gedde

Asked what inspired her to become an astrophysicist, Haley Gomez identifies her school experiences. A maths teacher called Hugh Griffiths recommended that she read a book called *Masters of Time* by John Boslough, a science journalist. It contains a description of Vera Rubin, an American astronomer who discovered the first evidence for the existence of dark matter, and Haley was hooked.

"Vera Rubin was very interesting to me. She was the only astronomy major in her class when she did her degree at Vassar. She went to Cornell and then she had to go to Georgetown to do her PhD because women couldn't do astronomy at Princeton. She loved stars and she was looking at the way they rotated around the centre of our galaxy, and she identified that they were rotating too quickly for the gravitational pull of visible matter. So she proposed that there must be dark matter, which would explain the rate of rotation."

Almost four decades later, Haley herself was facing similar difficulties in pursuing her subject of choice. She attended a girls' school in Barry but it did not offer A-level physics so, instead, she had to go to the boys' school.

"The boys my age were fine and I have an older brother. But the younger boys got quite vocal. They acted like they had never seen a girl and it was intimidating to go into the corridor. It is more of a shock now, as an adult, to realise how few women scientists there are."

Reading about Vera Rubin inspired Haley to follow her dreams. It also fuelled her inclination to work hard at the subjects she found difficult. Haley's stellar performance was fired by long hours of study.

"Rubin didn't find it easy being a woman in a male-dominated environment. But she did something that was so simple and so clean and so wonderful. What made her different was that she was very open about how much hard work she had to do to achieve this, and the power of her resolve has always stayed with me. At school I preferred studying English and drama, but I found science more challenging. It was interesting enough that I really worked at it and I got better marks than in any other subject. A teacher told me that, if you do maths and physics, you can do anything you want. So that is what I did."

As the first person in her family to go to university, Haley was unsure of whether it would be the right choice for her. But after she had completed her A-levels, a spell on work placement at the University convinced her to enrol in higher education.

"Both my parents left school aged 11 and my mum had three children by the age of 21. They had a hard time in looking after us. I went to a tough school but the teachers were inspirational. After A-levels I did a work placement at Cardiff University with Professor Sathyaprakash in physics and

astronomy, undertaking a small project. I loved it."

After graduating with first-class honours from her four-year MPhys programme, Haley embarked on a PhD in astrophysics, examining the distribution of cosmic dust from massive exploding stars called supernovae. This stardust helps to form planets and the building blocks of life.

"Cosmic dust is a nuisance to astronomers because it blocks out optical light, obscuring the view. But it is very important because dust affects star formation, the formulation of molecular hydrogen and of planets. Recent work hints that the explosion of supernovae may produce a lot more dust than was previously thought. This is especially important in the early universe, where fast-lived, massive stars would be the only source of dust."

Her PhD was judged to be the best UK doctoral thesis in astronomy and astrophysics in 2005, in a competition run by the Royal Astronomical Society. Haley was then awarded a research fellowship by the Royal Commission of the Exhibition of 1851.

"Because of that, I received an invitation to Buckingham Palace to present my research to Prince Philip and various politicians. I had three minutes to present my work. My husband was there (we met at university) and Prince Philip initially assumed that he was there to talk about his work. Afterwards we drank wine in the piano room."

Now Haley is going from strength to strength. In July she is due to be awarded the Royal Astronomical Society's Fowler prize, which is given to an astronomer who has "made a particularly noteworthy contribution to the astronomical sciences at an early stage of their research career". The citation describes her as being an internationally respected researcher who has published more than 75 refereed journal papers in the past ten years. She is also busy supervising PhD students, lecturing in astrophysics, being an active member of various research council committees and refereeing for other fellowships. Yet she makes time to combine 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 for them. The parents are the ones who change their minds when they are presented with ideas. It is the parents who say, "I didn't know my daughter could work for Corus or

go to CERN, the European particle physics laboratory outside Geneva."

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 maybe 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.

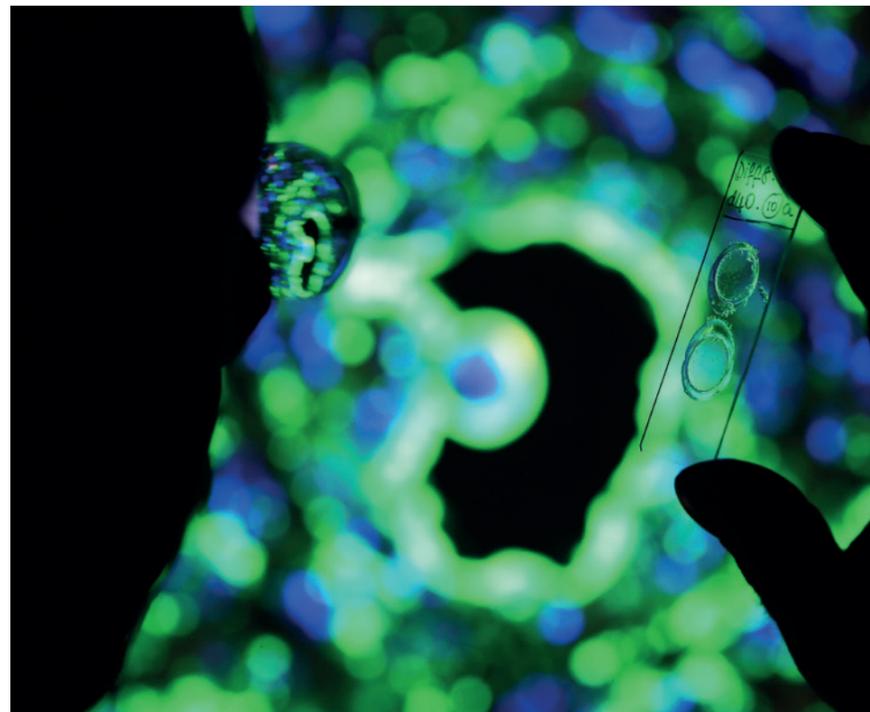
"I was awarded an ERC consolidator grant to study the origins of cosmic dust in our Universe. Cosmic dust is responsible for hiding half of all starlight since the Big Bang from telescopes like Hubble. This obscured starlight is re-radiated in a region of the electromagnetic spectrum that is still relatively unexplored. The Herschel Space Observatory provides a unique opportunity to resolve this by revealing the 90% of dust too cold to be detected before as previous telescopes were designed to detect light at shorter wavelengths. To date only a tiny 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 up 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 372 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."

