

# futurum

ISSUE 37  
April 2026

Inspiring the next generation

[futurumcareers.com](http://futurumcareers.com)



© iSchoolAfrica

## Zero Project

Advancing innovative solutions and  
breaking down barriers

## iSchoolAfrica Education Trust

Empowering educators and learners

## Research

From cow manure to  
corporate crime

# Be part of a **STEM and SHAPE** education community

## Want more articles like these from researchers, students and associate organisations?

By signing up to **Futurum Careers**, you are subscribing to a community of academics, educators, employers, students – people like you – who want to show the world just how fascinating and rewarding a career in **STEM** and **SHAPE** can be.

## What's in it for you?

As a member of Futurum Careers, you'll receive:



The **latest articles** from academics and associate organisations



**Teaching and classroom resources** relating to specific topics in STEM and SHAPE



**Careers resources**, including PowerPoints, animations and articles about inspirational role models



Sent to you once a month **for free.**

Scan to sign up for free,  
or visit the website:  
[futurumcareers.com/sign-up](https://futurumcareers.com/sign-up)



### A note about your privacy

Your privacy is very important to us. We will not share, sell, reveal, publicise or market your details in any way, shape or form. Our full privacy policy can be found on the Futurum Careers website: [futurumcareers.com/privacy](https://futurumcareers.com/privacy)

# ISSUE 37

## Zero barriers; maximum inclusion

WELCOME

“The goal is ‘a world with zero barriers’, so every person can fully participate in society,” says Judith Hermetter, Global Head of Communications at Zero Project. Judith tells us about the research-driven global initiative that finds and shares solutions that improve the daily lives of people living with disabilities (p 4).

The annual Zero Project Awards shine a light on the many ingenious tools and programmes making our world more inclusive. These celebrate barrier-breaking innovations in fields such as accessibility, education, employment and the arts. We highlight just a few of this year’s recipients (p 8).

A previous Zero Project Award winner, iSchoolAfrica Education Trust, aims to increase inclusivity in education (p 44). By providing technology and learning programmes to under-resourced schools in South Africa, iSchoolAfrica is empowering learners and teachers alike. Founder and Director Michelle Lissoos explains how the organisation’s work aims to “ensure all learners – especially those who are marginalised or have disabilities – can access meaningful learning opportunities.”

It’s a pleasure to highlight organisations – and the people behind them – that work hard to celebrate innovation and facilitate inclusion. With barriers removed, potential is endless...

**Brett Langenberg**  
Founder/Managing Director

**Chris Dowell**  
Project Manager

**Lewis Simpson**  
Project Manager

**Erica Morgan**  
Editor

**Isla Foffa**  
Assistant Editor

**Joe Aslett**  
Editorial Assistant

**Sophia Kerby**  
Senior Graphic Designer

**Sonia Guarnerio**  
Graphic Designer

### Our writers

**Jacob Ashton, MA**

**Rania Bouka, BSc**

**Rebecca Landon, MSc**

**Kate Wilkinson, MA**

### Published by Sci-comm Consulting

Digital ISSN 2632-8399

A limited company registered in England.

Company No: 10791252



### Contact

+44 117 9099150

info@futurumcareers.com

futurumcareers.com



### PowerPoints

Our PowerPoints summarise the articles and include reflective ‘Talking Points’, making them a fantastic classroom resource:

[futurumcareers.com/ppts](http://futurumcareers.com/ppts)



### Animations

As part of our free package of education resources, we include animations that bring many of the research stories to life:

[futurumcareers.com/animations](http://futurumcareers.com/animations)



### Podcasts

Featuring researchers talking candidly about their personal experiences, our podcasts are accessible, engaging and inspiring:

[futurumcareers.com/stem-shape-podcasts](http://futurumcareers.com/stem-shape-podcasts)

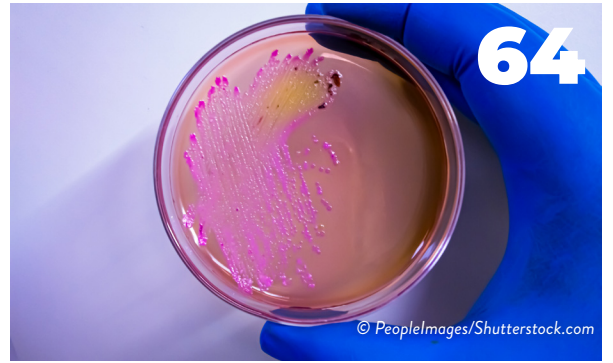
### Socials

- @FUTURUMCareers
- @Futurumcareers
- Futurum Careers
- @futurumcareers
- Futurum Careers
- @futurumcareers.bsky.social
- @futurumcareers

# CONTENTS

## Research articles

- 10** **Transforming college mathematics education through hands-on modelling experiences**  
Professor Jeff Anderson
- 14** **How can community voices transform HIV modelling and prevention?**  
Professor Sharmistha Mishra, Jeffrey Walimbwa, Nancy Tahmo and Dr Lisa Lazarus
- 20** **How does food shape our health?**  
Dr Jeannette Beasley
- 24** **Hungry Stories: using the arts to share research findings about food insecurity**  
Professor Elaine Power
- 28** **How did the pandemic affect children's attitudes to singing?**  
Dr Ardelle Ries
- 32** **What can pottery from the past teach us about containment today?**  
Professor Carl Knappett
- 36** **Speaking between worlds: how P'urhepecha changes across communities**  
Dr Kate Bellamy
- 40** **Bribery, forgery and fraud: the murky world of economic crime**  
Dr Jennifer Quaid
- 48** **How can immunology improve treatments for urinary tract infections?**  
Dr Juan de Dios Ruiz-Rosado



## Research articles

- 52** **Chronic pain in teenagers: the risks of self-medicating with cannabis**  
Dr Joe Kossowsky
- 56** **How can remote sensing make agriculture more sustainable?**  
Dr Angela Kross
- 58** **Forecasting frost to protect cranberry crops**  
Dr Peter Jeranyama
- 60** **How can we use methane to make industries more sustainable?**  
Professor Akshat Tanksale at the ARC Research Hub for Carbon Utilisation and Recycling (RECARB Hub)
- 64** **Can lactic acid fermentation disinfect manure?**  
Dr Hannah Halm and Dr Sören Woelke
- 68** **How to use Futurum resources**

## INTERVIEWS

- 04** **“We are in the privileged position of seeing innovative approaches and solution-oriented thinking across our global community every day.”**  
Global Head of Communications Judith Hermetter introduces Zero Project, an initiative sharing solutions that improve the daily lives of people living with disabilities.
- 44** **“When access is equitable and supported by strong teaching, technology can allow our youth to be active participants in shaping their own futures.”**  
Michelle Lissoos, Founder and Director of iSchoolAfrica Education Trust, tells us how the organisation is working to ensure all learners can access meaningful learning opportunities.



**COVER  
STORY**  
iSchoolAfrica  
**04**



# Zero Project – for a world with zero barriers

## ZERO PROJECT

**Judith Hermetter**, Global Head of Communications at **Zero Project**, tells us about the global and research-driven initiative that finds and shares solutions that improve the daily lives of people living with disabilities.

### When and why was Zero Project formed?

Zero Project was founded by The Essl Foundation – a charitable foundation established by the Essl family – in Austria in 2008. At the time, the United Nations Convention on the Rights of Persons with Disabilities (CRPD) had just come into force, and many countries around the world agreed to implement it. Zero

Project was created to advance this implementation by identifying and sharing innovative solutions worldwide. The goal is ‘a world with zero barriers’, so every person can fully participate in society.

### Who makes up Zero Project network?

Zero Project has its office in Vienna, Austria, where a small team works with a

global network throughout the year. The global Zero Project Network consists of more than 10,000 experts, policymakers, business leaders, academics, and other persons with and without disabilities. They contribute to Zero Project in various ways: through annual research, strategic partnerships, advisory roles, publications and events.



© Zero Project / Rupert Passl

### What connects the different solutions being developed around the world?

Everyone who takes part in Zero Project’s research and initiatives does so with the intention to collaborate and learn from each other. It is for all people, sectors of society, countries and types of disabilities. Consequently, there is a large diversity of innovations among the awardees. However, since the barriers persons with disabilities face are often similar, the same solutions may apply – perhaps with some adaptations to fit the local context. Here are just a few examples:

#### Mobility/Employment:

Social enterprise **Neomotion**, from India, developed an attachment for wheelchairs so users can work as delivery drivers and run their own businesses. Similarly, this year’s awardee, **Matt Movilidad**, from Colombia, created a low-cost wheelchair attachment using bicycle parts, enabling wheelchair users to work as local guides.

#### Emergency services:

**TapSOS** (UK) and **AccessSOS** (US) are

apps that allow persons with disabilities to contact emergency services without making a phone call. This is critical for people who are deaf or non-verbal, but the technology is also useful for the elderly or individuals who have had a stroke and cannot speak. Both apps integrate with their respective national

emergency services.

To be effective, an innovation must be co-designed with or led by persons with disabilities. The famous quote, “nothing about us without us”, ensures that individuals who truly understand the barriers are involved from the beginning. ➔



“  
**The goal is ‘a world with zero barriers’, so every person can fully participate in society.**  
”



Matt Movilidad’s mobility devices are tried out by conference participants © Zero Project / Rupert Pessl

## How are Zero Project awardees chosen?

Once a year, the Zero Project Network reaches out to all corners of the world during a 'Call for Nominations' for the Zero Project Awards. Last year, 586 nominations from 93 countries were submitted thanks to this collective effort. Nominations can include products, services, public policies and other types of initiatives. All types of organisations can nominate - from small grassroots initiatives and startups to large corporations, non-government organisations (NGOs) and public sector bodies.

Each year, the Call for Nominations addresses a specific topic, such as accessibility, education, employment,

independent living or political participation. Information and communication technology (ICT) is addressed every year due to its significance for disability inclusion, and there is also a special focus on inclusive arts.

To be successful in the selection process, each nomination must meet three main criteria: innovation, impact and scalability. In a months-long selection process that involves the global network, each nomination is fact-checked, evaluated and peer-reviewed. More than 400 experts contributed last year. From the original pool of nominations, around 75 innovative solutions are selected for a Zero Project Award every year. Awardees receive support from the global network

and present their work at the annual Zero Project Conference at the United Nations Office in Vienna.

## What were the highlights of this year's conference?

The Zero Project Conference 2026 (#ZeroCon26) was held in February, with more than 1,400 participants, with and without disabilities, and without disabilities from around 100 countries attending.

The highlight is the Award Ceremony, where the Zero Project Awardees receive their official certificates and their work is celebrated by the global community. However, personal highlights differ for every participant: for some, it's the opportunity to pitch their work to

Enzo Romero (Awardee from Peru: LAT Bionics) presenting at Zero Project Conference 2026  
© Zero Project / Rupert Pessl



potential partners; for others, it's learning from experts or discussing opportunities to scale their solutions.

What makes Zero Project conferences unique worldwide is the focus on community-selected innovations that can be replicated. Participants also often describe a unique energy at the event, as every person attends in a spirit of collaboration. As the organisers, we do our best to make the event as accessible as possible, for instance, through tactile flooring, International Sign interpretation in sessions and a quiet room.

### What impact is Zero Project having?

Zero Project is always an enabler or platform

to share and amplify the work of others. As such, the impact is not always immediate, and it varies. We know that Zero Project events have sparked new partnerships around the world. Through publications and media-related efforts, little-known initiatives receive visibility. Some awardees receive increased support in their countries because of the Zero Project Award's international reputation. Others gain access to important stakeholders, such as policymakers, while some improve their products by learning from the community.

For many, it's also very encouraging to see that they are not alone in their work for disability inclusion. Being at the Zero Project Conference and having this sense of belonging to a community is also a big motivational boost

for those of us on the team.

### What does the future hold for Zero Project?

It's a difficult time for diversity, equity and inclusion (DEI) initiatives around the world, and there are multiple crises – such as conflicts and the climate crisis – where persons with disabilities are among the most vulnerable groups. It is not an easy time for this community, but Zero Project is here to stay and will continue to provide a global platform for disability innovation. We are in the privileged position of seeing innovative approaches and solution-oriented thinking across our global community every day, so while barriers are real, we know that the work towards a world with zero barriers continues – and it is powerful. →



**“  
To be effective, an innovation must be co-designed with or led by persons with disabilities.  
”**

# Removing educational barriers

Here are just a few recipients of **Zero Project Awards 2026**:



© Zerobionic



© Zero Project / Rupert Pessl

**Solution:** Zerobionic Robotic Hand  
**Organisation:** Zerobionic  
**Country of implementation:** Kenya

Zerobionic, headquartered in Nairobi, is an ICT start-up focusing on inclusive educational technology, the core project of which is a robotic hand using AI to translate classroom

STEM (science, technology, engineering and mathematics) content into real-time sign language. Launched in 2022, Zerobionic has grown through partnerships and international replication, reaching over 500,000 students in 120 African schools and 9,500 students in four Swiss schools by 2024, and training 320 educators worldwide.

“  
**We are in the privileged position of seeing innovative approaches and solution-oriented thinking across our global community every day.**  
 ”



© Dramaski Productions



© Zero Project / Rupert Pessl

**Solution:** Dramaski Productions  
**Organisation:** Dramaski  
**Country of implementation:** Sweden

Dramaski is a small public-funded media company based in Stockholm, run by and employing Deaf persons in all roles. The company produces original TV

content, translates video/web materials, and develops educational resources all in Swedish Sign Language. The main language is authentic sign language from concept to production, supporting the linguistic development, cultural identity and visibility of children, young people and adults. Dramaski’s model has been replicated by broadcasters in other Scandinavian countries.



# Transforming college mathematics education through hands-on modelling experiences

STEM students start college hoping to build purpose for their lives and valuable skills for their careers. These students desire to find meaningful answers to questions like, “How does what I learn in school apply to problems I want to solve?” and “How does this relate to the future I want to create?” However, many college STEM courses do not prepare students for a career in their chosen field and focus on content that is far removed from students’ lives. This is why, at **Foothill Community College** in California, USA, **Professor Jeff Anderson** is developing an open-access learning curriculum alongside hands-on mathematical activities and laboratory equipment to create rich applied learning experiences for his students.



**Professor  
Jeff Anderson**

Department of Mathematics,  
Foothill Community College, Los Altos Hills,  
California, USA

## Fields of research

Applied mathematics education; numerical  
linear algebra

## Research project

Developing a hands-on, open-access, applied  
linear algebra curriculum alongside accessible  
mathematical models and inexpensive  
laboratory resources to help students build  
transferable skills while falling in love with  
applied mathematics

## Funders

Patreon community; YouTube revenue; private  
donors; self-funded

## Websites

[youtube.com/@JeffAndersonMath](https://youtube.com/@JeffAndersonMath)  
[jeffandersonmath.wordpress.com](https://jeffandersonmath.wordpress.com)

doi: 10.33424/FUTURUM682

In the US, less than half of college students graduate within the first 4 years of their degree. This staggering statistic raises a difficult question: if airline companies designed planes that killed half of their passengers, would anyone buy a ticket? Yet in higher education, such outcomes are accepted as normal.

## Talk like an ... **applied mathematician**

**Applied mathematics** — the process of using mathematical methods to solve practical problems in other fields like engineering, science, medicine and finance

**Linear algebra** — a subfield of mathematics that is commonly used to model, analyse and improve solutions to real-world problems

**Mathematical modelling** — using mathematics to represent, analyse, make predictions about or otherwise provide insight into authentic problems related to real-world phenomena

**STEM** — science, technology, engineering and mathematics

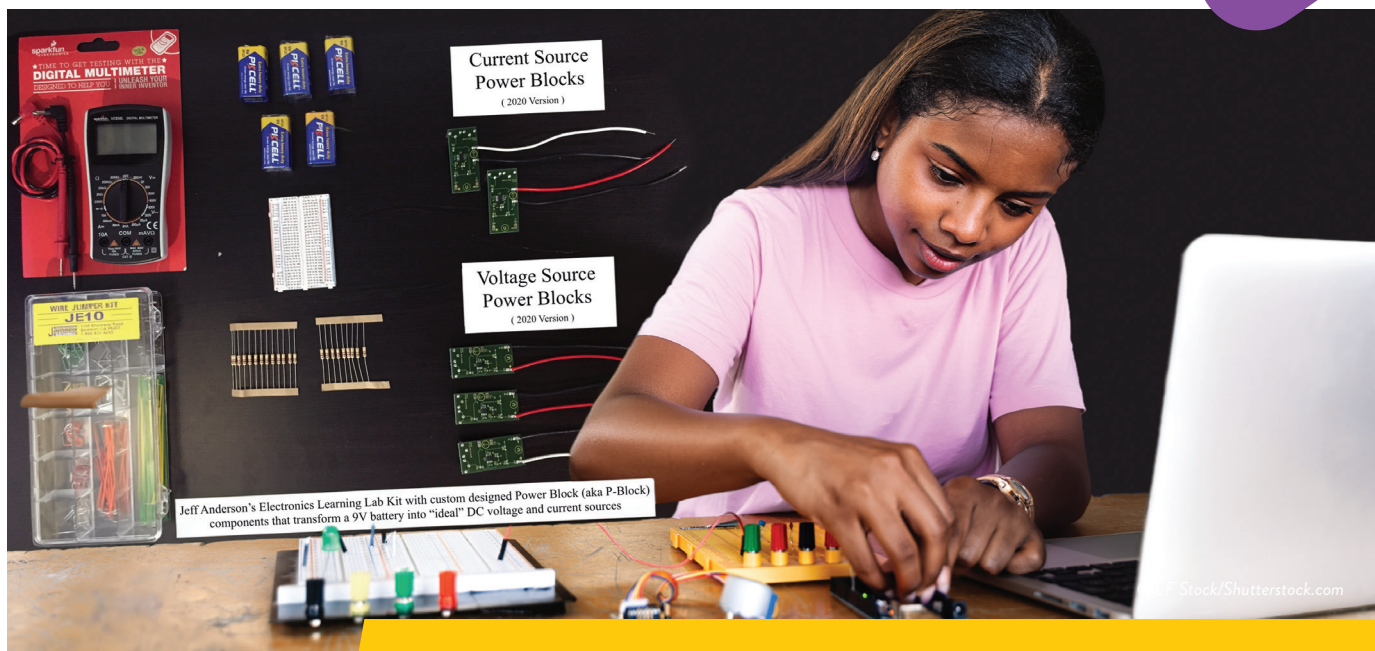
Dr Jeff Anderson, a mathematics educator at Foothill Community College, refuses to accept this status quo and has dedicated his career to transforming college STEM education. “I focus on designing engaging classroom experiences that empower students to build transferable skills that they can use to transform their world, build their dreams and ignite their careers,” says Jeff. “I believe that the best way to do this is to put students to work using hands-on learning experiences that are directly related to their academic and career interests.”

## The problem with traditional STEM education

Instead of igniting students’ interest and excitement, college STEM classes often leave students feeling

disengaged, discouraged and uncertain about how course content is relevant to their lives, career goals and their wider world. “College math textbooks often present a long list of definitions, theorems and examples without demonstrating how that math can be applied in the world to solve meaningful problems,” says Jeff. “I believe we can and should do better. When students show up to class, they are looking for purpose, inspiration and hope for the future.”

“In addition to these problems with traditional classes, many professors do not explicitly help their students learn how to learn,” continues Jeff. “This is a huge mistake. One of the best things I can do for my students is to teach them how to be more sophisticated



learners. While most linear algebra teachers believe our job is to teach linear algebra, I disagree. I believe that I teach students how to learn, and I do this using linear algebra!”

### How can linear algebra help?

Most students first encounter linear algebra when using equations such as  $y = mx + c$  to plot straight lines on a graph. This relationship is foundational and underlies an important idea: many complex systems can be modelled using linear algebra. Linear algebraic tools are central in applied mathematics for transforming real-world problems into mathematical models that can be used to find meaningful insights and develop possible solutions. Using these methods, a problem that might have taken huge amounts of time and money to prototype can be turned into a simulation.

For example, early aeronautical engineers built physical aeroplane prototypes and pushed them off cliffs, only to watch years of their lives and piles of their money go up in flames. Although this process eventually led to success, it was very costly. Starting in the 1980s, airline companies began using mathematical models to simulate plane designs and improve their engineering methods, saving a lot of time and money.

Unfortunately, college STEM courses often do not teach these types of applied modelling processes. Well-designed, hands-on mathematical modelling experiences allow students to apply their knowledge directly towards solving problems they believe are meaningful. Thankfully, Jeff is pioneering novel, open-access learning resources that put students in the driver’s seat.

### The LANA project

“When I designed the Linear Algebraic Nodal Analysis (LANA) project, I focused on building learning experiences in which students participate in the entire mathematical modelling process,” says Jeff. “I want to give students authentic modelling experiences that mirror what they might do as professionals after they graduate from college.” LANA is a hands-on modelling project in which college students gain experience in both electrical engineering and applied mathematics.

Professional electrical engineers design circuits using mathematical models that simulate a circuit’s behaviour. “This process saves them time and money because they can improve their design before manufacturing physical prototypes for testing,” explains Jeff.

The LANA project simulates this reality by allowing students to create mathematical models of electrical circuits. To verify their models, Jeff expects students to build and test physical prototypes of their circuits. “Unfortunately, testing a circuit traditionally involves using a bench power supply, which can cost up to \$500,” says Jeff. “So, as part of my effort to develop the LANA project, I worked with an expert engineering team, including two students, to create something that we call a power block, or P-block for short.”

P-blocks are inexpensive power supplies that enable students to test circuit behaviour anywhere they want, even at their own kitchen table. “The goal of the P-blocks project is to make it easy for students to

build physical prototypes of their circuits and check the accuracy of their mathematical models for themselves,” explains Jeff. “This means that students no longer need to depend on a teacher to check their work. Instead, they can check their own work by building their circuits, testing the values and comparing their measured data against the mathematical results they produce in their modelling process.”

### Power to the students

One of Jeff’s students, Natalie Thiel, spent over fifty hours working on the LANA project, and this experience gave her the confidence to apply for her first paid engineering job. After Natalie’s successful interview, Jeff received a call from her new manager, asking if he could hire more students who had gone through this type of training.

Another Foothill alumnus, Nick Litvinov, completed the LANA project and later told Jeff that, “It was the most meaningful and memorable experience I had in any of my undergraduate classes.” Considering that Nick went on to attend one of the highest-ranked universities in the US, this praise speaks volumes about Jeff’s revolutionary teaching practices.

“When students are diligent in this work, they begin to develop a large collection of transferable skills including the ability to make connections between their math classes and their target fields of study,” says Jeff. “I love helping students discover that they can use mathematical thinking to improve their world, build their dreams and help the people they love.”

# About *applied mathematics*

**L**inear algebra is to mathematical modelling what oxygen is to the human body - essential. It provides us with the mathematical language to model, analyse and improve solutions to real-world problems, and without it, the field of applied mathematics simply would not work.

The engineers, mathematicians and scientists who built the first digital computers did so with the goal of accurately simulating the physical world using mathematical models. "The first computers were paid for by the US military during World War II to simulate atomic bomb shockwaves and calculate the trajectories of missiles fired at Nazis," says Jeff. "However, once they were

finished with their bombs and missiles, scientists soon realised that these techniques could be applied across many areas of knowledge. Scientists from different fields used them to model the motion of planets, design rockets, develop new medicines, design buildings and bridges, build social networks, and much more."

The vast scope of applied mathematics means that students can make use of it, whatever their interests. "I believe that learners who take mathematics seriously can use their skills to transform the world and realise their dreams," says Jeff. "Mathematical modelling is like a muscle. For a muscle to be strong, we must train and exercise it often. However, it is also

true that once we have strong muscles, we must make conscious choices to use our strength in service of other goals we have."

One question that Jeff likes to ask his students is, "How can you use your mathematical modelling skills to build a better world that aligns with your deepest values?" The answer to this question lies in your own interests, dreams and ambitions. "A fun byproduct of this reality is that we can also earn a living from our ability to create models," says Jeff. "In other words, we can use mathematical models to improve human life while also generating income that can pay for our rent, food and other things we need to live."

## Pathway from school to *applied mathematics*

At school, build a solid foundation in mathematics. At the same time, continue to pursue other interests, as you may be able to combine them with your mathematics skills and knowledge.

Jeff recommends learning how to read and do mathematical proofs, and how to solve problems. These books can help you get started:

- **Book of Proof** by Richard Hammack
- **How to Read and Do Proofs** by Daniel Solow
- **How to Solve It: A System of Thinking That Can Help You Solve Any Problem** by George Pólya
- **Thinking Mathematically** by John Mason

"Once you know how to read and do proofs and solve problems, you can teach yourself any math that has ever been written on any subject," says Jeff. "You can create new solutions to problems that have never been solved. By developing those two skills, you will be able to teach yourself as much linear algebra as your heart desires."

