

Horizons

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Pioneering research from
the University of Cambridge



UNIVERSITY OF
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November 2020 Contents

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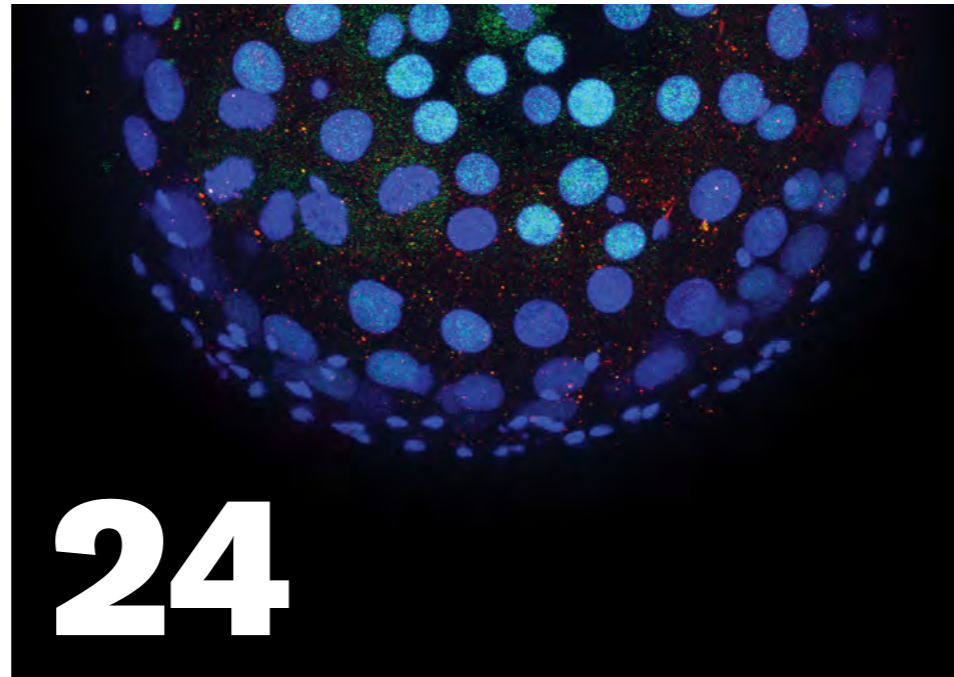
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Spotlight Reproduction



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Surviving birth

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Fertility futures

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Foreword

Vice-Chancellor Professor Stephen J Toope introduces a special focus on COVID-19 research.

Image Machines developed by a Cambridge University spinout being used to diagnose infection with SARS-CoV-2 at Cambridge University Hospitals NHS Foundation Trust

To remark that the past year has been unusual is an understatement. Things that seemed unimaginable this time last year – the clear and present risk to public health, the shutting down of our institutions, the cutting off of our social contacts – were, quite suddenly, the new pattern of our lives.

It fills me with enormous gratitude that, at the moment of greatest challenge, our community rallied and rose to the occasion. Colleagues across the collegiate University worked tirelessly to modify teaching and assessments, develop new systems for business-critical activities, manage the closing and reopening of buildings, and put together public health measures to keep everyone as safe as possible.

Meanwhile our researchers jumped into action. Dozens of new research projects began on the nature and transmission of the SARS-CoV-2 virus, on finding therapeutics and a vaccine, and on understanding the impact of anything from mental health to social behaviour.

Work had already started on this edition of *Horizons* when the national lockdown was announced in March. The enforced pause offered an opportunity to rethink its contents to highlight some of Cambridge's extraordinary contributions to tackling the COVID-19 crisis.

The projects highlighted here are the tip of the research iceberg. You will read of how one of our newest institutes – the

Cambridge Institute of Therapeutic Immunology and Infectious Disease – pivoted almost the entirety of its research towards studying, treating and testing for COVID-19. And of how the University and nearby Wellcome Sanger Institute are leading the COVID-19 Genomic UK (COG-UK) Consortium, a major national effort to deliver large-scale and rapid whole-genome sequencing of the virus to guide UK public health interventions.

Others focused on NHS capacity, and on the logistics and supply chains for frontline resources like personal protective equipment. An award-winning, low-cost, open-source ventilator was designed for use in low-income countries by a team from the Department of Engineering's Whittle Laboratory, working with colleagues from the Institute for Manufacturing and in collaboration with a manufacturer in South Africa.

A large number of research projects have also begun on post-COVID recovery, including studies on the economic impact of the pandemic on social and educational equality and, vitally, on how we can prevent future pandemics.

And there is so much more – again and again we've seen researchers across the disciplines contribute their time and expertise at this challenging time. We often remark on the University of Cambridge's mission: to contribute to society through education, learning and research. I cannot think of a more

powerful contribution to society than Cambridge's response to this global health emergency.

As this issue of Horizons was being completed, we learned with deep sadness of the sudden death of our colleague Professor Chris Abell. As Pro-Vice-Chancellor for Research since 2016, Chris helped to coordinate and support the University's research endeavour, the results of which have regularly been reviewed in this magazine. He was instrumental in coordinating the University's response to the national need for COVID-19 testing. Much of what is covered in this special issue was made possible, in some way, thanks to his personal efforts. He will be missed by all of us.



COVID-19

People powered



Professor Julia Gog OBE
Department of Applied Mathematics and Theoretical Physics

Julia Gog is an expert on modelling the transmission of infectious diseases like influenza. Since the start of the crisis, she has been focusing on the spread of COVID-19, particularly among children, and in schools and universities – and advising the government via the Scientific Advisory Group for Emergencies (SAGE) and Cambridge's Centre for Science and Policy.

Her team looks at how and when people come into contact to work out the virus reproduction ratio, R, which in turn helps to model how a pandemic spreads. The evidence has been used to shape advice on options for reopening schools and developing principles for future interventions.

“Our knowledge of the virus is building very quickly, as is our understanding of the changing patterns of spread in the UK,” she says. “We’re doing our utmost to address the right questions quickly, to ensure the science can best inform good policy.”



Dr Jag Srail
Department of Engineering

Manufacturing firms have had a rocky few months, and yet some have not only survived but also thrived during the pandemic. This could be ‘Operational Darwinism’ in action says Jag Srail – and the results could help businesses prepare for future disruptions.

“The pandemic has sent a shockwave across all sectors, with firms thrown into chaos by unstable supply and demand. It’s normal to have disruption at times, but the crisis has brought fracturing at multiple points in the supply chain and it’s been difficult for firms to anticipate where these failures will be.”

Srail and colleagues have been watching carefully. They’ve noticed that changes triggered by the crisis are liberating some to experiment with new ways to make products. Transitions in business and operational models that would normally take five to 10 years have been happening in just a few months.

“We are now distilling what manufacturing firms can learn from this period of mass experimentation at scale.”



Professor James Wood
Department of Veterinary Medicine

James Wood works on zoonoses – diseases caused by viruses like SARS-CoV-2 that jump between animals and humans. He leads several large-scale programmes aiming to reduce zoonotic spread in Sub-Saharan Africa and India. He’s worried that the health infrastructure in these regions could easily be overwhelmed, and that health and wealth inequalities will be accentuated.

Wood’s focus during much of 2020 has been on organising the Vet School’s research and policy responses to the crisis in the UK, and working with colleagues to do the same through Cambridge Infectious Diseases, one of the University’s Interdisciplinary Research Centres.

“I suspect that the pandemic will further raise interest in zoonotic infections and help us to do more about them. This has been a colossally neglected area. I hope that future pandemics like this can be averted through better preparation and evidence-based policies.”



Professor Duncan McFarlane
Department of Engineering

Duncan McFarlane admits he knew very little about hospital operations before March this year but, as the scale of the pandemic became apparent, he and a team of Cambridge students and staff thought they could help.

“Hospitals were scrambling to make the operational changes needed to deal with a surge in COVID-19 patients. We offered to apply what we know from industrial settings: instead of production lines it would be wards; instead of products and materials it would be the flow of patients and supplies.”

Working with local hospitals, the team adapted information engineering principles to manage the flow of patients and to anticipate shortages of beds, equipment and staff. They helped design, set up and manage a temporary logistics hub for millions of items of donated PPE, and designed, built and tested an emergency ventilator sharing system in just four weeks.

Since August, McFarlane has also been responsible for the logistics of the University-wide Asymptomatic Pooled Student COVID-19 Testing Programme, working with clinicians, students and staff to prepare test kits and deliver and collect student test samples from Colleges.



Professor Sarah-Jayne Blakemore
Department of Psychology

Humans are inherently social. The parts of the brain that enable us to recognise the mental states, feelings and actions of others develop throughout adolescence – so what happens when teenagers have reduced face-to-face contact during a pandemic? This is a question that concerns Sarah-Jayne Blakemore.

“The pandemic has meant young people have had fewer chances to interact in person with peers at a time in their lives when this is crucial for their development. Waves of social distancing and restrictions, even if only temporary, represent a large portion of a young person’s life.”

She and colleagues have been studying the impact of social distancing on the development and mental health of adolescents, and are now looking at the effects of social isolation on their cognition and emotions. “Digital communication has been a lifeline to many and so our study will look at whether social media lessens the effects of social distancing – if so, how much social media and what kind?”

She has also been involved in setting up Reachwell, an organisation highlighting the needs of young people when pandemic-related policy decisions are being made.



Professor Diane Coyle CBE
Bennett Institute for Public Policy

Economist Diane Coyle says that it’s not possible to avoid the economic hit of a global pandemic, “but it’s essential to be aware of why the pandemic will be particularly damaging to living standards, and to ensure these lessons inform future policy choices.”

She’s especially worried about productivity, particularly in today’s ‘knowledge economy’ and how ideas and technology shape work and daily lives. During lockdown, she looked at what was happening to the household division of labour and economic activity – and the effects of government policies in the face of collapsing productivity.

“Governments around the world have, rightly, turned to massive spending to try to limit the immediate damage to people’s livelihoods. But fiscal sticking plasters, no matter how big, need something to stick to. It will not be long before the crisis management focus needs to turn from public health to repairing the engine of prosperity.”

As one of the Directors of the new national £32.4m Productivity Institute, she will be working with others in Cambridge and the UK to tackle questions of job creation, sustainability and wellbeing in the UK’s post-pandemic future.

Meet a few of the many who are helping to address the spread and impact of the global pandemic.

Words Louise Walsh
Illustrations Tracy Worrall

As the COVID-19 pandemic sent Britain into lockdown, researchers on the Cambridge Biomedical Campus were at the heart of the University's response to this unprecedented challenge.

Words Craig Brierley
Illustrations Zoë Barker

“In it for the long haul”

When I first meet Professor Ken Smith in his new office, out of instinct we go to shake hands. There's an awkward moment as we remember the public health advice and stop ourselves, opting for 'elbow bumps' instead.

It's 10 March and we're at the Cambridge Institute of Therapeutic Immunology and Infectious Disease (CITIID), which opened in autumn 2019 in the Jeffrey Cheah Biomedical Centre with Smith as its Director. Less than two weeks after we meet, Britain entered lockdown as SARS-CoV-2 swept across the country.

By the time I return months later, the building – and, indeed, the world – is a

very different place. There are fewer people about. Hand sanitiser dispensers greet you at the entrance and signs remind you to keep your distance.

