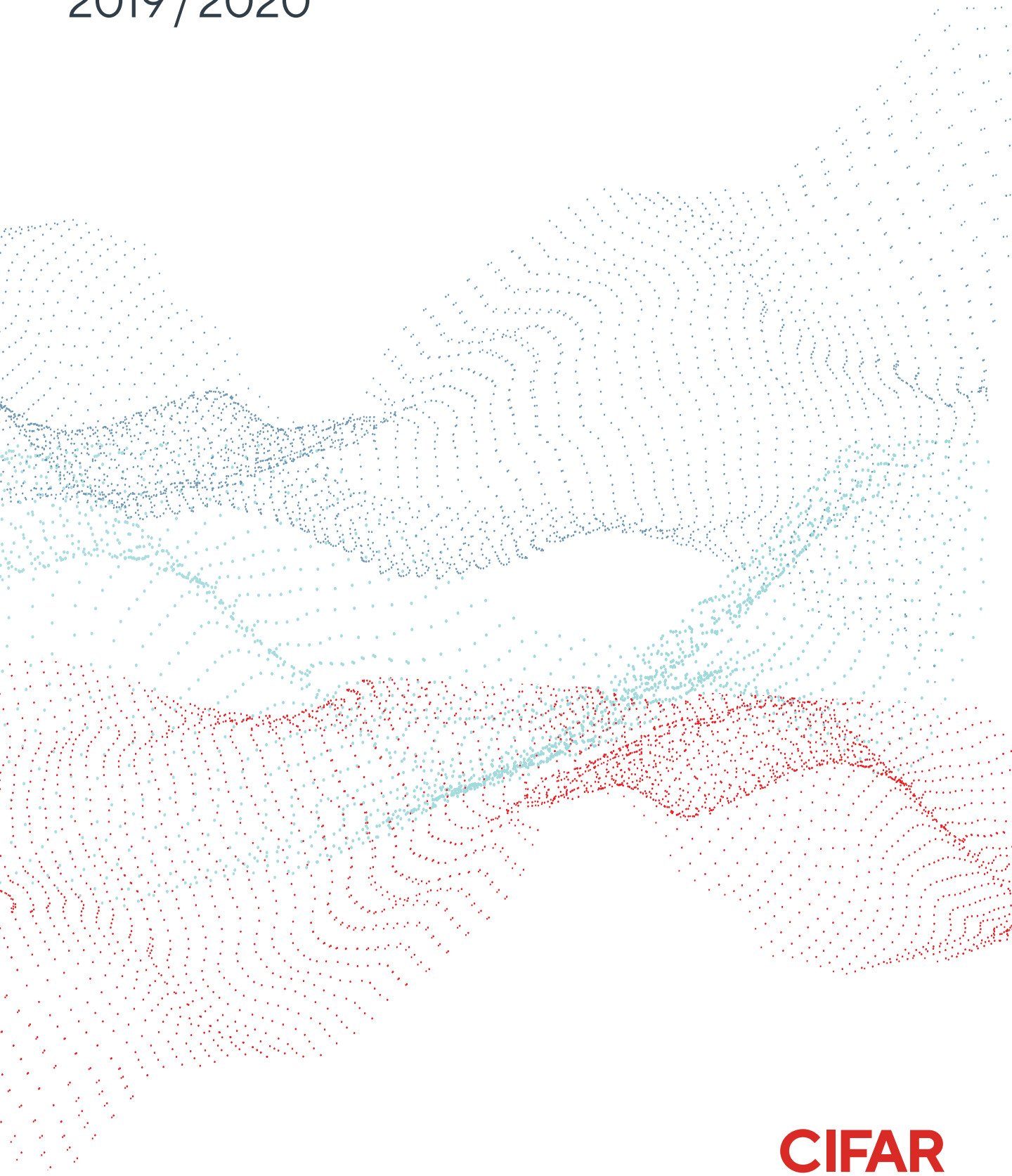
IMPACT REPORT

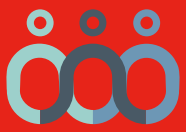
2019 / 2020



CIFAR

Equity, Diversity & Inclusion

CIFAR's success is built on the combination of diverse perspectives. We acknowledge that there is more we can do to ensure that underrepresented groups, who experience systemic barriers in science, research organizations, and academia, are included in our organization and in our programs and initiatives.



In April 2020, CIFAR's first ever Action Plan on Equity, Diversity, and Inclusion (EDI) was unanimously approved by our Board of Directors. In it, we articulate our commitment to practices that promote Equity, Diversity, and Inclusion.

We commit to:

- Championing EDI efforts throughout the organization, especially at the Board and senior leadership levels
- Creating ongoing opportunities for training and education in EDI topics
- Developing frameworks for recruitment at CIFAR informed by EDI principles
- Reporting on EDI efforts internally and externally
- Embedding EDI into our fellowship, application, and program review processes
- Supporting EDI within the broader research community

The Action Plan represents the culmination of a year of activity led by an internal working group and consultants. A thorough discovery, development, and research phase, including a confidential survey of CIFAR's community, informed the final Action Plan.

Women have traditionally been underrepresented in CIFAR programs. The proportion of women profiled in this report does not reflect their representation in our community of fellows, scholars, advisors and donors. While we have chosen to overrepresent women in this report, we acknowledge that cultural diversity among those profiled is lacking. This aspect of diversity is reflective of our current community and is one of the equity, diversity, and inclusion issues we are working on as an organization.

CIFAR is located in the MaRS West Tower at 661 University Avenue in Toronto.

For thousands of years, this area has been the traditional territory of many nations including the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit. Today, this meeting place is still home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work, learn, and share on this land.

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MESSAGE FROM OUR CHAIR

As we begin to look to our future beyond the pandemic, it is clear that the transformative advances needed to bring about a safe and prosperous future will come from networks of extraordinary minds who are unconstrained by geographic borders.

When I accepted the nomination to chair CIFAR's Board of Directors, COVID-19 had not yet dominated research agendas, policy debates, and dinner table conversations.

I accepted the role because CIFAR is an essential part of the global research and innovation landscape, filling a unique niche that complements the work of universities, governments, and the private sector. CIFAR convenes extraordinary minds with the intellectual weight of the world's top universities and the agility and ingenuity of a start-up. Our research community navigates complexity through interdisciplinary collaboration, inspiring new ideas and solutions. In my opinion, the world needs more CIFAR.

I could not have known how my conviction about CIFAR's necessity would be proven by the COVID-19 pandemic, and I could not be more proud of how much CIFAR contributed to the world in this time of great need. From its home in Canada — with international reach — CIFAR brought together world-leading experts to stimulate important discussions and share best practices.

Faced with a crisis, CIFAR's community of staff, donors, fellows, advisors, chairs, and CIFAR Azrieli Global Scholars sprang into action, convening important conversations and supporting much-needed research on the biology of COVID-19 as well as its political, technological, and social implications. Our global network of leading researchers came together to address critical questions of safety, efficacy, ethics, and responsibility, and CIFAR immediately delivered those insights to policy-makers. In addition, our President & CEO, Dr. Alan Bernstein, who built an international career leading key science organizations during crucial times, has quickly emerged as a trusted global leader in the COVID-19 pandemic, identifying knowledge gaps, influencing policy directions, and catalyzing new directions for research.

As we begin to look to our future beyond the pandemic, it is clear that the transformative advances needed to bring about a safe and prosperous future will come from networks of extraordinary minds who are unconstrained by geographic borders.

I am proud to lead this organization, as both a donor and the Board chair. Now, more than ever, I am convinced that our approach is essential, and I am delighted to have the opportunity, together with our exceptional Board of Directors, to guide CIFAR towards a truly remarkable fifth decade.

William L. Young

Chair, CIFAR Board of Directors

MESSAGE FROM OUR PRESIDENT & CEO

As I write this, the world is going through a period of tumultuous change. The topics that dominated the news in the last six months of 2019 — wildfires in Australia, climate change rallies, pipeline protests in Canada, and political turmoil in the U.K. — all now seem distant. Those memories have been replaced by unprecedented social and economic upheaval in virtually every country on the planet.

During the COVID-19 pandemic, science and our trust in its results have become the beachhead in our battle against the virus; PCR tests, neutralizing antibodies, and RNA vaccines have become part of everyday conversations.

The pandemic has thrust science onto centre stage, and researchers from across every discipline — epidemiologists, social scientists, ethicists, virologists, clinical trialists, and drug developers — are addressing the questions and providing the tools needed to shape our successful response to the COVID-19 pandemic.

At the outset of this pandemic, we had to decide how CIFAR would respond.

We reinforced ties within our community of fellows by continuing regular meetings of our global research programs, adapting to the new constraints of virtual gatherings, and providing opportunities to connect researchers keen for deep, stimulating discussions.

But that wasn't enough. As we reflected on our strengths, it became clear that our convening power and global community of extraordinary minds could support high-impact research with immediate relevance to the pandemic.

Right away, we convened important, high-level discussions on artificial intelligence in the pandemic and provided counsel to the Office of the Chief Science Advisor of Canada on new technologies such as contact-tracing apps. We launched a series of virtual talks showcasing the extraordinary research of our fellows and funded collaborative projects addressing social and laboratory aspects of the pandemic.

Nearly one-quarter of our global community of over 400 fellows, CIFAR Azrieli Global Scholars advisors, and Canada CIFAR AI Chairs also pivoted their research to address COVID-19. For example, Eran Elinav, a fellow in our Humans & the Microbiome program from the Weizmann Institute in Israel, is developing a new PCR-based diagnostic test for the virus; Marzyeh Ghassemi, a Canada CIFAR AI Chair at the University of Toronto and the Vector Institute, is using artificial intelligence to detect early signs of COVID-19 in lung scans; Allison Harell, a fellow in our Boundaries, Membership & Belonging program and a professor at l'Université du Québec à Montréal, is analyzing levels of fear, personal social distancing behaviour, norms around social distancing, and satisfaction with governments' handling of the pandemic.

The list goes on.

CIFAR's community of fellows is addressing these timely societal questions with the same intensity, excellence, and curiosity they use to address the long-term, complex questions that drive our research programs.

COVID-19 is shining a light on existing strengths and weaknesses in the fabric of our societies. Through all of this, one thing remains clear: CIFAR's unique role as the global convenor of extraordinary minds addressing questions of importance to science and humanity is more important than ever.

Thank you for your interest and your support. As you read this year's report, you will be struck by the impact of CIFAR's global community. Their new ideas are driving profound change.

Dr. Alan Bernstein
OC, OOnt, PhD, FRSC/MSRC

President & CEO

A Global Research Organization

CIFAR convenes extraordinary minds to address the most important questions facing science and humanity.

By building long-term, interdisciplinary, global communities of collaboration, we provide the world's top researchers with an unparalleled environment of trust, transparency, and knowledge sharing. Our time-tested model inspires new directions of inquiry, creating a culture of risk-taking, accelerating discovery, and yielding breakthroughs across borders and academic disciplines.

Through knowledge mobilization, we are catalysts for change in industry, government, and society.

In 2017, the Government of Canada appointed CIFAR to develop and lead the Pan-Canadian Artificial Intelligence (AI) Strategy, the world's first national AI strategy.

CIFAR's community of fellows, advisors, CIFAR Azrieli Global Scholars, and Canada CIFAR AI Chairs has included 20 Nobel laureates and now counts more than 400 researchers in 18 countries. We are supported by the governments of Canada, Alberta, British Columbia, Ontario, and Quebec, Canadian and international partners, as well as individuals, foundations and corporations.

CIFAR: WHAT'S IN A NAME?

[see-far]

As our organization has evolved over the last four decades, so has our name. Today, CIFAR symbolizes the global, interdisciplinary, and limitless nature of our focus.

There has never been a more important time for CIFAR's approach to research.

CIFAR has been supporting top interdisciplinary researchers, marshalling knowledge, and influencing action in industry, government, and society for nearly 40 years.

Our model has led to numerous landmark advances, including in AI, quantum computing, the recognition of the importance of a child's early years, and the socio-economic determinants of health.

Now, we are uniquely positioned to mobilize action and innovation to address the critical social, health, economic, environmental, and political challenges magnified by COVID-19.

The CIFAR Model

MOST IMPORTANT QUESTIONS FACING SCIENCE AND HUMANITY

- Global, interdisciplinary research networks
- Open Inquiry
- Sustained long-term commitment
- Environment that fosters risk taking, trust and collaboration

Our model reinforces five interconnected pillars of excellence:

Pursuing high-risk, high-reward questions with the potential to drive profound change through our global research programs

Accelerating discovery through next generation initiatives and Catalyst Funds

Strengthening Canada's leadership in disruptive new technologies including AI, through the Pan-Canadian AI Strategy, and quantum computing

Creating societal impact through our Knowledge Mobilization program

Stimulating scientific curiosity through our public engagement program

Leading in a Pandemic

CIFAR took immediate action during the COVID-19 pandemic, leveraging our experience as a global convenor of multilateral discussions to address the most urgent questions facing science, society, and governments.

FUELLING INNOVATION

We allocated two rounds of high-impact rapid-response funds, supporting new research collaborations that address COVID-19.

Our COVID-19 Action Fund was launched to support responsive, meaningful actions and collaboration during the pandemic.

The Action Fund was supported by individuals, partners, foundations, and corporations, raising $325,000 by the end of the fiscal year. All donations to the Action Fund support initiatives such as our high-impact rapid-response grant programs that spur innovation and research collaborations.

Shortly after COVID-19 was declared a pandemic by the World Health Organization, we issued a call for innovative, high-risk, high-reward proposals that use AI to address the pandemic.

Fourteen research projects were selected. Among them were efforts to repurpose existing drugs, research to identify at-risk populations, and social media analyses to understand the mental health implications of the pandemic. CIFAR's AI & COVID-19 Catalyst Grants Program was supported in part by the Government of Ontario, Microsoft through the AI for Health (AI4H) program, the Max Bell Foundation, the Natural Sciences and Engineering Research Council of Canada (NSERC), and Genome Canada.

Building on our long-standing partnership, CIFAR and Manulife launched a new program to provide seed funding for projects to address the impact of the pandemic on society.

Projects funded through the Manulife CIFAR Population Health & Well-being Grant Program explore the myriad effects of social distancing and the lifelong impact of the crisis on health and development. Outcomes of projects may immediately affect community-based screening tools, wearable technologies, and the use of robots in healthcare or with the elderly. They will also have longer-term implications for policy and governance.

A History of Impact in Population Health

The partnership between Manulife and CIFAR began in 1987, coinciding with Manulife's 100th anniversary. Since then, Manulife has been a committed partner, supporting pioneering research in health and social sciences that has informed the development of policies and practices to improve the health, well-being, and resilience of communities across Canada.

SPOTLIGHT: Three CIFAR AI and COVID-19 Catalyst Grant projects use AI to address the pandemic

Using AI to look through the existing medicine cabinet of approved drugs

A team including Canada CIFAR AI Chairs Jian Tang (HEC Montreal/Mila), William Hamilton (McGill University/Mila), and Yoshua Bengio (Université de Montréal/Mila) is using machine learning to find drugs that affect the same proteins targeted by COVID-19. Their approach is similar to the way social networks recommend friends. "In social networks, for example, you want to recommend friends based on existing links," says Tang. "In this case, it's the same intuition. Based on the existing links between the drugs and proteins and the proteins and disease, we try to predict those new links."

Another approach, championed by a Toronto team led by CIFAR Azrieli Global Scholar Jean-Philippe Julien (University of Toronto, The Hospital for Sick Children) and Costin Antonescu (Ryerson University) is testing AI-identified drug candidates in cellular assays. With labs already set up to investigate the interactions between drugs, cells, and viruses, Julien and Antonescu are turning their attention towards SARS-CoV-2.

Who is most at risk from COVID-19? Data can tell us.

An Alberta team including data scientist Randy Goebel (University of Alberta/Amii) and Canada CIFAR AI Chair Martha White (University of Alberta/Amii) believe that, by analyzing large amounts of comprehensive health data that includes COVID-19 status, they will be able to tease out subtle connections and identify vulnerable segments of the community.

With the help of medical doctors, sociologists, and ethicists at the University of Alberta and Alberta Health Services, Goebel and White are working to gain simple, uniform, and secure access to health data from across the province, apply machine learning models, and communicate their findings to the public.

Analyzing tweets to check in on the world's mental health

Faced with hurdles such as home schooling, unemployment, and social distancing from friends, colleagues and families, many people around the world have experienced new and worsening mental health issues.

Alona Fyshe, a fellow in CIFAR's Learning in Machines & Brains program and Canada CIFAR AI Chair based at the University of Alberta, is working with a team of computer scientists to apply AI techniques to social media to better understand these challenges and what impact they have on our mental health.

CONNECTING GLOBAL EXPERT COMMUNITIES & MOBILIZING KNOWLEDGE

In the first few months of the pandemic, we quickly connected scientists and organizations for discussions and advice on AI, data, ethics, contact-tracing apps, and changing social dynamics.

Our roundtable on AI and COVID-19 brought together international experts and resulted in a comprehensive report for policy-makers.

Led by CIFAR, a group of 70 Canadian and international leaders in AI, business, infectious disease, epidemiology, and medicine explored opportunities for collaboration and data sharing. Within 12 hours, we published a comprehensive report on the policy-relevant insights that emerged from the expert roundtable. This report was used at a virtual policy briefing of more than 50 policy-makers and health officials from federal and provincial governments across Canada, the U.S., and the U.K.

We laid the groundwork for collaborations and sparked new ideas for interdisciplinary inquiry around COVID-19.

Our Call to Action on Machine Learning & COVID-19 for fellows, CIFAR Azrieli Global Scholars, and advisors in our Learning in Machines & Brains program resulted in several collaborations across the program and led to the first joint CIFAR–European Laboratory for Learning and Intelligent Systems (ELLIS) meeting on contact tracing.

A Pandemics & Expanded Personal Space workshop that brought together fellows from seven research programs defined critical questions and opportunities caused by the sudden shift in social interaction.

We created a clear reference for governments on the implications of deploying novel technologies in response to COVID-19.

At the request of the Chief Science Advisor of Canada, Dr. Mona Nemer, we established an expert advisory group of senior scholars to advise on the technical, social, legal, and ethical considerations for deploying novel technologies in response to COVID-19, with a particular focus on contact-tracing apps. This independent group, chaired by the Vice-Chair of CIFAR's Board of Directors and former deputy Prime Minister Anne McLellan, included leading Canadian experts in law, regulatory innovation, AI, epidemiology, clinical care, philosophy, ethics, and public policy. Their recommendations included a framework of guiding principles and specific implementation advice for government.