## Explore careers in *applied mathematics*

"The trick of applied mathematics is to create mathematical models that describe problems in your life that you care about solving and to believe you can make an impact in your world," advises Jeff. "If you do that well, I believe you can transform the world and collect a pay cheque at the same time!"

Explore this careers brochure from The Society for Industrial and Applied Mathematics: [siam.org/programs-initiatives/professional-development/career-resources/careers-in-applied-mathematics/careers-brochure](https://www.siam.org/programs-initiatives/professional-development/career-resources/careers-in-applied-mathematics/careers-brochure)

To help students explore the connections between applied linear algebra and mathematical modelling in STEM, Jeff is developing a free *Applied Linear Algebra Fundamentals* textbook. Learn more here: [appliedlineeralgebra.com](https://www.appliedlineeralgebra.com)



## Meet Jeff

This article was written by Duy Nguyen, a 4th-year undergraduate Electrical Engineering student working with Jeff at Foothill Community College.

**From the age of 10 to 14, I survived intense bullying** and even received a concussion after being body slammed at school. Post recovery, I started martial arts. By age 23, I had earned black belts in jujitsu and judo. I also won national tournaments and got my amateur boxing licence. During my decade on the mat, I strengthened my body, practised high levels of self-discipline and learned to face my fears.

**When making big decisions, I like to imagine the future.** I saw that many older warriors had unstable careers, broken bodies and damaged brains. In contrast, older mathematicians had healthy bodies, sharp minds and stable jobs. These mathematicians also practised mental toughness. However, instead of using violence, they used their intellect. I saw that, when done skilfully, we can use mathematical reasoning to help create a better world.

**The game of research academia devalues great teaching.** College professors are incentivised to do research, win grants, compete for prestigious awards and earn lucrative textbook contracts at the expense of time spent with students. During my mathematics education, several professors told me: “You are stupid,” “You do not belong here,” “You will never be good at math,” “You ask too many questions,” “Please just do what I say.” However, I know how to protect myself. When professors tried to weed me out, I stood my ground. I showed up. I made these people work. And I promised myself I would do better for my students!

**I dedicate my career to the next generations.** I want to be part of and help grow a community of educators who shift the culture of college STEM education away from our harmful status quo by transforming teaching policies and practices. I want to help create a world in which students learn deeply, feel inspired and build valuable transferable skills in college classes that feature 100% success rates. This problem is quite hard.

**I take lots of pride in making memories with people I love and caring for my health.** I have two sons and often say to them, “Being your dad is the best thing I have ever done with my life.” I also love to spend time with my amazing wife. In my free time, I enjoy running, exercising, physical training and going for hikes in nature.

---

### Jeff's top tips

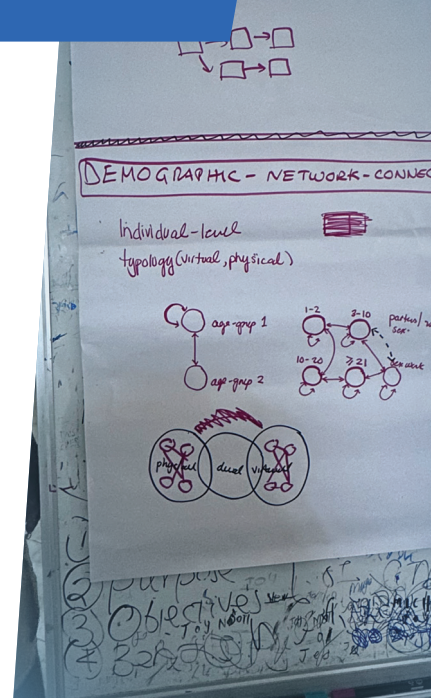
1. Learn how to read. If you can read deeply, you can teach yourself anything you want to learn, including mathematics. I love a quote I learned from the amazing educator Harriet Bell: “Reading is knowledge. Knowledge is power. Power is money.” When students ask me how to make money, my response is always: learn to read!
2. Remember that you are the world's leading expert on your own learning. You know more about yourself, your dreams and your experiences than any teacher ever will.
3. The future is unwritten, so you can play an active role in creating a new world. As you do so, think for yourself. Ask questions. Show up and force teachers, experts and authority figures to work for you and to help you build the types of learning you want to create.

Download Jeff's resources from  
[futurumcareers.com/transforming-college-mathematics-education](https://futurumcareers.com/transforming-college-mathematics-education)



# How can community voices transform HIV modelling and prevention?

In Kenya, men who have sex with men (MSM) face higher risks of HIV, yet their voices are often missing from the science that shapes health decisions. A team of academic and community researchers, including **Professor Sharmistha Mishra, Jeffrey Walimbwa, Nancy Tahmo** and **Dr Lisa Lazarus**, is co-developing mathematical models of HIV with MSM organisations. By combining lived experiences with mathematical models and epidemiology, this community-led project aims to create more accurate models, improve HIV prevention and empower communities.



## Talk like an ... epidemiologist and social scientist

**Ethnography** — a research method used to explore social and cultural practices and contexts, which involves spending time with communities, building relationships and collecting data (through conversations, observations and note taking) to build an understanding of social worlds

**Epidemic** — a widespread disease outbreak

**HIV (human immunodeficiency virus)** — a virus (passed between people through unprotected sex or blood) that weakens the immune system, leaving someone vulnerable to other infections. Medicines can prevent HIV spreading and suppress it in people living with HIV

**Mathematical model** — a set of equations and data that represents mechanisms in a real system, commonly used in epidemiology to study how and why infections spread

**Mechanism** — a pathway that links events or experiences, such as how people are connected to each other (our social network is a type of mechanism) or how one infection could lead to many infections in a short period of time

**Participatory modelling** — co-creating mathematical models with affected community members to ensure data and assumptions about mechanisms match real-life experiences and improve the usefulness of the results

**Prevalence** — the percentage of people in a population who have an infection or disease at a specific time

**Public health intervention** — an organised action (e.g., testing, vaccines, treatment or education) designed to prevent infection and improve health in a whole community, not just in one person

### Research project

Co-developing mathematical models of HIV epidemics with affected communities

### Fields of research

Mathematical modelling; epidemiology; social sciences

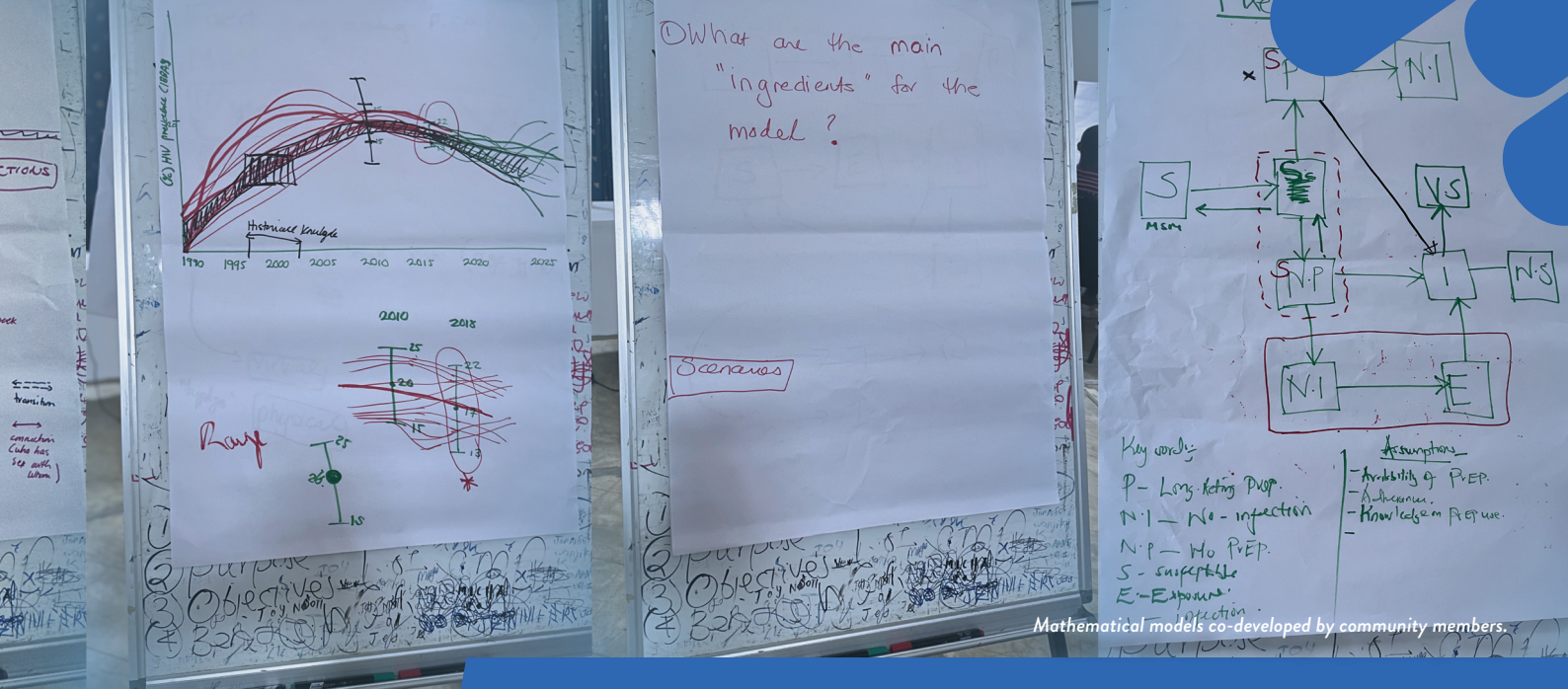
### Funder

New Frontiers in Research Fund (NFRF) - Exploration grant number NFRFE-2023-00436

doi: 10.33424/FUTURUM681

**H**IV (human immunodeficiency virus) is a virus that, if untreated, weakens the body's immune system and can lead to AIDS (acquired immunodeficiency syndrome). Although there is currently no cure for HIV, there are medicines that can completely suppress the virus and keep the immune system strong and healthy. There are also medicines that prevent the virus from being passed on and medicines that prevent people from acquiring HIV. Without these medicines, the virus can be spread through unprotected sex or blood-to-blood contact.

With the right medicines and prevention tools, HIV transmission can be reduced to zero. Yet access to prevention and care is not equal everywhere. In Kenya, around 1.4 million adults are living with HIV. And, like in many places, the Kenyan HIV epidemic has disproportionately affected men who have sex with men (MSM). "HIV prevalence among MSM is around 19%," says Jeffrey Walimbwa, Program Manager for Ishtar MSM, a community organisation that provides HIV testing, treatment, counselling and legal support for MSM in Nairobi. This is nearly three times higher than in the wider population. These numbers reflect social realities rather than biological differences. "Criminalisation and



discrimination of same-sex partnerships and stigma related to sex and HIV are large barriers to accessing the services and medicines that can help prevent and treat HIV,” explains Professor Sharmistha Mishra, an infectious diseases doctor and epidemiologist at the University of Toronto in Canada.

“There are limited MSM-friendly services that provide HIV treatment and prevention in Kenya,” explains Jeffrey. “Criminalisation of same-sex relationships means people are scared to seek help due to fear of arrest. Most of the interventions are led by community drop-in centres started by MSM.”

By combining academic expertise with MSM community organisations, Sharmistha and Jeffrey are co-developing mathematical models of the HIV epidemic with affected communities.

### What are mathematical models of epidemics?

Mathematical models help scientists understand how viruses spread through populations. First, researchers design the ‘architecture’ of the model by mathematically describing important mechanisms, such as how a virus behaves in the body and how people come into contact with each other such that a virus could be passed on (transmission). There are different ways in which people come into contact and different reasons for contacts, so depending on the virus being studied, what is meant by a ‘contact’ can be different. For example, for HIV, contacts often refer to sexual intercourse.

Modellers and epidemiologists then add data to the model, such as infection rates

“**It is essential that the people whose lives are impacted by [public health] decisions have ownership over the modelling process.**”

or the number of people diagnosed with the infection over time, to test whether the model reflects what is observed to be happening in real life. Once a model is working well, it can be used to test ‘what if?’ questions to explore the effects of different public health intervention strategies designed to reduce the spread of infection.

Public health authorities can use these models to predict how epidemics may spread, plan how resources should be allocated and decide which prevention strategies are likely to work best. “For example, government public health teams widely used mathematical models during the COVID-19 pandemic,” says Sharmistha. They are also used by community organisations who are managing outbreaks, and for advocacy teams to decide what resources are needed and what programmes to prioritise.

### How are communities shaping mathematical models of HIV?

This project is rooted in community leadership. Many members of the Kenyan organisations

involved in the project are themselves MSM, meaning they bring direct or indirect lived experiences of HIV, knowledge of community needs and practical understanding from working in HIV programmes. “This project began when Jeffrey approached me and said Ishtar MSM wanted to develop mathematical modelling projects to understand the spread of HIV,” says Sharmistha. “Input from MSM shapes the epidemiology models we are building because, instead of models relying on assumptions from literature and academia, they are based on real lived experiences and knowledge from community members.”

“At the same time, community researchers are learning how mathematical models are built and how their results can influence HIV services and policy decisions,” says Nancy Tahmo, an epidemiology PhD student at the University of Toronto. This growing understanding helps communities engage more confidently with science and advocate for better care.

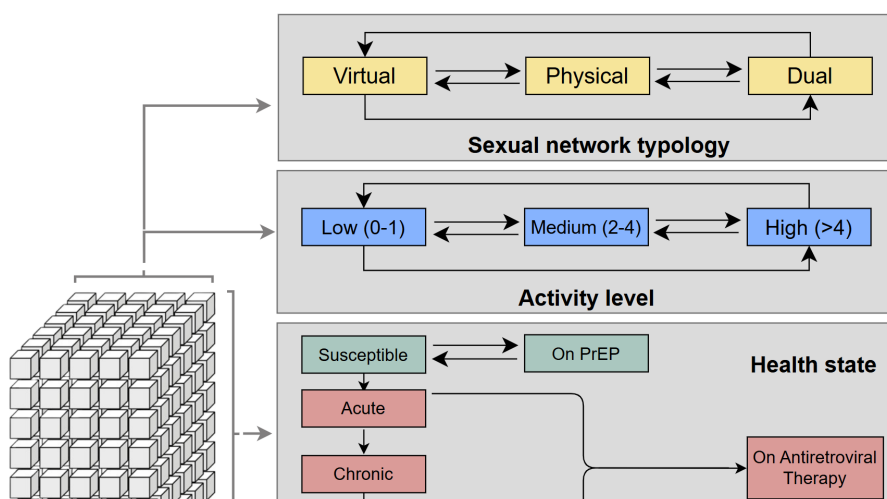
### Why is participatory modelling so important?

“Epidemiology models are used to inform public health interventions and decisions, so it is essential that the people whose lives are impacted by these decisions have ownership over the modelling process,” explains Sharmistha. By involving MSM directly, the project replaces assumptions with real lived experiences, improving the accuracy and relevance of the models. It also gives communities more knowledge, and therefore more power, to make decisions about their own health, which is especially important for groups who have historically been marginalised. ➔

“

**When community voices drive modelling, results are richer and more impactful for advocacy and designing interventions.**

”



Part of the team's mathematical model.

The project also includes an ethnography to capture the research process. “Our ethnography involves taking detailed ‘field notes’ to help us document and analyse our participatory processes to better understand the ethical implications of our work,” says Dr Lisa Lazarus, a social scientist at the University of Manitoba in Canada. “This allows us to share lessons from our collaboration with others who might be interested in starting their own participatory modelling projects.”

For community partners, the benefits of participatory modelling go far beyond science. “This project has empowered community members with skills to unpack data into language they can understand,” says Jeffrey. Through project training workshops, community members learnt how to clean data, address data quality issues, write computer code and formulate research questions. “With these skills, we have gone back to our organisations to work on our data, and now our outlook has taken a different form,” says Jeffrey. “We feel empowered to understand data in a professional way and we call ourselves ‘community professors’ with the knowledge and skills we have learnt.”

### What has the project achieved so far?

Over the past two years, the team has run a series of workshops with community members, starting by teaching the basics of data systems, modelling concepts and terminology. These workshops gradually built up to a stage where the community members co-designed their own mathematical model alongside the academic researchers. “This was a great

success – it took a lot of knowledge sharing and training together to get to this point,” says Sharmistha. “The fact that community members co-designed the architecture of the mathematical model means it is based on their real lived experiences instead of just assumptions from the academic literature.”

Another key achievement has been training community members to lead the analysis of data collected by local MSM organisations. “These data become the inputs for our co-developed mathematical models to better understand the persistence of HIV epidemics,” explains Sharmistha.

An important component of the project involved critically reviewing over 9,000 published infectious disease models

“

**Instead of models relying on assumptions from literature and academia, they are based on real lived experiences and knowledge from community members.**

”

to examine how often community participation is included. Several community members were involved in the review process. “Preliminary results confirm our hypothesis that community involvement in mathematical modelling of infectious diseases is still quite rare,” says Nancy. “These insights reinforce the importance of our work – by co-developing a model with community partners, we are contributing to the evidence that participatory modelling can uniquely foster representation and the relevance of research.”

Lastly, during the model co-development process, the team recognised that meaningful community participation requires a shared understanding of modelling fundamentals. To support this, they developed a digital learning module that explains key modelling concepts and provides examples relevant to the local context. One of the community researchers helped refine the module before it was shared with the group, ensuring it was practical and accessible. These steps have strengthened both the skills and confidence of community researchers, enabling them to contribute to the models, interpret data effectively, and apply findings to HIV prevention and care in their communities.

“When community voices drive modelling, results are richer and more impactful for advocacy and designing interventions,” says Jeffrey. “This participatory modelling process proves that community expertise is essential, and it challenges traditional assumptions about who can contribute to scientific understanding.”

# About the intersection of infectious disease epidemiology and social sciences

**E**pidemiology is the study of how infections spread through populations and how they can be prevented or controlled. “Epidemiologists try to understand patterns of infection, which could be at a community or whole population level,” says Sharmistha. “By understanding how an infectious disease might spread, epidemiologists try to understand how we can support communities and populations to prevent the spread and become healthier.”

When combined with insights from social sciences, epidemiology gains a deeper understanding of human behaviour, community dynamics and the structural factors that shape health outcomes. “Critical social scientists are interested in better

understanding issues of power, relationships, and social and political contexts,” says Lisa. “The ethnographic methods that we have added to our project aim to track ethical issues in attempts to make visible what is often hidden in projects.” This interdisciplinary approach ensures that models and public health interventions are grounded not only in biological and statistical data but also in lived experiences and community knowledge.

One of the most rewarding aspects of this work is seeing how diverse perspectives come together to tackle complex health challenges. Community members bring insights that can reshape scientific thinking, prompting new questions, simulations or analyses that would not have arisen

otherwise. “Communities know their needs better than researchers can ever imagine, and they are eager and motivated to see the research contribute to something positive,” says Nancy. For researchers, these interactions, which are often informal conversations, highlight the importance of integrating community knowledge with epidemiological methods, ensuring that models and interventions are both scientifically robust and truly responsive to the communities they serve. Witnessing community members gain skills and ownership in the research process is also deeply rewarding, as it demonstrates how participatory approaches can democratise science and amplify the voices of those most affected by health decisions.

## Pathway from school to epidemiology and social sciences

Epidemiology, mathematical modelling and the social sciences are very broad and interdisciplinary, so almost any educational path could lead you to a career in these fields!

In high school, focus on mathematics, biology, computing, social studies and humanities.

At university, it would be useful to take courses in epidemiology, public health, social sciences, sociology, anthropology or health policy.

“Epidemiologists and social scientists need critical thinking skills to question what they observe and critically analyse data, as well as communication skills to explain results,” says Sharmistha. “Epidemiologists also need to be able to think logically and creatively to solve problems – board games and escape rooms are great for developing these skills!”

“Social scientists often work with social theories (which involves a lot of reading) and analyse qualitative data,” says Lisa. “Writing skills are also incredibly important.”

## Explore careers in epidemiology and social sciences

“Epidemiologists critically examine data and try to explain what is going on – skills which can be applied in a wide range of areas from public health to wildlife ecology to genetics to virology,” explains Sharmistha. “Social epidemiologists use epidemiology principles and tools to understand and address inequalities, not just in health but in any sector of society.”

“Social sciences is not a single field, so there are endless career possibilities, depending on your interests,” says Lisa.

“If you’re interested in epidemiology or modelling, remember that numbers only make sense in context,” says Nancy. “Take every opportunity to connect with communities, because understanding the realities behind the data will make you a far stronger scientist.”

“Volunteer with community-based organisations to build relationships and learn about community needs,” advises Lisa. “Come in ready to listen to what people are telling you about their own needs, and partner in ways that support community-identified approaches.”

Many international organisations provide learning resources, training opportunities and insights into careers in epidemiology and social sciences, such as the World Health Organization ([who.int](http://who.int)) and UNAIDS ([unaids.org](http://unaids.org)).



## Meet Sharmistha

**Professor and Infectious Diseases Doctor,**  
Department of Medicine, University of Toronto,  
Canada

**As a child, my family moved from India to Canada.** We moved in December and my first memory is of huge mounds of snow and sliding down snowy hills in the park! I remember missing my extended family back home a lot, but over time, I found a community of new friends. Initially, I was the ‘odd kid out’ at my new school in Canada as there were only two other non-white students. Over the years, more children from different backgrounds gradually arrived which made a difference as we gravitated toward each other.

**As a teenager, I think medicine appealed to me** because it was what many of my friends were interested in. It wasn’t until my third year of medical school, when I first got a chance to practice it, that I realised I loved medicine. I had no plans to do research until the very end of my clinical training, when I attended a talk about the collaborative response to the HIV epidemic in India. This inspired my interest in epidemiology.

**As an infectious diseases doctor,** I spend my days seeing patients, listening to their stories, and trying to diagnose and treat their conditions. As a mathematical modeller and epidemiologist, a typical day involves problem-solving by drawing diagrams of mechanisms and writing or debugging code to run epidemiology models.

**Co-developing mathematical models with affected communities is very rewarding.** I like it when something unexpected arrives from community expertise to re-shape our thinking.

**I worked with the World Health Organization during the 2014 Ebola epidemic in Sierra Leone.** I used my clinical expertise as an infectious disease doctor to care for sick patients, and I used my epidemiology expertise to support outbreak investigation and management. I collaborated with colleagues in Sierra Leone to study the impacts of the Ebola outbreak on other health conditions and services.

---

### Sharmistha’s top tips

1. I think 15-year-old you could be very surprised by what 25-year-old or 35-year-old you ends up doing with your life and work!
2. Looking back, the most fulfilling work experiences were the ones that I was most scared of trying.



## Meet Jeffrey

**Program Manager,** Ishtar MSM, Kenya;  
Research Lead, Community Research and  
Technical  
Support Hub

**When I was a teenager, I dreamt of becoming a chef.** Cooking was my creative outlet, and it taught me patience and attention to detail. I also enjoyed dancing, which was another way for me to express myself and connect with others, and reading, which opened my mind to new ideas and different worlds.

**My first experience with research** came during a fellowship at the Human Rights Advocacy Program at Columbia University, USA. At the time, I didn’t see myself as a ‘researcher’. I was an advocate, deeply committed to the rights and dignity of gay men. That fellowship opened my eyes to how research could be a powerful form of advocacy when grounded in the voices and experiences of the communities it aims to serve.

**For me, research is never just about the data** – it’s about the people behind the data. I’ve participated as a researcher in numerous studies, always grounded in the belief that data must lead to action.

**I believe that communities are the experts in their own lives.** For too long, research on gay men has been done to communities, not *with* them. To challenge this, I co-founded Action for Access, an international community-led study into gay men’s health and rights, to show that research can be a tool for empowerment when it is community led.

**In my role at Ishtar MSM,** I am involved in coordinating our programmes, advocating for community needs, engaging with policymakers, ensuring our interventions are impactful, and translating research into actionable tools that inform policy and practice. I have also established a Community Research and Technical Support Hub to strengthen community-led research projects.

**I am passionate about community-based participatory research** because it centres the voices and expertise of those affected by the issues being studied. It is empowering to see how co-developing mathematical models of HIV fosters a sense of ownership among MSM as they take an active role in shaping the models.

---

### Jeffrey’s top tips

1. Stay consistent and focused.
2. It is not an easy road if you are gay in Kenya, where you can be at risk of violence. So stay strong.



