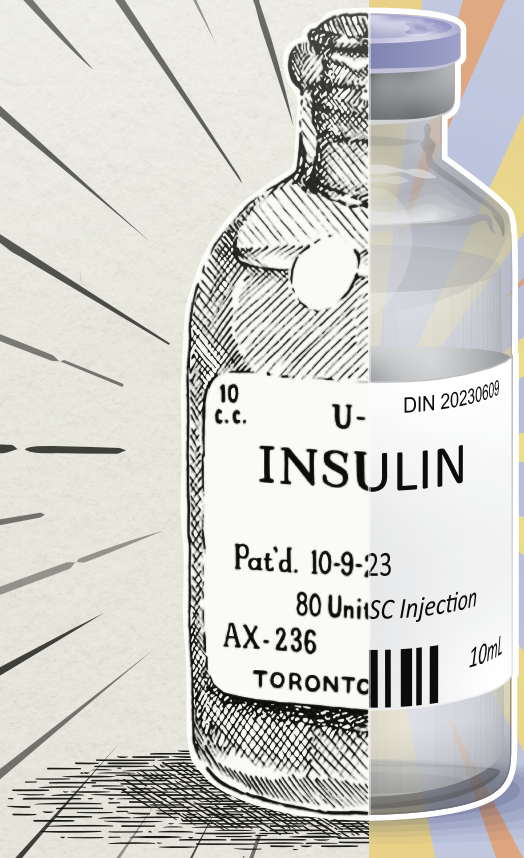
RCIScience

2022 ANNUAL

MAGAZINE



INSULIN TO INNOVATION

Honouring the 100*th* Anniversary of the Discovery of Insulin

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INSULIN TO INNOVATION 100 YEARS

Insulin to Innovation

2021 marked the 100th anniversary of the discovery of insulin. This pivotal moment in medical history happened right here in Canada, at the University of Toronto. Since its discovery, insulin has saved millions of lives, moving diabetes from a death sentence to a manageable condition.

Today, the legacy of this discovery continues through the many people living with diabetes, health care providers, researchers, caregivers and others who have felt the impact of this miraculous drug. Still, insulin is not a cure for diabetes, and that fact drives many to continue to innovate and engage in the search for a solution.

Our consortium of organizations came together to celebrate the discovery of insulin and explore the many ongoing efforts across Canada to improve the lives of those living with or affected by diabetes.

Learn more about one of Canada's greatest gifts to the world—visit www.rciscience.ca/100-lives-of-insulin.

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RCIScience

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SANOFI

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WELCOME.

At the age of 14, Leonard Thompson was 5'11", 65 pounds and starving himself to stay alive. Diagnosed with diabetes mellitus at a time when the only way to manage the condition was to limit what he ate, he was on the verge of a diabetic coma when his parents desperately brought him to Toronto General Hospital in December 1921. There, he became the first patient to receive insulin injections, discovered and developed by the team of Frederick Banting, Charles Best, James Collip and J.J.R. Macleod.

The effect of insulin was almost immediate. Leonard was discharged from the hospital a few months later and would need to take insulin for the rest of his life. He lived another 13 years before dying of complications from pneumonia.

A century later, the legacy of the insulin discovery lives on in everyone who, like Leonard, takes this life-saving drug to manage a condition that doesn't yet have a cure. It lives on in the inspiration of future generations of scientists, many of whom are living with diabetes themselves, committed to pushing the boundaries of scientific discovery to develop better treatments and a cure. It lives on in the globally-leading research ecosystem in Canada, built on the foundations of Banting and his team, to discover, innovate and transform healthcare worldwide.

Stories of game-changing science continue to take centre stage, with groundbreaking innovations in vaccines and therapeutics helping us to navigate the ongoing COVID-19 pandemic and regain a sense of normalcy. As science continues to advance frontiers in the face of growing existential threats, it's more important than ever to create opportunities for the public to engage, understand and connect with the scientific process and those in it.

