United Nations Sustainable Development Goals. The Sustainable Development Goals are the blueprint to achieve a better and more sustainable future for all. They address the global challenges we face, including poverty, inequality, climate change, environmental degradation, peace and justice.

SDG Explainer

GOAL 1: NO POVERTY
GOAL 2: ZERO HUNGER
GOAL 3: GOOD HEALTH AND WELL-BEING
GOAL 4: QUALITY EDUCATION
GOAL 5: GENDER EQUALITY
GOAL 6: CLEAN WATER AND SANITATION
GOAL 7: AFFORDABLE AND CLEAN ENERGY
GOAL 8: DECENT WORK AND ECONOMIC GROWTH
GOAL 9: INDUSTRY, INNOVATION AND INFRASTRUCTURE
GOAL 10: REDUCING INEQUALITY
GOAL 11: SUSTAINABLE CITIES AND COMMUNITIES
GOAL 12: RESPONSIBLE CONSUMPTION AND PRODUCTION
GOAL 13: CLIMATE ACTION
GOAL 14: LIFE BELOW WATER
GOAL 15: LIFE ON LAND
GOAL 16: PEACE, JUSTICE, AND STRONG INSTITUTIONS
GOAL 17: PARTNERSHIPS FOR THE GOALS

Contents

04 Foreword by Professor David Nabarro
05 Foreword by Professor Alice Gast
06 Introduction
08 Tackling the threat of antimicrobial resistance
09 Empowering communities with innovative off-grid energy solutions
10 Boosting global crop yields to end hunger
11 Leading the fight to eradicate malaria
12 Driving the global transition to zero pollution
14 Nurturing generations of Change Makers to tackle global challenges
16 Helping the injured victims of conflict around the world
17 Delivering vaccines to those who need them most
18 Empowering enterprising women to drive societal change
20 SDG Start-ups
22 Design and innovation meets global development
23 The world’s most advanced centre for disease and emergency analytics
24 Paving the way for next-gen quantum tech
25 Innovation for global energy challenges
26 Getting a grip on infectious disease
27 The unique centre striving for more sustainable global business
28 The WISER project – working towards cleaner water to prevent schistosomiasis
29 Building equitable, healthy cities for the future
30 School students around the world compete to tackle the SDGs
31 Tackling childhood mortality in sub-Saharan Africa
32 Inclusive STEM learning and innovation
34 Research by Imperial physicists spans local energy and health tech discoveries
35 Delivering innovative solutions to improve global health
36 Managing rainforests for the ecological and economic benefit of all
37 Synthetic biology paves the way for new drugs, materials, fuels and food
38 Mastering the elements
39 Calculated progress – Mathematicians progressing the SDGs number by number
40 Imperial’s new Global Development Hub
Foreword

Pursuing world-leading research and education for the benefit of society has always been at the heart of Imperial College London’s mission. Our staff and students operate across sectors and disciplines to develop new technologies, discover new cures, educate and inspire the next generation and find ways to answer the greatest of challenges, as exemplified by a network of collaborations in over 192 countries. Imperial’s research and education transforms lives, creates opportunity and moves us towards achieving the United Nations’ 2030 Agenda for Sustainable Development. The case studies selected for this booklet illustrate the College’s breadth of talent, diversity of thought and extensive global outreach creating culturally relevant solutions. We are proud to have the greatest concentration of high-impact research across every major UK university and to have a unique environment where students, our work and expertise alongside our leading researchers in multi-cultural, multi-national teams. Our deep-seated culture of entrepreneurship, innovation and community-embedded solutions adds an extra dimension to this environment and our ability to impact on the SDGs. Imperial’s new White City Campus is home to a significant cluster of start-ups and growing enterprises. Our new Global Development Hub will advance our contribution to the SDGs by building communities of practice across sectors and disciplines. It will be a vital connection point for building new institutional partnerships focused on policy impact and translation of research into economic and social progress. We take our position on the global stage seriously and by working together we are confident that we will continue to make further progress towards creating a better society.

ALICE GAST
PRESIDENT OF IMPERIAL COLLEGE LONDON

Introduction

In September 2015, the leaders of the world’s nations agreed on a vision for the future of our world. It establishes priorities for urgent action to ensure the well-being of all people and the regeneration of our planet’s natural resources. It was produced through the worldwide collaborative and partnership efforts of thousands of citizens from all walks of life. It took more than two years of soundings, dialogue, expert consultations, and intense negotiations. It is called the 2030 Agenda for Sustainable Development. The vision focuses on the people, needs where they live. It is interconnected and calls for integrated responses, implemented through collective action. At its heart is a strategy built around 17 goals with multiple targets. Implementing this strategy calls for innovation in social organisation, governance, business strategies and political leadership. As an international university focused on science, engineering, medicine and business, Imperial College London is making major contributions through collaborating in both research and education. Here is what I have seen since I arrived in 2018. First, elements of the strategy are incorporated into our daily work and everyday behaviours that are reflected across the College. Its principles and goals are incorporated into our teaching, extra-curricular competitions and opportunities for all students. Second, the College seeks to ensure that vital STEM education can be accessed by school-aged students around the world. This contributes to the SDGs and inspires future generations to achieve more in years to come. Third, the 2030 Agenda encourages Imperial to nurture innovations that have relevance in a variety of different contexts internationally. Priority is given to approaches that are relevant to the SDGs and these are showcased here. Fourth, the College’s leadership is increasingly focused on the complex systems challenges that result in persistent inequalities, infectious diseases, climate change and the damage to nature. These have been made more visible as nations have sought to respond to the COVID-19 pandemic. The Imperial community is fully engaged in research, analysis, formulation of policy and action that relate to these systems challenges. As we advance into the current decade, I sense that the College will increasingly be guided by the 2030 Agenda when contributing to human and planetary well-being. That is why I am so pleased that the College’s contributions will be accelerated through a Global Education Hub, which will increase the synergy and impact of innovations flowing from groups across the College. I am delighted that our Institute of Global Health Innovation will be part of this effort. For me the 2030 Agenda is both a compass and an inspiration. I am excited to be part of the College community as we intensify our commitment to a world of the future that is sustainable, equitable, just and leaves no one behind.