## Meet Nancy

**PhD student**, Division of Epidemiology, University of Toronto, Canada

**I have always wanted to bring hope to people**, because I believe keeping hope alive helps people stay motivated and thrive. This led me toward community health, as I understood first-hand the vicious cycle of poor health and well-being.

**I wanted to be a doctor, so I studied science subjects at school** and took the medical entrance examination in Cameroon. But I failed. I studied biochemistry at university instead, where I found my true calling in infectious disease prevention and control. In hindsight, my interests have matured in a beautiful way because of that failure.

**My inspiration to become an epidemiologist** came from Dr Judith Shang at the Centers for Disease Control and Prevention in Cameroon. She was the first person to talk to me about public health. Until that day, I only knew about healthcare, but through her, I learned about the critical role of public health in supporting population-wide disease prevention and control efforts.

**In the middle of the COVID-19 pandemic, I moved by myself to Omaha, Nebraska** – a place that felt worlds apart from Cameroon. The culture, weather and pace of life were all very different. My biggest challenge was navigating imposter syndrome as a young Black African woman in a predominantly White Midwest environment. At the same time, the move was transformative, helping me learn more about myself and truly become independent.

**During my work with zoonotic diseases** (that spread from animals to humans) in Sub-Saharan Africa, I collaborated with research teams in Cameroon and the US to understand the burden of infectious diseases such as Ebola. We worked with tribal chiefs, communities and health district leaders to learn from their lived experiences, and we combined our findings from research and community conversations to inform surveillance and response efforts.

### Nancy's top tips

1. Remember to enjoy the growth process. My journey hasn't always gone as planned, as things have evolved in unexpected ways. So it is important to have a plan but to also stay open to the magic of the moment.
2. Surround yourself with good people who understand your vision and will support you along the way.



## Meet Lisa

**Assistant Professor**, Institute for Global Public Health, College of Community and Global Health, University of Manitoba, Canada

**As a teenager, I really enjoyed music** and went to a lot of concerts. One of my first jobs was at a music store selling CDs, well before streaming became the main way that we listen to music.

**I started my professional career as a social worker** at a hospital-based clinic in Montreal, working with people living with HIV. While I loved my job, I became interested in the recurring systemic issues within the healthcare system. This led me to pursue a master's degree in public health, where I met Dr Robert Lorway and learnt about community-based research methodologies. Community-based research allows me to address systemic health issues while collaborating with community members who have lived experiences of interacting with healthcare systems. Rob and I still work together, and he is also a member of this participatory modelling project.

**I credit Ashodaya Samithi with my on-the-ground education in community-led practices.** Ashodaya Samithi is a sex worker-led organisation in India which was established in response to the HIV epidemic. Community leaders run the organisation, which provides medical care, prioritises community voices in health interventions, and advocates for the needs and rights of sex workers. I began collaborating with Ashodaya Samithi in 2009 and, for my doctoral research, I studied how the organisation's community-led delivery of HIV prevention medicine among sex workers increased uptake.

**There really is no 'typical' day as a social sciences researcher!** When I am travelling for work, I spend time with community partners collaborating on our research activities. This includes meeting to co-develop our research methods, working together to analyse data, and discussing how to disseminate our findings to community or government partners. When I am at the University of Manitoba, I write papers to share our findings, write grant applications to get funding for projects, and read about the latest research.

### Lisa's top tips

1. There are lots of avenues in public health research, so reach out to people who do work that interests you.
2. Spend time volunteering to build genuine relationships and listen to what communities are telling you.

Download the team's resources from [futurumcareers.com/how-can-community-voices-transform-hiv-modelling-and-prevention](https://futurumcareers.com/how-can-community-voices-transform-hiv-modelling-and-prevention)



# How does food shape our health?

A good diet is essential to our well-being, and the importance of a healthy diet only increases as we get older. While healthy diets help to keep us free from disease, diets lacking key nutrients can contribute to conditions such as heart disease and diabetes. That is why **Dr Jeannette Beasley** from **New York University** in the US is researching how we can improve our diets to keep diseases at bay, especially as we approach old age.



**Dr Jeannette Beasley**

Associate Professor, Department of Nutrition and Food Studies, Department of Medicine, New York University, USA

## Fields of research

Dietetics; nutrition epidemiology

## Research project

Exploring the links between diet and disease

## Funders

New York University; US National Institutes of Health; Centers for Disease Control and Prevention; American Diabetes Association; Institute for the Advancement of Food and Nutrition Sciences; American Heart Association

doi: 10.33424/FUTURUM688

Talk like a ...

## dietitian and nutrition epidemiologist

**Biomarker** – a measurable substance in an organism that indicates the level of exposure to a substance or presence of a disease

**Cardiovascular** – relating to the heart and blood vessels

**Chronic disease** – long-lasting health conditions that require ongoing medical attention and/or limit daily activities

**Cognitive** – relating to the mental processes involved in gaining knowledge and understanding

**Holistic** – dealing with problems by looking at the whole situation, rather than at each individual part

**Metabolic** – relating to the chemical processes within an organism that produce energy and maintain life

**Type 2 diabetes** – a chronic metabolic disorder characterised by high blood sugar resulting from the body's inability to use insulin properly

**T**he food that we eat provides the molecules that make up every part of our body. “Nutrients such as protein, fibre, healthy fats, vitamins and minerals help regulate energy, support immune function, maintain muscle, and protect heart and brain health,” says Dr Jeannette Beasley from New York University. When these systems go wrong, diseases emerge. And the longer we live,

the more vulnerabilities these systems accumulate. “Over time, our dietary patterns can either reduce or increase our risk of chronic disease,” says Jeannette. “I study how improving diet quality can help people not just live longer, but better.”

Jeannette is involved in a number of projects, studying and communicating what constitutes a healthy diet – in particular, for older adults

who are more likely to face health problems. A healthy diet is not just about avoiding unhealthy foods, but also about ensuring that the foods we do eat have the optimal levels of nutrients that our body needs.

## Diet and disease

Many chronic diseases are caused by a mixture of factors relating to a person's genes, environment and lifestyle. For



instance, risk factors for the development of type 2 diabetes include obesity, physical inactivity, genetics, age and diet. “Diets high in added sugars and salt increase the risk of diabetes,” says Jeannette. High intake of these molecules makes the pancreas release excessive quantities of the hormone insulin to manage blood sugar spikes. If this process is repeated for a long time, the body simply stops being receptive to insulin, leading to an inability to manage blood sugar levels effectively. But while some foods heighten these risks, other foods do the opposite. “Diets rich in fruits, vegetables, whole grains, and beans can lower risk,” explains Jeannette. “Not just for diabetes, but for a whole range of chronic diseases.”

As we get older, certain aspects of our diet require more careful attention. “My research indicates that higher protein intake is associated with better physical mobility and lower frailty among older adults,” says Jeannette. “As we age, maintaining muscle mass becomes critical for independence.” Chronic diseases, including diabetes and heart disease, become more likely in older age. “Maintaining a diet that is rich in fibre and potassium and lower in salt plays a role in maintaining cardiovascular health into old age,” continues Jeannette.

### A BRIDGE for older adults

Given that diseases like diabetes are affected by many lifestyle factors, it is important to have holistic programmes in place to prevent these diseases from developing. “The US National Diabetes Prevention Program is focused on helping high-risk individuals improve diet and physical activity through lifestyle intervention,” says Jeannette.

“  
***I study how improving diet quality can help people not just live longer, but better.***  
 ”

“Research indicates that participation in this programme can reduce diabetes risk by nearly 60 percent.”

Jeannette felt that the already effective programme could be improved by accommodating the specific needs of older adults. This is why she developed a project called BRIDGE: BRInging the Diabetes prevention program to GERiatric populations. “To make the programme more accessible for older adults, we adjusted materials to account for hearing and vision loss, focused on building social support, and made age-appropriate recommendations for physical activity,” she says. “We also included dietary recommendations from sources such as the US National Institute of Aging.” Age-related issues, such as lower muscle mass or bone density, were acknowledged and incorporated into the programme. Jeannette’s research indicated that this specially tailored programme boosts engagement and participation of older adults.

### Using data to inform dietetic practice

Jeannette’s research, including BRIDGE, is

founded on a strong evidence base. Dietitians and nutrition epidemiologists, like Jeannette, use a range of tools and analytical skills to help them study how diet influences health across populations. “We use a range of questionnaires that ask participants which types of food they typically consume, or what they consumed in a set time period, such as the last 24 hours,” explains Jeannette. “We also use objective biomarkers, such as measuring nitrogen concentration in urine samples, to improve measurement accuracy.” Advanced statistical techniques and different types of trials help generate a range of high-quality comparable data.

Digital technologies are making data collection and processing easier than ever. “Electronic health records allow us to study real-world patient outcomes across large populations,” says Jeannette. “They provide data on diagnoses, laboratory values and long-term health outcomes.” It is important to include demographically diverse populations in these studies because disease risks can vary hugely across different cultures and socioeconomic contexts. “Inclusive research ensures recommendations are equitable,” says Jeannette.

Jeannette’s latest projects are embracing these technologies and ensuring inclusivity. “I am collaborating on projects that are exploring digital and AI-supported interventions, while continuing to improve our understanding of the role of dietary patterns in cardiovascular, metabolic and cognitive health,” she says. “My long-term goal is to improve diet quality among older adults while increasing equity and inclusion in nutrition research.”

# About dietetics and nutrition epidemiology

**D**ietetics is the study of diet and its effect on health and nutrition. “Dietetics combines biology, behaviour, medicine and public health,” says Jeannette. “It offers opportunities to conduct research, work clinically, influence policy and educate communities.”

Nutrition epidemiology focuses on how diet affects health across populations. Researchers analyse dietary patterns, health data and biomarkers to understand how food influences diseases like diabetes and heart disease, and to identify ways to prevent them.

A day in the life of a dietitian or nutrition epidemiologist is typically very varied. “My days include mentoring students

and junior faculty, teaching, analysing data, reading and contributing to papers, writing grants, and collaborating with clinicians and community partners,” says Jeannette. “No two days are the same, which makes the field dynamic and rewarding.”

Everyone eats, so dietetics affects us all. “Nutrition affects nearly every chronic disease, so the potential for impact is enormous,” says Jeannette. Dietetics also engages with the socioeconomic side of nutrition, acknowledging the health disparities that arise due to differences in ability to access nutritious food. For instance, around 19 million people in the US live in ‘food deserts’ (areas far away from the nearest supermarket) meaning they may rely on

processed foods found in smaller stores or fast-food outlets close by. Addressing these challenges involves a lot of advocacy and communication work.

The importance of effective communication is also exemplified in countering myths about nutrition. Public opinion on which foods are healthy or not is changing all the time, and is not always based on evidence. “Combatting misinformation and finding ways to make accurate measurements to better understand the science are big challenges in our line of work,” says Jeannette. “To meet these challenges, it’s important to have strong communication and critical thinking skills.”

## Pathway from school to dietetics and nutrition epidemiology

At school, subjects such as biology, chemistry, mathematics (especially statistics) and psychology are useful for understanding the core material around dietetics and nutrition.

At university or college, the same subjects can lead to a career in dietetics – as can fields such as food science, clinical nutrition, public health or human physiology. A dietetic internship and registration exam are also necessary milestones for becoming a registered dietitian in the US.

Jeannette also recommends getting research or volunteer experience in healthcare or in community settings to understand more about dietetics as a career path and what it looks like in practice.

## Explore careers in dietetics and nutrition epidemiology

Jeannette recommends exploring professional organisations such as the American Heart Association, where she serves on the nutrition committee: [professional.heart.org/en/science-central/lifestyle-cardiometabolic-health/nutrition#t=HighlightsTab](https://professional.heart.org/en/science-central/lifestyle-cardiometabolic-health/nutrition#t=HighlightsTab)

Careers in dietetics may fall under job titles such as clinical dietitian, public health nutritionist, research scientist, professor, policy advisor or digital health innovator. You can find out more about the path to become a Registered Dietitian Nutritionist here: [eatright.org/become-an-rdn](https://eatright.org/become-an-rdn)

As Jeannette mentions, dietetics careers (and salaries) are very varied. Dietitians can work in hospitals, private practice, health departments or academic research, like Jeannette.



## Meet Jeannette

**When I was five, I chose to become a vegetarian** for ethical reasons. In high school, my biology teacher questioned whether I would get enough protein to grow. This sparked my interest in nutrition science and eventually shaped my career.

**I love discovering new insights about diet.** I enjoy uncovering how diet influences long-term health, which unlocks the possibility of preventing chronic disease and helping people age with strength and independence. I also love mentoring the next generation of researchers and seeing them grow into professionals.

**Curiosity and persistence are essential 'soft skills' in dietetics.** Additionally, strong quantitative analysis skills are very handy, as is a focus on establishing and nurturing strong mentor relationships.

***I love mentoring the next generation of researchers and seeing them grow into professionals.***

**I have run five marathons across the United States, Italy and Ireland!** Staying active is important to me: I love running, yoga and keeping up with my son, which keeps me balanced and energised. Seeing his curiosity and hearing his constant questions about science and health reminds me why science communication and mentorship matter.

Download Jeannette's resources from  
[futurumcareers.com/how-does-food-shape-our-health](https://futurumcareers.com/how-does-food-shape-our-health)



### **Jeannette's top tips**

Ask questions, embrace statistics, stay active and do not let doubt discourage you. Curiosity can turn into a lifelong career.

# Hungry Stories: using the arts to share research findings about food insecurity

After decades of researching the negative impacts of food insecurity and how they can be reduced, **Professor Elaine Power** from **Queen's University** in Canada realised that sharing evidence with policymakers and politicians was not enough to create change. So, she shifted her focus to reaching the public, sharing knowledge and understanding with them, and encouraging them to speak up and hold governments accountable. Along with other activist-scholars, Elaine founded **Hungry Stories** to share not just the facts about food insecurity, but the real human experiences and emotions behind them too.



**Professor Elaine Power**

School of Kinesiology and Health Studies,  
Queen's University, Canada

## Fields of research

Food insecurity; arts-based knowledge mobilisation; public health

## Research project

Using arts-based knowledge mobilisation to share research findings about food insecurity

## Funder

Social Sciences and Humanities Research Council of Canada (SSHRC)

## Website

[hungrystories.ca](http://hungrystories.ca)

doi: 10.33424/FUTURUM679

## Talk like an ... **arts-based knowledge mobilisation practitioner**

### **Arts-based knowledge mobilisation (ABKM)**

— the use of creative tools like art, theatre, stories or zines to share research in ways that are engaging and easy to understand

### **Basic income guarantee**

— a regular payment from the government that gives people enough money to meet basic needs, no matter their job status

**Food drive** — an organised campaign to collect food donations for people suffering from food insecurity

**Food insecurity** — not having reliable access to enough affordable, nutritious food

**Living wage** — a wage high enough for someone working full-time to afford basic needs like food, housing and transportation

**Minimum wage** — the lowest hourly pay an employer is legally allowed to give workers

**Public health issue** — a problem that affects the health and well-being of many people and requires community or government action to address

**C**an an art exhibition help change public policy? Can a graphic novel explain research better than an academic report and inspire change? Professor Elaine Power from Queen's University believes the answer is yes, so she is turning to the arts to share the important findings of her research on food insecurity.

"Food insecurity is a public health emergency in Canada," says Elaine. "Rates of food insecurity have increased dramatically since the end of the COVID-19 pandemic and have never been higher. At least 25% of the population live in food insecure households, including

2.5 million children. Alarm bells should be ringing; however, there are no serious steps being taken to address this crisis."

Food insecurity is linked to material deprivation, with food insecure households often struggling to pay other bills. Not having enough good quality food can lead to physical and mental illness, increased healthcare costs and even premature death. For children and babies in the womb of food insecure mothers, these health impacts can last a lifetime.

## **The problem with food banks**

In the early 1980s, Canadians began setting up food banks to protect their fellow citizens from going hungry, intending them to be a short-term response to rising financial hardship. However, almost 50 years later, food banks are more common than ever. "Giving a food bank donation is something practical that people can do, and can be very satisfying for donors," says Elaine. "However,



© SeventyFour/Shutterstock.com

we should donate food *and* demand that governments live up to their human rights commitments to their citizens.” International agreements like the Universal Declaration of Human Rights state that everyone has the right to an adequate standard of living; however, food banks can reduce pressure on governments to tackle the root causes of food insecurity.

Despite growing need, 80% of food insecure people do not use food banks, often due to embarrassment. Running food banks can be difficult due to reliance on volunteers and donations, and they cannot solve the underlying issues, meaning that users remain food insecure. “Many food banks say they are at breaking point,” says Elaine.

### Raising incomes to beat food insecurity

“We need public policies that reliably increase household incomes so that people can afford to meet the basic costs of living,” continues Elaine. Key policy changes could include moving from a minimum wage to a living wage, and improving financial support and child benefits to lift households out of poverty.

“A basic income guarantee has a number of advantages, including lack of stigma, unconditionality and simplicity of administration,” says Elaine. “Canada already has a basic income guarantee for seniors’ pensions, and we know that for the poorest Canadians, their high rates of food insecurity fall dramatically when they turn 65 and become eligible. Some people want to extend that basic income guarantee to all working age adults, from ages 18–65.”

### Arts-based knowledge mobilisation

Elaine has been disappointed to find that 30 years of research showing the health harms of food insecurity has not been enough to convince policymakers. “Like many academics, I thought that once we had a strong body of evidence, policy would change,” says Elaine. “But this belief neglects politics, which is about power and who has it. Whoever pushes the hardest and has the most influence gets movement.”

Knowledge mobilisation is about sharing research evidence so that it can create change, and involves methods targeted at policymakers. However, when it was clear that this approach wasn’t working, Elaine switched tactics. She now hopes to convince the general public that food banks cannot address high levels of food insecurity, and to empower them to demand adequate living standards for all.

Elaine is doing this through arts-based knowledge mobilisation (ABKM). “ABKM uses the arts to translate academic research into forms that deliver more emotional impact and are more accessible to the general public or specialised audiences like healthcare providers,” says Elaine. “This might include drama, animation, poetry, dance, fictional writing, painting, photography, video, zines, circus arts and more. For example, the powerful stories of people’s experiences in healthcare can become even more poignant, memorable and moving when dramatised in a theatre production. While traditional forms of knowledge mobilisation rely on making evidence available and accessible, ABKM uses emotion to speak to the heart as well as the head.”

### Hungry Stories

In 2018, Elaine and two other academics became concerned about the approach towards food drives at their children’s schools. “The cheerful, celebratory character of food drives puts the focus on the donors and makes the food bank recipients and their food insecurity invisible,” says Elaine. “The Hungry Stories project was created in response to this concern and is a collaboration among a small group of activist-scholars who research, create, write, teach, present and advocate on the topic of food insecurity.”

Elaine and her colleagues recruited author Dian Day and artist Amanda White to produce a graphic novel called *Shy Cat and the Stuff-the-Bus Challenge*, published in March 2026. “This graphic novel features the endearing friendship of Mila and Kit, gently exploring Kit’s experiences of food insecurity and the limitations of the available responses,” says Elaine.

The Hungry Stories team is also producing a picture book, a young adult novel and an art exhibition, all exploring food insecurity. As well as this, Chloe Halpenny, a doctoral student at Queen’s University, is developing a zine exploring how people in Ontario changed their eating habits in response to receiving a basic income guarantee, and plans to measure the impacts of various Hungry Stories ABKM materials.

“We will be doing some evaluation research about what children, teachers and care givers learn from *Shy Cat*,” says Elaine. “We hope people participating in food drives will begin to question their effectiveness and demand better responses from politicians.”

# About arts-based knowledge mobilisation

“In a world that is flooded with information and disinformation, it is hard to catch people’s attention,” says Elaine. Researchers are turning to the arts to find new ways of engaging people with their research findings when conventional approaches fail.

“Arts-based knowledge mobilisation (ABKM) speaks to people’s hearts and minds and engages feelings in ways that academic texts cannot,” says Elaine. “By speaking to our hearts, art can help us change our minds about things. Art helps open up the possibilities to imagine how the world could be otherwise.”

In ABKM, researchers collaborate with artists to bring their research and ideas to life. “Sometimes academic researchers have an artistic talent and skills, but that is unusual,” says Elaine. “Some skills are easier to learn than others, but that might not be the best use of a researcher’s valuable time.” However, when collaborating with artists, it is important to pay people fairly for their work, so funding can sometimes be an issue. As a result, it can take time to build the right team, and it is important to have great team-working skills. “Our team has been working together for many years, and we can only do this because we like and respect each other,” says Elaine.

Despite the challenges of ABKM, the results make it all worthwhile. “I’ve seen powerful theatre productions about healthcare that communicate patients’ experiences of breast and prostate cancer treatment, dementia care, and discrimination in emergency room services,” says Elaine. “Similarly, a doctoral student working with me, who interviewed dietitians about the barriers to social justice in their practices, is making startlingly profound and powerful poetry using the interviewees’ words from the transcripts. I think this type of knowledge translation is about to become very popular.”

“I was able to take lunch. Nothing extravagant... day break... d thank... I can... nds wh... riendsh...

...tely all... ed fam... ch othe... trying t...

...tely all... ed fam... ch othe... trying t...

...tely all... ed fam... ch othe... trying t...

from our horrible work... and being frustra... sad all the...

Download the team’s resources from [futurumcareers.com/hungry-stories-using-the-arts-to-share-research-findings-about-food-insecurity](https://futurumcareers.com/hungry-stories-using-the-arts-to-share-research-findings-about-food-insecurity)



## Pathway from school to arts-based knowledge mobilisation

At school, make sure you develop a good foundation in science — both natural sciences and social sciences.

Build your communication skills, practice working and collaborating with others, and spend time developing your artistic and creative skills.

In your spare time, immerse yourself in the arts. Go to the theatre and to dance performances, visit art exhibitions, read novels, and explore anything that sparks your curiosity and imagination.

## Explore careers in arts-based knowledge mobilisation

You can learn more about the work of Elaine, Chloe and their colleagues in the School of Kinesiology and Health Studies at Queen’s University in Canada here: [skhs.queensu.ca](https://skhs.queensu.ca)

Queen’s University offers a number of different summer camps for high-school students: [queensu.ca/child-youth-programs](https://queensu.ca/child-youth-programs)

“Anyone pursuing a research career in which they want their research to change policy, practice or public opinion should keep ABKM in their toolkit as an effective way to translate knowledge,” says Elaine. “I think we will be seeing much more use of it!”

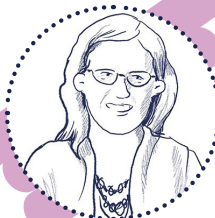
mor... this... my... par... do... drin... you'... c...

# Meet the Hungry Stories team



**Jennifer Brady**

**Dr Jennifer Brady** is an Associate Professor in Nutrition and Dietetics at Acadia University, Nova Scotia.



**Jennifer Black**

**Dr Jennifer Black** is an Associate Professor of Food, Nutrition and Health in the Faculty of Land and Food Systems at the University of British Columbia.



**Dian Day**

**Dr Dian Day** is an award-winning novelist and the author of the graphic novel, *Shy Cat* and the *Stuff-the-Bus Challenge*, based in Antigonish, Nova Scotia.



**Amanda White**

**Dr Amanda White** is a Canada Research Chair in Sustainability, Ecological Justice, and Climate Action in Creative Practices (Tier II) and an Assistant Professor of Critical Studies at Emily Carr University, on unceded Musqueam, Squamish and Tsleil-Waututh territories.



**Meet Chloe Halpenny**

**PhD candidate**, School of Kinesiology and Health Studies, Queen's University, Canada

**Fields of research:** Social policy; poverty and income security; feminist/disability studies

**As a teenager, I was interested in everything.** I loved musical theatre and competitive dance, but I was also fascinated by history, law and the environment. I had a strong sense that I wanted my work to align with my values and do some kind of social good. Having varied interests helped me make decisions later on.

**I moved to Ottawa** for an interdisciplinary undergraduate programme in public policy and public affairs, where I studied everything from communications and journalism to political science, law and research methods. I worked as a House of Commons Page in my first year of university, which gave me a first-hand glimpse into policy-making and the political process.

**The moment that really changed everything came in 2018.** Ontario's provincial government was providing a basic income guarantee to test whether it could effectively address poverty. A newly-elected government cancelled the trial after one year, deleting the data before it could be evaluated. I was furious. I pivoted my graduate research to focus on the trial, interviewing 26 participants — primarily women — about what receiving a basic income had meant for them. Every person described how it fundamentally improved their lives. Hearing those stories gave me a deep sense of responsibility to make those realities visible and to show that alternatives are possible.