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 UK¹. 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 those 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,

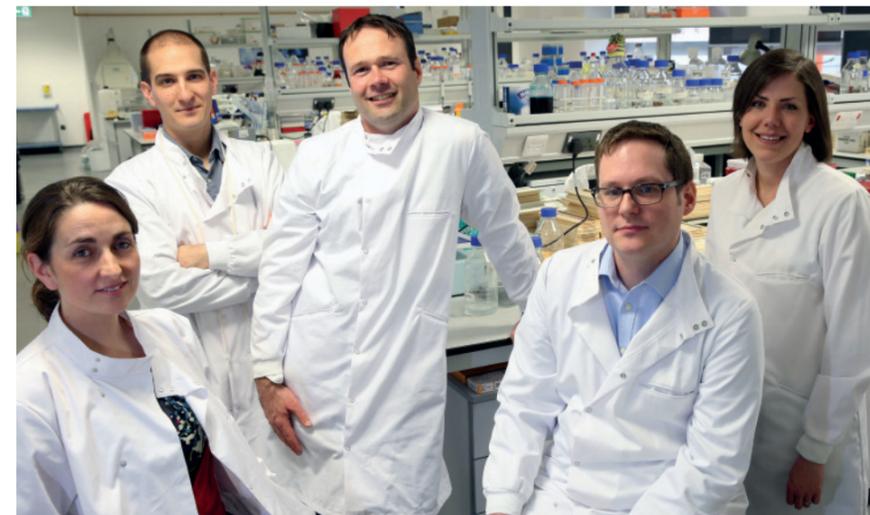
it was launched on the international stage via a major scientific conference held at the Celtic Manor Resort, Newport in July 2013. Two years on, it is recognised as an internationally renowned 'Centre of Research Excellence', having gained leading national status as the Cancer Research UK Cardiff Centre 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 camps: those advocating the existence of cancer stem cells and those opposed to this concept. However, there have been significant changes over the last few years –

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

namely the publication of a series of high impact scientific papers which provide growing evidence of cancer stem cells.

These cells offer the potential to transform the way that cancer is tackled. There is evidence that they play a key role in the creation and growth of tumours, and the way they spread around the body. If this is correct, it may be possible to treat cancer more effectively by focusing therapy at the stem cell, rather than all the cells in the tumour, as current treatments do.



Institute Director, 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.

¹Source: Office for National Statistics www.ons.gov.uk/ons/dcp171778_381807.pdf

Notable achievements/ Key developments

- Deputy Director Dr Matt Smalley is leading one EU (Horizon 2020) Consortium and is a partner in another.
- Dr Richard Clarkson is the lead researcher from the Institute in a team that has developed the first commercial novel anti-cancer stem cell agent capable of targeting aggressive tumour cells originating from the breast, pancreas, colon and prostate in collaboration with Tiziana Life Sciences.
- The Institute has been successful in securing a number of substantial philanthropic donations, most notably six-figure gifts from the Jane Hodge Foundation and Amser Justin Time.
- September 2014 saw the Institute host the Symposium: Tumour Heterogeneity and Stratified Medicine with 150 attendees listening to 20 speakers during the two-day event. Comments such as “was one of the most enjoyable I have been to, great mix of speakers and a real buzz” helped to secure the Institute’s reputation as an international powerhouse in this research field.
- Since its inception, the Institute has recruited an international team of Research Fellows, post doctoral researchers and PhD students from over 15 different countries.

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 Neil 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 Joaquín de Navascués** - 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 Girish Patel** - Exploring the origin and evolution of cancer stem cells in primary and metastatic skin cancers and their role in disease recurrences
- 10 Dr Florian Siebzehnrubl** - Identifying 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



KEEP IN TOUCH



@cardiffuni



facebook.com/cardiffuni



youtube.com/cardiffuni

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

Comments and suggestions regarding Challenge Cardiff are welcome and should be sent to challengecardiff@cardiff.ac.uk

Cardiff University is a registered charity, no. 1136855

www.cardiff.ac.uk

Printed on 100% recycled paper, in line with the University's commitment to sustainability. www.cardiff.ac.uk/sustainability