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Michael G. DeGroote
INSTITUTE FOR INFECTIOUS DISEASE RESEARCH

ANNUAL REPORT 2024

Report captures Jan. 1 to Dec. 31, 2023

Global Nexus

CP2H Canadian Pandemic Preparedness Hub

CMCB Centre for Microbial Chemical Biology

David Braley Centre for Antibiotic Discovery

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Report spans Jan. 1 to Dec. 31, 2023

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A Message from the Director

Matthew Miller


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My first full year as director of the Michael G. DeGroote Institute for Infectious Disease Research (IIDR) was a memorable one! Our Institute made landmark discoveries, secured important research funding, celebrated trainee successes, led major outreach activities, and grew considerably. Indeed, this past year was transformational for the Institute in every sense of the word.

Reflecting on this busy year of research, training, and outreach, a few stories stand out to me as particularly noteworthy. I want to highlight Jon Stokes' amazing AI-guided drug discovery research, which was named among the year's top scientific achievements by the *New York Times*. Likewise, I want to celebrate Jianping Xu's critical studies into the prevalence of drug-resistant fungi in remote environments and our institute's collaborative efforts on the continued development of the inhaled next-generation COVID-19 vaccine, which has now completed Phase I clinical trials and will begin Phase II this year.

It was my great pleasure to play a small role in two massive outreach events: IIDR Trainee Day and the Future of Vaccinology Symposium. Both events, held this past fall, brought together students, faculty, and staff from across our Institute, as well as key stakeholders from government, industry, and public health. My sincere thanks go out to the organizing committees of both of these wonderful events.

Finally, it has been a personal joy for me to watch the IIDR family grow over the past year. Vishal Soni joined our operations team as the IIDR's new manager of finance and administration, Larissa Viana was recruited as a new administrative assistant, and we welcomed Blake Dillon back to the mix as Communications Manager, balancing both the Global Nexus and IIDR portfolios. Special thanks to Angelina Lam, who filled the communications role with incredible skill and competence while Blake was working exclusively on the Global Nexus file. We also welcomed Ali Ashkar, Cameron Currie, Lindsay Kalan, Brian Lichty, James McNulty, Manali Mukherjee, and Anthony Rullo as new members, and Madoka Akimoto as a new research technician at the CMCB.

As you'll see in this report, we accomplished a lot this year. But pausing and reflecting on the past is only making me more excited for the future!

Matthew Miller
Director, IIDR

A Message from the Associate Director

Lori Burrows


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This past year was yet another in which the Michael G. DeGroote Institute for Infectious Disease Research (IIDR) made a range of important discoveries across an array of different research areas. From advancements in AI-guided drug discovery and vaccine development to landmark studies into phages, aptamers, and ancient DNA, our institute continued to define the cutting edge of infectious disease research.

Jon Stokes' discovery of a new antibiotic using AI was certainly a highlight for our group, as were Hendrik Poinar's fascinating studies into the origins of the Black Death plague. I'm also especially proud of the research that came out of my lab this year, some of which helped identify new vulnerabilities in drug-resistant bacteria. There's more on all of this — and other important research — later in this report.

Outside of the lab, I had the great pleasure of mentoring an amazing cohort of PhD students through our Braley Fellows Program. The six scholars enrolled in the program committed to studying antimicrobial resistance (AMR) from a diversity of perspectives, ranging from diagnosis and stewardship to policy and surveillance. Together, we met with leaders in AMR research and visited public health laboratories to see first-hand the AMR-related initiatives underway at the government level.

We also proudly continued our ID/IIDR Combined Rounds webinar series, which featured talks from 19 speakers representing 13 member labs. Additionally, Nathan Bahr from the University of Kansas delivered a special in-person Rounds talk — our first off Zoom in several years. These monthly lectures help foster connections between experts working in clinical settings and those working in basic research labs, and are well attended by trainees, faculty, and staff from across the McMaster community.

Finally, working alongside Matthew Miller through his first year as director of the IIDR has been an absolute delight. We, of course, miss Gerry Wright's sage leadership, but Matthew has done a masterful job of filling big shoes as he continues our founding director's mission. I'm looking forward to watching the institute grow with him at the helm.

Lori Burrows
Associate Director, IIDR

About the IIDR

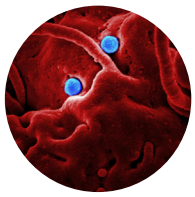
The Michael G. DeGroote Institute for Infectious Disease Research (IIDR) is a world-leading centre for transdisciplinary infectious disease research based at McMaster University.

Since its inception in 2007 — made possible by an unprecedented gift from our namesake Michael DeGroote — the IIDR has assembled a large team of scientists and trainees, all of whom are committed to delivering new knowledge and solutions to some of the most pressing challenges in infectious disease.

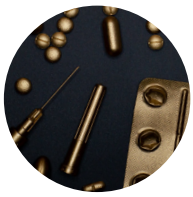
Members of the institute span a variety of disciplines, ranging from medicine and biochemistry to mathematics, anthropology, engineering, and beyond. Through collaborative research that spans the lab and the clinic, this interdisciplinary team is dedicated to finding new treatments and preventions to infections that have devastating impacts on health.

The breadth of research initiatives at the IIDR is large, reflecting the complexity of global challenges in infectious disease research and clinical practice; however, most activities fall into at least one of the following categories:

Microbial and Antimicrobial Research



Host-Pathogen Interaction Research



Research Into New Technologies and Health Products

In addition to world-class infectious disease research, the IIDR also facilitates in-lab training for hundreds of students and postdoctoral fellows at McMaster. The institute also conducts and participates in a broad range of important outreach activities, including events, webinars, digital communications, media appearances, EDI initiatives, and more.

2023
by the numbers

45
Member Scientists

400+
Peer-Reviewed Publications

53
Conference Proceedings

174
Conference Presentations

52
Postdoctoral Fellows Trained

152
Graduate Students Supervised

149
Undergraduate Students Supervised

9
Visiting Scholars Welcomed

104
Degrees Completed (UG & Grad)

15
Reports Developed for Partner Organizations

29
IP Disclosures

19
Patents

26
Licenses

Oversight & Support

The IIDR has long provided administrative oversight, strategic direction, and staff support for other infectious disease-related entities at McMaster. In 2023, Global Nexus and CP2H formally joined the mix, bringing new capacity to the institute.

The David Braley Centre for Antibiotic Discovery (DBCAD) is a research centre dedicated to developing meaningful solutions to the growing global threat of antimicrobial resistance (AMR). Scientists at the DBCAD are addressing AMR in the following ways: discovering new antibiotics, antibiotic adjuvants, and other antibiotic alternatives; developing diagnostic strategies that ensure the right drug is used for the right bug; improving clinical practices for human and animal health; minting lasting partnerships with relevant stakeholders from outside of academia; and providing training to next-gen researchers and medical practitioners.

The Centre for Microbial Chemical Biology (CMCB) is a state-of-the-art laboratory dedicated to providing research support, hands-on training, and services in chemistry and biology to faculty, staff, and external partners. The 7,000-square-foot biosafety level-2 lab boasts experienced staff and over 65 specialized pieces of equipment, enabling cell culture, assay development, high-throughput screening, small molecule synthesis, natural product isolation, and more. The CMCB also holds a cannabis analytics license from Health Canada, enabling research activities involving the identification and quantification of cannabinoids in a variety of matrices and products.

Global Nexus is a health innovation accelerator, where experts from academia, industry, government, public health, and communities work together on co-designed solutions to complex health challenges. At Global Nexus, key partnerships and infrastructure are leveraged to ensure important healthcare solutions like vaccines, diagnostics, technologies, and medications can move efficiently from discovery to society. This unique, collaborative hub is purpose-built to transform how the modern university serves society by creating a bigger impact beyond the academic sphere.

The Canadian Pandemic Preparedness Hub (CP2H), co-led by the University of Ottawa and McMaster University, is one of five research hubs established by the Canada Biomedical Research Fund (CBRF) and the Biosciences Research Infrastructure Fund (BRIF). The hub, established in 2023, is designed to bolster Canada's translation of novel biotherapeutic discoveries into new clinical products with commercialization potential. This unique collaboration between industry, academia, government, and healthcare will allow Canada to pivot more quickly in the face of future epidemics, pandemics, and outbreaks.

Our People

The Michael G. DeGroote Institute for Infectious Disease Research comprises an interdisciplinary team of expert staff, skilled laboratory technicians, and leading scientists. Our group has grown considerably over the past year — New indicates those who joined our team in (or around) 2023.

IIDR Staff

Name	Role	Contact
Matthew Miller	Scientific Director	mmiller@mcmaster.ca
Lori Burrows	Associate Director	burrowl@mcmaster.ca
New Vishal Soni	Manager, Finance and Administration	vishal.soni@mcmaster.ca
Laurel Person Mecca	Project Officer	personml@mcmaster.ca
New Larissa Viana	Administrative Assistant	gauchgol@mcmaster.ca
Blake Dillon	Strategic Communications Manager	dillonb@mcmaster.ca
New Angelina Lam	Marketing and Communications Associate	lama48@mcmaster.ca

Core Lab (CMCB) Staff

Name	Role	Contact
Tracey Campbell	Research Manager	campbtl@mcmaster.ca
Susan McCusker	Protein Lab Technician	smccus@mcmaster.ca
Cecilia Murphy	High-Throughput Screening Lab Technician	htstech@mcmaster.ca
Nicola Henriquez	Mass Spectrometry Technician	henriqn@mcmaster.ca
New Madoka Akimoto	Research Technician	akimotm@mcmaster.ca

Member Scientists

Name	Title	Home Department	Contact
Sara Andres	Assistant Professor	Biochemistry & Biomedical Sciences	andressn@mcmaster.ca
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Russell Bishop	Associate Professor	Biochemistry & Biomedical Sciences	bishopr@mcmaster.ca
Dawn Bowdish	Professor	Medicine	bowdish@mcmaster.ca
Eric Brown	Professor	Biochemistry & Biomedical Sciences	ebrown@mcmaster.ca
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Brian Coombes	Professor & Chair	Biochemistry & Biomedical Sciences	coombes@mcmaster.ca
New Cameron Currie	Professor	Biochemistry & Biomedical Sciences	curric7@mcmaster.ca

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Charu Kaushic	Professor	Medicine	kaushic@mcmaster.ca
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New Brian Lichty	Associate Professor	Medicine	lichtyb@mcmaster.ca
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Nathan Magarvey	Associate Professor	Biochemistry & Biomedical Sciences	magarv@mcmaster.ca
Jakob Magolan	Professor	Biochemistry & Biomedical Sciences	magolan@mcmaster.ca
Andrew McArthur	Professor	Biochemistry & Biomedical Sciences	mcarthua@mcmaster.ca
New James McNulty	Professor	Chemistry & Chemical Biology	jmcnult@mcmaster.ca
Dominik Mertz	Associate Professor	Medicine	mertzd@mcmaster.ca
Matthew Miller	Associate Professor	Biochemistry & Biomedical Sciences	mmiller@mcmaster.ca
Karen Mossman	Professor	Medicine	mossk@mcmaster.ca
New Manali Mukherjee	Assistant Professor	Medicine	mukherj@mcmaster.ca
Jeffrey Pernica	Associate Professor	Pediatrics	pernica@mcmaster.ca
Hendrik Poinar	Professor	Anthropology	poinarh@mcmaster.ca
New Anthony Rullo	Associate Professor	Medicine	rulloa@mcmaster.ca
Fiona Smaill	Professor	Medicine	smaill@mcmaster.ca
Marek Smieja	Professor	Medicine	smiejam@mcmaster.ca
Leyla Soleymani	Associate Professor	Engineering Physics	soleyml@mcmaster.ca
Jonathan Stokes	Assistant Professor	Biochemistry & Biomedical Sciences	stokesjm@mcmaster.ca
Michael Surette	Professor	Medicine	surette@mcmaster.ca
John Whitney	Associate Professor	Biochemistry & Biomedical Sciences	jwhitney@mcmaster.ca
Gerry Wright	Professor	Biochemistry & Biomedical Sciences	wrightge@mcmaster.ca
Zhou Xing	Professor	Medicine	xingz@mcmaster.ca
Jianping Xu	Professor	Biology	jpxu@mcmaster.ca
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Awards & Honours

The IIDR prides itself on the award-winning science happening everyday in its member labs. This year, members of our institute were recognized by McMaster leadership, by national and international scientific bodies, by leading media organizations, and by other relevant groups from across the world. Here's just a small sample of our 2023 awards and honours.

Two IIDR scientists honoured by the Canadian Society for Molecular Biosciences

Lori Burrows and John Whitney, members of the Michael G. DeGroote Institute for Infectious Disease Research, received prestigious Canadian Society for Molecular Biosciences (CSMB) awards for their unique research programs. Burrows received the Canadian Science Publishing Senior Investigator Award, which recognizes inclusive excellence in research, mentorship, leadership, and outreach, and Whitney received the CSMB New Investigator Award, which is awarded to early-career researchers who exhibit research and leadership excellence.