**In 2020, I helped establish the Basic Income Youth Collective**, a group of young people advocating for a basic income guarantee. Through this group, I share research about basic income and economic justice in creative, accessible forms. Findings from my interviews and the research of fellow BIYC members have been brought to life through initiatives like *Basic Income Bought Me*, a social media campaign about how people spent their basic income, and *Room to Dream*, a zine about the Ontario Basic Income Pilot, pairing research findings with handmade collages. These projects influence how I approach knowledge mobilisation in my PhD, which looks at medical eligibility for disability benefits.

---

## Chloe's top tip

Figure out what you care about (and accept that this may change over time), find other people who care about the same thing, and get involved. Whether they're already doing something about it or want to start — form communities with people with shared interests.

# How did the pandemic affect children's attitudes to singing?

The COVID-19 pandemic rocked society, affecting the daily lives of nearly everybody on the planet. Children were especially affected; schools closed down and opportunities for learning and socialising diminished dramatically. As a Professor of Music at the **University of Alberta** in Canada, **Dr Ardelle Ries** is a strong advocate for the developmental importance of singing from an early age. She is investigating how the pandemic affected children's attitudes to singing, and what this means for their development.



**Dr Ardelle Ries**

Professor of Music, Department of Fine Arts & Humanities, Augustana Faculty, University of Alberta, Canada

## Fields of research

Music; music education

## Research project

*From the Voices of Children:* Investigating how the COVID-19 pandemic affected children's attitudes towards singing

## Funders

University of Alberta Endowment Fund for the Future; University of Alberta Support for the Advancement of Scholarship; University of Alberta Kule Institute for Advanced Studies; University of Alberta President's Fund for the Creative and Performing Arts; Alberta Teachers' Association; Social Sciences and Humanities Research Council of Canada (SSHRC)

## Website

[fromthevoicesofchildren.com](http://fromthevoicesofchildren.com)

doi: 10.33424/FUTURUM669

Talk like a ...

## music education researcher

**Advocacy** — an activity that supports a particular cause

**Qualitative research** — research methods based on the collection and analysis of non-numerical data, such as words, observations and experiences

**Quantitative research** — research methods based on the collection and analysis of numerical data

**Singing identity theory** — the concept of how a person's identity is linked to the use of

and belief in their singing abilities which impacts how confidently and willingly they sing

**Sociocultural** — relating to groups in society based on cultural factors, such as art, music, values and beliefs

**Socioeconomic** — relating to groups in society based on economic factors, such as education, income and occupation

well-being. "Children are a particularly vulnerable demographic when it comes to big societal changes," says Professor Ardelle Ries from the University of Alberta. "They saw significant shifts in their daily routines, learning environments and opportunities for social engagement."

There has been a lot of investigation into how the pandemic affected children's development, and how we can potentially remedy any negative effects. Ardelle has been researching how the pandemic affected one

important developmental tool: singing. "From infancy, musical interactions contribute to language acquisition and early literacy skills," she says. "Singing also boosts healthy social behaviour and cooperation between children." But the pandemic meant that opportunities for singing, especially in social settings, were extremely reduced. "Prior to March 2020, the idea of a world without singing was unimaginable," says Ardelle. "As efforts to rebuild continue, are future generations of singers under threat?"

**T**he COVID-19 pandemic was the biggest health crisis of modern times. From 2020 to 2023, the world witnessed massive disruptions that aimed to mitigate the spread of the SARS-CoV-2 virus, and these disruptions had knock-on effects on many other aspects of health and



© From the Voices of Children

### From the Voices of Children

To investigate these questions, Ardelle founded the 'From the Voices of Children' (FVC) project. Supported by a team of undergraduate and graduate research assistants, FVC explores many different aspects of the pandemic's impact on children's attitudes towards singing. "We began with a review of existing literature about the pandemic's effects on child well-being, arts education and community engagement," explains Ardelle. "This led us to take a qualitative approach for our research, rather than a quantitative approach." Ardelle and her team concluded that qualitative information – non-numerical information derived, in this case, from interviews and surveys – would lend additional insight to the questions they were asking.

Phase One of the FVC project involved conducting one-on-one interviews with children. "We put out an open call for participants between 6 and 12 years old, with the support of their guardians, from both rural and urban areas within 100 km of our campus," says Ardelle. "The open call was issued to community choral organisations, school divisions and private studios." The response was overwhelming. The team had aimed to interview 25 to 50 children, but interviewed 83. "We identified the child participants as co-researchers, to give them more agency in the research process – something that challenges the status quo," says Ardelle.

Phase Two involved sending out an online survey to school jurisdictions over a broader geographical area. "In contrast to Phase One, we focused on just school settings, to provide a clearer picture of the pandemic's impact on school music programmes," explains Ardelle.

Two versions of the survey were designed for two different groups: one for children aged nine to 12 who had taken part in music-making in school prior to the pandemic, and one for children aged six to eight who had not had that experience due to lockdown restrictions. "We received a total of 18 student responses in total, far fewer than the 250 we had aimed for," says Ardelle. "This was due to the stringent conditions for ethical research within the school system, combined with competing against the high workloads of school administrators and teachers."

Phase Three built on the successes and challenges of the first two phases, using a combination of interviews and surveys. "These generated both qualitative and quantitative data from an even wider pool of participants within Alberta," says Ardelle. In addition, the children were allowed to interview each other in Phase Three, providing yet more emphasis on the children as co-investigators in the process.

### The results are in

Once all three data collection phases were complete, analysis began. "Our data revealed that children's attitudes towards singing are both complex and incredibly varied," says Ardelle. "Overall, it is clear that children naturally recognise that singing enhances mood and general well-being." Many children spoke about why singing was important to them socially and culturally, and how their own singing identities were evolving. "It is evident that these identities are vulnerable to the influences of family, school and other environments," says Ardelle.

When analysing the effects of the pandemic,

the results were concerning. "The data suggest a complex interplay of negative factors, including reduced opportunities for participation and increased anxiety," says Ardelle. "However, there are also potential positives, such as deeper appreciation for singing and increased opportunities for informal family singing."

### From data to documentaries

The team's work is not yet over; the FVC project yielded a huge amount of data for analysis, which will take a long time. In the meantime, the team decided to communicate their established findings through the production of a short documentary. "We filmed additional footage to create a 15-minute documentary that reveals children's own perceptions of singing first-hand," says Ardelle. "The film will be used as an advocacy tool for music educators." The documentary takes a unique approach, focusing almost entirely on the voices and perspectives of children; adult voices are mostly absent.

The team is also working on other communication tools. "We are aiming to compile and publish a collection of essays by esteemed music educators from Canada and beyond to accompany our findings," says Ardelle. "We also have plans for the production of a second documentary." These efforts will help educators to adjust their teaching approaches accordingly. "Understanding shifts in attitude is crucial for informing post-pandemic recovery strategies in music education," says Ardelle. "We hope that our findings will provide music educators, arts service organisations and the general public with a deeper understanding of how children relate to singing."

# About *music education research*

**M**usic education research typically involves working closely with both music teachers and students to understand best practices for music education and how this creative outlet influences students' development beyond the classroom. The From the Voices of Children project focused on this process in young children. "Children are a source of unlimited wonder and awe," says Ardelle. "Musicality begins even before birth, through vibration, the heartbeat and attuning to environmental sounds."

While all children are naturally drawn to music, the opportunities open to them often depend on practical realities. "A broad and complex array of socioeconomic and sociocultural factors can either encourage or prevent access to quality music education experiences,"

explains Ardelle. "It's important to address preventative factors. Participation in music enriches child development and fuels passion, motivation and dedication." Technological developments are also presenting challenges. "It's easier to watch a YouTube video or an Instagram or TikTok reel than it is to sing or compose a song," says Ardelle. "The next generation of music educators will need to consciously advocate for active, rather than passive, participation in music."

The importance of active participation is highlighted by the singing identity theory – that a person's identity is linked to singing and the use of their voice, and that what you believe about yourself as a singer affects how confidently and willingly you sing. With singing linked to self-perception, self-esteem and social

belonging, song-based music education can play a hugely positive role in young people's lives.

In any social science, it is important to think about how to interpret qualitative results – something Ardelle is very conscious of. "Research processes shouldn't be considered fully reliable," she says. "For example, it can't be assumed that researchers are able to fully and objectively interpret the actions or statements shared by children." Overcoming this is not easy – but is critical. "Understanding children's attitudes to music, and the factors that contribute to these attitudes, is vital for the future of singing," says Ardelle. "We need future generations to fully and freely embrace singing as a fundamental form of human expression."

## Pathway from school to *music education research*

At school, many subjects can lead to music education research, including music, humanities, mathematics (especially statistics), sciences, languages and fine arts.

Ardelle recommends nurturing your own musical tendencies. Take music lessons, participate in ensembles in or outside school, and build your musical knowledge. Gaining an understanding of teaching methods is also important.

Equally, many different university courses can lead to a career in music education research, including degrees in music, teaching qualifications, social sciences and psychology.

## Explore careers in *music education research*

Ardelle suggests the International Society for Music Education (ISME) website for learning about the worldwide network of music educators: [isme.org](http://isme.org)

Ardelle highly recommends talking to music educators close to you – potentially within your school and community – to seek opportunities for mentorship, work experience, networking and inspiration. The ISME Directory of Music & Music Education Institutions can help you locate music education institutions and organisations worldwide: [idmmei.isme.org](http://idmmei.isme.org)

The Augustana Faculty at the University of Alberta, where Ardelle is based, enables undergraduate music students to act as teaching assistants for ensembles, among other opportunities: [ualberta.ca/en/undergraduate-programs/bachelor-of-music-performance-based-pedagogy.html](http://ualberta.ca/en/undergraduate-programs/bachelor-of-music-performance-based-pedagogy.html)

Careers and their respective salaries vary widely in this sector. According to Glassdoor, a music researcher in Canada can expect to earn about CAN \$61,000 per year: [glassdoor.ca/Salaries/music-researcher-salary-SRCH\\_KO0,16.htm](https://www.glassdoor.ca/Salaries/music-researcher-salary-SRCH_KO0,16.htm)



## Meet Ardelle

**My mother played an integral role in my musical development.** From my earliest memories and throughout my childhood and beyond, my mother was a font of support and encouragement, providing me with a rich and fertile environment where I could fall in love with music.

**Singing has, quite literally, saved my life.** While dealing with personal challenges as a young adult, it was singing in choral ensembles that kept me going. Once I'd completed degrees in music and education, I was hired to teach within a music programme in a primary school. I was determined to be the best teacher possible for my students. This was a deeply transformative experience; the sounds of those young voices sparked my dedication and passion for children's singing.

**Many gifts have launched and influenced my career.** Aside from my good fortune studying with superb voice teachers and choral music educators, a successful audition for a professional Canadian choir led to amazing international travel, study and performance opportunities. My experiences at the Kodály Institute of the Liszt Academy of Music and teaching music in a Kodály school in Hungary for some years were life-changing!

**I am very proud of and grateful for my work at the University of Alberta.** I have provided quality educational and performance experiences for my students, successfully organised an international music educators' symposium, secured numerous grant applications for music education research, and established a multigenerational, inclusive community choir, SingAble.

**Singing is simply an essential part of life.** Though I am moving through the final phase of a fulfilling 40-year career, until the end of my days I will continue to encourage one and all to embrace, explore and enjoy singing.

**[Singing] just lets  
all the bad things  
go and all the good  
things come into my  
heart.**

**- FVC participant**

### **Ardelle's** top tip

Celebrate and have confidence in the gift of your beautiful and unique voice.

Download Ardelle's resources from  
[futurumcareers.com/how-did-the-pandemic-affect-childrens-attitudes-to-singing](https://futurumcareers.com/how-did-the-pandemic-affect-childrens-attitudes-to-singing)



# What can pottery from the past teach us about containment today?

In a storeroom on the coast of the Greek island of Crete, a team of archaeologists is attempting an almost-4000-year-old 3D jigsaw puzzle. Led by **Professor Carl Knappett** from the **University of Toronto** in Canada, these archaeologists are piecing together pottery fragments they have excavated from the Minoan site of Palaikastro. By restoring these ancient pots and vases, the team is shedding light on Bronze Age society and asking questions about what 'containment' means today.



**Professor Carl Knappett**

Department of Art History, University of Toronto, Canada

## Field of research

Archaeology

## Research project

Excavating and analysing pottery containers from the Minoan site of Palaikastro in Crete, Greece

## Funders

Social Sciences and Humanities Research Council of Canada (SSHRC); US Institute for Aegean Prehistory; Hal Jackman Foundation; University of Toronto; British School at Athens

## Website

[amc.art.utoronto.ca](http://amc.art.utoronto.ca)

doi: 10.33424/FUTURUM674

**“T**hink of all the things that surround you – your phone, street signs, desks in your classroom,” says Professor Carl Knappett. “This is ‘material culture’. You may not pay these items much attention because they are so much a part of your daily life, but they can be very informative once you start noticing.”

## Talk like an ... **archaeologist**

**Artefact** — physical objects (material culture) excavated by archaeologists

**Bronze Age** — the archaeological period characterised by the widespread use of bronze which, in Europe, occurred from 3200 BCE to 800 BCE

**Containment** — the act of confining something within boundaries

**Egalitarian** — the principle that everyone is equal and deserves the same rights and opportunities

**Excavation** — the process of uncovering buried artefacts and structures

**Material culture** — any physical objects or spaces (e.g., pottery, tools, artwork, buildings) that contribute to the culture of a place

**Minoan** — a Bronze Age civilisation that existed on the island of Crete from 3000 BCE to 1100 BCE

**Sherd** — a fragment of pottery

As an archaeologist from the University of Toronto, uncovering and analysing material culture is exactly what Carl spends every summer doing at Palaikastro, an archaeological site on the Greek island of Crete. In 1700 BCE, during the boom of Minoan civilisation in the Bronze Age, Palaikastro was a bustling harbour town where the inhabitants relied on the sea for food and trade. They made textile dyes out of shells, grew cereals, vines and olive trees, and kept sheep and goats. “The people were skilled in a range of crafts,” says Carl. “They made

bronze tools and weapons, stone vases, and pottery.”

## Excavating Palaikastro

The history of excavating Palaikastro goes back many years, as archaeologists first started working on the site in 1902. Carl has been leading projects there for the last twenty-five years. When most people think of archaeology, they imagine digging into the ground to excavate artefacts. However, modern archaeologists also use a range of specialist equipment and techniques.



© Carl Knappett

“We use geophysical techniques like radar and magnetometry to ‘see’ remains below the surface, and we use drones to take high resolution survey photos from the air,” explains Carl. “We take soil samples so we can recover tiny plant remains to analyse human-plant interactions.” To document the buildings, the team 3D-scans the remains of architecture to make accurate reconstructions. “And a dive team has recently been surveying underwater, documenting submerged Bronze Age buildings as well as a Roman shipwreck.”

Carl’s team does still excavate by hand, which is how they find material culture. This mainly consists of millions of pottery fragments, known as sherds, that must be painstakingly reassembled. Over the years, archaeologists have almost fully reconstructed thousands of pottery vessels from sherds, which have given them considerable insight into how the inhabitants of Palaikastro lived. “In the Bronze Age, people used pottery for everything, from eating and drinking, to transporting olive oil and wine, to cooking and lighting their houses,” says Carl.

### Finding patterns in the past

Once the team has uncovered and reassembled pottery sherds, the next step is to figure out what the items can teach us about the past. “To ascertain how people lived, we try to find patterns that can explain why certain vessels were found where they were,” explains Carl. “For example, are there lots of cups and jugs stored in a cupboard next to a hall, suggesting people gathered and celebrated there? Do we find many jars in certain rooms that indicate substantial storage, and could this imply that some families were wealthier than others?”

“**Pretty much all these Minoan pots we study were used for containment of one form or another.**”

As well as questions about exactly how items were used, Carl also asks how the pottery was made. “Were there many craftspeople? Did they all use the same materials and techniques? Were they all equally skilled?”

### What has Carl discovered?

One of the fascinating things Carl has noticed over the years is how none of the pottery vessels he has excavated at Palaikastro have been particularly different to the rest. “That may sound a bit negative, but it’s actually quite the opposite!” he enthuses. “This is interesting because what it means, in my opinion, is that everyone back then had access to the same resources. We don’t see fancy houses where some inhabitants had much nicer things than everyone else. In every house we find much the same set of pottery vessels.”

Another discovery along the same lines is that no palace has ever been found in Palaikastro, even though most other Minoan towns on Crete had one. “This makes me think that the inhabitants here found a way of living

that was more egalitarian,” says Carl. “This is fascinating as it shows that, even on an island, people in different settlements didn’t all live in the same way.”

### What else can Bronze Age pottery teach us?

Learning about the past can inspire interesting philosophical questions about how we live today. “The more I study ancient pottery, the more I feel it is essential to think not about the vessel standing in front of you, but about the ‘invisible’ elements for which it was ultimately designed. That is to say, the liquids it was to contain, or the heat it was supposed to withstand when on the hearth,” says Carl. “We easily forget that pretty much all these Minoan pots we study were used for containment of one form or another. Once we make containment our focus, we can make better sense of both use and design.”

Considering the external container and internal contents of objects and spaces is philosophically relevant today. “In the modern world, we are surrounded by and immersed in containment, but it is easy not to give containment a second thought,” says Carl. “Our houses and vehicles contain us, and we carry containers such as bags and coffee cups. Why do you put clothes in a wardrobe? Why is fruit that is contained in its own skin wrapped in plastic in the supermarket? With all these containers, is it any wonder that we need to ‘think outside the box’?!”

By studying the past and uncovering objects from thousands of years ago, archaeologists like Carl gather insights not only into how people used to live, but also into how we approach our own lives today.

# About *archaeology*

**“B**eing an archaeologist gives you a unique perspective on the past,” says Dr Rachel Phillips, an archaeologist who works at Palaikastro. “Just one object can tell us so much about people in the past – what they ate and drank, or how they lived.”

“People often assume that archaeology is only about excavation,” Rachel continues. “But objects also need to be conserved and studied after they come out of the ground.” There is so much more to day-to-day archaeology work than digging. “Archaeology teaches you to handle evidence with care, to question assumptions, and to think expansively about how societies form

and change,” says PhD student Jacob de Juliis. “At its core, archaeology is a way of understanding people and their resilience, creativity and humanity, and that makes it endlessly relevant to the world we live in now.”

## What does a typical day of work at Palaikastro involve?

“It gets pretty hot in Greece in the summer, so we start early,” says Carl. “The whole team is on site at 6am and we finish excavating at 2pm.” To excavate the site, the team digs in trenches. Every artefact they discover, down to the smallest sherd, is bagged, labelled and catalogued, then taken to the ‘apotheke’ (storeroom) for analysis. “In the afternoon, we work

on the pottery out of the sun in the apotheke,” says Carl. Sometimes, there will be thousands of sherds laid out on tables as the team tries to find pieces that fit together so they can restore whole pots and vases. “It’s a bit like doing several 3D jigsaws at once, but without the picture on the box to guide you!” says Carl. “This can be pretty difficult, especially when you go for hours without finding any joins. But it’s very satisfying in the end once the vase has been put back together. All in all, it’s quite a full day of work, so it’s great to have the sea close by to cool off. And we’re lucky to have a really supportive local village that is invested in this project.”

## Pathway from school to *archaeology*

“There is no single pathway into archaeology,” says Carl. “You can study languages, sciences, history or geography. Archaeology really does encapsulate a wide range of approaches, from philosophy to lab-based science.”

At university, a degree in archaeology would provide a direct route to a career in the field. Or you could study a related degree such as anthropology, history or art history.

“Learning basic digital skills (like photography) will give you a strong foundation,” adds Jacob.

“Visit archaeological sites and museums in your local area,” says Rachel. You can also explore museum collections online, such as those at the Heraklion Archaeological Museum which hosts many artefacts from Palaikastro: [heraklionmuseum.gr](http://heraklionmuseum.gr)

## Explore careers in *archaeology*

Volunteer on excavations to get practical experience and learn what a career in archaeology involves. “If you get the chance to participate in a field school, go with an open mind and remember that some of the most important work is behind the scenes,” advises Jacob.

“There is so much breadth of opportunity to study whichever time or part of the world you are most interested in,” says Zoë Arzuman, who worked at Palaikastro as a student. “Archaeology teaches you many specialised skills to study the past. It is expansive in both what part of the past you want to study, and what tools you use to do so.”

Explore the websites of archaeology organisations such as the Canadian Archaeological Association ([canadianarchaeology.com](http://canadianarchaeology.com)), the British Archaeological Association ([thebaa.org](http://thebaa.org)) and the Society for American Archaeologists ([saa.org](http://saa.org)) to learn about current research and to find fieldwork opportunities.

# Meet the team

Download the team's resources from [futurumcareers.com/what-can-pottery-from-the-past-teach-us-about-containment-today](https://futurumcareers.com/what-can-pottery-from-the-past-teach-us-about-containment-today)



## Zoë Arzuman

Research Assistant,  
University of Toronto, Canada

**When I think of Palaikastro, my mind often goes to memories of watching the sun rise** over the Aegean Sea and hearing crashing waves next to our dig trench. I also think of the close friends I made – we still meet for lunch and take trips together.

**I spent six weeks excavating at Palaikastro** during the summer of 2022. Since then, I've spent two summers working at the Heraklion Archaeological Museum, where I helped catalogue pottery which had been excavated from Palaikastro over 100 years ago. Each vessel description

(including what it is made of and what decoration is present) contributes to a fuller understanding of what the lives of the people at Palaikastro were like during the Bronze Age.

**Say yes to every opportunity, because you never know where it will take you.**

When I started university, I didn't imagine myself as an archaeologist. But working at Palaikastro led me to a place where I can imagine myself as an archaeologist studying Aegean prehistory for years to come.



## Jacob De Juliis

PhD Student,  
University of Toronto, Canada

**My role at Palaikastro involves the careful digital documentation** and management of artefacts by creating a coherent digital record that preserves each object's condition, origin and features. While less glamorous than some aspects of archaeology, this job ensures that the material culture remains accessible for future study, comparative analysis and long-term conservation.

**Working at Palaikastro is truly a dream,** thanks to the people I've met there – and the fact that I get to work side by side with my best friend! The opportunities

you have and friendships you form during archaeological fieldwork are truly unmatched.

**Archaeology lets me bring together the two forces that shaped me** – a fascination with deep time, which I inherited from my father who works in palaeontology, and a commitment to human stories and lived experience, shaped by my mother's work with refugee communities. Archaeology sits exactly at that intersection as it asks how people lived, adapted, created and connected across vast spans of time, and why their choices still matter today.



## Dr Rachel Phillips

Researcher,  
British School at Athens, Greece

**As an archaeologist at the British School at Athens,** I work on the pottery found in the excavations at Palaikastro, helping to identify and catalogue the different vessels. I write down the shape and size of the pot, the kind of clay it's made from, and any decoration it has.

**Some vessels are found intact** and so are easier to identify (to work out what kind of cup or jar it is, for example), but some are just tiny fragments. However, even these fragments can help us to date a

building more precisely or tell us how it was used by people in the past.

**Palaikastro is a beautiful place to work,** close to the mountains and the sea. But my favourite thing about working at Palaikastro is the people that I've met. Archaeological fieldwork offers an opportunity to meet people from all over the world, to make new friends, and to be part of a community of people interested in similar things.

# Speaking between worlds: how P'urhepecha changes across communities

P'urhepecha is an Indigenous language of Mexico that is also spoken by diaspora communities in the USA. At **Leiden University** in the Netherlands, **Dr Kate Bellamy** is investigating how P'urhepecha varies between these communities, and how multilingual environments influence the way the language is used.



**Dr Kate Bellamy**

Centre for Linguistics, Leiden University,  
The Netherlands

## Field of research

Linguistics

## Research project

Studying the influences of Spanish and English on P'urhepecha

## Funders

Current: Nederlandse Organisatie voor Wetenschappelijk Onderzoek (Dutch Research Council); British Academy/Leverhulme Trust

Previous: Newberry Library (Chicago, USA); Endangered Languages Documentation Programme; KU Leuven Postdoctoral Mandate; Marie Curie-Skłodowska Individual Fellowship

doi: 10.33424/FUTURUM683

**L**anguages shape the way we see the world. They allow us to share ideas, tell stories, build relationships and express who we are. Around the globe, millions of people grow up speaking more than one language, switching effortlessly between them at home, school and in their communities. But what happens to a language when it is used alongside others every day?