GROUNDBREAKING RESEARCH

Nearly one-quarter of our global community of over 400 fellows, advisors, Canada CIFAR AI Chairs and CIFAR Azrieli Global Scholars have focused their research to address the challenges of COVID-19.

Their projects span six broad thematic areas:

- **COVID-19 Response Leadership**
- **Biology of SARS-CoV-2**
- **Epidemiology & Transmission**
- **Medical Countermeasures**
- **Social & Economic Impact**
- **Mental Health & Well-being**

GLOBAL REACH

We highlighted the research insights and work of our global community by launching a series of free, virtual public talks held every other week entitled "Science Is the Exit Strategy."

The talks covered community approaches to COVID-19 screening, what past pandemics can teach us about today's pandemic, and combining X-ray diagnostics with AI to predict COVID-19 severity, among other important topics.

In the first four months of the pandemic, our community of researchers and members of our executive team were featured in more than 8,300 news stories worldwide.

CIFAR experts were cited by *Barrons,* the BBC, CBS News, *The Guardian, The Hill Times, The Independent, National Geographic, The New York Times, Science,* and many other international media outlets.

EVOLUTION OF THE PANDEMIC

MARCH 15
CIFAR begins working remotely and pivots to virtual meetings and engagements

MARCH 23
AI & COVID-19 Catalyst Grants call for proposals launched

MARCH 24
AI & COVID-19 Virtual Policy Briefing

APRIL 21
Society, Technology & Ethics in a Pandemic (STEP) Expert Advisory Group first meeting

APRIL 30
STEP Expert Advisory Report published

MAY 12
AI & COVID-19 Catalyst Grant projects announced

JUNE 16
Pandemics & Expanded Personal Space workshop

MARCH

1

2

MARCH 20
CIFAR Learning in Machines & Brains Program Call to Action: Machine Learning & COVID-19

MARCH 23
CIFAR International Roundtable on AI & COVID-19

3

APRIL

APRIL 6
COVID-19 Action Fund launched

APRIL 30
Science Is the Exit Strategy: CIFAR Virtual Talks launched

MAY

4

MAY 26
Manulife CIFAR Population Health & Well-being Grant Program launched

Manulife

JUNE

5 •••

1 **MARCH 11**

The World Health Organization declares COVID-19 a global pandemic

2 **MARCH 17**

The Government of Ontario enacts a Declaration of Emergency

3 **APRIL 2**

Worldwide cases reach 1,000,000

4 **MAY 15**

The official global death toll passes 300,000

COVID Alert
Let's protect each other
Canada
Health Canada Santé Canada

5 **JUNE 18**

The Government of Canada announced plans for a nationwide COVID-19 contact tracing app

Ideas Driving Profound Change

When most of us think of world-changing outcomes from science and research, we often do not consider the decades of work that led up to the discoveries that make headlines.

Time allows researchers to challenge paradigms and explore high-risk ideas for high-reward outcomes, and that's why time is a central ingredient in CIFAR's unique approach to advancing knowledge.

Through our research programs, we provide an environment of open inquiry and the time our fellows, advisors, and CIFAR Azrieli Global Scholars need to take risks, explore radical new ideas, and bring concepts into reality.

We actively engage industry, academia, and governments to identify areas of opportunity for high-impact solutions. We create custom knowledge mobilization plans for each of CIFAR's research programs, taking into consideration emerging needs and trends in each of the sectors we serve.

David Poulin (Université de Sherbrooke), the late co-director of our Quantum Information Science program, embodied the bold, collaborative spirit of CIFAR's model.

We concentrate on bold questions and futuristic ideas, so that the impact of our work reverberates through entire fields of study and sectors of society. From AI and quantum computing to full-day kindergarten and the social determinants of health, tracing the roots of many important contributions to global science leads through CIFAR.

This report highlights key collaborations and milestones that took place during 2019–2020.

Our portfolio of research programs spans four broad themes:

LIFE & HEALTH

INDIVIDUALS & SOCIETY

EARTH & SPACE

INFORMATION & MATTER

GROUNDBREAKING RESEARCH

GLOBAL COMMUNITIES

72
Advisors

263
Fellows

428
researchers*

161
institutions

26
CIFAR Azrieli Global Scholars

18
countries

80
Canada CIFAR AI Chairs

3,000+
researchers, policy-makers, and industry leaders came together for **94 meetings** and events, totalling **116 days** of meetings in 2019–2020.

STAYING CONNECTED

34 **program meetings and cross-programmatic events in 2019–2020**

Of which **18** were held virtually from March 2020 to June 2020.

EXTRAORDINARY MINDS

105 **major awards received by fellows, advisors, CIFAR Azrieli Global Scholars, and Canada CIFAR AI Chairs**

Including the 2019 **Körber European Science Prize**, the 2019 **Social Sciences and Humanities Research Council Gold Medal**, and two **Sloan Fellowships**

ADDRESSING THE MOST IMPORTANT QUESTIONS FACING SCIENCE AND HUMANITY

1611

publications influenced by CIFAR activities**

437

publications authored by two or more CIFAR researchers***

93.1%

of researchers report that participation in CIFAR activities has positively informed or impacted their research (e.g. influence on their research directions, new ideas, etc.)

HIGH-IMPACT SCHOLARSHIP

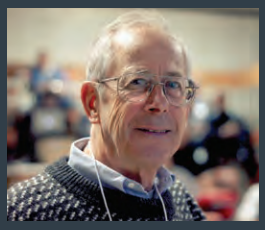
TOP 1%

256 fellows, advisors, CIFAR Azrieli Global Scholars, and Canada CIFAR AI Chairs (**60%**) contributed to the top **1%** of most-cited papers worldwide from 2013 to 2017.****

A HUB FOR COLLABORATION

60

formal partnerships with governments, research organizations, industry, and foundations



CIFAR'S 20TH NOBEL CONNECTION

Manitoba-born James Peebles, Albert Einstein Professor Emeritus of Science at Princeton University, was awarded the **2019 Nobel Prize in Physics** "for contributions to our understanding of the evolution of the universe and Earth's place in the cosmos." He was a founding member of CIFAR's Cosmology & Gravity program in 1985, in which he remained actively engaged for more than 25 years.

NOBEL PRIZES AWARDED TO CIFAR-AFFILIATED RESEARCHERS

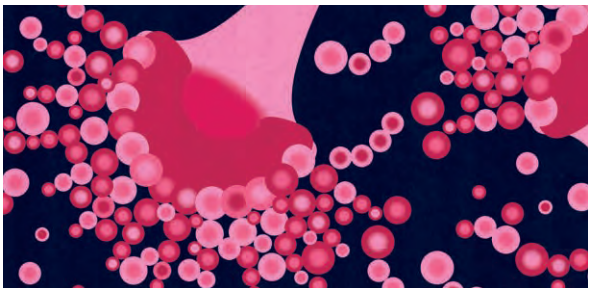
20

* Includes researchers in all CIFAR programs, including Institutions, Organizations & Growth, Successful Societies, and Genetic Networks, since they continued to hold CIFAR-supported meetings as part of their transition to alumni. 13 Canada CIFAR AI Chairs are also appointed as fellows or advisors in CIFAR research programs.

** Self-reported number of peer-reviewed journal articles & conference papers, books and book chapters, and publicly released working papers, white papers, or policy reports influenced by participation in CIFAR programs. (Source: Program Member Annual Reports, 2020, n=202 researchers.) Excludes researchers in sunsetting programs because they were not required to fill in the Annual Survey.

*** Self-reported number of publications co-authored with other CIFAR researchers. (Source: Program Member Annual Reports, 2020, n=202 researchers.) Excludes researchers in sunsetting programs because they were not required to fill in the Annual Survey.

**** Percentage of CIFAR researchers contributing to the top 1% of most-cited papers at the world level from 2013 to 2017. Statistics produced by Science-Metrix using data from Scopus (Elsevier).



LIFE & HEALTH

FUNGAL KINGDOM: THREATS & OPPORTUNITIES

FOUNDED

2019

PROGRAM DIRECTORS

Leah Cowen
University of Toronto

Joseph Heitman
Duke University

FELLOWS

12

ADVISORS

5

MEETINGS IN 2019-2020

November 2019
Toronto, ON, Canada

May 2020
Virtual

As antibiotic producers and deadly pathogens, necessary members of ecosystems and invasive species, fungi are complex, and understanding their kingdom demands a multidisciplinary approach. CIFAR's Fungal Kingdom program includes diverse scientists who interrogate the unique facets of fungal biology in order to mitigate the threats posed by fungi and harness their extraordinary potential.

Collaboration, goal-setting, and a "first" for CIFAR.

Fellows and advisors met for the first time as a program in Toronto in November 2019 and outlined their ambitious research agenda. In a first for a CIFAR program, the meeting report was published in the peer-reviewed journal *Genes, Genomes, Genetics* in June 2020.[1]

A joint research initiative introduced the program as a unified group to the wider research community.

All 19 fellows and advisors in the program co-authored a review article in the May 2020 issue of the journal *mBio* on the threats posed by the fungal kingdom.[2]

Three Catalyst Fund projects accelerated additional collaborations within the program.

One project, which includes five fellows*, examines the evolution of fungicide resistance in fungi that infect wheat and could inform future crop protection strategies.

Inspired by issues arising out of the COVID-19 pandemic, the program will engage diagnostic companies as part of their knowledge mobilization plan.

Fellows and advisors in the program will engage diagnostics companies and public health organizations on the early detection of emerging fungal pathogens that could cause future pandemics.

**The unknown diversity of crop myco-biomes: Fungicide resistance in wheat endophytic fungi,* includes fellows Christina Cuomo (Broad Institute, Harvard/MIT), Matthew Fisher (Imperial College London), Sarah Gurr (University of Exeter), James Kronstad (University of British Columbia), and Eva Stukenbrock (Christian-Albrechts University of Kiel and the Max Planck Institute for Evolutionary Biology)

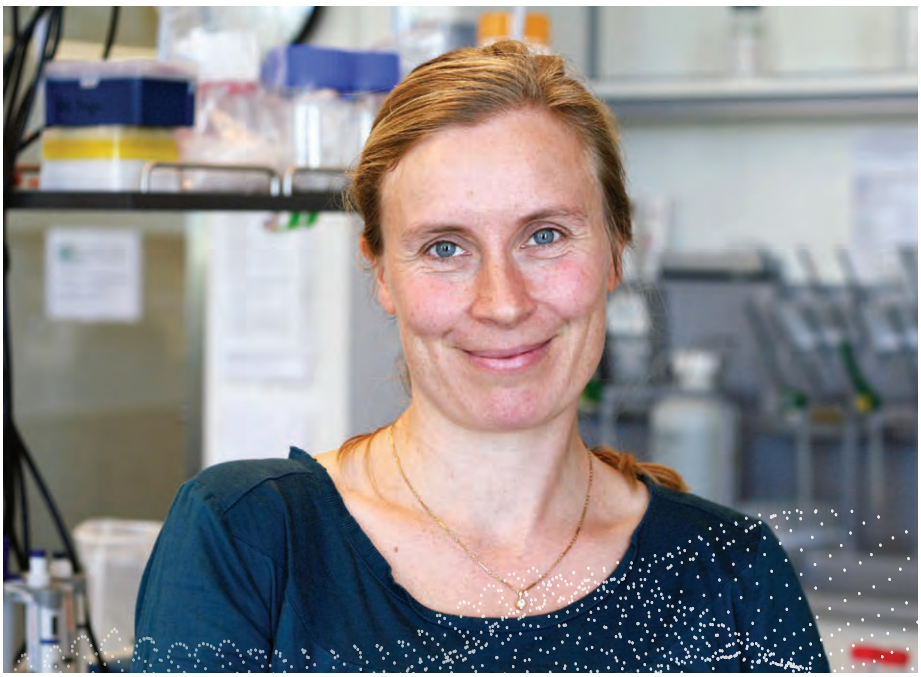
> ***"What I value most about our CIFAR program is the opportunity for wider impacts of our scientific work—new ideas, collaborations, and big-picture thinking."***
>
> **CHRISTINA CUOMO**
> CIFAR Fellow, Broad Institute, Harvard/MIT

UNDERSTANDING THE DARK SIDE OF FUNGI

For Eva Stukenbrock, fungi are fascinating, fickle creatures. They can be essential, useful, or deadly. This varied nature is the focus of the Fungal Kingdom: Threats & Opportunities program.

Most plants live alongside a large diversity of fungi, and only relatively rarely does a fungus turn to the dark side. What makes a species of fungus switch from good or neutral to bad? This question captivates Danish-born Stukenbrock, a fellow in CIFAR's Fungal Kingdom program who leads a lab at Christian-Albrechts University of Kiel and the Max Planck Institute for Evolutionary Biology. She is focused on understanding this dark side of fungi, specifically how fungal pathogens like *Zymoseptoria tritici* evolve and spread.

Together with experts on fungi that infect plants, wildlife, and humans, each bringing their unique perspective to the program, Stukenbrock is excited about the group's ability to understand and combat diseases that affect human health, the environment, and the food chain. "I see a lot of potential for scientific exchange between these different systems," Stukenbrock says. "This is a fantastic initiative to get a small group of scientists together to really talk about science."



EVA STUKENBROCK

LIFE & HEALTH

HUMANS & THE MICROBIOME

FOUNDED

2014

PROGRAM DIRECTORS

Brett Finlay
University of British Columbia

Melissa Melby
University of Delaware

FELLOWS

13

CIFAR AZRIELI GLOBAL SCHOLARS

5

ADVISORS

5

MEETINGS IN 2019-2020

November 2019
Toronto, ON, Canada

April, May, June 2020
Virtual

RESEARCH PARTNERS

Brain Canada Foundation through the Canada Brain Research Fund, Fonds de recherche du Québec - Santé (FRQS), Genome British Columbia, Genome Canada

SUPPORTERS

Canada Life,
Anonymous donor

There is increasing evidence that the bacteria, viruses and fungi that inhabit our body — collectively called the human microbiome — have a tremendous impact on human health. This program brings anthropologists, biologists, and other scholars together to ask questions about the microbiome's impact on human health and development, and how it is affected by individual and societal behaviour.

Renewed for a second five-year term, and with new leadership, the program will continue to think holistically about the microbiome at the community level.

Moving forward, fellows, advisors, and CIFAR Azrieli Global Scholars in the program will focus on how climate change and COVID-19 might affect the microbiome, as well as the role of the microbiome in early and later life. Melissa Melby (University of Delaware) became co-director with Brett Finlay (University of British Columbia), and Janet Rossant (University of Toronto, The Hospital for Sick Children) moved to the program's Advisory Committee.

An article in the journal *Science*, co-authored by eight CIFAR fellows and advisors, suggested obesity, heart disease, and diabetes may be communicable through the microbiome.[3]

The article flowed out of interdisciplinary discussions at the March 2019 program meeting in Victoria, B.C., and gave an entirely new perspective on these common diseases.

A Focus Issue of the journal *BioEssays* featured the diverse research within the program.[4]

With contributions from many fellows, advisors, and CIFAR Azrieli Global Scholars in the program, the essays covered a wide range of interdisciplinary subjects related to the human microbiome. This included an argument for including the microbiome when studying the human nervous system and a review of host-microbiome interactions across the animal kingdom. [5,6]

The program advanced their knowledge mobilization plan to integrate microbiome knowledge into public health curricula.

In the fifth workshop between the program and senior leaders at Canadian and U.S. schools of public health, a working group was established to conduct a landscape analysis of current curricula and, in partnership with public health schools, develop curriculum modules for pilot testing.

> ***"CIFAR plays a critical role by providing the infrastructure and resources to catalyze [international interactions]. CIFAR is also very attuned to current events and global priorities, and is able to rapidly pivot and respond to emerging needs such as the COVID-19 crisis."***
>
> **MEGHAN AZAD**
> CIFAR Fellow, University of Manitoba

TAMARA GILES-VERNICK

FINDING HUMANITY'S PLACE IN THE WEB OF LIFE

The history of medicine and biology can be understood as a history of humans coming to terms with the fact that we do not exist in isolation. The fundamental premise underlying the Humans & the Microbiome program is that our health depends not just on what we consume and cultivate, but also on our interactions with the microbes — bacterial, viral, and fungal — that surround us, outnumbering human cells in our own bodies.

Investigating the physical processes of infection, immunity, mutualism, and symbiosis is imperative, but without understanding the social and historical dimensions of why those interactions take place, we would be lost. And that's what captivates Tamara Giles-Vernick, a fellow of CIFAR's Humans & the Microbiome program and professor at France's Institut Pasteur.

While her methods may be unconventional for the biologists and physicians with whom she often collaborates, they provide the key to understanding the broader picture of disease. In the same way that a doctor might ask for a medical history to diagnose an ailment, Giles-Vernick determines the cultural and anthropological roots of a disease.

Giles-Vernick says she is naturally inclined to look at the bigger picture, and her involvement with CIFAR has helped her frame disease in an even wider context. "The Humans & the Microbiome program has been instrumental in making me step back a bit," she says. "We should be thinking about a 'web of life,' and what it is that people, and all of these other living beings, share."

INDIVIDUALS & SOCIETY

THE AZRIELI PROGRAM IN BRAIN, MIND & CONSCIOUSNESS

FOUNDED

2014

PROGRAM DIRECTORS

Melvyn Goodale
Western University

Adrian Owen
Western University

Anil Seth
University of Sussex

FELLOWS

15

CIFAR AZRIELI GLOBAL SCHOLARS

5

ADVISORS

6

ASSOCIATE FELLOWS

2

MEETINGS IN 2019-2020

December 2019
Toronto, ON, Canada

June 2020
Virtual

RESEARCH PARTNERS

Brain Canada Foundation through the Canada Brain Research Fund, Anonymous partner

SUPPORTERS

The Azrieli Foundation, Canada Life, Michael and Sonja Koerner, The Lawrence and Judith Tanenbaum Family Foundation

The quality of our consciousness is what sets us apart from other species, and is one of the defining traits of being human. Yet the nature of consciousness remains a mystery. The Azrieli Program in Brain, Mind & Consciousness program brings together neuroscientists, philosophers, and psychologists to grapple with the fundamental underpinnings of consciousness, relating the findings to biology on the one hand and to philosophical questions on the other.

Renewed for a second five-year term, the program will move away from broad exploratory themes and towards specific applications of consciousness.

Anil Seth (University of Sussex), a fellow since 2016, became co-director alongside Koerner Fellow Adrian Owen (Western University) as the program began to explore core questions about the neural and cognitive mechanisms of human consciousness, with new emphasis on education, aesthetics, art, and emerging technology and policy, and a particular focus on AI and virtual reality.

"Islands of Awareness": fellows examined whether brain tissue without any sensory connection could support consciousness.

