UNIVERSITY OF BIRMINGHAM

CONSTANTLY QUESTIONING

OVER 100 YEARS OF RESEARCH THAT MATTERS

For more than 100 years, a strong civic mission has underpinned research at the University of Birmingham, making a powerful contribution not only to our city, region and nation but also extending across the globe.

We are immensely proud of our achievements and I am delighted to present highlights of the exciting work taking place at Birmingham. As we look to the future, I warmly invite you to join our quest to think in original ways, to seek different paths and to ask the most pertinent questions.

Professor Sir David Eastwood
Vice Chancellor of the University of Birmingham

Research that matters

The University of Birmingham is a founder member of the Russell Group of research intensive universities in the UK and is ranked a top 100 university in the world. We have established a powerful reputation, since our foundation in 1900, for both high quality fundamental research and research that addresses the needs and challenges of our time.

The driving force of our strategy is 'Research that Matters'. Research can only matter if it is of value to others – not just those conducting the research. As a university, we support a research agenda that is genuinely transformative – whether it be transforming our understanding of a field of research, our paradigms and our methodologies, or transformational in terms of its impact on policy, on innovation, on productivity and growth in the economy, or because of the way that it affects the lives of individuals and communities, in our region, nationally or globally.

Research at Birmingham is also characterised by its breadth. Across our five Colleges, this research encapsulates more disciplinary areas than almost any other university in the UK, with genuine strength from arts and humanities, through the social sciences to physical sciences, engineering, life sciences and medicine.

We have a strong sense of civic mission, engaging with the challenges of the West Midlands region and the city of Birmingham as well as with local business and industry, alongside an established and growing global presence, including a new campus in Dubai and strong strategic partnerships across the world.

At the heart of our research are the brilliant people who deliver it: researchers – from postgraduate research student to professor – who have come to Birmingham from more than 100 countries to form a creative, ambitious and inclusive research community. Our outstanding technical support staff are an important part of that research community too. In the last three years, we have placed particular emphasis on enhancing the research environment and culture, building critical mass, encouraging those 'fizzy conversations, valuing impact, developing leaders, teams and collaborations and ensuring we have a world class infrastructure to match the needs of world class research.

In reading this publication, I trust you will gain a strong impression of the richness of the portfolio of 'research that matters' carried out at this university, and will also recognise that we are very much an outward- and forward looking university, and that partnership and collaboration are a critical element of everything we do.

Professor Tim Softley
Pro Vice Chancellor for Research and Knowledge Transfer
University of Birmingham

The University in facts and figures

Our strategic vision is to build on the foundation of our research intensive environment, growing research output and strengthening the translation of research into economic and societal benefit for all.

Ranked in the **TOP 100** of the world's universities**

Founding member of **Universitas 21** and major participant in Erasmus

We contribute **£3.5 billion** to the UK economy each year of which our Research and Knowledge Transfer activity is worth **£885 million**

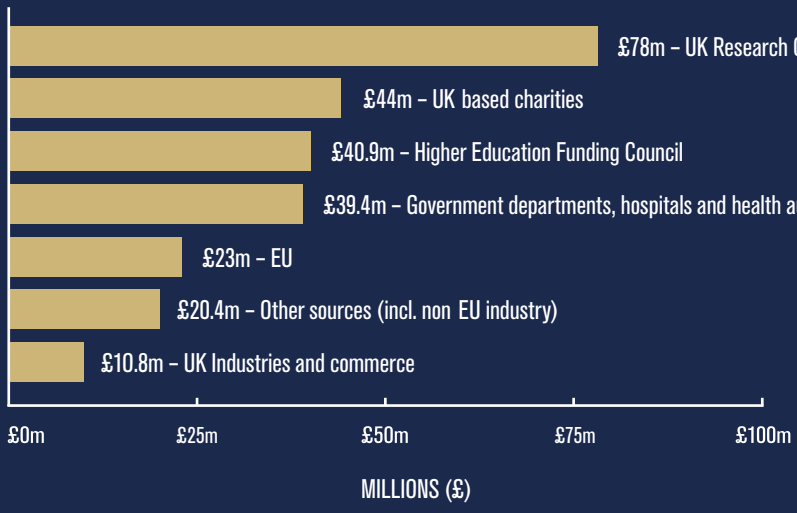
We teach over **34,000** students at both undergraduate and postgraduate levels

We are investing **£1 billion** in our campus over ten years

11 alumni staff recognised as **Nobel Prize winners**

Birmingham is the **third most targeted** university in the UK by top employers

More than one-third of academic staff are overseas nationals



In 2018/19, we attracted more than £250 million in external research awards.*

Total: £256.4 million

*including HEFCE QR

***QS World University Rankings 2020*

England’s first civic university

Birmingham is a world within a ‘city . The wider West Midlands region is home to a stable, diverse population of more than 5 million people, of whom more than 1 million are children. As England s first civic university, we continue our mission to play a strong role in our community, leading the pursuit of knowledge and to invest in impactful initiatives that benefit the region.

Our researchers are working closely with the city and the region to improve air quality and deliver long term health benefits to people, and our City Region Economic and Development Institute (City REDI) is focused on supporting regional economic growth policy, helping accelerate economic growth.

Birmingham Health Partners (BHP) is a strategic alliance between the University of Birmingham and two NHS Foundation Trusts – Birmingham Women s and Children s and University Hospitals Birmingham. Its unique ecosystem enables the full spectrum of translational medicine, rapidly translating healthcare research findings into new diagnostics, drugs and devices for patients.

In 2015, we opened the first secondary university training school in the country. The University of Birmingham School s mission is to create a diverse learning community, which reflects the city of Birmingham and to transform the lives of its pupils by raising aspirations. It s a school for youngsters of all abilities, aptitudes and backgrounds – with a non selective admissions process that welcomes students and families from some of the most deprived areas of the city. Pupils benefit from a close connection to the University, alongside a curriculum that is informed by the latest research from our Jubilee Centre for Character and Virtues and the School of Education.

We make an important contribution to the region through our world renowned cultural collections. The Lapworth Museum of Geology boasts the largest and finest geological collection in the West Midlands, The Barber Institute of Fine Arts houses a beautiful and varied collection of works, perhaps best known for its fine collection of French 19th century paintings and late medieval and Renaissance panel paintings and the Cadbury Research Library, home to an extensive collection of rare books and manuscripts, is also home to the ‘Birmingham Qur an , which is one of the earliest surviving fragments of the Qur an in the world.

We are now establishing a new home in the city centre, following the purchase and restoration of one of the city s best known civic buildings. Formerly the Municipal Bank, ‘The Exchange’ reflects our commitment to playing an active role in the development of the city and to sharing research and knowledge beyond campus boundaries.

Our civic contribution is not only measured in the economic impact and contribution to the economy of the region, but in the lives of the communities we serve, for whom we will continue to strive and make a difference.

DISCOVER OUR WORK IN
QUANTUM TECHNOLOGIES

Are quantum sensors the key to transforming our lives?

Quantum sensors could be the key to fighting dementia, unlocking productivity and building resilience to cyber-attacks.

Quantum technology is set to have a transformative impact on everyday life, as well as in industry sectors such as transport, civil engineering, communications, computing; even in space. This fast emerging technology will help to make the world a safer, faster and more productive place to live in.

This industry encompasses computing, communication, imaging and sensors. The last of the four, quantum sensors, are providing qualitatively new data about our world, which can be turned into valuable information about our environment. This will underpin advances in everything from autonomous transport, navigation and brain imaging to the Internet of Things.

We are leading an £80 million consortium, the UK Quantum Technology Hub for Sensors and Metrology, which is developing cold atom science into a range of practical sensors for measuring basic quantities, such as gravity, magnetic field and time. The team is investigating how these can be used to address challenging problems such as seeing underground or imaging brain activity, both of which have significant economic and societal impact.

MAPPING THE UNDERWORLD

Buried infrastructure, from pipes, cables and sewers to mineshafts and sinkholes, poses geotechnical risks, particularly for maintenance and development. Millions of pounds are spent on site investigations for projects such as the high speed railway project in the UK (HS2) while the utility industry undertakes 1.5 million street works annually.