DAVID NABARRO
DIRECTOR GENERAL OF THE INSTITUTE OF GLOBAL HEALTH INNOVATION AND WHO DIRECTOR GENERAL’S SPECIAL ADVISOR ON COVID-19
Tackling the threat of antimicrobial resistance

Growing levels of resistance to antimicrobial treatments present a threat to all human health (SDG3) which Imperial is tackling through an interdisciplinary programme of research and translation.

In 1928, Alexander Fleming ushered in the era of modern medicine when he discovered the antimicrobial properties of penicillin whilst working at St Mary’s Hospital (now part of Imperial). Yet, he also presciently warned that bacteria might eventually adapt and become resistant to antibiotics.

Without action to address antimicrobial resistance (AMR), there could be an estimated 10 million extra deaths a year by 2050 – with simple infections no longer easily treatable, and initially the SDGs did not have a single indicator specific to AMR. However, modern medicine, as well as SDGs 1, 2, 3 and 8, depends on ensuring life-saving drugs continue to work.

Professor Alison Holmes leads Imperial’s response to this challenge as Director of the Antimicrobial Research Collaborative. “There will be no single solution to the global threat of antimicrobial resistance,” she comments. “We need to tackle this problem synergistically, on multiple fronts, spanning technological, behavioural and policy approaches. For example, artificial intelligence for clinical decision support, pragmatic surveillance systems, online GP prescribing tools to optimise antibiotics use, interventions targeting health-seeking and health-provision behaviours, point-of-care diagnostic systems to identify pathogens and resistance, and microneedle biosensors that track patients’ antibiotic levels.”

As well as SDG3 (health and well-being), this work also contributes to SDG9 (industry, innovation and infrastructure) and to SDG10 (reduced inequalities) by looking at timely access to effective anti-infectives and excess use of antibiotics, investigating where the burden is highest within and across countries.

Empowering communities with off-grid solutions

An innovative social enterprise from the Imperial ecosystem is helping to deliver affordable, reliable, sustainable and modern energy to communities across Africa (SDG7). Global access to electricity has been steadily rising in recent decades; yet some 840 million people around the world are still entirely without it and close to three billion rely primarily on inefficient and polluting cooking systems.

In 2008, three Imperial students established a charitable organisation called eQuinox. The charity, which is still going strong today, sees students creating and installing solar kiosks in remote villages in countries such as Tanzania and Rwanda, providing electricity to communities for the first time.

After graduating, the students setup Bboxx, a next generation utility, transforming lives and unlocking potential through access to energy. Bboxx provides solar and clean cooking installations on a “pay-as-you-go” basis, helping people in areas with limited energy infrastructure access electricity and cooking solutions which they pay for using mobile money.

Bboxx has installed over 500,000 systems, monitored with Bboxx Pulse® and using machine learning to track customers’ energy use and payments. In 2019, the company raised a $30 million Series D round, led by Mitsubishi Corporation, to expand to more homes and communities in Africa. They also launched a new product line, Bboxx Cook, providing clean cooking services for both urban and rural areas using LPG.

Manooshe Hamayan, CEO and Co-Founder of Bboxx, said: “In 2021 it is unacceptable for billions of people to live in energy poverty. We are steadfast in our mission to use technology to transform lives and unlock potential and Bboxx Cook is fundamental to helping meet SDG7 – clean energy for all.”

Electricity enables local businesses to take off and catalyzes economic growth. Abreast of advancing clean energy access, Bboxx helps communities to live and work more sustainably today, for a more equitable and healthy tomorrow.

Below: Professor Alison Holmes leads a regular ward round in the adult intensive care unit at Hammersmith Hospital, where healthcare professionals are constantly vigilant for antimicrobial resistance.
Boosting global crop yields to end hunger

Working alongside industry, Imperial initiatives have helped to boost crop yields sustainably and ensure access to safe, nutritious and sufficient food all year round (SDG 2)

Imperial’s institute of Chemical Biology (ICB) Centre for Doctoral Training (CDT) provides key opportunities for students to develop new generation molecular tools and technologies to strive towards the fourth industrial revolution. One focus of the CDT is agri-science, which is driving innovation to support an increase in food demand, given the world’s population is estimated to grow to nine billion by 2050.

Students work on various complimentary research projects to develop new technologies to explore how agrochemicals, including fertilisers and insecticides, are transported within plant cells. They also look at how they interact once they reach their target. A number of the projects also team with industry leaders such as Syngenta, in order to find ways to increase plateauing yields whilst making crop production environmentally sustainable and resilient to climate changes.

Several students from the programme have established successful agri-tech start-ups. These include:

- **FungiAlert** which has developed a unique technology to provide data about the soils’ microbial community to reveal how the microbial dynamics vary with different farming practices and to identify new microbial candidates for agricultural products.
- **AnywhereHPLC**, which is developing a handheld device to monitor pesticide levels in the soil. By giving instant results it means less carbon-emitting travel for lab tests and a reduction in the over-fertilisation of crops, decreasing negative environmental impact.

Dr Laura Barter, Deputy Director of the ICB CDT, said: “By directly partnering with industry, our students learn about the agrochemical innovation pipeline, turn their research into practical tools which are having a significant impact upon society.”

Leading the fight to eradicate malaria

Researchers at Imperial are delivering major breakthroughs and radical new approaches in the fight to eradicate malaria by 2030 (SDG 3).

Despite considerable progress in preventing and treating malaria in the past two decades, the disease continues to take a heavy social and economic toll, especially in Africa. In 2018, there were around 238 million malaria cases and an estimated 405,000 deaths worldwide, mostly of children under five years old.

Imperial is now at the vanguard of the global fight against malaria, taking a truly multidisciplinary approach to the problem through the Network of Excellence in Malaria. Here, researchers are focusing on every stage of the complex life cycle of the disease, as well as diagnostics, treatment of clinical symptoms, epidemiology, mathematical modelling and economics of the disease.

Imperial also leads an international consortium, Target Malaria, which is backed by the Bill & Melinda Gates Foundation and the Open Philanthropy Project, and aims to reduce the numbers of malaria mosquitoes to reduce the transmission of the disease. Projects being led include development of innovative gene drive technology that spreads a variant rapidly through malaria-causing mosquito populations, ultimately causing their numbers to crash. The work has been validated in caged populations of mosquitoes and computer modelling shows it could significantly reduce malaria in the wild. The teams are working with local communities in the sub-Saharan African countries where Target Malaria trials will take place.