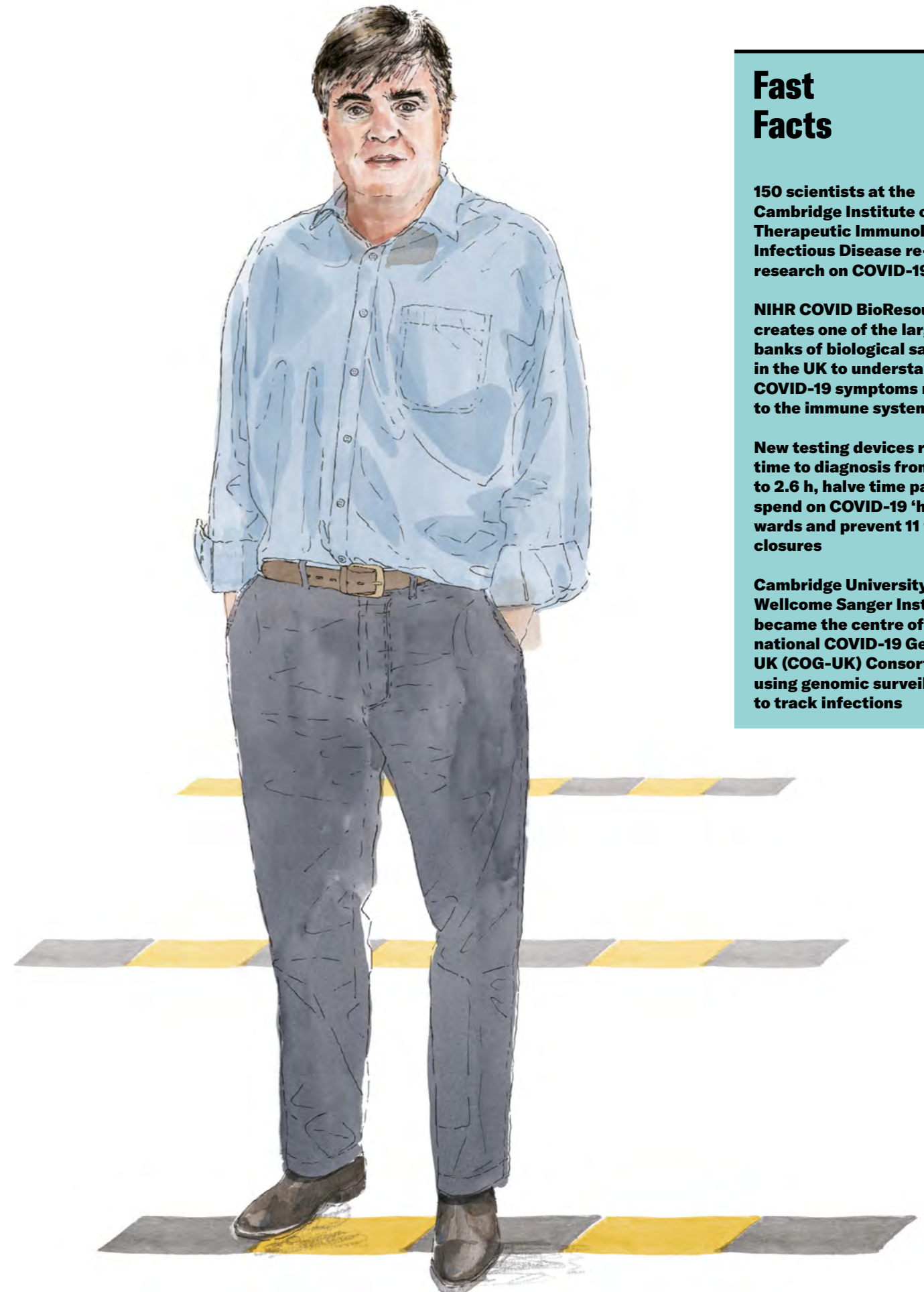
But beyond the visible transformation, something fundamental has changed. CITIID was one of the few University buildings to remain open throughout lockdown. As the world faced an unprecedented threat, Smith knew his team had vital expertise that could help fight the pandemic.

“The Institute was really set up to deal with this sort of thing,” says Smith. He had intentionally recruited people with a broad range of expertise, including immunology, inflammation, infectious

disease, virology, cell biology, global health and pathogen surveillance.

Running at about 50% capacity, CITIID's labs have had around 150 scientists working on COVID-related areas, including researchers from labs across the Cambridge Biomedical Campus. Some 60% of the Institute's group leaders also work at one of the hospitals on the campus, including Addenbrooke's Hospital, part of Cambridge University Hospitals NHS Foundation Trust (CUH).

Back to basics SARS-CoV-2 is a coronavirus: spherical, with 'spike' proteins on its surface that bind to →



Professor Ken Smith
Director of the Cambridge Institute of
Therapeutic Immunology and Infectious Disease

Fast Facts



150 scientists at the Cambridge Institute of Therapeutic Immunology and Infectious Disease re-focus research on COVID-19

NIHR COVID BioResource creates one of the largest banks of biological samples in the UK to understand how COVID-19 symptoms relate to the immune system

New testing devices reduce time to diagnosis from 26.4 h to 2.6 h, halve time patients spend on COVID-19 'holding' wards and prevent 11 ward closures

Cambridge University and Wellcome Sanger Institute became the centre of the national COVID-19 Genomics UK (COG-UK) Consortium using genomic surveillance to track infections

ACE2, a receptor found on cells in the upper respiratory tract, nasal pharynx and lungs – which is why the virus can spread by airborne infection.

“There’s still a question mark over what ACE2 actually does in the airways,” says Professor Paul Lehner, who leads CITIID’s Intracellular Immunity Team.

His group is using genetic approaches to understand why ACE2 is important

and to look for other factors that might help the virus to enter cells. They are also using their expertise in proteomics – the study of proteins – to work out how the virus manipulates the host cell’s machinery to enable it to replicate, yet evade the immune system.

Lehner admits his work may not produce any ‘quick wins’, but that is not the point. “We’re in it for the long haul.

We have to be prepared not just for this virus, but also for the next viruses that come along. If we can identify new drug targets, which we could use as antivirals, then that might help us in the future.”

Smith, too, is interested in the immune system, and in particular the role it plays in the severity of COVID-19 – why does the disease kill some people while others remain asymptomatic?

Smith has teamed up with Professor John Bradley and colleagues at the National Institute for Health Research (NIHR) Cambridge Biomedical Research Centre, to establish the NIHR COVID BioResource. This builds on the existing national NIHR BioResource, initially set up in Cambridge, which collects blood samples from healthy volunteers and patients to examine the links between genes, environment and health.

A “small army of volunteers” from CITIID and other laboratories, plus medical and nursing staff from CUH, helped recruit patients, ferry blood samples across the campus and process them, working seven days a week for the first month.

Smith’s work entails detailed analysis of which immune cells are present and how this changes over time (a technique known as immunophenotyping). By marrying this information up against the patient’s medical records, it’s possible to see how the symptoms of COVID-19 relate to changes in the immune system.

“The aim is to identify abnormal pathways that might be targets of existing therapeutics, but also to identify people more likely to get severe disease,” he explains. “The ability to predict disease outcome is something we need to have, as early treatment is likely to be more effective.”

In just a few months, Smith’s team has created one of the largest, most intensively immunophenotyped cohorts in the country. Over 200 COVID-19 patients have had blood samples taken throughout their stay in hospital, and samples will be taken at one, three, six and 12 months later. The team has also recruited healthcare workers who screened positive for COVID-19, allowing study of those with asymptomatic and mild disease.

One of the more surprising aspects of COVID-19 has been how long recovery can take. Even some patients with only mild disease have reported taking several months before they have fully recovered.

“There’s a lot more long-term damage than we’d envisaged,” says Smith. “We just don’t know the rate at which the different aspects of disease improve and correct. That’s why we need to follow

people up, to work out ways in which we might help that recovery process.”

Another reason for following patients over a long period is to measure how long their immune response lasts. Typically, our immune system produces antibodies that will neutralise the infection should we encounter it again. No one knows if this will be the case with SARS-CoV-2 infection.

Testing times As the pandemic started to take hold, Smith realised his team could also help on another front: to relieve some of the intense pressure the NHS was facing by providing improved testing facilities. Together with the Infectious Diseases team at Addenbrooke’s Hospital, CITIID helped establish a screening programme to test hospital staff frequently and to help the hospital tighten up infection control measures.

Rapid point-of-care testing in emergency departments became possible using SAMBA II machines developed by Diagnostics for the Real World, a Cambridge spin-out company set up by Dr Helen Lee. Virologist Professor Ravi Gupta showed that the testing devices provided a diagnosis within an average time of 2.6 hours compared with 26.4 hours for standard laboratory tests. The average length of time patients had to spend on a COVID-19 ‘holding’ ward almost halved and 11 ward closures were prevented in the 10 days after implementation.

Gupta then showed that combining the SAMBA tests with antibody tests allowed them to identify 100% of COVID-19 patients. CUH has since implemented this combination of tests in the emergency department.

Genomic expertise Cambridge University and the nearby Wellcome Sanger Institute lead the COVID-19 Genomics UK (COG-UK) Consortium, a national initiative that includes the NHS, public health agencies and academic institutions across the UK.

Viral samples from patients with confirmed COVID-19 are sent to a network of sequencing centres for large-scale, rapid sequencing. The results enable changes in the virus to be tracked at a national scale to understand how it is spreading and whether different strains are emerging.

“This virus is one of the biggest threats our nation has faced in recent times, and crucial to helping us fight it is understanding how it is spreading,” explains Professor Sharon Peacock, who leads COG-UK, and is also Cambridge’s Chair of Public Health and Microbiology,

and Non-executive Director on the Board of CUH. “Building on Cambridge’s expertise in genomics, we can tease apart the complex picture of coronavirus spread in the UK, and rapidly evaluate ways to reduce the impact of this disease on our society.”

In eight months, over 100k viruses have been sequenced, providing a unique tool to investigate clusters of cases in hospitals, care homes and the community. Now, with £12.2 million government funding, COG-UK will expand capacity to meet an increase in COVID-19 cases expected this winter.

For hospitalised patients, genomic surveillance is also being used in intensive care units to monitor secondary infections by antimicrobial-resistant

“It’s not going to go away in a hurry,” says Smith. “A bit like the flu, it will come and go and be something we will have to deal with in an ongoing fashion.”

He believes that, even if we cannot eradicate it through vaccination, we will improve its management with antiviral and anti-inflammatory drugs, and therapeutics based on antibodies against SARS-CoV-2.

“Even in the absence of a highly effective vaccine, I think it’s likely that our medical care will improve. We’ll be able to intervene earlier, and more effectively, and the mortality rate will drop.”

Before COVID-19, experts had long been warning of the risks of the next pandemic. H5N1 bird flu, SARS, MERS

Snapshots

The intensive care medic



“Intensive care specialists are like the canaries in a coalmine: they’re often the first to spot something that’s new and worrying,” says Dr Charlotte Summers, a University Lecturer in Intensive Care Medicine in the Department of Medicine. By January this year, “it was clear from colleagues in Asia there was something very nasty heading our way.”

This was the very challenge she’d trained for: her specialism within intensive care is in respiratory illnesses and she had been part of the preparations for the previous MERS coronavirus. “It’s no exaggeration to say that my career has been exactly about preparing for a pandemic. I couldn’t be sure how bad it would be, but I suspected it was likely to be the biggest challenge in our lifetimes so far.”

Because of her expertise, Summers has advised the Cabinet Office, the Chief Medical and Chief Scientific Officers, and major funders on issues such as ventilators and developing therapies for COVID-19.

At the same time, she led a GSK phase 3 multicentre trial for a COVID-19 therapeutic. It didn’t stop there: Summers was chosen to lead the bronze intensive care unit crisis team at Addenbrooke’s Hospital, helping to reconfigure the entire hospital.

Dr Charlotte Summers

The superbug sleuth



Twenty years of clinical research experience in infectious diseases in the UK and overseas has helped to prepare Dr Estée Török for her work on COVID-19.

Török works in the Department of Medicine, and at Addenbrooke’s Hospital, where she focuses on using genome sequencing to investigate the transmission of pathogens in hospital and community settings.

In March, she turned her attention to SARS-CoV-2. Together with colleagues, she set up a system to rapidly sequence clinical samples and analyse epidemiological and genomic data from COVID-19 patients at Addenbrooke’s. This information was fed back to the hospital clinical, infection control and management teams to help investigate and manage suspected outbreaks of infection.

“COVID-19 is a global public health emergency that requires national and international collaborative efforts,” she says. She herself is involved in COG-UK, and the RECOVERY trial, which is investigating potential treatments for COVID-19. She also set up and ran the Cambridge arm of the Oxford vaccine trial, screening and vaccinating several hundred volunteers in just over three weeks.

“With a dedicated and enthusiastic team it is possible to achieve extraordinary things.”

Dr Estée Török

In numbers...

100k+

SARS-CoV-2 genomes sequenced by the COVID-19 Genomics UK (COG-UK) Consortium in eight months starting March 2020

pathogens like MRSA – ‘superbugs’ that can no longer be treated by frontline medicines. Speed of diagnosis is crucial. In most hospitals, it can take days to get a result, during which time the patient would have been given a broad-spectrum antibiotic rather than a more appropriate treatment.

