

Demonstrating Resilience in a Pandemic: Scientists as First Responders



UNIVERSITY OF
TORONTO

The COVID-19 pandemic has changed the way the world lives, studies and works. With government support and community and industry partnerships, the University of Toronto and its affiliated researchers have mobilized to support Canada’s efforts to combat and control the virus.

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1 INTRODUCTION

Today, we are poised between hope and anxiety. Hope that science, which mobilized in an unprecedented demonstration of global connection and collaboration, will find a path out of the pandemic so that Canadians can resume their lives. Anxiety that a pandemic that has already caused so many losses will not subside without inflicting further costs.

The work of the country's scientists should reassure all Canadians that there is reason for optimism and hope. Supported by [\\$1.1-billion in federal funding](#), academics, clinicians and industry partners are developing options for therapeutic and clinical interventions and medical countermeasures,¹ including supplies of personal protective equipment. Research on developing and producing made-in-Canada vaccines continues. And social scientists, economists and artists are shining a light on the inequities that have been revealed by the pandemic and must be redressed.

The University of Toronto, along with its affiliated hospitals and medical research centres, is on the frontlines of every aspect of the national response. Governments and the public are seeking informed advice from our scientists, whether they are researchers in public health, clinicians or policy leaders.

With deep expertise in epidemiology, public health, artificial intelligence and precision medicine, [U of T scientists were among the first](#) to study the virus. They continue to make breakthrough discoveries about how it attacks and defeats our immune system. Their work has propelled the University to rank in the Top 10 institutions in the world in the [volume of international scientific research](#) on the novel coronavirus.

As this report details, researchers at the University of Toronto and its affiliated hospitals and medical research centres are part of a global scientific community whose work supports the economic, social and intellectual connections between people and countries. Indeed, the connective tissue established during the pandemic among researchers around the world, and between academia, industry and governments, can help us create a more prosperous and equitable world. Learning from the contributions of Canada's and U of T's research community can provide the foundation for a national strategy to transform a health-care crisis into a source of national innovation.

“Across so many fields and in so many different ways, the University of Toronto community is applying its expertise and experience to help Canada and the world resolve this unprecedented global crisis.”

— University of Toronto
President Meric Gertler



2 U OF T RESEARCHERS: FIRST RESPONDERS TO A GLOBAL CRISIS

“If the virus’s genome was a book, we’re going to figure out its entire story,” molecular geneticist **Robert Kozak** said in the early days of the pandemic.

In the subsequent months, U of T researchers have decoded the virus’s genetic profile and have made the University one of the world’s most significant centres for research on the novel coronavirus and its impacts². Of the federally supported research projects on the virus now underway at Canada’s top six research institutions and their hospital and research affiliates, more than 40 per cent are taking place at U of T or one of its network partners.³

This achievement is remarkable, but not surprising.

U of T is a global research and innovation powerhouse, placing in the top 50 in 35 subjects in the Academic Ranking of World Universities. In the [Times Higher Education](#) subject rankings, U of T is [North America’s top public university](#) in the subject of “clinical, pre-clinical and health.” It ranks 27th in the world in Reuters’ ranking of the world’s most innovative universities. It is Canada’s

top university, and North America’s third-highest-ranked public institution in the prestigious [World University Rankings](#). This reputation has translated into a rapid, sustained response that combines established research expertise with advanced tools and techniques and interdisciplinary collaboration.

Scientists at U of T were among the first in the world to begin investigating the virus and its potential impacts. Kamran Khan, an associate professor at the Institute of Health Policy, Management and Evaluation at the Dalla Lana School of Public Health, started BlueDot Inc. in the wake of the SARS virus, seeking a way to develop a warning system against virulent diseases. In December 2019, the company’s technology flagged an unusual cluster of pneumonia cases arising in a market in Wuhan, China. A team of scientists — including infectious-diseases specialist Isaac Bogoch and researchers at the Li Ka Shing Knowledge Institute at St. Michael’s Hospital —



analyzed the data [and published their analysis less than a month later](#).⁴ BlueDot would eventually be [contracted by the federal government](#) to use its data-analysis techniques to inform national modelling and pandemic preparedness.