Meanwhile, another Imperial group has spearheaded efforts to identify compounds that could prevent malaria parasites from being able to infect mosquitoes, halting the spread of disease.

The leader of this research, Professor Jake Baum said: “Fighting malaria is a constant battle as parasites become resistant to antimalarial drugs. Since transmission occurs in the mosquito, drugs targeting this process have the added benefit of being naturally much more resistance-proof, which could be essential for eliminating malaria.”
Driving the global transition to zero pollution

Imperial’s aim to help the world transition to a zero pollution future encompasses many of the Sustainable Development Goals and several research projects and start-ups are already helping to create the innovative new industries and frameworks required. (SDG 2, 3, 7, 12, 13)

Imperial’s pioneering new research and education programme, Transition to Zero Pollution, will help tackle the challenge of global pollution. The programme, led by materials scientist Professor Mary Ryan, aims to help society build a future free from human-made pollution and will bring together scientists, engineers and economists collaborating on a scale not seen before. The programme will inspire fundamental changes in areas such as the way materials are used in manufacturing (SDG 12), how we produce food and energy (SDG 2 & 7), and will help mitigate the impact of air pollution on people’s health (SDG 3 and 13).

Professor Ryan, Vice-Dean (Research) of the Faculty of Engineering, said: “We see CO2 as a pollutant, a major and urgent pollutant, but not the only thing we should be thinking of. "It’s really about an entire system: thinking about pollution in the whole life cycle”.

Professor Ryan says momentum is building around the zero pollution space, but there’s even greater opportunity for government, industry and research-intensive universities to work together on problems. The programme will look to identify solutions which take a global approach to pollution and not ‘simply offshoring our problems’ to other developing countries.

Professor Ryan says “We need to be wary when, for example, somebody proposes making the most efficient, highest capacity battery that’s ever been made, without a sense of where the raw materials for that will come from and whether it’s recyclable and how that links into a broader infrastructure of power supply.”

Imperial has the foundations to deliver a framework for zero pollution through its unique multi-disciplinary centres, including the Grantham Institute - Climate Change and the Environment, the Energy Futures Lab, and Centre For Environmental Policy.

Imperial is collaborating with startup Arborea to develop pioneering ‘BioSolar Leaf’ technology to improve air quality in cities IMPEAL SDG GOALS MET:

“l’m really about an entire system: thinking about pollution in the whole life cycle”
Since its inception in 2012, all of Imperial’s students have had the opportunity to become Change Makers. Aligning with SDG 4, cross-departmental teams of students are tasked with using their skills to design broad, innovative and inclusive solutions for global challenges. In the first-year Change Makers module, students are introduced to the SDGs by critiquing the framework through the lenses of strategy, measurement and innovation. Over 240 students registered for this optional module in 2020, demonstrating the student body’s immense enthusiasm for interdisciplinary and solutions-driven learning.

Following that, the modules are directed towards teams of students designing feasible solutions for real-world sustainable development challenges. This builds upon the students’ knowledge of the SDGs, with projects focusing on the inclusion of women in development (SDG 5), smart cities (SDG 11) and health and wellbeing (SDG 3). Postgraduate students are also offered the opportunity to experience Change Makers. Elysia Lucas, a PhD candidate in the Department of Chemical Engineering, embarked on an undergraduate module and has since returned to the programme as a co-learner. Elysia states that “The Change Maker module truly enriched my degree by allowing me to explore the wider sustainable development context. Now as a co-learner, I have the opportunity to facilitate a similar experience for current students.”

Course director Dr Elizabeth Hauke is keen to emphasise the real-world impact that every person has the power to make. She states: “The first steps are for the students to build their own understandings of the issues facing humanity, alongside exploring the SDG framework. Students need to feel that the SDGs capture and frame issues that they care deeply about and empower them to create and live change in their own communities and beyond.”

Imperial College’s NExAir – Air Quality Network is bringing together a multi-disciplinary network of researchers to find a range of solutions to improving air quality for all (SDG 3, 11, 12, 13 & 15). Dr Apostolos Voulgarakis uses high-resolution satellite images at the Global Data Observatory in the Data Science Institute to examine the impact of wildfires on the environment.
Helping the injured victims of conflict around the world

Researchers at Imperial are committed to improving the health, quality of life and opportunities of survivors of blast and conflict injuries around the world (SDG 3 & 10) through interdisciplinary programmes of research and technology development.

Conflict-related death and injury are major contributors to the global burden of disease. In 2017, a partnership between Imperial, the University of Moratuwa (Sri Lanka) and the American University of Beirut (Lebanon) set up a conflict injury hub. The group is working to understand the injury burden from wars in Sri Lanka, Lebanon and Gaza, and how to save limbs after blast and gunshot injuries. The team is developing a low-cost external fixator that can be made in low-resource settings from local materials, using local machines. It is also developing biodegradable scaffolds which may also be able to prevent osteomyelitis – a bone infection often seen in these injuries.

Furthermore, the College is working in partnership with groups in Cambodia to develop a low-cost prosthesis that specifically caters for the economic, environmental, lifestyle and cultural requirements in low-resource countries. In 2019, researchers from the Centre for Blast Injury Studies (CBIS), together with Save the Children, launched the world’s first guide for treating children severely injured by explosives. The Paediatric Blast Injury Field Manual is designed for medics in war zones facing this community (SDG 10), often living with disabilities, through development of assistive technologies.”

Project lead, Professor Anthony Bull, says: “The UN Sustainable Development Goals encompass a target to promote peaceful and inclusive societies (SDG 17), but we must also address the harmful legacy of past and current conflicts around the world. Through our programmes of interdisciplinary translational research we aim to improve the health and well-being of survivors of conflict injuries in line with SDG 3. Crucially we want to try and reduce the inequalities facing this community (SDG 10), often living with disabilities, through development of assistive technologies.”