## Talk like a ... linguist

**Article** — a type of word (found in some languages) that indicates whether a noun is known (definite article – ‘the’) or unknown (indefinite article – ‘a/an’) and whether it is singular or plural

**Bilingual** — the ability to speak two languages

**Clitic** — a small element (found in some languages) that must attach to another word to convey a certain meaning, such as to indicate the subject of a sentence

**Code-switching** — using two or more languages within a single word, sentence or conversation

**Diaspora** — a community

of people who live outside their original homeland

**Grammatical gender** — a system (present in some languages) to classify nouns, e.g., in Spanish, nouns are masculine or feminine

**Multilingual** — the ability to speak more than two languages

**Sociolinguistic interview** — a structured conversation to study how language is used in social contexts, and how it can vary

**Subject** — the person, place or thing in a sentence that performs an action or undergoes an experience

Dr Kate Bellamy, a linguist at Leiden University, is studying P'urhepecha, an Indigenous language spoken in Mexico, and exploring how it varies between communities in its homeland and diaspora communities in the USA. P'urhepecha is spoken mostly in the state of Michoacán in west Mexico by around 140,000 people, and there is also a notable diaspora community in the USA. “Most P'urhepecha speakers in Mexico speak Spanish too, and those

in the USA often also speak Spanish and English,” says Kate, who is investigating the influences of Spanish and English on P'urhepecha.

## What makes P'urhepecha unique?

P'urhepecha is a language isolate, meaning it has no known relatives. Languages are grouped into families because they share similarities in vocabulary and grammar that point to a

# P'urhepecha uandakua sési jáxesti



A wall in Santa Fe de la Laguna, a P'urhepecha town in Michoacán, that reads 'The P'urhepecha language is beautiful'. © Kate Bellamy

common origin. For example, English, Dutch and German are in the Germanic branch of the Indo-European language family, while Spanish, French and Italian are in the Romance branch. In contrast, linguists have not found any systematic links between P'urhepecha and any other language, living or extinct.

P'urhepecha contains features that neither Spanish nor English have. One example is the use of subject clitics – small, movable elements that attach to words to indicate who is carrying out an action or experiencing a state. However, P'urhepecha lacks a feature that is central to Spanish – grammatical gender. In Spanish, every noun is classified as either masculine or feminine, signalled by the definite article *el* or *la* ('the') and the corresponding adjective ending *-o* or *-a*, respectively. "P'urhepecha does not have a comparable system," says Kate. "In fact, it doesn't have a word for 'the'!" Instead, *ima* ('that') can be used for definite reference and *ma* ('one') can be used to express the indefinite article 'a'. "The use of these forms as articles is a relatively recent development in the language," explains Kate.

## How might Spanish and English influence P'urhepecha grammar?

When languages are in close contact, they can influence one another in important ways. Kate is interested in how contact with Spanish and English affects the way P'urhepecha speakers express the subject of a sentence – in other words, how they indicate who is performing an action (e.g., 'I eat'), undergoing an experience (e.g., 'You are scared of snakes'), or in a particular state (e.g., 'He is tired').

Different languages solve this problem

in different ways. English uses subject pronouns, such as 'I', 'she' or 'we'. Subject pronouns are not always necessary in Spanish because the verb ending signals who the subject is (*como* – 'I eat'; *come* – 'she eats'; *comemos* – 'we eat'). P'urhepecha, however, has several possibilities. To say 'I am eating', speakers can use a subject pronoun (*j*í** *t'irexaka*), a verb ending alone (*t'irexaka*) or a clitic that attaches to the verb to identify the subject (*t'irexakani*). These forms can also appear together (*j*í** *t'irexakani*).

"I hypothesise that bilingual speakers in Michoacán, who speak P'urhepecha and Spanish, will use subject clitics more frequently, since Spanish also indicates the subject using the verb," says Kate. "In contrast, in the diaspora in the USA, where speakers also use English, I hypothesise that subject pronouns will be more prevalent, because they are obligatory in English and, therefore, heard more often."

## How does Kate study variation in P'urhepecha?

"One of my main approaches is to conduct sociolinguistic interviews with P'urhepecha speakers in Mexico and the USA," Kate explains. "I ask them about their family, where they are from, their education and occupation, how they view the language, and how things have changed in their community over the years." This allows Kate to compare the words, grammatical structures and pronunciation that people use, revealing patterns of change across regions and generations.

To study code-switching – the use of P'urhepecha words or phrases in Spanish or English sentences, or vice versa – Kate

records conversations and runs linguistic experiments. These include spoken games, where pairs of participants must switch languages to complete a sentence, and written questionnaires, where participants must choose which Spanish gender they would assign to genderless P'urhepecha nouns.

## How does P'urhepecha vary in different contexts?

Kate's research has revealed that when code-switching, bilingual P'urhepecha and Spanish speakers in Mexico use different strategies to assign gender to P'urhepecha words in Spanish sentences, depending on the task. "In spoken tasks, participants tend to use a default approach, assigning masculine gender to over 90% of P'urhepecha nouns," says Kate. In contrast, when reading or writing, the final vowels of words become more noticeable, and speakers are more likely to assign the gender that matches the word ending. For example, *japunda* ('lake') ends in *-a* and so is associated with the feminine gender (*la japunda*), even though the Spanish translation (*el lago*) is masculine.

"P'urhepecha in the diaspora naturally contains far more English words than the Mexican variety does," says Kate. Many diaspora speakers are trilingual, fluently speaking P'urhepecha, Spanish and English, and they often switch between all three within the same sentence. Living in such a multilingual environment expands speakers' linguistic repertoire and shapes the way they use P'urhepecha in everyday communication. This lived experience shows how languages adapt and evolve depending on community and context – which is what makes linguistics so fascinating!



# About *linguistics*

**L**inguistics is the study of languages. It looks at how people speak, understand and use language, as well as how languages evolve. “The field of linguistics has something for everyone,” says Kate. “It covers the study of different languages around the world and aspects of written and spoken language.” For example, it includes the sounds we make when we speak (phonetics and phonology), how words are formed (morphology), how sentences are structured (syntax), and how these features vary across different languages (typology).

Linguists also examine how people use language in different social contexts (sociolinguistics), what they mean when they speak (semantics and pragmatics), how language is processed in the brain (psycholinguistics and neurolinguistics), and how languages change over time (historical linguistics and language contact). Multilingualism is a key area of study, exploring how people juggle multiple languages, including how they code-switch between them. Another important focus is documenting endangered languages to preserve knowledge

and ways of thinking that cannot be expressed in any other way.

For young people, linguistics is an exciting field. “Language is all around us – it is part of what makes us human,” says Kate. “You could study a language in the highlands of Mexico or analyse communication in a school in London.” Linguistics can take you to places you never expected, let you experience new cultures, and show you different ways of seeing the world – all while learning more about language and yourself.

## Pathway from school to *linguistics*

“At school, study English and modern foreign languages to learn how languages are structured and used, as well as how they can vary from each other,” advises Kate. Classical languages, if they are offered, will also be useful as they will teach you about grammar and language structure.

“Psychology will help with certain sub-disciplines of linguistics, such as psycholinguistics and neurolinguistics,” says Kate. “Computing (especially programming) will also come in handy, especially as AI becomes more prominent in the field. Other humanities subjects, such as history and English literature, will help you develop strong analytical and writing skills. And maths will be useful for areas like computational linguistics.”

Study linguistics at university. You could then obtain a postgraduate degree in a sub-discipline such as sociolinguistics (language and society), neurolinguistics, or language description and documentation. You could also combine your linguistics studies with a degree in languages and/or literature.

## Explore careers in *linguistics*

Prospects provides information about what you can do with a degree in linguistics: [prospects.ac.uk/careers-advice/what-can-i-do-with-my-degree/linguistics](https://www.prospects.ac.uk/careers-advice/what-can-i-do-with-my-degree/linguistics)

“Explore resources provided by national linguistics associations,” recommends Kate. Examples include the Linguistics Association of Great Britain and Northern Ireland ([lagb.org.uk](https://www.lagb.org.uk)), the Linguistic Society of America ([lsadc.org](https://www.lsadc.org)), the Societas Linguistica Europaea ([societaslinguistica.eu](https://www.societaslinguistica.eu)), the Canadian Linguistic Association ([cla-acl.ca](https://www.cla-acl.ca)) and the Asociación de Lingüística y Filología de América Latina ([mundoalfal.org](https://www.mundoalfal.org)).

*Lingthusiasm* ([lingthusiasm.com](https://www.lingthusiasm.com)) and *A Language I love is...* ([dannybate.com/podcast](https://www.dannybate.com/podcast)) are accessible podcasts that discuss different topics in linguistics and introduce languages you have probably never heard of before.



## Meet Kate

**I've always loved to read and travel.** Both entail an innate sense of curiosity as you are constantly exploring and learning something new. That sense of wonder and the desire to never stop learning are always with me.

**Although I didn't realise it at the time, I began linguistics research at school.** I studied English language as one of my A levels and, for my final project, I explored how the language use of my two Jamaican uncles varied in different contexts – when they were talking to each other and when they were talking to me. A classic sociolinguistic project, as it turned out!

**I studied modern and medieval languages at university,** focusing mostly on French and Italian from about 1200 CE to the present. After graduating, I worked in sales for a large brewery but didn't enjoy it. So, I found a job that made use of my language skills by researching education systems and qualifications throughout Europe and beyond to establish standards of comparison between them. Nonetheless, I felt like I was wasting one of my main talents – my multilingualism. I moved to Luxembourg to work as a project coordinator at a university, which made me realise I wanted to study more. And so I ended up at Leiden University in the Netherlands, where I gained a Master's degree and PhD in linguistics, and now work as a linguistics researcher.

**I love learning new languages** because I love being able to interact with people who speak different languages. It opens my eyes to their culture in a different way. I am fluent in English (my mother tongue), Dutch, French, Italian and Spanish, I can have conversations in German, I can get by in P'urhepecha, and I can do basic things like ordering food in Russian and Georgian. Last year, I also started learning Limburgian, the local language of the region where I live in the Netherlands.

**One of my favourite memories from my linguistics research** was when I organised a trip to the Newberry Library in Chicago for P'urhepecha speakers living in the area. The library holds P'urhepecha books written in the 16th and 17th centuries, and it was very moving to see members of the P'urhepecha community come face-to-face with these books for the first time – to be able to turn the pages and read the words aloud.

---

### **Kate's top tips**

1. Study what you enjoy – don't study something just because you think it will get you a job.
2. Be prepared to get out of your comfort zone – the results can be very rewarding.
3. Don't let failure or rejection get you down – know it will just make you stronger. Remember that persistence and hard work pay off!

Download Kate's resources from  
[futurumcareers.com/how-purhepecha-changes-across-communities](https://futurumcareers.com/how-purhepecha-changes-across-communities)



Street art on a wall in Cherán, Michoacán. © Kate Bellamy

# Bribery, forgery and fraud: the murky world of economic crime

Catching an individual who has committed theft poses challenges, but forensics and CCTV make it easier for law enforcement to do so. However, pinning down complex, large-scale cases of fraud, money laundering or corruption can be very difficult, and charging an organisation with an economic crime can sometimes cause a whole cascade of negative effects on innocent parties. At the **University of Ottawa** in Canada, **Dr Jennifer Quaid** studies the law around economic crime and corruption, and how it can be best used to catch and charge those who manipulate systems illegally for financial gain.



**Dr Jennifer Quaid**

© Mary Ellen Covett

Professor, Civil Law Section, Faculty of Law, University of Ottawa, Canada

## Fields of research

Criminal law; economic crime; corporate criminal law; competition law; business regulation; AI governance

## Research project

Studying the effectiveness of a new tool (the remediation agreement) added to Canada's Criminal Code on economic crime and corruption enforcement, including comparing Canada's approach to those used in France and Switzerland

## Funders

Social Sciences and Humanities Research Council of Canada (SSHRC); Civil Law Section, University of Ottawa; Foundation for Legal Research; Quebec Bar Foundation

doi: 10.33424/FUTURUM680

**A**n economic crime is any illegal behaviour done with the intention of financial gain. "Such crimes may include fraud, corruption, bribery, bid-rigging, money laundering, tax evasion, forgery and theft," says Dr Jennifer Quaid, a professor in the University of Ottawa's Faculty of Law. "It's a broad term!" The tactics used by economic criminals also vary hugely –

Talk like a ...

## criminal law researcher

**Charge** – the accusation made against someone, claiming they violated the law

**Corruption** – dishonest conduct by those in power, usually involving bribery

**Economic crime** – illegal acts committed to obtain a financial advantage

**Enforcement** – ensuring compliance with a law or rule

**Prosecution** – conducting

legal proceedings against someone following the charge

**Remediation agreement (RA)** – in Canadian law, an agreement between an accused organisation and a prosecutor to not pursue criminal charges if the accused fulfils certain terms. (RAs are similar to other non-trial resolution mechanisms in other countries, such as a deferred prosecution agreement, or DPA, in the UK and a convention judiciaire d'intérêt public in France.)

beyond simple theft, they may employ deception, manipulation, abuse of trust or power, and other sophisticated strategies. "Many of these strategies make it hard to spot what is really happening," says Jennifer. "Victims may include individuals, organisations, governments or society at large."

Because many economic crimes are complex and well-disguised, many victims may not immediately realise they have been targeted. "Economic crimes committed by businesses are more challenging to bring to justice because the evidence can be buried

within mountains of documents and private transactions," explains Jennifer. "Unlike other types of crime, there's no specific event that signals that a crime has happened, so investigators are always playing catch-up." This lack of a single or obvious criminal incident does not make economic crimes any less serious – often, quite the opposite. "There are often consequences beyond simple financial loss," says Jennifer. "Economic crimes may involve violence, human rights violations, environmental damage, or threats to democracy itself."



© Rawpixel.com/Shutterstock.com

## Corruption in Canada

One particular aspect of economic crime is especially damaging for a democratic society: corruption. “At its most basic, corruption occurs when one party gives an unfair advantage to another party in exchange for something of value, often money,” explains Jennifer. “A good example is when a public official accepts a bribe in exchange for selecting a certain supplier for a government contract.” Corruption undermines public confidence in the government and encourages injustice. “Our understanding of democracy is underpinned by the idea of equality,” says Jennifer. “Corruption damages this – imperilling democracy and, sometimes, ushering in or maintaining authoritarian regimes.”

Laws are highly specific to individual countries. “Canada has not brought a lot of prosecutions in corruption matters,” says Jennifer. “Some say this indicates that Canada is weak on enforcement – but the number of prosecutions is not necessarily the best measure of good enforcement.” This prosecution rate is low for varied reasons, one being that Canada’s legislation dictates that it has to be demonstrated that the people involved in the corruption case did it knowingly, which is not always easy. “Many experts believe that Canada should create a different kind of offence that focuses on lack of diligence more than active criminal guilt,” says Jennifer. “The case would become more regulatory, rather than a truly criminal matter.”

## Remediation agreements

A significant issue with economic crime is an organisation’s willingness to address it through the law. If a company realises they

are at risk of corruption, or even have staff committing corruption, harsh laws may incentivise them to hide it rather than take action. Criminal convictions for economic crimes can doom a company, in particular by massively restricting its ability to apply for public contracts.

Beyond the business itself, it is also important to consider the innocent people that may depend on it, such as employees, shareholders, communities, creditors and governments. A criminal conviction within the business could damage these innocent parties through financial and livelihood losses – a punishment that they have done nothing to deserve.

To address this, Canada recently introduced a new type of legislation, called a remediation agreement (RA). “An RA is similar to a plea deal,” says Jennifer. “It allows settlements of charges for a business’s economic crimes without the need for criminal conviction.” Under an RA, the accused organisation has to publicly admit engagement in economic crimes, and fulfil certain terms – financial penalties, independent monitoring or victim compensation, for instance – typically within three years.

## A shaky start

Despite vocal support from businesses when RAs were first considered, they have not been widely used since they were rolled out in 2018. “The new RA regime got off to a bad start due to disagreements between prosecutors and a big Canadian multinational organisation over its use, which culminated in politicians improperly pressuring the country’s Attorney General to intervene,”

explains Jennifer. “This generated a major political scandal which cast a shadow on RAs for years.”

Improvements to the RA regime might help rebuild its reputation. “There is still limited information about how the negotiation process works, so setting this out more clearly would help,” says Jennifer. “RAs also need to be more transparent and made public once approved.” Additionally, non-government organisations and civil society groups are lobbying for more established benefits for victims, including those who have been victims of corruption in other countries due to the actions of Canadian organisations.

## The future of economic crimefighting

RAs do not cover all economic crimes – far from it. “Right now, there’s a lot of attention on economic crimes connected to large criminal organisations and terrorist groups,” says Jennifer. “These would never be eligible for an RA but are an important enforcement priority for Canadian law to focus on.”

The Canadian federal government has announced an array of new measures to tackle the most serious economic crimes. “This includes a National Anti-Fraud Strategy, which will increase capacity to address mass market fraud, including how criminals use data and algorithms to deceive and defraud,” says Jennifer. “Canada is also creating a Financial Crimes Agency, which will support expertise in dealing with sophisticated financial crimes such as major money laundering schemes and cyber-attacks.”



## About *criminal law*

**T**he field of criminal law is wide and often varies a lot between countries. “Law is a dynamic field,” Jennifer says. “As the world changes, so must the law. Every year there is new legislation, new cases and new policy.” As the ‘world order’ appears to be reshaping, this may create a more unpredictable global environment, and we will need good legal experts to navigate it. “We’ll be needed as new rules are developed, especially if we move to a system of multiple alliances. For example, if different countries worked together under new trade agreements, laws would be affected,” says Jennifer.

Jennifer is a legal researcher, which means she spends a lot of time

analysing legal sources. “This includes documents, laws, regulations and court decisions,” she says. “I also read articles and books by other legal researchers.” Much of Jennifer’s research involves watching how real-world cases use and challenge legal rules. She also spends a lot of time in conversation with different people. “Journalists ask for my opinion on stories related to my areas of research,” she says. “This also gives me some great ideas for new research questions.” Additionally, Jennifer talks to people involved in law enforcement and in legal cases. She also collaborates with researchers from different countries to share insights and research tools.

For Jennifer, her work often feels like untangling a logic puzzle. “I enjoy the challenge of digging into the details of a legal problem to figure out how to apply a set of legal rules, and explaining this to others in straightforward ways,” she says. “These little nuggets help me see patterns or connections to other problems.” She also believes that it is important to strive for better laws and legal practices. “I believe that our role as researchers is to search for evidence to help make the world a better place,” she says. “It might be through small and incremental contributions, but I find being part of a bigger collective effort so rewarding.”

### Pathway from school to *criminal law*

Jennifer says that reading comprehension and writing proficiency are essential, as is a strong knowledge of history, which provides the context for laws. She adds that speaking several languages is an asset, as is a strong capacity for critical thinking. At school, subjects that can develop these skills include law, English, history, political science, sociology and foreign languages.

At university, there are many law degrees and variants. Adjacent fields that can lead to a career in legal research include many social sciences, such as criminology, sociology, psychology and public policy.

Download Jennifer’s resources from  
[futurumcareers.com/bribery-forgery-and-fraud-the-murky-world-of-economic-crime](https://futurumcareers.com/bribery-forgery-and-fraud-the-murky-world-of-economic-crime)



## Explore careers in *criminal law*

Jennifer emphasises that law is highly jurisdiction-specific, meaning that learning the legal landscape of one country may not be applicable to others – so it is important to think about where you want to work before you begin your studies and find appropriate resources to help your decision. For Canada, this page from Canadian Lawyer can help this process: [canadianlawyermag.com/resources/legal-education/how-to-start-studying-law-in-canada-law-school-enrollment-guide/392938](https://canadianlawyermag.com/resources/legal-education/how-to-start-studying-law-in-canada-law-school-enrollment-guide/392938)

Jennifer's work as a criminal law researcher often involves talking to the media and explaining the legal background and/or implications of well-known legal cases. Watch these interviews with Jennifer to gain an insight into the cases and issues work in her field can involve (the first two are in English and the third in French):

- ▶ [youtube.com/watch?v=SyWuflGwG8c](https://youtube.com/watch?v=SyWuflGwG8c)
- ▶ [youtube.com/watch?v=iPRegg3qetg&t](https://youtube.com/watch?v=iPRegg3qetg&t)
- ▶ [youtube.com/watch?v=xiAJVRa6\\_B8](https://youtube.com/watch?v=xiAJVRa6_B8)

In this video, Jennifer discusses corporate criminal liability (in French and with English subtitles):

- ▶ [youtube.com/watch?v=U5SAedNNIDE](https://youtube.com/watch?v=U5SAedNNIDE)

The Faculty of Law at the University of Ottawa runs the Jurivision project, which highlights the work of legal researchers and practitioners in Canada and around the world: ▶ [youtube.com/@jurivision](https://youtube.com/@jurivision)



© Mary Ellen Cavett

## Meet *Jennifer*

**I was first drawn to law by the idea of 'fighting the good fight' in court.** In high school, I liked debating and public speaking, which I thought meant I'd be good at law. The truth is much more nuanced as many lawyers never even go to court. Even those that do spend a lot more time preparing, reading, writing and thinking than they do in court.

**I practised as a lawyer before I was a researcher.** Oral communication and advocacy skills were essential, and not just in court. The work of a lawyer involves a lot of interaction with colleagues, clients and public officials. Working closely with clients was a highlight of my time in private practice.

**I have had some extraordinary luck in my career.** My research expertise has proven relevant to several significant events in Canada and the wider world, which has enabled me to contribute to important public policy debates.

**My proudest moments are when I can help move discussions forward,** to provide information and evidence to people who need it, and to encourage productive consensus. Some of these moments may not seem very remarkable in themselves – a radio interview, a classroom discussion or a published paper – but they always move the needle on understanding.

**I have a big research project lined up.** I will study the recent reform to Canadian competition law, exploring how its ambition can be translated into concrete action. In the longer term, I plan to write a textbook on corporate criminal liability in Canada. Economic crime will be a big part of that.

## Jennifer's top tips

1. Take time to find your place professionally. Careers are long, and there will be twists and turns that might surprise you.
2. All experiences, including mistakes and obstacles, are important opportunities to learn and grow.
3. Believe in yourself. Persistence and hard work will pay off – but remember that success is state of mind, not a moment.



# Putting the right technology into the right hands

By providing technology and learning programmes to under-resourced schools in South Africa, **iSchoolAfrica Education Trust** is empowering learners and teachers alike. Founder and Director **Michelle Lissoos** tells us how the organisation is working to ensure all learners can access meaningful, inclusive learning opportunities.

# iSchoolAfrica



with the digital skills demanded by the modern economy. It does more than provide information; it builds confidence, creativity and agency. When access is equitable and supported by strong teaching, technology can give our youth the opportunity to be active participants in shaping their own futures.

## How does iSchoolAfrica facilitate inclusivity in education?

Everything we do is about inclusivity in education; all our programmes are designed in ways that ensure all learners — especially those who are marginalised or have disabilities — can access meaningful learning opportunities

## What motivated you to set up iSchoolAfrica? What was the 'educational change' that you wanted to see happen?

We were seeing Apple technology having an incredible impact in private schools, and, at the same time, we were seeing the divide getting bigger and bigger between resourced and under-resourced schools. We were also seeing compromised, low-quality devices being 'dumped' on marginalised communities. With that in mind, iSchoolAfrica was established in 2009 to bring the world's best technology and education practices to under-resourced schools, to empower all educators and learners.

iSchoolAfrica wants to see a South Africa where every learner has the same access to the tools and education that can help

them reach their full potential. At its heart, iSchoolAfrica is working to create empowered teachers, confident learners and inclusive education for all.

## Why is technology so closely linked to reducing inequalities and enhancing opportunities?

When the right technology is placed into the right hands, it truly becomes a powerful equaliser. In a world where education, employment, communication, financial services and healthcare are increasingly digital, those without access are automatically excluded. Technology breaks down the barriers of geography, disability and limited resources — connecting rural learners to global knowledge, giving children with disabilities tools to communicate and learn independently, and equipping young people

iSchoolAfrica equips under-resourced schools with secure mobile iPad labs, pre-loaded with curriculum-aligned educational apps and software tailored for learners with different needs. iPad's built in accessibility features support learners with disabilities, helping make learning more inclusive. These tools support students with autism, visual impairment, deafness, cerebral palsy, dyslexia and other challenges, allowing them to engage with curriculum content in ways that work for them. Mobile device management software keeps the iPads secure — so they can be tracked and deactivated when they leave the school premises.

But inclusivity isn't only about the tools — iSchoolAfrica trains and mentors teachers to use technology effectively and to adapt

teaching practices for diverse learning needs. This builds confidence and capacity within schools to sustain inclusive learning long-term.