Two months later, in March, [Samira Mubareka and Robert Kozak](#), in collaboration with McMaster virologist Arinjay Banerjee, isolated the virus, using specimens collected at Sunnybrook Hospital from Canada's first infected patient. Their work gave researchers across Canada a ready supply of virus on which to test treatments. Kozak is now developing a vaccine as part of a [national collaboration with Université Laval](#).

As headlines multiplied about the toll the virus was taking in other countries, Canada's federal government turned to scientists to help solve the emerging national crisis. An initial investment in [March of \\$27-million](#) for academic research on COVID-19 would grow to [more than \\$114.9-million](#) to be granted through the Canadian Institutes of Health Research (CIHR) and its partner organizations. In addition, almost half a billion dollars has been directed towards maintaining and [advancing research during the pandemic](#). In total, \$1.1-billion has been earmarked to support post-secondary researchers, public- and private-sector partners, private-sector vaccine and therapy trials, and Canadian biomanufacturing opportunities, the latter through the [Strategic Innovation Fund](#).

Thanks to CIHR funding of \$42-million for projects at U of T and its partner network, researchers are working on predicting and preventing acute lung damage, testing anti-viral compounds, developing molecular and cellular therapies, driving public communication on risk reduction, fighting discrimination and evaluating population frailty and the risk of acute COVID-19.⁵ Additional [support from Ontario](#) is driving discoveries among researchers at universities across the province, including at U of T. Over 110 federally-supported research teams at U of T and its affiliated hospitals and research centres are addressing the pandemic, one-third of the total number of projects across Canada's leading U15 research universities and their networks.⁶

To support its role as Canada's leading research institution, the University of Toronto translates its knowledge for public benefit. Last August, the Dalla Lana School of Public Health (DLSPH) launched the Institute for Pandemics, which will seek to boost governments' capacity to prepare for future communicable diseases by learning from the current crisis. [With a health-equity lens](#), the Institute aims to consider how inequities revealed by health crises can be addressed during and after a crisis has passed. Adalsteinn Brown, Dean of the DLSPH is co-chair of the Ontario government's COVID-19 Science Table. Jennifer Gibson, director of the University of Toronto Joint Centre for Bioethics, leads the Ontario government's [Bioethics Table](#), which provides ethics input and guidance to support decision-making at the Ministry of Health.

The full extent of the mobilization of the U of T community cannot be captured here, but a selection of projects reveals that research spans all fields, from the Faculty of Medicine to the Faculty of Arts and Science, and across the University's three campuses.

- An historic donation of \$250-million from James and Louise Temerty and the Temerty Foundation is providing transformational support to the Faculty of Medicine, which includes financing the establishment of a new Centre for AI Research and Education in Medicine. This centre will revolutionize diagnostics, drug discovery and patient care and increase capacity to foresee and address future health threats. In gratitude for this landmark gift, the University has named the Faculty the Temerty Faculty of Medicine.
- The Temerty Foundation advanced \$10-million of this donation in April to expand U of T's Containment Level 3 facility and enable other efforts to accelerate the scope and pace of COVID-19 research.
- 31 labs on campus at the Temerty Faculty of Medicine are now conducting research into COVID-19 with 250 faculty, learners and staff engaged in this work.

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- Approximately 40 faculty members are researching multiple aspects of the pandemic through the \$10.35-million COVID-19 Action Fund. The fund received 338 applications soon after it opened, and the University announced its first recipients less than 30 days later, after a peer-reviewed evaluation process. Researchers are developing therapeutics, studying how to assist vulnerable populations, and tending to the mental-health needs of front-line workers.
 - The Creative Destruction Lab at the Rotman School of Management launched a new stream in its startup programs, CDL Recovery. CDL Recovery is the latest addition to an initiative that brings together science-based entrepreneurs, mentors and investors. The Lab is a model that has now been exported to eight other universities around the world. With a global mandate and mentorship team, CDL Recovery aims to provide information-based solutions to the multiple crises engendered by the pandemic.
 - A \$1-million gift from the Vohra Miller Foundation supported the establishment of the Institute for Pandemics at the Dalla Lana School of Public Health, allowing the school to bring in experts and new students, who are applying an interdisciplinary lens to population-wide health and equity issues.
 - At all levels of government, U of T experts in public health and public policy are serving as trusted advisors. They are members of the federal government's COVID-19 Immunity Task Force, its Therapeutics Task Force, and the Ontario government's COVID-19 Science Advisory Table, among others. When Canada's media outlets seek an expert opinion, they turn to U of T researchers first.⁷
 - With targeted federal funding from the Social Sciences and Humanities Research Council's Partnership Engage Grants, U of T faculty are developing policy recommendations for recovery strategies for small and medium-sized enterprises in Ontario, and for increasing access to drug trials for diverse populations, among other topics.