Conventional imaging relies on radio frequency electromagnetic sensors such as Ground Penetrating Radar (GPR), but can be inadequate for detecting deep assets.

Quantum technology gravity sensors can ‘see’ much further – theoretically, all the way to the centre of the Earth. They could guide environmental work like carbon sequestration, spot threats like magma flows, and uncover new minerals and water resources. They could also, by tracing gravitational dynamics of the Earth, support navigation in autonomous ships, and underwater vessels with limited access to satellite navigation and radio.

Quest

THE FULL RESOLUTION BRAIN

Next generation brain imaging will help us respond to public health threats like dementia; 850,000 people already live with the condition, the cost of which is £23 billion per year, forecast to triple by 2040. This is higher than cancer, heart disease and stroke.

Quantum sensors are supporting the development of magnetoencephalography – the measurement of magnetic fields generated by the flow of current through neuronal assemblies in the brain – revealing how the brain forms and dissolves networks of neurons, on a millisecond timescale, as part of the processes supporting cognition.

With quantum sensors, this can even be done while the subject is moving, unlike current tools. Eventually, such innovations could support the diagnosis and monitoring of other conditions like Attention Deficit Hyperactivity Disorder (ADHD) and even enable mind directed game-playing.

International funding for brain imaging reflects growing interest in this least understood realm of human biology. Revealing the brain s workings, and upgrading its capacities, will be central narratives in 21st century science as robotics and AI acquire greater cognitive powers.

QUANTUM CLOCKS: NAVIGATION AND TIMEKEEPING RESILIENCE

Communication within the information economy relies on three pillars – computer networks, broadcasting and telecommunications. All depend on accurate, synchronised time over a geographically distributed network, and are often dependent on global navigation satellite systems (GNSS). Precision timing and positioning underpins everything from smartphones to high speed financing trading. Atomic clocks are how satellites keep time, which is done by measuring the microwave frequency needed to make electrons jump from lower to higher orbits as they absorb and lose energy. Atomic clocks have actually been one of the first quantum technologies entering the real economy. Quantum technology now offers the potential to move to optical clocks, which replace the microwave with a laser, leading to a massively better precision.

Following UK government funding renewal, a second chapter in quantum research is now set to speed technology transfer, support larger field trials, and enable the bringing together of users and system developers. This will help to ensure quantum sensors play a key role in the transformation of our knowledge economy, putting quantum innovation at the heart of UK science and securing our global leadership in one of the most exciting frontiers of the 21st century. The University is proud to be at the vanguard of this innovation.

DISCOVER OUR WORK IN QUANTUM TECHNOLOGIES: WWW.BIRMINGHAM.AC.UK/QUEST/QUANTUM

DISCOVER OUR WORK
IN AIR POLLUTION

How can we identify the causes and effects of air pollution to influence government policy to clean up the skies?

Ninety-one per cent of the world's population live in places where outdoor air quality exceeds WHO guideline limits.

More than 7 million people around the world die each year from air pollution, including 34,000 people in the United Kingdom. Our researchers are working collaboratively to identify the causes and effects of air pollution and are applying their learning to public policy globally to help to develop clean air solutions in areas such as India, China and East Africa, as well as in cities and regions across the UK. We host one of three national UK air quality supersites, based on our Edgbaston campus. These use state of the art monitoring systems to identify harmful pollutants more accurately than ever before.

Air pollution in the West Midlands affects some 2.8 million people, reducing average life expectancy by several months, and is responsible for direct and indirect economic costs of several hundred million pounds. The West Midlands Air Quality Improvement Programme (WM Air) is a £5 million project within the Regional Impact from Science of the Environment (RISE) initiative, funded by NERC.

WM Air will deliver clean air science for the West Midlands, providing improved understanding of pollution sources and levels in the region and new capability to predict air quality, health and economic impacts of potential policy measures.

TACKLING THE GLOBAL THREAT

In Delhi, rated the most polluted city in the world for ambient air pollution by the World Health Organization (WHO), our researchers are helping to determine the sources and processes responsible, taking a systems approach to develop options to mitigate air pollution. This will allow the researchers to assess the likely effectiveness of changes in behaviour for example, odd/even number plate traffic bans to improve air quality.

In China, we are leading collaborations with top universities and research institutes in the area of atmospheric science – looking at the causes and impacts of poor air quality and atmospheric pollution events in Beijing and the prediction of future extreme weather events in China and East Asia.

A Systems Approach to Air Pollution in East Africa (ASAP East Africa), brings together UK and East African experts in air pollution, urban planning, economic geography, public health, social sciences and development studies to provide a framework for improved air quality management in East African cities.

We will continue to grow our research capacity across the world and, in doing so, we will play a vital role in providing the air-quality data and science to inform policy-makers and protect the public health of citizens in the world's emerging cities, and support the emergence of low pollution development models.

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This photo is a collaboration between digital artist Robin Price and Professor Francis Pope, to visualise the amount of hazardous fine particulate matter (PM2.5) present in the air through experimental photography. This photo was taken at Qutub Minar – PM2.5 500 600 micrograms per cubic meter.

DISCOVER OUR WORK IN ENVIRONMENTAL SCIENCES: WWW.BIRMINGHAM.AC.UK/AIRPOLLUTION

DISCOVER OUR WORK IN
LIVER TRANSPLANTATION

Can machine perfusion safely increase the number of liver transplants?

A third of donated livers don't meet current transplant criteria and aren't used.

Chronic liver disease incidence in the UK is rising annually, a result of continuing alcohol misuse and obesity, causing approximately 8,500 deaths per year. For those with end stage liver disease, a transplant is the only hope for survival, but demand for livers suitable for transplantation far outstrips supply. In 2016/17, up to 20 per cent of people awaiting a transplant operation died or were removed from waiting lists due to ill health.

For a donated liver to be transplanted, it must pose minimal risk of complications. Many do not meet existing criteria and are discarded. We are questioning whether common criteria are causing unduly high rejection rates.

Supply is already short of demand. Young donors were once a big contributor of healthy livers in the event they suffered brain death (for example, following accidents) but the number of deaths from trauma have declined.

Consequently, a growing proportion of donated livers are instead coming from donors following circulatory death (DCD) – in which patients with no prospect of recovery are allowed to die naturally and their organs harvested or when a patient has suffered a cardiac arrest that is unexpected and from which the patient cannot or should not be resuscitated. These livers are of lower quality both because of donor characteristics such as comorbidities (they are usually of older age), having been deprived of blood supply which damages tissue and also because the frequency of steatosis (fatty liver) has increased.

So called 'marginal livers' pose risks to recipients, and as a result, the majority of DCD livers are not transplanted.

The criteria for rejection, however, are not consistently made – and may be subjective. There are significant regional differences in decision making, and in expertise regarding organ viability. This means people on waiting lists may not be receiving viable organs that could save or prolong their lives. Concerns about the increased demand for transplantation is driving researchers to challenge viability criteria through a novel research programme which is delivering promising results.

RE-THINKING ORGAN VIABILITY

Birmingham has been at the forefront of liver transplantation medicine; it was the location of the UK s first liver transplant and currently houses one of the largest liver transplant programmes in Europe. Now, researchers at the University of Birmingham and the Queen Elizabeth Hospitals Trust are pushing the frontiers of transplantation science by exploring ways to improve patient safety and efficiency in liver transplantation.