“This is not good because antibiotic use drives the emergence of antibiotic resistance and you can actually make the case worse,” explains Professor Gordon Dougan, another member COG-UK. “Because we can tell [the medics] within a few hours, then they can give a much more targeted treatment to the patient.”

Ready for next time Twelve months ago, no one had heard of COVID-19. Now, social distancing and lockdown – even the R number – are part of everyday conversations. The coronavirus has changed our world dramatically: is it here to stay?

and Ebola all threatened to spread beyond regional boundaries but fortunately failed to become pandemics.

“In a way, we have been relatively lucky so far,” says Dougan. “Even with SARS-CoV-2, this could have been a much more aggressive and virulent virus, for example impacting children.” He argues that richer nations have gradually lost their sense of danger concerning epidemics and serious infections. “We must reacquire this instinctive memory. We shouldn’t have to rely on luck.”

That’s why having an institute like CITIID – together with the huge collaborative research effort towards combating COVID-19 that has taken place across Cambridge – has been so important, says Smith. “What we are learning about the relationship between infectious disease and our immune systems will help us in this pandemic – and it will also help us to be ready for what comes next.” ●

Innovations, explorations, news, views and discovery. Read the full stories and many others at cam.ac.uk/topics/COVID-19

Ad Hoc.

RESEARCH

Search for a vaccine

A Cambridge-developed vaccine candidate against SARS-CoV-2 could begin clinical trials in the UK early next year with £1.9m funding from the government.

Professor Jonathan Heeney and team at the Laboratory of Viral Zoonotics and Cambridge spin-out company DIOSynVax have taken a “revolutionary” synthetic DNA approach to generating a vaccine against the virus.

“We’re looking for chinks in its armour, crucial pieces of the virus that we can use to construct the vaccine to direct the immune response in the right direction,” explains Heeney.

The researchers used 3D computer modelling of the SARS-CoV-2 virus structure to make a library of synthetic genes that can train the human immune system to target key regions of the virus – while avoiding parts that could worsen the infection.

“Our approach – using synthetic DNA to deliver custom-designed, immune-selected vaccine antigens – is revolutionary and is ideal for complex viruses such as coronavirus,” adds Dr Rebecca Kinsley, Chief Operating Officer of DIOSynVax and a postdoctoral researcher. “If successful, [our approach] will result in a vaccine that should be safe for widespread use and that can be manufactured and distributed at low cost.”

VIEWPOINT

Epidummyology
“A platform to translate the vast array of complex epidemiological terms that we are currently bombarded with into plain English.”

... also the brainchild of PhD student Charlotte Milbank, who is explaining the trends, data and terms around COVID-19 in everyday words.

Read more
 → [instagram.com/epidummyology](https://www.instagram.com/epidummyology)

TECHNOLOGY

Support for low-resource countries

From early on in the COVID-19 crisis, Cambridge researchers have been working with colleagues in countries that have particularly poor access to medical equipment, PPE and public health information.

Among these enterprising projects, the Open Ventilator System Initiative (OVSI) designed an economical and easy-to-fix ventilator based on readily available components in low- and middle-income countries. By May, the first ventilator suitable for intensive care was being manufactured in Africa.

Others supported a ‘maker’ community in Malawi to print masks and shields for local hospitals. Cambridge engineer Dr Lucia Corsini is now using the experience of working with Malawian engineer Maya Nkoloma to develop a ‘blueprint’ for using digital fabrication technologies in future emergencies.

Engineer Professor Andrew Woods and architect Professor Alan Short developed a series of simple, low-cost ventilation designs that would limit the dispersal of coronavirus in marriage halls used as emergency COVID-19 hospitals in India.

Dr Rosalind Parkes-Ratanshi adapted a phone-based system to help the Ugandan Ministry of Health monitor those in quarantine during the coronavirus pandemic; and Dr Ebele Mogo helped translate WHO COVID-19 public health guidelines into 18 of the most spoken languages across the African continent.

Image Maya in a prototype mask
Read more → bit.ly/CGC_COVID

NUMBERS

Maths at home

Over 1.5 million UK schoolchildren, parents and teachers accessed free online maths resources for ages three to 18 from NRICH – a maths outreach website provided by the University’s Faculties of Mathematics and Education. Resources were tailored for pupils working from home to help them get back on track when classrooms reopened.



1.5m

VIEWPOINT

Risky Talk

The public appetite for scientific evidence during the pandemic has been voracious. But communicating it well is a fiendish balancing act. How can governments give clear advice while also acknowledging uncertainty? How can scientists debate complex evidence while supporting strong interventions? And how can the media scrutinise public health measures without undermining them?

Professor Sir David Spiegelhalter navigates the principles and pitfalls of communicating evidence in a pandemic as part of the Risky Talk podcast series he hosts.

Read more

→ bit.ly/riskytalk

NUMBERS

Now open for applications

Cambridge University is one of 22 founding members of the Trinity Challenge, a £10m global search for ideas to protect the world from future health emergencies. Formed from a coalition of organisations and individuals in business, academia and the social sector, the Trinity Challenge will support winning ideas with access to people, data and resources.

£10m

VIEWPOINT

“The crisis is not over. But as we live through these challenging experiences we are also learning from them.”

Professor Andy Neely, Pro-Vice-Chancellor for Enterprise & Business Relations, introduces *Beyond the Pandemic*, a new online series in which we ask our experts: what have we learned that will help us recover well?

Read more
→ bit.ly/BtPand

RESEARCH

Lower skills for 50 years?

Schools have fully reopened after the nationwide shutdown in March but, with COVID-19 cases on the rise again, researchers like Professor Anna Vignoles from the Faculty of Education are watching intently to see what happens.

“Shutting down schools has impacted all children but children from low-income households are more likely to lack the space, equipment and home support to engage fully with remote schooling. Those with pre-existing conditions are at risk of experiencing a worsening of their mental health. This has to be taken into account in how we come out of this pandemic.”

A recent study she co-led on behalf of the Royal Society highlights the potential impact on the 13 year groups of students affected by lockdown and estimates that, without action, around a quarter of the entire workforce will have lower skills for 50 years after the mid-2030s.

TECHNOLOGY

Go Viral!

A new online game that puts players in the shoes of a purveyor of fake pandemic news is the latest tactic in efforts to tackle the deluge of coronavirus misinformation that is costing lives across the world.

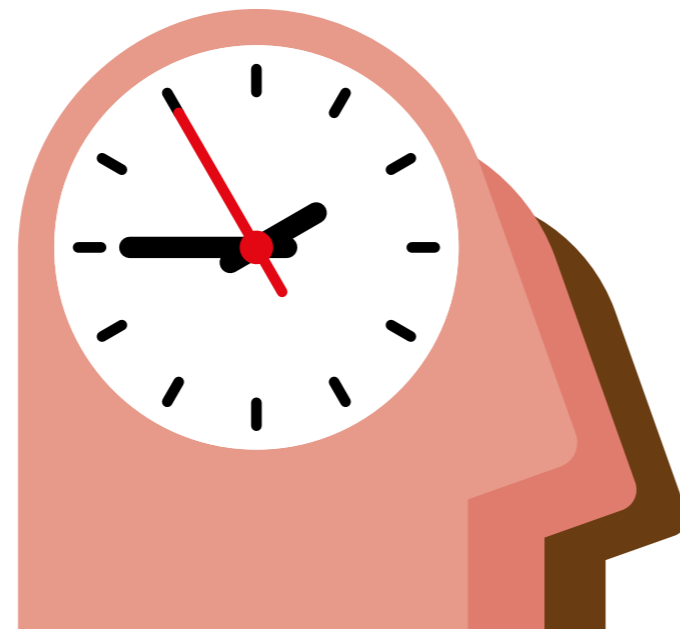
Go Viral! has been developed by Cambridge's Social Decision-Making Lab in collaboration with media agency DROG and the UK Cabinet Office.

It builds on research from Cambridge psychologists which found that, by giving people a taste of the techniques used to spread fake news on social media, it increases their ability to identify and disregard misinformation in the future.

“Fake news can travel faster and lodge itself deeper than the truth,” says Dr Sander van der Linden, who leads the project at Cambridge. “Fact-checking is vital, but it comes too late and lies have already spread like the virus.”

“We are aiming to pre-emptively debunk, or pre-bunk, misinformation by exposing people to a mild dose of the methods used to disseminate fake news.”

The latest findings show that a single play of a similar game the research team developed pre-COVID, *Bad News*, which has been played over a million times since its 2018 launch, can reduce susceptibility to false information for at least three months.



RESEARCH

Cut hours, not people

The pandemic has dramatically affected the working lives of millions in the UK. Many now work from home, while others had hours cut and thousands lost their jobs completely.

The government's furlough scheme supported workers and businesses hit by the spring lockdown. Dr Brendan Burchell argues that while furlough was “aimed at the financial fallout” of COVID-19, it also stemmed the tide of mental health problems predicted by experts.

Research from the Department of Sociology's Employment Dosage team,

led by Burchell, suggests that furloughed workers and those on reduced hours had the same risk for poor mental health as those who remained in full-time employment. But data from April and May shows the likelihood of mental health issues doubling in those who lost all work due to coronavirus – with some 58% falling into the “at risk” category.

To mitigate a mental health crisis as furlough rolls back, researchers say the UK should emulate ‘short-time working’ schemes used by many European nations to share out working hours.

Says Burchell: “As well as the individual misery caused, the costs of poor mental health to the UK's productivity and health service are vast, and cannot be afforded.”

VIEWPOINT

“Tracking COVID-19 will continue to be a major priority for my team. Questions that still remain will keep us busy for years.”

Professor Daniela De Angelis, whose team at the MRC Biostatistics Unit is informing the government on tracking and predicting the spread of the virus

Respect for the Mongolian landscape is engrained within her, says Onon Bayasgalan. Her work is helping herders in her home country to preserve livelihoods and lands that are under threat from the luxury fashion industry.

This Cambridge Life Onon Bayasgalan

Onon Bayasgalan
Cambridge Gates Scholar
and Masters in Conservation
Leadership
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Interview Charis Goodyear
Photography Nick Saffell

I would watch as my grandmother sprinkled milk to honour Mother Nature before breaking the soil to plant seedlings. Respect for the natural world was something my grandmother had grown up with, and in turn taught me. It's a mentality that is entwined with Mongolian culture.

The Mongolian landscape is vast, harsh and untamed. Crucially for the nomadic herders who live there, it's not partitioned off into pockets of land. Herders make up 40% of the population and being able to roam freely and graze goats is essential for preserving their livelihoods.

The herders are vulnerable to exploitation during the two-month 'combing' season when cashmere is gathered from the goats. They rely predominantly on cashmere for their income and it's very much a buyers' market, with middlemen using psychological tactics to persuade the herders to sell at a lower price for fear of the price dropping further.

Under pressure to produce more cashmere for the fashion industry, the herders increase their herds to sizes that the landscape cannot sustain indefinitely. Over time, the grasslands are becoming deserts – it's estimated that 70% has now been damaged, mostly due to overgrazing. Larger herds mean less food for the goats, lowering the quality of cashmere, which fetches a lower price at market.

I helped set up the Sustainable Cashmere Project while working for the Wildlife Conservation Society in Mongolia. The project promotes sustainable herding while protecting the livelihoods of herders. We established quality and sustainability standards and taught the herders techniques, such as sorting cashmere by colour and combing it in a specific way to increase the value of the wool, which reduces the need for larger herd sizes.

Projects like this require personal relationships built with time and trust.

Over a period of four years, I would regularly stay with the same community of herders. I listened to their stories, shared meals with them and slept in their yurts – in the winter the temperatures would drop to –40°. Every time I returned to the community, I was reminded of why I had chosen to work in conservation.

Collaboration with businesses was equally important to the project's success. We worked with a fashion house among other private and public sector organisations to develop a model of working that benefited everyone.

The idea that you can separate economics and conservation is an illusion. We need to understand how our desired goals fit into the wider economic system and try to find a win-win solution for both conservationists and businesses. Until we do, our victories will be small and localised – only when we work collaboratively will we see widespread change.

To learn how to do this better, I enrolled on Cambridge's Masters in Conservation Leadership a year ago as a Cambridge Gates Scholar, the first from Mongolia. One of the most mind-blowing concepts I've learnt about is the 'doughnut economy'. As a cohort we discussed whether it was possible to rethink the whole paradigm of economics. Doughnut economies involve making sure that the economy meets the social needs of humans while respecting the planetary boundaries. I'm convinced that this is the sort of approach we need to sustain land, livelihoods and business.