Building on conversations at CIFAR meetings, Tim Bayne (Monash University), Marcello Massimini (University of Milan), and Anil Seth (University of Sussex) proposed "islands of awareness" in a provocative paper on the cover of *Trends in Neurosciences*.[7] Their paper spurred debate in the community, with published commentary and rebuttals.[8,9]

Fellows, advisors, and CIFAR Azrieli Global Scholars continued working with experts in the Extended Reality (XR) industry.

Through their knowledge mobilization plan, a community from Canada, the U.S., and the U.K. is collaborating on making virtual and augmented reality technologies more immersive by deepening our understanding of the brain and mind.

> ***"The multidisciplinary interactions CIFAR enables and the discussions between scientists in small groups at our meetings leave me inspired and full of ideas to pursue. There is no other group like it in my experience. It has made a big difference to my research directions."***
>
> **LAUREL TRAINOR**
> CIFAR Fellow, McMaster University

THE MYSTERY OF CONSCIOUSNESS

Anil Seth, the co-director of The Azrieli Program in Brain, Mind and Consciousness and director of the Sackler Centre for Consciousness Science at the University of Sussex, loves difficult questions.

Why am I who I am? Why is it like anything to be me? How am I conscious? What does it mean to be a self in the world?

To some, these questions may seem impossible to answer, but Seth revels in the mystery. He uses every tool at his disposal, from classic psychology experiments and neuroimaging to artificial intelligence and virtual reality, to answer fundamental questions about the nature of human experience.

Joined by a team of neuroscientists, philosophers, psychologists, biologists, and computer scientists in The Azrieli Program in Brain, Mind and Consciousness, Seth is at the centre of a burgeoning field concerned with solving the mystery of consciousness.

The team is driven to gain a deeper understanding of the way we experience the world in part because it could lead to better treatments for conditions like depression, anxiety, psychosis, chronic fatigue, and dementia. "These conditions manifest themselves through alterations in conscious experience," says Seth. "So if we can understand how the brain generates and shapes consciousness, this gives us new windows into understanding and treating a whole variety of conditions that affect and afflict our everyday lives."

ANIL SETH

INDIVIDUALS & SOCIETY

BOUNDARIES, MEMBERSHIP & BELONGING

FOUNDED

2019

PROGRAM DIRECTORS

Irene Bloemraad
University of California, Berkeley

Will Kymlicka
Queen's University

FELLOWS

10

ADVISORS

5

MEETINGS IN 2019-2020

September 2019
Toronto, ON, Canada

March, May, June 2020
Virtual

SUPPORTERS

BMO Financial Group, The Jarislowsky Foundation, Jacqueline Koerner

All societies distinguish members from non-members. The Boundaries, Membership & Belonging program explores ways to create and empower groups without reinforcing ideas that produce harmful divisions and hierarchies. The program brings together leading social scientists and political and legal theorists who collaborate to make sense of membership politics.

First opportunities for collaboration and planning.

Fellows and advisors met for the first time as a program in September 2019 to plan the trajectory of the next five years. Virtual meetings that propelled their research agenda forward were held in March, May, and June 2020.

Cross-disciplinary work by fellows and an advisor in the program examined solidarity and national identity.

Drawing on public policy, political psychology, and moral philosophy, Advisor Keith Banting (Queen's University), Fellows Allison Harell (Université du Québec à Montréal) and Will Kymlicka (Queen's University), and collaborator Rebecca Wallace (Ryerson University) published a chapter in *Liberal Nationalism and Its Critics: Normative and Empirical Questions*.[10] The chapter examines the Canadian public's belief in the deservingness of minority groups for social support as a function of the groups' perceived commitment to Canada.

New collaborations developed within the program through Catalyst Fund projects.

One project is tracing the characteristics of nationalist discourse since 1945 through computational analysis of media data. Another is using an online survey to examine Canadian attitudes to immigrant "others."

> ***"Being part of a CIFAR program is career-changing. The emphasis on asking big and risky questions in an interdisciplinary and collaborative atmosphere with leading scholars from around the world is unparalleled. Every time I speak with other program members, I have new ideas for projects to explore, new collaborators to do it with, and I know the financial support would be there to get these projects off the ground."***
>
> **ALLISON HARELL**
> CIFAR Fellow, Université du Québec à Montréal

YASMEEN ABU-LABAN

BUILDING AN INCLUSIVE FUTURE

No two people are exactly alike.

The process of deciding which differences are valuable and which are unacceptable, of drawing boundaries between who is "in" and who is "out," is what fascinates fellows in the Boundaries, Membership & Belonging program. The process has also shaped, and will continue to shape, the political and cultural world we inhabit.

Yasmeen Abu-Laban, a fellow in the program, Canada Research Chair in the Politics of Citizenship and Human Rights, and professor of political science at the University of Alberta, is particularly interested in citizenship, and how governments and people respond to diverse others in a world where migration is on the increase.

Her work takes her across Canada and around the world, interviewing community groups, policymakers, and members of different communities to discover how people who come from varying backgrounds live together, and what the impacts of policies like knowledge tests and language requirements are on citizenship.

The CIFAR program enables Abu-Laban to collaborate with historians, philosophers, sociologists, economists, psychologists, and other political scientists to understand whether it's possible to build an inclusive future. "I think the way CIFAR brings people together and supports research advances over many years is distinct," she says. "It is generative. And it's conducive to new kinds of breakthroughs."

INDIVIDUALS & SOCIETY

CHILD & BRAIN DEVELOPMENT

FOUNDED

2003
(formerly Experience-Based Brain and Development until 2013)

PROGRAM DIRECTORS

Takao Hensch
Harvard University and University of Tokyo

Candice Odgers
University of California, Irvine

FELLOWS

13

ADVISORS

5

ASSOCIATE FELLOWS

5

MEETINGS IN 2019-2020

November 2019
Tokyo, Japan

May 2020
Virtual

SUPPORTERS

Canada Life, The Joan and Clifford Hatch Foundation, Anonymous donor

*Elisabeth Binder (Max Planck Institute of Psychiatry), W. Thomas Boyce (University of California, San Francisco), Ami Citri (The Hebrew University of Jerusalem), David Forrest Clayton (Queen Mary University of London), Brian Dias (University of Southern California), Paul Frankland (University of Toronto), Anna Goldenberg (University of Toronto/Vector Institute), Takao Hensch (Harvard University/University of Tokyo), Daniela Kaufer (University of California, Berkeley), Michael Kobor (University of British Columbia), Bryan Kolb (University of Lethbridge), Joel Levine (University of Toronto), Thomas McDade (Northwestern University), Michael Meaney (McGill University), Sara Mostafavi (University of British Columbia/Vector Institute), Charles Nelson (Harvard University), Candice Odgers (University of California, Irvine), Nadine Provençal (Simon Fraser University), Kieran O'Donnell (McGill University), Gene Robinson (University of Illinois at Urbana-Champaign), Marla Sokolowski (University of Toronto), Jenny Tung (Duke University)

The Child & Brain Development program examines the effect of the early environment on children, and how adversity can have lifelong impacts on health and development. Over the past decade, fellows, advisors, and CIFAR Azrieli Global Scholars in the program, including biologists, psychologists, and medical doctors, have generated important findings related to the biological effects of our early experiences as children and transformed our understanding of the interplay between nature and nurture.

Fellows in the program established a clear relationship between the strength of social bonds and health across species.

Daniel Belsky (Columbia University) and Jenny Tung (Duke University), along with colleagues, extended the idea of the social determinants of health into other species in the journal *Science*.[11]

A crucial reference publication was created.

In a special issue of *PNAS (Proceedings of the National Academy of Sciences)*, fellows and advisors in the program* reported on original CIFAR-supported research about the timing of brain development, published a primer on what is currently known about epigenetics and the biological embedding of experience, and laid out conceptual models for studying timescales in child development.[12–15] The volume is a model for the impact of interdisciplinary research and the articles, individually and collectively, are a crucial reference for child development research.

Fellow Thom McDade (Northwestern University) found a way to collect cell cultures in the field.

The laboratory infrastructure required for cell culture has limited research in community-based settings, which in turn limits scientific understanding of phenomena in places far from labs. McDade is addressing this gap with two "field friendly" cell culture protocols that will give his colleagues in the CIFAR program a versatile tool to understand the full biological effects of early life experiences.

A partnership with the International Research Center for Neurointelligence (IRCN) at the University of Tokyo led to new collaborations.

Led by Takao Hensch (Harvard University, University of Tokyo), the IRCN is one of 13 elite World Premier International Research Centers established by the Government of Japan. IRCN hosted the program's November 2019 meeting in Tokyo as the first activity under the new memorandum of understanding with CIFAR.

> ***"CIFAR encourages exactly the type of interdisciplinary dialogue that I find most exciting in science — and, equally as importantly, provides flexible funding support to turn those conversations into tangible research outcomes."***
>
> **JENNY TUNG**
> CIFAR Fellow, Duke University

OVERCOMING THE BARRIERS TO SOCIAL MOBILITY

As the first member of her family to graduate from high school, Candice Odgers understands the barriers to education and social mobility that youth can face. Now the co-director of CIFAR's Child & Brain Development program and a professor of psychology at the University of California, Irvine, she studies those barriers and hopes to find ways to help youth overcome them.

She and other CIFAR fellows in the program have found that family income, postal code, life experiences, and genetic code can all interact in complex ways to make it difficult for people to move up the social ladder.

For psychologists like Odgers, the ubiquity of technologies like smartphones and social media are an incredible opportunity to build a world where therapy and support are always a tap away. But Odgers worries that instead of seeing opportunities, most people are succumbing to fears. "There is a huge disconnect between the narrative that is being portrayed in the media and among adults, and what we were seeing in any data that have been collected by us or other people," she says. "People are so busy focusing on phones and fears, we are missing the real opportunities to support kids' mental health."

CANDICE ODGERS

INDIVIDUALS & SOCIETY

INNOVATION, EQUITY & THE FUTURE OF PROSPERITY

FOUNDED

2019

PROGRAM DIRECTORS

Dan Breznitz
University of Toronto

Susan Helper
Case Western Reserve University

Amos Zehavi
Tel Aviv University

FELLOWS

9

ADVISORS

4

MEETINGS IN 2019-2020

September 2019
Alton, ON, Canada

Two meetings in May 2020
Virtual

Innovation that exacerbates inequality can undermine public support for science and innovation and can contribute to broader political alienation. CIFAR's Innovation, Equity & the Future of Prosperity program brings together economists, political scientists, engineers, and historians to examine how the policies used to generate and diffuse innovation affect the distribution of opportunities and outcomes in society.

A program research agenda was established.

The program's first meetings set the research agenda for the next five years and examined how technologies interact with local economies and societies.

In the first international survey of its type, fellows examined the impact of automation on automobile industries in the U.S. and Italy.[16]

Building on discussions at program meetings, Aldo Geuna (Collegio Carlo Alberto, University of Torino) and Susan Helper (Case Western Reserve University) analyzed the organizational and employment impact of robots, AI, sensors, and other technologies associated with Industry 4.0.

A collaboration among fellows provided a basis for studying how innovation policy affects people with disabilities.[17]

Dan Breznitz (University of Toronto) and Amos Zehavi (Tel Aviv University) examined the development and implementation of technologies that assist people with disabilities. They found that policy across the four countries they studied (Canada, Israel, Sweden, United States) is broadly similar, that differences cannot be explained by traditional left/right politics, and that support for development of assistive technology does not correlate with support for the adoption of that technology.

A new project was launched to understand the role robots can play in long-term care homes affected by the pandemic.

Goldie Nejat (University of Toronto) and Amos Zehavi (Tel Aviv University) are studying how the introduction of new technologies into the long-term care settings could enable physical and emotional care for residents while maintaining physical distance.

The program identified opportunities to advise industrial and government leaders on the equity effects of new technology and innovation policies.

A new CIFAR-led international industry advisory committee will bring program members together with a range of experts to mobilize new knowledge emerging from research.

> ***"At a time when the world is facing problems that can only be solved by creative, cross-disciplinary thinking and cooperation, CIFAR is one of a handful of organizations making the investment in the intellectual resources needed to address these problems."***
>
> **KENNETH LIPARTITO,** CIFAR Fellow, Florida International University

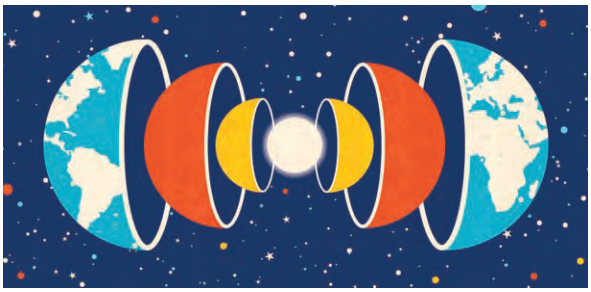
RAY GOSINE

TECHNOLOGY'S RIPPLE EFFECT

Ray Gosine is a fellow in CIFAR's Innovation, Equity & the Future of Prosperity program and an engineer who has spent a career designing robots, drones, and pattern recognition systems to make natural resource industries like mining safer and more efficient. His robots keep workers out of hazardous conditions and allow them to do more with less.

But when a robot, or any new technology, is introduced into a system, it has a ripple effect. When one person is able to remotely control a machine that used to take four operators, what happens to the other three workers? These are the types of questions being addressed by the program.

Gosine, who also serves as Associate Vice President (Research) at Memorial University of Newfoundland, is excited about what a small group of committed, intelligent scholars spanning the disciplines of history, engineering, and the social sciences can do to understand the societal impact of innovation. "I think it's an incredibly enriching network," he says. "[CIFAR] brings people together with different backgrounds, and provides the forum and encouragement to engage, to be able to do something very unique that otherwise would not happen."



EARTH & SPACE

EARTH 4D: SUBSURFACE SCIENCE & EXPLORATION

FOUNDED

2019

PROGRAM DIRECTORS

John Mustard
Brown University

Barbara Sherwood Lollar
University of Toronto

FELLOWS

8

ADVISORS

4

MEETINGS IN 2019-2020

November 2019
Toronto, ON, Canada

May 2020
Virtual

Beneath our feet is a vast, unexplored world consisting of up to tens of kilometres of thick crust containing water, gases, nutrients, resources, and various forms of life. CIFAR's Earth 4D program draws on geology, chemistry, planetary science, and engineering to investigate the interactions between the subsurface and the surface on Earth. The program is expanding our understanding of planetary evolution and the possibility of finding life elsewhere.

First opportunity for collaboration.

Fellows and advisors met for the first time in November 2019 to plan the trajectory of the next five years. Three ideas for collaborations sparked at that meeting led to Catalyst Fund projects in the spring of 2020.

Multiple fellows working across disciplines collaborated on their second influential review paper.

The first, published last year in the prestigious journal *Nature Astronomy*, argued that the best place to look for life on Mars is under the surface.[18] The second, in *Environmental Science and Technology,* reviewed state-of-the-art techniques in identifying leaks and contaminants from fracking operations.[19]

Through their knowledge mobilization plan, the program began engaging the international space exploration community to further the search for water (and potentially life) on Mars.

Working with the International Space Science Institute, fellows will meet with space agencies and the aerospace industry to discuss the tools and missions that would be required to look for signs of life under the surface of other planets.

> ***"CIFAR is an example of truly interdisciplinary research, bringing the abilities of a wide cross-section of scientists together, and providing the spark from which we hope new insights into our world will flare."***
>
> **NIGEL SMITH**
> CIFAR Fellow, Laurentian University & SNOLAB

BARBARA SHERWOOD LOLLAR

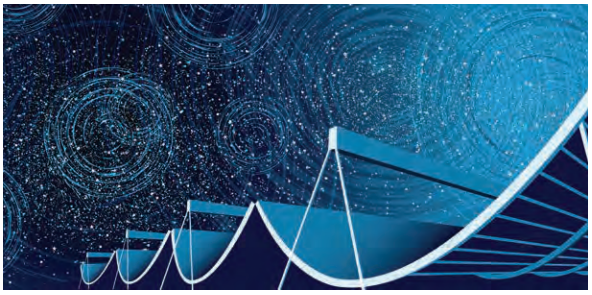
FINDING LIFE ON OTHER PLANETS

Barbara Sherwood Lollar, the co-director of CIFAR's Earth 4D: Subsurface Science and Exploration program and University Professor of Earth Sciences at the University of Toronto, has devoted her career to understanding how water interacts with planets and life over time.

The recipient of many major awards in Canada and abroad, including the Order of Canada, the NSERC Herzberg Gold Medal, the Killam Prize in Natural Sciences, and fellowship in the Royal Society, Sherwood Lollar is a recognized leader and science communicator. "You can't be a good scientist without being a people person," she says. "Science is a very people-oriented occupation,partly because of the focus on teamwork and on communication."

She brings her collaborative approach to the program, which launched in July 2019 and has already taken its research in exciting new directions.

"There was no sitting around waiting until our first meeting," Sherwood Lollar says. "Some of [the fellows] had already started thinking about papers they could write. So when we came to the first meeting, already out of the starting gate, they were presenting papers, abstracts, and ideas. It was extraordinarily fun, because it allowed us to then put some plans around those ideas and develop them more fully."



EARTH & SPACE

GRAVITY & THE EXTREME UNIVERSE

FOUNDED

1986
(formerly Cosmology & Gravity until 2017)

PROGRAM DIRECTOR

Victoria Kaspi
McGill University

FELLOWS

17

CIFAR AZRIELI GLOBAL SCHOLARS

6

ADVISORS

6

ASSOCIATE FELLOWS

12

MEETINGS IN 2019-2020

October 2019
Workshop with the Perimeter Institute
Waterloo, ON, Canada

June 2020
Virtual

SUPPORTERS

R. Howard Webster Foundation

For most of human history, our only information about the universe came from visible light. Later we learned to detect other forms of electromagnetic radiation like infrared and radio waves. Now we can finally detect gravitational waves, and that opens the door to fundamentally new ways of observing and understanding the universe. Astronomers, cosmologists, physicists, and computer scientists in CIFAR's Gravity & the Extreme Universe program ask questions about the nature of extreme gravity, the origin and evolution of the universe, and the structure of compact objects such as black holes and neutron stars, as well as profound questions about fundamental physics and astrophysics.

A series of rapid discoveries highlighted the unique power of the Canadian Hydrogen Intensity Mapping Experiment (CHIME) telescope.

In August 2019, the CHIME team* announced the discovery of eight repeating fast radio bursts (FRBs).[20] In January 2020, they reported that a periodic pattern of bursts was discovered from one of those sources.[21] In May 2020, a highly magnetized young neutron star known as a magnetar was found to produce the right kind of radio burst to strongly support the idea that magnetars are the origin of at least some FRBs.[22]

An important discovery of how black holes could be formed reinforced the strength of the program's "multimessenger" approach to astronomy.