“This is just a completely different way of doing science. As researchers with deep expertise in specific disciplines, we don’t typically pivot to new areas like this. But I think so many of us have realized that we have the biggest crisis of our lifetime on our hands, and we need to be helping to find a solution now.”

— **Prof. Shana Kelley**, director of PRiME, the Precision Medicine Initiative at U of T



The Power of Research Networks

In a crisis, research networks forged over decades of collaboration became engines of rapid knowledge creation. Last January, watching news coverage of the emerging virus, hospitals in the Toronto Academic Health Science Network (TAHSN), in partnership with the University of Toronto, drafted plans to manage the health and social impacts of any possible global outbreak. As the pandemic continued to grow, the network created [extensive resources](#) to maintain learning continuity for students on clinical placements at hospitals. Possible shortages of medical staff also led the network and the [Temerty Faculty of Medicine](#) to [provide guidance documents and training](#) for clinicians who may be deployed to work in critical-care units on an emergency basis.

PRiME, U of T's precision medicine initiative, brought together a multidisciplinary team to investigate the biology of the virus, and to accelerate the development of new diagnostic tools and

therapeutics. These leading experts on diagnostic development, drug discovery and disease biology are now pursuing medical advances that will allow us to combat not just COVID-19, [but future pandemics](#). Research teams at the University are working closely with clinicians at Sunnybrook Health Sciences Centre and the [Hospital for Sick Children](#).

U of T startups in the health sector pivoted to meet the demand for fast, accurate information to address the virus and the new demands it created. DNASTack, a research software company co-founded by U of T alumnus Marc Fiume, launched its [COVID-19 Beacon Network](#) tool, a search engine that indexes genetic information about the virus, speeding up the sharing of information among scientists around the world. [Hypercare](#), an app developed by U of T alumnus Albert Tai to facilitate fast communication among hospital staff, was [piloted at East York's Michael Garron Hospital](#). And MedEssist, a platform that provides a patient communication and scheduling solution for flu shots, has integrated vaccine deployment into its product offerings.

Startup app Hypercare was piloted at East York's Michael Garron Hospital.



The U of T Advantage: Artificial Intelligence and Machine Learning

In recent years, there has been significant public reinvestment in discovery science, and in foundational research on Artificial Intelligence. This funding has significantly advanced many multidisciplinary and collaborative research initiatives at U of T. Since 2017, the Pan-Canadian Artificial Intelligence Strategy has catalyzed Toronto as a hub of scientific collaboration, attracting a significant home-grown and global talent base. Across Canada, the AI Strategy has enabled the creation of more than 670 companies in Canada as of 2019.

Our researchers are now using the tools of machine learning and AI to target COVID-19, accelerating the pace of discovery.

- The Vector Institute for Artificial Intelligence is harnessing its data-processing power — 240 cutting-edge NVIDIA Quadro RTX 6000 Graphics Processing Units (GPUs)— to help the Ontario government launch and operate the [Ontario Health Data Platform](#), a provincial government initiative to [detect, plan and respond to the pandemic](#). In addition, experts at the Schwartz Reisman Institute for Technology and Society at the University of Toronto proposed a conceptual model for protecting the privacy of individuals while preserving as much utility in health data as possible. Their work has the potential to be applied to other health care challenges.
 - Through SciNet4Health, U of T has teamed up with semiconductor giant AMD to securely analyze massive amounts of health data, accelerating the work of its clinician-scientists and partner hospitals. This initiative will allow the University to further its research in vaccine development and drug discovery.
- Dozens of faculty, post-docs and graduate students at Vector are attacking the virus on multiple fronts. Among these researchers is Marzyeh Ghassemi, assistant professor of computer science and medicine, and a Canada CIFAR AI Chair at Vector. Ghassemi is co-leading a project to develop an AI tool to classify chest X-rays for diagnosing COVID-19.
 - Alán Aspuru-Guzik, another Canada CIFAR AI Chair at the Vector Institute and the Canada 150 Research Chair in Theoretical & Quantum Chemistry, is working to identify [novel therapeutic candidates to target the virus](#).