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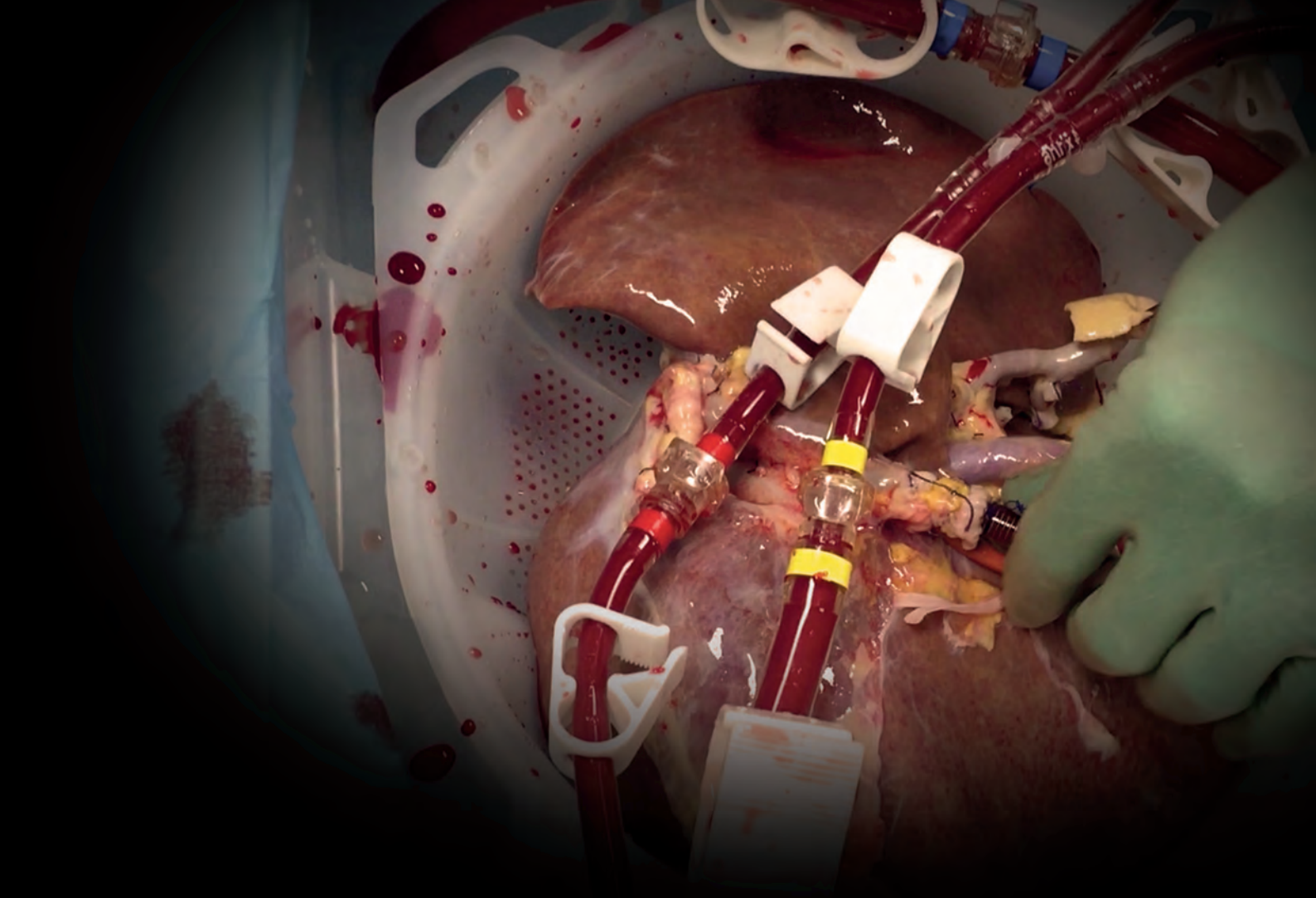


Normothermic machine perfusion of the liver (NMP L) is a method for maintaining near physiological conditions in livers by supplying them with oxygen and nutrients at body temperature. This prevents detrimental effects of static cold storage such as ischaemic cell damage, and permits the study of liver function outside the human body. Research has demonstrated that NMP L is superior to static cold storage at preserving liver function.

The use of this technology to study the physiological function of high risk livers is now progressing rapidly. If ex vivo liver function can be objectively assessed, rates of transplantation could be increased without necessarily increasing the risk to recipients.

Research is currently pursuing the development of quantitatively objective criteria regarding organ viability. The Welcome Trust funded the VITTAL (Viability Testing and Transplantation of Marginal Livers) clinical trial and researchers began recruiting patients on a waiting list for liver transplantation in October 2016. The study was designed to determine if a rejected liver is viable using normothermic machine liver perfusion, and to demonstrate successful transplantation of livers that had previously been declined but subsequently demonstrated to meet viability criteria.

In the study, livers considered unsuitable for transplant according to conventional criteria were placed under perfusion with oxygen and nutrients at body temperature for six hours. Following this, a range of indicators of liver function were measured. The primary indicator was the organ s ability to clear lactate to an accepted level, a function of a normal liver.

This research marks important progress in transplantation medicine, indicating both the development of more objective viability criteria, and the novel application of NMP L to maintaining liver function until transplantation. The study gives surgeons more confidence when making decisions about using a particular organ, by providing more objective criteria to base their decisions on.

The National Institute for Care Excellence in the UK recommended in January 2019 the use of machine perfusion under special arrangements while more data is gathered into its efficiency, and NHS England will decide whether to fund the technique.

We hope to see further refinement of the assessment techniques used to develop viability criteria, involving the use of novel biomarkers alongside the existing physiological and anatomical parameters. We are also leading the pharmacological treatment and reconditioning of steatotic donor livers to remove excessive fat and improve bile production and developing a perfusion solution which contains an artificial oxygen carrier rather than blood. We hope that all of our work will reduce the numbers of discarded livers whilst reducing the risks of transplanting them.

DISCOVER OUR WORK IN IMMUNOLOGY: WWW.BIRMINGHAM.AC.UK/LIVERTRANSPLANTS

Research without borders: a university with global reach

The University of Birmingham has been international since it was founded in 1900. We admitted our first international students in 1903; now, there are over 7,500 international students at the University from 150 different countries, and 37 per cent of our academic staff are from other countries.

Our global research reach stretches to over 4,700 collaborating institutions worldwide. While we work with the very best researchers and institutions wherever they are located, we have signature initiatives in Australia, Brazil, China, Europe, India and the US.

Our engagement in China is focused on sister-city links with Guangzhou and Nanjing. In Guangzhou, we have developed research platforms in healthcare (primary and translational medicine) and advanced manufacturing – contributing £37 million every year to the city's economy, according to an independent economic impact report. In Nanjing, we have a growing strategic partnership with Southeast University, including an institute for technology transfer in biomedical engineering. We have also developed an innovative collaboration in Shakespearean studies involving Nanjing University and Phoenix Publishing, a Nanjing-based media conglomerate.

An innovative research and education partnership with Trinity College Dublin strengthens our European academic links and involves collaboration across three shared research strengths: clinical trials and training; biomaterials, and digital textual editing. Our partnership with the University of Amsterdam is the product of a long track-record of collaboration and focuses initially on two areas: equality, diversity and inclusion (EDI); and medical training and research.

In the US, our signature partnership is with the University of Illinois at Urbana-Champaign, signed in 2014. Today, there are over 60 faculty-to-faculty collaborations, with research spanning population genetics, brain trauma, water technology, cultural heritage and race and education; our BRIDGE Fellowship programme allows us to jointly recruit high-potential researchers in areas of mutual strategic priority. At the core of our collaboration with the University of Melbourne are joint PhDs – the Priestley Scholars – spanning Medical and Health Sciences, Arts and Engineering. This partnership involves high-quality and impactful research across 55 projects in areas as diverse as youth mental health, energy storage, biomechanics, artificial intelligence and robotics.

- Over **4,700** collaborating institutions worldwide
- Over **23,000** co-authored publications
- **51.6%** of publications via an international collaboration

In Brazil, we were joint partners in establishing the first UK on-site presence at Brazil's premier research facility, the Center for Research in Energy and Materials (CNPEM). This provides researchers from the Centre of Membrane Proteins and Receptors (COMPARE), a £10 million flagship project, with unique access to the world's only fourth-generation light source synchrotron. This will help in identifying new approaches for the prevention and treatment of cardiovascular disease, respiratory disease and cancer angiogenesis.