What inspires me? In a word: Mongolia. I hope one day I will be able to take my grandchildren to the grasslands and say: "What you see before you is how it looked when I was a child – and how it looked when my grandmother was a child." ●



DISPLACED



Whether in parliamentary debates or the media, migrants' stories have been drowned out by concerns about security, integration and preserving European ways of life. For the past three years, RESPOND, a Horizon 2020 project, has been investigating migration governance in 11 countries by foregrounding the insights of asylum-seeking migrants.

RESPOND's principal investigator at Cambridge is social anthropologist Dr Naures Atto. "All humans develop a deep connection to their home and homeland. It takes something huge to make someone decide to leave," says Atto, whose own family fled Turkey in the 1980s. "But more and more, migration is seen as an internal security issue not a humanitarian one. At the same time, people ignore the fact that most displaced people desperately want to do something positive with their lives."

The scale of the humanitarian crisis in the Middle East has made it all too easy for individual atrocities to go unnoticed. In July 2014, the Iraqi city of Mosul lost its entire Christian population, a community established almost 2,000 years ago. Having captured the city, ISIS gave its last remaining 30,000 Assyrians three days to convert to Islam, leave or be killed. The vast majority fled, as did around 200,000 more Assyrian Christians from Qaraqosh and the villages of the Nineveh Plain.

Coming amid preparations to commemorate the centenary of the 1915 genocide of Christians in Ottoman Turkey, this new existential threat sent shockwaves across the Assyrian diaspora. Beyond it, however, the plight of an entire society forced from their ancient homeland went largely unnoticed.

Three years on, a Syrian woman awaiting an asylum decision in Germany told RESPOND: "Some friends told us to go to another European country like

The 'refugee crisis' triggered by the outbreak of the Syrian Civil War in 2011 transformed Europe's attitudes and actions towards migrants. Yet, public awareness of these seismic shifts remains limited. Even less well known are the experiences of those who have been turned back at borders, detained, deported, separated from families and granted asylum far from home.

Holland just to gain time and see if changes meanwhile will happen in Syria, so we can go there again. But, I can't do that anymore. I am so tired. I cannot change camps anymore and sleep in a bed that is not mine [she starts crying]... You reach a state where you dislike everything... you feel as if Europe is suffocating you. But that's what God gave us, to be refugees."

In 2015/16, nearly 800,000 asylum-seeking migrants arrived in Germany, stretching the country's cut-back reception and procedural systems to breaking point. Having survived treacherous journeys over land and sea, new arrivals encountered lengthening delays and procedural errors.

Nearly 12% of asylum-seekers interviewed by RESPOND reported failings by immigration officers or lawyers – including the loss of papers, identities and files being mixed up, erroneous changing of names and dates of birth, and incompetent translators. These failings had decisive effects on their chances to secure protection status.

When told his papers had been lost, a young Syrian recalled being "totally broken" because "I wanted to bring my parents, and I knew that repeating everything would take a year". A Libyan, who went to court to remove an interview from their record, said: "The translator was deceitful. It put words in my mouth I never said." And a Syrian struggling to reunite his family in Germany complained: "That's the worst thing... They keep you on hold". Eighteen months after receiving his residence permit, the man's teenage brother was granted the same. Later still, their mother was allowed to join them, but their father and other siblings had to stay in Turkey.

RESPOND's researchers, from 14 partner organisations, have interviewed more than 550 refugees in 66 cities, as

well as more than 200 stakeholders working in migration. The project's recent reports – covering the transit countries of Turkey, Lebanon, Greece, Italy, Poland and Hungary; and the destination countries of Germany, Sweden, Austria and the UK – draw attention to numerous state-specific circumstances and failings.

The UK screening interview faces criticism for the evidential weight placed on it, but also for the behaviour of interviewers and translators. Other concerns focus on the UK's increasing use of detention centres – one asylum-seeker told RESPOND: "It was a proper prison... I was shocked, especially after the bad experiences of being in prison in Iran".

The project's researchers also draw attention to problems that have transcended borders. In addition to pervasive delays and administrative failings, the team links a restrictive turn in policymaking to a significant reduction in refugee rights, opportunities for family reunification and access to legal support and social welfare.

Project co-ordinator Soner Barthoma from Uppsala University says: "When faced with mass migration, governments fall back on a tired repertoire of failed solutions. They put aside concerns about human rights and reach for quick fixes. The securitisation of migration has blocked the search for better solutions to societal problems."

In Cambridge, Atto's work focuses on the experiences of Assyrian Christians and Yazidis, populations indigenous to ancient Mesopotamia, and today mainly concentrated in northern Iraq refugee camps. At least 400,000 Yazidis have been displaced by ISIS, and thousands more have been killed and abducted. "There needs to be more strategic intervention in conflict zones to prevent the mass displacement and persecution

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Words Tom Almeroth-Williams

of minoritised indigenous groups," Atto says.

To this end, she raises awareness in the West through talks, exhibitions and film. She has also given expert testimony in asylum cases and aims to help people retain some elements of their cultural identity after having lost everything back home, including hope for a future there, as they establish new lives in unfamiliar host countries.

In late 2020, she curated *Displaced Bodies and Hearts*, a digital art exhibition featuring work by migrant artists that represents the suffering and hopes of peoples forced to leave their homelands. Some of the most poignant and disturbing pieces were created by Assyrian and Yazidi artists who survived Islamic State's genocidal violence. One painting, by Yazidi artist Narin Ezidi, now living in Canada, depicts the 19 Yazidi women burned to death in cages in Mosul. Atto is also directing and producing a film in which displaced migrant women inform us about the extreme challenges which they have had to overcome.

She says: "We developed this project at the start of the crisis. The number of migrants coming to Europe has fallen but the region's displaced people are more vulnerable than ever. As Europe reflects on its actions, we are determined to give voice to the millions of people who continue to be denied a home and basic human rights." ●

→ respondmigration.com
→ exhibition.respondmigration.com

LIVES

The world's ice sheets are undergoing dramatic, potentially irreversible change with catastrophic consequences for our planet. Building on a 100-year history, researchers at the Scott Polar Research Institute are studying the changing ice conditions, and using their results to predict what the future might hold for our polar regions and for global sea level rise.

MELT



Credit Tom Chudley / RESPONDER project

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Words Sarah Collins

temperatures rise, the vast terrains of ice locked around the poles melt faster and faster. The ice sheets of Antarctica and Greenland are already major contributors to sea level rise, and there is a real risk that the West Antarctic ice sheet will collapse. Over the coming century, rising sea levels will mean towns, cities and even entire nations will be at increasing risk from flooding and some may have to be abandoned completely.

For the researchers at SPRI, the polar regions are a laboratory, vital to understanding our changing planet and planning for an uncertain future.

Glaciologist Dr Ian Willis is currently focused on the stability of the massive floating sections of ice that skirt about 75% of the Antarctic coastline, where they act as a buttress against ice flow from inland.

Like the rest of the ice in the polar regions, these buttresses are weakening, as witnessed most dramatically in 2002. Scientists monitoring NASA satellite images of the Larsen B Ice Shelf watched in astonishment when roughly 1,250 square miles of ice fragmented and collapsed in little over a month.

"These shelves are thinning because warm water currents are eating away from below as the oceans heat up, and from the top as summer air temperatures

breakup of the George VI Ice Shelf on the Antarctic Peninsula.

The team has set out instruments to measure melting, lake filling and draining, as well as the bending of the ice shelf produced by these phenomena. Using satellite imagery and numerical models, they hope to gain a better understanding of the processes that can lead to ice shelf fracture and to predict where, when and how the ice shelf, and others like it, may break in the future.

The consequences of ice shelves breaking up are already being seen in the West Antarctic ice sheet further south, where Dr Poul Christoffersen is leading one of eight large science projects in the International Thwaites Glacier Collaboration. Involving over 60 scientists and students, it is one of the most ambitious scientific partnerships ever to take place in the polar regions and aims to understand why the glacier is retreating and what the long-term consequences of a continued and prolonged retreat may be.

At the other end of the planet, Christoffersen has also been observing another lake filling and draining phenomenon. With funding from the European Research Council, his RESPONDER project studies the dynamics of the world's second-largest

provides us with, perhaps, the most detailed understanding of Greenland's fast-flowing glaciers to date, and more accurate predictions in the longer term," says Christoffersen. "Not many groups are linking modelling and observations like we are. We want to make the models the best they can be, based on real observations and real physics. If not, they won't have any real powers of prediction."

Although the conditions at both polar regions are extreme, in the Antarctic, SPRI researchers have the benefit of working with logistics provided by the United States Antarctic Program and the British Antarctic Survey, both of which have bases on the continent. But in the Arctic, SPRI researchers are on their own, managing logistics and camping in tents.

Christoffersen says the effects of climate change are most easily felt through talking to the local communities he works with in Greenland. The Inuit of the high Arctic have relied on the sea ice for transport and hunting for centuries but, over the past few decades, long-established routes over the ice have disappeared. As the world continues to warm, and with the Arctic warming twice as fast as the rest of the world, traditional ways of life are

DOWN

The polar regions are places of mystery, myth and adventure. The names associated with the 'heroic era' of polar exploration are part of this country's collective memory, and none looms larger than Captain Robert Falcon Scott who, along with his crew, perished returning from the South Pole in 1912.

The Scott Polar Research Institute (SPRI), which was founded in 1920 as a memorial to Scott, has celebrated its centenary this year. As well as its Polar Museum and archive, SPRI houses a world-leading polar research centre that, since the 1930s, has been the base for numerous scientific expeditions to the Arctic and Antarctic.

Today, our polar regions are like a ticking time-bomb. As global

rise," says Willis, whose research is funded by the Natural Environment Research Council and the US National Science Foundation.

Before the Larsen B breakup, satellite images showed the buildup of small lakes on the surface followed by their sudden disappearance. The assumption is that the lakes added stress to the ice shelf, causing cracks to form, draining the water, and then collapse.

"We are seeing more and more water forming on ice shelves, which is worrying," says Willis who, with colleagues from the University of Colorado Boulder, Columbia University and the University of Chicago, is investigating the effects of surface water on the flexing, fracturing and possible

ice sheet in Greenland, and how it's affected by meltwater lakes.

This section of the Greenland ice sheet moves up to 3 metres per day: much faster than other parts of the ice sheet. His team uses numerical models combined with field observations in the sometimes 'wild west' conditions of northern Greenland using drones, sensors and fibre-optic cables to determine how and why glaciers in Greenland move especially fast. They are the only team to drill boreholes to the base of the deeply crevassed and fractured glaciers, which contribute directly to sea level rise because of their fast flow.

"Our model, combined with the measurements we've made in the field,

increasingly being lost.

"The continued melting of the world's ice masses will impact us all – no one is going to be immune; all countries, regions and continents will be affected somehow," says Willis.

"You really feel the importance of the polar regions in your bones here at SPRI. There are items here that take you right back to that heroic age – I walk by Captain Oates' sleeping bag and scientific instruments from Scott and Shackleton's expeditions on most days in our Museum, and they never fail to stop me in my tracks. It's the links to the past that make this such a unique and interesting place to work, but it's the research that's being done right now that has implications for the future." ●

Walking at ‘botanist pace’ on Mount Terror in South Africa, Dr Ángela Cano likes to stop and smell the succulents. She then measures, photographs, presses specimens and gathers seeds. Her work is helping to safeguard some of the rarest plants on Earth.

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Words Louise Walsh
Read more bit.ly/FN_wild

Fieldnotes

Call of the wild collector

An army of tiny seedlings has broken surface behind the scenes at Cambridge University Botanic Garden (CUBG). They are new arrivals, fresh from a year in quarantine. A regular visitor to check on their progress is Assistant Curator Dr Ángela Cano. She is one of Cambridge University’s ‘wild collectors’.

Last year Cano travelled to Mount Terror in the ‘Succulent Karoo’ of South Africa’s Richtersveld. This remote region stretching between South Africa and Namibia is a biodiversity hot spot with over 4,800 plant species, 40% of which are found nowhere else on Earth. Succulents live in abundance here – their fleshy water-storing leaves help them to survive in the tough arid conditions of this desert wilderness.

But climate change, poachers and over-grazing now threaten this unique ecosystem, and the South African government had given the CUBG team permission to collect seeds from around 200 species and take them back to Cambridge for research and conservation.