In celebration of the 100th anniversary of the insulin discovery right here in Canada, RCIScience Magazine looks both to the past and future, with a reminder that scientific breakthroughs don't just happen overnight. Confronted with the climate crisis, food insecurity and other growing global health concerns, we continue to bring you stories of the researchers, policymakers, journalists and others working tirelessly to build resilience and guide us through these challenging times.

We hope that you'll continue to join us as we work to strengthen Canada's science culture, fostering an informed citizenry that contributes to evidence-based decision-making and policy development.

The RCIScience Editorial Team

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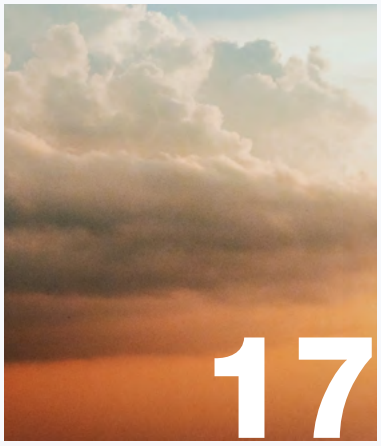
COVER ART: The past and present of insulin, from 1921 to modern times. *(By Darren Cheng)*



Formed in 1849 and receiving a Royal Charter in 1851, RCIScience has been connecting people in Canada for almost 175 years. Follow us @RCIScience.

MESSAGE FROM THE CHAIR

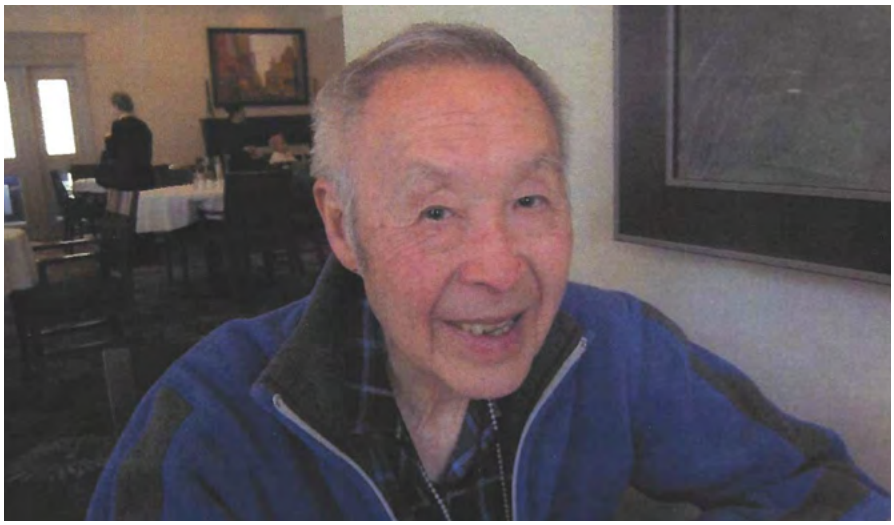
AS MY TERM AS BOARD CHAIR of the Royal Canadian Institute of Science comes to a close, I wanted to reflect on the successes and challenges of the 2021-22 program year. Despite the ongoing pandemic, we were able to host a number of engaging and informative events, including discussions on food security, exercise and everyone's favourite topic of small talk, weather forecasting. Celebrating the 100th anniversary of the discovery of insulin—Canada's greatest gift to the world—continued to take centre stage, as we examined the intersection of healthcare and society, and looked ahead to the future of diabetes research. Our virtual format allowed us to feature researchers from across Canada and we were thrilled to see so many people engaging with our programs from across the world.

As Canada's oldest scientific society, RCIScience has a long history of promoting scientific education and inquiry. Throughout my tenure as Board Chair, I have been impressed by the dedication and passion of our members, volunteers, and staff. Together, we have continued to uphold our mission of fostering scientific curiosity and understanding, and I am proud of what we have accomplished during the organization's second global pandemic. Looking forward, I am excited to see what the future holds for RCIScience. I am confident that our organization will continue to play a vital role in promoting science culture in Canada and beyond. I encourage all of our readers to join us in this important mission and to stay engaged with our programs and events.

