Horizons
Pioneering research from the University of Cambridge
COVID-19

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

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

08 “In it for the long haul”
Biomedical researchers at the heart of the health crisis are also preparing for the viruses that come next

12 Ad Hoc
Search for a vaccine (against fake news too), the £10m challenge, looking beyond the pandemic, and more

Features

16 This Cambridge Life
The Mongolian conservationist helping nomadic herders preserve lands under threat from the fashion industry

18 Displaced lives
Dr Naures Atto is determined to give voice to the migrants denied a home and basic human rights

20 Meltdown
100 years of polar research – and the catastrophic changes to ice sheets at both ends of the planet

22 Fieldnotes
Walking on Mount Terror in South Africa, botanist Dr Ángela Cano likes to stop and smell the succulents

Editor
Dr Louise Walsh

Feature writers
Dr Tom Almeroth-Williams
Craig Brierley
Sarah Collins
Jacqueline Garget
Charis Goodyear
Fred Lewsey
Dr Louise Walsh

Spotlight advisory editors
Professor Graham Burton
Professor Sarah Franklin
Christina Rozeik
Professor Gordon Smith

Design
Modern Designers

Cover illustration
Sam Falconer

Surviving birth
Research at one of the busiest maternity hospitals in the world aims to help more women survive complicated pregnancies and birth

(C)When) are you going to have children?
What influences one of the most significant choices many people will ever make – and how has this changed over time?

Set up for life
How does the environment experienced in the womb programme us for diseases later in life – and even the health of our grandchildren?

Fertility futures
Four decades after IVF was conceived in Cambridge, sociologists investigate the new ‘haves and have-nots’ in our fertility futures

A brief history of reproduction
From the banks of the ancient Nile to the fertility clinics today, 4,000 years of making (and not making) babies (in brief)
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.
People powered

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

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.”

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 Posed 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?”

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 the knowledge economy and to the needs of young people when pandemic-related policy decisions are being made.”

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 Posed 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?”

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 the knowledge economy and to the needs of young people when pandemic-related policy decisions are being made.”

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 Posed 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?”

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 the knowledge economy and to the needs of young people when pandemic-related policy decisions are being made.”
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).

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 Intraacellular Immunity Team. His group studies the mechanisms used by viruses to escape immune surveillance, "quick wins", but that is not the point. "We're in it for the long haul.

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 British intensive care unit crisis team at Addenbrooke's Hospital, helping to reconfigure the entire hospital.

Dr Charlotte Summers

Snapshots

The intensive care medic

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.

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

Dr Estée Török

The superbug sleuth

We have to be prepared not just for this virus, but also for the next viruses that come along, says Dr Gordon Dougan, who 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 Bradbury 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 they respond over time (a technique known as immunophenotyping). By marrying this information up against the patient's clinical records, it's possible to see how the symptoms of COVID-19 relate to changes in the immune system.

"This will 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, and early treatment is likely to be more effective."

In just a few months, Smith's team has created one of the largest, most intricate blood pheno-phenotypic datasets 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 five more volunteers who have screened positive for COVID-19, allowing study of those with asymptomatic and mild disease.

"In most hospitals, it can take days to get a result, during which time the patient can no longer be treated by frontline therapy. 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.

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 of 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 conversation. The coronavirus has changed our world dramatically: is it here to stay?

It's not going to go away in a hurry," says Smith. "A bit like the flu, it will come and go and we will have to deal with it 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 this is likely, that our medical care will improve. We’ll be able to intervene earlier, and more effectively, and the mortality rate will drop."

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

Ebolavirus threatened to spread beyond regional boundaries but fortunately failed to become a pandemic. "Ebolavirus always had the qualities to be a really, really lucky one" 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 and research efforts towards combating COVID-19 that has taken place across Cambridge – has been so important, says Smith. "We are learning about the relationship between infectious disease and our immune system, and it will also help us to be ready for what comes next."

Dr Dougan, Dr Smith
Innovations, explorations, news, views and discovery. Read the full stories and many others at [cam.ac.uk/topics/COVID-19](http://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 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.”

**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 infrastructure.

Among these enterprising projects, the Open Ventilator System Initiative (OVS) 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 Nikolova 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.