Fellow Vasikili Kalogera (Northwestern University) used data from gravitational waves to show how massive black holes could be formed dynamically from previous black hole mergers.[23]

Fellows, advisors, and CIFAR Azrieli Global Scholars in the program planned for a July 2020 collaboration with AI and biomedical imaging researchers and companies.

For their knowledge mobilization plan, discussions with experts will explore how the hardware and software used for astrophysics and observational cosmology can be deployed in other fields of applications, and vice versa.

> ***"When the hallowed halls of our academic institutions become at-times stifling corridors for the mundane and commonplace, CIFAR provides the intellectual freedom that is promised, but too often not achieved, within academia."***
>
> **JUNA KOLLMEIER**
> CIFAR Fellow, Carnegie Institution for Science

*The CHIME collaboration includes Gravity & the Extreme Universe program members J. Richard Bond (University of Toronto), Matt Dobbs (McGill), Mark Halpern (University of British Columbia), Gary Hinshaw (University of British Columbia), Victoria Kaspi (McGill University), Ue-Li Pen (University of Toronto), Scott Ransom (National Radio Astronomy Observatory), Ingrid Stairs (University of British Columbia) and CIFAR Azrieli Global Scholar alumnus Keith Vanderlinde (University of Toronto).

CHANGING THE WAY WE LOOK AT THE SKY

For Matt Dobbs, a fellow in CIFAR's Gravity & the Extreme Universe program and professor at McGill University, being an astronomer is as much about people as it is about the stars.

The repeated, intense, and collaborative interactions with fellows, advisors, and CIFAR Azrieli Global Scholars in the program have shaped Dobbs's work and his approach to it. "A lot of the change in what I do in my research program has happened either in CIFAR or with CIFAR," he says.

His most recent adventures have taken him to CHIME, a unique array of cylindrical radio dishes in B.C. designed both to understand the large-scale structure of the universe and to hunt for mysterious fast radio bursts (FRBs).

Because fellows in the CIFAR program had expertise not only in cosmology, but also in extreme events like FRBs and supernovae, discussions at CIFAR meetings played an important role in realizing the telescope could serve dual purposes.

Dobbs is an expert in telescope design. He created and is maintaining the electronics system that handles the vast amounts of data being pulled down from the sky by CHIME. "The raw data rate of CHIME, what we're actually sending into our electronics, is just enormous," he says. "It's 13.2 terabits per second, which is larger than all of Canada's internet traffic."

MATT DOBBS

INFORMATION & MATTER

BIO-INSPIRED SOLAR ENERGY

FOUNDED

2014

PROGRAM DIRECTORS

Curtis Berlinguette
University of British Columbia

Gabriela Schlau-Cohen
Massachusetts Institute of Technology

Greg Scholes
Princeton University

FELLOWS

10

CIFAR AZRIELI GLOBAL SCHOLARS

5

ADVISORS

5

MEETINGS IN 2019-2020

October 2019
Toronto, ON, Canada

April 2020
Virtual

RESEARCH PARTNERS

Fonds de recherche du Québec - Nature et technologies (FRQNT), Genome Canada, Ontario Genomics

SUPPORTERS

Arthur J.E. Child Foundation, Chisholm Thomson Family Foundation, Gerald Heffernan, Ivey Foundation, Max Bell Foundation, The George Cedric Metcalf Charitable Foundation

The process of photosynthesis, which plants use to turn the sun's energy into fuel, has been optimized over billions of years of evolution. The Bio-inspired Solar Energy program examines the biological, physical, and chemical lessons of photosynthetic organisms to create better ways of harvesting, transporting, and storing light energy.

The program was renewed for a second five-year term.

Curtis Berlinguette (University of British Columbia) and Greg Scholes (Princeton University) became co-directors and Gabriela Schlau-Cohen (MIT) was appointed as associate director. The new leaders will work with fellows, advisors, and CIFAR Azrieli Global Scholars in the program to advance our understanding of the catalysts required to drive useful chemical reactions from light.

Inspired by nature, fellows collaborated to provide a new perspective on sustainable catalysts.

CIFAR Azrieli Global Scholars Yogesh Surendranath (Massachusetts Institute of Technology), Jenny Y. Yang (University of California, Irvine), and others outlined the opportunities and challenges of replacing expensive and rare catalysts like gold and platinum with more readily available elements in a review in the journal *Science*.[24]

Program members pushed our understanding of how systems (both biological and artificial) can efficiently harvest light in highly variable environments.

Advisory Committee Chair Richard Cogdell (University of Glasgow), CIFAR Azrieli Global Scholar Alumnus Nathaniel Gabor (University of California, Riverside), and Fellow Rienk Van Grondelle (VU Amsterdam) modelled how, by minimizing noise, light-harvesting molecules in plants can maximize power conversion.[25] This provided a theoretical basis for why molecules like chlorophyll *a* and *b* absorb different wavelengths of light.

Fellows, advisors, and CIFAR Azrieli Global Scholars in the program began building a roadmap for scaling CO_2 utilization.

For the program's knowledge mobilization plan, the challenges, solutions, and next steps for developing catalysts in systems that convert CO_2 to useful chemical feedstocks like fuels and precursors to plastic were discussed at a virtual roundtable in March 2020, which included international experts in academia, industry, and national government laboratories.

> ***"By bringing together a diverse cohort of experts and encouraging us to be free with ideas, failures, and successes, CIFAR catalyzes discussion and interaction to produce scientific advances beyond the sum of individuals."***
>
> **CHRISTOPHER CHANG**
> CIFAR Fellow, University of California, Berkeley

CREATING SUSTAINABLE FUELS WITH PHOTOSYNTHESIS

When asked to describe her research, Gabriela Schlau-Cohen, associate director of CIFAR's Bio-inspired Solar Energy program and a chemistry professor at MIT, doesn't skip a beat.

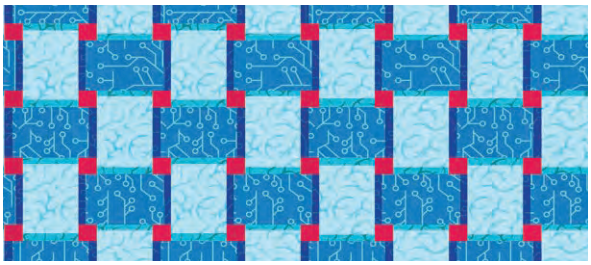
"We hit leaves with lasers," she declares. "We are particularly interested in delving down to understand how the very first steps of photosynthesis work. How leaves grab light energy to convert it into electricity."

By investigating the efficient and adaptable ways that nature has evolved to turn light into fuel, Schlau-Cohen and her colleagues in the program are hoping to create systems that can seed the next revolution in energy production.

Her methods for discovering the intricacies of photosynthesis rival science fiction with femtosecond lasers that record the movement of molecules on timescales almost too small to comprehend (a femtosecond is a millionth of a billionth of a second).

By understanding the processes used by plants, and with the help of the chemists, physicists, and engineers in the CIFAR program, Schlau-Cohen hopes to adapt that knowledge for human use, creating sustainable fuels using light and readily available compounds like carbon dioxide.

GABRIELA SCHLAU-COHEN



INFORMATION & MATTER

LEARNING IN MACHINES & BRAINS

FOUNDED

2004
(formerly Neural Computation and Adaptive Perception until 2016)

PROGRAM DIRECTORS

Yoshua Bengio
Université de Montréal

Yann LeCun
Facebook AI Research and New York University

FELLOWS

14

ADVISORS

6

ASSOCIATE FELLOWS

10

MEETINGS IN 2019-2020

December 2019
Vancouver, BC, Canada

June 2020
Virtual workshop with ELLIS — European Laboratory for Learning and Intelligent Systems

RESEARCH PARTNERS

Brain Canada Foundation through the Canada Brain Research Fund

SUPPORTERS

Alfred P. Sloan Foundation, Bristol Gate Capital Partners, Facebook

The CIFAR Learning in Machines & Brains program draws on neuro- and computer science to investigate how brains and artificial systems become intelligent through learning. The program's fundamental approach — going back to basic questions rather than focusing on short-term technological advances — has the dual benefit of improving both the engineering of intelligent machines and understanding intelligence.

A provocative *Nature Neuroscience* paper by several fellows proposed a deep learning framework for brain research.[26]

Program co-director Yoshua Bengio (Université de Montréal/Mila), as well as Fellows Konrad Kording (University of Pennsylvania), Blake Richards (McGill University/Mila), and Joel Zylberberg (York University), were co-authors on the influential publication. Bengio, Richards, and Zylberberg co-presented a poster on how the brain coordinates learning between brain areas at the Cosyne conference, an important forum for interdisciplinary discussion in computational neuroscience.

Fellows in the program collaborated to apply machine learning to sustainability and climate change.[27]

This includes improving climate models, designing new materials for batteries and carbon capture, and visualizing the future impact of climate change.

A Catalyst Fund collaboration led to new research on training AI systems with human brain patterns.

Alona Fyshe (University of Alberta/Amii) and Joel Zylberberg (York University) were awarded a New Frontiers in Research grant to use data from the brains of human experts while they do a task as a "teacher signal" in order to show AI algorithms how to gain expertise.

The program partnered with the European Laboratory for Learning and Intelligent Systems (ELLIS), a grassroots organization of leading European AI scientists, to advance cutting-edge machine learning research.

In June 2020, they hosted their first joint virtual workshop to discuss approaches to using contact-tracing apps during the COVID-19 pandemic.

> ***"My membership in the CIFAR Learning in Machines & Brains program opens the door for non-traditional research interactions that have had a huge impact on my research program. Thanks to CIFAR, I am tapped into a network of researchers who have similar interests in this sort of interdisciplinary research that links computer science with neuroscience."***
>
> **BLAKE RICHARDS**
> CIFAR Fellow and Canada CIFAR AI Chair, McGill University/Mila

CHELSEA FINN

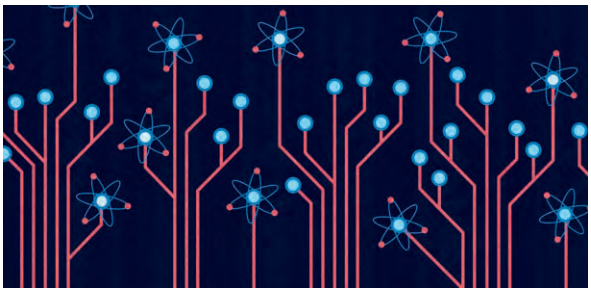
TEACHING ROBOTS TO LEARN

One of Chelsea Finn's first big scientific breakthroughs came in 2015, when she and a team of researchers at the University of California, Berkeley built a robot that learned to pick up a bag of rice with a spatula and put it in a bowl.

She was excited with the result, but Finn, who is now a fellow in CIFAR's Learning in Machines & Brains program, an assistant professor at Stanford University, and a member of the Google Brain team, was frustrated that her spatula-wielding robot would balk at a spoon. "What the robot really learned wasn't how to use spatulas, it learned how to use *that* spatula to lift *that* object into *that* bowl in *that* room," she says.

Finn, like her colleagues in the CIFAR program, takes inspiration from the human brain's ability to learn quickly and generalize easily. She believes that applying lessons from human capabilities to robotic systems will make them more useful and is interested not just in how to increase productivity, but also in the nature of learning itself.

"I like robots because they are grounded in the real world," she says. "If you can get something working on a robot, then you can convince yourself that you've actually solved an important challenge."



INFORMATION & MATTER

QUANTUM INFORMATION SCIENCE

FOUNDED

2002
(formerly Quantum Information Processing until 2014)

PROGRAM DIRECTORS

David Poulin
Université de Sherbrooke

Aephraim Steinberg
University of Toronto

FELLOWS

11

ADVISORS

5

ASSOCIATE FELLOWS

5

MEETINGS IN 2019-2020

February 2020
Montreal, QC, Canada

IN MEMORIAM: DAVID POULIN (UNIVERSITÉ DE SHERBROOKE)

A brilliant quantum physicist with a penchant for taking on difficult challenges, co-director David Poulin was honoured by his peers at a virtual Festschrift event in June 2020 celebrating his deep impact on the field. Long a valued member of the community, Poulin formally became a CIFAR fellow in 2014 and in 2018 he became co-director of the program, leading it through renewal. He passed away on June 25, 2020.

The Quantum Information Science program focuses on the fundamental science behind quantum information in order to discover how best to harness it, solve important computational problems, and develop new insights into physics and information. The program takes a broad interdisciplinary approach, bringing together physicists, computer scientists, and others working in connected disciplines in order to address the field's most fundamental challenges.

A fellow's breakthrough ended 90 years of controversy about the timing of quantum tunnelling.[28]

After nearly 20 years of experiments in his lab and 17 years as a fellow in the program, Aephraim Steinberg (University of Toronto) measured how much time a quantum particle takes to tunnel through a laser barrier. This important result, accepted for publication in *Nature*, shed light on fundamental properties of quantum systems and allowed for clearer thinking about what is actually happening in a quantum computer.

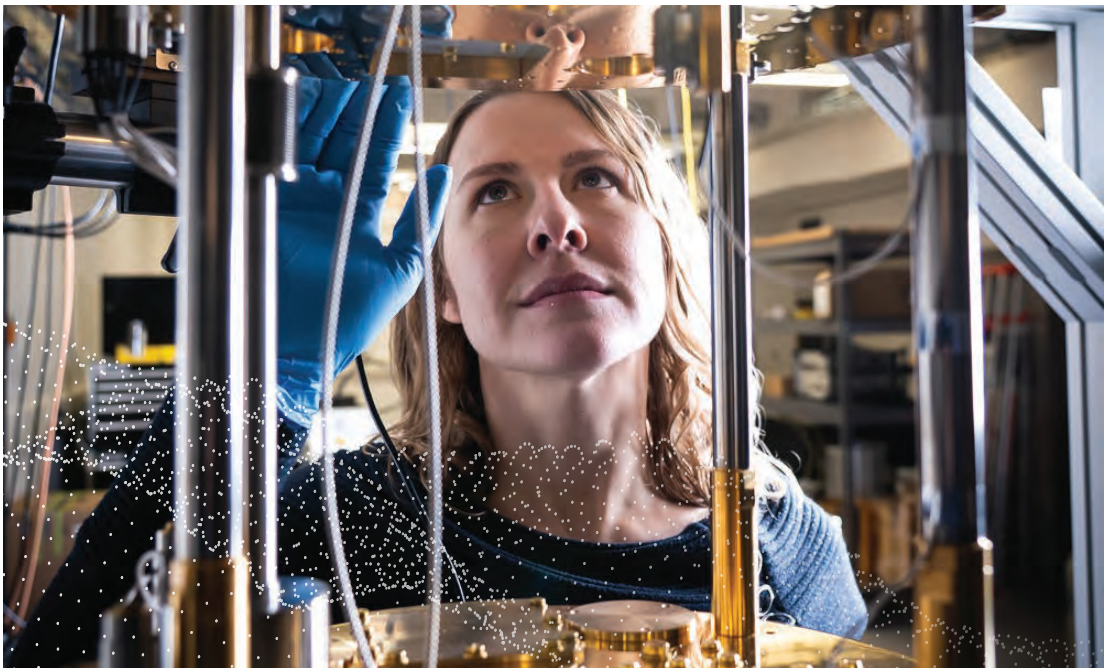
Quantum supremacy was achieved by a team including Associate Fellow David Bacon (Google).[29]

The result, the first time a real quantum computer was able to quickly solve a problem that would give a normal, classical computer pause, was built on decades of experimental and theoretical work by members of the program. This included Advisor John Preskill (California Institute of Technology), who coined the term "Quantum Supremacy," and Fellow Alexandre Blais (Université de Sherbrooke), who first proposed a superconducting quantum computer.

Leveraging their cross-disciplinary experience, program members identified quantum hardware and quantum computing applications as opportunities for societal impact.

Fellows and advisors will engage experts in academia, industry, and government in discussions about hardware design, use cases, and policy considerations to advance the quantum technology ecosystem.

> ***"CIFAR's Quantum Information Science program is a conduit for important ideas in a highly interdisciplinary field. The program provides a means through which I can engage in long-term interactions with other researchers working in sub-areas of quantum information that differ from my own, which are not well-supported by traditional academic structures."***
>
> **JOHN WATROUS**
> CIFAR Fellow, University of Waterloo



STEPHANIE SIMMONS

BETTING ON SILICON

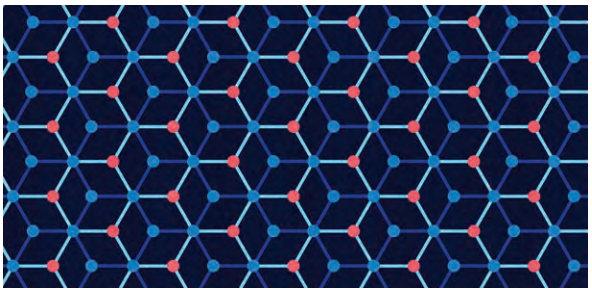
There is no standard way to make a quantum computer. Much like building a house, there are dozens of viable variations. Success depends on the design and the appropriate combination of raw materials.

The quantum quarry is full of options: there are ion traps, superconductors, optical lattices, quantum dots, and more. Each has its own benefits and pitfalls. CIFAR's Quantum Information Science program brings people from these different areas together with theorists to make advances in quantum computation and communication.

For Stephanie Simmons, a fellow in the program and an assistant professor of physics at Vancouver's Simon Fraser University, nothing beats the combination of silicon and photons.

She is admittedly bullish about her choice of quantum hardware. "You don't ever really want to bet against silicon," she explains. "Given its history, silicon always wins. We know how to work with it better than almost any other material on earth. That's why we have supercomputers in our pockets."

Simmons values the opportunity she has to contribute to the CIFAR Quantum Information Science program, a space for people working on different aspects of quantum computing to come together. "We need a space where we can all communicate effectively, and continue to build up a common language."



INFORMATION & MATTER

QUANTUM MATERIALS

FOUNDED

1987
(formerly Superconductivity until 2002)

PROGRAM DIRECTORS

Leon Balents
University of California, Santa Barbara

Louis Taillefer
Université de Sherbrooke

FELLOWS

13

ADVISORS

3

MEETINGS IN 2019-2020

October 2019
Orford, QC, Canada with Institut quantique

February 2020
Workshop with CCQ — Centre for Computational Quantum Physics
New York, U.S.

May 2020
Virtual

This program is working towards bringing on the Quantum Age by integrating theory, materials synthesis, and experiment to explore and advance the frontiers of quantum physics. The program is structured around four main thrusts: quantum spin liquids; topological materials; the pseudogap phase of cuprate superconductors; and strange metals. The team is developing new tools, new models, and new materials to understand the working principles of quantum matter.