Thank you for your support of RCIScience and for your ongoing commitment to scientific inquiry and curiousity.

Suzanne MacDonald

REMEMBERING
DR. JOHN Y.H. CHAU



RCIScience would like to pay tribute to one of its Lifetime Members, Professor John Y.H. Chau, who passed away in 2019.

Born in Hong Kong in 1932, Dr. Chau's family fled to other parts of southeast Asia after Japan's occupation of China in 1941, and settled in Sydney, Australia shortly after the end of the war. Dr. Chau attained a First Class Honours BSc and MSc, both from the University of Sydney, and completed his PhD in 1961 at the University of Wales. Over the years his teaching and research in chemistry brought him to New York, Halifax, Sudbury and Thailand.

John shared a great interest in music and travel with Vera, his wife of 51 years. But John always maintained a keen interest in science. In his retirement, he became a Lifetime member of RCIScience and was a regular attendee of its meetings and lectures, usually with Vera by his side.

We are deeply grateful to Vera Chau for her gift to RCIScience in her late husband John's memory. The gift will support all our work connecting Canadians to science—and will be fittingly recognized at RCIScience's upcoming events to memorialize their decades of learning about science together.

An in-memoriam gift to RCIScience is a powerful way to celebrate your loved one's passion for science, all while supporting our vital work. To find out more, contact information@rciscience.ca.

SUPPORT RCIScience

From the science in everyday life to its role in solving our greatest challenges, our free and engaging programs connect thousands of Canadians to trusted sources of scientific information every year.

As a charitable organization, the support of our donors makes all our work possible. Please join us in building a stronger, more informed country by making a gift.

Click here to donate to RCIScience.

IF YOU DEVELOP TOOLS FOR PEOPLE WITHOUT INVOLVING THE PEOPLE WHO ARE GOING TO USE THEM, THEN THEY'RE NOT GOING TO WORK.

HOLLY WITTEMAN

RCIScience Receives 2022 NSERC Award

The Royal Canadian Institute for Science (RCIScience) is honoured to receive the NSERC Award for Science Promotion (Organization), recognizing our long-standing efforts to connect Canadians with science.

The NSERC Awards for Science Promotion honour individuals and groups who make an outstanding contribution to the promotion of science in Canada through activities encouraging popular interest in science or developing science abilities. Two recipients (one individual and one group) may be selected for the awards each year.

Our members enjoying the conversation at the 2019 Fleming Medal ceremony.

Since its founding in 1849, the Institute has helped shape the scientific landscape of Canada and it currently fills a critical need: to foster public engagement with science.

A common thread running through the long history of RCIScience is connecting Canadians with science. Seventy years ago, attending an "Institute" talk meant dressing up on a Saturday night and heading down to the University of Toronto to listen to an eminent scientist give a presentation. Today, you can still hear talks from eminent scientists, but right alongside them are early-career researchers on the cusp of discovery. If you've dressed up, it's more likely that you're at a tasting to explore the chemistry behind a wheel of brie or you're attending a science-themed variety show.

Fun times to be had at Science is a Drag!

RCIScience is one of the few organizations that keeps its focus mainly on adult audiences. Using many types of engagement, RCIScience reaches a range of audiences, from the merely curious to the deeply knowledgeable.

Science-themed face painting at our Spark After Dark variety show.

Different programs allow people to participate at their own pace, by attending live events, watching them later on YouTube, reading a blog or following an Instagram takeover. RCIScience provides many pathways to engagement with science, technology, engineering and math (STEM).

The COVID-19 pandemic took this outreach to a new level. Rather than shutting down (as it did during the influenza pandemic of 1918 to 1921), RCIScience turned entirely to online program delivery. While some events covered timely topics such as the COVID-19 vaccines and pandemic trends, others talked about forest fires, the future of food, and the importance of exercise for mental as well as physical health.