### What learning programmes do you offer schools, and how do these work?

Our learning programmes are designed to integrate iPad technology meaningfully into everyday teaching and learning – not as an ‘add-on’, but as a powerful enabler of deeper understanding, creativity and future-ready skills.

Our key programmes include:

**Numeracy and Literacy Programme** – for early learning and foundation phase. Curriculum-aligned digital learning using iPad technology to strengthen literacy, numeracy and critical thinking in the early years.

**Coding and Robotics Programme** – we bring Apple’s Everyone Can Code project to schools, providing a full coding curriculum, from block-based coding concepts to app development.

**Disability and Inclusion Programme** – a specialised programme supporting learners with disabilities through assistive technology and inclusive teaching strategies.

**Media Change Makers Programme** – designed to empower young people to become agents of change through media and storytelling.

### How does iSchoolAfrica’s work empower both students and teachers?

iSchoolAfrica empowers learners by giving them access to technology that unlocks creativity, critical thinking and opportunity. Through interactive digital lessons, coding and robotics, and inclusive assistive tools, they build confidence as they develop real-world skills and gain

exposure to future career pathways.

Every iSchoolAfrica programme includes educator support and mentoring. Programme champions are also appointed in each school. iSchoolAfrica builds educator confidence, competence and leadership in a digital world. Through structured training, ongoing coaching and classroom-based support, educators learn how to integrate technology meaningfully into the curriculum. Teachers are also awarded the global recognition of Apple Teacher. An ongoing support network of best practice is created. ➔



“  
**At its heart, iSchoolAfrica is working to create empowered teachers, confident learners and inclusive education for all learners.**  
”





“

***When access is equitable and supported by strong teaching, technology can give our youth the opportunity to be active participants in shaping their own futures.***

”



© iSchoolAfrica

### Who are the iSchoolAfrica facilitators, and what support do they offer schools?

iSchoolAfrica facilitators are trained specialists in education technology integration. They work on the ground at each school, where an iSchoolAfrica programme is implemented. They support and mentor the educators to ensure confidence and independence.

### What collaborations make iSchoolAfrica's work possible?

Partnerships and collaboration are key to iSchoolAfrica's success and sustainability. Our work is made possible through a wide range of partnerships with private companies, non-government organisations (NGOs), foundations and community organisations. And, of course, central to all our programmes is the commitment of school leaders, educators and learners.

### What impact has iSchoolAfrica had so far?

Since its formation in 2009, iSchoolAfrica has had a significant and measurable impact on South Africa's education landscape. Over 340 schools have participated in iSchoolAfrica's programmes. Our initiative has impacted more than 120,000 learners from Early Childhood Development through Grade 12. Over 3,500 teachers have been trained to integrate technology and learner-centred practices effectively in the classroom.

### What have been the highlights for you, personally?

I am very proud of the impact iSchoolAfrica has made. The highlights for me are always seeing the personal triumphs of our programme: a Grade 1 learner in a rural village gets access to personalised numeracy and literacy lessons; a child in hospital does

not miss out on school learning; township teenagers make movies on issues that are important to them; a non-verbal learner with autism communicates for the first time; deaf youth become successful app developers; teachers thrive as they see their learners succeed – this is the everyday life of iSchoolAfrica.

### What's next for iSchoolAfrica?

iSchoolAfrica is always looking for ways to scale and strengthen partnerships for increased impact and reach. We look forward to new, innovative ways of increasing access to quality education. It will be exciting to see how AI will assist this.

### Connect with iSchoolAfrica Education Trust

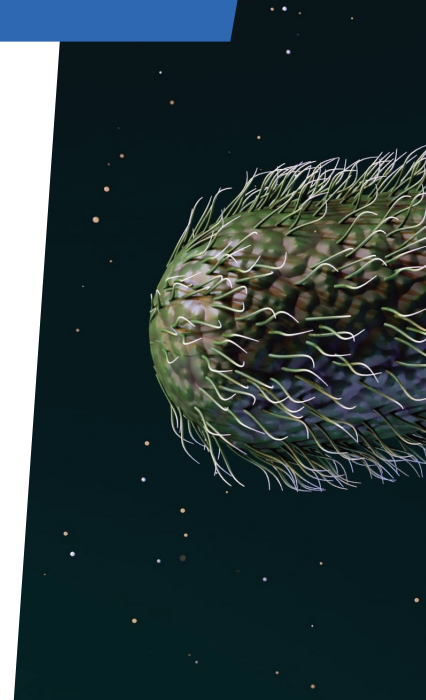
**iSchoolAfrica**  
Education Trust

- [ischoolafrica.com](https://www.ischoolafrica.com)
- [facebook.com/ischoolafrica](https://www.facebook.com/ischoolafrica)
- [linkedin.com/company/iSchoolAfrica](https://www.linkedin.com/company/iSchoolAfrica)
- [x.com/iSchoolAfrica](https://x.com/iSchoolAfrica)
- [youtube.com/channel/UCtSLoyaxL1IIB6FbrdhLZQ](https://www.youtube.com/channel/UCtSLoyaxL1IIB6FbrdhLZQ)

**“ Partnerships and collaboration are key to iSchoolAfrica's success and sustainability. ”**

# How can immunology improve treatments for urinary tract infections?

Urinary tract infections (UTIs) affect hundreds of millions of people every year. While antibiotics can clear the bacteria, some patients — especially children — are left with permanent kidney damage. **Dr Juan de Dios Ruiz-Rosado**, an immunologist at **Nationwide Children's Hospital** in the US, is studying how the immune system fights UTIs, aiming to develop new treatments that strengthen the body's natural defences.



**Dr Juan de Dios Ruiz-Rosado**

Principal Investigator, Assistant Professor of Pediatrics, Kidney and Urinary Tract Research Center, Abigail Wexner Research Institute, Nationwide Children's Hospital, Ohio State University, USA

## Field of research

Renal immunology

## Research project

Studying and manipulating the immune system to fight urinary tract infections

## Funders

Research in the Ruiz-Rosado Lab is supported by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK; K01 DK128379) and the Clinical and Translational Intramural Funding Program (IFPAWRI052023) at the Abigail Wexner Research Institute, Nationwide Children's Hospital, USA. Inicure (Sweden) generously provided newly discovered NADPH oxidase activators.

doi: 10.33424/FUTURUM686

**U**rinary tract infections (UTIs) are one of the most common bacterial infections worldwide. "They occur when microorganisms — most often bacteria — enter and multiply within the urinary tract," explains Dr Juan de Dios Ruiz-Rosado from Nationwide

Talk like a ...

## renal immunologist

### Acute pyelonephritis

— a serious bacterial infection of the kidneys that can cause inflammation and, in some cases, permanent scarring and loss of kidney function

**Antibiotic resistance** — the ability of bacteria to survive and continue multiplying despite treatment with antibiotics

**Chronic kidney disease** — a long-term condition in which the kidneys gradually lose their ability to filter waste and maintain fluid balance

**Kidneys** — the organs that filter waste and excess fluid from the blood while keeping the body's chemical levels balanced

**Macrophage** — an immune cell that can detect, engulf and destroy microbes while also coordinating other parts of the immune response

**Neutrophil** — a short-lived white blood cell that is among the first immune cells to arrive at sites of infection and kill invading bacteria

**Reactive oxygen species** — highly reactive molecules produced by immune cells that help destroy invading microbes

**Renal** — relating to the kidneys

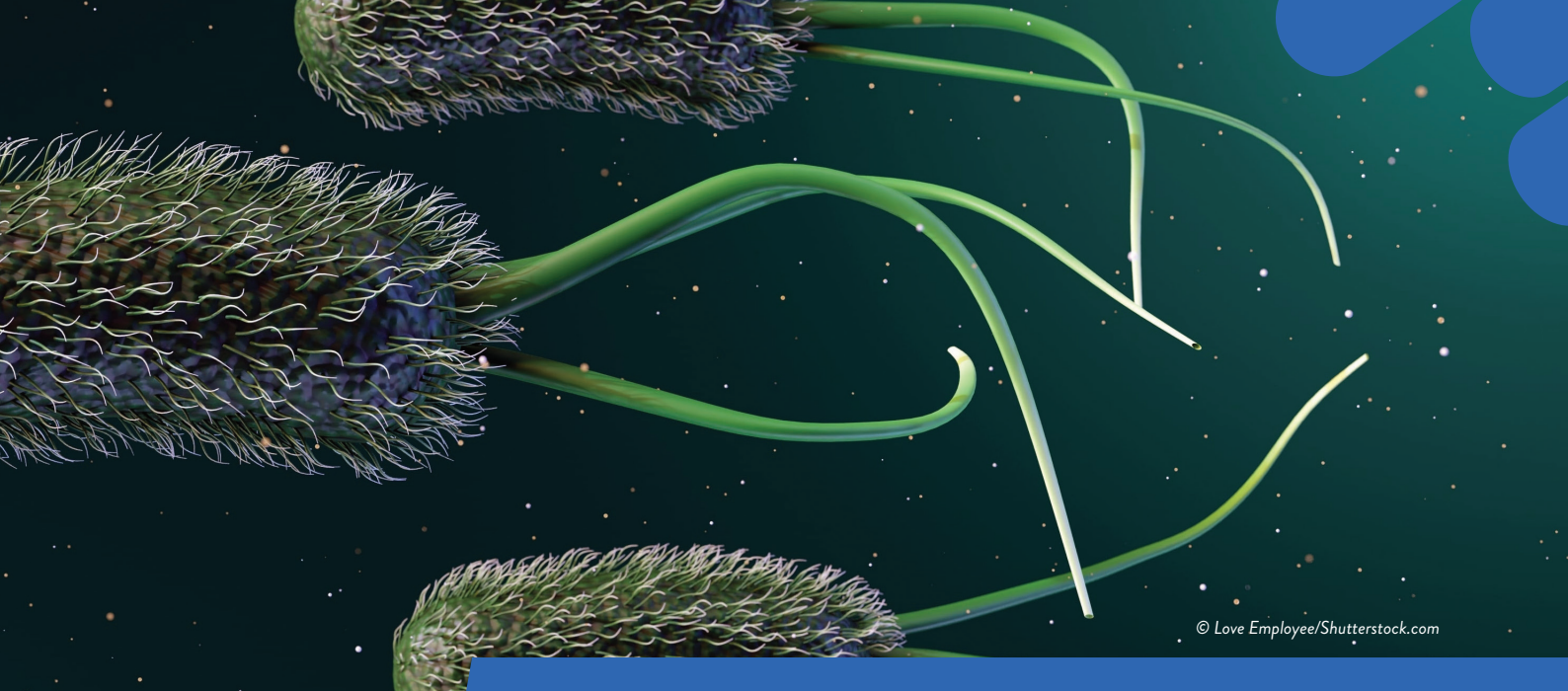
Children's Hospital. "They can affect any part of the urinary system, including the urethra, bladder and kidneys, which all work together to remove waste from the body through urine."

The leading cause of UTIs is *uropathogenic Escherichia coli* (UPEC), a strain of bacteria responsible for around 75% of cases. Globally, an estimated 400 million people develop

a UTI each year. While many cases are straightforward to treat, some can spread to the kidneys and lead to lasting health consequences.

## What is acute pyelonephritis?

Acute pyelonephritis is a serious kidney infection that develops when bacteria spread from the bladder to the kidneys. This typically happens when bacteria such as UPEC travel



upwards through the ureters, the tubes connecting the bladder and kidneys. These microbes are well adapted for the journey: they use hair-like structures called fimbriae to attach to the urinary tract lining, tail-like flagella to move forwards and can even enter the cells lining the tract to avoid being flushed out with urine or detected by the immune system. In children with a condition called vesicoureteral reflux — where urine flows backwards towards the kidneys — this spread is more likely.

Because the kidneys are responsible for filtering waste from the blood and regulating the body's fluid balance, kidney infections can have serious consequences. "Even when antibiotics successfully treat a kidney infection, about 15–20% of children with acute pyelonephritis develop permanent kidney scarring," explains Juan. Over time, this reduction in healthy tissue can lower kidney function and increase the risk of high blood pressure and, in more severe or repeated cases, chronic kidney disease.

### How do neutrophils fight kidney infections?

Neutrophils are the most common type of white blood cell and are among the first immune cells to arrive at a site of infection. Although they live for less than a day, they respond quickly, engulf invading bacteria and destroy them. Juan's research highlights how important they are in UTIs caused by UPEC. In mouse studies, when neutrophils are absent, bacteria spread rapidly, leading to more severe kidney infections and greater tissue damage, mirroring observations in human patients with low neutrophil counts.

Inside neutrophils, an enzyme called NADPH oxidase plays a crucial role in the elimination of UPEC. After a bacterium is engulfed, NADPH oxidase produces reactive oxygen species — toxic molecules that help kill the microbes. But NADPH oxidase does more than destroy bacteria: it also helps control inflammation, preventing the immune response from becoming too strong and harming healthy kidney tissue. "We are currently investigating strategies to selectively enhance NADPH oxidase activation in neutrophils to boost their bacteria-killing ability, while avoiding harmful overactivation of the immune system," says Juan. "Our preliminary results are promising; in mouse models, we see that activation of NADPH oxidase in neutrophils promotes bacterial killing, and we observe fewer bacteria in the kidneys."

### What role do macrophages play in infection?

Macrophages are another key type of immune cell and form part of the body's first line of defence. Some live permanently in tissues such as the bladder and kidneys, while others are recruited from the blood during infection. They act as guards, using specialised receptors to detect invading microbes, engulfing and destroying bacteria, and releasing chemical signals that attract other immune cells — especially neutrophils — to the site of infection. In this way, they both fight bacteria directly and coordinate the wider immune response.

"Macrophages usually help protect the body during a UTI, but sometimes their response can become too strong or last too long," explains Juan. While inflammation helps

eliminate infection, excessive or prolonged inflammation can damage healthy tissue. Over time, this can lead to the build-up of scar tissue, reducing kidney function and increasing the risk of chronic kidney disease.

### Why are new treatments for UTIs urgently needed?

"Antibiotic-resistant bacteria are becoming more common, mainly because antibiotics are often overused or not taken correctly," says Juan. "When this happens, the most vulnerable bacteria are killed, but resistant ones survive and multiply." Over time, this makes infections harder to treat. Some strains of UPEC now show high levels of resistance to commonly prescribed antibiotics, with rates of resistance ranging from 55% to 85% in some developed countries.

Antibiotics also do not solve every part of the problem. While they can remove bacteria, they do not directly control the inflammation that can damage kidney tissue. This helps explain why some children develop permanent scarring even after treatment.

Juan and his team are developing strategies to regulate macrophage-driven inflammation to reduce kidney damage. "We're seeing early evidence that targeting overactive macrophages helps reduce inflammation and prevent scarring in infected mouse kidneys," says Juan. "Our ultimate goal is to create innovative, immune-based therapies that reduce dependence on antibiotics, enhance the body's natural ability to fight infection and protect children from permanent kidney damage."

# About renal immunology

**R**enal immunology is the study of how the immune system works within the kidneys. It sits at the intersection of immunology, nephrology (the study of kidneys), microbiology and infectious disease research, exploring how immune cells protect the kidneys from infection and prevent damage to this vital organ. Because the kidneys have a unique environment — with high sodium and urea levels, tightly controlled metabolism, and regions of low oxygen — immune cells behave differently in the kidneys compared to other parts of the body. “This is an exciting field because we still know relatively little about how immune cells behave within the unique environment of the kidneys,” says Juan. “Immune cells do not function in isolation — they constantly respond to signals from the tissues around them.”

Renal immunology is important not only for acute pyelonephritis, but also for conditions such as autoimmune diseases (when the immune system attacks healthy cells), diabetic kidney disease, acute kidney injury and kidney transplant rejection. In all these conditions, inflammation can lead to long-term loss of kidney function. “For these reasons, renal immunology is not only essential for understanding infections, but also for advancing treatments across a broad range of kidney diseases that affect millions of people worldwide,” explains Juan.

According to Juan, one of the greatest rewards of working in renal immunology is knowing that the research addresses a major and meaningful health problem. UTIs account for millions of healthcare visits and many hospitalisations each

year, placing a medical, economic and emotional burden on patients and families. “Contributing even a small piece to a better understanding of disease — and helping advance how we prevent or treat it — is one of the most meaningful aspects of this work,” says Juan.

Like many fast-moving scientific fields, renal immunology also comes with challenges, such as keeping up with the rapidly expanding body of research. “Staying current is essential to avoid duplicating prior work and to identify new directions,” says Juan, who makes continuous learning a priority in his lab. “Young scientists should be curious and persistent, and pursue bold, innovative ideas in this field, which is both challenging and deeply rewarding.”

## Pathway from school to renal immunology

“To pursue renal immunology, students should build a strong foundation in biology, chemistry and creative writing during high school,” says Juan. “Courses in statistics and basic programming are also increasingly valuable.”

“At the university level, I recommend courses in immunology, microbiology, cell and molecular biology, anatomy, and infectious diseases,” says Juan. “Also, courses in creative or scientific writing help with publishing papers and applying for fellowships.”

Laboratory placements, summer research programmes and internships will allow you to develop practical skills and learn how scientific studies are designed and conducted. Early research experience can also help you identify your interests and build confidence.

## Explore careers in renal immunology

According to Juan, professional societies are a great place to start. Organisations such as the American Association of Immunologists ([aai.org](http://aai.org)), the American Society of Nephrology ([asn-online.org](http://asn-online.org)) and the American Society for Microbiology ([asm.org](http://asm.org)) offer webinars, conferences and networking opportunities for students interested in immunology and kidney research.

Textbooks such as *Basic Immunology* and *Cellular and Molecular Immunology* by Abbas, Lichtman and Pillai are widely used in medical and graduate training and provide a strong foundation in immune system biology.

Online learning platforms can help build knowledge and skills. Courses from the Foundation for Advanced Education in the Sciences ([education.faes.org](http://education.faes.org)) and classes on Coursera ([coursera.org](http://coursera.org)) cover topics such as immunology, microbiology and data analysis. Educational YouTube channels like *Khan Academy*, *Osmosis* and *eLife* can also help you learn about complex concepts.

# Meet the team

Download the team's resources from [futurumcareers.com/how-can-immunology-improve-treatments-for-urinary-tract-infections](https://futurumcareers.com/how-can-immunology-improve-treatments-for-urinary-tract-infections)



**Israel Cotzomi-Ortega**  
Research Scientist

**I believe that the people who surround us gradually shape our interests.** I was fortunate to have inspiring teachers throughout my education, and they awakened in me a passion for asking questions and searching for answers. I see myself as a simple person, drawn to simple questions: Why are leaves

green? Why is blood red? What happens inside our bodies when we fall ill? Yet, what appears simple often conceals great complexity, and I believe it is our responsibility to understand that complexity and transform it into knowledge that serves humanity.

**I have had the opportunity to work in several research labs** and across different scientific fields. These experiences have allowed me to acquire and apply a wide range of research techniques to address our current scientific questions. Another key element of a successful career is collaboration and teamwork. Today, science is marked by advances so large and complex that they would take a single person or research group an extraordinary amount of time to achieve alone.

**Exploring new paths within the vast world of knowledge** is both a privilege and a responsibility. In our field, many research questions arise, and after analysing what is already known, we design experimental strategies to address them. But the process does not end there: we must also analyse and interpret the results to propose new knowledge, which is then examined by the broader scientific community.

## Israel's top tip

Empathy is important in the fields of science and medicine. It is fascinating to seek answers in a universe waiting to be discovered and understood for the benefit of all living beings.



**Yuriko I. Sanchez-Zamora**  
Postdoctoral Scientist

**In school, I really liked biology, chemistry and math.** At first, I wanted to study

medicine and help people, particularly those affected by cancer. In my free time, I used to do simple experiments at home, and I even dreamed of studying whales and running a lab on a boat. That curiosity and excitement about discovery ultimately led me into the world of research.

**I think a big part of my success comes from being genuinely passionate** about research and naturally curious. Over the years, I've learned how to stay organised, multitask and troubleshoot when experiments don't go as

planned, which happens a lot in science.

**I love that my job doesn't really feel like a job.** I feel like I get paid to do my hobby. I'm fascinated by discovering how every cell has a very specific role, almost like it has a backup plan for every challenge it faces.

## Yuriko's top tip

Don't get too distracted — there's time for everything, but you need to stay focused.



**Gamaliel Sanchez-Orellana**  
Senior Research Associate

**As a teenager, I was interested in scientific topics and figuring out how things work,** but I was equally drawn to computers and technology. I remember taking apart and reassembling my PC when I was around 10 — I enjoyed problem-solving and spending time learning how systems functioned.

**Later on, I realised that I didn't have to choose between these interests.** Discovering bioinformatics allowed me to combine my interest in biology with computational tools and programming, which ultimately shaped my decision to pursue this career path.

**Attention to detail, persistence and a strong curiosity for science** have played an important role in my career. Research often involves working through complex data and unexpected results, and being patient and thorough has been essential. My training in bioinformatics and hands-on research experience have helped me approach challenging questions in renal immunology with a critical and analytical mindset.

**I enjoy knowing that my work contributes to a clear and meaningful goal.** My goal is to understand and ultimately improve the outcome of urinary tract infections. This purpose motivates me to keep improving my skills.

## Gamaliel's top tip

If you find an area that genuinely interests you, pursue it and don't be afraid to invest time in learning and improving.

# Chronic pain in teenagers: the risks of self-medicating with cannabis

Imagine developing pain somewhere in your body, which starts to affect your sleep, mood, energy levels, physical activity, anxiety and ability to concentrate. Despite doing your best to make it go away, it is still there months later. To what lengths would you go to stop it? At **Harvard Medical School** and the **Boston Children's Hospital** in the US, **Dr Joe Kossowsky** is investigating chronic pain in teenagers, and the methods they are using to manage it.



**Dr Joe Kossowsky**

Assistant Professor of Anaesthesia, Harvard Medical School; Director, Laboratory for Digital Assessment, Research, and Treatment (Dart Lab), Boston Children's Hospital, USA

## Fields of research

Paediatric pain; critical care; pain medicine; sleep medicine; clinical psychology; neuroscience; anaesthesia

## Research project

Studying the risks for teenagers self-medicating with cannabis to manage chronic pain

## Funders

US National Institutes of Health (NIH); National Institute of Drug Abuse (NIDA)

## Website

[research.childrenshospital.org/research-units/dart-lab-research](https://research.childrenshospital.org/research-units/dart-lab-research)

doi: 10.33424/FUTURUM685

“**A**pproximately one in five young people experience pain lasting longer than three months at a time,” says Dr Joe Kossowsky, Assistant Professor of Anaesthesia at Harvard Medical School and Director of the DART Lab at Boston Children's Hospital.

Talk like a ...

## paediatric pain researcher

**Cannabis** – a drug that can affect your brain and impact sleep, anxiety and energy levels

**Cannabis use disorder** – a problematic pattern of cannabis use that negatively impacts other areas of someone's life

**Chronic pain** – pain that lasts for longer than three months in one or more parts of the body

**Circadian** – recurring naturally on a 24-hour cycle

**Deep sleep** – an important and restorative stage of sleep where the body is truly relaxed

**Paediatrics** – the branch of medicine focused on children

**Self-medicate** – the use of drugs to treat a condition without a doctor's advice

**Wearable device** – an electronic device worn on the body or implanted, monitoring health data such as heart rate, blood oxygen levels or sleep

In teenagers, chronic conditions might include headaches, back pain, repeated migraines, nerve pain, stomach aches or fatigue. Unsurprisingly, these conditions can have significant impacts on someone's life, and dealing with them can be challenging. “In addition to physical limitations, chronic pain in adolescence is associated with school absences, social difficulties, depression, anxiety and reduced quality of life,” explains Joe. “Importantly, adolescent pain can also persist into adulthood, increasing the risk for long-term physical and mental health challenges.”

## Cannabis as pain relief

Joe is a paediatric pain researcher studying how teenagers try to manage chronic pain. Of the teenagers with chronic pain that Joe has worked with, almost a quarter use cannabis to self-medicate. “Among those, more than 75% report using it to treat physical or psychological symptoms,” he says.

Joe has found that teenagers' top three reasons for using cannabis are to alleviate their pain, reduce their anxiety and help them sleep. By combining daily smartphone questionnaires, wearable



© kasarp studio/Shutterstock.com

## Support information

(US) [adolescenthealth.org/resources/resources-for-adolescents-and-parents/substance-use-resources-for-adolescents-and-young-adults](https://adolescenthealth.org/resources/resources-for-adolescents-and-parents/substance-use-resources-for-adolescents-and-young-adults)

(UK) [youngminds.org.uk/young-person/coping-with-life/drugs-and-alcohol](https://youngminds.org.uk/young-person/coping-with-life/drugs-and-alcohol)

“If you are self-medicating to deal with pain, sleep problems, or anxiety, the most important thing you can do is talk to someone you trust (a parent, teacher, counsellor or general practitioner) so you can find approaches that truly work for you.” – Joe

devices and clinical data, Joe is investigating what impact this cannabis use is having on them.