A discovery about how cuprates achieve superconductivity provided a major future direction for the program.

Inspired by discussions with co-director Leon Balents (University of California, Santa Barbara) and Fellow Subir Sachdev (Harvard University), Louis Taillefer (Université de Sherbrooke) and colleagues discovered a giant thermal Hall effect in the pseudogap phase of cuprates, which may be responsible for superconductivity in these materials.[30]

A new laser developed by Fellow Andrea Damascelli (University of British Columbia) will help program members gain new understanding about high-temperature superconductivity in new materials.[31]

The laser allows time-resolved photoemission spectroscopy and can be used to visualize electron scattering processes at ultrafast timescales.

Kate Ross (Colorado State University) and collaborators found intriguing potential in a new rare-earth pyrochlore, $Yb_2Ge_2O_7$. [32]

This previously unstudied material, which is related to the well-studied $Yb_2Ti_2O_7$, has properties very close to the edges of classical phase boundaries and represents an ideal system for studying quantum magnetism.

The program partnered with the Institut quantique at the Université de Sherbrooke to foster a highly interactive program meeting in Orford, Quebec.

Fellows and advisors in the program identified the field of advanced measurements and instrumentation, particularly neutron scattering, as a key area for knowledge mobilization.

In December 2020, the program will meet with academic, industrial and policy experts to discuss the future of neutron facilities in Canada, which are key for materials research and industrial applications.

> *"CIFAR allows me to connect to the top researchers in the field and regularly bounce ideas off of them. The meetings are extremely rewarding, exciting, and have led to new directions and collaborations for my research program."*
>
> **KATE ROSS**
> CIFAR Fellow & Azrieli Global Scholar Alumna, Colorado State University

UNDERSTANDING SUPERCONDUCTIVITY

Electrons usually have difficulty flowing through materials. They bump into things, get stuck to atoms and, like easily distracted children in an arcade, struggle to make it through unimpeded.

However, in certain materials under the right conditions, electrons flow effortlessly. They zoom through without any loss of energy. This phenomenon is called superconductivity, and understanding it would open the door to revolutions in computation and power transmission.

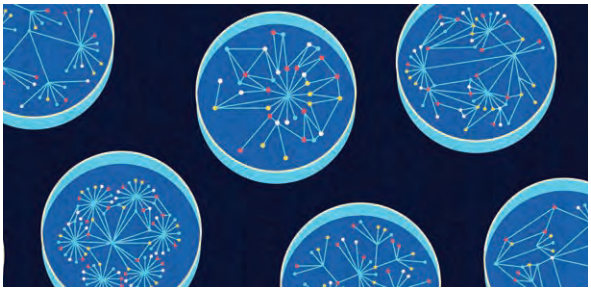
Pablo Jarillo-Herrero, a fellow in the Quantum Materials program, professor of physics at MIT, and rising star in condensed matter physics who was recently awarded the prestigious Wolf Prize in Physics, finds the very fact of superconductivity strange and counterintuitive. Jarillo-Herrero and his team discovered in 2018 that two layers of single-atom-thick graphene could become a superconductor when pressed together and twisted at exactly 1.1 degrees with respect to each other. This is true despite the fact that neither layer is a particularly good conductor on its own, and that the effect goes away when the layers are lined up perfectly.

Jarillo-Herrero, like his colleagues in the Quantum Materials program, is fascinated by these macro manifestations of effects happening on the smallest of scales.

"Very often, to see quantum mechanical effects, you have to go to individual electrons or atoms," he says. "[Superconductivity] is something that you can see in big pieces of materials. It is one of those remarkable, all-around striking physics phenomena."

PABLO JARILLO-HERRERO

THE FOLLOWING ARE COMPLETING THEIR WORK AS CIFAR PROGRAMS



GENETIC NETWORKS (2005 – 2020)

The Genetic Networks program charted genetic and molecular interactions to understand how biological systems work and how they fail. The program closed in 2019.

In the program's final term (2014-2020), members of the program developed the first genetic interaction map of a yeast cell.[33]

> ***"At [program] meetings, I always feel like nothing is off the table: no problem is too big to solve, no experimental difficulty is insurmountable, and most importantly, and in contrast to conventional funding agencies, no project is 'too ambitious.' Interacting with my CIFAR collaborators has made my research program more creative as well as providing access to technical advantages from other labs."***
>
> **RACHEL MARTIN,**
> Fellow, Molecular Architecture of Life, University of California, Irvine

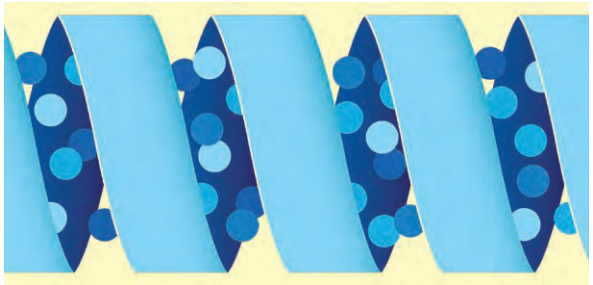
INSTITUTIONS, ORGANIZATIONS & GROWTH (2004 – 2020)

The Institutions, Organizations & Growth program studied why some nations succeed economically while others continually fail; why institutions that foster wealth and well-being in one culture, location, or historical period may be less effective in another; and what policies will create the greatest potential for progress. The program will hold its final meeting when it is possible to hold in-person meetings again following the pandemic.

In its final term (2014–2020), the program provided fertile ground for a steady output of seminal scholarship on the foundations of social order, including how institutions and social orders may support each other.

SUPPORTERS

BMO Financial Group, Anonymous Donor



MOLECULAR ARCHITECTURE OF LIFE (2014 – 2021)

Until recently, we could only understand the processes of life by looking at static pictures of its building blocks. But life is dynamic, and processes are in constant states of change. Using tools such as ultrafast imaging that can record molecules in motion, the Molecular Architecture of Life program looks to understand life at the smallest levels. The ultimate goal is to create a detailed molecular map of the cell. The program will be concluding activities in the calendar year 2021.

Fellows in the program discovered receptors which could enable better drug design.

Wolfgang Baumeister (Max Planck Institute of Biochemistry), Oliver Ernst (University of Toronto), and Krzysztof Palczewski (University of California, Irvine) found the structure of G protein-coupled receptors (GPCRs) at a molecular level.[34] Using cryo-electron microscopy and a "molecular ruler," they discovered that the receptors, which are often the target of pharmaceuticals, organize in rows of dimers.

A collaboration between two fellows uncovered that a structural protein in the eye has a surprising function.

Rachel Martin (University of California, Irvine) and Dwayne Miller (University of Toronto) studied the complex molecular interactions of γS-crystallin, a protein found in the lens of the eye, and found it is actually the eye's last line of defence against oxidation.[35]

Fellows developed a new way to measure proteins on a molecular level.

Oliver Ernst (University of Toronto) and John Vederas (University of Alberta) created a new amino acid that can be incorporated into proteins to find out how they move and interact with the inside and outside of cells.[36]

SUPPORTERS

Canada Life

SUCCESSFUL SOCIETIES (2002 – 2019)

The Successful Societies program focused on the interaction of institutional and cultural frameworks to understand how societies create opportunities for individual fulfillment and happiness. The program held a virtual meeting in May 2020 to transition to alumni.

In fall 2019, the program held two capstone events:

- A roundtable in New York City with civil society leaders, in partnership with the Ford Foundation, to discuss the roles of representation, recognition, and narratives in reinforcing inequalities.
- A two-day capstone conference at Harvard's Weatherhead Center for International Affairs, bringing together program members from throughout its 17-year history to reflect on the impact of the program. This included a public event to celebrate the launch of a special edition of *Daedalus* focused on inequality. Published by the American Academy of Arts & Sciences, *Inequality as a Multidimensional Process* features interdisciplinary research from across the program that seeks to understand how cultural and institutional frameworks interact to produce inequality.[37] The event's discussions focused on the implications of inequality research for current and emerging policy.

SUPPORTERS

BMO Financial Group, Anonymous Donor

"CIFAR's global community of top researchers sets the bar for what research should be. "

LAURA ARRELL
WHY I GIVE

Laura Arrell, managing director of the Arrell Family Foundation, speaks with Leslie McCarley, CIFAR's Vice-President, Advancement

Laura Arrell is the managing director of the Arrell Family Foundation, which works to improve human and planetary health through food. Although she had been a director of her family's foundation for many years, she took on the task of running it four years ago, in 2016. The foundation began supporting CIFAR that same year.

Prior to managing the foundation, she was a managing director at Toronto investment bank Raymond James, where she worked for 15 years. Arrell is also a mother of three children, and is passionate about travel and food.

How did you become involved with CIFAR?

We became involved with CIFAR through Alan Bernstein, whom we got to know when he provided great advice to our family leading up to our gift to the University of Guelph to create the Arrell Food Institute. I have come to work closely with him related to the Arrell Food Institute, where he serves as an advisor. He has incredible science acumen and there couldn't be a better leader for CIFAR. Strong organizations are led by brilliant leaders, and Alan fits the bill.

What has been the most exciting and interesting aspect of your involvement?

If we want to find solutions to the world's biggest challenges, we have to be agnostic about borders, and collaborate across disciplines. CIFAR's global community of top researchers sets the bar for what research should be. I'm inspired by the unique borderless approach to research and policy influence.

Is there a particular area of the work that CIFAR does that has been most compelling to you?

The research CIFAR is doing in its Humans & the Microbiome program — with its potential implications for mental health and overall well-being — is absolutely fascinating. There's no denying these days that gut health and the microbiome should be a key area of research focus and application.

I'm also very interested in brain research. I have close personal connections with people living with Parkinson's and bipolar disorder, and so research with potential applications for them has been a big focus of our foundation. CIFAR's Brain, Mind & Consciousness program is doing really important, fundamental work understanding the underpinnings of those conditions.

With many demands on your time and resources, why give to CIFAR? Why now?

I think we're really backing a good leader. Both my father and I, with our business backgrounds, look at grants that we're making as investments: You wouldn't invest in a publicly listed company with a weak CEO. We really believe in backing good people, and Alan, and CIFAR, are among the very best.

What do you wish other people knew about CIFAR, and what might you say to somebody else considering supporting the work that we do?

It's funny you ask, because I often talk about CIFAR with friends and encourage them to get involved. There are so many great areas of activity that I can usually find a fit for someone's priorities in life.

As we get great research coming out in key areas like AI and the microbiome that are in the public interest right now, hopefully the public awareness of CIFAR grows. I think funders want to support good people and good research, and I certainly think that CIFAR is a very well-run organization that knows how to build teams and get the best of the best together. You're a class act!

Leslie McCarley, CIFAR's Vice-President, Advancement, leads CIFAR's efforts to advance private revenue support. She is a highly respected and entrepreneurial leader with a background in journalism, advertising, and philanthropy.

Advancing Canada's Leadership in AI

CIFAR PAN-CANADIAN AI STRATEGY

Now in its fourth year, the CIFAR Pan-Canadian AI Strategy is fuelling research and innovation and applying AI to address important challenges facing society, including health, the climate crisis, and the COVID-19 pandemic.

Our Canada CIFAR AI Chairs Program has recruited and retained 80 world-class researchers.

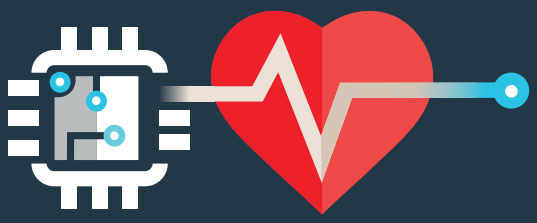
CIFAR provides Canada CIFAR AI Chairs with long-term, dedicated research funding to support their ideas and help them train the next generation of AI leaders in Canada.

We supported a range of training opportunities across Canada to help students and early-career researchers from all over the world develop skills, expertise, and networks.

The **CIFAR OSMO AI4Good Lab** promotes an inclusive tech culture by providing undergraduate women enrolled in STEM programs a hands-on, collaborative learning experience. The 2019 cohort developed a range of projects, such as Ad Awareness, a prototype that detects gender bias in commercials; AI.D, an intelligent schedule tracker for chronic pain; and Bean There, a chatbot that helps students navigate the mental health landscape at their university.

The annual **CIFAR Deep Learning + Reinforcement Learning (DLRL)** Summer School provided an opportunity for the world's brightest graduate students, postdoctoral fellows, and professionals to come to Canada and learn from world-class AI pioneers such as Yoshua Bengio, Richard Sutton, and Doina Precup, deepen their AI knowledge, and create new connections with Canadian AI startups and companies.

AI FOR HEALTH



AI's ability to draw insights from huge datasets makes it a powerful tool for data-rich health settings. AI could help doctors diagnose diseases more quickly and make the system more efficient. But it could also pose risks to privacy and security if not properly regulated.

To understand AI's role in the future of Canadian health care, we convened the AI for Health (AI4H) Task force, a group of 17 leaders from across the AI, health research, and innovation ecosystems.

Led by the esteemed co-chairs David Naylor (University of Toronto) and Tim Evans (McGill University), the task force worked closely with government officials at the federal and provincial levels to create a set of recommendations.

The report, *Building a Learning Health System for Canadians,* recommends the creation of a coordinated, integrated AI4H strategy.[38]

> ***"Being surrounded by intelligent women with a wide variety of educational backgrounds empowered me to ask any kind of question, where in other environments I most definitely would have kept quiet."***
>
> **GILLIAN CARTAR**
> 2019 AI4Good Summer Lab participant

DLRL SUMMER SCHOOL 2019

APPLICANTS

1,200 FROM **75** COUNTRIES

ATTENDEES

300 FROM **36** COUNTRIES

ATTENDEES WHO IDENTIFIED AS WOMEN

38%

HOURS OF EDUCATIONAL SESSIONS AND EVENTS

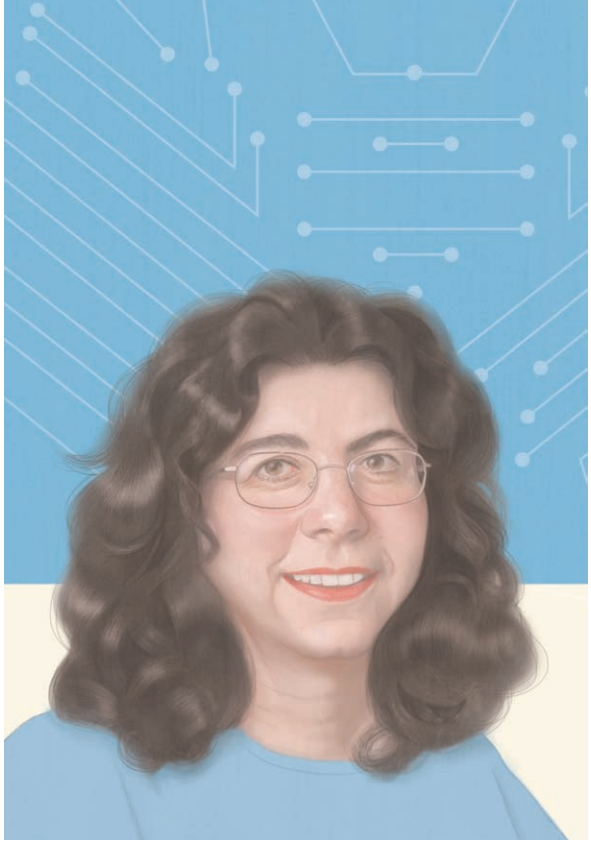
90

INTERNATIONAL PATICIPANTS

128 INCLUDING **28** FROM LOW-INCOME COUNTRIES

The 2019 CIFAR DLRL Summer School, held in Edmonton, Alberta from July 24 to August 2, 2019, was sponsored by Alberta Innovates, DeepMind, LG, The Climate Corporation, AltaML, and other local partners.

#REALBRAINS



Meet three Canada CIFAR AI Chairs who are blazing the trail for the next generation of AI technologies and researchers. They are building agents that see the world not only as humans see it, but as we hope for it to be.

DOINA PRECUP IS TRAINING THE NEXT GENERATION OF WOMEN IN AI.

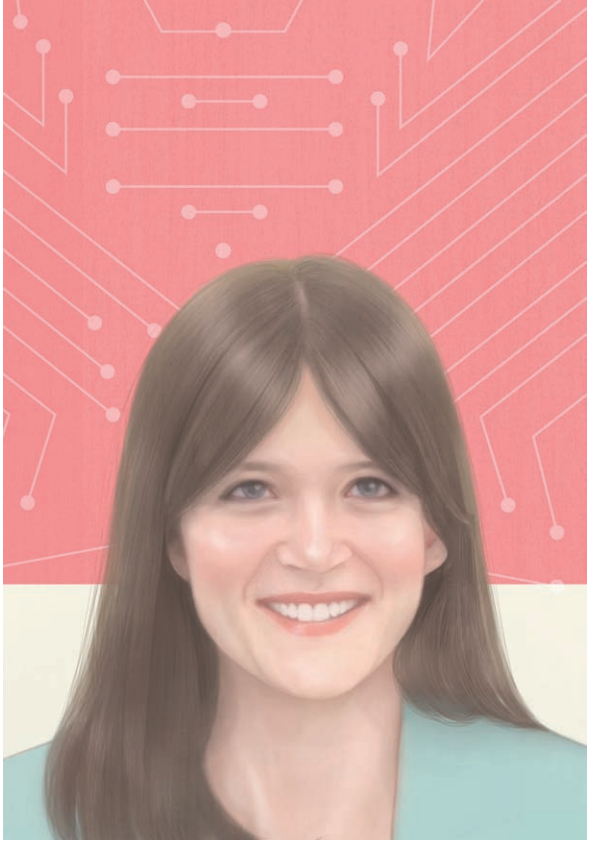
Canada CIFAR AI Chair Doina Precup, an associate professor with McGill University's School of Computer Science, an academic core member of Mila, and Research Team Lead at DeepMind Montreal, is teaching machines to understand and interact with the world the way humans do through reinforcement learning (RL). RL is a technique that enables agents to learn from their interactions with the environment through trial and error, and through rewards and feedback.

Growing up in communist Romania, Precup says studying computer science was not unusual for women. She noticed that was not the case in Canada or the United States.

Together with Angelique Manella, her colleague at McGill University, Precup founded the CIFAR OSMO AI4Good Lab, a summer training program for undergraduate women. The Lab provides lectures, workshops, and networking opportunities. It also provides a small stipend to participants to help offset the cost of devoting six weeks to training.