Brian Coombes elected as a fellow of the American Academy of Microbiology

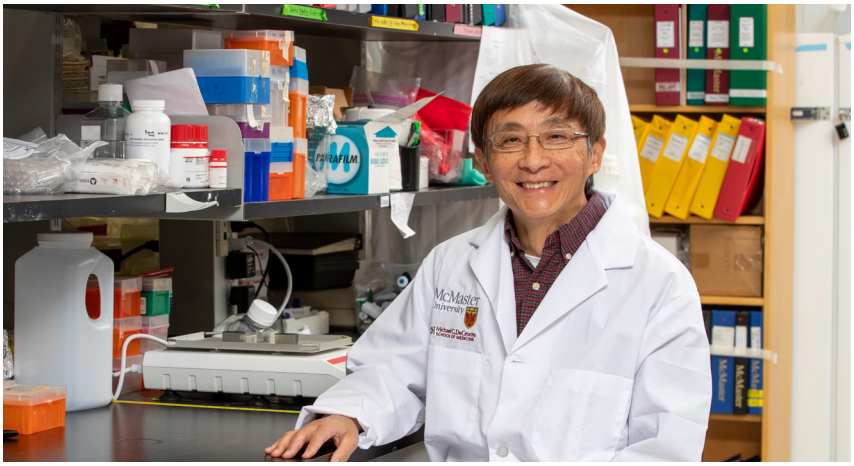
The American Academy of Microbiology (AAM) elected IIDR member Brian Coombes to its 2023 class of fellows. An honorific leadership group within the American Society for Microbiology, AAM fellows are elected annually through a highly selective, peer-review process based on records of scientific achievement and original contributions that have advanced the field of microbiology.

Lori Burrows wins CACMID's prestigious John G. FitzGerald Award

The Canadian Association for Clinical Microbiology and Infectious Diseases (CACMID) named IIDR member Lori Burrows the recipient of its 2023 John G. FitzGerald Award. Burrows was honoured for her lab's research into *Pseudomonas aeruginosa*, a ubiquitous drug-resistant pathogen that causes pneumonia and other hospital-acquired infections.

Jianping Xu awarded Faculty of Science Research Chair

IIDR member Jianping Xu has been named the Faculty of Science Research Chair in Understanding Fungal Threats to Humans. The annual peer-nominated and selected chair program recognizes research excellence by Science faculty at McMaster.

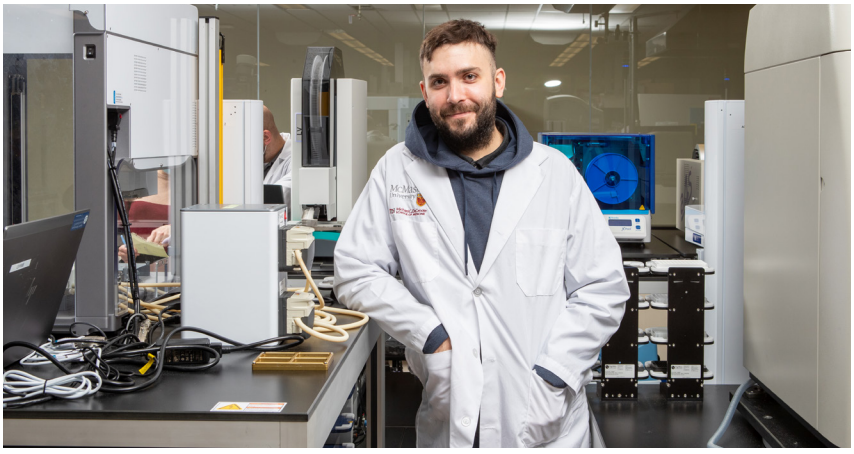


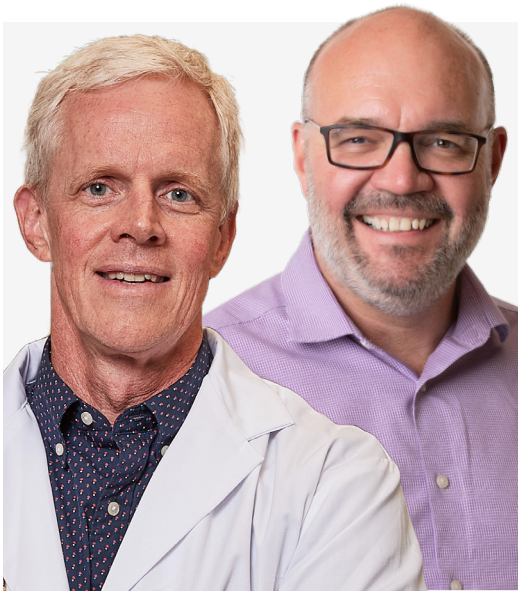
Zhou Xing wins prestigious immunology award for research into mucosal vaccines

The Canadian Society for Immunology (CSI) announced McMaster University's Zhou Xing as the 2023 recipient of its prestigious Hardy Cinader Award. Granted annually, the Cinader Award recognizes distinguished scientific leadership and accomplishments in the field of immunology and is the highest honour bestowed by the CSI. Xing, a professor of medicine and a member of the Michael G. DeGroote Institute for Infectious Disease Research, was honoured for his renowned immunology research program, which focuses on respiratory mucosal immunity, infectious diseases, and vaccine development.

Stokes Lab antibiotic discovery ranked among best of 2023 by *The New York Times*

Jonathan Stokes' use of artificial intelligence to identify a new antibiotic with activity against the superbug *Acinetobacter baumannii* was heralded as one of the most important scientific and technological advances of the year by *The New York Times*.





Two IIDR members named to list of world's most influential researchers

IIDR members Eric Brown and Gerry Wright were added to the Clarivate Analytics list of Highly Cited Researchers. This list recognizes the most influential researchers at universities, research institutes, and commercial organizations around the world. Inclusion on the list is determined by the amount of "Highly Cited Papers" they have published, which are defined as publications that rank in the top one per cent of citations in the researcher's field over the past decade. These papers then face qualitative analysis and expert judgement to determine their standing. Overall, Highly Cited Researchers account for 1 in every 1,000 scholars globally.

Eric Brown elected Fellow of the Royal Society of Canada

IIDR member Eric Brown was named a fellow of the Royal Society of Canada. Brown was elected for his national and international leadership in the fields of drug discovery, antibiotic resistance expertise, and biomedical research.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Michael G. DeGroote
INSTITUTE FOR INFECTIOUS DISEASE RESEARCH

RESEARCH

Curiosity. Discovery. Innovation.

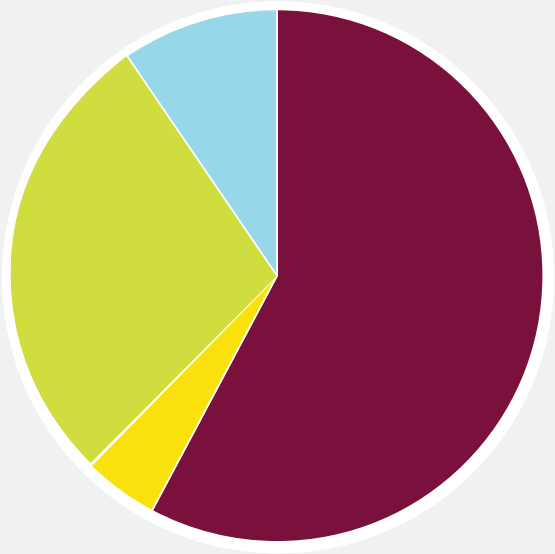
2023 Research Funding Highlights

Research at the IIDR is fuelled by a vast network of funding partners from industry, government, academia, not-for-profit, and beyond. Their collective support enables a range of important studies that help keep McMaster University at the forefront of infectious disease research. In total, the IIDR had 47 new research projects funded by external funding bodies in 2023. Here, we highlight select grants and the research that they powered.

Top-10 IIDR Member-Earned Grants by Dollars Received in 2023

Lead PI	Funding Body	Research Area	Amount
Leyla Soleymani	MITACS	Rapid diagnostics for viral and bacterial bugs	$1,655,000
Yingfu Li	Weston Family Foundation	DNAzyme tech for clinical diagnostics	$1,272,000
Alexander Hynes	Weston Family Foundation	Training the microbiome	$993,464
Gerry Wright	CIHR	Antibiotic resistance	$956,250
Gerry Wright	CIHR	Microbial natural products	$956,250
Eric Brown	CIHR	Harnessing bacterial membrane potential	$891,225
Dawn Bowdish	CIHR	Gut microbiome's impact on aging and frailty	$856,800
Jonathan Stokes	CIHR	Generative AI for antibiotic discovery	$841,500
Dawn Bowdish	CIHR	Chronic inflammation from respiratory infections	$750,000
Nathan Magarvey	Bill & Melinda Gates Foundation	Malaria and tuberculosis	$680,882

Total NEW Funding in the Past Year: **$16,542,659**



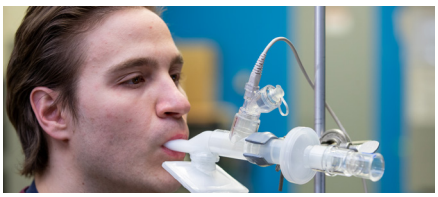
Funding Source

- Government
- Partner Institution
- Industry
- Charity & Non-Profit

Additionally, the IIDR received **$34,318,382** in renewed grants this year, for a total of **$50,861,041**.

$8M in CIHR funding will power vaccine clinical trials

IIDR researchers Zhou Xing, Matthew Miller, Fiona Smaill, and Brian Lichty received more than $8 million in funding from the Canadian Institutes for Health Research (CIHR) to help move their made-at-McMaster inhaled COVID-19 vaccine to Phase-II clinical trials. Learn more about this exciting grant on page 20.



Feds Bring Pandemic Hub to Mac

Through the IIDR and Global Nexus, McMaster University has taken a leading role in a new federal initiative designed to protect Canadians against future pandemics and infectious disease outbreaks. McMaster and the University of Ottawa are co-leading the Canadian Pandemic Preparedness Hub (CP2H), one of five new research groups funded by the Canada Biomedical Research Fund (CBRF) and the Biosciences Research Infrastructure Fund (BRIF).

Co-led by McMaster and the University of Ottawa, CP2H is part of a $10 million federal investment. The multidisciplinary research hub will accelerate the research and development of next-gen vaccines, therapeutics, and diagnostics, and also support their commercialization. The new hub will also work to develop the next generation of skilled talent.

CP2H brings together more than 45 strategic partners from academia, industry, non-profit, and governmental agencies from across the country to ensure Canadian discoveries are turned into the medicines of tomorrow in a cost-effective and timely fashion.

Its lead scientists are "academic entrepreneurs" who have organized national team projects and have led the design, building, and acquisition of the specialized infrastructure that is key to the hub's success.

Karen Mossman, McMaster's vice-president, research and a member of the IIDR, says McMaster is already on the leading-edge of infectious disease-related research, so the new hub will be right at home at the university.

"We're perfectly positioned to co-lead this initiative and work with our industry and academic partners to support both Canada's and Ontario's life sciences strategy, expand our innovation ecosystem, and bridge the gap between lab and market," she says.

Mossman will chair the hub's executive committee, while Matthew Miller, director of both the IIDR and Global Nexus at McMaster, will serve as CP2H's inaugural co-scientific director.

Sylvain Charbonneau, the University of Ottawa's vice-president, research and innovation, said their team is very eager to actively contribute to this ground-breaking national effort to grow a strong and competitive biomanufacturing and life sciences sector.

"The ultimate goal is to make Canada a global leader in emerging vaccines, therapeutics, and diagnostics, enhancing the national capacity to prevent and respond to future pandemics," said Charbonneau.

The government has also announced additional funds earmarked for cutting-edge research, talent development, and research infrastructure projects associated with the new research hubs.

IIDR & DBCAD Seed Funding Program

Every year, the IIDR actively supports member research by granting seed funding to new collaborations and high-risk projects. Each project is given $50,000 per year for up to two years. Eligible projects fall under the overarching themes of anti-infective innovation, diagnostics, or laboratory/clinical collaboration. Projects related to antimicrobial resistance are similarly granted $50,000 per year for up to two years, but those funds are provided by the David Braley Centre for Antibiotic Discovery. Together, this seed funding is designed to get new ideas off the ground, so that members can generate the preliminary data and evidence needed to procure additional funding from other agencies. In 2023, the following projects were funded or had funding renewed.