In air pollution, our researchers are working with IIT Delhi, the Chinese Academy of Sciences in Beijing and the African Centre for Technology Studies in Nairobi, among others, to create detailed understanding of the causes and cures for and policies for this growing problem. These are just a few examples, from many, of our international collaboration, and in all cases, our approach is the same: we collaborate with breadth across a range of projects and areas; we invest to ensure success and do so in a sustained way. Most importantly, we seek and support excellence, in terms of both fundamental science and its application and impact.

The University of Birmingham Dubai opened its doors to students in 2018 and we are now working with the Dubai Health Authority to identify research, education, training and management opportunities in healthcare.

International collaboration is in the DNA of the leading research-led universities and we are no exception. We realise that no matter how distinguished our history, how brilliant are our people, and how well-resourced we are, the major questions that we all face can be tackled only by harnessing the power of strategic partnerships.

Professor Robin Mason
Pro-Vice-Chancellor (International)


2F Adaptive Gripper
2018 S/N C-40290
Made in Canada
pat. pr.robotiq.com
ROBOTIQ

How to connect the vision of transformative research with business and industry?

Our Business Engagement team's expertise brings together business partners alongside other funding streams to create centres such as the National Centre for Nuclear Robotics.

Ranked as the sixth most innovative University in the UK*, business chooses to work with the University of Birmingham because of our track record in delivering impact and growth. Our Business Engagement Team is an award winning, best in class, knowledge exchange unit, supporting industry and academic collaboration across the University. The team initiates and develops relationships with companies from all sectors, of different sizes and from many geographies who can grow through partnering with our research and innovation.

We provide a bespoke and specific pathway for each business, ensuring that the partnership with the University is fully supported, for the best experience and outcomes for all stakeholders. We support a range of engagements, from non financial activity, working with companies to exchange ideas through events and lectures, through to multi million pound research awards, from industry, government and research bodies, to establish research centres.

Industry works with our academics to provide insight that helps product development and innovation, supports business strategies and provides answers to global challenges. Our unrivalled expertise spans advanced manufacturing, technology, professional and financial services, medical and dental sciences and life and environmental sciences. In addition, we work closely with key business intermediaries, such as the Confederation of British Industry, to ensure we garner insight on the top challenges for business at both the national and international level.

Through partnerships we are able to produce innovative, transformative projects such as the National Centre for Nuclear Robotics (NCNR) which is a consortium of eight universities, led by Birmingham, with £42 million of investment to develop state of the art robotics, sensing and AI technologies to address the major societal challenges posed by nuclear environments and materials.

The creation of the Centre for Responsible Business in July 2017 was the result of a unique collaboration with academics at the Birmingham Business School, our Business Engagement team and Lloyds Banking Group. This partnership was underpinned by a desire for positive change, the need for collective, creative thinking, sharing insights and debating the complex issues associated with responsible business.

Lloyds Banking Group and the Centre for Responsible Business ended their partnership in 2022, culminating their five-year relationship with the launch of their Urgent Business Book. The Centre is continuing to operate and deliver research, building on the innovative and thought-leading research of this fruitful partnership.

Our experience demonstrates that by working closely with researchers, we can connect the vision for their work with external business and industry opportunities, supporting academic endeavour and increasing the reach and significance of transformative research.

READ MORE AT: WWW.BIRMINGHAM.AC.UK/PARTNERS

**Times Higher Education* Top 100 most innovative universities 2018

CONST
QUEST

Over 100 years of

ANTLY

research that matters

Nurturing the greatest minds

The University received its Royal Charter in 1900 but the foundations for our establishment had been laid for years previously.

Innovation in research has characterised our philosophy, enabling us to nurture the greatest minds, combining original thinking with focus and rigour, intellectual curiosity with practical application. In the company of our 11 Nobel Prize-winners, our researchers continue to make a lasting impact on peoples, cultures, industry and society.

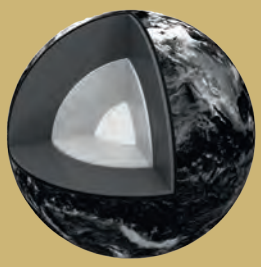
1767

John Tomlinson holds 29 weeks of medical education seminars, the first outside London.

1847

Langston Parker, a student at Queen's College (later merging to become Birmingham Medical School) is the first to use ether as an anaesthetic in Birmingham.

1891

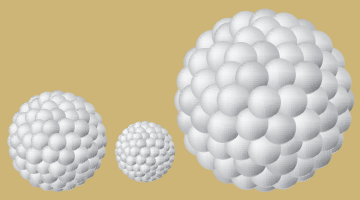


John Henry Poynting is the first person to successfully calculate the mean density of the Earth.

1900

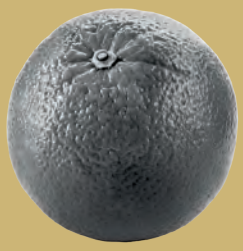
Florence Price becomes the first woman at the University to matriculate in a medical degree.

1922



Francis William Aston invents the Mass Spectrometer, winning the Nobel Prize in Chemistry.

1937



Norman Haworth wins the Nobel Prize in Chemistry for synthesising Vitamin C.

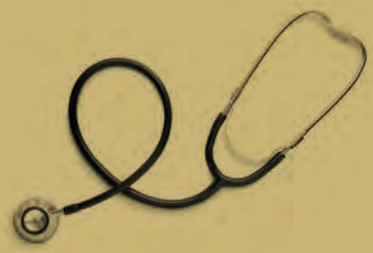
1937

Robert Cecil wins Nobel Peace Prize for helping establish the League of Nations.

1940

John Randall and Harry Boot develop a cavity magnetron.

1944

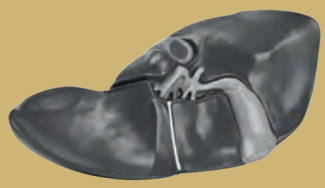


Hilda Lloyd becomes our first female professor, later the first female President of the Royal College of Obstetricians and Gynaecologists saving lives through her midwife ‘flying squads’.

1960

Leon Abrams and Ray Lightwood develop and implant the first variable rate pacemaker.

1960

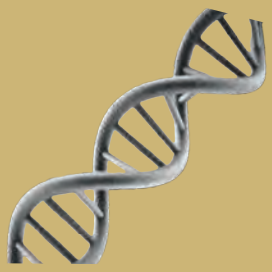


Peter Medawar wins Nobel Prize in Physiology or Medicine for pioneering transplant surgery.

1961

Peter Scott, former Chancellor, helps found the World Wildlife Fund.

1962

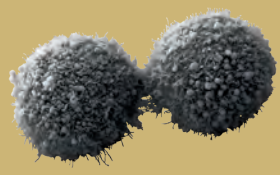


Maurice Wilkins wins Nobel Prize in Physiology or Medicine for revealing structure of DNA.

1982

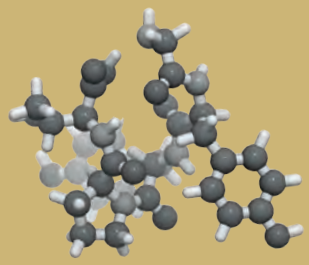
John Vane wins Nobel Prize for Medicine for revealing how aspirin produces pain relief.

2001



Paul Nurse wins Nobel Prize in Physiology or Medicine for inspiring new cancer treatments.

1968

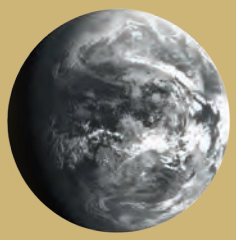


Charlotte Anderson demonstrates the role of gluten in Coeliac Disease, leading to the introduction of gluten-free diets.

1987

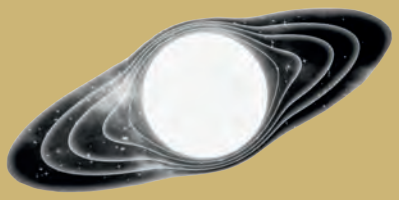
John Sinclair publishes the first COBUILD dictionary using 'real-world' text.