Precup explains that a career path in AI presents many barriers for women, and emphasizes that it is important to have multiple paths of entry for underrepresented groups in AI.

"We need non-traditional paths for people who are from underrepresented groups to come into the field because they may not take the traditional one," she explains.



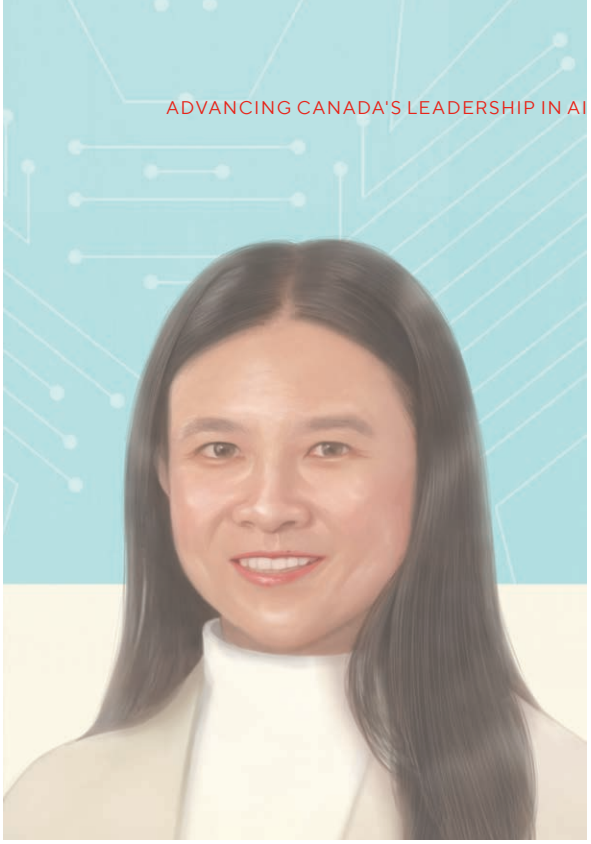
ANGELA SCHOELLIG IS TRAINING ROBOTS TO ACT INDEPENDENTLY.

"We envision robots moving out of the industry environment where they only have partial knowledge, and operating in more human-centric environments," says Canada CIFAR AI Chair Angela Schoellig, who is an assistant professor at the University of Toronto Institute of Aerospace Studies and affiliated with the Vector Institute in Toronto. Her research applies control theory to machines such as robots, drones, and autonomous vehicles. She is one of a dozen researchers in the world who began pioneering research on safety and performance on robotics using AI five years ago. Now the area of research has expanded.

Schoellig's work in autonomous vehicles has gained her widespread recognition in the international community. Schoellig was named one of 35 Innovators under 35 by *MIT Review* in 2017. She is also a Canada Research Chair in Machine Learning for Robotics and Control.

Schoellig completed her PhD at ETH Zurich in Switzerland before coming to Canada. She says her favourite aspect of living in Canada is its multiculturalism.

"In some ways it feels like Canada is living in the future because of how mixed it is. We never do research in isolation — it's the kind of ecosystem that accelerates innovation and allows researchers to have big goals," she says.



ANGEL CHANG IS TEACHING MACHINES TO SEE THE WORLD IN 3D.

Canada CIFAR AI Chair Angel Chang is laying the groundwork for AI technologies that will make human-robot interaction more natural. With robotic agents already on the ground of some factory floors, Chang's research will support future applications that enable robotic agents to become adept at operating in a 3D world.

An assistant professor at Simon Fraser University and a fellow at Amii, Chang specializes in natural language processing, an AI technique that teaches machines to understand and process the language of humans. Specifically, she's focused on generating 3D scenes from text and was inspired by the complexities of how humans understand language.

"When you think of how babies learn language, we read them books that teach them about colours and shapes," she says.

"In order to understand language, it's important to consider it not in isolation, but in connection with images and objects in the real world."

LEADING GLOBAL CONVERSATIONS ABOUT AI & SOCIETY

CIFAR brings together experts from across sectors, including academia, industry, law, ethics, healthcare, and government, to discuss, collaborate, and act on the most important challenges that AI presents to society.

This year we worked with international organizations and national governments around the world to lead global policy conversations and bridge the divide between powerful AI technologies and the policies that will ensure their responsible use.

Eight AI & Society workshops generated a deeper understanding of how AI impacts health, security and culture.

At one workshop, a team of experts explored opportunities where AI can be applied to combat climate change. They published an initial framework for leveraging digital technology for sustainability in March 2020 [39] and the *Montreal Statement on Sustainability in the Digital Age* in summer 2020.[40] The statement calls for a global collaboration among business, civil society, researchers, and innovators to use AI to help build a sustainable and equitable world.

We examined the future of work, data governance, and regulatory innovation for Canada and the U.S.

We partnered with Innovation, Science & Economic Development Canada and the U.S. Department of State in January 2020 to consider innovative public policy that develops competitive AI strategies for economic growth, while mitigating potential societal risks for both countries.[41]

Our analysis of AI strategies from 28 countries provided a global snapshot of the rapidly evolving technology policy landscape.

The second edition of our report, *Building an AI World: Report on National and Regional Strategies,* highlighted that countries with national AI strategies continue to be concentrated among the advanced economies of Western Europe, North America and East Asia.[42] New strategies also tend to be more comprehensive, addressing most or all of eight major policy areas (research, talent development, skills, industrial policy, ethics, data and digital infrastructure, AI in government, and inclusion).

Yoshua Bengio (Université de Montréal/Mila), a Canada CIFAR AI Chair and co-director of CIFAR's Learning in Machines & Brains program, presents his vision for how AI can contribute solutions to climate change at the Sustainability in the Digital Age workshop in Montreal in September, 2019.

Trooper Sanders, CEO of the Benefits Data Trust, speaks at the Canada-U.S. AI Symposium on Economic Innovation.

A watercolour illustration of the Indigenous Protocol & AI workshop team learning the traditional E Hō Mai chant.

CENTRING INDIGENOUS PERSPECTIVES IN DESIGNING AI

Indigenous researchers and experts from around the world teamed up to publish *Indigenous Protocol and Artificial Intelligence*, a position paper that provides a starting place for designing ethical AI through an Indigenous-centred approach.[43]

"Many of the guidelines and manifestos that are coming out mostly centre around the human, which is not in alignment with most Indigenous methodologies," explains Jason Edward Lewis, a Hawaiian-Samoan professor with Concordia University's Design and Computation Arts department and a member of the workshop leadership group.

"We as a society allow AI to collect our data and make decisions that impact us, so we should develop an understanding of what kind of relationship we want to have with AI," says Lewis. "Is AI a slave to a human master, or do we want to create intelligent systems with respect? It's a better world for all of us if we treat these systems with respect, and teach them to treat us with respect."

The Indigenous Protocol & AI workshop team, supported by the CIFAR AI & Society program, developed the paper following discussions that took place over 20 months and across 20 time zones. Those discussions included two workshops which brought together people from Indigenous communities across Aotearoa (New Zealand), Australia, North America, and the Pacific Region. The paper offers a range of ideas, questions, and approaches to be considered when centering Indigenous knowledge in the development of AI.

Accelerating Discovery

We support bold ideas and creative people because the next world-changing breakthrough might be just one conversation away.

By cultivating the next generation of research leaders through initiatives like the CIFAR Azrieli Global Scholars program and by enabling high-risk, high-reward ideas through Catalyst Funds, we accelerate discovery.

CULTIVATING THE NEXT GENERATION OF RESEARCH LEADERS

A diverse cohort of 14 inspiring early-career researchers was selected for the 2019-2021 CIFAR Azrieli Global Scholars program.

Scholars from eight countries of citizenship joined five CIFAR research programs. The international cohort will contribute new energy and ideas to the programs they join, while developing their own professional networks and skills.

We developed interactive and virtual opportunities for CIFAR Azrieli Global Scholars to meet, learn, and collaborate during the pandemic.

Twenty-five current and past CIFAR Azrieli Global Scholars received mentorship training in a virtual session led by Dr. Geraldine Richmond, Program Director of COACh Global and past president of the American Association for the Advancement of Science.

CIFAR Azrieli Global Scholars submitted five collaborative Catalyst Fund proposals.

To foster imaginative, high-risk, high-reward interdisciplinary collaborations among early-career researchers, we facilitated video calls between CIFAR Azrieli Global Scholars to explore each other's work and brainstorm on potential future projects. These sessions led to five Catalyst Fund proposals submitted in June, creatively spanning diverse programs and disciplines, including a potential collaboration between the Gravity & the Extreme Universe and the Azrieli Brain, Mind & Consciousness programs.

This year, 13 CIFAR Azrieli Global Scholars took part in 17 leadership development opportunities supported by the Love Family Leadership Development Fund. This financial support provides access to one-on-one coaching, online resources, and courses or conferences to advance skills.

Enabling High-Risk, High-Reward Ideas

Our Catalyst Funds are time-limited grants of approximately $50,000 that facilitate and support high-risk ideas and projects within and across CIFAR's portfolio of research programs. They provide flexibility for early-stage projects, encourage interdisciplinary collaborations, and address emerging and exploratory themes within or between research programs.

Our Catalyst Funds

CATALYST FUNDS

32

+ 14 fast-response COVID-19 & AI Catalyst Grants

$1.58M

committed to high-risk, high-reward projects that will accelerate discovery

CATALYST FUND HIGHLIGHTS

CIFAR's Catalyst Funds often support multi-year collaborations. Several of these interdisciplinary projects had significant impacts realized this year.

BRAINSTEM AROUSAL SYSTEMS: EFFECTS ON CONSCIOUSNESS AND COGNITION

In February 2020, David Menon's lab published a study in the journal *Human Brain Mapping* showing how the brain uses different connection patterns to perform the wide range of tasks we need it to.[44] This builds on work supported through a 2017 Catalyst Fund project with Koerner Fellow Adrian Owen, which investigates how the brain's network reacts to sleep and sedation.

Azrieli Brain, Mind & Consciousness
David Menon (Cambridge University) & Adrian Owen (Western University)

PANDEMICS & EXPANDED PERSONAL SPACE

A 2016 Catalyst Grant brought Graham Taylor, Joel Levine, and Takao Hensch together to study animal social behaviour using AI image recognition. Building on this fruitful collaboration, they planned a cross-programmatic Collective Intelligence workshop for June 2020 to examine the many ways intelligence manifests in group behaviour, which was adapted to become the virtual Pandemics & Expanded Personal Space workshop in light of COVID-19.

Learning in Machines & Brains, Child & Brain Development
Graham Taylor (Canada CIFAR AI Chair, Learning in Machines & Brains, University of Guelph), Joel Levine (Child & Brain Development, University of Toronto Mississauga) & Takao Hensch (Child & Brain Development, Harvard University)

DETECTING THE ROOTS OF CONSCIOUSNESS IN INFANTS

An interdisciplinary Catalyst Fund project to examine the roots of consciousness in infants led to fruitful collaboration between Janet Werker and Alona Fyshe, who, together with other colleagues, proposed a project about the influence of oral language skills, home language and culture, and digital media on literacy development. The project was awarded a $2.5 million Partnership Grant from Canada's Social Science and Humanities Research Council (SSHRC). Werker and Fyshe, two scholars in vastly different academic areas but with a shared interest in language and brain development, met through CIFAR.

Child & Brain Development, Azrieli Brain, Mind & Consciousness, Learning in Machines & Brains
Janet Werker (Child & Brain Development, UBC) & Alona Fyshe (CIFAR Azrieli Global Scholar 2016-2018, Brain, Mind & Consciousness, Fellow, Learning in Machines & Brains, Canada CIFAR AI Chair, Amii, University of Alberta)

Catalyst Fund projects often focus on emerging and exploratory themes; below are three examples from this year's recipients.

SILICON TELECOM COLOUR CENTRES FOR QUANTUM INFORMATION SCIENCE

Networking quantum computers can unleash tremendous computational power, but this requires quantum information to be transmitted over large distances. The hardware to make this dream a reality is still in development, but CIFAR Fellow Stephanie Simmons may have recently had a breakthrough working in silicon. To evaluate whether her discovery could enable a quantum internet, she is collaborating with CIFAR Fellow Lilian Childress, who is a world-renowned expert in the nitrogen-vacancy colour centre in diamond.

Quantum Information Science

Stephanie Simmons (Simon Fraser University) & Lilian Childress (McGill University)

NULL DETECTION OF LIFE: TOWARDS A MORE REFINED UNDERSTANDING OF THE TRUE LIMITS OF HABITABILITY

Almost everywhere researchers have ever looked on Earth — deep underwater, deep underground, up in the stratosphere — there is life. When life isn't found, it's often assumed to be because the instruments used weren't sensitive enough to detect it. Sometimes that may be the case, but with this project, researchers will search for naturally sterile environments and, combining literature review, lab analysis, and computational modelling, find out exactly what makes them so.

Earth 4D: Subsurface Science & Exploration

Heather Graham (NASA), Bénédicte Ménez (Paris Diderot University) & Magdalena Osburn (Northwestern University)

DISCOVERING AND IMPLEMENTING THE FUNCTIONS OF CONSCIOUSNESS IN LEARNING MACHINES

Current AI approaches do not often incorporate concepts of consciousness, and yet there is increasing evidence that intelligence and consciousness go hand in hand. In this Catalyst Fund project, researchers from across CIFAR's Learning in Machines & Brains and Brain, Mind & Consciousness programs will come together for a series of workshops to strengthen the links between the neuroscientific and philosophical study of consciousness and AI research.

Learning in Machines & Brains and Brain, Mind & Consciousness

Blake Richards (Learning in Machines & Brains, Canada CIFAR AI Chair, McGill), Yoshua Bengio (Learning in Machines & Brains, Canada CIFAR AI Chair, Mila, Université de Montréal), Anil K. Seth (Brain, Mind & Consciousness, University of Sussex) & Alona Fyshe (Learning in Machines & Brains, CIFAR Azrieli Global Scholar 2016-2018, Canada CIFAR AI Chair, Amii, University of Alberta)

Creating Societal Impact

MOBILIZING KNOWLEDGE TO TRANSFORM OUR WORLD

We invite experts in industry, civil society, healthcare, and government to join global research leaders for in-depth, cross-sectoral, future-focused conversations that drive change and innovation.

In 2019–2020 we initiated impact plans focusing on health, policy, and technology.

HEALTH & WELL-BEING

- We launched working groups that are leading the development of new public health curricula which underscore the important role of the microbiome in human health and development.

INDUSTRY & TECHNOLOGY

- We fostered collaborative projects between academia and industry for more immersive Extended Reality (XR) experiences and a better understanding of human consciousness.
- We convened experts to develop a research and development roadmap for commercial-scale CO_2 electroreduction systems, a promising avenue for carbon-neutral fuels and climate change mitigation.
- We established a new partnership with the International Space Science Institute to explore the science, tools, and mission requirements for the search for subsurface life on Mars.
- We partnered with the Canadian Neutron Initiative to shape a national neutron strategy for rebuilding Canada's capacity for materials research with neutron beams.

POLICY & SOCIETY

- We engaged civil society organizations and foundations to identify and combat factors contributing to persistent social inequality.
- We briefed policy-makers on the role of biological, environmental, and social factors on child health and development.

Our research, policy, and event briefs provided valuable insights to our communities and broader networks.

Fourteen reports were published this year, from case studies on how virtual reality could be used to create more effective psychology experiments to summaries of the latest clean carbon discoveries. They served as go-to references for our workshop participants and beyond.

Rebecca Finlay, CIFAR's Vice-President, Engagement & Public Policy, knew that research could be mobilized into action with careful planning and strategic support. This is why she founded our Knowledge Mobilization practice in 2014.

Five years later, CIFAR's knowledge mobilization work is thriving. In 2019 Finlay was elected a Fellow of the American Association for the Advancement of Science (AAAS) "for distinguished work in science communication for innovators in business, policy making and civil society, thereby accelerating the societal impact of scientific research." This is the first time a member of CIFAR's administration team has been elected as a fellow of the AAAS for their work at CIFAR.

THIS YEAR, 5 KNOWLEDGE MOBILIZATION EVENTS ENGAGED 81 PEOPLE FROM 6 COUNTRIES IN MEANINGFUL DISCUSSION.

90% of attendees reported the events were good/excellent	94% plan to integrate new ideas into their work
92% reported improved understanding of the topic	82% plan to share their new learnings with their network
84% gained new ideas that will benefit their work	81% made new connections

SPOTLIGHT: KNOWLEDGE MOBILIZATION IN ACTION

WEAVING THE MICROBIOME INTO NEW PUBLIC HEALTH PROGRAMS, PRACTICES, AND POLICIES.

Research in CIFAR's Humans & the Microbiome program has clearly established the important role our microbiome — the bacteria, viruses, and fungi that live in and on us — has to play in our health. However, the research is so new that few students of public health learn about it as part of their formal curricula.

With COVID-19, many people are dramatically shifting their social behaviours (e.g., isolation, hand-washing), diets, and built environments (e.g., frequent surface disinfection), some of which could have negative implications for the microbiome. The question is, what does this mean for promoting health and wellness in the current pandemic and in the world after COVID-19? Integrating the microbiome into the public health curriculum has never been more timely.

To bridge this gap, fellows and CIFAR Azrieli Global Scholars in the Humans & the Microbiome program, in discussions with senior leaders at public health schools in Canada and the U.S., are establishing ways to incorporate microbiome-related curriculum materials in public health schools. Program members met for the fifth time with public health school leaders in March 2020 and plan to continue this work through an ongoing working group.

"CIFAR's leadership in convening research on the human microbiome is an important contribution to the evidence base supporting public health decision-making today and into the future."

HEATHER ORPANA
Public Health Agency of Canada

DEVELOPING IMMERSIVE EXPERIENCES AT THE INTERSECTION OF XR, NEUROTECHNOLOGY, AND BRAIN RESEARCH.

Extended Reality (XR), the suite of technologies including augmented, virtual, and mixed reality, can create experiences that feel incredibly real. Artists and innovators have used these technologies to create games and films that totally immerse the user in an imagined world. However, there are still many open questions about what exactly our brains are doing to convince us that the worlds we see and hear are real, and XR platforms could be the perfect tool to study this aspect of consciousness.

Fellows and CIFAR Azrieli Global Scholars in the Azrieli Brain, Mind & Consciousness program are working with international academic experts, developers, and content creators from the XR industry to understand the nature of immersiveness and harness it for both entertainment and research. At the third roundtable in May 2020, they explored the hurdles to developing more immersive XR experiences, as well as how XR can lead to a better understanding of human consciousness and brain-body interactions.

"As an AI/XR content creator, this CIFAR workshop was tremendously inspiring. Not only did it provide valuable insights on how XR technologies can be used to study cognition and perception, but it also served as a collaborative hotbed for discussion on how creativity and storytelling can propel incredible research toward the cultural celebration it deserves."