Recipients: Marek Smieja and colleagues

Project Title: Prevalence of Sexually Transmitted Infections in the Hamilton Shelter Health Network

Funder: Michael G. DeGroote Institute for Infectious Disease Research

Recipients: Lori Burrows and Eric Brown

Project Title: Profiling the potential for resistance to the novel Trojan Horse monobactam MLEB-22043

Funder: David Braley Centre for Antibiotic Discovery

Recipients: Dawn Bowdish and colleagues

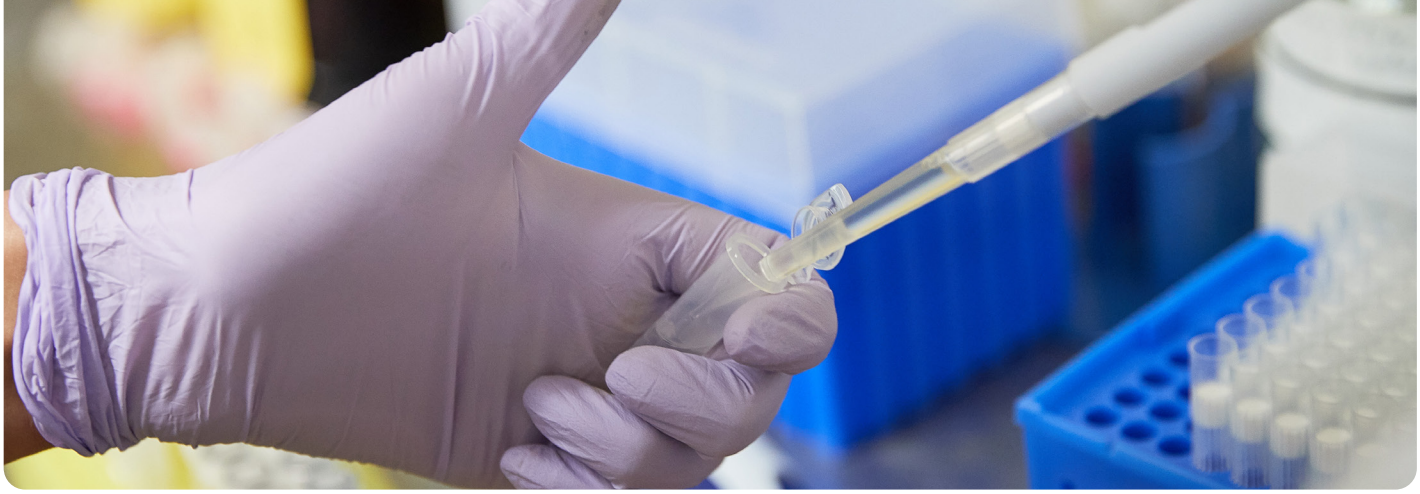
Project Title: Post-pneumonia sequalae in older adults due to impaired resolution of inflammation

Funder: Michael G. DeGroote Institute for Infectious Disease Research

Recipients: Sara Andres and Jonathan Stokes

Project Title: Designing inhibitors with machine learning for *Pseudomonas aeruginosa* DNA repair proteins

Funder: David Braley Centre for Antibiotic Discovery



Recipients: Lesley MacNeil, Gerry Wright, and colleagues

Project Title: Worming our way out of resistance: Discovering new drug candidates for helminths

Funder: David Braley Centre for Antibiotic Discovery

Recipients: Lori Burrows and colleagues [renewed from 2022]

Project Title: High-throughput phage purification strategies to enable human phage therapy

Funder: Michael G. DeGroote Institute for Infectious Disease Research

Recipients: Jon Stokes, Jakob Magolan, and Brian Coombes [renewed from 2022]

Project Title: Deep Learning-Guided Narrow-Spectrum Antibiotic Discovery

Funder: David Braley Centre for Antibiotic Discovery

Recipients: Gerry Wright and Jakob Magolan [renewed from 2022]

Project Title: Chemical Tools for Rapid Point-of-Care Diagnosis of AMR

Funder: David Braley Centre for Antibiotic Discovery

2023'S TOP RESEARCH STORIES

Scientists use AI to find promising new antibiotic that fights evasive hospital superbug

By Michelle Donovan

Scientists at McMaster University and the Massachusetts Institute of Technology have used artificial intelligence to discover a new antibiotic that could be used to fight a deadly, drug-resistant pathogen that strikes vulnerable hospital patients.

The process they used could also speed the discovery of other antibiotics to treat many other challenging bacteria.

The researchers were responding to the urgent need for new drugs to treat *Acinetobacter baumannii*, identified by the World Health Organization as one of the world's most dangerous antibiotic-resistant bacteria. Notoriously difficult to eradicate, *A. baumannii* can cause pneumonia, meningitis and infect wounds, all of which can lead to death.

A. baumanni is usually found in hospital settings, where it can survive on surfaces for long periods. The pathogen is able to pick up DNA from other species of bacteria in its environment, including antibiotic-resistance genes.

In the study, published in the journal *Nature Chemical Biology*, researchers used an artificial intelligence algorithm to predict new structural classes of antibacterial molecules, and identified a new antibacterial compound, which they named abaucin.

Discovering new antibiotics against *A. baumannii* through conventional screening has been challenging. Traditional methods are time-consuming, costly, and limited in scope.

Modern algorithmic approaches can access hundreds of millions, possibly billions, of molecules with antibacterial properties.

"This work validates the benefits of machine learning in the search for new antibiotics," says Jonathan Stokes, lead

Published in *Nature Chemical Biology*


nature chemical biology

Article

https://doi.org/10.1038/s41589-023-01349-8

Deep learning-guided discovery of an antibiotic targeting *Acinetobacter baumannii*

Received: 25 March 2022

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Check for updates

Gary Liu[1,10], Denise B. Catacutan[1,10], Khushi Rathod[1,10], Kyle Swanson[2], Wengong Jin[2], Jody C. Mohammed[3], Anush Chiappino-Pepe[1,4], Saad A. Syed[5], Meghan Fragis[1], Kenneth Rachwalski[1], Jakob Magolan[1] ✉, Michael G. Surette[5], Brian K. Coombes[1], Tommi Jaakkola[2], Regina Barzilay[2,6], James J. Collins[1,6,7,8,9] ✉ & Jonathan M. Stokes[1] ✉

Acinetobacter baumannii is a nosocomial Gram-negative pathogen that often displays multidrug resistance. Discovering new antibiotics against *A. baumannii* has proven challenging through conventional screening approaches. Fortunately, machine learning methods allow for the rapid exploration of chemical space, increasing the probability of discovering new antibacterial molecules. Here we screened ~7,500 molecules for those that inhibited the growth of *A. baumannii* in vitro. We trained a neural network with this growth inhibition dataset and performed in silico predictions for structurally new molecules with activity against *A. baumannii*. Through this approach, we discovered abaucin, an antibacterial compound with narrow-spectrum activity against *A. baumannii*. Further investigations revealed that abaucin perturbs lipoprotein trafficking through a mechanism involving LolE. Moreover, abaucin could control an *A. baumannii* infection in a mouse wound model. This work highlights the utility of machine learning in antibiotic discovery and describes a promising lead with targeted activity against a challenging Gram-negative pathogen.

Acinetobacter baumannii is a nosocomial Gram-negative pathogen that often displays multidrug resistance due to its robust outer membrane and its ability to acquire and retain extracellular DNA[1] that frequently encodes antibiotic resistance genes. Moreover, it can survive for prolonged durations on surfaces and is resistant to desiccation. Discovering fundamentally new antibiotics against *A. baumannii* has proven challenging through conventional screening approaches. Indeed, most new antibiotics that achieve clinical use are analogs of existing classes[2]. However, while structural analogs of existing antibiotic classes may satisfy short-term clinical needs, their long-term efficacy is inherently

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This research was published in *Nature Chemical Biology*, a top peer-reviewed journal in the area of biochemistry and molecular biology. The study, led by IIDR member Jon Stokes, also features IIDR members Jakob Magolan, Michael Surette, and Brian Coombes as collaborators.

author on the paper and an assistant professor in McMaster's Department of Biochemistry and Biomedical Sciences.

Stokes conducted the work with James J. Collins, a professor of medical engineering and science at MIT, and McMaster graduate students Gary Liu and Denise Catacutan.

"Using AI, we can rapidly explore vast regions of chemical space, significantly increasing the chances of discovering fundamentally new antibacterial molecules," says Stokes, who works through the Michael G. DeGroote Institute for Infectious Disease Research and McMaster's Global Nexus.

"AI approaches to drug discovery are here to stay and will continue to be refined," says Collins, Life Sciences faculty lead at the MIT Abdul Latif Jameel Clinic for Machine Learning in Health. "We know algorithmic models work, now it's a matter of widely adopting these methods to discover new antibiotics more efficiently and less expensively."

Abaucin is especially promising, the researchers report, because it only targets *A. baumannii*, meaning bacteria are less likely to rapidly develop resistance to it. The findings could also lead to more precise and effective treatment options.

Most antibiotics are broad spectrum in nature, meaning they kill all bacteria, disrupting the gut microbiome, which opens the door to a host of serious infections, including *C. difficile*.

"We know that broad-spectrum antibiotics are suboptimal and that pathogens have the ability to evolve and adjust to every trick that we throw at them," says Stokes. "AI methods afford us the opportunity to vastly increase the rate at which we discover new antibiotics, and allow us to do it at a reduced cost. This is an important avenue of exploration for new antibiotic drugs."

2023'S TOP RESEARCH STORIES

Drug-resistant fungi thrive in even the most remote regions of Earth

By Blake Dillon

A disease-causing fungus — collected from one of the most remote regions in the world — is resistant to a common antifungal medicine used to treat infections, new McMaster research finds.

Seven per cent of *Aspergillus fumigatus* samples collected from the Three Parallel Rivers region in Yunnan, China were drug resistant, showed the study, which was published in the journal *mSphere*.

Perched 6,000 metres above sea level and guarded by the staggering glaciated peaks of the Eastern Himalayas, the region is sparsely populated and undeveloped, which makes the presence of antimicrobial-resistant strains of *A. fumigatus* all the more striking for Jianping Xu, who led the study with colleagues in China.

"Seven per cent may seem like only a small number, but these drug-resistant strains are capable of propagating very quickly and taking over local and regional populations of this species," explains Xu, a professor of biology at McMaster and a member of the Michael G. DeGroote Institute for Infectious Disease Research. "There is a need for increased surveillance of drug resistance in the environment across diverse geographic regions."

This study is the third in a trio of related studies by Xu and colleagues. The first found that approximately 80 per cent of *A. fumigatus* samples from Yunnan greenhouses were resistant to commonly used antifungal drugs; the second study determined that around 15 per cent of samples from Yunnan agricultural fields, lake sediments, and forests were likewise resistant.

While there is increasing evidence supporting the natural development of resistance in the environment, the outward gradation of resistance from greenhouses indicates that these resistant Himalayan strains of *A. fumigatus* were likely born from the spores of other fungi that were overexposed to agricultural fungicides in other settings, says Xu.

That these drug-resistant spores could potentially travel to and propagate in such remote areas is concerning for global spread, says Xu, whose research supports activities at McMaster's Global Nexus.

"This fungus is highly ubiquitous — it's around us all the time," he explains. "It is estimated that we all inhale hundreds of spores of this species every day. While it doesn't always cause noticeable health problems, three to four million people experience disease symptoms caused by *A. fumigatus* each year.

"This fungi can be very dangerous — it can lead to lung removal or even death — and now, increasingly, many of these infections will be impacted by drug resistance."

In his other research, Xu has already examined identical mechanisms of resistance in strains of fungi found in Canada's Northwest Territories and India — some 10,000 kilometres apart.

"Unlike viruses like COVID-19, fungi don't need a host to spread," Xu explains. "They can travel on humans, through trade, and even on strong winds."

With that in mind, Xu has since returned to the mountainous regions of China to sample the air for fungal spores, which he hopes will add clarity to how these resistant strains are reaching and growing in such remote regions.

2023'S TOP RESEARCH STORIES

New inhaled COVID-19 vaccine receives more than $8M as it enters next stage of human trials

By Michelle Donovan

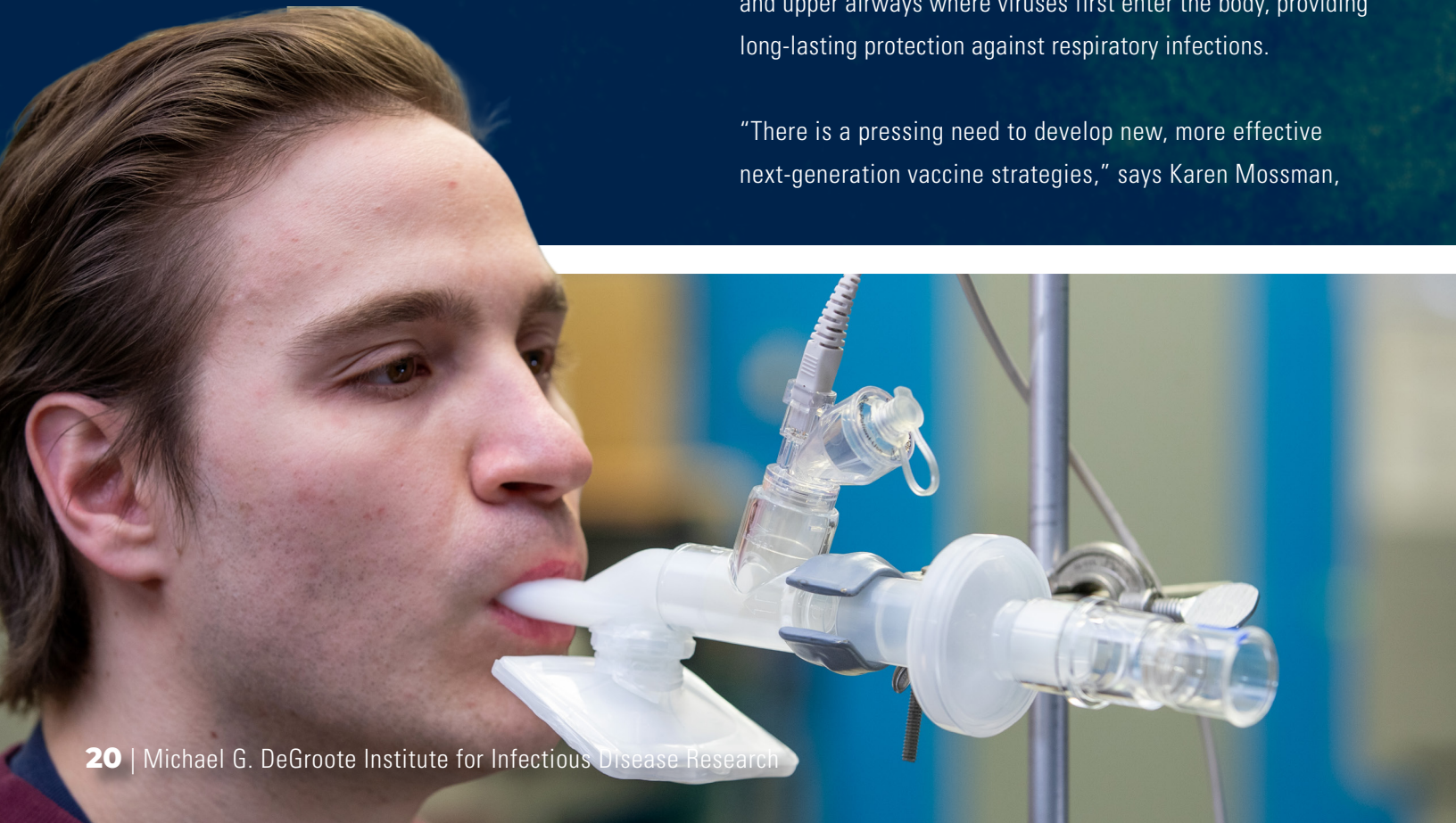
Researchers at McMaster University have received more than $8 million in funding from the Canadian Institutes for Health Research (CIHR), enabling them to proceed with Phase-2 human trials for a next-generation, aerosol-borne COVID-19 vaccine.