2007



Peter Bullock wins Nobel Peace Prize for research to understand climate change.

2016



Researchers develop and build components for the LIGO sensors that observe gravitational waves for the first time.

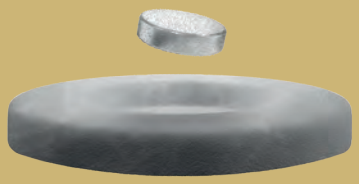
2006

The first over-the-counter male fertility tests for men are developed by Chris Barratt.

2015

Birmingham Qur'an manuscript is dated as amongst the oldest in the world.

2016



Mike Kosterlitz and David Thouless win Nobel Prize in Physics for deepening understanding of exotic matter

J. Fraser Stoddart wins Nobel Prize in Chemistry for pioneering molecular machines.

DISCOVER OUR WORK
IN ANCIENT TEXTS

What does research into ancient texts mean to our world today?

Specialist expertise and new technologies are revealing age-old beliefs and life across thousands of years.

The Institute for Textual Scholarship and Electronic Editing (ITSEE) has a long history of researching ancient texts and manuscripts, some of which have only recently been rediscovered, from antiquity to the early modern period.

Our researchers use digital tools to locate and view original materials, ranging from single manuscripts to multiple versions of a text, such as a copy of the Magna Carta or a verse from the Bible. They transcribe them into electronic form, use technology to reveal text that has been obliterated, and compare and analyse different examples of text to arrive at a more definitive version.

The software applied in Birmingham is now used in institutions across the world. It has also pioneered the use of existing technologies in novel ways such as applying algorithms originally developed for the decoding of DNA in analyses of multiple related texts.

THE DEAD SEA SCROLLS

The Dead Sea Scrolls were found in 11 caves on the north western shore of the Dead Sea, and also known as the Qumran Texts. Their discovery in the late 1940s revealed remains of almost a thousand ancient Jewish manuscripts. Research is shedding fresh light on a movement devoted to the study of law in the Second Temple Period and the Jewish background of Jesus and his earliest followers. They are, therefore, an important source to further our understanding of the New Testament and the history of Judaism.

THE BIRMINGHAM QUR'AN – ONE OF THE EARLIEST SURVIVING FRAGMENTS OF THE QUR'AN

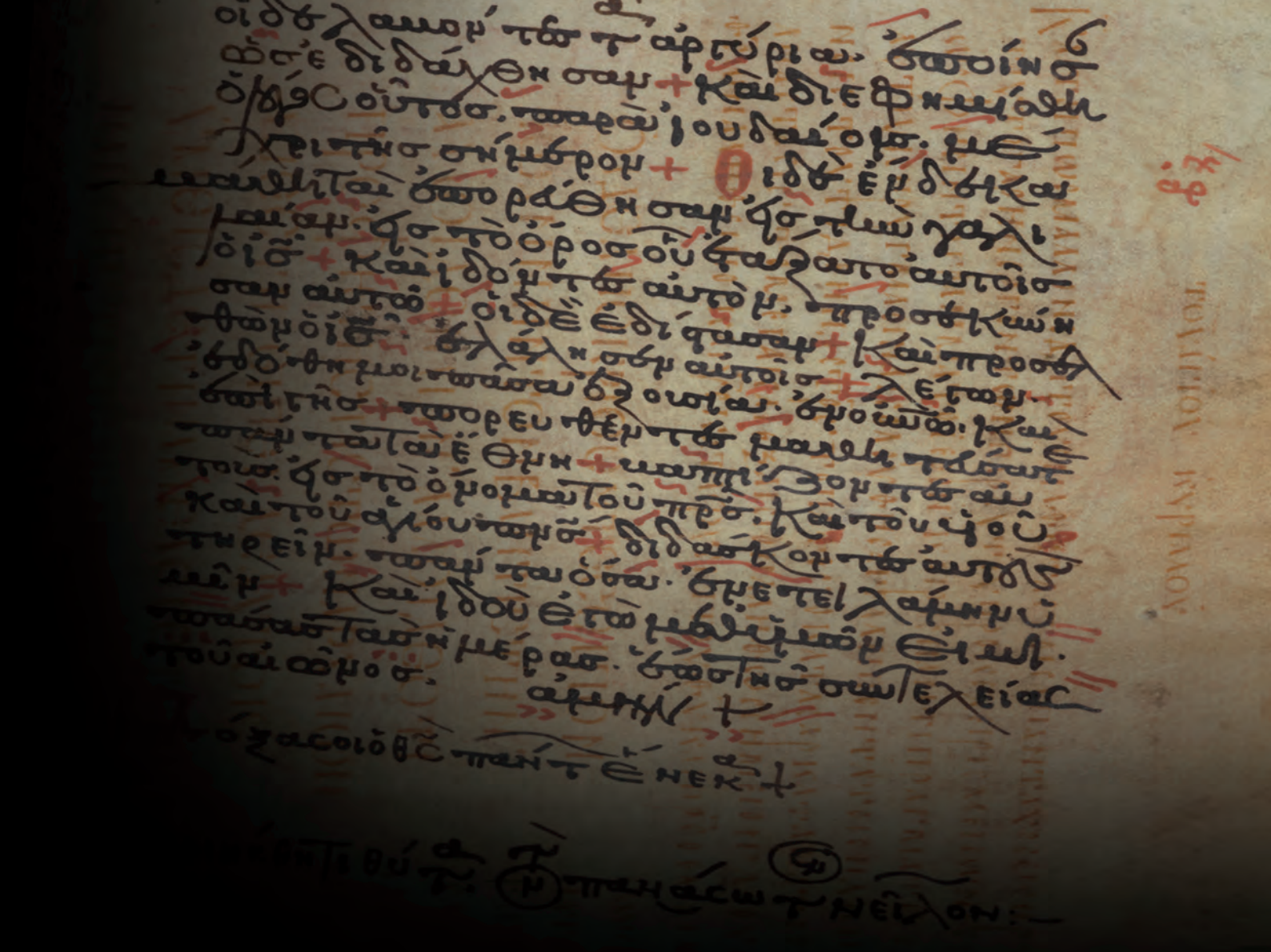
The Birmingham Qur an Manuscript contains parts of surahs 18 20 of the Islamic holy book, written on parchment in an early form of Arabic script known as Ḥijāzi. In 2014, radiocarbon dating of the parchment on which the text is written placed the manuscript in the period between 568 and 645 with 95.4 per cent probability. This suggests the manuscript dates back to the first century of Islam, close to the lifetime of the Prophet Muhammad (about 570 632) and the rule of the first three Caliphs.

The Birmingham manuscript is, therefore, one of the earliest surviving fragments of the Qur an and one of only a handful of early manuscripts of the Qur an in the world to have been radiocarbon dated.

THE MOST COMPREHENSIVE EDITION OF THE GREEK NEW TESTAMENT

Birmingham is home to the International Greek New Testament Project (IGNTP), a worldwide consortium of scholars leading research on the textual transmission of the New Testament.

Quest



Its members are engaged in producing the Editio Critica Maior, the first major edition of the Greek New Testament for over a century and the only one to be based on an analysis of all 5,000 known surviving manuscripts.

Using digital approaches, the editors are producing a new reconstruction of the earliest attainable text, as well as a commentary explaining how variations arose in the biblical text during the first millennium of its transmission. Published in association with partners in Germany and by the German Bible Society, this new edition has already led to revised versions of the standard hand editions of the Greek New Testament used by students, scholars and pastors across the world, and will form the basis of new translations for decades to come.

RE-UNITING THE WORLD'S OLDEST BIBLE

Members of ITSEE led a pioneering project to create a digital edition of the oldest surviving copy of the whole Bible in Greek, Codex Sinaiticus. This fourth century manuscript is now dispersed across four institutions: the British Library, the National Library of Russia, Leipzig University Library and St Catherine s Monastery on Mount Sinai. The only way to see the whole manuscript is through the online portal, which brings together high resolution digital images, a full electronic transcription of every word (linked directly to the images) and a translation of its text. In its first two days online, the website (www.codexsinaiticus.org) received 96.4 million hits.