PIETRO GAGLIANO
Transforms.ai

DEVELOPING NEW WAYS TO EFFICIENTLY CONVERT CARBON DIOXIDE IN THE AIR INTO CLEAN, EFFICIENT, AND RENEWABLE FUELS.

Our economy is based on carbon from fossil fuels we pull from the ground, and the process of turning that fuel into energy and useful products releases CO_2 that accelerates climate change. If we could efficiently pull carbon from the air and turn it into fuels and plastics, we would no longer have to extract it from the ground, and we could move closer to a renewable future. While technically possible, this procedure requires a litany of complex processes that are not yet scalable.

Fellows and CIFAR Azrieli Global Scholars in CIFAR's Bio-inspired Solar Energy program are meeting with experts outside the program to identify how to accomplish each step in the CO_2 conversion process. In March 2020, at the second in a series of roundtables, they had a fruitful meeting with international experts from academia, industry, and national government laboratories to discuss catalysts, the chemicals that accelerate the crucial CO_2 electroreduction reaction.

"The discussion of high-temperature catalysts and comparison to low-temperature catalysts was very useful in highlighting the obstacles that should be overcome for low-temperature catalysis. I will be using it to design experiments that attempt to resolve these obstacles and move the field towards deployment of low-temperature catalysts on an increased scale."

PARTICIPANT
Effectiveness of Catalysts in CO_2 Electroreduction Systems workshop

Fuelling Scientific Curiosity

CIFAR President & CEO Alan Bernstein (left), CIFAR Fellow Prerna Singh (centre) and CIFAR Fellow Vlada Stamenković (right) share insights and provoke discussion at CIFAR Presents: The Walrus Talks events that took place across Canada.

PUBLIC ENGAGEMENT & STRATEGIC COMMUNICATIONS

CIFAR's public engagement activities serve two important functions: to fuel scientific curiosity among the public by sharing the latest research from top scholars and scientists from around the world, and to share advances within our programs back to the stakeholders who support us.

Through a partnership with *The Walrus*, we engaged new audiences with our first formal public engagement program.

CIFAR Presents: The Walrus Talks, a series of three public events, featured our fellows and focused on the key themes addressed by our research programs. Talks were held across Canada in Montreal, the National Capital Region, and Calgary. A fourth talk, scheduled to take place in New York City on April 14, was rescheduled due to COVID-19 and will be held virtually in October 2020 from Toronto.

When the COVID-19 pandemic began, we grew our public engagement program, moving it online, and launched CIFAR Virtual Talks.

CIFAR Virtual Talks is a bi-weekly series of free 30-minute events connecting global audiences to the people behind important new research. All CIFAR Virtual Talks are archived on our YouTube channel.

We grew our online community exponentially.

Our renewed content strategy attracted new followers to our social media channels. Our total following across Twitter, Facebook, YouTube, and LinkedIn grew by 6,220, bringing our online community to 24,815 followers and subscribers. This represents a 33% increase over the year, which is 100x faster growth than average for non-profit organizations. Our online publications and digital content continued to draw an international audience, with 140,554 views of cifar.ca from outside of Canada, a 9% increase over the previous year.

"I give because CIFAR's approach is most likely to lead to a deeper understanding of the important questions we face now and that we are going to face in the future."

PATRICIA BAIRD
WHY I GIVE

One of CIFAR's longest-standing donors speaks with Leslie McCarley, CIFAR's Vice-President, Advancement

Patricia Baird is a medical geneticist in Vancouver, a UBC University Killam Distinguished Professor Emerita, an Officer of the Order of Canada, and a Member of the Order of British Columbia.

Baird joined CIFAR's Research Council in 1987 and was an associate fellow in CIFAR's Population Health program (1987 – 1998). Members were early champions of the social determinants of health, and the program spawned a new way of approaching public health in government and society.

She went on to chair a joint Advisory Committee of the Human Development program (founded in 1993) that was a precursor to CIFAR's current Child & Brain Development program. Braid was also a member of CIFAR's Board of Directors (1991 – 2010).

Leslie McCarley, CIFAR's Vice-President, Advancement, spoke with Braid about her longstanding commitment to CIFAR.

Thank you for agreeing to share your CIFAR story. To begin, how did you become involved with CIFAR?

I found out about CIFAR through [CIFAR's founding President] Fraser Mustard in the mid-1980s. I was head of the department of Medical Genetics at UBC, and he was building CIFAR. He would come to B.C. on occasion to interview people as possible fellows for CIFAR's programs, and he made a habit of coming by my office and taking me for coffee.

Fraser was a real force of nature. He asked me to become a member of the Research Council 33 years ago. I said yes, of course. Ever since, I've been involved in one way or another with CIFAR.

I was most deeply involved in CIFAR's Population Health and Human Development programs. I found that interesting because, not only was I present at the birth of some of the new ways of looking at population health, but I also saw ideas evolve into mature insights. These insights became accepted and adopted by the medical and policy communities.

So I saw the whole process, from important questions – like "why are some people healthy and others not?" – to ideas being fleshed out with evidence, and then brought to the attention of policy-makers and clinicians. This was a panorama that showed how, in any given area, the whole idea of CIFAR can work.

You outline CIFAR's process nicely: identifying an important question, bringing people together, spurring ideas, and then moving evidence forward to change practices and policies. What has been the most exciting and interesting aspect of your involvement?

Being associated with CIFAR has been the most stimulating intellectual experience in my professional life. I find what I've learned through CIFAR to be more interesting than even genetics, my own discipline. And that is really a tribute to the broad-mindedness and adventurous spirit of CIFAR.

Being associated with CIFAR is stimulating because it opens up new avenues of thinking, and it shows the need to recognize the interconnectedness of phenomena.

You've been a donor for quite some time – nearly 30 years. And with many demands on your time and resources, why give to CIFAR? Why now?

Ultimately, unless we try to understand some of these questions for their own sake, we're not going to be able to make changes in the world for the better. There are few institutions that have the boldness and ambition to even attempt what CIFAR does. I give because CIFAR's approach is most likely to lead to a deeper understanding of the important questions we face now and that we are going to face in the future.

CIFAR Supporters

We express our sincere thanks to our partners and donors for helping us to address science and humanity's most important questions.

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$10,000,000 AND ABOVE

The Azrieli Foundation

$1,000,000 - $4,999,999

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The Fraser Mustard Legacy Society

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George A. Fierheller

Elizabeth Gerrits

Richard W. Ivey

Lawrence Tanenbaum

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Canada

$25,000,000 AND ABOVE	GOVERNMENT OF CANADA	Innovation, Science and Economic Development Canada Canadian Institutes of Health Research Social Sciences and Humanities Research Council
$2,000,000 - $9,999,999	GOVERNMENT OF BRITISH COLUMBIA	Ministry of Health
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$1,000,000 - $1,999,999	GOVERNMENT OF ALBERTA	Ministry of Economic Development and Trade
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If you have any questions about this listing, or if your recognition wishes have changed please contact giving@cifar.ca or 416.971.4453.

Financial Overview, Selected Research Citations & Appendices

FINANCIAL OVERVIEW

Revenue

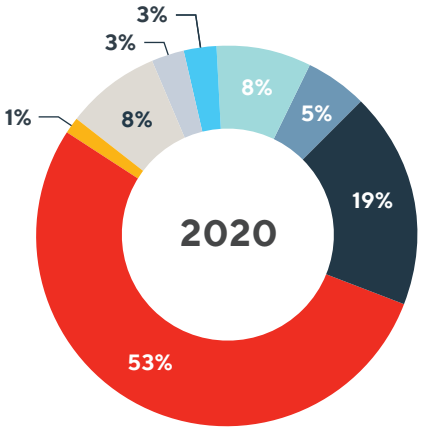
- Partnerships
- Provincial
- Investment Income

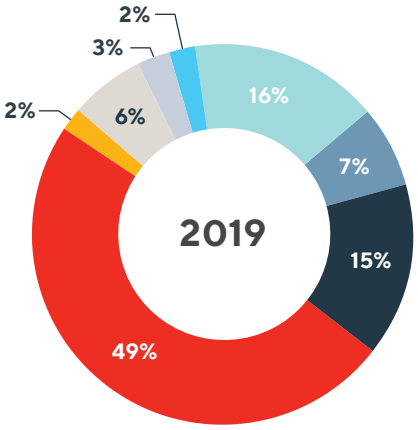
Private Sector:

- Individuals
- Foundations
- Corporations

Federal:

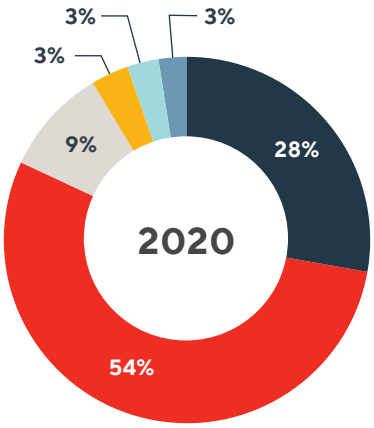
- Pan-Canadian AI Strategy
- Operational Funding

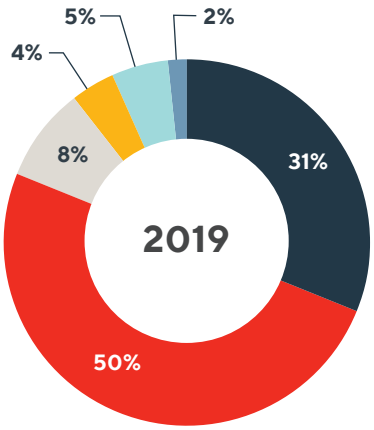




Expenses

- Pan-Canadian AI Strategy
- Knowledge Creation
- Knowledge Mobilization and Communications
- Governance and Administration
- Advancement
- Next Generation





STATEMENT OF OPERATIONS

Year ended June 30, 2020

Revenue	2020 (000s)	2019 (000s)
GOVERNMENT FUNDING		
Federal		
Operational funding	7,550	7,000
Pan-Canadian AI Strategy	21,792	22,823
Provincial	3,362	7,450
	32,704	**37,273**
PARTNERSHIPS		
Research organizations	2,079	3,027
Universities and others	2	171
	2,081	**3,198**
PRIVATE SECTOR		
Corporations	562	895
Foundations	3,283	2,941
Individuals	1,067	1,353
	4,912	**5,189**
Investment income	1,132	1,054
	40,829	**46,714**

Expenses		
PROGRAM EXPENSES		
Knowledge creation	11,409	14,586
Pan-Canadian AI Strategy	22,117	23,460
Knowledge mobilization and communications	3,769	3,940
Next generation	1,381	1,801
	38,676	**43,787**
NON-PROGRAM EXPENSES	2,125	3,048
	40,801	**46,835**
Excess (deficiency) of revenue over expenses	28	(121)
Unrealized gain (loss) on investments	(1,416)	16
DEFICIENCY OF REVENUE OVER EXPENSES	**(1,388)**	**(105)**

STATEMENT OF FINANCIAL POSITION

Year ended June 30, 2020

Assets	2020 (000s)	2019 (000s)
CURRENT ASSETS		
Cash	9,226	1,658
Accounts receivable	6,850	2,650
Investments	–	8,500
Prepaid expenses	320	234
	16,396	**13,042**
Investments	19,099	19,745
Property, equipment, and leasehold improvements	1,273	1,510
Intangible assets	502	348
	37,270	**34,645**

Liabilities		
Accounts payable and accrued liabilities	9,978	8,122
Deferred revenue	5,844	4,549
Deferred tenant allowance	40	40
	15,862	**12,711**
Deferred revenue	1,771	868
Deferred tenant allowance	240	281
	17,873	**13,860**

Net Assets		
Invested in property, equipment, leasehold improvments, and intangible assets	1,495	1,537
Externally restricted endowment fund	500	500
Internally restricted reserve	10,000	10,000
Unrestricted	7,402	8,748
	19,397	**20,785**
	37,270	**34,645**

SELECTED RESEARCH CITATIONS

[1] Case, N. T., **Heitman, J.**, & **Cowen, L. E.** (2020). The rise of fungi: A report on the CIFAR program Fungal Kingdom: Threats & Opportunities inaugural meeting. G3: Genes|Genomes|Genetics, 10(6), 1837–1842. https://doi.org/10.1534g3.120.401271

[2] **Fisher, M. C., Gurr, S. J., Cuomo, C. A., Blehert, D. S., Jin, H., Stukenbrock, E. H., Stajich, J. E., Kahmann R., Boone, C., Denning, D. W., Gow, N. A. R., Klein, B. S., Kronstad, J. W., Sheppard, D. C., Taylor, J. W., Wright, G. D., Heitman, J., Casadevall, A.**, & **Cowen, L. E.** (2020). Threats posed by the fungal kingdom to humans, wildlife, and agriculture. MBio, 11(3), e00449-20. https://doi.org/10.1128mbio.00449-20

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(Université de Montréal)
Mila

TAL ARBEL
(McGill University)
Mila

ALÁN ASPURU-GUZIK
(University of Toronto)
Vector Institute

JIMMY BA
(University of Toronto)
Vector Institute

PIERRE-LUC BACON
(Université de Montréal)
Mila

MARC BELLEMARE
(Google Brain; McGill University)
Mila

SHAI BEN-DAVID
(University of Waterloo)
Vector Institute

YOSHUA BENGIO
(Université de Montréal)
Mila

DANILO BZDOK
(McGill University)
Mila

JUAN FELIPE CARRASQUILLA
(University of Waterloo)
Vector Institute

SARATH CHANDAR
(École Polytechnique de Montréal)
Mila

ANGEL CHANG
(Simon Fraser University)
Amii

LAURENT CHARLIN
(HEC Montréal)
Mila

JACKIE CHEUNG
(McGill University)
Mila

AARON COURVILLE
(Université de Montréal)
Mila

FERNANDO DIAZ
(Microsoft Research, Montreal;
McGill University)
Mila

MARC-ANTOINE DILHAC
(Université de Montréal)
Mila

CHRISTOPHE DUBACH
(McGill University)
Mila

AUDREY DURAND
(Université Laval)
Mila

MURAT ERDOGDU
(University of Toronto)
Vector Institute

AMIR-MASSOUD FARAHMAND
(University of Toronto)
Vector Institute

SANJA FIDLER
(University of Toronto; NVIDIA)
Vector Institute

DAVID FLEET
(University of Toronto; Google Brain)
Vector Institute

JAKOB FOERSTER
(University of Toronto)
Vector Institute

ALONA FYSHE
(University of Alberta)
Amii

CHRISTIAN GAGNÉ
(Université Laval)
Mila

ANIMESH GARG
(University of Toronto; NVIDIA)
Vector Institute

PASCAL GERMAIN
(Université Laval)
Mila

MARZYEH GHASSEMI
(University of Toronto)
Vector Institute

ANNA GOLDENBERG
(SickKids Research Institute;
University of Toronto)
Vector Institute

GEOFFREY GORDON
(Microsoft Research, Montreal;
McGill University)
Mila

ROGER GROSSE
(University of Toronto)
Vector Institute

WILLIAM HAMILTON
(McGill University)
Mila

SIMON LACOSTE-JULIEN
(Université de Montréal; Samsung)
Mila

HUGO LAROCHELLE
(Google Brain; Université de Montréal)
Mila

FRANÇOIS LAVIOLETTE
(Université Laval)
Mila

NICOLAS LE ROUX
(Google Brain; McGill University)
Mila

KEVIN LEYTON-BROWN
(University of British Columbia)
Amii

CHRIS J. MADDISON
(University of Toronto)
Vector Institute

RUPAM MAHMOOD
(University of Alberta)
Amii

ALIREZA MAKHZANI
(University of Toronto)
Vector Institute

SHEILA McILRAITH
(University of Toronto)
Vector Institute

IOANNIS MITLIAGKAS
(Université de Montréal)
Mila

QUAID MORRIS
(University of Toronto)
Vector Institute

SARA MOSTAFAVI
(University of British Columbia)
Vector Institute

LILI MOU
(University of Alberta)
Amii

TIM O'DONNELL
(McGill University)
Mila

SAGEEV OORE
(Dalhousie University)
Vector Institute

CHRISTOPHER PAL
(Ecole Polytechnique de Montréal; Element AI)
Mila

NICOLAS PAPERNOT
(University of Toronto)
Vector Institute

COURTNEY PAQUETTE
(McGill University)
Mila

LIAM PAULL
(Université de Montréal)
Mila

GENNADY PEKHIMENKO
(University of Toronto)
Vector Institute

JOELLE PINEAU
(Facebook AI Research, Montreal; McGill University)
Mila

TONIANN PITASSI
(University of Toronto)
Vector Institute

PASCAL POUPART
(University of Waterloo)
Vector Institute

DOINA PRECUP
(DeepMind; McGill University)
Mila

REIHANEH RABBANY
(McGill University)
Mila

GUILLAME RABUSSEAU
(Université de Montréal)
Mila

SIAMAK RAVANBAKHSH
(McGill University)
Mila

SIVA REDDY
(McGill University)
Mila

BLAKE RICHARDS
(McGill University)
Mila

IRINA RISH
(Université de Montréal)
Mila

DANIEL ROY
(University of Toronto)
Vector Institute

FRANK RUDZICZ
(Li Ka Shing Knowledge Institute, St Michael's Hospital; University of Toronto)
Vector Institute

MARK SCHMIDT
(University of British Columbia)
Amii

ANGELA SCHOELLIG
(University of Toronto)
Vector Institute

LEONID SIGAL
(University of British Columbia)
Vector Institute

NATHAN STURTEVANT
(University of Alberta)
Amii

CSABA SZEPESVÁRI
(DeepMind; University of Alberta)
Amii

JIAN TANG
(HEC Montréal)
Mila

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(Université de Sherbrooke)
Mila

PASCAL VINCENT
(Facebook AI Research, Montreal; Université de Montréal)
Mila

BO WANG
(Peter Munk Cardiac Centre, University Health Network; University of Toronto)
Vector Institute

ADAM WHITE
(University of Alberta)
Amii

MARTHA WHITE
(University of Alberta)
Amii

FRANK WOOD
(University of British Columbia)
Mila

JAMES WRIGHT
(University of Alberta)
Amii

YAOLIANG YU
(University of Waterloo)
Vector Institute

SELECTED AWARDS & HONOURS RECEIVED

In 2019-2020, CIFAR Fellows, Advisors, CIFAR Azrieli Global Scholars and Canada CIFAR AI Chairs received **105 major awards and honours.** In addition, Rebecca Finlay, Vice-President, Engagement & Public Policy, CIFAR was elected as a Fellow of the American Association for the Advancement of Science and James Peebles, a founding fellow of CIFAR's Cosmology & Gravity program (now Gravity & the Extreme Universe), received a 2019 Nobel Prize in Physics.