Vaccines are one of the great success stories of modern medicine, having eradicated or controlled many severe infections of major global importance, improving the lives of millions across the world. Yet, nearly one in five infants across the world, or 19.5 million children, do not currently have access to basic vaccines. Almost one third of deaths among children under five could be prevented through vaccine use. Distributing vaccines in developing countries, particularly in rural areas, is often difficult because of the need for refrigerated distribution. Yet, nearly one in five infants across the world, or 19.5 million children, do not currently have access to basic vaccines. Almost one third of deaths among children under five could be prevented through vaccine use. Distributing vaccines in developing countries, particularly in rural areas, is often difficult because of the need for refrigerated distribution. Imperial is a world-leading centre for vaccine research and is pioneering new approaches to manufacturing and outbreak response – ultimately helping to end the epidemics of coronavirus, AIDS, tuberculosis, malaria and infectious diseases (SDG 3).

Delivering vaccines to those who need them most

Imperial is a world-leading centre for vaccine research and is pioneering new approaches to manufacturing and outbreak response – ultimately helping to end the epidemics of coronavirus, AIDS, tuberculosis, malaria and infectious diseases (SDG 3).
Empowering enterprising women to drive societal change

A thriving community of entrepreneurial women has emerged at Imperial, whose ideas, start-ups and social enterprises are having a profound impact on the Sustainable Development Goals.

In total 253 female entrepreneurs have been supported, 34 ventures have been incorporated and £3.2 million has been raised in funding.

Over the past five years, the WE Innovate programme has supported hundreds of women on their entrepreneurial journeys.

253
Female entrepreneurs have been supported

“The businesses to emerge from the programme have the potential to disrupt industries, solve problems and improve lives.”

“A 2019 government-backed review found that the UK is losing out on £250 billion of economic value every year because women face barriers to becoming successful entrepreneurs. Meanwhile a recent Harvard Business Review revealed that among venture capital-financed, high-growth technology start-ups, only 9% of entrepreneurs are women. Catalysing women’s entrepreneurship and economic empowerment will accelerate the achievement of the Sustainable Development Goals, especially SDG 5 on achieving gender equality and empowering all women and girls.

Imperial has been working in this area for several years with the WE Innovate pre-accelerator programme, which caters for early stage business ideas led by women. In total over 350 female entrepreneurs have been supported, 59 ventures have been incorporated and £3.2 million has been raised in funding.

Crucially, these start-ups are having an impact on the UN Sustainable Development Goals. Alumni Olivia Ahn founded start-up Planera which has developed the world’s first certified zero-waste, flushable menstrual pads to tackle the environmental impact of disposable sanitary products. Planera is working with the Indian government to develop low cost reusable sanitary pads, that can be given to schools and villages in a bid to make menstrual health and hygiene sustainable and accessible to all.

Another student from the programme, Clementine Chambon, launched Oorja Development Solutions, which is currently working in rural India installing pay-as-you-go community solar pumping systems, as an alternative to expensive and unreliable diesel irrigations pumps. They have already run three successful pilots in the region – transforming the fortunes of farming communities.

Professor Maggie Dallman, Vice President (International) and Associate Provost (Academic Partnerships) comments: “Over the past five years, the WE Innovate programme has supported hundreds of women on their entrepreneurial journeys. At a time where fewer than one in ten venture capital dollars go to female-founded companies, this support is critical.

“The businesses to emerge from the programme have the potential to disrupt industries, solve problems and improve lives.”

Imperial SDG Goals Met:
SDG goals
start-ups

Imperial’s innovative ecosystem has produced a plethora of startups and social enterprises that are tackling the entire spectrum of SDGs.
Design and innovation meets global development

Imperial’s Dyson School is training the next generation of design engineers to create breakthrough solutions to global sustainable development challenges through the GoGlobal programme (SDG 3, 4, 11, 12).

The world’s most advanced centre for disease and emergency analytics

The Jameel Institute (J-IDEA) was set up to rapidly respond to emergencies such as pandemics, extreme climate events, and natural and humanitarian disasters (SDG 3, 13, 17). The Institute is part of Imperial College’s COVID-19 Response Team, which has been at the forefront of the response to the novel coronavirus pandemic.

From air pollution, to sexual health and from Ghana to Russia, the GoGlobal module, which forms part of the Innovation Design Engineering (IDE) dual masters programme, takes students on a three-week cross-cultural collaborative project which covers globally significant themes within a local context. The ethos of the module stems from the philosophy that impactful design can change behaviour and offer a new perspective to how teams. The conversations have been transformative, with students from the Nairobi Design and Innovation module leads from Imperial.

This most recent module was run by teaching teams from Dr Weston Baxter and Dr Kevin Chaim, a 2020 IDE graduate said “Perhaps the most powerful and memorable moments from GoGlobal stem from cultural immersion, excursions and creative discussions within multi-disciplinary teams. The conversations have offered a new perspective to how design can change behaviour and impact lives with a focus on real contextual projects.”

With particular relevance to the UN Sustainable Development Goals, The COVID-19 Response Team has developed tools which have been accessed by over 100 Low- and Middle-Income Countries (LMICs) during the pandemic. Examples includes a weekly short-term forecast of COVID-19 deaths in multiple countries and a hospital planning tool, which calculates how much capacity for COVID-19.”

The Imperial-Jameel Institute has experience in planning for, and dealing with, disease outbreaks all over the world – these have included ongoing epidemics such as malaria and HIV as well as emerging diseases such as swine flu, SARS, MERS, Ebola and Zika.

In October 2019 this expertise was consolidated with the creation of the Jameel Institute, which brings together leading epidemiologists, biostatisticians, medics and data scientists to form the world’s most advanced institute for disease and emergency analytics. Shortly after its launch, the Jameel Institute mobilised to understand the emergence of the novel coronavirus in China in January 2020. The Institute subsequently had a major influence informing government policy around the world in controlling the pandemic – primarily through its world-class epidemiological modelling.

The Jameel Institute’s Director, Professor Neil Ferguson, said “Our quantitative approach spanning data analytics, epidemiological modelling, and health system analysis, is proving a powerful tool in combating the threat of COVID-19.”

Below: Imperial’s Dyson School is training the next generation of design engineers to create breakthrough solutions to global sustainable development challenges through the GoGlobal programme (SDG 3, 4, 11, 12).
Paving the way for next-gen quantum tech

Imperial is pioneering fundamental research into next-generation quantum technologies which could herald a step change in drug design and even climate modelling.