**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.


**TECHNOLOGY**

**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](http://instagram.com/epidummyology)

**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.

**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.


**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 infrastructure.

Among these enterprising projects, the Open Ventilator System Initiative (OVS) 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 Nikolova 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.

**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.

**VIEWPOINT**

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

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

---

**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.

---

**VIEWPOINT**

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

---

**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.
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 herd 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.”

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.

Onon Bayasgalan
Cambridge Gates Scholar and Masters in Conservation Leadership
ob333@cam.ac.uk

Interview Charis Goodyear
Photography Nick Saffell

This Cambridge Life
Onon Bayasgalan
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 avoiding an asylum decision in Germany told RESPOND: “Some friends told us to go to another European country like 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 into my mouth I never said.” And a Syrian struggling to reunite his family in Germany complained: “That’s the worst thing... They keep you in 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 850 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 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 1918 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.”

 respomigration.com
 exhibition.respondmigration.com

Words Tom Almeroth-Williams

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.
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.

Dr Poul Christoffersen
Scott Polar Research Institute
pc350@cam.ac.uk

Dr Ian Willis
Scott Polar Research Institute
iw102@cam.ac.uk

Words Sarah Collins

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 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 79% 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 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 collapsing.

“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 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 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, 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 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 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 back to that heroic age – I walk by Captain Oates’’ sleeping bag 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.”

*"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."
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.
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.

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

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.

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.
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

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 of the Wellcome Trust. “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 commodification. It represents a sense of impermanence. It’s considered ‘something that needs help’. You know, 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 status. “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 believes, “and why the question of causality is so very complex.” “Politicians like broad sweeps of applicability, the ‘nudge’, because they are not going to be meaningful social change, telling people to go on holiday and make more children for grandma will only get you so far.”

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 Egg 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 piling into egg freezing – often coming from places with no links to the fertility industry,” says Van de Wiel. “The first wave of doctors doing clinical freezing services are seeing such an influx of capital that they are acquiring many established independent IVF clinics, creating corporate fertility franchises out of nowhere previously seen.”

The technology has improved dramatically. An egg is the largest cell in human body and freezing can cause crystal formation in the cell. Slow-freezing techniques were initially used to circumvent this problem, followed by the more successful flash-freezing ‘vitrification’ which 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 those who might want a baby in the future. “Egg freezing is both an infertility treatment for the future 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 fertility life.”

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

**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
T
owards 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 suffering the same; there was a disastrous and deadly siege. An estimated 800,000 civilians died as a result of the ensuing shortages.

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

These 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 where new health problems than average can arise in later life.”

Changes from the fames 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,” explains Fowden. “This will have consequences later in 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 being born smaller, 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?

Erasing the past

Epigenetic inheritance is an idea that has captured people’s imagination. The idea is that the health of our grandchildren, for example, may in part be programmed in the womb. But what if there is a mismatch? That’s when more health problems than average can arise in later life.

“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 epigenetic modifications, it doesn’t exist, it’s just that there are other mechanisms to explain how the effects of the environment might appear to be inherited across generations. To some extent, that’s why studying effects transmitted via the father, who is not directly influenced by his own 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.

Fowden-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 study that 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 her offspring’s 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 the lived experiences of our parents and grandparents affect us before we are even conceived, they are investigating how we can counteract adverse outcomes.

Professor Sue Ozanne from the Welcome-MRC Institute of Medical Science looks at the effects of overnutrition and obesity during pregnancy. She has shown in mice that, if the mother is obese during pregnancy, it can programmes her offspring to overeat and become obese, potentially priming her offspring’s food intake overeating. “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 resveratrol, a molecule found in red wine, and a common drug used to treat diabetes, might help.

“G Hamasch and his colleagues, is interested in whether specific antioxidants could counter the oxidative stress seen in different organs systems in his experimental models.”

Finding pharmaceutical solutions will not be easy, however. First is the challenge of identifying those regions of pregnancy 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 – exerting too much control 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.

“Obviously 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. “There are very few clinical trials in pregnancy itself. It’s safer to treat the baby once it’s born. That way, 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.

Snapshots

The ‘father’ of genomic imprinting

We inherit one set of chromosomes from each of 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 ‘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 way of putting this is to say that 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 also imprint first to 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
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 Annettee 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 emotions.”