“We hiked all day to the top of the mountain carrying our tools, food and water, and at night we slept outside in a sleeping bag next to a fire,” she describes. “You wake very early because of the cold and you just want to collect and collect and collect. We record as much information as we possibly can because we don’t know what people will need to know in a hundred, two hundred years from now.”

The Garden is looking to double the percentage of their 14,000 plants to 40% wild origin as part of their new 10-year strategy, helping to safeguard some of the planet’s rich floral diversity for the future.

As Cano looks over her seedlings, she wonders what we will learn from them: “on fieldtrips, you are inspired by nature and you have questions. How did these plants evolve? What’s their ecology? If we let the time pass we will miss the opportunity to study and protect them. Who knows what we might need them for one day?” ●

Expeditions are currently on hold as a result of the pandemic but will be resumed as soon as possible.

RICHTERSVELD

LOCATION
28° 36' 0" S, 17° 12' 14" E

STATUS
UNESCO cultural and botanical World Heritage Site

LANDSCAPE
Arid desert

RAINFALL
5–200 mm / year

PLANT SPECIES
Over 4,800

PLANT RARITY
40% endemic, mostly aloes and succulents

RICHTERSVELD





The big picture

From understanding ancient ideas of generation to exploring new frontiers in fertility, Cambridge researchers are working across disciplines to study reproduction from multiple perspectives. Professor Kathy Niakan, new Chair of the University's Strategic Research Initiative on Reproduction, introduces our Spotlight on some of this work – and explains how reproduction matters to us all.

Image Human embryo; Kathy Niakan

Every year, more than 130 million babies are born worldwide. Reproduction is vital for the survival of our species, and, at a personal level, for our own families. It is little wonder, then, that debates around reproductive rights and reproductive technologies – around the very acts of conceiving and giving birth – ignite such passion and controversy.

Reproduction has relevance to every single one of us because of the way it connects individuals, families and populations, and because it raises questions that reach in scope from intimate experiences through to global policies.

Why do three million babies and 300,000 women still die globally each year in childbirth, despite huge leaps in medicine and public health?

How have present reproductive practices like childbirth, infertility treatment, abortion and population policies been shaped by the past?

In what way does the environment experienced in the womb programme

us for diseases later in life – and even across generations?

Do changing patterns of family relationships – adoption, single parenthood, same-sex parents, for example – influence child development?

How do we balance the risks and benefits of novel reproductive technologies in plants and animals?

If there are ways to alleviate life-limiting diseases like cystic fibrosis, is there a moral imperative to use any means necessary to avoid their transmission or is this opening a slippery slope to design babies with specific attributes?

Major questions like these require informed input from diverse disciplines. Finding new perspectives and offering practical solutions must take into account cultural, religious and societal expectations – and often challenges existing sociological, ethical and legal frameworks.

In 2018, the University launched a Strategic Research Initiative (SRI) on Reproduction led by Professors Graham Burton, Sarah Franklin, Anne Ferguson-Smith and Nick Hopwood. Its vision is to pool resources to address the most urgent, challenging and complex questions about reproduction and the diverse ways that it has an impact on our lives.

The Cambridge Reproduction SRI enables these issues to be approached holistically – from historical, ethical, legal, cultural, gender-based, sociological, psychological, demographic, public health, policy, biological and clinical perspectives – and through engagement with policy teams and funding bodies.

Given the long-standing history of cutting-edge reproductive studies in Cambridge, including Sir Robert Edwards' seminal Nobel Prize-winning work that led to IVF treatment, it is fitting that many of the challenges in human reproduction will be investigated and debated here. ●

→ repro.cam.ac.uk

Professor Kathy Niakan is a biologist working in human developmental and stem cell biology. In 2016 she was the first scientist globally to gain national regulatory approval to edit the genomes of human embryos for research into early human development and was named as one of the 100 most influential people in the world by Time Magazine. In October 2020 she became Director of Cambridge's Centre for Trophoblast Research and Chair of the Cambridge Reproduction SRI.

Cambridge Reproduction SRI brings together world-leading expertise from across the University, including from the: Centre for Trophoblast Research; Centre for Family Research; Cambridge Centre for Law, Medicine and Life Sciences; Cambridge Group for the History of Population and Social Structure; Reproductive Sociology Research Group; Wellcome Trust-Cambridge Centre for Global Health Research; Wellcome-MRC Institute of Metabolic Science; and several departments; as well as the nearby Babraham Institute and Wellcome Sanger Institute.



Credit The Francis Crick Institute



A major research project sees sociologists situated at emerging hot spots of reproductive change, investigating the new 'haves and have-nots' in our fertility futures.

Words Fred Lewsey

Image 'The Instruments of Life' by artist Gina Glover

Fertility futures

Fast Facts

Exploration of changing perceptions and practices of reproduction reveals social drivers behind fertility statistics

Researchers track the commercial explosion in ARTs since IVF was pioneered by Cambridge Nobel scientist Sir Robert Edwards

Inequalities in reproduction opportunities revealed for migrant women in British healthcare



Reproduction doesn't just happen by itself, says Professor Sarah Franklin, Head of the Sociology Department. "Reproduction is organised, and the way people organise reproduction tells you so much about how they organise everything else."

"Right now, I'd describe fertility as a condensed signifier of precarity. It represents a sense of imperilment. It's considered 'something that needs help', you know?"

Franklin is Principal Investigator of Changing (In)Fertilities, a major interdisciplinary research project funded by the Wellcome Trust that is ongoing in the Reproductive Sociology Research Group she leads. The project explores how everything from technology to politics is changing the perceptions and practices of reproduction.

For the past eight years, Franklin has been working with a global network of

something under threat, says Franklin. However, the reasons behind these fluctuations are elusive.

The research team is getting under the skin of modern reproduction through what Franklin calls "indicative anecdotes": case studies that reveal the underlying social drivers behind fertility statistics.

"Resurgent fertility politics needs to be closely watched. It carries ideas about who should have reproduction assisted or curtailed. We want our gallery of situated projects to help show the ways reproduction is deeply implicated in all aspects of life," she says, "and why the question of causality is so very complex."

"Policymakers like broad sweeps of applicability, the 'nudge', but if there's going to be meaningful social change, telling people to go on holiday and make more children for grandma will only get you so far."

circumvent this problem, followed by the more successful flash-freezing 'vitrification' that transformed the egg into a glass-like stasis, after which success rates for post-thaw conception jumped.

What became apparent was the potential egg-freezing client base outstripped that of IVF alone, as it included not just women who want a baby, but also all those who might want a baby in the future.

"Egg freezing is both an infertility treatment for the fertile and a fertility treatment for the infertile," says Franklin's colleague Dr Lucy van de Wiel, whose research focuses on the explosion in the popularity of this ART.

"Increasingly younger women are encouraged to freeze their eggs in preparation for future infertility, and those frozen eggs promise an extension to fertile life."

younger. And the marketing pitch isn't a newborn babe, but rather freedom and reproductive control.

"Look at Prelude, founded by an IT entrepreneur," says Van de Wiel. "Within two years they had bought dozens of clinics across the USA, and now claim to be the country's largest fertility company. Much of their marketing depicts single young women, not families with babies."

"Their pitch to women is: freeze your young eggs, use our extra testing, so you have the best genetic material for making a baby when the time is right for you. Feel reassured that you can live free from your body clock, because meeting the right partner at the right age and conceiving through sex is too unpredictable."

"Their pitch to investors is: with our treatments, people can have children when they are ready, even if that is at a time when they are no longer fertile. Combined with fertility demands for same-sex couples, it's a market set to increase – and one likely to stay strong in economic downturns. Children are priceless; people are willing to spend a lot to have them."

She adds: "While the average age of a woman freezing eggs in the UK is still 37, there is an idea increasingly sold that the younger you do it the better. I've heard about fertility preservation stalls at graduate fairs."

Freezing can lock women into a financial cycle. Eggs need to be stored, which means regular payment, ranging from upwards of £200 annually in the UK to over \$1,000 in the USA. The more eggs, and the more cycles, the higher the chances of conception down the line. Some countries impose a shelf life – eggs are destroyed after 10 years in the UK.

The new industry has got this covered. Some start-ups specialise in fertility loans or subscription plans. In the USA, fertility insurance packages that include egg freezing are used by employers to attract the best female graduates or executives.

The expansion of ARTs can create "new forms of dependency," says Van de Wiel, as well as reproductive anxieties in women from younger ages. "Certain demanding careers may come to be seen as contingent on ARTs such as egg freezing if women entering them want the option of children. To have a healthy child at the best time, women can become reliant on companies to test their fertility, or preserve and store their eggs, or implant a healthy, tested embryo."

Van de Wiel says she's all for technologies such as egg freezing, "but it's important to stay well informed, and not just about the biological facts, but

also the business structures you're participating in."

Birth debt Access to ARTs relies on access to capital: money makes many babies in the 21st century. But poor women in rich nations still want children, still become pregnant, and still need maternal care. In the UK, we might like to think this is a basic right afforded to all women regardless of status or bank account. We'd be wrong.

"The 2017 introduction of healthcare charges for migrants in Britain for everything except a GP and A&E means it now costs to have a baby," says Dr Kathryn Medien, who has recently moved from the Sociology Department to the Open University. She argues that these charges mark a financial transition in British healthcare, a "privatisation of the underclass".

"It's easy to become a visa overstayer. Visas cost thousands of pounds, and few people have that. Certainly not a woman who arrives to marry a man who becomes abusive, or abandons them, when pregnant. Or soon-to-be-mothers with failed asylum claims, or yet to be processed claims."

She has been unpicking some of the mechanisms behind these charging systems, and building a dataset of charging for maternity care across the NHS using Freedom of Information requests, starting in London. She has also been conducting interviews with the doulas, or birthing companions, who work with migrant women: "One of the first questions a doula is often asked is 'can you help me with a hospital payment plan?' such is the fear of debt collectors or deportation."

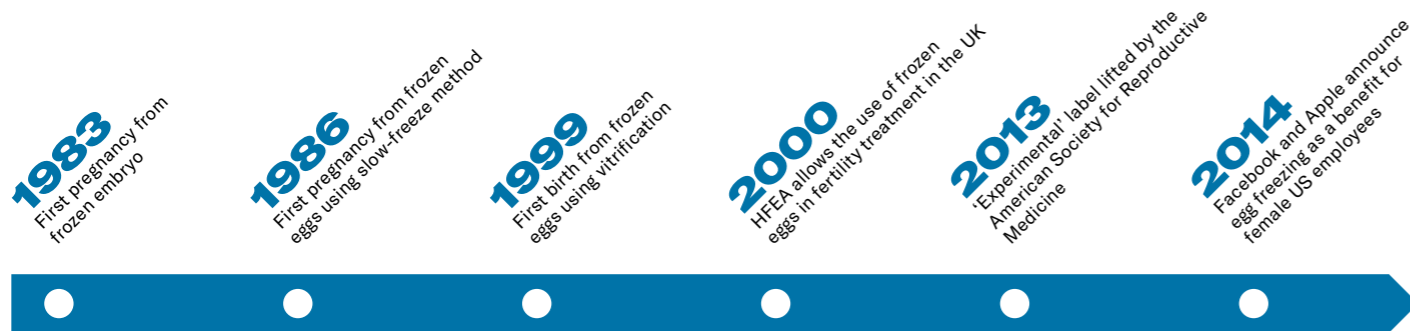
"A lot of practitioners are very concerned that this is eroding principles of universal healthcare in Britain," says Medien. "Vulnerable women with newborns, who are living in hostels or sofa-surfing, are being chased for maternity payment running to thousands. Bailiffs are appearing on doorsteps."

She argues that, while this case study is UK based, it's part of a global trend. "The proliferation of ARTs means an increased ability to reproduce for populations who couldn't before – whether that's LGBTQ people, or single or older women – so long as they are wealthy enough."

"At the same time, there is a closing down of reproduction opportunities for poorer migrant populations – those fleeing war or economic hardship." For many women, reproducing means incurring debt, whether to extend fertility or get maternity care. "It raises the question: who gets to access reproduction?" ●

Timeline of egg freezing

Source Human Fertilisation and Embryology Authority (bit.ly/3559PEK)



social scientists looking at a wide range of fertility issues – from Western in vitro fertilisation (IVF) clinics to reproductive health in rural Nepal. One key finding is both highly paradoxical and yet somehow intuitive: the more you plan for children, the fewer you have.