Filomena Tassi, MP for Hamilton West-Ancaster-Dundas and minister responsible for the Federal Economic Development Agency for Southern Ontario, made the announcement at McMaster, as part of CIHR's Clinical Trials funding initiative, involving seven projects at the university.

The new inhaled vaccine, with the potential to induce robust mucosal immunity against strains of SARS-CoV-2, including Omicron and other variants of concern, is entirely Canadian-made, from design and biomanufacturing at McMaster's Robert E. Fitzhenry Vector Lab to pre-clinical and clinical testing conducted by a team of experts in infectious disease and immunology.

Pre-clinical trials have shown that the inhaled aerosol vaccine is far more effective at inducing protective immune responses than traditional injections, partly because it targets the lungs and upper airways where viruses first enter the body, providing long-lasting protection against respiratory infections.

"There is a pressing need to develop new, more effective next-generation vaccine strategies," says Karen Mossman,



McMaster's Vice-President, Research. "As international leaders in respiratory mucosal immunity and vaccines, our researchers pivoted quickly with the arrival of the COVID-19 pandemic, drawing on an already strong inhaled vaccine research program focused on tuberculosis."

During Phase 1 of the trials, researchers are evaluating safety and dose levels of the inhaled vaccine in 30 healthy volunteers, who have received at least two doses of an mRNA vaccine.

A large Phase 2 study will further evaluate safety and immune responses and is expected to begin in the coming months. It will involve up to 500 participants who have received at least three doses of a mRNA vaccine and include those who are older, have other health conditions, and may have a prior history of COVID infection.

"If we can show the new inhaled vaccine is safe and effective, as we anticipate, the impact will be significant for human health, medical costs and better quality of life," says Fiona Smaill, professor emerita in the department of Pathology and Molecular Medicine.

Smaill is leading the trials with colleagues Matthew Miller, Scientific Director of the Michael G. DeGroote Institute for Infectious Disease Research; Zhou Xing, a professor of medicine; and Brian Lichty, an associate professor of medicine. Together, they are working with collaborators at Dalhousie University and the University of Ottawa.

The work is a critical part of the mission of Global Nexus, a health innovation accelerator based at McMaster.

"The current vaccination strategy for COVID-19 has us constantly chasing the virus, and it's clear that we simply can't keep up," says Miller. "Our team has developed a vaccine strategy aimed at circumventing this cycle and the need to constantly update these vaccines by targeting parts of the virus that are resistant to mutation, and inducing strong immunity at the site where infection actually occurs."

Researchers are concerned about the declining uptake of booster vaccines, which is part of broader pandemic fatigue, and they anticipate a no-needle, pain-free vaccine will be much more appealing and convenient.

The new vaccine strategy will position Canada at the forefront for facing new stages of the current pandemic and preparing for the next pandemic, while advancing our understanding of new inhaled vaccines against other infections, such as tuberculosis and influenza, they say.

CIHR's Clinical Trials Fund is designed to reinforce Canada's clinical trials ecosystem from discovery to implementation.

2023'S TOP RESEARCH STORIES

McMaster researchers discover new way of creating protection against infections like COVID-19

By Adam Ward

An exciting therapeutic discovery involving synthetic aptamers being worked on by researchers at McMaster University is showing promise in protecting against viral infections like COVID-19.

McMaster researchers Matthew Miller and Yingfu Li, along with a team of scientists, have been conducting experiments with synthetic aptamers. These aptamers are made up of DNA — genetic material — that can be fashioned to stick to various targets, much like antibodies. One of the aptamers Li created is able to bind to all variants of SARS-CoV-2, the virus that causes COVID-19. This aptamer was then handed over to Miller's team who wanted to see if it could block the virus from infecting cells.

"What we actually found is amazing," says Li, a professor in McMaster's Department of Biochemistry and Biomedical Sciences. Li directs a lab at McMaster that works on developing new aptamer technologies for diagnostics and therapeutics.

What Li's lab discovered is that this aptamer, which was originally intended to detect viruses, could bind to a part of the virus that is used to enter cells. This is similar to what happens when our body creates antibodies to combat a virus.

Researchers then created a treatment where the aptamer was placed directly into the respiratory tract of mice. They then exposed the mice to the COVID-19 virus.

"We found that the aptamer protected the mice from infection just as well as the clinically approved antibodies that have been used during the pandemic," says Miller, director of McMaster's Michael G. DeGroote Institute for Infectious Disease Research and executive director of Global Nexus. "It's very exciting."

Unlike current antibody treatments that need to be adjusted as the virus mutates, the aptamer method can provide protection for all descendants of the COVID-19 virus.

"What's really cool is that this aptamer is able to neutralize or prevent infection with variants for which all of the previously approved antibodies no longer work," Miller says.

Another benefit is cost. Antibodies are expensive to make and require specialized equipment to administer. Li believes the cost for the aptamer treatment could be reduced by a minimum of 100-fold compared to antibodies, with an aim of it costing around $10 to make.

Historically, aptamers have been studied most intensely as diagnostic tools, but have been less successful as therapeutics.

"Antibody therapy has been well-established, and aptamers are still the new kid on the block," says Li.

One of the reasons aptamers haven't been used in the way Li and Miller have discovered is due in part to preconceived concerns it would break down too quickly in the body.

"What we found is that we can give one dose of aptamer a full day before we infect these animals. And the aptamer is still 100 per cent protective," Miller says.

This is very important if the drug is to ever be used in humans because it would need to be administered in reasonable intervals. Miller says this suggests a once daily dose could be sufficient in providing protection.

This is also why Miller's team is experimenting with topical treatments like a nasal spray that would facilitate easy, at-home administration.

Miller describes synthetic aptamers as a platform technology, meaning it could be applied to all kinds of different viruses.

"We can make aptamers that are specific to seasonal flu, avian flu, and any other virus that were to emerge," Miller says.

The discovery by Li and Miller could also be a game-changer in protecting some of the most vulnerable people in Canada, especially those living in long-term care homes.

"Exposure risk in those facilities is very high, and older individuals are often more at risk of serious illness from these viruses. So, if we have a spray that can be administered daily, for example, it could provide them with a critical additional layer of protection," Miller says.

Ideally, the researchers want to see this as an over-the-counter treatment that anyone can pick up at their local pharmacy. If that happens, Miller believes the benefits could extend to parents who have sick toddlers or even travellers looking to avoid picking up a virus on a packed flight.

Li and Miller are still making modifications to the aptamer to achieve greater stability in humans.

But the possibility of a phase one trial isn't that far off. Once preclinical testing is complete, a clinical trial application will be compiled and sent to Health Canada for approval. This is the typical process any treatment needs to go through before a phase one trial happens. If approved, treatment would begin in humans on a small scale. Miller believes this could happen in 12 to 15 months.

"Because there are aptamers approved for ocular diseases, we know that there is a precedent for these to be safe in humans. We would obviously be thinking about a different route of administration, so that needs to be considered, which is why you still have to do safety trials," he says.

McMaster is collaborating with Zentek Ltd., a Canadian technology company located in Guelph, Ont. The company owns the exclusive, global licensing rights for all aptamer-based technology from the collaboration with the university.

"Zentek is excited to launch this new venture with the amazing researchers at McMaster University. Dr. Yingfu Li and Dr. Matthew Miller are leaders in their respective disciplines, and we believe combining their experience and the great teams they have assembled will result in something truly special," said Greg Fenton, CEO of Zentek, in an Oct. statement announcing the launch of a subsidiary for aptamer-based tech.

Li says Zentek is an important part of the future for their aptamers, as the company can provide key insights on commercialization options if the therapeutic is approved for use in humans.

2023'S TOP RESEARCH STORIES

Researchers discover path into drug-resistant bacteria that could lead to new ways to treat infections

By Blake Dillon

Some bacteria have double-layered membranes that prevent antibiotics from effectively reaching their targets, but researchers at McMaster University have discovered a new way to overcome these barriers.

Lori Burrows, associate director of the Michael G. DeGroote Institute for Infectious Disease Research, says the need to capture iron from the environment may leave those otherwise difficult-to-treat bacteria vulnerable to antibiotics.

"Bacteria have complex regulatory systems dedicated to iron acquisition," explains Burrows, whose research supports Global Nexus, a health innovation accelerator based at McMaster. "Iron is essential for bacterial growth, and so, when they are low on iron, these gram-negative bacteria produce molecules called siderophores that go out and trap iron, and then bring it back across their outer membrane."

Burrows says that, given the scarcity of iron in our bodies, bacteria can get greedy and take in the iron-bound siderophores that are produced by other bacteria. In fact, in new research published in the P*roceedings of the National Academy of Sciences* (*PNAS*), the Burrows Lab showed that the iron transporters of the opportunistic pathogen *Pseudomonas aeruginosa* — which causes pneumonia and

> **It's a 'Trojan horse' approach to tricking bacteria into letting antibiotics in.**

other hospital-acquired infections — can take in a foreign siderophore called bisucaberin, as well as siderophore-mimicking antibiotics.

Researchers believe this behaviour may be useful in the design of new ways for antibiotics to breach the outer barrier of these drug-resistant bugs.

"One of the major challenges of antibiotic development is getting drugs across that outer membrane," says Derek Chan, a PhD candidate in the Burrows Lab and the lead author on the paper. "Our research suggests that we can take advantage of the promiscuous nature of bacterial nutrient transporters to overcome this challenge, which could inform the development of new drugs or lead to novel applications for existing ones."

This work builds on previous research out of the Burrows Lab, where they discovered that the antibiotic thiocillin could exploit the same iron transporters of *Pseudomonas aeruginosa* to infiltrate its outer membrane. Elsewhere, related research has led to the development of the recently FDA-approved antibiotic cefiderocol, which also hijacks bacterial iron transporters.

Researchers are cautiously optimistic that other antibiotics could be combined with or attached directly to other siderophores to create all-new treatment options for a range of otherwise resistant infections.

"It's the microbial equivalent of food poisoning," Burrows explains. "The bacteria think that they're getting iron, but they are actually unknowingly getting an antibiotic, too. It's a 'Trojan horse' approach to tricking bacteria into letting antibiotics in."

Published in *the Proceedings of the National Academy of Sciences (PNAS)*


PNAS

Interactions of TonB-dependent transporter FoxA with siderophores and antibiotics that affect binding, uptake, and signal transduction

This research was published in *the Proceedings of the National Academy of Sciences* (*PNAS*), one of the world's most-cited and comprehensive peer-reviewed journals.

2023'S TOP RESEARCH STORIES

Researchers cover thousands of years to understand the elusive origins of the 'Black Death' plague

By Michelle Donovan

Seeking to better understand the origins and movement of bubonic plague in ancient and contemporary times, researchers at McMaster University, the University of Sydney and the University of Melbourne have completed a painstaking granular examination of hundreds of modern and ancient genome sequences, creating the largest analysis of its kind.

Despite massive advances in DNA technology and analysis, the origin, evolution and dissemination of the plague remain notoriously difficult to pinpoint.

The plague is responsible for the two largest and most deadly pandemics in human history. However, the ebb and flow of these, why some die out and others persist for years has confounded scientists.

In a paper published in the journal *Nature Communications Biology*, McMaster researchers use comprehensive data and analysis to chart what they can about the highly complex history of *Y. pestis*, the bacterium that causes plague.

The work was meticulously conducted by graduate student Katherine Eaton over the course of several years.

The research features an analysis of more than 600 genome sequences from around the globe, spanning the plague's first emergence in humans 5,000 years ago, the plague of Justinian, the medieval Black Death and the current (or third) pandemic, which began in the early 20th century.

"The plague was the largest pandemic and biggest mortality event in human history," explains evolutionary geneticist Hendrik Poinar, director of McMaster's Ancient DNA Centre. "When it emerged and from what host may shed light on where it came from, why it continually erupted over hundreds of years, why it died out in some locales but persisted in others, and, ultimately, why it killed so many people."