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

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
feels worse in pregnancy. It’s a silent killer, but it’s impossible to predict or prevent. The only course of action is careful monitoring and early intervention.

Over the past decade, Nakimuli has worked back and forth between her research lab at Makerere University in Kampala and an international 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 much more of a problem in Africa. Their collaboration led to the discovery of much more of a problem in Africa.

Nakimuli is now hopeful that recent collaborations that now exist in areas 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 is dialogue is perturbed in women who suffer an early pregnancy loss."

Snapshots

The placenta grows

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 ‘organsoids’ that so closely resemble first-trimester placenta 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 is dialogue is perturbed in women who suffer an early pregnancy loss."

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 Annettie Nakimuli Obstetrician in Kampala, Uganda, and researcher at Makerere University

---

"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 Annettie Nakimuli Obstetrician in Kampala, Uganda, and researcher at Makerere University

---

“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 Annettie Nakimuli Obstetrician in Kampala, Uganda, and researcher at Makerere University
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

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.

*Fast Facts*

“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 →
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 happened, it’s interesting to ask why.”

Reid’s research focuses on the UK from 1850 to 1950, 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 would have taken some quite determined people 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, when 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 understanding 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 Szterer, 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 Szterer. “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 is alive and well 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 £202,000 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 be a useful 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 expected to grow from 7.7 billion in 2019 to 9.7 billion by the year 2050. “Population growth is a product of three main components,” says Reid. “These are increasing life expectancy, population momentum and fertility rate.”

Around 21 children per woman would ensure a broadly stable population but, despite the overall population increase, 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 is due to population momentum: the existing large cohorts of women of reproductive age who don’t have any 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.

Another reason for concern is that the current large cohorts will reach retirement age. Over a quarter of Japan’s population is already past retirement age. Even in a successful scenario where fertility rates rise, the baby boomers will make up a large slice of the population. Some worry that this could lead to overpopulation and reduced economic activity.

**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 had the biggest impact on 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 large 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 on our planetary health on their future children’s lives that they are pledging not to have children.”

She adds: “BirthStrike and No Future Children are very strategic and thoughtful about their decision. But they don’t 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 be able to afford the costs of ‘concerns about the weather’, she might change her mind if there was a threat of not being able to put food on the table because her daughter refused to have a baby under the current system.

“These groups are imagining really dystopian scenarios,” adds Dow. “Women 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 heightened by the news 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 this 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 a decision. But if there’s one indisputable fact, it’s that if everyone made the same reproductive choice, the results would be disastrous.

---

**Notes**

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

---

**Birth in decline**

Total fertility rate by region, estimates and projections, 1950–2010

<table>
<thead>
<tr>
<th>Region</th>
<th>1950</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Saharan Africa</td>
<td>5.5</td>
<td>2.8</td>
</tr>
<tr>
<td>Northern Africa &amp; Western Asia</td>
<td>4.6</td>
<td>2.3</td>
</tr>
<tr>
<td>Central &amp; Southern Asia</td>
<td>3.7</td>
<td>2.2</td>
</tr>
<tr>
<td>Eastern &amp; South-Eastern Asia</td>
<td>3.0</td>
<td>2.1</td>
</tr>
<tr>
<td>Latin America and the Caribbean</td>
<td>2.8</td>
<td>2.1</td>
</tr>
<tr>
<td>Austral &amp; New Zealand</td>
<td>2.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Oceana (exc. Aus &amp; NZ)</td>
<td>2.6</td>
<td>1.9</td>
</tr>
<tr>
<td>Europe &amp; North America</td>
<td>2.2</td>
<td>1.9</td>
</tr>
</tbody>
</table>

---

**Snapshot**

The geographer of reproductive rights

Hating, or not having, a baby is 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 vigil, 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 ‘buffer’ exclusion zones. In 2018, the Home Office ruled out the introduction of these laws in England but, in June 2020, MPs voted in favour of a Bill that would create buffer zones outside abortion 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
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

Credits (1, 2, 4) Wellcome Collection; (3, 5, 6) Cambridge University Library; (7) T. S. Welton, Rhythm Birth Control (Grosset & Dunlap, 1960); (8) Jessica Hughes

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

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