### Data from technology

“Although clinical data from hospitals provide valuable information, this is only a snapshot of a patient’s health,” says Joe. “Often, little is known about what is happening to patients between visits.”

By using smartphones, teenagers in Joe’s study answer questions throughout the day, regarding their pain, mood, anxiety, fatigue and concentration, as well as when they have taken any substances. “This means we can examine how symptoms change hour-to-hour and day-to-day, which allows us to identify patterns over time. For example, whether poor sleep precedes increased pain or substance use the following day,” explains Joe. “It also gives teens the opportunity to contextualise their data, helping us better understand their lived experiences and, ultimately, inform more effective treatments.” For Joe and his team, it is important that there is no judgement in their work – they are collecting these valuable data to help the teenagers manage their pain, not to criticise them.

The team combines the smartphone surveys with real-time health data from wearable devices, such as Fitbits and sleep and heart rate monitors. This combination of data gives the team a complete picture of what the teenagers’ lives are like, and the real impacts of chronic pain and the substance they are using to self-medicate.

### Expectation versus reality

Joe’s findings show that although cannabis

can seem to help to begin with, it often makes issues worse in the long-term. “Cannabis may help teens fall asleep more quickly in the short-term, but it can reduce the amount of time spent in deep sleep, which is important for physical recovery, emotion regulation and memory consolidation,” says Joe. Compared to people who start using cannabis in adulthood, under 18-year-olds are also four to seven times more likely to develop cannabis use disorder through repeated cannabis use.

“One of our most important findings has been demonstrating how tightly interconnected sleep, pain, stress and functioning are during adolescence,” says Joe. “In a recent adolescent sample, we found that sleep quality explained 82% of the association between stress and school functioning and nearly 62% of the association between stress and pain.” This means that once someone starts sleeping badly, the effect that the resulting physical and mental stress has on their school performance and pain sensitivity might become much more significant. “Adolescents who use cannabis also report greater day-to-day functional impairment, suggesting that what feels helpful in the moment may contribute to longer-term challenges,” adds Joe.

### Better alternatives

Now that their initial research stage is done, Joe and his team are focusing on finding new ways for young people to manage chronic pain – alternatives that do not come with the harmful long-term effects of cannabis use. “We are developing prevention strategies grounded in cognitive-behavioural therapy, mindfulness-based stress reduction, and behavioural pain management,” says Joe. “Healthy coping

skills for stress and sleep may be the most effective prevention strategies for pain.”

Through their work with smartphones and wearables, the team has been able to find patterns showing when teens are more likely to turn to substance use, meaning that help can be provided at the right time. “When we detect these patterns, we aim to deliver brief, targeted digital interventions before teens fall into a pattern of using substances to cope,” says Joe.

### More to come

The team has also started exploring the role of circadian rhythms in pain, cannabis use and sleep. “Our bodies have an internal 24-hour clock, managed by the brain, which regulates sleep and alertness as well as mood, pain sensitivity and immune function,” explains Joe. “During the teen years, this clock naturally shifts later, resulting in later bedtimes.” However, the early start of a typical school day clashes with this shift in teenagers’ natural cycles, which can lead to them missing out on sleep. “Our next step is to develop interventions that target the circadian clock,” says Joe. “This is an exciting approach because circadian disruption may represent a shared biological pathway linking pain sensitivity, mood regulation and substance use risk.”

Combining different research angles, Joe and his team aim to provide accessible, personalised and ongoing support that is helpful in the long-term. “Our hope is that our work can help teens with pain get back to full, active and fulfilling lives,” says Joe.

# About *paediatric pain research*

**P**aediatric pain research is a field which looks to diagnose, manage and treat pain in adolescents, as well as to understand the impacts of health conditions on young people as they grow up. It falls within the larger category of anaesthetics – a medical field focused on pain management and pain relief.

Researchers in this field might work within community groups, schools, hospitals and laboratories. It is a collaborative field that involves a wide range of people working together to come up with the best solutions. “Paediatric pain research brings together psychologists, physicians, physical therapists, neuroscientists and data scientists, as well as experts in bioinformatics and digital health,” says Joe.

The interdisciplinary nature of the field makes it highly rewarding. “It is intellectually exciting to see how different perspectives fit together, and how we can work together to develop novel interventions and better understand why some teens develop persistent pain while others recover,” explains Joe. “At the same time, there are still many unanswered questions, both in how we assess paediatric pain and how we treat it effectively. The possibility that our research can directly inform better, more personalised interventions for teens with pain is incredibly meaningful.”

It is a very exciting time to enter paediatric pain research. “The next generation will have remarkable tools

at their disposal,” says Joe. “Wearable technologies and biosensors are evolving at tremendous speed, making it possible to continuously monitor not just sleep and activity, but also physiological signals like heart rate variability and skin conductance that may reflect pain and stress in real time.”

Machine learning and AI are providing new ways to find patterns in these large datasets that would have been impossible to detect even a decade ago. “Together with advances in genomics and digital therapeutics, the field is moving toward more personalised and precise treatments for individual patients,” says Joe.

## Pathway from school to *paediatric pain research*

Get a good grounding in biology, chemistry, physics and, if possible, psychology while in high school. Language skills are also important, as being able to communicate well with others is an important part of working as a paediatric pain researcher.

There are various ways to enter paediatric pain research, with degrees in psychology and neuroscience being common pathways. “Because paediatric pain is such a multidisciplinary field, many different subjects can be beneficial for a future career in pain research,” says Joe. “Some of these subjects include psychology, biology, medicine, neuroscience, occupational therapy, physical therapy, statistics and computer science.”

After obtaining a bachelor’s degree, you will need a master’s degree and PhD to work in research like Joe.

If you live in Boston or Massachusetts, Joe recommends applying for Harvard Medical School’s Project Success ([occe.hms.harvard.edu/paths-opportunity/project-success](https://occe.hms.harvard.edu/paths-opportunity/project-success)) or the AP Biology Hinton Scholars Program ([occe.hms.harvard.edu/paths-opportunity/ap-biology-hinton-scholars-program](https://occe.hms.harvard.edu/paths-opportunity/ap-biology-hinton-scholars-program)).

## Explore careers in *paediatric pain research*

“To get experience, explore summer research opportunities at children’s hospitals or university labs. Volunteering in a ‘child life programme’, which offers educational and emotional support to children and their families in paediatric hospitals, can provide a meaningful window into what patients and their families experience,” says Joe. The Boston Children hospital has internship programmes that Joe recommends: [jobs.bostonchildrens.org/working-at-childrens/internships/?addtln\\_categories%5b%5d=Internship](https://jobs.bostonchildrens.org/working-at-childrens/internships/?addtln_categories%5b%5d=Internship)

To explore the field, have a look at the International Association for the Study of Pain ([iasp-pain.org](https://iasp-pain.org)), which has a Paediatric Special Interest Group. “The International Symposium for Paediatric Pain ([childpain.org/index.php/symposium](https://childpain.org/index.php/symposium)) is also a very welcoming community,” Joe adds. The symposium is organised every two years, with the next event being in 2027.

“My Canadian colleagues have a wonderful programme ([kidsinpain.ca](https://kidsinpain.ca)), which is a great starting point for learning more about current thinking in pain research,” adds Joe.

# Meet some of the DART Lab team

Download the team's resources from [futurumcareers.com/chronic-pain-in-teenagers](https://futurumcareers.com/chronic-pain-in-teenagers)



**Nicole Tacugue**  
Study Coordinator

**Fields of research**  
Paediatric pain research;  
clinical psychology

**Growing up,** I always enjoyed art and graphic design. Cultivating a creative mindset taught me to consider how people receive and understand information in different formats.

**I majored in neuroscience and psychology in college,** where I quickly became fascinated with the realm of sleep while working as a lab volunteer. As a graduate student, I participated in an internship programme with Dr Kossowsky's lab.

**A rewarding part of my work as Study Coordinator** is explaining to young patients how their participation in our studies is helping to improve current knowledge and benefit others just like them. It's especially rewarding to see all our team's efforts culminate in publications and witness how participants' contributions are reflected in the findings. The most challenging aspect of research is accepting that meaningful change isn't immediate and takes time.

**My proudest career achievements thus far** are acting as first-author on my first publication and coordinating a workshop where I used my artistic background to teach students the importance of sleep in creative ways.

**To switch off from the pressures of work,** I intentionally spend my free time engaging in enjoyable activities that also reinforce my creative identity beyond the workplace. In the future, I aspire to attend medical school and apply what I've learnt in clinical research to improving patient care as a physician.

## Nicole's top tips

1. Always say yes to opportunities that interest you. Follow what excites you, even if those interests don't seem to connect. Your experiences will come together to form a unique skill set that can benefit you in unexpected ways.
2. Do not be afraid to start something before you feel ready.



**Dr Bridget Nestor**  
Research Fellow

**Field of research**  
Clinical psychology

**When I was younger,** I enjoyed my classes, but I didn't find a subject area I was particularly excited about until taking an introduction to psychology in my first year of college.

**My family always emphasised** the importance of finding work that contributed positively to society. Being a clinical psychologist is intellectually stimulating and provides an opportunity to support others, whether through research, teaching or clinical practice. My dad is also a clinical psychologist, so he inspired me, too!

**In our lab, I am involved in all aspects of our projects** from formulating research questions to analysing data, to writing up our results for publication. We use digital technologies, like Fitbits, for objective assessments of sleep and physical activity. We also use smartphones for real-time data from teens in their daily lives.

**Research can be difficult, tedious and slow-going,** but knowing that our work may be helpful for teens with various psychological and physical health challenges is certainly rewarding. I also really enjoy mentoring junior students/lab members as they learn about the research process.

**Having supportive relationships helps me** maintain a healthy work/life balance. I feel extremely grateful to work with and learn from such smart and kind colleagues (Dr Joe Kossowsky, Dr Camila Koike and Nicole Tacugue) – they make any challenges all the more bearable.

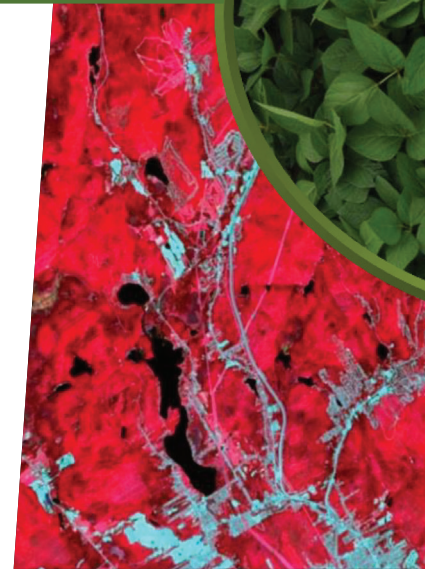
**I am proud of all the work we do together in our lab.** I hope to continue our research, with particular focus on novel sleep interventions for teens with chronic pain, as I think these could lead to real clinical benefit.

## Bridget's top tip

Be curious and find supportive colleagues and mentors.

# How can remote sensing make agriculture more sustainable?

Agriculture is essential for feeding the world's population. However, the land clearance, chemicals and intensive working of the soil that come with it can all cause significant damage to the environment. To make agriculture more sustainable, **Dr Angela Kross** from **Concordia University** in Canada, is investigating how remote sensing technologies can be used to monitor the environmental impacts of agriculture.



**Dr Angela Kross**

Department of Geography, Planning and Environment, Concordia University, Canada

## Fields of research

Remote sensing; environmental sciences; ecology; geography

## Research project

Advancing multi-sensor and multi-source data integration methods for improved characterisation and quantification of crop development and its impacts on the environment

## Funder

Natural Sciences and Engineering Research Council of Canada (NSERC) Discovery Grant number RGPIN-2023-05646

doi: 10.33424/FUTURUM675

**W**hen forests and wetlands are cleared for farming, wildlife habitats are lost, biodiversity declines and soils become more vulnerable to erosion. Agriculture damages water quality when chemicals wash into waterways, as pesticides kill organisms and fertilisers causes eutrophication which harms aquatic life. And poor soil management can lead to erosion and loss of stored carbon. Together, these pressures can seriously affect ecosystems and long-term food production.

“Agriculture is essential for food security and livelihoods,” says Dr Angela Kross, a remote sensing scientist at Concordia University who uses Earth

... Talk like a ...

## remote sensing researcher

**Eutrophication** — the process that occurs when too many nutrients enter the water (for example due to fertiliser being washed off fields), causing excessive algae growth that leads to a lack of oxygen in the water

**Reflectance value** — how much light is reflected from a surface

**Remote sensing** — the science of collecting information about Earth's surface, oceans and atmosphere from a distance,

typically using sensors on satellites, aircraft or drones

**Spectral signature** — the unique pattern of light that a material reflects or absorbs at different wavelengths

**Spectral vegetation index** — a mathematical value calculated from remotely sensed spectral data, which indicates vegetation properties such as health or density

observation technologies to study agricultural systems. “Agriculture is also one of the largest drivers of environmental change. It affects biodiversity, soils, water and climate, and is responsible for 10-12% of global anthropogenic greenhouse gas emissions. My research aims to make these impacts visible and measurable so they can be managed more effectively.”

## How does Angela analyse remote sensing images?

Remote sensing involves taking measurements from a distance, typically using satellites, aircraft or drones. Angela uses a mix of satellite

and field-based technologies to study vegetation and environmental properties at different scales. “Remote sensing technologies measure how the Earth's surface reflects sunlight in different wavelengths of the electromagnetic spectrum, such as visible light and near-infrared wavelengths,” explains Angela.

At the field scale, Angela collects data using drones equipped with red-green-blue cameras and thermal cameras. Red-green-blue cameras produce true-colour images by recording red, green and blue light, just like human eyes do. Thermal



Download Angela's resources from [futurumcareers.com/how-can-remote-sensing-make-agriculture-more-sustainable](https://futurumcareers.com/how-can-remote-sensing-make-agriculture-more-sustainable)



*Not just a pretty picture! From pixels to plant properties: Vegetation appears red in false-colour satellite images and spectral vegetation indices can be calculated from spectral signatures to determine plant health. © Angela Kross*

cameras measure infrared radiation and record temperature differences, which allows Angela to identify crop stress and wildfires. At the wider scale, Angela uses images collected by satellites.

To analyse the images produced by remote sensing cameras, Angela interprets patterns called spectral signatures. "Spectral signatures show how different surfaces, such as vegetation, soil or water, interact with sunlight by absorbing, reflecting or emitting energy across various wavelengths," she explains. "Each material has its own 'spectral fingerprint' in the electromagnetic spectrum, allowing me to identify what is on the ground and assess its condition. Interpreting these signatures allows me to monitor plant health and reveal information that would otherwise remain invisible to the human eye."

Spectral signatures guide the creation of colour composite images and the calculation of spectral vegetation indices. For example, in some false-colour satellite images, near-infrared light (which humans cannot see) is displayed as red. Healthy vegetation reflects a large amount of near-infrared radiation, so it appears bright red, making differences in plant health easy to visualise.

Spectral vegetation indices build on the same idea by converting the complex data from spectral signatures into simple numerical values. "This is done by mathematically combining reflectance values from specific parts of a spectral signature, usually wavelengths where the differences between healthy vegetation, stressed vegetation, soil or water are

most pronounced," Angela explains. The most well-known index is the normalised difference vegetation index (NDVI), which gives a simple score that indicates vegetation health based on how plants reflect red and near-infrared light. Healthy, leafy vegetation absorbs red light for photosynthesis and reflects near-infrared light, so NDVI values are high. In contrast, stressed, sparse or non-vegetated areas have low or negative NDVI values. NDVI is widely used by scientists but it has limitations, so many other indices have been developed to study different crops and environmental properties.

These indices are used as model inputs so satellite images can estimate real-world measurements of variables such as crop water content (an indicator of crop stress). "It's important that remote sensing models are validated with data from the ground," says Angela. "For example, we can develop models based on the relationship between spectral indices and chlorophyll concentration (an indicator of eutrophication) measured from water samples, then apply the validated model to satellite images to map chlorophyll concentration in lakes and locate areas contributing to nutrient runoff."

### How can remote sensing make agriculture more sustainable?

Remote sensing provides spatially and temporally continuous information on environmental variables affected by agricultural practices, such as biodiversity, water, soil and crop health. By transforming satellite observations into meaningful environmental indicators, remote sensing can provide large-scale estimates of

environmental conditions that would otherwise require extensive ground data collection. This makes it possible to identify areas of concern and guide management actions.

Beyond its practical value, the ability to reveal information that cannot be seen directly is one of the most powerful aspects of remote sensing. "I love how remote sensing makes the invisible visible!" says Angela. "Remote sensing reveals hidden patterns in plants, soils, water and whole ecosystems that our eyes could never detect alone. It is a constant reminder that the world around us is so much richer than what we can perceive with our senses." These hidden patterns provide clues about biodiversity, water pollution, plant health and soil conditions.

Angela believes that remote sensing technologies should be incorporated into agricultural environmental impact assessments so that farmers can monitor how agricultural practices are affecting the environment. "I want remote sensing to become a practical, accessible tool that helps align agricultural production, biodiversity conservation and climate goals, rather than treating them as competing objectives," says Angela. "Ultimately, I hope my research will help make agriculture more sustainable by giving farmers tailored information about where environmental risks (such as erosion hotspots and biodiversity conflict zones) are highest. I also hope remote sensing of environmental indicators will be integrated into routine monitoring and policy tools, such as agricultural environmental impact assessments, to improve the sustainability of agriculture."

# Forecasting frost to protect cranberry crops

Cranberries contribute a huge amount of money to North American economies, yet a single frosty night can destroy an entire crop in a matter of hours. Taking vital measures to protect cranberries from frost relies on being able to predict their stages of development and understanding when they are most vulnerable. At the **University of Massachusetts Amherst** in the US, **Dr Peter Jeranyama** is studying three predictive models to understand which is the most useful for helping growers protect their crops and continue providing the world with this superfood.



**Dr Peter Jeranyama**

Cranberry Station, Center for Agriculture, Food, and the Environment, University of Massachusetts Amherst, USA

## Field of research

Plant physiology

## Research paper

*Advancements in spring frost protection to sustain cranberry production in Massachusetts.*

Jeranyama P., Kennedy C. (2021)

doi: [10.1002/agj2.20928](https://doi.org/10.1002/agj2.20928)

## Funders

US Department of Agriculture's Agricultural Research Service (USDA ARS); Cape Cod Cranberry Growers Association (CCCCGA)

doi: [10.33424/FUTURUM672](https://doi.org/10.33424/FUTURUM672)

**C**ranberries are small, red berries, native to North America, that have a well-earned reputation as a superfood. "They are rich in antioxidants, phytochemicals and tannins, which promote gastrointestinal health and stave off diseases such as cancer," says Dr Peter Jeranyama from the University of Massachusetts Amherst. "The US and Canada produce the majority of the world's commercial cranberries, creating an industry worth over \$1 billion to North America."

Talk like a ...

## plant physiologist

**Dormancy** — a period when an organism stops growth and development to withstand harsh environmental conditions

**Exothermic** — a process or reaction that releases heat

**Growing degree days** — a measure of accumulated heat used to predict plant development over time

**Phenology** — the study of cyclic and seasonal patterns in nature

**Physiology** — the branch of biology that studies how organisms function, including their organs, cells and molecules

**Phytochemical** — naturally occurring chemicals found in plants

**Tannin** — a biomolecule found in plants

**Thermal** — related to heat

**Yield** — the amount of crops produced

However, ensuring a strong cranberry harvest is not always easy. Cranberries are susceptible to adverse weather conditions, in particular drought and frost. "The spring months can bring with them severe frost events, which can greatly impact the quantity and quality of yield," explains Peter. "Frost can destroy an entire season's harvest in a matter of a few hours." To address this, Peter is helping growers to track their crops' development and understand, in advance, when they need protection from frost.

## Physiology and phenology

To protect their crops from spring frosts, growers rely on a number of methods. "Approaches include wind turbines or blowers," says Peter. "The main approach, however, uses sprinkler irrigation." On frosty nights, water is applied to cranberry crops, where it freezes. Counterintuitively, the freezing of water is exothermic – it releases energy, in the form of heat – which warms the adjacent cranberries enough to prevent frost damage. "This is because the change of water from a liquid to a solid involves the



© Urban Nature/Shutterstock.com

breaking of hydrogen bonds,” says Peter. “The breaking of these bonds, which give ice its structure, releases energy.”

Interestingly, growers only need to provide frost protection once the weather begins to get warmer. Cranberry plants endure freezing winters without coming to harm, so why do they suddenly become vulnerable in the spring? “Warming temperatures in the spring stimulate cranberry buds to break dormancy and begin developing,” explains Peter. “At the same time, they lose their ability to withstand cold temperatures.” These effects are explored by phenologists who study how the changing seasons and other cycles stimulate changes in plants and animals’ physiologies.

### Growing degree days

So, growers have measures to protect against frost, but using these measures effectively relies upon being able to predict when cranberry buds have developed enough to need this protection. Doing this involves accurately tracking their crops’ phenology using mathematical models. “For the Massachusetts cranberry industry, most growers use the Franklin model, a frost forecasting model first developed in the 1940s,” says Peter. “However, many growers have questioned the usefulness of this model and are eager for a more robust and accurate approach.”

To help meet this need, Peter turned to thermal models – models that use temperature data to predict a crop’s growth, development and stress over time. “The main output of these models is the calculation of growing degree days

“

**Interestingly, growers only need to provide frost protection once the year begins to get warmer.**

”

(GDD),” says Peter. “GDD measures how many days throughout the year have been sufficiently warm enough for growth, which relates to development and vulnerability to frost.”

This is a way of quantifying phenology: when a cranberry plant has surpassed a certain GDD value, it is likely that its buds have broken dormancy and become vulnerable to frost. “For example, using one thermal model called the Dee model, we start monitoring for potential frost damage once 100 GDD has been reached,” says Peter. “We call this the critical GDD.” But for models to be useful, they need to closely mirror reality, and this was the focus of Peter’s investigations.

### The results are in

Peter compared the Dee model with two other models, which have different temperature thresholds for defining whether a day is a GDD or not, among other differences. “We verified these

models with actual bud samples that we examined under the microscope to determine their phenology,” explains Peter. “We found that for most years, all three models have a margin of error of one to three days around when the critical GDD has been achieved.” However, when it came to abnormal years with less predictable spring temperatures, one model – known as the Wisconsin complex model – was more accurate than the others.

Peter’s project also revealed a troubling finding: across 65 years of data, the critical GDD has been surpassed earlier and earlier in recent years. “This means that cranberry buds are developing earlier, which increases the risk of frost damage,” says Peter. “This is related to rising average air temperatures.” This is almost certainly an impact of climate change, which is disrupting the phenologies of countless species, both wild species and commercial crops that are important for human health.

Peter hopes that his research can help growers meet the challenges of a changing world. “Now, I’m working on improving spring frost forecasting in cranberries by combining field observations with machine learning techniques,” he says. “Our ability to develop good models depends on accurate data collection and curation, and analytical strength.”

Download Peter’s resources from [futurumcareers.com/forecasting-frost-to-protect-cranberry-crops](https://futurumcareers.com/forecasting-frost-to-protect-cranberry-crops)



# How can we use methane to make industries more sustainable?

Carbon dioxide and methane are highly potent greenhouse gases and are two of the leading drivers of climate change. However, through a process called dry reforming, we can combine carbon dioxide and methane to create 'syngas', which can be used to make fuels and plastics. Unfortunately, current dry reforming methods are inefficient and rely on fossil fuels. To address this, **Professor Akshat Tanksale** and his team at the **RECARB Hub** at **Monash University**, Australia, are designing a new reactor to improve efficiency and sustainability.



**Professor Akshat Tanksale**

Department of Chemical and Biological Engineering, Monash University;  
Deputy Director, ARC Research Hub for Carbon Utilisation and Recycling

## Fields of research

Chemical engineering; catalysis; carbon capture and utilisation

## Research project

Creating an electrified reactor to make syngas production more efficient and environmentally friendly

## Funders

Australian Research Council (ARC);  
Industry partners

doi: 10.33424/FUTURUM684

In order to mitigate the effects of climate change, we must rapidly reduce the levels of greenhouse gases in our atmosphere. Although carbon dioxide is the main driver of climate change, other greenhouse gases also contribute to the problem. For example, methane is responsible for around 30% of the rise in global temperatures since the Industrial Revolution of the 1800s.