Poinar is a principal investigator at the Michael G. DeGroote Institute for Infectious Disease Research and a contributor to the work underway at McMaster's Global Nexus.

The team studied genomes from strains with a worldwide distribution and of different ages and determined that *Y. pestis* has an unstable molecular clock. This makes it particularly difficult to measure the rate at which mutations accumulate in its genome over time, which are then used to calculate dates of emergence.

Because *Y. pestis* evolves at a very slow pace, it is almost impossible to determine exactly where it originated. Humans and rodents have carried the pathogen around the globe through travel and trade, allowing it to spread faster than

its genome evolved. Genomic sequences found in Russia, Spain, England, Italy, and Turkey, despite being separated by years, are all identical, for example, creating enormous challenges to determining the route of transmission.

To address the problem, researchers developed a new method for distinguishing specific populations of *Y. pestis*, enabling them to identify and date five populations throughout history, including the most famous ancient pandemic lineages which they now estimate had emerged decades or even centuries before the pandemic was historically documented in Europe.

"You can't think of the plague as just a single bacterium," explains Poinar. "Context is hugely important, which is shown by our data and analysis."

To properly reconstruct pandemics of our past, present, and future, historical, ecological, environmental, social and cultural contexts are equally significant.

He explains that genetic evidence alone is not enough to reconstruct the timing and spread of short-term plague pandemics, which has implications for future research related to past pandemics and the progression of ongoing outbreaks such as COVID-19.

Select Publications – 2023-2024

In 2023, IIDR members collectively published over 400 research articles in the world's top scientific journals. Here, we showcase just a small sample of the important studies happening at our institute. **Bold** text indicates that the cited researcher is an IIDR member.

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Michael G. DeGroote
INSTITUTE FOR INFECTIOUS DISEASE RESEARCH

TRAINING

Mentorship. Programs. Student Success.

Celebrating Trainee-Led Research

Hundreds of McMaster University faculty, staff, students, and trainees gathered on November 10, 2023 at CIBC Hall for "IIDR Trainee Day," the institute's annual capstone research symposium. The event, organized and executed by a committee of IIDR trainees, recognized and celebrated the innovative work being led by IIDR students and postdoctoral fellows throughout 2023. More than 80 trainees from across the institute presented research during the showcase, each one exploring infectious diseases from a unique perspective. We learned about vaccines, artificial intelligence, antimicrobial resistance, drug discovery, HIV, tuberculosis, and so much more. Here, we look back on a great day of science.

Meet the Keynote

Dr. Andrew L. Goodman, Director of the Yale University Microbial Sciences Institute, flew in to spend the day with IIDR trainees. He delivered the keynote lecture, which focused on dietary xenobiotics — fascinating research that explores how the foods we eat can impact our risk of disease.

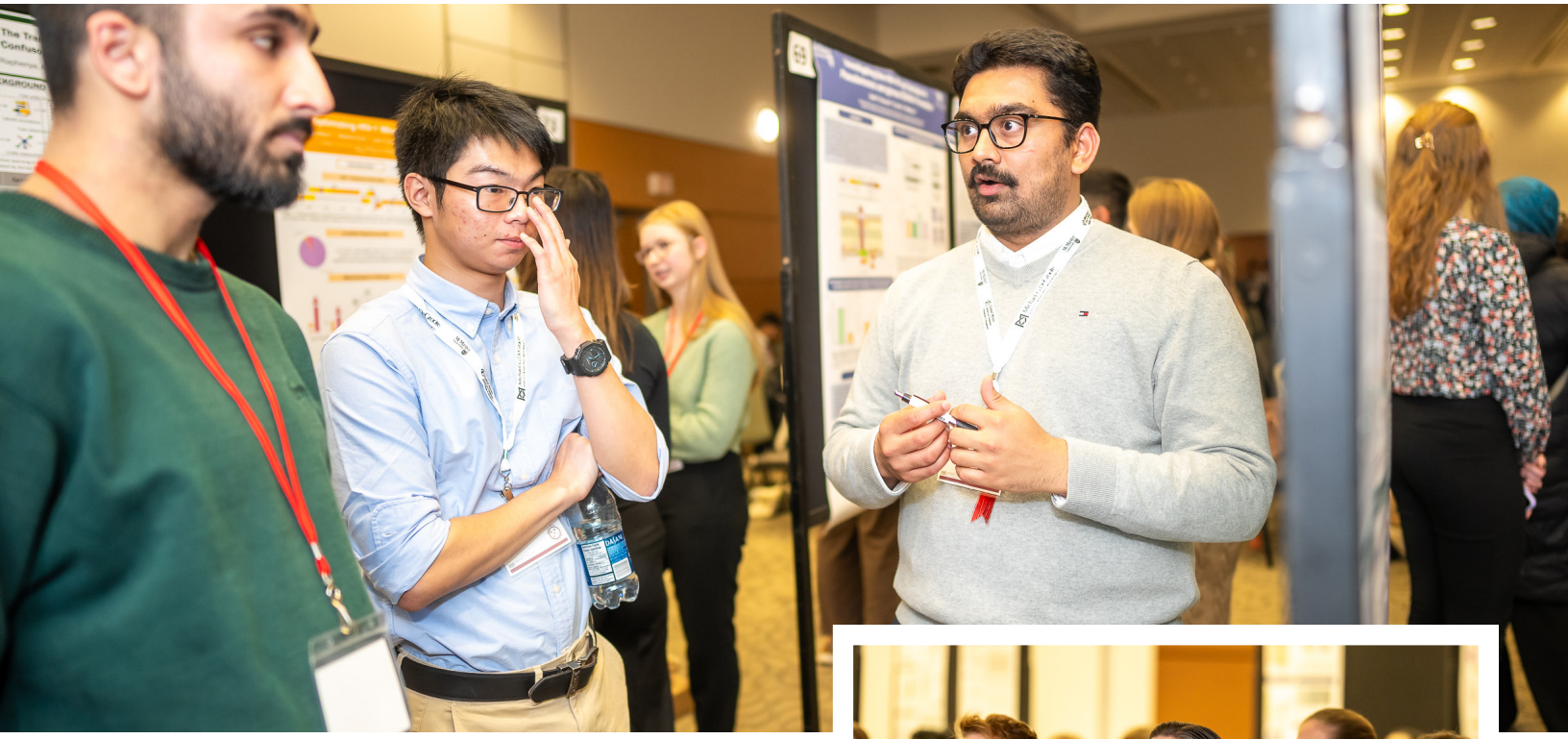
Poster Session

The event featured a two-hour open house-style poster session, at which students and trainees presented their latest research to a hall-full of guests.

Award-Winning Research

The following trainees were presented with the IIDR's highest honours at the research event:

- Jarrod Johnson (Magolan Lab), Michael Kamin Hart Staff Award
- Autumn Arnold (Stokes Lab), Michael Kamin Hart Undergraduate Award
- Victoria Lee (Gillgrass Lab), Michael Kamin Hart MSc Award
- Michael D'Agostino (Miller Lab), Michael Kamin Hart PhD Award
- Luke Yaeger (Burrows Lab), Michael Kiley Award
- Manoj Jangra (Wright Lab), Mildred Gulliver Postdoctoral Award
- Jessica Breznik (Bowdish Lab), Gerard Wright & Teresa Gubala Postdoc Award
- Nathan Bullen (Whitney Lab), Mildred Gulliver Best Graduate Oral Talk Award
- Nathan Yuen (Burrows Lab), Fisher Scientific Undergrad Poster Award
- Manpreet Kaur (Wright Lab), IIDR Postdoctoral Award of Excellence
- Haley Zubyk (Wright Lab), IIDR PhD Award of Excellence
- Jeremie Alexander (Stokes Lab), Global Nexus MSc Poster Award



Grad Student Presentation Competition

Six graduate students squared off in an oral presentation competition, each focusing on different aspects of infectious disease. Speakers took questions from the audience and were ranked by competition judges, who declared Nathan Bullen the winner of the Mildred Gulliver Best Graduate Oral Talk Award.

Amna Abbas, Wright Lab

A Novel Glycosyltransferase Confers Resistance to Novobiocin in the Environment

Dominique Tertigas, Surette Lab

Leveraging Metagenomics to Identify Enterobacteriaceae Genes Enriched in Active Ulcerative Colitis

Gary Liu, Stokes Lab

Generative AI for designing and validating easily synthesizable and structurally novel antibiotics

Winner

Nathan Bullen, Whitney Lab

Evolution of Phage Protein Supports Antiphage Escape

Megan Tu, Brown Lab

Exploiting the Fitness Cost of Carbapenem Resistance

Thy Nguyen, Kalan Lab

Mining Antimicrobials in the Human Skin Microbiome

Promoting Inclusivity in STEM Education

The IIDR is a proud partner of the Biochemistry and Biomedical Sciences Summer Scholars Program (SSP), a fully funded 12-week program that provides students who self-identify as Black, Indigenous, and/or 2SLGBTQIA+ with cutting-edge skills training, mentorship, and career-development opportunities. The IIDR offers staff and technological support, and many of its members offer mentorships and lab placements for SSP students throughout the summer term.

About the Program

The SSP is designed to engage, encourage, and assist students from equity-deserving groups, giving them the opportunity to pursue biomedical research training and careers in biomedical science. The program aims to support students that face barriers to academic research, as well as those who have not had opportunities to explore STEM-related research in the past. As such, entry into the program requires no previous research experience, and students receive a stipend of $7,000, a meal card for dining on and off campus, residence on campus if needed, and financial coverage of transportation, parking, and childcare. Students also receive two weeks of intensive skills training at the Biochemistry and Biomedical Sciences teaching labs at McMaster, prior to a 10-week immersive lab placement.

2023 Program Scholars who Studied in IIDR Labs

Students enrolled in the SSP are placed in labs that span the entire Department of Biochemistry & Biomedical Sciences; however, most study in IIDR labs, where they conduct important research into infectious disease-related problems.

Nikina Bear-Lowen
Bowdish Lab

Studying COVID-19 re-infection in long-term care settings

Tyler Carmona
Magolan Lab

Studying bacterial outer-membrane permeation

Tegvir Grewal
Li Lab

Studying DNAzyme Pseudouridine cleavage activity

Elisabeth Jonah
MacNeil Lab

Studying *C. elegans* as a model for Alzheimer's Disease

Emma Robertson
Gillgrass Lab

Studying transgenes in humanized mice for HIV/TB research

Training Tomorrow's Top AMR Experts

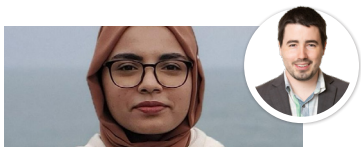
The Braley Fellows Program is an advanced training program that provides an elite cohort of IIDR PhD candidates with several real-world applications of antimicrobial resistance (AMR) research.

About the Program

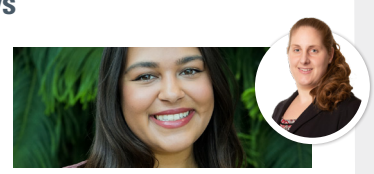
Trainees enrolled in the Braley Fellows Program gain a fulsome understanding of the complexity and challenges of diagnosing and managing AMR through a tailored academic experience. The program embraces a case-study and problem-based learning approach, and consists of two key components: a lecture-based academic course and a research project conducted during the summer practicum.

The Braley Fellows Program trains students in five key subject areas: diagnosis and detection of AMR; antibiotic use in the clinic; tracking AMR at the population level; antimicrobial stewardship; and AMR-related policy and guidelines. Students also visit the Public Health Ontario laboratory in Toronto to gain a better understanding of AMR surveillance practices at the provincial level. The program is currently facilitated by Lori Burrows.

Meet the 2023 Braley Fellows



Rabia Fatima
Hynes Lab

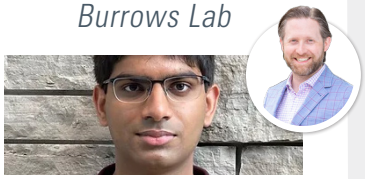


Dana Sowa
Andres Lab

Monica Warner
Andres Lab

Victoria Coles
Burrows Lab

Megan Tu
Brown Lab



Vithushan Surendran
Miller Lab

2023 Braley Fellows Invited Speakers and Talks

- Lori Burrows: Braley Fellows overview
- Gerry Wright: The history of AMR
- Jeffrey Pernica: Clinical decision-making
- Andrew McArthur: Molecular surveillance
- Marek Smieja: Clinical detection of AMR
- Cheryl Main: Hamilton General Micro Lab tour
- Dani Peters: Industry view of AMR policies
- Dominik Mertz: Antibiotic stewardship
- Erin Duffy: CARB-X and the antibiotic pipeline
- Greg German: Using phage to overcome AMR
- Romy Olsha: Ontario Public Health Lab tour

2023'S TOP TRAINING STORIES

IIDR postdoc awarded $160,000 fellowship to study *Clostridium difficile* transmission

By Blake Dillon

Postdoctoral fellow Sheridan Baker has been awarded a prestigious Mitacs Elevate fellowship with $160,000 in funding to study how *Clostridium difficile* is asymptomatically transmitted in hospital settings.

The Mitacs Elevate program, which emphasises professional development, facilitates strategic partnerships between academic institutions and industry partners to address complex challenges over two years.

Baker will use the fellowship to work between McMaster and St. Joseph's Healthcare Hamilton to conduct this cross-disciplinary research.