"We're very familiar with the narrative of women having more reproductive options these days," she says. "But how does that translate into actual experience?"

"IVF, for example, is expensive and difficult and nerve-racking. A much-wanted child may result in a desire to provide a sibling, then it's back on the IVF track, more time, more money. What's seen as a solution often creates further problems. We need a better account of the problems the technology is supposed to be solving."

While the 20th century saw fears of overpopulation, birth rates have plummeted in many wealthy nations, and fertility is on government agendas as

Beat the clock Louise Brown, the world's first IVF baby, was born in 1978, the culmination of decades of research by Cambridge Nobel scientist Sir Robert Edwards. Since then, an estimated eight million babies have been born globally following IVF and other assisted reproductive technologies (ARTs).

While many different personal journeys have led to these births, there has typically been one unifying rationale: I want a baby, preferably as soon as possible. That's all changing.

The fastest-growing tech in the reproductive marketplace is 'oocyte cryopreservation', or egg freezing. In its early days, it was a resort for women with cancer diagnoses, but very low success rates often led to little more than false promise.

The technology has improved dramatically. An egg is the largest cell in the human body and freezing can cause crystal formation in the cell. Slow-freezing techniques were initially used to

By 2013, many of the world's professional fertility bodies had stopped labelling the treatment as 'experimental', triggering a gold rush in egg-freezing investment and marketing. Van de Wiel's book *Freezing Fertility*, published by New York University Press, tracks this rapidly expanding offshoot of the fertility industry, and the people it aims to attract.

"We've always had commercialisation of IVF, but there's a large amount of private equity and venture capital investment pouring into egg freezing – often coming from places with no links to the fertility industry," says Van de Wiel.

Start-ups focusing on clinical freezing services are seeing such an influx of capital that they are acquiring many established independent IVF clinics, creating corporate fertility franchises unlike anything previously seen.

The target customers for these new conglomerates are not just women in their mid-thirties but those a decade

Snapshot The regulatory expert

When it comes to implementing human rights, the devil lies in the detail, says Jinal Dadiya, a PhD student at the Faculty of Law, "particularly for rights administered with the help of many stakeholders and fast-evolving technology". She is investigating how states can best make good on their commitment to the right to reproductive health by regulating fertility clinics well.

"Rapid advances in reproductive technologies such as IVF, gamete preservation and surrogacy, along with a high demand for assisted reproduction, make fertility markets diverse and flexible," she explains.

"Each technological change throws up a whole range of legal issues. Governments worldwide work with medical and other experts to respond to them.

While each state evolves its own approaches to these issues, when it comes to devising regulation, they have a lot to learn from each other."

Dadiya compares different regulatory approaches to see which are best at furthering the right to reproductive health. She also looks at softer forms of governance, such as advertisement regulation.

"There isn't one correct approach to maximising reproductive health in all contexts," she says. "But some solutions are translatable. For instance, where one jurisdiction has worked out principles for the price regulation of reproductive services, others can consider these principles in their own circumstances."

Dadiya is currently exploring standard setting by fertility professionals and scientists: "A lot can get lost in translation when scientific standards directly enter the legal frameworks of countries as binding regulation."

Jinal Dadiya





We're used to the idea that as adults we have some control over our destiny: what we eat and drink and how much we exercise can affect our risk of poor health. But we now know that risks of heart disease and diabetes can be programmed much earlier – even before we were born.

Words Craig Brierley

SET UP FOR LIFE

Fast Facts



Diseases in later life can be programmed by the environment experienced in the womb

'Memory' of problems during pregnancy may be passed down to the next generation through sperm

Obesity during pregnancy can potentially programme offspring to overeat

A parent's emotional state during pregnancy can play a role in outcomes for the baby

Towards the end of World War II, a German blockade coupled with a severe winter led to a devastating famine in the Netherlands known as the Hongerwinter. Forced to live on fewer than 800 calories a day, around 20,000 people are believed to have died.

At the same time, Leningrad was coming to the end of a drawn out and deadly siege. An estimated 800,000 civilians died as a result of the ensuing famine.

Decades later, a startling difference emerged between the children – now adults – born from women pregnant during these terrible conditions. The Dutch survivors experienced an increased risk of obesity, diabetes and heart disease; those from Leningrad did not.

These very different outcomes tell us something important about what happens in the womb during pregnancy, says Professor Abby Fowden from the Department of Physiology, Development and Neuroscience.

“The fetus is programmed for the environment in which it expects to find itself. Most of the time, if what it has predicted in the womb ends up being what it experiences after birth, its future health is likely to reflect that of the general population. But what if there’s a mismatch? That’s when more health problems than average can arise in later life.”

Babies from the famines would have been undernourished; they would have been born smaller, their bodies programmed for a world where food was scarce. For the Leningrad babies, food was scarce: the famine lasted several years. In the Netherlands, however, food supplies returned to normal much quicker.

Just as diet, smoking and exercise affect our health as adults, so too can they affect the unborn baby while it is in the womb. But it’s becoming increasingly clear that the environment of these earliest months of life can also affect our long-term health, and even the health of our grandchildren.

Heart of the matter “If the mother doesn’t get a balanced diet, her stress hormones can increase and affect how tissues in the fetus develop – the pancreas or the number of cells that become fat cells, for example,” explains Fowden. “This will have consequences in later life.”

In the office next door to Fowden, Professor Dino Giussani is looking at how the environment in the womb programmes our cardiovascular health in later life. Using animal models, he has

shown that lower than normal levels of oxygen in the womb result in babies born with fewer of the cells needed to build the heart, resulting in it being weaker. Their blood vessels are less able to contract and relax, and there are signs of damage in the developing heart and blood vessels caused by excess ‘free radicals’.

“If we think of heart disease, the first thing that comes to mind is how your genetic makeup interacts with lifestyle factors like smoking, obesity or a sedentary life to increase your risk,” says Giussani. “But even more important may be how the environment in the womb interacts with the genetic makeup of the fetus.”

Our genome has the potential to become ‘decorated’ with effects from the environment through ‘epigenetic’ modifications in which methyl molecules attach and turn genes on or off. These modifications are also essential for regulating normal cell development and, as cells divide and replicate, they are passed on to other cells. Could these epigenetic modifications be inherited further, from generation to generation?

“If the mother doesn’t get a balanced diet, her stress hormones can increase and affect how tissues in the fetus develop.”

Professor Abby Fowden
Department of Physiology, Development and Neuroscience

Erasing the past Epigenetic inheritance is an idea that has captured people’s imagination. The effect has certainly been observed in plants and nematode worms, and evidence suggests that the daughters of mothers who experience adverse pregnancies not only have increased risk of obesity and type 2 diabetes but also pass this risk on to their own children.

But there is a problem, says Professor Anne Ferguson-Smith from the Department of Genetics.

“When I ask an undergraduate what epigenetics is, some say ‘Isn’t that how the environment influences how our genes work and gets transmitted across generations?’ This particular perspective of epigenetics has become almost textbook stuff. But the evidence doesn’t really stack up.”

In fact, her own research has thrown a spanner in the works: changes resulting from our environment occur only in certain regions of the genome, and they are not passed on indefinitely. In mammals, there is a mechanism that erases all the epigenetic marks, not once but twice, she explains. These erasures occur early on in the process that will

lead to the generation of eggs and sperm, and then again at fertilisation (see panel).

While there is evidence that epigenetic modifications in some genetic regions escape erasure, these are thought to be the exceptions and most likely regions of the genome that are not responsive to the environment, she says. So could there be another way of explaining how problems during one woman’s pregnancy are passed down to her grandchild that doesn’t require inheriting epigenetic modifications?

Yes, says Ferguson-Smith. Take the situation where a mother is undernourished. This will affect her offspring, making them more susceptible to obesity and metabolic disease. If a girl grows up with metabolic disease then, when she is pregnant, this will in turn have an impact on her own child’s health. “So the grandmother caused the defect in the daughter, and the daughter caused the defect in her offspring.”

But she adds: “That doesn’t mean that transgenerational epigenetic inheritance doesn’t exist, it’s just that there are other mechanisms to explain how the effects of the environment might appear to be perpetuated across generations. To some extent, that’s why studying effects transmitted via the father, who is not directly influencing the baby in pregnancy, is better at addressing this.”

The father effect While there is a focus on the impact of the mother’s health and wellbeing on that of her offspring, perhaps more surprising is the contribution that the father may also play.

Ferguson-Smith has shown that the ‘memory’ of problems during pregnancy or early life can be passed down to the next generation through sperm. Evidence from other groups has suggested that this might be through molecules known as RNA. This supports Giussani’s studies, which most recently have found that heart disease risk from hypoxia in the womb can be passed between generations, but only from father to child. In fact, there is evidence that the mother can pass on to her offspring a protective effect against this transmission of heart disease risk via her mitochondria.

Even a parent’s emotional state can play a role in outcomes for the baby. Professor Claire Hughes from the Centre for Family Research has looked at how the family’s emotional struggles during pregnancy affect their child’s behaviour. She discovered that a very young child was more likely to have emotional problems if the mother was stressed

during pregnancy. But surprisingly, this link was equally strong if the father had a ‘difficult pregnancy’ emotionally.

Healthy beginnings As researchers continue to unpick how both the lived experiences of our parents and grandparents affect us before we are born, others are investigating how we can counteract adverse outcomes.

Professor Sue Ozanne from the Wellcome-MRC Institute of Metabolic Science looks at the effects of over-nutrition and obesity during pregnancy. She has shown in mice that, if the mother is obese during pregnancy, it programmes her offspring to overeat and become obese, potentially programming her own offspring to overeat. “It’s a vicious cycle,” she says.

Ozanne’s work suggests that one way of breaking this cycle might be to get the mother exercising during pregnancy. “It’s difficult to lose weight once you’re obese, but we’ve shown that with sufficient exercise, even if you don’t lose weight, you can improve your metabolic fitness and become more insulin sensitive.”

Another possible solution is drug therapy. Ozanne is looking at whether metformin, a common drug used to treat diabetes, might help.

Giussani, meanwhile, is interested in whether specific antioxidants could counter the oxidative stress seen in different organ systems in his experimental models.

Finding pharmaceutical solutions will not be easy, however. First is the challenge of identifying those pregnancies where it would be appropriate to intervene – and, if so, when? Then there is the subtlety of changing the course of a disease process while maintaining normal function – excess free radicals may cause oxidative stress, but we need some of them for our bodies to function. Clinical trials in humans then raise a whole other set of issues.

“The problem is that you’re treating two patients: you’re treating the mother and the child, and that’s hugely difficult from an ethical as well as a scientific point of view,” says Giussani. “That’s why there are very few clinical trials in pregnancy itself. It’s safer to treat the baby once it’s born, you’re treating one individual, not two.”

For now, it seems, the way to give a baby its best chance of a disease-free adulthood is to follow common-sense advice during pregnancy: don’t drink, don’t smoke, avoid stress, do exercise and eat well. And everything in moderation. ●

Snapshot The ‘father’ of genomic imprinting

We inherit one set of chromosomes each from our mother and father, but it wasn’t until a discovery in 1984 by Professor Azim Surani – after his PhD under IVF pioneer Sir Robert Edwards – that it was known that we need chromosomes from both parents for normal development. His discovery was to provide the impetus for the field of epigenetics.

“This suggested that the chromosomes contained extra information that was dependent on a ‘memory of its origin’ from the mother or the father,” says Surani, now at the Gurdon Institute.

Surani named this ‘genomic imprinting’, a form of epigenetic inheritance in which the regulation of a gene is influenced by the sex of the transmitting parent without altering the genetic sequence.

“The imprints are first erased in germ cells (precursors of sperm and eggs), and then reintroduced as they develop. Another wave of erasure occurs after fertilisation, but the imprints are protected at this time and inherited, playing a vital role in the development of the fetus and placenta, and are transmitted through to adulthood.”

Surani also showed that germ cells are among the first cells to emerge after the embryo implants, and identified the key genes and mechanism involved in their development.

He has now teamed up with a consortium of researchers from Cambridge University, the Babraham Institute and across the UK to build a ‘family tree’ of how cells divide and specialise following fertilisation. The £10m Human Developmental Biology Initiative is funded by the Wellcome Trust.