DISCOVERING THE SECRETS OF THE OLDEST GREEK NEW TESTAMENT CATENA MANUSCRIPT

Codex Zacynthius, seen in the picture, is the oldest manuscript of the Greek New Testament to contain extracts from writings by early Christian theologians, known as a catena, as well as the biblical text. The manuscript was copied around the year 700. It is what is known as a palimpsest: in the 13th century, the manuscript was dismembered and the writing washed away in order to be overwritten with a new text. Much of the older text is now illegible to the naked eye. By using multi spectral imaging, a project at Birmingham will recover the original underlying text for the first time, and be able to make the first complete transcription. This gives new glimpses of lost writings and interpretations.

Understanding the variety of forms in which ancient texts were written and transmitted is vital to a proper appreciation of the diversity of modern faith and practice. Even though some of these artefacts are well over 1,000 years old, digital tools and new analyses continue to lead us to important new discoveries and insights.

DISCOVER OUR WORK IN ANCIENT TEXTS: WWW.BIRMINGHAM.AC.UK/ANCIENT-TEXTS

DISCOVER OUR WORK IN
RESPONSIBLE BUSINESS

How can we build a responsible future that gives everyone an equal chance?

We embed responsible business at the core of our research.

Over recent years, there have been unprecedented levels of change in our society: the 2008 financial crisis; the 2016 UK referendum vote to leave the European Union; the threat of global warming; the risks of pervasive plastic pollution. Researchers at Birmingham Business School consistently strive to embed responsible business at the core of the research we carry out, building resilience in our cities and regions, here in the UK and across the world.

Our dedication has led to the creation of our Centre for Responsible Business, focusing on how businesses globally can be rewired responsibly to the benefit of the communities they serve. For a truly responsible future, the UN Sustainable Development Goals (SDGs) are a central part of our focus, and the Centre for Responsible Business places the SDGs at the heart of business practice and governance, but also examines responsible finance, gender equality and ethical practice within industry.

As well as conducting research addressing worldwide issues to prepare and mitigate negative impacts, we are also invested in helping our local communities to grow in a way that is inclusive of all and sustainable.

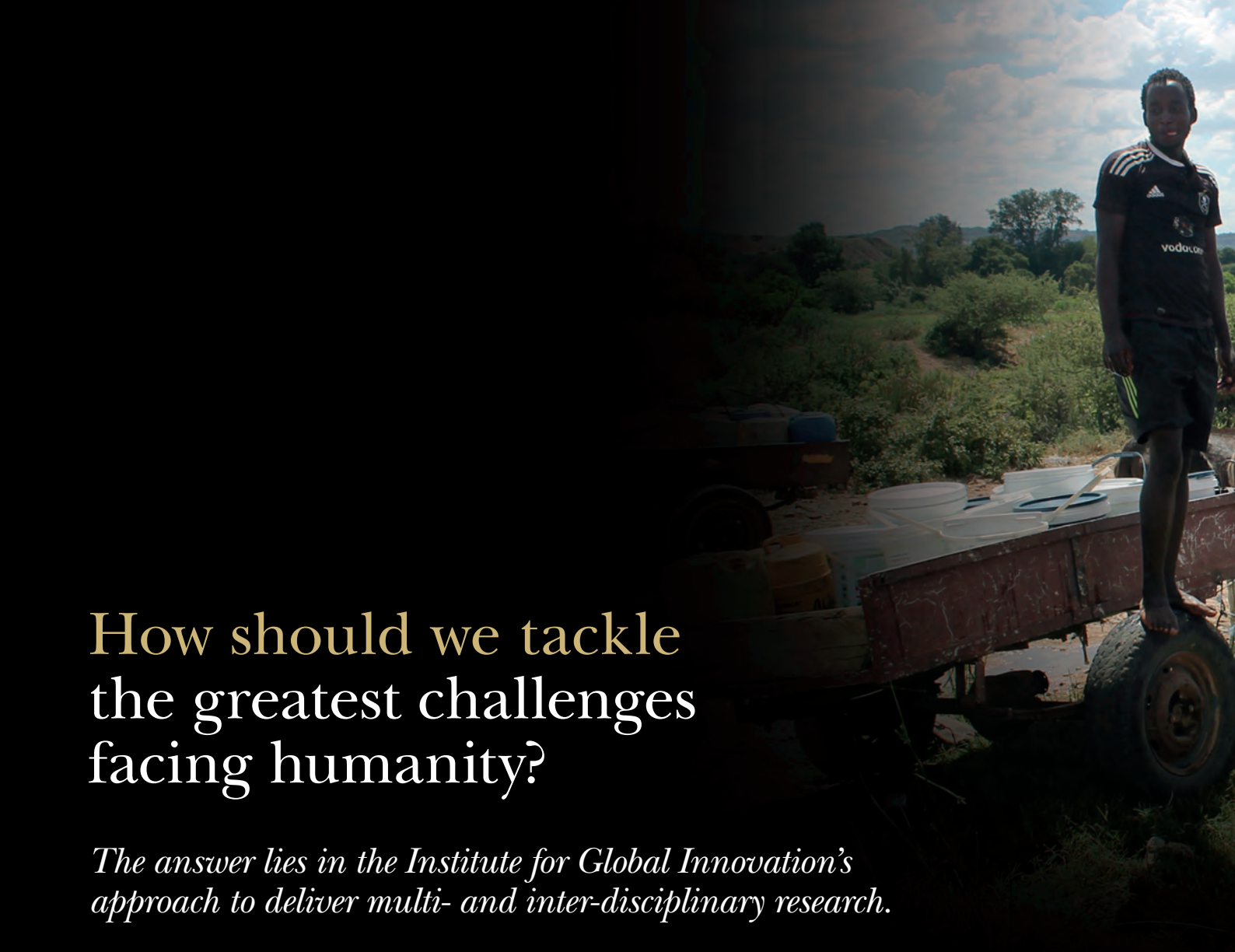
The issues surrounding workplace inclusivity are addressed by our Centre for Women s Enterprise, Leadership, Economy & Diversity (WE LEAD), which is committed to ensuring that the future of leadership is diverse and inclusive, giving everybody an equal chance no matter what their background may be. Innovative research examines the roles of leadership, family, business, and diversity, and the Centre s academics have played a leading role in researching diversity for the West Midlands Combined Authority s *Leaders Like You* report, which will have an impact on entrepreneurs now and in the future.

Working with regional partners, the Business School s City Region Economic and Development Institute (City REDI) is working to develop a constantly growing economy within the UK s city regions. The Institute s research focuses on the impact that leaving the European Union will have on the UK s more vulnerable regions, but also examines how communities can be encouraged to grow in a way that leaves no one behind and allows everyone to have the skills they need to thrive in society through a fair and equal labour market.

Our Centre on Household Assets and Savings Management (CHASM) has shaped areas of the UK government s policy on savings for low income households, specifically through its 'Help to Save' scheme. The Centre is dedicated to ensuring that everyone in society, especially the most vulnerable, has the financial means and capability to manage ongoing economic change. Through its work, it has shaped debate and practice within the financial sector.

Our research is thoroughly committed to bringing about the responsible business revolution for the better of society and businesses globally. Within our research centres and through our research projects, we are engaging with policymakers and the general public to make real true-to-life changes.

DISCOVER OUR WORK IN RESPONSIBLE BUSINESS:
WWW.BIRMINGHAM.AC.UK/RESEARCH/RESPONSIBLE-BUSINESS



How should we tackle the greatest challenges facing humanity?

The answer lies in the Institute for Global Innovation's approach to deliver multi- and inter-disciplinary research.

We believe that research works best when people work together, whether that s our own researchers here in Birmingham who enhance and accelerate research through collaborating from across different disciplines, or through our networks of collaborators across the world.

To nurture this way of working within our research environment and make a sustained, meaningful difference, the Institute for Global Innovation has been established to inspire, support and deliver world leading, multi- and inter disciplinary research that focuses on addressing pressing global challenges.