C. difficile, an intestinal bacterial pathogen, is one of the leading causes of serious hospital-acquired diarrheal infections, Baker explains. While the symptoms of the infection are well known to researchers, Baker is primarily interested in studying asymptomatic spread.

"People who get this infection often have diarrhea and can easily spread it to others that way; however, we believe that asymptomatic transmission of *C. diff* may actually be more common," he says.

Baker, who works under Andrew McArthur and Michael Surette at the Michael G. DeGroote Institute for Infectious Disease Research (IIDR) at McMaster, will test this hypothesis with another IIDR member, Marek Smieja, in clinical microbiology labs at St. Joe's.

Here, Baker will conduct whole genome sequencing on *C. diff* grown from cultured rectal swabs collected in 2018 and 2019. Findings will then be analyzed back at the McArthur Lab at McMaster using bioinformatics approaches to better understand the scope of asymptomatic transmission occurring in Hamilton-area hospitals.

For Baker, who sequenced and reported on thousands of SARS-CoV-2 isolates during the COVID-19 pandemic, the Mitacs Elevate fellowship offers an opportunity to appreciate the clinical applications of his research.

"This fellowship is allowing me to work at the intersect of basic research, translational science, and clinical microbiology, which is really exciting for me," Baker says. "Getting exposure to the clinical side of infectious disease and collaborating with clinicians on research that has real implications for patients is particularly interesting."

Over the course of the fellowship, Baker hopes to develop novel diagnostic methods for detecting *C. diff* in the absence of symptoms in order to reduce the incidence and burden of the disease.

Research at the crossroads of healthcare and bioinformatics

Baker's Mitacs Elevate fellowship is a formal research collaboration between the labs of IIDR members Marek Smieja and Andrew McArthur. With their mentorship, Baker's academic work will have important clinical impact in the area of infectious disease diagnostics.

2023'S TOP TRAINING STORIES

IIDR lab opens its doors to biology undergrad on a mission

By Jay Robb

Rebecca Batstone had a problem. Sierra Vaillancourt came up with the solution. And Alexander Hynes, a member of McMaster's Michael G. DeGroote Institute for Infectious Disease Research (IIDR), helped make it happen.

Batstone, an assistant professor in the Faculty of Science's Department of Biology, wanted to start working with bacteriophages, viruses that selectively hunt and kill bacteria.

"If we had phages, we could start running experiments that explore fundamental questions in evolutionary biology," Batstone told her team.

But phages aren't easy to work with and handling them requires special skills — skills no one in her lab had at the time.

So Vaillancourt, a fourth-year science student working in Batstone's lab, took up the challenge, making it her mission to stock the lab with phages.

Batstone recommended Vaillancourt read up on phage research by Hynes. They'd first met at Memorial University when Batstone was starting her master's and Hynes was finishing his PhD.

After reading Hynes' research, Vaillancourt emailed him. Hynes, who runs a phages bootcamp for students in his lab, invited Vaillancourt to enroll — the first undergraduate student from outside his lab to participate in it. He also tapped IIDR trainee Felix Croteau to be Vaillancourt's guide into the world of phage research.

Over the course of nearly two weeks, Vaillancourt learned how to amplify phages and conduct both plaque and adsorption assays.

"The work I'm doing in Dr. Batstone's lab wouldn't have been possible without the bootcamp and Felix's help," says Vaillancourt.

Vaillancourt returned to Batstone's lab familiar with protocols on everything from growth curves and phage titrations to phage DNA extraction procedures.

"Because of Felix, I started working on a research project in Dr. Batstone's lab that I'm passionate about," Vaillancourt says. "Everyone in Dr. Hynes' lab was incredibly welcoming. I can't say enough about how grateful I am for all of their help."

Croteau says he was happy to lend a hand.

"Supervising Sierra was a great experience," he says. "Science is at its best when it's collaborative across departments and disciplines. I think phages are some of the coolest things in the microbial world and I'm always happy to see other scientists develop an interest."

Along with sharing her newfound knowledge in Batstone's lab, Vaillancourt connected with a PhD student at the University of Toronto, who is researching the same bacterial species, to offer up advice, protocols and phage stock.

"I got to pay it forward," says Vaillancourt.

Batstone's lab is now stocked with phages, underscoring the drive and curiosity of undergraduate students and the spirit of collaboration at McMaster.

"Sierra took the initiative, Dr. Hynes welcomed Sierra into her lab, and Felix did an outstanding job of showing her the ropes," Batstone says. "Because of Sierra, Alex, and Felix, our lab is ready to begin working with phages. I'm quite excited. I study the evolution of cooperation, so it's fitting that scientific progress in my lab relies on cooperation with other labs and researchers. It's great that Mac fosters these types of interactions."

About the Hynes Lab

The Hynes Lab aims to identify new phages, characterize them, and ultimately determine the roles they play in shaping the microbial populations within us.

Croteau (left) and Vaillancourt (right).

Funding Trainee Research Placements

The Michael G. DeGroote Institute for Infectious Disease Research (IIDR) and the David Braley Centre for Antibiotic Discovery (DBCAD) provide full sponsorship of select undergraduate research projects through their annual Summer Fellowship Competition. These awards are intended to support the research goals of students working in IIDR member labs during the summer term. Every year, 10 awards — five from the IIDR and five from the DBCAD — are made available to students. Each award grants the successful applicant $4,000 to pursue infectious disease research at McMaster. The DBCAD funds projects related to antibiotic discovery or mitigation of antibiotic resistance, while the IIDR funds projects more broadly associated with infectious diseases. These competitions are highly competitive, and applications are vetted by faculty and senior trainees. This year's cohort of fellows tackled a range of infectious disease issues, including HIV-TB co-infection, phage therapy, antimicrobial resistance, drug discovery, and more.

Isabelle Chan
Biomedical Discovery & Commercialization

Training in the Burrows Lab

Studying phages for type-IV pili in *P. aeruginosa*

Vritti Vashi
Biomedical Discovery & Commercialization

Training in the Andres Lab

Studying DNA repair mechanisms in *M. tuberculosis*

Margaret Choi
Biomedical Discovery & Commercialization

Training in the Gillgrass Lab

Studying HIV/TB co-infection in humanized mice

Tiffany Ta
Biomedical Discovery & Commercialization

Training in the McArthur Lab

Studying natural language processing applications for AMR

Melissa Speagle
Hons. Biochemistry

Training in the Coombes Lab

Studying chemical compounds with activity against *Salmonella*

Stewart McLellan
Hons. Microbiology (University of Guelph)

Training in the Brown Lab

Studying natural products for use against *E. coli*

Madeline Standen
Hons. Biodiversity and Environmental Sciences

Training in the Currie Lab

Studying actinobacteria strains from Attine ant colonies

Asha Subramaniam
Hons. Biochemistry

Training in the Andres Lab

Studying molecular mechanisms of non-homologous end joining

Joseph Atto
Hons. Biochemistry

Training in the Kaushic Lab

Studying the effects of lactic acid isomers on STI susceptibility

Yaser Al Moayad
Biomedical Discovery & Commercialization

Training in the Burrows Lab

Studying mutations that lead to phage resistance in *P. aeruginosa*


McMaster University
SECURITY & PARKING SERVICES

Michael G. DeGroote
INSTITUTE FOR INFECTIOUS DISEASE RESEARCH

KNOWLEDGE MOBILIZATION

Outreach. Partnerships. Events.

Communications

The IIDR excels at translating complex science into interesting, digestable formats fit for a range of different audiences. Leveraging social media, owned content platforms, university channels, and external media partners, we told a number of research success stories in 2023. Social media campaigns, house-made multimedia content, and media relations activities helped broaden the reach of our important infectious disease research.

Social Media Activity

The IIDR communicates news, research, and other information using a range of social media channels; however, Twitter/X remains the institute's primary platform. Key campaigns from 2023 included World AMR Awareness Week and IIDR Trainee Day, which collectively earned 39,800 impressions and several new followers.

2023 Social Media Audience Metrics

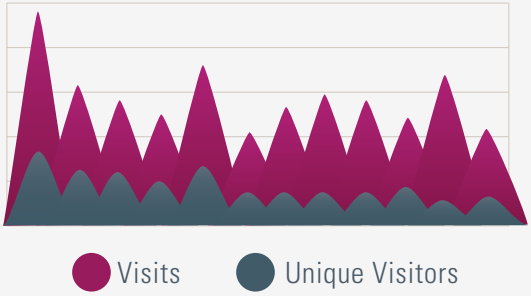
2,514 Followers

263 Connections

57 Subscribers

The all-new iidr.mcmaster.ca

The IIDR's website was re-designed and re-launched in early-2023. The new site is intuitively designed to help visitors learn more about the institute, its members, and their research. Through its first year, the new site saw relatively consistent traffic, becoming a trusted resource for more than 5,000 people.



Annual Totals:

Visits: **17,842**
Unique Visitors: **5,311**

House-Made News Content

IIDR comms staff worked with member scientists to develop a range of custom media content, including articles, advisories, releases, and more. Much of this work had uptake centrally at the university and with external media partners. Highlights include:

Expert Brian Coombes on what you need to know about *Salmonella*

Trojan horse tactics: Researchers discover path into drug-resistant bacteria

Drug-resistant fungi thrive in even the most remote regions of earth

Collaboration gives scientists on-demand access to global superbug data

Climate change could lead to more fungal disease in humans, says McMaster expert

McMaster postdoc awarded $160,000 fellowship to study *C. difficile* transmission

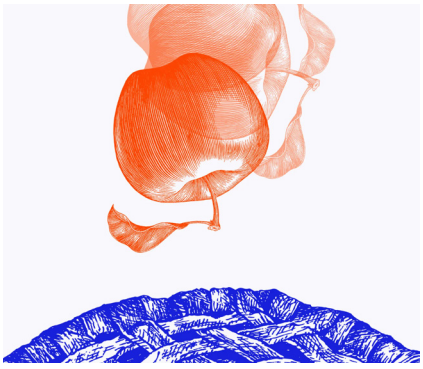
Media Relations

McMaster University's infectious disease experts made several hundred media appearances over the past year. Working with journalists from a range of traditional and new media channels, we were counted upon for our expertise in a number of trending infectious disease-related topics. We contributed to third-party news articles about COVID-19, documentary films about antimicrobial resistance, videos about fungal pathogens, podcasts about antibiotic discovery, and advisories on public health threats, like avian influenza, *Salmonella*, *Shigella*, and more. Here, we recap the highlights from a busy year with our media partners.

IIDR members star in BBC documentary: "Race Against Resistance"

McMaster researchers Eric Brown (left) and Jon Stokes (right) featured prominently in the BBC documentary film *Race Against Resistance: The Life And Death Struggle To Save Antibiotics*. Brown and Stokes, along with IIDR and Global Nexus communications staff, worked closely with filmmakers to explore the antimicrobial resistance crisis and explain how McMaster research teams are taking critical steps toward solving it. The full documentary is available to stream on YouTube.

Stokes Lab discovery ranked among best of 2023 by *The New York Times*



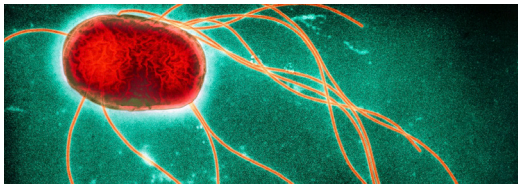
Jon Stokes' use of artificial intelligence to identify a new antibiotic with activity against the superbug *Acinetobacter baumannii* was heralded as one of the most important scientific and technological advances of the year by *The New York Times*.

Noteable outlets that relied on McMaster's infectious disease expertise (2023-24)

- BBC
- CBC
- CHCH News
- CNN
- CTV News
- Global News
- Maclean's
- National Geographic
- National Post
- New York Times
- Newsweek
- PBS
- The Conversation
- The Globe and Mail
- The Hamilton Spectator
- The Hill Times
- The Toronto Star
- Yahoo! Canada
- YouTube Health

National Geographic leans on the IIDR for *Salmonella* expertise

In the wake of an international drug-resistant *Salmonella* outbreak, marquee outlets like *National Geographic* worked closely with McMaster expert Brian Coombes to draft important public health advisories.



Commentary & Opinion

In addition to serving as a trusted resource for journalists all over the world, our experts are also keen to hold the pen themselves on occassion. Every year, IIDR scientists write important op-eds and commentaries for publications with international impact. Here, we highlight a few of our favourites from 2023.

IIDR Expert Opinion on X (formerly Twitter), sorted by most Followers

Zain Chagla / @zchagla / 21,300
Dawn Bowdish / @MsMacrophage / 5,936
Lori Burrows / @Dr_Lori_Burrows / 4,838
Dominik Mertz / @DocDominik / 3,906
Manali Mukherjee / @DrMMukherjee / 3,845
Brian Coombes / @BrianKCoombes / 3,372
Gerry Wright / @gerryiidr / 2,752

My Prediction: The Threat of Superbugs Will Loom Too Large to Ignore — by Gerry Wright, for *Maclean's Magazine*

Several years ago, I contracted a foodborne illness while travelling in Europe. It didn't respond to oral antibiotics, and I grew sicker, the bug spreading through my bloodstream, until I had no choice but to check into a hospital to treat it with IV antibiotics. They saved my life.