Professor Azim Surani



Surviving birth



Ugandan researchers are working with Cambridge colleagues in one of the busiest maternity hospitals in the world to help more women survive complications of birth. Their research in Kampala is vitally important: levels of maternal deaths are nearly 50 times higher for women in Sub-Saharan Africa and their babies are 10 times more likely to die in their first month of life compared with high-income countries.

Words Louise Walsh

Photography Valente Inziku, whose wife died in childbirth in Arua, Uganda, photographed by Tadej Znidarcic

“IN a bad month we can have up to 15 mothers dying. For babies, the number is usually double or three times that figure.” These are the words of Dr Annetee Nakimuli, an obstetrician working in one of the world’s busiest maternity hospitals, in Kampala, Uganda.

Looking after up to 28,000 deliveries a year, she and the other doctors and midwives work under intense pressure. Every day, 300 pregnant women visit the antenatal clinic. Up to 100 patients are in the labour ward, around 40 of whom will have complications – obstructed labour, haemorrhage, sepsis or pre-eclampsia – and up to 25 emergency caesarean sections will need to be carried out.

“When women come to the labour ward they hope to come out with the best of it – they hope to come out with a live baby, and come out alive themselves. But women go to hospital with mixed →

Fast Facts



Genes linked with risk and protection in pre-eclampsia discovered in African women

First contemporary textbook of obstetrics by African doctors for African women to be published by Cambridge University Press

Large-scale studies in the UK and Uganda search for predictors of adverse pregnancy outcomes

feelings – they’ve seen others die before them, so there’s a tendency to think of maternal death as something inevitable rather than avoidable,” says Nakimuli.

Part of the challenge is the sheer number of patients compared with the number of doctors and midwives. “We are a national referral hospital so we receive everybody... we can’t deny admission because we are full,” says Nakimuli. “In fact we’re not even sure what full means – we’ve always worked above 100% capacity.”

But Nakimuli is convinced that, even with the difficulties of resourcing and logistics, something can be done to reduce the mortality rate. Despite an astonishing workload, she and others have had the drive to question why so many pregnant women die in Africa – and improve their chances of survival.

Silent killer Ten years ago, Nakimuli arrived in Cambridge as part of the Cambridge-Africa Programme, a University-wide initiative to make its expertise and resources available to support ‘African researchers working in Africa on African priorities’. She was embarking on a PhD with Professor Ashley Moffett, an expert on the life-threatening condition pre-eclampsia that results from the placenta developing abnormally.

Pre-eclampsia occurs more commonly in women of African ancestry compared with Europeans, and happens earlier in pregnancy and is more severe, says Moffett: “What makes the disease a ‘silent killer’ is that it’s impossible to predict or prevent. The only course of action is careful monitoring and emergency delivery.”

Over the past decade, Nakimuli has travelled back and forth between her research lab at Makerere University in Kampala and Cambridge’s Department of Pathology to learn techniques, analyse samples and spend time with Moffett examining why this complex disease is so much more of a problem in Africa. Their collaboration led to the discovery of particular genes found only in women of African descent that are linked with risk and protection in pre-eclampsia.

Moffett is now hopeful that recent work on ‘mini-placentas’ with Cambridge colleagues Dr Margherita Turco (see panel) and Professor Graham Burton will provide a much-needed experimental tool to understand this mysterious disease – and the role of the placenta in general.

But even with these major steps forward, the researchers know they are still a long way off being able to offer early diagnosis and treatment, as

“What motivates me every day is the belief that, in my lifetime, I will see preventable maternal death being talked about as a thing of the past, even within Sub-Saharan Africa.”

Dr Annetee Nakimuli
Obstetrician in Kampala, Uganda, and researcher at Makerere University

Nakimuli explains: “I’ve really worked on trying to understand pre-eclampsia and we’ve made discoveries that will help us to understand the basic disease, but sometimes the endpoint of being able to help the patients is not easy to reach. In the meantime, it’s very obvious that we need to find other ways of helping women right now.”

Stories to books Ugandan obstetrician Dr Imelda Namagembe is also trying to improve maternal health by, as she explains, “learning from the stories of the women who have died.”

In the UK, if a woman dies during or after pregnancy, the circumstances of her death are collected anonymously by a national service called MBRRACE (Mothers and Babies; Reducing Risks through Audits & Confidential Enquiries across the UK), which then makes national recommendations to improve future care.

Namagembe would like to see a similar system in Uganda, where the level

of systematic processing and reviewing of reasons for maternal death is low. The first step is to identify the barriers to this process, which she is doing for her PhD as part of the Cambridge-Africa Programme, co-supervised by Nakimuli and Dr Catherine Aiken from Cambridge’s Department of Obstetrics and Gynaecology.

“One of the things that makes an enormous difference to women surviving is somebody systematically collecting the reasons why mothers have died, reviewing them, understanding what’s happening, and then learning from it,” says Aiken. “And no one has done this in Uganda.”

She adds: “Given the pressure that doctors like Imelda and Annetee are under, it’s amazing that there’s also the will and the determination to say look we can do something about this.”

It’s a sentiment echoed by Aiken’s colleague Dr Charlotte Patient, a Consultant Obstetrician at the Rosie Maternity Hospital in Cambridge, part

of Cambridge University Hospitals NHS Foundation Trust. She visits Kampala each year with a volunteer team of NHS clinicians and midwives from the Rosie organised by Cambridge Global Health Partnerships.

“The staff in Kampala don’t need clinical expertise – they’re very good,” says Patient. “What they asked us for help with was in building clinical guidelines that could be used everywhere and updated easily. They’d had no breathing space to take a step back and develop standardised approaches.”

As the Ugandan and Cambridge teams worked together to develop guidelines for the major causes of maternal mortality, there were some unexpected successes, says Nakimuli: “Our midwives gained confidence. We saw, for example, Charlotte the doctor and Kimberley the midwife discuss matters as equal partners. It showed us how interdisciplinary teams work well. Around 80% of our deliveries are in the hands of midwives, and so the more empowered they are, the better.”

Back in the UK, Patient says she has a new perspective on her own work: “You come back with a completely different appreciation for the NHS. I really think about use of resources and how we don’t always make best use of what we have. The experience has made me a better doctor.”

Another success is on the way to being born: the first contemporary textbook of obstetrics written by African doctors for African women. Nakimuli and her Ugandan colleagues are currently writing the contents planned for publication in print and online by Cambridge University Press in 2021. Meanwhile, her Cambridge colleagues are providing advice and have raised funds for the book to be available as open access.

Predicting outcomes Nakimuli is also starting a new study to understand how to predict a complicated pregnancy. Her Pregnancy Outcome Prediction Study (or POPs), funded by the Royal Society and the African Academy of Sciences, and thought to be the first of its kind in Africa, is based on a model designed by Professor Gordon Smith in Cambridge’s Department of Obstetrics and Gynaecology.

Smith’s study followed 4,212 UK women for five years from early pregnancy through to delivery in order to identify predictors of adverse pregnancy outcomes. “In the UK, although some women are identified as high risk for pregnancy complications from their medical history, most complications

occur in women with no known risk factors,” he explains. Smith’s unique data-rich approach looks for the ‘biological signature’ of an unhealthy pregnancy using regular ultrasound scans and blood sampling, DNA sequencing, analysis of samples of placenta, fetal membranes and umbilical cord, and details of the delivery and outcome.

The huge volume of data is already providing health benefits: for instance, his team discovered that offering universal late pregnancy ultrasounds at 36 weeks’ gestation eliminates undiagnosed breech presentations of babies, lowers the rate of emergency caesarean sections, improves the health of mothers and babies, and could actually save the NHS money. “Practice only changes when guidelines change, and guidelines only change when the evidence to support change is strong,” adds Smith.

Nakimuli’s goal is to look specifically at the ‘signature’ for pre-eclampsia: “Until now we have been studying the women who have developed the disease,” she says. “We need to move a stage earlier and do prospective studies that will help us to understand which women we should pay special attention to when they become pregnant. Because African women have more severe forms of the disease, we think this is an opportunity to understand the disease as never before.”

Optimism Moffett believes that Nakimuli has the passion and ability to make a difference: “She’s a leader. She’s not only established and maintained these wonderful collaborations between Makerere University and Cambridge but she’s been a role model for all the other collaborations that now exist in areas like sepsis, placental malaria, hypertension, anaesthesia and infection control. For change to happen it needs to be led by Africans like Annetee.”

Nakimuli herself is optimistic that the small successes in reducing the rate of maternal mortality in Africa will become bigger successes: “Globally, maternal and neonatal health has become a high priority among the international community, and there is more awareness in Africa that we should not accept that it is normal to die during childbirth. We are seeing small successes so, when they announce every few years there is a bit of decline, I think: yes... we will finally get there.

“What motivates me every day is the belief that, in my lifetime, I will see preventable maternal death being talked about as a thing of the past, even within Sub-Saharan Africa.” ●

Snapshot The placenta grower

Pregnancy complications are often the result of defective placental development and function. But how and why this should happen is a ‘black box’. These are particularly human problems and it’s not possible to study the organ inside the mother.

So Dr Margherita Turco working with Professors Ashley Moffett and Graham Burton came up with a transformative solution: she grew a uterus and a placenta in a dish. “Without a reliable experimental model that mimics how placental cells interact with the maternal tissues, it was impossible to ask even basic questions,” says Turco, from the Department of Pathology and Centre for Trophoblast Research.

“We can now grow miniature functional ‘organoids’ that so closely resemble first-trimester placentas that the cells record a positive response using a pregnancy test, showing they are secreting hormones.

“Our mini-placentas will help to shed light on the mysteries surrounding the relationships between the placenta, uterus and fetus. They could be used to understand the role of the placenta to protect the baby and how chromosomal abnormalities perturb normal development, as well as to screen the safety of drugs to be used in early pregnancy.

“To me, one of the most exciting aspects is that the events when a mother and her fetus first physically interact through the uterus and placenta have been impossible to capture. Now we can see exactly what happens when the two sides ‘talk’ to each other, and if that dialogue is perturbed in women who suffer an early pregnancy loss.”

Dr Margherita Turco





The decision about if and when to have children can be one of the most significant many people will ever make. But – for those who have the choice – what influences come into play, and how have these changed over time?

Words Jacqueline Garget

(When) are you going to have children?



“When you have a child you’re making a decision about someone else’s entire existence. That’s a really, really big decision,” says Dr Simon Beard at Cambridge’s Centre for the Study of Existential Risk. As a moral philosopher, Beard has thought deeply about the ethics of having children. He’s troubled by the simplistic way that many people talk about such an important decision – or don’t talk about it at all.

“People want to see it as a private decision, and believe they should be able to do whatever they want,” he says. “But throughout history, the decision to have children has always been strongly influenced by social and ethical values. A lot of people have children because they think it’s what other people want, whether parents or partners. They’re brought up with views about what good families look like. They’re influenced by their religious upbringing, or ideas about their career, or what stage they’re at in life.”

Taking control Today people spend more time preventing pregnancy than allowing it, until they actively decide otherwise. But before the advent of reliable contraception, it was the other way around. “Until the middle of the 19th century, if you were engaged in a →

Fast Facts



Researchers studying birth rates in Britain relate declining fertility from 1850 onwards to the growing cost of children and the increased acceptability of deliberate fertility control

An uncertain economic climate relating to COVID-19 might be a short-term deterrent to childbearing

Environmental issues are now part of the mix that influences reproductive decision-making

sexual relationship, particularly if you were married, you didn't try to prevent pregnancy," says Dr Alice Reid, a historical demographer in the Department of Geography. "So when a major fertility decline does happen, it's interesting to ask why."

Reid's research focuses on the UK from 1850 to 1930, when the birth rate dropped from 4.5 children per woman to fewer than two. She thinks this is linked to the emergence of people's ability to choose.

"Perhaps women hadn't wanted big families for a long time," says Reid, "but it gradually became more acceptable to do something about it. Contraceptives weren't easily available or very effective at the time. We think people knew how to stop having children through sexual abstinence and withdrawal – but these methods can only work with the agreement of both parties within a marriage. The growth in education benefited women. It led to more equal relationships, or at least more discussion about having children."

Fertility declines were recorded in the British working class towns of South Lancashire and West Yorkshire in the late 19th century, where women had earning potential. "Married women in these places

were more heavily involved in jobs like textile weaving and cotton spinning," says Reid. "Having one or two children didn't stop them working, but having more children did. There might have been an agreement between the husband and wife not to have too many children too fast, otherwise she would have to leave the workforce and their income would drop."