Although methane is produced naturally by

Talk like a ...

## chemical engineer

**Biogas** — gaseous fuel, such as methane, produced by the fermentation of organic matter

**Catalyst** — a substance that increases the rate of a chemical reaction without undergoing permanent change itself

**Dry reforming** — a catalytic process that converts methane and carbon dioxide into syngas

**Global warming potential** — a measure of how much heat a greenhouse gas traps in the atmosphere

**Magnetic induction heating** — the use of an alternating magnetic field to generate heat within electrically conductive metals

**Syngas** — short for synthesis gas: a mixture of carbon monoxide and hydrogen, produced industrially

volcanoes and the decomposition of organic matter in wetlands, more than 60% of methane emissions into the atmosphere are caused by human activities such as cattle farming, waste management and fossil fuel extraction.

In contrast to carbon dioxide, which stays in our atmosphere for hundreds of years, methane tends to stick around for a much shorter period of time – about 12 years. Even so, methane can trap 80 times more heat than carbon dioxide over a 20-year period. Due to its short atmospheric

lifetime and high global warming potential, reducing methane emissions could be the quickest way to slow global warming.

This is what motivates Professor Akshat Tanksale and his team at the ARC Research Hub for Carbon Utilisation and Recycling (RECARB Hub) at Monash University. They are designing a new reactor that uses a process known as dry reforming to transform methane and carbon dioxide into useful products – mitigating climate change and providing valuable resources at the same time.



© Orange Dragoon Studio/Shutterstock.com

“In urban areas, methane produced from the decomposition of organic waste at landfill sites can be avoided by separating organic waste from solid waste at the source,” says Akshat. “The organic waste can then be sent to anaerobic digesters, oxygen-free tanks that use microorganisms to break down organic waste and produce biogas (a mixture of methane and carbon dioxide).” Likewise, in rural and farming areas, manure can be sent to anaerobic digesters to produce biogas. “The biogas can then be upgraded to syngas using the technology we have developed,” explains Akshat.

### Dry reforming

“When methane and carbon dioxide are heated together in the process of dry reforming, they react to form syngas, a mixture of hydrogen and carbon dioxide,” continues Akshat. Syngas is an incredibly valuable product that can be used to make fuels, plastics and a wide range of chemicals, and is already used in many industries. “So, instead of letting methane and carbon dioxide escape into the atmosphere and worsen climate change, we can reuse them as raw materials,” explains Akshat. “It’s recycling greenhouse gases into useful products, rather than throwing them away.”

Unfortunately, current dry reforming processes are inefficient and can do more harm than good in terms of climate change. “Dry reforming is typically carried out in large industrial reactors that are heated by burning fossil fuels,” says Akshat. “This creates a big problem: even

though you’re transforming greenhouse gases, you’re also producing more emissions just to keep the reactor hot.”

Current methods have other issues too. “The catalysts inside the reactors get damaged over time through the build-up of carbon, which stops them working properly,” explains Akshat. “Additionally, the heat inside these reactors is uneven, which wastes energy and shortens the system’s lifespan.” In theory, dry reforming is a great idea, but in practice, the process is inefficient and unsustainable.

### A new reactor

To turn dry reforming into a viable strategy for mitigating climate change, Akshat and his team have designed a new reactor that addresses the current inefficiencies. “We heat our reactor using electricity through a process called magnetic induction heating – similar to how induction stoves work,” says Akshat. “The electricity we use can be generated from renewable sources, such as solar and wind, which means that we can run this very hot chemical reaction without producing extra carbon emissions.”

“We also use carefully-designed, 3D-printed metal structures that sit inside the reactor,” says Akshat. “These structures allow for more even heating and gas flow, making the reaction faster, more efficient and more stable.” This also avoids carbon build-up on the catalysts, so the reactor can work for longer and with less wasted energy.

### Into industry

The team’s next goal is to test the

reactor under the conditions found in existing syngas industries. “This means it must be able to run for longer periods of time, produce higher quantities of syngas, and process gas mixtures that more closely resemble real-world sources such as biogas, which is produced by the fermentation of organic matter in waste systems, agriculture and landfills,” says Akshat. “We want to continue improving our reactor design so that it uses even less energy and works reliably for thousands of hours, not just in the lab, but as an important part of many different industries.”

Many industries, such as chemical, plastics and fuel manufacturing, already rely heavily on syngas, so the team’s new reactor will slot right in to their existing processes, meaning they can produce the same products with much lower emissions. “Our reactor is compact and modular, so companies could install it more easily than traditional systems,” explains Akshat. “It could even be placed near methane sources such as landfills and biogas plants, reducing transport and energy costs, allowing these industries to become more sustainable and save money at the same time.”

“Climate change is especially hard to tackle in these industries that rely on extremely high temperatures, but our work shows that even these processes can be powered by clean electricity,” continues Akshat. “This is not a golden bullet for climate change, but it would be a big step toward a cleaner industry and a more sustainable future.”

# About *methane reduction*

The field of methane reduction involves researching how to prevent or mitigate methane emissions into the atmosphere to minimise their contribution to global warming. “Research in methane reduction combines chemistry, engineering, materials science, energy systems and climate science,” says Akshat. “It’s a growing field with huge opportunities, giving young scientists and engineers a chance to be part of the global transition to a low-carbon future.”

Methane is a potent greenhouse gas, but it does not stay in the atmosphere as long as other gases, such as carbon dioxide. “This means that reducing methane emissions can have a fast and meaningful impact on climate change,” says Akshat.

“As a researcher, it’s incredibly motivating to consider that your work can make a real difference within just a few years.”

It is important to consider methane’s value as a resource, which can also help build the financial incentive to use it rather than lose it. “When we convert methane into fuels, chemicals or hydrogen, we’re solving an environmental challenge while supporting the industries people rely on,” says Akshat. “We have to think beyond the impact on the climate; if a system is too expensive, it won’t be used.”

However, even if the theory is sound, its application can be another matter. “Reactions are complex and involve high temperatures,” explains Akshat. “This

means that they require a lot of energy and put a lot of stress on the materials involved.” There is, therefore, a strong focus on designing systems to be efficient, durable and safe – not to mention collaborating with engineers and industry partners to ensure solutions work at scale.

There are plenty of exciting emerging technologies for the next generation of researchers to tackle. “Future researchers will work on electrified reactors, new catalysts, renewable energy integration and circular carbon technologies,” says Akshat. “They won’t just be studying climate change; they’ll be actively building the solutions.”

Download the team’s resources from [futurumcareers.com/how-can-we-use-methane-to-make-industries-more-sustainable](https://futurumcareers.com/how-can-we-use-methane-to-make-industries-more-sustainable)



## Pathway from school to *methane reduction*

Akshat says that studying chemistry, physics and mathematics is vital for entering the field of methane reduction. He also recommends studying environmental science, engineering or computer science if you have the opportunity to do so.

At university, relevant degree courses include chemical engineering, chemistry, materials science, environmental engineering, energy engineering and physics. Akshat also suggests learning coding, data science or modelling, which are becoming increasingly important in his field of research.

## Explore careers in *methane reduction*

The scope of careers related to methane reduction is broad. “Graduates can work as research scientists or engineers, designing cleaner reactors and catalysts,” says Akshat. “There are also roles in clean energy companies, chemical and fuel industries, climate tech start-ups, as well as policy and environmental regulation.”

Akshat recommends building a habit of learning beyond the classroom. He recommends exploring the websites of NASA ([science.nasa.gov/climate-change](https://science.nasa.gov/climate-change)), the International Energy Agency ([iea.org](https://iea.org)) and Our World in Data ([ourworldindata.org](https://ourworldindata.org)).

Akshat also recommends watching educational videos on YouTube. Some good channels to try include Kurzgesagt ([youtube.com/@kurzgesagt](https://youtube.com/@kurzgesagt)), Veritasium ([youtube.com/@veritasium](https://youtube.com/@veritasium)) and Real Engineering ([youtube.com/@RealEngineering](https://youtube.com/@RealEngineering)).

# Meet the team



**Dr Hamza Asmat**  
Research Fellow

**Growing up, I was fascinated by how energy and chemical systems work.** I loved experimenting and trying to understand the 'why' behind everyday processes. This curiosity led me to study chemical engineering, where

I could combine my interest in science with practical problem solving. Over time, I became more aware of the environmental challenges we face and saw the potential for technology to create meaningful change.

**This project formed the core of my PhD.** I developed the fundamental catalyst and reactor concepts for methane reduction through electrified reforming. I now continue this work as a postdoctoral researcher, leading its scale-up and optimisation.

**I love being involved in research that tackles the toughest challenges in energy transition.** And I enjoy collaborating with a talented team, learning from diverse perspectives and

collectively pushing the boundaries of what is possible.

**Outside of work, I spend time with my family.** We often go for walks or enjoy simple activities at home. I also find cooking and listening to music help me return to work feeling refreshed, motivated and balanced.

---

### **Hamza's top tip**

Be patient and persistent. Meaningful impact takes time but is incredibly rewarding.



**Ashwin Hatwar**  
3rd Year PhD student

**As a teenager, I was deeply interested in the problem of climate change – and the search for solutions.** I regularly took part in science exhibitions and presented models that demonstrated the science behind climate change. The sense of urgency, and

my curiosity about solutions, motivated me to pursue research focused on developing sustainable technologies.

**My role in this project is to develop and study this new type of reactor.** I focus on designing the reactor, selecting and testing catalysts, and understanding how heat and electricity can be used more effectively.

**Curiosity and persistence have been essential in my research.** Experiments often require patience and an ability to learn from failure. Adaptability and clear communication have also allowed me to work effectively with others and adjust when research takes unexpected directions.

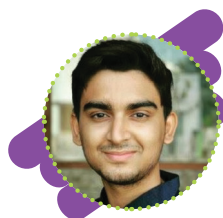
**I love feeling that my work connects directly to a global challenge.** Every experiment feels meaningful. I also enjoy the excitement of discovery – seeing an idea work in the lab and knowing it could one day make a real difference is incredibly rewarding.

**Outside of work, I like watching movies, going out with friends and cooking.** I stay active through sports like badminton and cycling, which help me clear my mind and recharge.

---

### **Ashwin's top tip**

Even small contributions matter. We can all be part of a global effort to create a more sustainable future.



**Mohammad Arfin**  
3rd Year PhD student

**Climate change is one of the defining challenges of our time.** Developing more sustainable chemical processes to help address this challenge feels both meaningful and rewarding. This has shaped my current work.

**In this project, I focus on developing scalable, electrified dry reforming processes.** While research shows the potential of these technologies, scaling them remains a major challenge. I help bridge that gap by focusing on real-world implementation strategies.

**Curiosity has been central to my research approach: always asking 'why' and 'how'.** Staying aware of the latest developments in the field is also important to help me identify ideas that are both innovative and practically achievable.

**This research brings a strong sense of purpose.** I love the idea of creating real 'impact

through research', and it is motivating to see our work steadily moving in that direction.

**I'm a family person.** I like staying connected with my family, but also value some moments alone to reset and recharge.

---

### **Arfin's top tip**

View challenges as learning opportunities to help build resilience and long-term confidence.

# Can lactic acid fermentation disinfect manure?

Cow manure is a valuable fertiliser but can also be a biohazard as it can contain harmful bacteria. It is important to kill off pathogens before manure is spread on fields, but disinfection at such a scale is not easy, and current methods have their drawbacks. At the **Friedrich Loeffler Institute** in Germany, microbiologist **Dr Hannah Halm** and veterinarian **Dr Sören Woelke** are testing whether lactic acid fermentation can disinfect manure, providing an effective new way of controlling pathogens.



**Dr Hannah Halm**



**Dr Sören Woelke**

Federal Research Institute for Animal Health,  
Friedrich Loeffler Institute, Germany

## Field of research

Microbiology

## Research project

Investigating lactic acid fermentation as a method to disinfect cow manure containing salmonella

## Funder

German Federal Ministry of Research,  
Technology and Space

doi: 10.33424/FUTURUM678

**S**almonella bacteria are not to be trifled with. They are one of the most common serious contaminants in foods, the most notorious example being in raw chicken. “In humans, common symptoms of salmonellosis include diarrhoea, fever, abdominal cramps and vomiting,” says Dr Hannah Halm, a microbiologist at the Friedrich Loeffler Institute.

 Talk like a ... **microbiologist**

**Anaerobic** — in the absence of oxygen

**Biogas** — a renewable source of gas, produced by fermenting organic waste

**Lactic acid** — an organic acid produced by various processes, such as metabolism and in muscles during strenuous (anaerobic) exercise

**Lactic acid bacteria (LAB)** — beneficial bacteria that ferment carbohydrates (including sugars) to make lactic acid

**Lactic acid fermentation** — an anaerobic metabolic process that converts carbohydrates (including sugars) into cellular energy and lactic acid

**Microbe** — a microscopic organism, such as a bacterium or virus

**Pathogen** — a harmful microbe

**Salmonella** — a group of harmful bacteria that causes salmonellosis disease

Other animals can also be infected by salmonella, and contaminated faeces are a primary way that the bacteria are spread. This is a problem for cow farming as, if an outbreak of salmonella occurs on a farm, all the manure produced by infected cows will be contaminated. Hannah and her colleague, veterinarian Dr Sören Woelke, are studying how other types of bacteria could be used to disinfect manure contaminated with salmonella, reducing disease risks for humans and livestock alike, and helping farms become safer and more efficient.

## Current disinfection methods

Methods to disinfect contaminated manure already exist, but none of them are ideal. Depending on the treatment, the manure can then be spread on fields in limited quantities as fertiliser, which returns valuable nutrients to the soil.

“Various chemicals, such as lime or caustic soda, can be added to manure to destroy bacteria,” says Sören. “However, these can lead to the release of dangerous gases like hydrogen sulphide.”



© Tatevosian Yana/Shutterstock.com

Manure can also be decontaminated by heating it in biogas facilities. The heat kills the pathogens, then the manure is broken down by microbes in various processes in the fermenter. At the end of this process, methane is produced, which is collected and used as fuel. However, this process relies on transporting the manure to a biogas facility, which creates opportunities for pathogens to spread.

A third option is simply to store the manure until the dangerous bacteria have died, at which point it can be used as fertiliser. But this takes between three and six months, and many farms do not have the space to safely store large quantities of manure for this long.

### LAB in the lab

Lactic acid is commonplace in biology. You may have come across it in human physiology, as a by-product of intense exercise, but it is also the product of an important group of microbes, known collectively as lactic acid bacteria (LAB). “LAB occur naturally in the guts of mammals, where they help with digestion,” says Hannah. “They are also used in food preservation, for instance to make pickles, sauerkraut and yoghurt.” LAB break down carbohydrates (including sugars) into lactic acid via the process of lactic acid fermentation.

Hannah and Sören wanted to investigate whether lactic acid fermentation can be used to disinfect contaminated manure through a process that can be easily undertaken on farms. “We used sucrose (regular household sugar), as an initial food for the bacteria to start fermentation, and oats, to provide longer-chain carbohydrates to keep the fermentation going,” says Hannah. “Our experiments were all performed under anaerobic conditions,

“  
**We found that lactic acid fermentation inactivated salmonella completely.**  
”

which LAB need to metabolise effectively.” They settled on oats for the carbohydrate source via trial-and-error. They first tried the process using hay, as it is more readily available on most farms, but fermentation was too slow. “Oats proved effective, and in theory any cereal should work just as well, though we need to test this,” says Sören.

Hannah and Sören prepared test tubes of cow manure mixed with specific amounts of sucrose and oats, then added salmonella bacteria (keeping some test tubes without salmonella as control samples) and put the test tubes in an incubator. They repeated the experiments with the incubator set to different temperatures to test the effect of temperature on fermentation.

### Top results

When the results came in, Hannah and Sören were astounded by their findings. “We expected that salmonella would be reduced in the samples, but we found that lactic acid fermentation inactivated salmonella completely,” says Hannah. “We were unable to detect salmonella at all.” The exact mechanisms by which this happens are still not totally clear. “We suspect it’s the combination of various processes, such as acidification of

the manure and the release of volatile fatty acids, that leads to this inactivation.” Hannah and Sören also discovered that fermentation (and, therefore, inactivation of salmonella) happens faster at warmer temperatures.

While the lab results were conclusive, it was then necessary to test the process at scale to make sure it was applicable for farms in the real world. “Our colleagues at the University of Hohenheim scaled up our experiments to the size of farm containers,” says Sören. “They showed that lactic acid fermentation also works at the farm scale.”

### From the lab to the farm

Lactic acid fermentation has several advantages over other methods currently used for disinfecting manure. It does not use dangerous chemicals or produce dangerous gases, it does not need transportation to a site off the farm, and the process is relatively quick, so the manure does not take up limited storage space for a long time.

Hannah and Sören are optimistic that this process could soon be rolled out in farms across Germany and beyond. “The implementation is relatively simple,” explains Hannah. “The manure is stored in a nearly airtight container and the carbohydrates are added. Then, it’s left alone.” Within a week, the pH should drop significantly (i.e., become more acidic). In warm conditions, the fermentation should be complete within four to six weeks, and the mixture should be salmonella-free. This process could help farms become much more efficient, helping farmers to produce food at a lower cost and through safer and more environmentally friendly means.

# About *microbiology*

**M**icrobiology is the study of microbes – microscopic organisms including bacteria, viruses, algae and amoebas. It is a broad and interdisciplinary field. “There are interactions with genetics, molecular biology, bioinformatics and molecular ecology, to name just a few,” says Sören, who combines his work as a veterinarian with microbiology research.

Careers in microbiology are diverse and varied. Hannah divides them roughly into ‘clean’ and ‘dirty’. “‘Clean’ microbiology is clinical microbiology,” she explains. “There are career possibilities in hospital

labs or university research labs as a biological scientist or technician. But if you prefer getting your hands dirty out in the field, I recommend environmental sciences. In addition to roles in universities, there are career possibilities in analytical labs and for environmental authorities.”

The working life of a microbiologist is also varied. “No day is like another,” says Hannah. “I might find myself taking samples in the lab, counting bacterial colonies or processing data.” There is a lot of collaboration as experiments are planned with colleagues, and results

are discussed to decide how they can be interpreted and what comes next. “Ideally, our results will be published as a paper or presented at a conference,” says Hannah. “Preparing for that involves a lot of time in front of the computer and drinking too much coffee!”

And, like any science, things don’t always go to plan. “Often, experiments don’t work the first time,” says Hannah. “You need a high tolerance for frustration. But once everything has worked out and results have emerged, you realise that all the hard work has paid off, and it’s a great feeling!”

Download the team’s resources from [futurumcareers.com/can-lactic-acid-fermentation-disinfect-manure](https://futurumcareers.com/can-lactic-acid-fermentation-disinfect-manure)



## Pathway from school to *microbiology*

At high school, Hannah recommends getting a good grounding in biology, chemistry (especially organic chemistry), maths (especially statistics) and physics.

“At university, I recommend studying what you are most interested in,” says Hannah. “Whichever topic you decide will become more interesting as you study it and explore the unknowns.” Useful degrees to consider include microbiology, biology, biochemistry, biomedical science and veterinary studies.

## Explore careers in *microbiology*

Most microbiology careers will involve working in a laboratory to study and analyse microbes, which could be in a hospital, veterinary clinic, university or other research institution.

The American Society for Microbiology gives a good overview of different careers in microbiology: [asm.org/articles/2018/november/careers-in-microbiology-and-the-microbial-sciences](https://asm.org/articles/2018/november/careers-in-microbiology-and-the-microbial-sciences)

The Friedrich Loeffler Institute, where Hannah and Sören work, offers internships and other opportunities for young academics: [fli.de/en/career/young-academics](https://fli.de/en/career/young-academics)



## Meet Hannah

**I've always had a lot of varied interests.** I've played the violin since I was eight and practised martial arts since I was seventeen. I watched a lot of animal documentaries when I was younger, and I've always had a strong interest in insects.

**In the school summer holidays, I attended a children's programme** at my local natural history museum. There, I looked in a microscope for the first time, and I realised that there were a lot of secrets in nature. I went on to study biology at university and became a marine biologist, focusing on algae.

**My PhD was about marine biogeochemistry and molecular ecology.** Defending my PhD was scary but also the happiest and proudest day of my life. Since then, I've studied microbiology of the deep biosphere (life below the Earth's surface), oncology (cancer research) and how to isolate bacteria from samples, gaining extensive methodological knowledge in the process, before finally landing in my current position. So you see, life paths do not have to be straight!

**Curiosity and fascination with the living world have always driven me.** When problems arise, persistence helps me find solutions. I like to think outside the box and enjoy listening to lectures from completely different fields, which helps keep me open-minded about other perspectives.

**In my free time, I like to make music and play sports.** I still play the violin in an orchestra, and I'm still fascinated by insects!

---

### Hannah's top tips

1. Always keep your eyes open and nurture your curiosity.
2. Stay persistent and never give up.
3. Make friends with statistics!



## Meet Sören

**I had lots of hobbies as a teenager.** I had lots of pets and was interested in aquariums and exotic animals. I played American football, which taught me about self-discipline and perseverance. And I enjoyed meeting up with friends after school to have fun.

**I went to university to study veterinary medicine** where I developed an interest in bovine (cow) medicine. Then, when I did an immunology internship during my studies, I decided I wanted to work in science as well. I gained extensive experience in the field of animal manure and microbiology, which has become a significant area of interest for me.

**The metaphor of the battle of David against Goliath** is particularly relevant to the remarkable way that a tiny microorganism can exert a substantial influence on an entire animal population. The COVID-19 pandemic also demonstrated the vulnerability of modern civilisation to microscopic pathogens.

**When I'm not working, I love spending time with my family.** I enjoy jogging to balance out my lab work, and gardening is a great way to feel grounded in what really matters.

---

### Sören's top tips

1. Be curious. Seeing the world through the inquisitive eyes of a child, whatever your age, is incredibly valuable.
2. Be honest. This can sometimes be a challenge, as nobody likes to admit mistakes. Start by being honest with yourself, and do what you believe in.
3. Don't commit yourself to plans for your entire future. You need to experience the world around you before you can identify your true interests.

# How to use our education and career resources

You will find a great range of free, inspiring research articles at [futurumcareers.com/articles](https://www.futurumcareers.com/articles)

**Learn** key terminology relating to the field



**Read** about fascinating research projects that are happening right now

**Meet** the people behind the research

**Explore** fields of research, and learn about future career opportunities



**Find** out how the researchers got to be where they are today

**Consider** different educational options

**Read** advice from inspiring people



## PowerPoints

Our PowerPoints summarise the articles and include reflective 'Talking Points', making them a fantastic classroom resource: [futurumcareers.com/ppts](https://www.futurumcareers.com/ppts)



## Animations

As part of our free package of education resources, we include animations that bring many of the research stories to life: [futurumcareers.com/animations](https://www.futurumcareers.com/animations)



## Podcasts

Featuring researchers talking candidly about their personal experiences, our podcasts are accessible, engaging and inspiring: [futurumcareers.com/stem-shape-podcasts](https://www.futurumcareers.com/stem-shape-podcasts)

# Keep in touch.

Thanks for reading Futurum. Did you know that all our articles and accompanying activity sheets, PowerPoints and animations are available online?

Visit our website: [futurumcareers.com](http://futurumcareers.com)

We regularly publish new articles, activity sheets, PowerPoints and animations. Keep up to date by signing up to our monthly newsletter:

[futurumcareers.com/sign-up](http://futurumcareers.com/sign-up)

## Contact the researchers in the articles



**Go to**  
[futurumcareers.com/articles](http://futurumcareers.com/articles)



**Select the article**  
and scroll to  
the bottom



**Type your question** in the  
comments field



**Click 'Notify me of follow-up comments via email'**



**Click 'Submit Comment'**



### Follow us

for updates on new instant articles, blogs and events:



#### Tell us what you think

We would LOVE to hear from you: send us a message through social media, comment on our articles or blogs, or send us an email: [info@futurumcareers.com](mailto:info@futurumcareers.com)



# Where Science Education Comes Together

Scientix<sup>®</sup> is the leading European community for science education, connecting teachers, researchers, policymakers, and industry to transform STEM learning for the 21st century.

- Access free, high-quality STEM teaching resources.
- Explore training, webinars, and online courses designed for teachers.
- Connect with peers across Europe through dedicated interest groups.
- Stay up to date with the latest science education trends.
- Discover projects, news, events, communities, and tools on the Scientix<sup>®</sup> portal.

[www.scientix.eu](http://www.scientix.eu)