AWARDS

3M NON-TENURED FACULTY AWARD (USA)

Ximin He (University of California, Los Angeles) *Bio-inspired Solar Energy and CIFAR Azrieli Global Scholars*

AI 2000 MOST INFLUENTIAL SCHOLARS – MACHINE LEARNING 2020 (AMINER, CHINA)

Jimmy Ba (University of Toronto and Vector Institute) *Learning in Machines & Brains and Canada CIFAR AI Chairs*

Yoshua Bengio (Université de Montréal and Mila) *Learning in Machines & Brains and Canada CIFAR AI Chairs*

Aaron Courville (Université de Montréal and Mila) *Learning in Machines & Brains and Canada CIFAR AI Chairs*

Geoffrey Hinton (University of Toronto, Vector Institute and Google Research), *Learning in Machines & Brains*

AI 2000 MOST INFLUENTIAL SCHOLARS – NATURAL LANGUAGE PROCESSING 2020 (AMINER, CHINA)

Yoshua Bengio (Université de Montréal and Mila) *Learning in Machines & Brains and Canada CIFAR AI Chairs*

Kyunghyun Cho (New York University) *Learning in Machines & Brains and CIFAR Azrieli Global Scholar Alumni*

Christopher Manning (Stanford University) *Learning in Machines & Brains*

AI 2000 MOST INFLUENTIAL SCHOLARS – ROBOTICS 2020 (AMINER, CHINA)

Pieter Abbeel (University of California, Berkeley) *Learning in Machines & Brains*

AI 2000 MOST INFLUENTIAL SCHOLARS – SPEECH RECOGNITION 2020 (AMINER, CHINA)

Geoffrey Hinton (University of Toronto, Vector Institute and Google Research) *Learning in Machines & Brains*

ALFRED P. SLOAN RESEARCH FELLOW (ALFRED P. SLOAN FOUNDATION, USA)

Renée Hložek (University of Toronto) *Gravity & the Extreme Universe and CIFAR Azrieli Global Scholars*

Adrian Liu (McGill University) *Gravity & the Extreme Universe and CIFAR Azrieli Global Scholars*

AWARD FOR EXCELLENCE IN MATERIALS CHEMISTRY (CANADIAN SOCIETY FOR CHEMISTRY)

Curtis Berlinguette (University of British Columbia) *Bio-inspired Solar Energy*

BARRINGTON MOORE BOOK AWARD (AMERICAN SOCIOLOGICAL ASSOCIATION)

Andreas Wimmer (Columbia University) *Boundaries, Membership & Belonging*

BBVA FOUNDATION FRONTIERS OF KNOWLEDGE AWARD (SPAIN)

Philippe Aghion (Collège de France) *Institutions, Organizations & Growth*

Gilles Brassard (Université de Montréal) *Quantum Information Science*

Bernhard Schölkopf (Max Planck Institute for Intelligent Systems) *Learning in Machines & Brains*

BREAKTHROUGH PRIZE IN FUNDAMENTAL PHYSICS (USA)

Daryl Haggard (McGill University) *CIFAR Azrieli Global Scholar Alumni (Gravity & the Extreme Universe)*

Ue-Li Pen (University of Toronto) *Gravity & the Extreme Universe*

C.L. DE CARVALHO-HEINEKEN PRIZE FOR COGNITIVE SCIENCE (ROYAL NETHERLANDS ACADEMY OF ARTS AND SCIENCES)

Robert Zatorre (McGill University) *Azrieli Program in Brain, Mind & Consciousness*

CAMILLE DREYFUS TEACHER-SCHOLAR AWARD (CAMILLE AND HENRY DREYFUS FOUNDATION, USA)

Gabriela Schlau-Cohen (Massachusetts Institute of Technology) *Bio-inspired Solar Energy and CIFAR Azrieli Global Scholar Alumni*

CLAIR C. PATTERSON AWARD (GEOCHEMICAL SOCIETY, USA)

Barbara Sherwood Lollar (University of Toronto) *Earth 4D: Subsurface Science & Exploration*

CREATIVE DESTRUCTION LAB IDEA AWARD (CANADA)

Alán Aspuru-Guzik (University of Toronto and Vector Institute) *Bio-inspired Solar Energy and Canada CIFAR AI Chairs*

Raquel Urtasun (University of Toronto) *Learning in Machines & Brains*

DISCOVERY ACCELERATOR SUPPLEMENT (NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL, CANADA)

Blake Richards (McGill University and Mila) *Learning in Machines & Brains and Canada CIFAR AI Chairs*

DOROTHY CROWFOOT HODGKIN AWARD (THE PROTEIN SOCIETY, USA)

Catherine Drennan (Massachusetts Institute of Technology) *Bio-inspired Solar Energy*

EARLY-CAREER SPOTLIGHT AWARD (ROBOTICS: SCIENCE AND SYSTEMS FOUNDATION, USA)

Angela Schoellig (University of Toronto and Vector Institute) *Canada CIFAR AI Chairs*

EARLY RESEARCHER AWARD (GOVERNMENT OF ONTARIO, CANADA)

Jean-Philippe Julien (Hospital for Sick Children, Toronto) *Molecular Architecture of Life and CIFAR Azrieli Global Scholars*

ENGINEERING MEDAL FOR ENGINEERING EXCELLENCE (PROFESSIONAL ENGINEERS OF ONTARIO, CANADA)

Goldie Nejat (University of Toronto) *Innovation, Equity & the Future of Prosperity*

EPIQS EXPERIMENTAL INVESTIGATOR (GORDON AND BETTY MOORE FOUNDATION, USA)

Peter Armitage (Johns Hopkins University) *Quantum Materials*

Pablo Jarillo-Herrero (Massachusetts Institute of Technology) *Quantum Materials*

FACEBOOK PYROBOT: DEMOCRATIZING ROBOTICS RESEARCH AWARD (USA)

Liam Paull (Université de Montréal and Mila) *Canada CIFAR AI Chairs*

FACULTY EARLY CAREER DEVELOPMENT (CAREER) AWARD (NATIONAL SCIENCE FOUNDATION, USA)

Prineha Narang (Harvard University) *Bio-inspired Solar Energy and CIFAR Azrieli Global Scholars*

FRIEDRICH WILHELM BESSEL RESEARCH AWARD (ALEXANDER VON HUMBOLDT FOUNDATION, GERMANY)

Tobias Rees (New School and Berggruen Institute) *Humans & the Microbiome*

GOOGLE FACULTY RESEARCH AWARD (USA)

Kyunghyun Cho (New York University) *Learning in Machines & Brains and CIFAR Azrieli Global Scholar Alumni*

GOOGLE QUANTUM RESEARCH AWARD (USA)

Juan Felipe Carrasquilla (University of Waterloo and Vector Institute) *Canada CIFAR AI Chairs*

HAMBURG PRIZE FOR THEORETICAL PHYSICS (GERMANY)

Matthias Troyer (Microsoft) *Quantum Information Science*

JAN SÖDERBERG FAMILY PRIZE IN ECONOMICS AND MANAGEMENT (SWEDEN)

Nathan Nunn (Harvard University) *Boundaries, Membership & Belonging*

JOHN BATES CLARK MEDAL (AMERICAN ECONOMIC ASSOCIATION)

Melissa Dell (Harvard University) *Institutions, Organizations & Growth*

JOHN CHARLES POLANYI PRIZE (GOVERNMENT OF ONTARIO AND COUNCIL OF ONTARIO UNIVERSITIES)

Maria Drout (University of Toronto) *Gravity & the Extreme Universe and CIFAR Azrieli Global Scholars*

JOSEPH O. HIRSCHFELDER PRIZE IN THEORETICAL CHEMISTRY (THEORETICAL CHEMISTRY INSTITUTE, USA)

Sharon Hammes-Schiffer (Yale University) *Bio-inspired Solar Energy*

KILLAM PRIZE FOR THE NATURAL SCIENCES (CANADA COUNCIL FOR THE ARTS)

Barbara Sherwood-Lollar (University of Toronto) *Earth 4D: Subsurface Science & Exploration*

KÖRBER EUROPEAN SCIENCE PRIZE (KÖRBER FOUNDATION, GERMANY)

Bernhard Schölkopf (Max Planck Institute for Intelligent Systems) *Learning in Machines & Brains*

KYUNG-AHM PRIZE (KYUNG-AHM EDUCATION & CULTURAL FOUNDATION, SOUTH KOREA)

Keun Lee (Seoul National University) *Innovation, Equity & the Future of Prosperity*

LIFETIME ACHIEVEMENT AWARD (CANADIAN IMAGE PROCESSING AND PATTERN RECOGNITION SOCIETY)

David Fleet (University of Toronto and Vector Institute) *Canada CIFAR AI Chairs*

MACARTHUR FELLOWSHIP (MACARTHUR FOUNDATION, USA)

Jenny Tung (Duke University) *Child & Brain Development*

MICROSOFT RESEARCH FACULTY FELLOWSHIP (MICROSOFT, USA)

Chelsea Finn (Stanford University) *Learning in Machines & Brains*

MISSION AWARD (SOCIETY FOR THE IMPROVEMENT OF PSYCHOLOGICAL SCIENCE, USA)

Laurel Trainor (McMaster University) *Azrieli Program in Brain, Mind & Consciousness*

Sandra Waxman (Northwestern University) *Azrieli Program in Brain, Mind & Consciousness*

NATHAN ROSEN PRIZE IN EXPERIMENTAL PHYSICS (ISRAEL PHYSICAL SOCIETY)

Iair Arcavi (Tel Aviv University) *Gravity & the Extreme Universe and CIFAR Azrieli Global Scholars*

NATURE'S 10 PEOPLE WHO MATTERED THIS YEAR (2019)

Victoria Kaspi (McGill University) *Gravity & the Extreme Universe*

NEW HORIZONS PRIZE (FUNDAMENTAL PHYSICS BREAKTHROUGH PRIZE, USA)

Kendrick Smith (Perimeter Institute for Theoretical Physics) *Gravity & the Extreme Universe*

NEW INVESTIGATOR AWARD (CANADIAN SOCIETY FOR IMMUNOLOGY)

Jean-Philippe Julien (Hospital for Sick Children) *Molecular Architecture of Life and CIFAR Azrieli Global Scholars*

NOBEL LAUREATE SIGNATURE AWARD FOR GRADUATE EDUCATION IN CHEMISTRY (AMERICAN CHEMICAL SOCIETY)

Yogesh Surendranath (Massachusetts Institute of Technology) *Bio-inspired Solar Energy and CIFAR Azrieli Global Scholars*

NSERC INDUSTRIAL RESEARCH CHAIR (GOOGLE AND NATURAL SCIENCES AND ENGINEERING RESEARCH COUNCIL, CANADA)

Alán Aspuru-Guzik (University of Toronto and Vector Institute) *Bio-inspired Solar Energy and Canada CIFAR AI Chairs*

OLIVER E. BUCKLEY CONDENSED MATTER PHYSICS PRIZE (AMERICAN PHYSICAL SOCIETY)

Pablo Jarillo-Herrero (Massachusetts Institute of Technology) *Quantum Materials*

OTHMER GOLD MEDAL (SCIENCE HISTORY INSTITUTE, USA)

Dame Carol Robinson (University of Oxford) *Molecular Architecture of Life*

PRESIDENTIAL EARLY CAREER AWARD FOR SCIENTISTS AND ENGINEERS (PECASE) (USA)

Nathaniel Gabor (University of California, Riverside) *Bio-inspired Solar Energy and CIFAR Azrieli Global Scholar Alumni*

Yogesh Surendranath (Massachusetts Institute of Technology) *Bio-inspired Solar Energy and CIFAR Azrieli Global Scholars*

Thomas Vidick (California Institute of Technology) *Quantum Information Science and CIFAR Azrieli Global Scholar Alumni*

ROYAL MEDAL (ROYAL SOCIETY, UNITED KINGDOM)

Dame Carol Robinson (University of Oxford) *Molecular Architecture of Life*

SCIALOG FELLOW (RESEARCH CORPORATION FOR SCIENCE ADVANCEMENT, USA)

Nathaniel Gabor (University of California, Riverside) *Bio-inspired Solar Energy and CIFAR Azrieli Global Scholar Alumni*

Magdalena Osburn (Northwestern University) *Earth 4D: Subsurface Science & Exploration*

Joel Zylberberg (York University) *Learning in Machines & Brains and CIFAR Azrieli Global Scholar Alumni*

SHAW PRIZE IN ASTRONOMY (SHAW PRIZE FOUNDATION, HONG KONG, CHINA)

Roger Blandford (Stanford University) *Gravity & the Extreme Universe*

SSHRC GOLD MEDAL (SOCIAL SCIENCES AND HUMANITIES RESEARCH COUNCIL, CANADA)

Will Kymlicka (Queen's University) *Boundaries, Membership & Belonging*

STEIN ROKKAN PRIZE FOR COMPARATIVE SOCIAL SCIENCE RESEARCH (INTERNATIONAL SCIENCE COUNCIL)

Andreas Wimmer (Columbia University) *Boundaries, Membership & Belonging*

TD'S 10 MOST INFLUENTIAL HISPANIC CANADIANS

Luis Lehner (University of Waterloo) *Gravity & the Extreme Universe*

WILLIAM DAWSON SCHOLAR (CANADA)

Adrian Liu (McGill University) *Gravity & the Extreme Universe and CIFAR Azrieli Global Scholars*

WISTEM2D SCHOLARS AWARD (JOHNSON & JOHNSON)

Carolina Tropini (University of British Columbia) *Humans & the Microbiome and CIFAR Azrieli Global Scholars*

WOLF PRIZE FOR PHYSICS (WOLF FOUNDATION, ISRAEL)

Pablo Jarillo-Herrero (Massachusetts Institute of Technology) *Quantum Materials*

Allan MacDonald (University of Texas at Austin) *Quantum Materials*

HONOURS

CORRESPONDING FELLOW OF THE BRITISH ACADEMY

Michèle Lamont (Harvard University) *Successful Societies*

Hazel Markus (Stanford University) *Boundaries, Membership & Belonging*

FELLOW OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES

Catherine Drennan (Massachusetts Institute of Technology) *Bio-inspired Solar Energy*

Karen Guillemin (University of Oregon) *Humans & the Microbiome*

Joseph Heitman (Duke University) *Fungal Kingdom: Threats & Opportunities*

Victoria Orphan (California Institute of Technology) *Earth 4D: Subsurface Science & Exploration*

Eva Silverstein (Stanford University) *Gravity & the Extreme Universe*

FELLOW OF THE AMERICAN ACADEMY OF MICROBIOLOGY

David Blehert (United States Geological Survey) *Fungal Kingdom: Threats & Opportunities*

Christina Cuomo (Broad Institute) *Fungal Kingdom: Threats & Opportunities*

Matthew Fisher (Imperial College London) *Fungal Kingdom: Threats & Opportunities*

Sarah Gurr (University of Exeter) *Fungal Kingdom: Threats & Opportunities*

Hailing Jin (University of California, Riverside) *Fungal Kingdom: Threats & Opportunities*

Jason Stajich (University of California, Riverside) *Fungal Kingdom: Threats & Opportunities*

Eva Stukenbrock (Max Planck Institute of Evolutionary Biology) *Fungal Kingdom: Threats & Opportunities*

FELLOW OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Vasiliki Kalogera (Northwestern University) *Gravity & the Extreme Universe*

Arthur McDonald (Queen's University) *Gravity & the Extreme Universe*

FELLOW OF THE AMERICAN PHYSICAL SOCIETY

James Analytis (University of California, Berkeley) *Quantum Materials*

FELLOW OF THE ASSOCIATION OF COMPUTING MACHINERY

Sheila McIlraith (University of Toronto) *Canada CIFAR AI Chairs*

FELLOW OF THE GEOLOGICAL SOCIETY OF AMERICA

Jennifer McIntosh (University of Arizona) *Earth 4D: Subsurface Science & Exploration*

FELLOW OF THE LATIN AMERICAN ACADEMY OF SCIENCES

Maria Gloria Dominguez-Bello (Rutgers University) *Humans & the Microbiome*

FELLOW OF THE ROYAL SOCIETY (UNITED KINGDOM)

Yoshua Bengio (Université de Montréal and Mila) *Learning in Machines & Brains and Canada CIFAR AI Chairs*

FOREIGN ASSOCIATE OF THE NATIONAL ACADEMY OF SCIENCES (USA)

Brenda Andrews (University of Toronto) *Genetic Networks*

Lewis Kay (University of Toronto) *Molecular Architecture of Life*

FOREIGN MEMBER OF THE ROYAL SOCIETY (UNITED KINGDOM)

Regine Kahmann (Max Planck Institute for Terrestrial Microbiology) *Fungal Kingdom: Threats & Opportunities*

GEOCHEMISTRY FELLOW (GEOCHEMICAL SOCIETY AND THE EUROPEAN ASSOCIATION OF GEOCHEMISTRY)

Barbara Sherwood Lollar (University of Toronto) *Earth 4D: Subsurface Science & Exploration*

HONORARY FELLOW OF THE JOHN BELL INSTITUTE FOR THE FOUNDATIONS OF PHYSICS

Aephraim Steinberg (University of Toronto) *Quantum Information Science*

INTERNATIONAL MEMBER OF THE NATIONAL ACADEMY OF ENGINEERING (USA)

Claudia Felser (Max Planck Institute for Chemical Physics of Solids) *Quantum Materials*

LEGACY FELLOW OF THE AMERICAN ASTRONOMICAL SOCIETY

J. Richard Bond (University of Toronto) *Gravity & the Extreme Universe*

MEMBER OF THE COLLEGE OF NEW SCHOLARS, ARTISTS AND SCIENTISTS (ROYAL SOCIETY OF CANADA)

Jean-Philippe Julien (Hospital for Sick Children, Toronto) *Molecular Architecture of Life and CIFAR Azrieli Global Scholars*

MEMBER OF THE EUROPEAN ACADEMY OF SCIENCES

Brett Finlay (University of British Columbia) *Humans & the Microbiome*

Claudia Felser (Max Planck Institute for Chemical Physics of Solids) *Quantum Materials*

MEMBER OF THE SOCIETY OF MULTIVARIATE EXPERIMENTAL PSYCHOLOGY

Candice Odgers (University of California, Irvine) *Child & Brain Development*

MEMBER OF THE NATIONAL ACADEMY OF SCIENCES (USA)

Janet Werker (University of British Columbia) *Azrieli Program in Brain, Mind & Consciousness*

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CIFAR

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