Across the University more widely, our researchers are focusing efforts on nine of the United Nations' Global Goals, exploiting our research strengths to produce practical solutions and are engaged in a variety of projects that are contributing to this endeavour.

The work of the Institute for Global Innovation, however, primarily focuses on global challenges that affect people in low- and middle income countries. The mission to make that happen is through combining expertise of academics from across the University with forward thinking organisations who share the same goals.

At any given time the Institute will support up to ten interdisciplinary teams. Researchers are be brought together from a wide range of disciplines – medical and biological sciences, physical sciences and engineering, social sciences and humanities – to contribute their expertise to address the challenges.

WE ARE FOCUSING EFFORTS ON FOUR CHALLENGE THEMES:

1. **Gender Inequality**

   Gender inequality is one of the most pressing contemporary global challenges. The UN has recognised the barriers posed to women and girls across the Global South in its Sustainable Development Goals. Concerted collaborative efforts are required to tackle a problem that encompasses so many areas of social, economic, political and cultural life.

   For too long, individual research strands have not sufficiently explored the interconnected factors that combine to result in poorer outcomes for women and girls. We are working to reduce gender inequality in the Global South by combining expertise in medicine, law, economics and beyond to produce a more fuller understanding of the challenges faced by women and girls.

2. **Resilient Cities**

   Global urbanisation is predicted to continue, with estimates that by 2030, 60 per cent of the world s population will be living in cities. While cities can bring many benefits, as drivers of economic growth and by providing critical mass that enables services to be delivered efficiently, there are also challenges.

Our researchers are focusing on how communities and individuals experience change or 'shocks'. By analysing responses at an individual, community, city and national level, across multiple sub systems and timescales we aim to build more resilient cities, improving the lives of its inhabitants and limiting negative impacts.

3. **Water Challenges**

Billions of people worldwide are confronted with serious water related challenges, from scarcity, extreme hydrological events, political conflict and also contamination.

Our researchers are addressing both natural and social science aspects of water including hydrology, water policy and governance, developing innovative and sustainable solutions to solve the water problems that societies are facing today. They explore the grand challenges in water research which require multidisciplinary approaches to address, such as managing water resources in a changing environment or changes in water quality that lead to floods and droughts.

4. **21st-Century Transnational Crime**

The changing nature of crime in the 21st century poses a global challenge. While there is a drop in some crime types, violent crime shows a complicated pattern globally. The phenomenal increase in cybercrime is challenging the way we conceptualise and observe crime in the digital era. Areas of emerging political instability and conflict interact with existing criminal networks to present risks not only to personal security, but to basic state functions.

Our researchers are employing a range of interdisciplinary approaches to understand, and develop solutions to new crimes in the digital era, helping us respond to technological advances and an increasingly interconnected world.

WE ARE SUPPORTING EMERGING THEMES

In addition to the four challenge themes, the Institute has identified four emerging themes which include Ageing and Frailty, Confronting Anti microbial Resistance, Clean Cooling and Environmental Pollution Solutions. All themes bring together a unique multidisciplinary combination of leading researchers to develop new insights and methodological innovation through collaborative working.

FOR MORE INFORMATION VISIT: WWW.BIRMINGHAM.AC.UK/IGI

A rich offering of research resources

From our campus to the city and across the wider region, we have a constantly evolving wealth of resources for researchers across all disciplines, contributing to the delivery of innovative work within a rich and vibrant community.

The Cadbury Research Library houses our extensive collection of rare books, manuscripts, archives, photographs and associated artefacts. Among these is the Mingana Collection of more than 3,000 Middle Eastern manuscripts in more than 20 languages, with the oldest item dating back to 2,500BC and includes the Birmingham Qur'an Manuscript, one of the earliest surviving fragments of the Qur'an, dated to between 568 and 645AD.

The Lapworth Museum of Geology has one of the finest and most extensive collections of fossils, minerals and rocks in the Midlands – with more than 250,000 specimens dating back 4.5 billion years and contains large collections of early geological maps and equipment, as well as zoological specimens and stone axes.

The Barber Institute of Fine Arts is a beautiful Art Deco building, with a concert hall and exhibition space, and holds one of the most outstanding and internationally significant collections of art assembled in Britain during the 20th century, including works by Monet, Turner, Gainsborough and Van Gogh. It also has one of the finest collections of Roman, Byzantine and Medieval coins in the world.

Our estate includes a number of historic houses. These include **Winterbourne House and Garden.** Constructed in 1903 in the Arts and Crafts style, gardens bloom with more than 6,000 plant species attracting a host of insects, including the resident bees, while the house has been transformed with interactive displays and hands-on learning exhibits for all ages.

The Birmingham Institute of Forest Research (BIFoR) will provide a step-change in our understanding of how our forests will respond to future increases in atmospheric carbon dioxide (CO_2). A Free-Air Carbon Dioxide Enrichment (FACE) experiment has been established in mature, unmanaged, temperate woodland, only the second such facility worldwide and the only one in the Northern Hemisphere.

Acting as a central hub for clinical trials acceleration and stratification, and clinical informatics, the **Institute of Translational Medicine** brings experts together to rapidly turn medical science into innovative patient and healthcare system applications. It does this by providing a platform for interaction between basic scientists, academic clinicians, clinical informatics, biostatisticians, trial design experts in biomarker development and validation to accelerate the development of drugs and devices.

We have made a significant investment in the **Tyseley Energy Park** that will be the energy and waste nexus for the city of Birmingham, showing how novel energy technologies can form an innovative industrial ecology. We will build an innovation hub that will provide businesses with the chance to develop their technology in collaboration with our researchers, becoming a centre for training associated with state-of-the-art energy, waste and low-carbon transport systems.

Birmingham Life Sciences Park (BLSP), due to open in 2022, will harness world-leading academic and clinical strengths while bringing new commercial power to the region to accelerate life sciences research, taking innovative new healthcare treatments and technologies from early development to real-life application.

Our nationally and University-recognised Research Institutes and Centres

COLLEGE OF ARTS AND LAW

- Centre for Byzantine, Ottoman and Modern Greek Studies
- Centre for Corpus Research
- Institute for Textual Scholarship and Electronic Editing
- Ironbridge International Institute for Cultural Heritage
- Shakespeare Institute
- Birmingham Research Institute for History and Cultures
- Centre for the Study of Global Ethics

COLLEGE OF SOCIAL SCIENCES

- Lloyds Banking Group Centre for Responsible Business
- Jubilee Centre for Character and Virtues
- Institute for Research into Superdiversity
- City Region Economic and Development Institute
- Centre on Household Assets Savings and Management
- Institute for Conflict, Cooperation and Security
- Centre for Crime, Justice and Policing
- Third Sector Research Centre

COLLEGE OF ENGINEERING AND PHYSICAL SCIENCES

- Birmingham Centre for Railway Research and Education
- Quantum Technology Hub
- High Temperature Research Centre
- National Centre for Nuclear Robotics
- National Buried Infrastructure Facility
- Birmingham Centre for Strategic Elements and Critical Materials
- Birmingham Centre for Nuclear Education and Research
- Healthcare Technologies Institute
- Birmingham Energy Institute
- Institute for Gravitational Wave Astronomy

FOR MORE INFORMATION ON OUR RESEARCH INSTITUTES AND CENTRES, PLEASE VISIT:

WWW.BIRMINGHAM.AC.UK/RESEARCH/INSTITUTES

COLLEGE OF LIFE AND ENVIRONMENTAL SCIENCES

- Phenome Centre Birmingham
- Henry Wellcome Centre for Biomolecular NMR
- Cerebra Centre for Neurodevelopmental Disorders
- Environmental Sciences
- Water Sciences
- Centre for Computational Biology
- Institute of Microbiology and Infection
- Institute for Mental Health
- Birmingham Institute of Forest Research
- Centre for Human Brain Health
- Centre of Precision Rehabilitation for Spinal Pain

COLLEGE OF MEDICAL AND DENTAL SCIENCES

- Birmingham Experimental Cancer Medicine Centre
- Cancer Research UK Birmingham Centre
- Birmingham Centre for Clinical Trials
- Centre for Human Reproductive Science
- MRC-ARUK Centre for Musculoskeletal Ageing Research
- NIHR Global Health Research Unit on Global Surgery
- NIHR Birmingham Biomedical Research Centre
- NIHR Surgical Reconstruction and Microbiology Research Centre
- Rheumatoid Arthritis Pathogenesis Centre of Excellence
- Scar Free Foundation Centre for Conflict Wound Research
- Tommy's National Centre for Miscarriage Research
- Centre of Membrane Proteins and Receptors

Birmingham In Action
Turning research into action to help protect our planet

As our planet heats up and more people begin to see the impact of climate change first hand, it has never been more important to understand the help that is at-hand from our forests, but also the risks our forests run living in a high carbon dioxide (CO_2) world. Forests worldwide absorb 25–30 per cent of the CO_2 we release and are the great cradles of biodiversity on land. They protect us from the worst of current climate change, but we may be approaching a tipping point at which it costs forest communities more energy to stay alive in a harshly changed climate than they can make from photosynthesis. That's the point at which we have a 'run' on the 'Bank of Mother Nature'.