Alan Aspuru-Guzik, Canada CIFAR AI Chair at the Vector Institute is identifying therapeutic candidates.

CL3 Lab

To defeat the SARS-CoV-2 virus, researchers must first understand it. That means conducting research on a virus that has been classified as a Risk Group 3 pathogen and can only be studied in a Containment Level 3 Unit.

The Faculty of Medicine's CL3 lab is a resource for all Canadian researchers. As part of a historic \$250-million gift from James and Louise Temerty and the Temerty Foundation, the CL3 lab expanded quickly at the beginning of the pandemic. The lab's virus biobank now houses samples of the SARS-CoV-2 virus, and researchers are welcome to use the facility at any hour of the day or night.

Molecular Genetics professor Scott Gray-Owen used the CL3 lab to establish the efficacy of a made-in-Canada solution that reduces the risks for health-care workers. An antimicrobial coating developed by the Quebec company I3 BioMedical Inc. reduces the risk of contracting and transmitting the virus by more than 99 per cent. Robert Kozak's work on vaccines, with Gary Kobinger of Laval University, is also based at the CL3 lab.



COVID-19 Action Fund

U of T is supporting more than 30 of its own groundbreaking researchers with an Action Fund that relies on private donors and University resources. Among these projects is a protein production initiative that brings down the cost of research on the virus for other scientists. The newly launched non-profit [Toronto Open Access COVID-19 Protein Manufacturing Centre](#) provides researchers with any of the approximately 25 viral proteins contained in the structure of SARS-CoV-2.

Scott Gray-Owen, molecular genetics professor, worked with Quebec company I3 BioMedical Inc. to test an antimicrobial mask coating.

3 SUPPORTING STRONGER COMMUNITIES

Canada's example to the world during the pandemic reaches beyond our advanced knowledge and policy advice. Canada's promise is to transform the crisis into an opportunity to build back stronger communities. It was these values that prompted our faculty, staff and students across three campuses to gather tens of thousands of pieces of PPE, provide child care to front-line workers and organize food drives for those in need or in isolation.

Throughout the pandemic, U of T social scientists and public health experts have called attention to structural inequities that have led to higher transmission and mortality rates among disadvantaged and racialized people.

In March, Andrew Boozary, Executive Director of Population Health and Social Medicine at the University Health Network, began leading the Toronto region's COVID-19 homelessness response, with colleagues and co-leaders Andrew Bond, a lecturer at the Faculty of Medicine and Medical

Director of Inner City Health Associates, and Angela Robertson, Executive Director of the Parkdale Queen West Community Health Centre. The team advised the City of Toronto on how to provide spaces for homeless people to isolate and recover after testing positive.

More recently, the Canadian Partnership for Tomorrow's Health, hosted by the University of Toronto's Dalla Lana School of Public Health, received a \$1.9 million investment from Canada's [COVID-19 Immunity Task Force](#) to fund a study of COVID 19 seroprevalence across Canada. The study focuses on populations that are at higher risk of exposure to COVID-19, including residents of long-term care homes and people living in underserved communities.

At the Institute for Gender and the Economy at the Rotman School of Management, a partnership with YWCA Canada produced an eight-point [Feminist Economic Recovery Plan for Canada](#). The plan looks

Nelson Saddler, a second-year medical student at U of T, gets groceries for busy health-care staff during the novel coronavirus outbreak.



at the reasons that women, particularly those who are racialized or live with a disability, have borne the brunt of the fallout from the pandemic, and proposes “a new path forward... with a focus on supporting the care economy, investing in social infrastructure and supporting women-owned businesses.”

The contributions of social scientists at U of T show the scope of the challenge before us. **Funding from CIHR** is enabling the following social-science-focused projects, among others:

- A research team led by Joseph Gillis, a professor in OISE’s Department of Applied Psychology and Human Development, is examining how the virus promotes stigma and misinformation, and how to fight these twin challenges.
- Professor Esme Fuller-Thomson, director of the Institute for Life Course and Aging, is studying the course of the disease in older adults, with the goal of better identification of the most vulnerable.