Scientific breakthroughs into the behaviour of matter at the smallest scales by figures such as Albert Einstein and Niels Bohr at the beginning of the 20th century underpin our modern world. The semiconductors in our digital devices and the fibres that connect them globally all take advantage of the basic principles of quantum mechanics. Researchers are now looking to exploit some of the more unusual phenomena of the quantum world, for example where subatomic particles can essentially exist in more than one state or place at the same time. Imperial has a world-leading presence here, in both theory and practical applications, for example through the work of the Imperial Centre for Quantum Engineering, Science and Technology. Quantum computing is one exciting area of current study. “There are classes of problems that you just can’t solve on any foreseeable future generation of conventional computer,” says Professor Ian Walmsley FRS, Imperial’s Provost and Chair of Experimental Physics. “One of the things that is plausible is simulations of other quantum systems: the idea that you can understand molecular structures and dynamics better and use that to help design molecules for bioprocesses – such as drugs, or more efficient fertilisers. What quantum computing brings is the possibility that we might have a way to do that, which could be transformative.”

Quantum computers have the potential to help in the design of better energy storage materials, logistics and supply chain problems, and even potentially fluid dynamics modelling for understanding climate change. There are also a whole host of other quantum technologies, such as quantum sensing, quantum imaging and even quantum compasses for better navigation. They all have the potential to help with solving Sustainable Development Goals (SDGs), but the important thing is to seed many ideas as a foundation for the future, says Professor Walmsley. “The way scientists work is to identify an important question and then to seek the best answer. Nine times out of 10, it turns out not to have an immediate use beyond new understanding, that’s just the nature of exploration. So if we need a group of ideas to build applications from, that will in turn help the SDG challenges, then we better have a large enough pool of good ideas to draw from. In that sense fundamental research remains really critical.”

Energy Futures Lab is Imperial’s global energy institute and aims to promote energy innovation and advance systemic solutions for a sustainable energy future. The institute supports researchers by bringing together the science, engineering and policy expertise at Imperial and fostering collaboration with a wide variety of external partners, and runs an outstanding interdisciplinary Masters’ programme. Energy Futures Lab builds networks with leading international institutions to support research with global impact.

Researchers at Imperial have also been integral to the cleantech revolution. Ceres Power, which is one example of a spin off company launched from Imperial’s research, is now one of the UK’s most valuable cleantech companies. It has been making fuel cell technology accessible and cost effective for a variety of applications, including transport, data centres, homes and commercial purposes.

Professor Nigel Brandon, Dean of Imperial’s Faculty of Engineering, and his colleagues in the Department of Materials first produced the research upon which Ceres Power is based over 20 years ago. He states: “Imperial has long been at the forefront in developing and refining electrochemical technologies such as fuel cells and batteries that underpin the shift to low carbon transport – and this work is starting to have a tangible impact as industries mature and scale up.”

Imperial brings together science, engineering and policy to generate positive energy solutions for the global stage, in strong alignment with SDGs 7, 9, 11 and 13.
Many current screening approaches often call for expensive equipment and trips to the clinic, which may not be feasible in rural or developing areas with little medical infrastructure. The emerging field of point-of-care diagnostics is therefore working on cheaper, faster, and easier-to-use tests.

For several years, the lab of Professor Molly Stevens (pictured, right) at Imperial has been pioneering the design and development of nanomaterials-based biosensors that could be used to detect a number of diseases with global implications including HIV, malaria, tuberculosis, heart disease and cancer.

Professor Stevens and team also published a framework in Nature detailing how healthcare workers in low-income countries could use existing smartphones to diagnose, track and control infectious diseases.

Many smartphones have sensors built in that could aid diagnosis, such as heart rate monitors and accelerometers, while simple testing technologies, of the like Stevens and team are developing, could be linked to phones. In theory, a person could test themselves using an app to collect sample, such as a pinprick of blood, and the results would be scanned onto mobile apps and sent to local clinics.

Professor Molly Stevens said: “People increasingly use smartphones to manage their money and connect with the world. It makes sense that phones can also play an even larger role in healthcare, bringing an end to the epidemics of AIDS, tuberculosis, malaria and infectious diseases by 2030 relies on cheaper, faster, and easier-to-use tests.”

The analysis of this unique digital dataset allows the definition of optimal portfolios of sustainability initiatives for each economic sector, maximising companies’ financial, social and environmental performance. This approach enables the design of integrated sustainability strategies, investment decisions and public policy interventions based on frontier research and scientific evidence.

Professor Zollo says: “Our ambition is to contribute to the definition of the most effective evolutionary pathways for companies, sectors and countries towards the realization of SDGs.”

The emerging field of point-of-care diagnostics is therefore working on cheaper, faster, and easier-to-use tests. The analysis of this unique digital dataset allows the definition of optimal portfolios of sustainability initiatives for each economic sector, maximising companies’ financial, social and environmental performance. This approach enables the design of integrated sustainability strategies, investment decisions and public policy interventions based on frontier research and scientific evidence. Professor Zollo says: “Our ambition is to contribute to the definition of the most effective evolutionary pathways for companies, sectors and countries towards the realization of SDGs.”
THE WISER PROJECT
Working towards cleaner water to prevent schistosomiasis

To reduce the incidence of the parasitic disease schistosomiasis, the WISER research group are exploring water processing techniques to remove or inactivate schistosome cercariae (larvae) in infested water.

Schistosomiasis, also known as bilharzia or ‘snail fever’, is a parasitic disease affecting an estimated 258 million people in 78 countries worldwide. It kills an estimated 280,000 people annually and ranks second only to malaria as the most common parasitic disease. The disease affects an estimated 258 million people in 78 countries worldwide. It kills an estimated 280,000 people annually and ranks second only to malaria as the most common parasitic disease. The disease causes infection. The interdisciplinary ‘Water Infrastructure for Schistosomiasis-Endemic Regions’ (WISER) team consists of water engineers, synthetic biologists, parasitologists and social scientists. These experts, hailing from the UK, Ethiopia and Tanzania, have come together to help tackle the challenges of SDG 6 (Clean Water and Sanitation) and SDG 3 (Good Health and Well-being). The research is funded by the EPSRC via the Global Challenges Research Fund.

One of the important impacts of this research is that it will inform the forthcoming updated edition of the WHO’s Schistosomiasis Fact Sheet, which will serve as authoritative guidance for worldwide schistosomiasis prevention practices. Professor Michael Templeton, the Principal Investigator of WISER also considers that “our research has raised awareness regarding schistosomiasis and its links with water and sanitation in our five research case study communities in Ethiopia and Tanzania, and the aim is that the behaviour change communication techniques that were trialled there during this project will be rolled out to further communities in coming years.”