Most people have taken antibiotics to fight common infections like strep throat and *E. coli*. Yet few of us realize just how foundational these drugs are to modern medicine. They allow patients to undergo organ transplants and chemotherapy without infections. They allow premature babies to survive their first days on earth. But since the discovery of penicillin, in 1928, science has been in an arms race with bacteria: they evolve to become stronger, and we make better antibiotics.

But recently we've started losing that race: many of our antibiotics are becoming less effective, and few new ones are emerging. Now we're hurtling toward a potential crisis, as conditions we can treat today could become untreatable, and life-saving procedures riskier. In part, that's because we've overprescribed antibiotics, giving bacteria more opportunity to develop resistance. So we're dealing with superbugs that can can cause blood, skin and lung infections, and in some cases even spread on surfaces such as floors and walls, or clothes. Health Canada now has its eyes on bacteria, including including *Salmonella* and *C. difficile*, which are growing resistant to multiple antibiotics.

Already, several thousand Canadians die annually due to antibiotic-resistant infections. Most of these deaths would have been peventable not long ago. If we don't make major policy and economic changes beginning this year, the problem will grow, and we'll come closer than ever to an existential problem for health care: routine procedures will become risky, and more Canadians will die of what should be preventable infections.

Read the full op-ed at Macleans.ca.

Will We Still Have Antibiotics in 50 Years?— with opinion from Lori Burrows, for *The Conversation*

Will We Still Have Antibiotics in 50 Years? Yes! Antibiotics are a crucial component of modern medicine, and we can't afford to lose them. Despite the rise of resistance in important pathogens (bugs), and the substantial decrease in new drugs in development, we have multiple tools at our disposal to protect antibiotics.

Stewardship — the principle of using antibiotics only when absolutely necessary — is key to maintaining the usefulness of current antibiotics and preventing resistance to new drugs from arising. New diagnostics, such as the rapid tests that became widely available during the pandemic, can inform stewardship efforts, reducing inappropriate antibiotic use for viral diseases. Finally, researchers continue to find creative ways, including the use of powerful artificial intelligence approaches, to identify antimicrobial compounds with new targets or new modes of action. Other promising tactics include using viruses that naturally kill bacteria, stimulating the host's immune system to fight the bacteria, or combining existing antibiotics with molecules that can enhance antibiotic activity by, for example, increasing uptake or blocking resistance.

Read the full op-ed at theconversation.com.

How Canada Continues to Let Older Adults Suffer and Die from COVID-19 — by Dawn Bowdish, for *The Conversation*

Three years into this pandemic, most Canadians have taken off their masks and many have stopped getting booster shots. However, COVID-19 is rising among the leading causes of death in Canada, reaching the No. 3 spot.

This is the first time an infectious disease has pushed its way into the top five causes of death during the last 80 years or so of the antibiotic era. Older adults account for most of those deaths, and we are letting it happen.

COVID is a vaccine-preventable disease, but we are not using vaccines as well as we could. Most Canadians don't understand the importance of booster shots in protecting them from long-term health issues that may follow infection, such as long COVID. Even fewer recognize that getting vaccinated helps protect their entire community, including older adults.

Read the full op-ed at theconversation.com.

The Fungus Zombies in 'The Last Of Us' are Fictional, but Real Fungi Can Infect People, and They're Becoming More Resistant — by Gerry Wright, for *The Conversation*

Many of the people watching *The Last of Us* are likely there for the zombies. I love the zombies too, but I'm really there for the fungus. I've been studying fungi since my PhD work in the 1980s, and I grow more fascinated by these amazing organisms with every passing year.

In the HBO series and the video game that inspired it, a parasitic fungus — a fictitious mutation of the very real cordyceps — jumps from insects to humans and quickly spreads around the world, rendering its victims helpless to control their thoughts and actions. Far-fetched fungal fear-mongering? It's definitely fictional, but maybe not as preposterous as it might seem.

Read the full op-ed at theconversation.com.

McMaster Video Content

Working closely with McMaster's multimedia specialists, IIDR members, trainees, and staff helped produce a range of in-house video content throughout the past year. Videos were developed to support research news, as evergreen content for slow news periods, and as a way to speak to new audiences during global awareness campaigns. The following is a mere selection of the on-camera work our experts led in 2023.

All videos and Rounds webinars are posted at:

iidr.mcmaster.ca/videos

Supporting the Faculty of Health Sciences' new *Explainer* Series

McMaster's Faculty of Health Sciences has teamed up with YouTube Health to ensure high-quality health videos are accessible to everyone. The popular online video platform launched YouTube Health to battle misinformation and provide users with access to reliable health info from medical experts. IIDR members Jonathan Stokes and Matthew Miller contributed to the Faculty's new 'Explainer' series, providing trustworthy info on antimicrobial resistance and H5N1, respectively.

The Biomedical Discovery and Commercialization Program

IIDR member Andrew McArthur developed a video highlighting McMaster's Biomedical Discovery and Commercialization Program, for which he serves as director. McArthur says the program is rooted in biochemistry and drug discovery, but "goes deep on developing business skills," so students who graduate will be equipped to bring new drugs to market.

Earth Day Special: Climate Change and Fungal Pathogens

For Earth Day 2023, IIDR member Jianping Xu helped create a video that explained our delicate relationship with fungi. Xu argued that climate change could lead to more fungal disease in humans.

Inhaled COVID-19 Vaccine gets Funded for Phase-2 Clinical Trials

A video featuring IIDR members Fiona Smaill and Matthew Miller was produced to announce that McMaster's inhaled COVID-19 vaccine had received $8M in CIHR funding for Phase-2 clinical trials.

Using Artificial Intelligence to Fight a Drug-Resistant Superbug

Following his landmark discovery of a new antibiotic with activity against *A. baumannii*, IIDR member Jonathan Stokes and his trainees contributed to a video that explained how AI can help us find new drugs.

ID/IIDR Combined Rounds Webinars

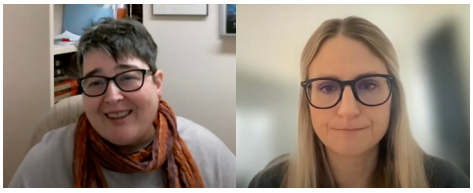
In partnership with our clinical colleagues at McMaster, the IIDR hosts regular webinars to share the latest on a topic of clinical relevance. Our members and trainees collaborate with their hospital-based peers to co-design a lecture that holistically explores problems shared between fundamental science and patient care. Webinars occur on the first Wednesday of every month during the academic year (with some exceptions), and each session is recorded and uploaded to YouTube for asynchronous viewing.

February

Diagnosing TB Meningitis

An in-person seminar featuring special guest speaker Nathan Bahr, an Associate Professor from the University of Kansas.

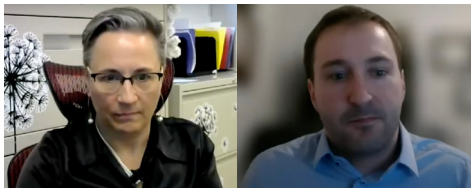
March



Diagnosing Wound Infections

Featuring talks from Eva Piessens (Medicine) and IIDR member Lindsay Kalan (Biochemistry & Biomedical Sciences).

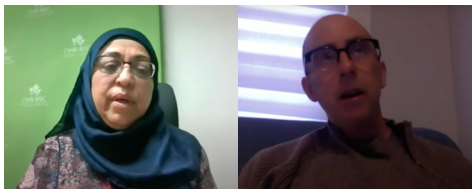
April



Multidrug-Resistant P. aeruginosa

Featuring talks from Cheryl Main (Medicine) and IIDR postdoctoral fellow Brent Weber (Brown Lab).

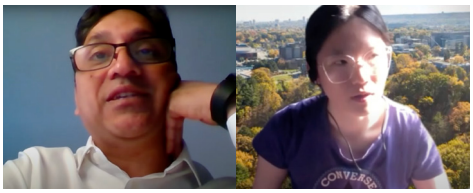
May



HIV-1 Prevention and Treatment

Featuring talks from IIDR research scientist Aisha Nazli (Kaushic Lab) and Tim O'Shea (Medicine).

June



Emerging Fungal Pathogens

Featuring talks from Shariq Haider (Medicine and IIDR) and IIDR PhD candidate Yue Wang (Xu Lab).

September

COVID-19 insights for future pandemics

Featuring talks from Mark Loeb (Medicine and IIDR) and IIDR Director Matthew Miller (Biochemistry & Biomedical Sciences).

October

Diagnosing Respiratory Illnesses

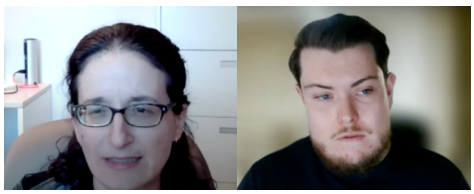
Featuring talks from IIDR members Jeffrey Pernica (Pediatrics), Yingfu Li (BBS), and Leyla Soleymani (Engineering).

November

New Insights on C. difficile

Featuring talks from Marek Smieja (Medicine and IIDR) and IIDR trainees Sheridan Baker and Maddie McCarthy (McArthur Lab).

December



TB or not TB? That is the Question

Featuring talks from Laura Erdman (Pediatrics) and IIDR PhD candidate Matt Zambri (Elliot Lab).

Industry Activity & Commercialization

Commercialization efforts and industry partnerships ensure IIDR research has real social impact. This past year, many members translated discoveries into new technologies, spin-outs, and partnerships that will help keep society safe from infectious diseases.

Lichty start-up gets $256,000 in seed funding

Co-founded by IIDR member Brian Lichty, biotech startup Esphera SynBio has been granted $256k from the McMaster Seed Fund for its a novel therapeutic technology, which is designed to treat infectious diseases and cancer. Esphera's platform technology generates exosomes that deliver defined payloads to targeted cells in the body. The technology can target several kinds of cells, including tumour cells and immune cells, and deliver a variety of therapeutic payloads, including enzymes and RNAs. It is designed to enhance existing immunotherapy and vaccine technologies and aid in gene therapy, enzyme replacement therapy, and cancer immunotherapy.

Lichty says the seed funding will support the company's technology development at McMaster and the Ottawa Hospital Research Institute – both of which house cutting-edge infrastructure for GMP manufacturing.

"Our novel platform has the potential to address unmet medical needs, enhance therapies for diseases that are difficult to treat, and improve outcomes for patients," he says. "It's fantastic to see McMaster investing in its startups; we're excited by this support, which will enable continued research and development at Esphera as we advance towards clinical trials."

IIDR researchers create food packaging tray that warns of contamination

In research supported by Toyota Tsusho Canada Inc., an indirect subsidiary of Toyota Tsusho Corporation in Japan, IIDR members Yingfu Li and Tohid Didar, along with colleagues in the Faculty of Engineering, have created a new packaging tray that can signal when *Salmonella* is present in packages of raw or cooked food, such as chicken. The new technology enables producers, retailers, and consumers to tell in real-time whether the contents of a sealed food package are contaminated without even having to open it. The prototype, shaped like a shallow boat, is lined with a food-safe reagent that allows a built-in sensor to detect and signal the presence of *Salmonella*. Researchers expect the technology will soon be adapted to test for other common food-borne contaminants, such as *E. coli* and *listeria*.

IIDR-made nanotech company signs exclusive worldwide license

FendX Technologies, established by IIDR members Leyla Soleymani and Tohid Didar, has made significant progress in the development and scale-up of its protective surface coating, which prevents the adhesion of pathogens and reduces their overall transmission. In 2023, the company successfully completed lab prototype testing and signed a development stage agreement with Dunmore International Corp. to create intermediate-sized prototype films, an important step toward automated manufacturing.

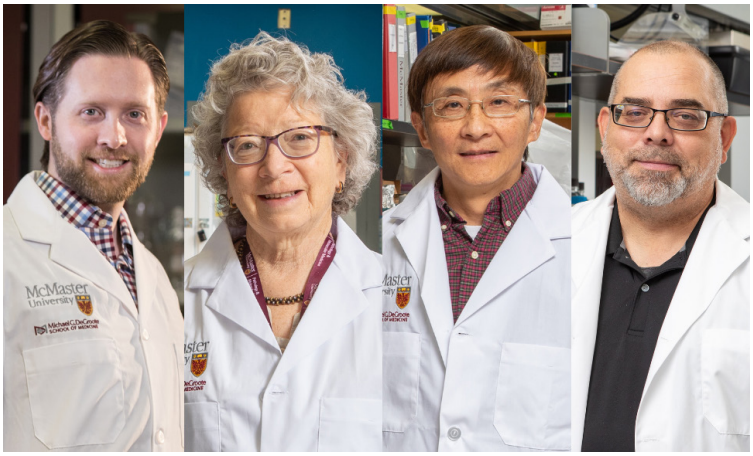
IIDR members partner with menstrual cup company to improve women's health

IIDR members Tohid Didar and Zeinab Hosseinidoust are working with a social enterprise partner on innovations to the menstrual cup in hopes of improving women's health. The duo is working with "Bfree Cup" inventor and Women's Global Health Innovations founder Leisa Hirtz to not only make the menstrual cup more hygienic and user-friendly, but also to develop a substance that can detect and treat vaginal infections.

Hosseinidoust says bacteriophages — viruses that target specific bacteria — can be leveraged to fight infections in this context. Phages are potent antimicrobials whose ability to target only bad bacteria are giving them a global renaissance as an alternative to antibiotics, which kill good bacteria along with the bad.