The **U of T COVID-19 Action Fund** is supporting a number of social science research projects led by University of Toronto professors, including:

- Blake Poland, at the Dalla Lana School of Public Health, is learning from community-led responses to the pandemic.
- Scott Schieman, at the Department of Sociology, is studying how the pandemic has changed the way Canadians work.
- Rima Styra, at the Faculty of Medicine, is researching mental-health outcomes in health-care workers.
- At U of T Scarborough, sociology professor Joseph Hermer is studying the criminalization of homelessness in Canada, with the goal of providing recommendations on how to learn from the pandemic and reduce such approaches.

Through the [Social Sciences and Humanities Research Council’s Partnership Grants](#), University of Toronto researchers are leading or collaborating on multiple projects, including:

- Brenda Gladstone, at the Dalla Lana School of Public Health, is working with researchers at Unity Health to study how the arts can help young parents connect and reduce inequality between families.
- Enrica Piccardo, at the Ontario Institute for Studies in Education, is looking at pedagogically innovative ways to foster language learning online.
- Marcelo Vieta, also at OISE, is working with a community partner to help small and medium-sized businesses that are considering converting to a co-op to survive the pandemic.

U of T students are directly involved in many aspects of this research. In [Joseph Wong’s seminar at the Munk School of Global Affairs & Public Policy](#), students have connected with counterparts at Tec de Monterrey in Mexico City; the two classes are comparing the impact of the pandemic on inequality in each country. At OISE, [Marcelo Vieta’s class created a website](#) featuring ideas on how to re-structure the economy so it benefits everyone. The site offers strategies to help African-Canadian businesses, promote credit unions, encourage tenant organizing and improve employment conditions for temporary or gig workers.

Finally, as the federal government’s Throne Speech recently expressed, “We cannot eliminate this pandemic in Canada unless we end it everywhere.”



Carmen Logie, associate professor at the Factor-Inwentash School of Social Work

At U of T, researchers are developing solutions that are practical and affordable for low- and middle-income countries. Carmen Logie, associate professor at the Factor-Inwentash School of Social Work, is working with community groups serving youth in Uganda to help them reduce virus transmission. Keith Pardee has designed a “lab-in-a-box” that serves as a portable diagnostics kit for use in developing countries and remote areas. Pardee, the Canada Research Chair in Synthetic Biology in Human Health, modelled the technology on a similar intervention he developed with colleagues in 2016 to address the Zika virus.

Translating Research To Public Communication

How can rapidly developing science more closely inform government policies on the pandemic? The [CanCOVID](#) network, established last summer and housed at the Dalla Lana School's Institute for Health Policy Management and Evaluation, connects more than 2,300 researchers across Canada to supply the federal government with evidence.

At the School of Cities, planning for Toronto's post-pandemic future began last summer. With its [Coronavirus and the City: One Question](#) initiative, the research centre on urban issues facilitates conversations among city leaders on work, transit, neighbourhoods, equity and the role of the arts in rebuilding. Working with Colorado State University colleague Michael Seaman, economist and scholar-in-residence Richard Florida has argued that cities that support the creative economy will recover faster. “Cities are going to come back stronger,” Florida says.

What's Next podcast?

Throughout the crisis, U of T scientists with extensive experience in public communications have kept Canadians informed about how to guard their health and help their communities. Vivek Goel, a professor at the Dalla Lana School of Public Health, launched a podcast to explain public health measures to the general public and the U of T community. As the founding head of Public Health Ontario and a member of the federal government's COVID-19 Immunity Task Force, Goel is uniquely positioned to offer an informed perspective. His popular podcast has recorded more than 30 episodes.

4 CONCLUSION: LESSONS FOR THE FUTURE

Throughout the pandemic, Canada's extraordinary science community has continued to be a crucial partner to government, offering a sustained response that is changing the virus's trajectory for individuals and society. Applying tools and solutions developed through discovery science, leveraging both established and new relationships between researchers and entrepreneurs, and expanding global collaborations, scientists at U of T are creating a positive legacy from one of the worst crises to confront humanity in generations. There can be no better evidence of the benefits that accrue when a country recognizes science as part of its economic and social development.