IMPERIAL SDG GOALS MET:

Building equitable, healthy cities

Partnering with six major cities around the world, Imperial leads a project using interdisciplinary methods and big data to help urban centres become ‘inclusive, safe, resilient and sustainable’ (SDG 3, 11).

More than half of the world population now lives in cities, with mega-cities such as Beijing and Dhaka home to more than 10 million people. Significant population growth is also expected in smaller cities, largely in low- and middle-income countries in Africa and Asia. Despite greater opportunities and better access to services in cities, there are growing health and life inequalities between the rich and poor.

In 2018, a major new research partnership was launched to explore ways of reducing health inequalities in cities around the world. Led by Imperial and funded by the Wellcome Trust, ‘Pathways to Equitable Healthy Cities’ focuses on co-production of rigorous evidence with partners in six cities: London, Vancouver, Tamale, Accra, Dhaka and Beijing.

Professor Majid Ezzati, who co-leads the project, says: “People have always lived in cities in order to have better opportunities for health and wellbeing. However, cities in both poor and rich countries are also a setting for inequalities that are fundamental barriers to sustainable human development.

‘What we need are plans and policies that leverage cities’ potential for innovation to improve the health of low-income and marginalised groups.

Crucially, the project uses interdisciplinary methods from social sciences, engineering, environmental science, epidemiology and big data to evaluate how policies and programmes can improve public health in urban regions.

For example, in 2019, Professor Ezzati and team published research showing how deep learning analysis of street-view images can be used to measure social, environmental and health inequalities in cities. This could be a helpful tool in monitoring the success of policies to reduce inequality, since open source data are updated more frequently than some government surveys or census data.
School students around the world compete to tackle the SDGs

In accordance with one of its key priorities of encouraging STEM engagement from an early age and SDG 4, Imperial has established a Schools Science and Innovation Competition which drives students to design solutions for specific SDGs.

This competition, run by the Faculty of Natural Sciences, was initially designed for London based schools, but soon became popular across the UK and then attracted entrants from around the world including China, India, Thailand and the USA.

Since 2018, the competition has been designed to emphasise innovations which specifically align to the SDGs. Teams of secondary school students select an SDG and create a novel idea to help tackle the SDG. Each team then submits a film depicting their idea and also has the opportunity to create a prototype. Six teams are then selected from approximately 150 entries from across the world to present their idea in person at Imperial in London. The entries are judged in a Dragon’s Den style format by esteemed judges, who for past competitions have included Professor Lord Robert Winston.

Winning ideas include “Aqua Power”, submitted by a team from Ashmole Academy in Southgate, UK, which focused on hydropower generation aligning to SDG 7 (Affordable and Clean Energy). A team from Pui Ching Middle School in Macau were successful the following year with their “Zinc-air batteries”, also aligning to SDG 7.

Competition organiser and Faculty Education Manager, Becky Middleton, states, “I am always amazed by the creativity and ingenuity of the ideas that the teams come up with to meet the sustainable development goals. It is an absolute privilege to be able to run the competition, to see such interest in science and innovation from young people across the world, and their genuine passion and enthusiasm for making a difference.”

Faculty of Natural Sciences competition organiser and

Below: A team of pupils from Ashmole Academy in London won Imperial’s Schools Science Competition with ‘Aqua Power’, a project focused on hydropower generation

Tackling childhood mortality in sub-Saharan Africa

Over the past 20 years, Professor Kathryn Maitland and her team have pioneered new research into treating children with severe malaria, anaemia, sepsis and malnutrition in sub-Saharan Africa – conducting some of the largest clinical trials in the continent that have helped drive down child mortality (SDGs 3 & 10).

According to the UN, the global childhood mortality rate for under-5s fell from 93 deaths per 1,000 births in 1990, to 38 deaths per 1,000 in 2019. While this data represents important progress, there is still much work to be done, with the data also revealing that in 2019, an estimated 5.2 million children aged under 5 died in Africa, often from preventable causes.

Since 2000, Imperial’s Professor Kathryn Maitland has been based full-time in East Africa, leading a group that has pioneered emergency care research to tackle childhood mortality in resource-limited hospitals in sub-Saharan Africa.

Professor Maitland has been based full-time in East Africa, leading a group that has pioneered emergency care research to tackle childhood mortality in resource-limited hospitals in sub-Saharan Africa.

Professor Kathryn Maitland and her team have pioneered new research into treating children with severe malaria, anaemia, sepsis and malnutrition in sub-Saharan Africa – conducting some of the largest clinical trials in the continent that have helped drive down child mortality (SDGs 3 & 10).
Since 2010, Imperial has run the pioneering Wohl Reach Out Lab to inspire and engage young people from all backgrounds in science, technology, engineering, and mathematics (STEM). With the development of the new White City Campus in West London, the College has taken its model of hands-on STEM outreach even further, opening The Invention Rooms in 2017. This unique space offers local people the opportunity to access workshops, cutting-edge design studios and interactive spaces to help them test out creative ideas, build real prototypes, and learn more about the world of science and technology.

Professor Maggie Dallman, Associate Provost (Academic Partnerships), said: "Our White City Campus is being purpose built to turn cutting-edge scientific research into real-world benefits for society and to address Sustainable Development Goals such as global health – SDG 3, clean energy – SDG 7 and climate change – SDG 13."

In addition to this, by engaging with the local White City community in exciting new ways, Imperial is also striving to create an inclusive society, reduce inequalities and provide equitable lifelong learning opportunities for all, in line with SDGs. Indeed, a specific target of SDG 4 is to ‘increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship’ – which is exactly what Imperial is striving to do at White City.

A number of transformative initiatives have been running from The Invention Rooms, including Maker Challenge programmes for local young people to develop an idea and see it through to creation; Agents of Change, a unique women’s leadership programme and network which aims to support local women lead social change in their communities; and a What the Tech?! programme to help older members of the community get online and get the most out of their smartphones, laptops and other digital devices.
Research by Imperial physicists spans local energy and health tech discoveries

"Through a greater understanding of nature, we often gain new insights into how to solve problems facing humanity – something which we actively champion and encourage" – Professor Michele Dougherty FRS, Head of Physics.