The first of its kind in Europe and one of only two worldwide, the Free Air Carbon Dioxide Enrichment (FACE) facility at Birmingham Institute of Forest Research (BIFoR) is a technological marvel that will help unlock the secrets of our forests.

Built into an existing oak woodland to deliver the most reliable and comprehensive predictions from a real setting, rings of towers (shown right) gently pump CO_2-enriched air into forest patches, simulating a future atmospheric CO_2 abundance. Researchers and robot sensors then help scientists measure how trees and soil respond.

Professor Rob MacKenzie, University of Birmingham lead for BIFoR FACE and a Director of BIFoR, says: 'We can't plant enough forests to make climate change go away, but at BIFoR we have created a unique "lab in the trees" to help us predict the effects of atmospheric changes expected by 2050.'

BIFoR was set up thanks to a gift of £15 million, with support from University of Birmingham alumni, research councils and other philanthropic organisations.

BIFoR will provide practical, actionable evidence about whether our woodlands can continue to mitigate the impact of climate change – and how we can help them. Additional research will also study how raised CO_2 levels could affect the food we eat as well as the air we breathe, by examining the impact on food crops.

A further part of the University's environmental research programme focuses on the pollution threat of plastics.

The deepest-ever dive to the bottom of the ocean in 2019 found a plastic bag and sweet wrappers in the Mariana Trench. Birmingham researchers are undertaking two key projects to understand the impact of plastic on our environment and find ways to repurpose it.

The plastic pollution problem in our oceans is well known. Could we prevent it by catching it first in our rivers? Reliable data is essential, so our researchers have developed a toolkit to test river sediments around the world, as they build a global map of aquatic plastic pollution.

On land, plastic waste is an increasing global problem – the average person in the UK throws away their own body weight in plastic every year. Yet, researchers at Birmingham are turning waste plastics into new biodegradable materials. These can be 3D printed to create temporary 'scaffolds' that help natural tissue grow back after surgery before disappearing like dissolvable stitches – reducing pain and helping healing and even preventing the return of tumours.

Our environmental research is just part of the University of Birmingham s fundraising and volunteering campaign. **Birmingham In Action** includes three other research programmes which tackle key challenges that will deeply affect our generation and the next.

One in two people in the UK will get **cancer** in their lifetime (Cancer Research UK, 2018). Finding it early and matching the right treatment to an individual make a huge difference to patients' survival prospects. With your support, we can focus research on finding cancer earlier, and identifying the exact right treatment for every individual.

Youth mental health is a growing global concern – early support can prevent decades of illness in adult life. Our experts need your support to understand what is causing an epidemic in young people s mental health needs and how society can offer early help. We must find the most effective treatments and create a society that supports mental health challenges.

It s nearly impossible to imagine what forces someone to become a refugee. Your support can help our academics understand the challenges faced by **traumatised families** and give UK communities the knowledge to welcome refugees – helping them to find healthcare, education and employment.

BIRMINGHAM ACTION

FOR MORE INFORMATION ABOUT HOW YOU CAN GET INVOLVED VISIT
WWW.BIRMINGHAM.AC.UK/ACTION

At the heart of our research are our postgraduate researchers

Postgraduate students have always been at the heart of our university life, being an integral part of our community, bringing global experience and new perspectives, all of which contribute to the academic and social richness of our global university.

Our ambition means that we strive to do more: appointing and developing outstanding academic talent across the breadth of our disciplines, investing in substantial new research programmes and scholarships, and building new national and international research collaborations.

MEET OUR FIRST GLOBAL CHALLENGE PHD SCHOLARS

Our postgraduate researchers work on pioneering topics that provoke global change through multi-faceted research. We are investing in fully funded Global Challenges PhD scholarships for UK/EU applicants, inviting the very best applicants to join us in our research. From combating the threat of drug resistance, to pioneering the creation of new technologies for water security; we make important discoveries and produce compelling insight into new approaches to today's global challenges.

FINDING A NEW TB VACCINE

Dr Danai Papakonstantinou

'TB is one of the biggest infectious disease killers on the planet. Hundreds of years after the first vaccine was developed, we still don't have effective immunisation and it doesn't protect people across the globe. We're combining expertise from across the University and beyond to bring a different approach to finding a new vaccine.

'It's a very collaborative approach. I'm an infectious diseases specialist and I'll be working with a team of very well established scientists including researchers who analyse DNA data, clinicians and immunologists.'

THE POSTGRADUATE COMMUNITY

At Birmingham, we have one of the UK's largest postgraduate communities, with over 14,000 postgraduate students (of which more than 3,000 are postgraduate research) making up more than 40 per cent of the total student population. Students are among like-minded people and receive the stimulation, support and challenges needed to succeed.

Our postgraduates have a distinctive voice and are highly valued members of the University. We ensure this through student representation and dedicated facilities and resources, such as our University Graduate School.

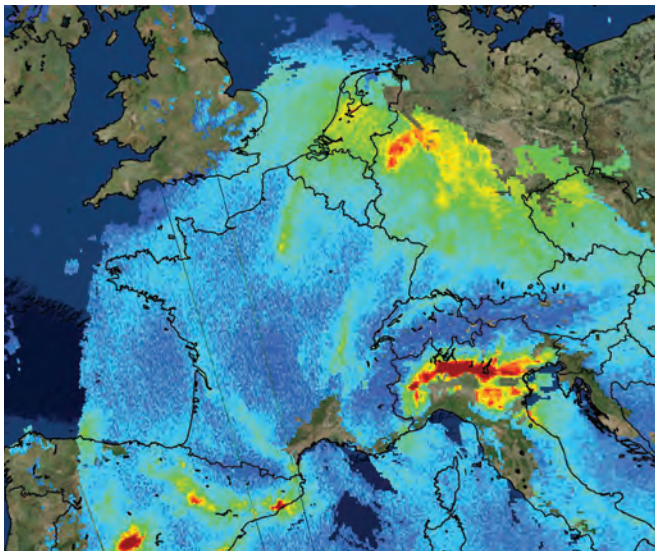
Life as a postgraduate student involves much more than just studying for a degree. Opportunities abound for getting involved in research and special interest groups, contributing to publications, talks and conferences, and taking advantage of a broad range of opportunities to gain new skills.

URBAN AIR POLLUTION

Karn Vohra

'My work involves trying to understand how urban air pollution is evolving over time, using satellite observations to monitor cities, particularly in the developing world. By building a tool to monitor air pollution, we can better understand the urban environment, and provide city planners and stakeholders with the information they need to develop action plans to improve air quality.

'This work excites me because we're trying to look for a solution to a problem of global concern. It's something that will have real-life impact as air pollution is detrimental to both human health and food security.'



Credit: *Nitrogen dioxide over Europe,* Science History Images

FOR MORE INFORMATION VISIT: WWW.BIRMINGHAM.AC.UK/POSTGRADUATE

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