As we rebuild, research across diverse fields— from medicine to economics to sociology— can be a source of economic renewal. It can lead to new, made-in-Canada health-care innovations in regenerative and precision medicine, collaborations with industry in sectors such as biotech and AI, and a resilient economy.

In September, a [gift of \\$250-million to the Faculty of Medicine](#) from the Temerty Foundation, the single-largest gift ever in Canada, became another example of how a cluster of advanced research centres can create new fields of knowledge and scientific breakthroughs. Part of the Temerty donation will support a new Centre for AI Research and Education in Medicine, headed by Muhammad Mamdani, vice president of data science and advanced analytics at Unity Health Toronto. The centre will deploy U of T's internationally recognized strengths in artificial intelligence, machine learning and deep learning to forecast and prevent future health-care crises.

At the same time, the pandemic has brought hardship to so many Canadians. It has preyed upon the most vulnerable in our society—those whose age, insecure employment, inadequate housing or other factors have left them particularly exposed to the effects of COVID-19. One of the lessons of the pandemic is that improving societal resilience must begin with remedying inequality. Future generations must be confident that today's rapid advances in science will serve as the foundation for renewed investments in our scientific and community-health infrastructure, which can help prevent future viruses from hijacking lives and economies.

In the coming years, Canada will face challenges— some anticipated, such as an aging population, others not yet visible, such as the timing of another pandemic. With the confidence and knowledge built during this pandemic, Canada can be an international leader in addressing the problems of tomorrow, thanks to the tremendous contributions of our innovators in biotech, artificial intelligence and precision medicine.

Already, [other jurisdictions are looking ahead to the transformational commitments](#) needed to address the many effects of the pandemic. Japan's Moonshot R&D program, for example, includes the development of a disease forecasting and intervention system. Australia has pledged \$500-million to genomic-based testing. Other efforts focus on promoting closer coordination between public and private entities, such as the United States' ACTIV public-private partnership on treatments and vaccines, and Ireland's Rapid Response Research and Innovation Funding Programme.

Similar approaches to commercialization of university research could be pursued through Canada's Strategic Innovation Fund (SIF), which has pledged \$600-million to the private sector to support vaccine and therapy clinical trials. One model can be found in the National Research Council's [Pandemic Response Challenge Program](#), part of its high-risk, high-reward initiative. Another path forward may lie through the [New Frontiers in Research Fund](#), which prioritizes the type of interdisciplinary research that addresses the multiple layers of the virus's impact.

In addition, measures that restart and re-commit to Canada's talent pipeline, drawn from top talent nationally and globally, will ensure the country has the people it needs to make "game-changing scientific discoveries," in the [aspirational words of the National Research Council](#). In short, how do you manage a pandemic? Canada is doing it by rapidly mobilizing researchers to contribute their talent, dedication and expertise to address its impacts on every aspect of human life. The approach demonstrates what is possible when government, universities and the private sector work together toward a common future.

"COVID-19 has exposed the limits of government and world bodies in detecting and responding quickly to emerging global disease threats. Universities have the range of expertise, the freedom to move quickly, the credibility of political neutrality and a duty to work closely with governments and other institutions to effectively respond."

— **Adalsteinn Brown**

Founding director of the Institute for Pandemics and Dean of the Dalla Lana School of Public Health



Endnotes

- 1 <https://betakit.com/feds-to-provide-600-million-for-sif-to-fund-private-sector-trials-of-covid-19-therapies/>
- 2 <https://www.utoronto.ca/news/u-t-and-sunnybrook-virologists-work-tools-combat-coronavirus-outbreak>
- 3 <https://www.utoronto.ca/news/we-re-learning-more-every-day-how-u-t-leading-efforts-understand-and-respond-covid-19>
- 4 Based on grants disbursed by the Canadian Institutes of Health Research.
- 5 Calculations based on CIHR funding results database:
<https://webapps.cihr-irsc.gc.ca/decisions/p/main.html?lang=en#sort=namesort%20asc&start=0&rows=20>
- 6 University of Toronto calculation based on CIHR database, data available on request.
<https://webapps.cihr-irsc.gc.ca/decisions/p/main.html?lang=en#sort=namesort%20asc&start=0&rows=20>
- 7 Data tabulated by Cormex Research.



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