Imperial’s Department of Physics has numerous breakthrough achievements to its name. Two such examples are the design of low-cost solar energy technologies to combat climate change, aligning with SDGs 7 and 13, and developing microscopy techniques and cancer research, driving towards SDGs 3 and 12.

Since 1989, Professor Jenny Nelson FRS has conducted research focusing on understanding the properties of semiconductor materials and investigating their application in low-cost organic solar cells. In 2010, Professor Nelson and her team began working with Imperial’s Grantham Institute to deliver clean energy systems for developing countries. This research has culminated with the design of ‘mini-grids’ that incorporate solar and other renewable forms of power generation – delivering working solutions for a refugee camp in Rwanda and a rural community health centre in India.

Professor Paul French, Vice Dean (Research) for the Faculty of Natural Sciences, is driving health technologies through physics. His team is developing an open source, modular, sustainable, low-cost instrumentation platform to widen access to cutting edge microscopy techniques for research, training and diverse applications including histopathology. He also leads a consortium supported by funding from Cancer Research UK to develop innovative 3D fluorescence microscopy techniques to study mechanisms of cancer drug resistance and help screen for new, more effective cancer treatments – ultimately helping to ensure healthy lives at all ages.

IMPERIAL SDG GOALS MET:

Delivering innovative solutions to improve global health

For 10 years, a unique institute at Imperial has been improving global health through evidence-based innovation – from developing wearables to tackle undernutrition to designing digital apps to support stroke survivors’ rehabilitation (SDG 3,10).

The Institute of Global Health Innovation (IGHI) brings together a multidisciplinary team of clinicians, engineers, designers, policy analysts and scientists. It includes five centres focused on: health policy, robotic surgery and technology, design in healthcare, patient safety, and African research and engagement.

Since forming in 2010, IGHI has had a profound and wide-ranging impact on the SDGs, including ensuring healthy lives at all ages, tackling inequalities in health care, and improved nutrition.

The Institute has developed a range of technologies that are currently being evaluated for their potential use and benefit in real world settings, including a digital platform that supports stroke survivors in their own recovery. IGHI researchers are also developing wearables for a number of different applications, including AI-powered devices that can assess the diets of people in developing nations and thus support the development of policies aimed at reducing undernutrition.

IGHI is also home to a team of digital health experts who are leading an ambitious programme of work on cyber security in healthcare. Their recent global framework for cyber security in healthcare aims to help safeguard health systems across the globe from the growing and present threat of cyber-attacks.

In response to increasing recognition of the impact of climate change on mental health, the Institute has also launched an initiative that aims to better understand and respond to this complex issue through research, innovation and policy.

In Summer 2019, IGHI partnered with the World Health Organization to make patient safety a global priority and improve the safety of care across the world – with a specific focus on low- and middle-income countries.

Professor the Lord Ara Darzi, IGHI Co-Director, said “Improving the safety of care is of paramount importance if we are to achieve the ambitious target of universal health coverage, where all people have the basic right of access to the health services they need.

“We can accelerate essential progress in patient safety that brings us closer to attaining international goals to develop safe and universal healthcare.”

IMPERIAL SDG GOALS MET:

ABOVE: Advanced nanocrystalline solar cells fabricated at Imperial, with one cell tested to drive an electric fan.

ABOVE: Delivering innovative solutions to improve global health.

BELOW: The Institute of Global Health Innovation (IGHI) brings together a multidisciplinary team of clinicians, engineers, designers, policy analysts and scientists.
Managing rainforest for the ecological and economic benefit of all

The oil palm industry has helped eradicate poverty and boost food production in the Far East, but unfeigned expansion of oil palm plantations can have a detrimental impact on the environment. The Stability of Altered Forest Ecosystem (SAFE) Project, led by Imperial, seeks to understand if plantations can have a detrimental impact on the environment.

For over a decade, Imperial has led one of the world’s largest ecological experiments in Malaysian Borneo to understand the impact of agriculture on the rainforest and how to achieve food production (SDG2), economic benefit (SDG8) and ecosystem preservation (SDG15) for the benefit of all (SDG12).

The SDGs

Synthetic biology paves the way for new drugs, materials, fuels and food

Advances in synthetic biology being made at Imperial are ushering in the next industrial revolution and a suite of new therapeutic drugs, sustainable materials, biofuels and foods. The innovative new organisms and materials produced using synthetic biology have exciting potential to advance many of the sustainable development goals (SDG 3,6,8,9,11,12,14,15).

Synthetic biology uses engineering principles to redesign or construct organisms and biological systems. By exploring new ways to engineer biology, scientists can harness nature to solve many of the challenges facing society today, from healthcare to biomaterials and sustainable energy.

Imperial is a world leader in synthetic biology, with interdisciplinary activities coordinated via the Imperial College Centre for Synthetic Biology (IC-CSynB). The Centre delivers world-class academic research and training and also works in partnership with SynbiCITE, the UK’s national centre for industrial translation and commercialisation of synthetic biology research, and the London DNA Foundry, which automates the design and manufacture of biological devices.

This offers a unique R&D and innovation pipeline that enables the transfer and application of academic research to tackle global challenges.

For example, in 2018 an Imperial group made a major breakthrough, vastly improving the efficiency and yield of the bioprocess used to make products such as biofuels, bioplastics and new medicines by modifying a key enzyme. It could help bring biofuels to the mainstream for a range of applications such as low carbon transport and clean electricity generation.

Meanwhile, in 2019 another group developed a new bio-scaffold that actively works with the body’s natural repair systems to drive the healing process. The technique could be used in a variety of injuries such as fractured bones, scar tissue after heart attacks, damaged nerves and diabetic foot ulcers.

Professor Guy-Bart Stan, Co-Director of the Imperial College Centre for Synthetic Biology, says: “The methods and techniques of synthetic biology and the new industries it is creating will be pivotal enablers in achieving many of the UN Sustainable Development Goals – from food security and sanitation through to clean energy and good health. With Imperial’s established pipeline of innovation in this area, from fundamental research though to application, we’re already having a tangible impact.”