Simon Szreter, Professor of History and Public Policy in the Faculty of History, says that most societies throughout history have found ways to control their reproduction. In 1798, Thomas Malthus wrote his famous essay *On the Principle of Population*, arguing that the Poor Laws of the time were encouraging people to have children by handing out money according to how many they had. When the law changed – stopping payments and sending the poor to workhouses instead – there was a corresponding rise in the age of marriage, and a drop in fertility.

"Another societal factor influencing reproductive choices was the rise of the British professional middle classes in the late 19th century," says Szreter. "Such good jobs required an expensive education, and every child you had was 18 years of rising expenditure stretching ahead of you. There's one very obvious

way to economise – don't have six or seven children, have three or four instead."

Beard says this thinking persists today in driving demographic change. A report from the Child Action Poverty Group estimates the overall cost of a child in 2019 up to age 18 in the UK was £185,000 for lone parents (up 19% since 2012) and £151,000 for couples (up 5.5% since 2012).

"The big shift around the world has been from 'successful parents have lots of children' to 'successful parents have successful children,'" he says. "People want money to invest in their children, and it's having a huge impact on their reproductive decision-making."

An uncertain economic climate can also be a short-term deterrent to childbearing, and Reid says that COVID-19 and its economic effects may reduce numbers of births in the short term. Some couples may recoup delayed births later, but that will not be possible for everyone and some women will end up with fewer children than they originally intended.

Population concerns According to the United Nations (UN), our global population is set to reach 10 billion by the year 2050. "Population growth is a product of three main components," says Beard. "These are increasing life expectancy, population momentum and fertility rate."

A fertility rate of 2.1 children per woman would ensure a broadly stable population but, despite the rise in overall population, global fertility has actually been falling for a long time, and looks set to continue to fall.

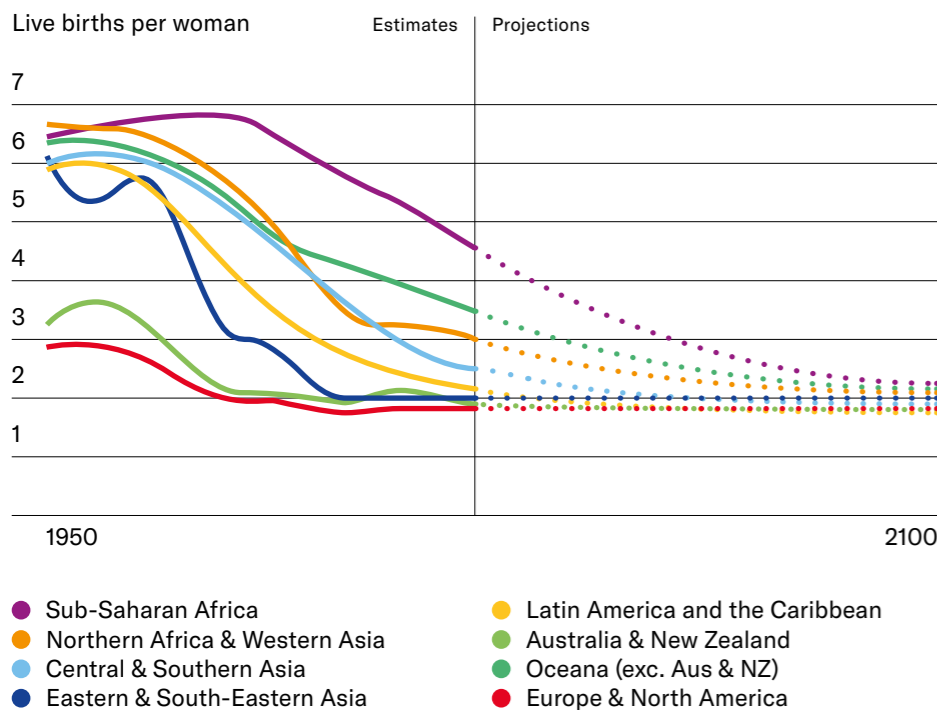
"If fertility was reduced to below replacement everywhere in the world right now, at least half or more of the population growth in the next 60 or 70 years would be due to population momentum: the existing large cohorts of women of reproductive age who don't have many children each, but collectively produce fairly large numbers," says Reid. "In the longer term, people deciding not to have children will reduce fertility and reduce the population. But it will also produce some very odd population structures and create many problems along the way."

Japan and Italy offer a glimpse of these problems – their fertility rates are so low that their populations are already in decline. "As we talk about a global population of 10 billion, we're also talking about a situation where increasing proportions of people will be past retirement age. Over a quarter of Japan's population is already over the age of 65," says Reid.

Birth in decline

Total fertility rate by region, estimates and projections, 1950–2100

Source United Nations Department of Economic and Social Affairs, Population Division (2019a), World Population Prospects 2019 (bit.ly/3k8qjG)



Snapshot The geographer of reproductive rights

Having, or not having, a baby raises a multitude of considerations and it polarises emotions – not least in relation to abortion.

Dr Francesca Moore from the Department of Geography and Homerton College is exploring how legal frameworks affect access to abortion. Her current focus is on anti-harassment buffer zones around abortion clinics. She uses case studies to examine their effect on patients, healthcare workers, protesters and local residents.

"Laws relating to abortion vary widely across regions and countries," she explains. "Women accessing healthcare clinics find anti-abortion protests extremely distressing and threatening. We're seeing an alarming rise in extreme protest tactics in the UK such as clinic vigils, graphic imagery and, in some cases, violence."

"In parts of London, anti-abortion protests around healthcare clinics were prevented using antisocial behaviour legislation that created protest exclusion zones. In 2018, the Home Office ruled out the introduction of these zones across England but, in June 2020, MPs voted in favour of a Bill that would create buffer zones outside all clinics in England and Wales. If successful, this legislation would bring an end to the 'postcode lottery' of harassment that women accessing abortion clinics face. Legal frameworks have been regulating reproduction in a geographically determined way."

Moore is also exploring the escalation of the anti-abortion protest in England and the role of American ideas of 'free speech' in this protest.

Dr Francesca Moore



"When you have a child you're making a decision about someone else's entire existence. That's a really, really big decision."

Dr Simon Beard
Cambridge Centre for the Study of Existential Risk

"That's not an issue that we can solve by reducing fertility – if anything that's likely to make things worse," adds Reid. "A population with lots of old people and not enough working-age people creates economic challenges, social care problems, and increases demands on healthcare services."

Environmental anxiety The decision whether to have children now also comes with an added dimension: concern for the state of the planet. A study published in the journal *Environmental Research Letters* in 2017 by Swedish and Canadian researchers found that four personal choices have a consistently high reduction in carbon emissions: eating a plant-based diet, living car-free, avoiding flying and having one fewer child. Of these, having one fewer child had by far the greatest impact, saving around 58.6 tonnes of carbon per year.

However, Dr Katie Dow in the Department of Sociology says that not everyone agrees with the view that there is a simple relationship between a larger human population and greater environmental degradation. In collaboration with Heather McMullen at Queen Mary University of London she has been following the online discussions of climate activist groups to understand how environmental issues influence reproductive decision-making.

"These groups are explicitly against population control, or populationism,"

says Dow. "Instead, the groups bring together people who are so worried about the impact of climate change and planetary health on their future children's lives that they are pledging not to have children."

She adds: "BirthStrike¹ and No Future No Children are very strategic and thoughtful groups. Their aim is to put pressure on governments and corporations to do something about climate change, and to try to make people care."

Dow recounts the story of one member who realised that while her mother wouldn't vote differently because of 'concerns about the weather', she might change her mind if there was a threat of not becoming a grandmother because her daughter refused to have a baby under the current system.

"These groups are imagining pretty dystopian scenarios," adds Dow. "Many members are climate activists and have been involved in environmental campaigning for some time. They are talking about food shortages, water shortages, civil unrest, forced mass migration, pressure on resources, very scary stuff. Their sense of urgency has been galvanised by the latest UN figures that we've only got 12 years left to prevent catastrophic climate change."

Dow says that these movements are using the common desire to have children, and common cultural associations between children and the future, to raise awareness of the fact that climate change will mean a very difficult future for humanity.

"A focus on population numbers is very simplistic, and obscures the fact that the vast majority of global carbon emissions come from just a handful of corporations, not from people having children. These groups are saying we might not have a future at all."

Making a decision So what, armed with the correct information and a long-term view, is the best decision for potential parents to make? Beard says there is no 'one-size-fits-all' policy on having children that could ever work. He is keen to see wider debate around population growth and reproduction, to help individuals think more critically about the advantages and disadvantages of having children before making their decision. But if there's one indisputable fact, it's that if everyone made the same reproductive choice, the results would be disastrous. ●

¹ BirthStrike has since announced the end of its campaign, citing reasons that include accusations of being populationists.

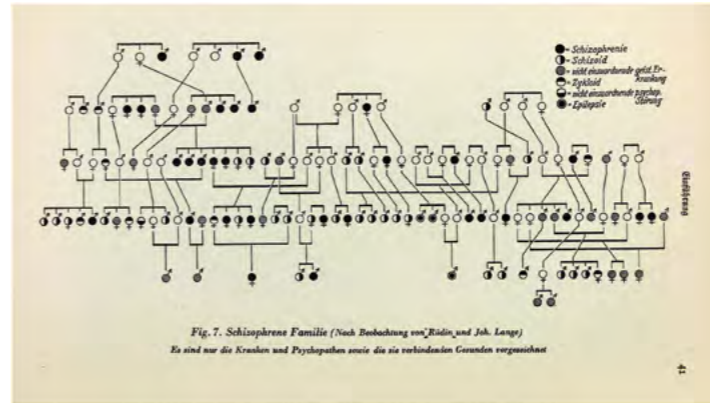
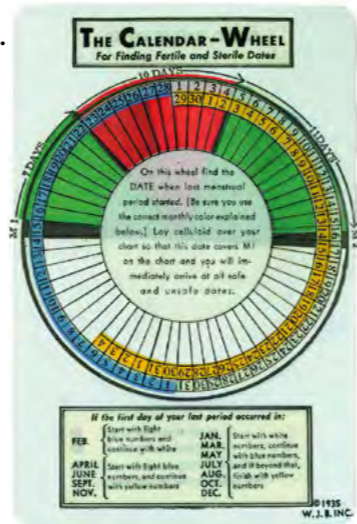
1. Divine aid, 4th–2nd century BC
Terracotta model of a swaddled infant from Hellenistic Italy, offered to the gods to secure family success

2. Monstrous birth, 1559
The 'monster of Cracow', an unusual-looking human child in a manuscript discussing diabolical causation

3. Generative parts, 1672
Engraving of follicles, or 'seed-preparing vessels', that feed the female 'balls, trumpets... womb and vagina'

4. Man-midwifery dissected, 1793
Satirical image, a weapon in debates over who should assist women in childbirth, medical men or midwives

5. Human embryos, 1799
The first connected series of pictures showing growth and increase in complexity through human development



A BRIEF HISTORY OF REPRODUCTION

The histories of how living things procreate – from the banks of the ancient Nile to the fertility clinics of today – have been brought together in an astonishing book covering 4,000 years of making (and not making) babies.

The volume represents decades of scholarship by 70 leading researchers and follows a five-year project funded by the Wellcome Trust. This is the brief version, told through a selection of the book's images.

Reproduction: Antiquity to the Present Day (2018), published by Cambridge University Press and now out in paperback, is edited by Professors Nick Hopwood and Lauren Kassell from the Department of History and Philosophy of Science, and Dr Rebecca Flemming from the Faculty of Classics.

Read more
→ bit.ly/reproductionbook
→ bit.ly/reproductionblog

6. Family pedigree, 1934
'Schizophrenic family' pedigree from a book explaining the Nazi sterilisation law to doctors and administrators

7. Calendar wheel, 1960
Wheel marketed to help women use the rhythm method to identify fertile and non-fertile days

8. Family planning, 1967
Indian stamps advocating a two-child family, shown here standing on the red triangle, a symbol of contraception

9. Room of ribbons, 2017
Photographs and ribbons, offerings for divine aid to have healthy children, in a Catholic shrine in Italy

Credits (1, 2, 4) Wellcome Collection; (3, 5, 6) Cambridge University Library; (7) T. S. Welton, *Rhythm Birth Control* (Grosset & Dunlap, 1960); (9) Jessica Hughes

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