"If we can develop a biosensor gel for the menstrual cup that can detect bacteria, then potentially use the cup to also release bacteriophages, we can proactively treat vaginal disease," Hosseinidoust explains.

Complications of undiagnosed and untreated disease like bacterial vaginitis can lead to infertility, increased risk of sexually transmitted infections, and low birth weight.



IIDR member-founded biotech company leads new COVID-19 vaccines into human trials

AeroImmune Technologies is advancing to Phase-2 human trials with its next-generation, aerosol COVID-19 vaccine. The McMaster-developed inhaled vaccine, led by experts in infectious disease and immunology, has shown promise in pre-clinical trials, demonstrating higher efficacy in inducing protective immune responses compared to traditional injections. By targeting the lungs and upper airways where viruses first enter the body, the vaccine provides long-lasting protection against respiratory infections, including Omicron and other SARS-CoV-2 variants. The company leading this work was co-founded by IIDR members Matthew Miller, Fiona Smaill, Zhou Xing, and Brian Lichty.

IIDR-discovered antibiotic being pushed forward by US social venture Phare Bio

Jon Stokes' landmark discovery of abaucin — a novel antibiotic with activity against the superbug *Acinetobacter baumanni* — is being pushed ahead by social venture company Phare Bio. The company, which Stokes co-founded, is currently searching for analogues of abaucin that boast better medicinal profiles. They also hope to lead studies that support future human testing of abaucin. Because the company is a nonprofit, it is leveraging philanthropy and grants to navigate the "chasm of death," a period of R&D stagnancy in which most potential antibiotics are abandoned. Once Phare emerges on the other side of the chasm with a viable product, it plans to partner with a company in Big Pharma to further develop the drug or to spin-out its own venture-funded company to help bring it to market.

Invited Guests & Lab Tours

Every year, the IIDR opens the doors to its core facilities for an array of esteemed guests. This year's visitors included partners from government, industry, and academia, each of whom brainstormed new opportunities for collaboration on the way through.

National Research Council visits the IIDR to discuss collaborations on infectious disease research

A new agreement between McMaster University and the National Research Council of Canada (NRC) will enable collaboration on evidence-based solutions to infectious disease problems. The Memorandum of Understanding establishes a shared interest in collaborating on research related to infectious diseases, antimicrobial resistance, drug discovery, diagnostics, biocompatible materials and other areas. Representatives from the NRC visited McMaster in May for tours of the IIDR and its core facilities.

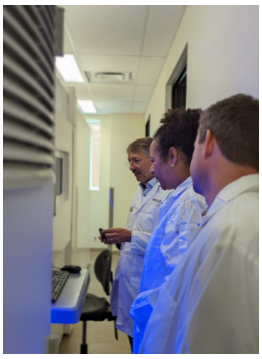
IIDR welcomes Hamilton's Economic Development team for lab tour and brainstorm

The IIDR welcomed members of Hamilton's Economic Development Office to its labs in July. The visit centred on discussions around driving investment in Hamilton.

Federal Health Minister visits IIDR facilities

Federal Health Minister Jean-Yves Duclos met with members of the IIDR in January and toured McMaster's infectious disease-related infrastructure.

Colleagues from Germany visit to find synergies with the IIDR and Global Nexus



Researchers from the IIDR and Global Nexus welcomed to McMaster a contingent of peers from the German Center for Infection Research (DZIF). The visit, held in May, included exploratory discussions pertaining to possible research collaborations around pandemic prevention, antimicrobial resistance, drug discovery, diagnostic development, vaccinology, and more. DZIF researchers also toured the IIDR's core facilities as part of the visit.

Sponsorships & Outreach

The IIDR is a staunch supporter of STEM-related activities in Hamilton and at McMaster. This year, we sponsored grassroots science, academic research opportunities, and a handful of relevant conferences and events.

The IIDR continues its longstanding support of the Bay Area Science and Engineering Fair

The IIDR has long supported the Bay Area Science and Engineering Fair (BASEF), a regional project fair where students in grades seven through twelve showcase their STEM research. This year, we pledged $400 in awards for projects related to infectious disease, drug discovery, and/or human health. We also provided the fair with volunteer judges, and provided expert council to the recipient of the gold-tier IIDR Award.

The IIDR serves as a co-funding partner for MIRA's Graduate Scholarship Program

The McMaster Institute for Research on Aging (MIRA) offers graduate scholarships that fund interdisciplinary student-led research on aging. This year, the IIDR served as a co-funding partner, pledging $7,500 for MSc projects and $9,000 for PhD projects that were positioned at the intersect of aging and infectious disease. The IIDR was one of six co-funding partners, part of a collaborative effort to enhance interdisciplinary research at McMaster.

The IIDR sponsors major NMR conference at McMaster

In October 2023, McMaster University played host to the MOOT NMR Symposium, an annual celebration of all things nuclear magnetic resonance (NMR). The IIDR sponsored the event, providing $2,000 in support. The event included guest speakers from the University of Toronto, Memorial University, Iowa State University, the University of Guelph, and the University of New Brunswick, and provided a forum for McMaster students to present their NMR-related research.

2023'S TOP KNOWLEDGE MOBILIZATION STORIES

Collaboration gives scientists on-demand access to global superbug data

By Blake Dillon

McMaster University, through the Michael G. DeGroote Institute for Infectious Disease Research (IIDR) and the Global Nexus, is working with the infectious disease team at the Chan Zuckerberg Initiative (CZI) to improve access to antimicrobial resistance (AMR) data, so scientists across the world can better prevent global health threats.

Leveraging McMaster's Comprehensive Antibiotic Resistance Database — better known as "CARD" — the CZI has developed an AMR module for its open-access metagenomics platform, CZ ID.

The new module allows for researchers from all over the world to track and investigate drug-resistant bacteria — or superbugs — on demand.

Developed at McMaster by Andrew McArthur and Gerry Wright, both professors in the Department of Biochemistry and Biomedical Sciences and members of the IIDR, CARD is a rigorously curated bioinformatics database that contains the world's knowledge of antimicrobial resistance genes.

"AMR is a constantly moving target," McArthur says. "There's always going to be new antibiotic resistance genes and new mutations. And due to the continued abuse of antibiotics and other factors, this will likely always be the case. Tools like CARD and collaborations like this one with the CZI are important if we hope to keep up with resistance."

The CZI, a philanthropic organization focused on solving a range of important societal challenges, is actively supporting the science and technology that will make it possible to cure, prevent, or manage all diseases. Tools like CZ ID were designed in service of this mission.

"Antimicrobial resistant microorganisms are a major health concern for communities around the world," says Patricia Brennan, vice president of science technology at the CZI. "CZ ID's new AMR module helps ensure that researchers have access to the tools and resources that they need to detect, investigate, and track emerging and novel pathogens, including resistant superbugs. We're grateful for McMaster's close collaboration on the implementation of reference data from CARD, which is an integral part of this new capability."

McArthur says that CARD is unique because it combines computer-assisted technology with human curation to ensure that only the best, most accurate, and most up-to-date information is captured.

"We rely on algorithms to read the scientific literature and to suggest what might be relevant, but the knowledge that appears in CARD is all curated by specialists at McMaster,"

he explains. "The core of CARD is a discipline of science called biocuration — it's hand-driven."

Today, the database describes over 7,000 resistance genes and mutations leading to treatment failure in people and animals, as well as drug resistance predictions for 377 important pathogens. These data, McArthur says, are used for an array of research activities, ranging from machine-learning and disease surveillance to pharmaceutical R&D.

And now, through this collaboration, these datapoints will allow for CZ ID users to detect and explore AMR genes in a variety of samples via interactive reports. Importantly, CZ ID is already used in 120 different countries, which will help provide the global research community with new levels of access to CARD data.

McArthur says that this new CZ ID module is the latest in a long string of collaborations for CARD, which is now used by public health agencies, industry groups, and academics based all around the world. For him, the growing utility of the tool signals not only the continued importance of solving drug resistance, but also the "critical role" that metagenomics and data science will play in doing so.

2023'S TOP KNOWLEDGE MOBILIZATION STORIES

McMaster conference focuses on the future of vaccine development, manufacturing, and access

By Beth Gallagher

Society needs next-generation vaccine technology that can be rapidly adapted for emerging outbreaks, because, as we learned during the pandemic, speed saves lives.

"Prevention efforts need to be at least as large as our focus on responding to future outbreaks," said Matthew Miller, director of McMaster's Michael G. DeGroote Institute for Infectious Disease Research (IIDR). "We want to keep people out of hospital until we can make highly specific neutralizing vaccines."

Miller was speaking at The Future of Vaccinology, a symposium hosted by the IIDR and McMaster's Global Nexus, where university experts and international researchers gathered to share developments in vaccine research.

"This symposium embodied the spirit of Global Nexus by bringing together experts from across sectors to discuss one of the most pressing issues of public health," said McMaster President and Vice-Chancellor David Farrar.

Keynote speaker Carl Zimmer, award-winning science author and *New York Times* columnist, opened the symposium with a reminder that COVID-19 vaccines prevented more than 14 million deaths. On the other hand, an additional one million deaths could have been prevented if there wasn't "shockingly poor" distribution to low-income countries, said Zimmer.

As a science journalist covering the pandemic, Zimmer said reporters "very quickly realized we were covering the story of developing vaccines," which he learned is a unique challenge, as promising vaccine candidates often never make it beyond the lab. The transition from laboratory to clinical trials, he said, is a stage known as the "valley of death."

Professor of medicine Zhou Xing is a co-principal investigator with Miller and others at McMaster on the university's inhaled COVID-19 vaccine, which is entering Phase-2 human clinical trials. He said, "We need next-generation vaccines not only for COVID, but for future pandemics."

The McMaster aerosolized vaccine, which is breathed in through the mouth rather than injected with a needle, has been shown to be more protective in preclinical studies, especially against variants of concern. Breathing in a vaccine through the mouth is also better than vaccines administered as nasal sprays, said Xing. When a vaccine is delivered through the mouth rather than nose or arm, the vaccine is deposited directly into the lower respiratory tract, stimulating a much better immune response, said Xing.

Brian Lichty, a professor of medicine and an IIDR member, shared developments on new technology that is designed to treat infectious diseases and cancer. The technology delivers therapy to targeted tumour or immune cells using exosomes, which contain parts that can communicate with other cells.

Lichty said the technology is a personalized medicine approach because, in theory, a patient's own tumour will support the development of the cancer vaccine.

On day two of the symposium, IIDR member Dawn Bowdish shared her team's research on vaccinated older adults living in long-term care and retirement homes. She pointed out that COVID infections are particularly bad for older adults and are associated with increased cardiovascular risk, frailty, and decreased lung function.

"When we think about vaccinating the older population, it's not just about keeping them from dying," said Bowdish. "It's about keeping them healthy so they can have the best twilight years possible."

For older adults, a critical factor that determines vaccine effectiveness is the length of time from the last vaccine, said Bowdish. An earlier study from her team found that one in five vaccinated long-term care residents was at risk of COVID because of low antibody levels. Those early findings prompted a policy change in Ontario in 2021 that resulted in residents getting a booster shot, a move that saved lives.

Sonia Anand, a professor of medicine and lead researcher of the COVID CommUNITY – South Asian research program, presented research about the South Asian community in Canada, with a particular focus on people living in the Peel Region, where there was a very high risk of infection during the early stages of the pandemic. Anand's colleagues at McMaster noticed gaps in the COVID response for South Asian communities, so they created testing centres and translated health information.

"Culturally targeted messaging and provision of materials was a key feature of what we did, and it can be a lesson learned for future pandemics," said Anand.

The research team found that community organizations helped public health officials increase vaccine access and confidence. Anand advised scientists and scholars to begin building relationships now so they can more quickly and effectively support marginalized communities during the next outbreak.

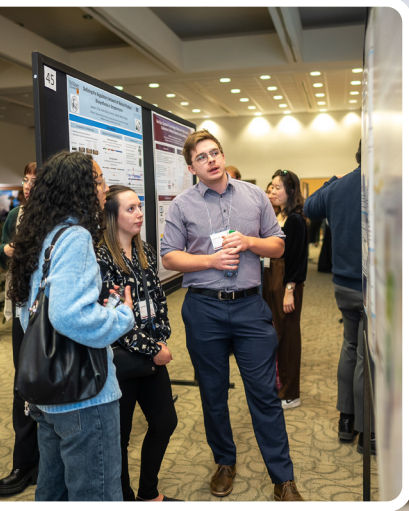
Nicole Blackman, provincial director of the Indigenous Primary Health Care Council, reminded symposium attendees that historical and present-day context is deeply connected to vaccine hesitancy among First Nations, Inuit, and Métis peoples.

Blackman said the history of colonization and racism are critical factors, with the legacy of segregated schools and hospitals being very unsafe places for Indigenous adults and children, who were subjected to testing without consent and abuse, as well as alarmingly high death rates.

"It's all about collaborating," said Blackman. "Be humble and recognize that Indigenous people do know what we're doing, and we know how to care for our people."

The Future of Vaccinology Symposium was rounded out by international experts who spoke on the history and development of vaccines for rotovirus, respiratory syncytial virus (RSV), influenza, and malaria, as well as vaccine policy and methods for evaluating vaccine efficacy and effectiveness.










Trainee Day
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Michael G. DeGroote

INSTITUTE FOR INFECTIOUS DISEASE RESEARCH