The methods and techniques of synthetic biology and the new industries it is creating will be pivotal enablers in achieving many of the UN Sustainable Development Goals – from food security and sanitation through to clean energy and good health. With Imperial’s established pipeline of innovation in this area, from fundamental research though to application, we’re already having a tangible impact.

Meanwhile, in 2019 another group developed a new bio-scaffold that actively works with the body’s natural repair systems to drive the healing process. The technique could be used in a variety of injuries such as fractured bones, scar tissue after heart attacks, damaged nerves and diabetic foot ulcers.

Professor Guy-Bart Stan, Co-Director of the Imperial College Centre for Synthetic Biology, says: “The methods and techniques of synthetic biology and the new industries it is creating will be pivotal enablers in achieving many of the UN Sustainable Development Goals – from food security and sanitation through to clean energy and good health. With Imperial’s established pipeline of innovation in this area, from fundamental research though to application, we’re already having a tangible impact.”
Mastering the elements

Imperial delivers a range of innovative Masters' degrees that equip the scientists and leaders of the future to tackle sustainable development challenges

**GLOBAL HEALTH**

Imperial is a world leader in public health research (SDG 3) and is now also helping to equip the future leaders of this field through an innovative education programme. In 2019 the College launched the Global Master of Public Health, its first fully-online degree in the health field, which provides ‘inclusive quality education’ (SDG4) across the college. Professor Helen Ward, who is leading the team tasked with developing the new course said: “We face growing epidemics of long-term conditions such as diabetes and obesity, the emergence and re-emergence of some serious infectious diseases, and developing health impacts of climate change, environmental hazards and inequality. Public health tools exist to mitigate many of these threats, but there are far too few people with the expertise to use these to best effect across the world. The Global Master of Public Health is helping to train a cadre of public health leaders to meet these needs.”

**MSC ENVIRONMENTAL TECHNOLOGY**

Applying a sound understanding of science and technology to develop practical policy and management solutions to contemporary sustainability issues is the foundation of Imperial’s MSc in Environmental Technology. For over four decades students from across the world and from a variety of professional backgrounds have come together to focus on the intersections between science, technology and policy. Tania Castillo Guido, a recent alumnus of the course from Peru says: “through a combination of lectures, field trips, and practicals, the MSc allowed me not only to learn how to identify and mitigate potential environmental impacts but also how to work collaboratively within a multidisciplinary team to create environmental strategies.”

**MSC CLIMATE CHANGE, MANAGEMENT & FINANCE**

Partnering with prominent Imperial initiatives the Grantham Institute and the Centre for Climate Change and Investment, this masters’ programme focuses on climate change and sustainability knowledge tailored for the business world, aligning with SDGs 7, 8, 9 and 13. A recent graduate of the course, Sudhiksha Unnikrishnan says: “The faculty are actively engaged in climate change in one way or another which means that the kind of insights they are able to give in class are unparalleled...the cohort is also extremely diverse, both in terms of nationality and cultures but also in terms of academic background, which means that teamwork is very exciting.”

Calculated progress – Mathematicians progressing the SDGs number by number

As mathematics underpins our understanding of life and the universe, research at Imperial’s Department of Mathematics spans many diverse topics including measurement towards the SDGs and specific SDG directed research.

**WILE assing progress towards the SDGs necessarily relies on statistics,** Imperial statisticians have recently interrogated the basis of official statistics and thus the measurement of progress. In their recent publication “From GDP to Sustainable Wellbeing: Changing Lives or Changing Statistics”, Professors Paul Ailion and David Hand also explore what improvements could be made for wellbeing and the 2030 Agenda. Furthermore, research by Imperial’s statisticians has also contributed to a new framework for monitoring COVID across the UK and the world, strongly aligning to SDG 3. With another strong drive towards SDG 3, the EPSRC Centre for Mathematics of Precision Healthcare connects mathematicians, engineers and computer science with medical science to address issues ranging from patient journeys to population analysis. An example of the centre’s research is developing mathematical tools to determine disease progression through clusters of symptoms. Climate change (SDG 13) is also a key focus for the Department. The EPSRC funded Mathematics of Planet Earth Centre for Doctoral Training trains students in mathematical and computational techniques required to predict and quantify uncertainty and risk for extreme weather and climate change.

**GLOBAL OUTREACH**

Imperial’s Department of Mathematics is further demonstrated through the relationship with African Institute of Mathematical Sciences (AIMS). AIMS’ former President, Professor Francis Allotey, who studied at Imperial in the 1960s, was the first Ghanaian to obtain a doctorate in mathematical sciences. His return to Ghana facilitated the strong partnering of Imperial’s mathematicians and engineering and computer science through the AIM’s relationship with African Institute of Mathematical Sciences (AIMS). His return to Ghana facilitated the strong relationship between Imperial and Ghana. AIMS has six centres of education and research across Africa and academics which include pure mathematics and statistics.
Imperial’s new Global Development Hub

We know that the SDGs can only be realised with strong equitable partnerships and cooperation across the disciplines (SDG 17). For many years Imperial’s students, staff, alumni and the wider College community have pursued education and research towards the 2030 Agenda for Sustainable Development and beyond. Imperial’s new Global Development Hub aims to create a central repository for these initiatives whilst establishing new networks and education programmes for the College.

The recently launched Global Development Hub has already hit the ground running. In order to promote the SDG-aligned work across Imperial and the wider community, the Hub has launched an SDG of the Month event series. For the first event, panelists from Imperial’s Business School and School of Public Health joined representatives from UNICEF and Good Things Foundation to provide interdisciplinary perspectives on SDG 10, Reduced Inequalities, and the digital divide.

In addition, the Hub has worked with representatives from UNDP posts in India, Nepal, Niger and Palestine to discuss the work of the UNDP Accelerator Labs in their countries towards SDG 5 and reducing gender inequalities. These events create opportunities to explore new innovative partnerships that move away from traditional academic partners to work with local groups that have in-depth knowledge of the issues in their communities.

Hub Co-Chair, Professor Mike Templeton says: “We are incredibly excited to be developing this interdisciplinary Hub which connects all Faculties, Institutes and facets of Imperial towards the goal of sustainable development. Imperial’s global reach in education and research enables us to forge some fantastic partnerships and we are looking forward to creating more opportunities and programmes going forward.”

Below: Professor Mike Templeton, Professor of Public Health Engineering, leads Imperial’s Global Development Hub