In the last three years alone, RCIScience has hosted more than 115 events featuring over 300 scientists and reaching more than two million people, both in person and online. Thanks to the help of over 100 volunteers, most of these programs are delivered free of charge or at very low cost to encourage participation.

Review past events on YouTube or subscribe to our newsletter and be the first to hear about upcoming activities!

Thank you to NSERC for recognizing our efforts in promoting science to the public. And a very special thank you to all of our members and supporters, speakers, volunteers and program partners, followers and attendees over the past 173 years—we can't wait to see what the next century brings for science, science engagement and RCIScience.

BIODIVERSITY

JOSIE CRICHTON

by KAUSAR PANCHBHAYA

Whether you enjoy it in your sushi or avoid it at the beach, seaweed plays a surprisingly significant role in our lives and is very important for our oceans. It serves as a breeding ground for many animals, including many fish species that humans rely on for food. As seaweed undergoes photosynthesis, it's able to capture carbon and release oxygen, making it an organism of interest in efforts to maintain water quality and offset carbon emissions. Seaweed is also harvested for uses in food, pharmaceuticals and fertilizers. It is classified into three major groups—Red (Rhodophyta), Brown (Phaeophyceae), and Green (Chlorophyta) algae. Both freshwater and marine algae range in size from microscopic, unicellular organisms to over 50 metres long.

Second year Masters student Josie Crichton researches seaweed biodiversity. Being close to the ocean at the University of New Brunswick, she studies red algae in the Atlantic and the uses of environmental DNA to monitor biodiversity in marine environments.

In Josie's field of work, biodiversity monitoring entails visiting beaches to collect and identify seaweeds—which sounds fun until you factor in that it can be time consuming, expensive, and not to mention laborious! Nearly identical seaweeds on the surface can turn out to be vastly different species underneath. That's where genetic DNA analysis comes in.

Environmental DNA (eDNA) sampling is the process of sequencing the DNA present in water, air or soil samples to determine what species occupy an area. The technique eliminates the need for experts to physically count and identify all species present and it can help detect species that are hard to find or identify. For her research, Josie collects environmental samples like water and extracts the DNA to sequence red algal DNA.

While it might not sound glamorous, biodiversity monitoring is really important work. If scientists know what species occupy an ecosystem, they can detect if something new appears, or if something old disappears—both signals that something is changing in the ecosystem.

To learn more about seaweed and Josie's research, follow her on Twitter @seaweedscience or explore her fascinating RCIScience Instagram Takeover, saved under ***Highlights***.

FREDERICK BANTING

CHARLES BEST

J.J.R. MACLEOD

JAMES COLLIP

Insulin to Innovation

by ANGELA ZHOU

While preparing for a lecture at the University of Western Ontario in the early 1920s, Canadian physician-scientist Dr. Frederick Banting had an idea that would forever change the lives of people living with diabetes worldwide.

For years, scientists hypothesized that an organ called the pancreas was secreting a hormone that controlled glucose metabolism—studies on dogs showed that animals who had their pancreas removed immediately experienced severe diabetes. The pancreas, however, also produces digestive enzymes that make extracting this hormone—now known as insulin—extremely difficult.

Banting wrote down a plan to extract insulin from the pancreas for injection into patients to help them control their blood sugar. He was recommended to Dr. John J. R. MacLeod, a physiologist at the University of Toronto who, while initially skeptical, offered Banting lab space and a summer research assistant, Charles Best, to support his investigations.

Banting and Best set out to isolate insulin by tying off the pancreatic ducts in dogs, keeping the organ inactive and effectively preserving the insulin-producing cells in it. In the summer of 1921, Banting and Best successfully extracted insulin and administered it into a dog without a pancreas. This treatment was able to reduce the animal's blood sugar levels. When the results proved promising, MacLeod began to support Banting's work and enlisted the help of Dr. James B. Collip, an accomplished biochemist, who helped purify and refine the insulin extract for use in human patients. In 1922, insulin was injected into a 14-year-old boy with severe diabetes named Leonard Thompson. The purified insulin extract successfully treated the disease.

Banting later sold the patent rights for insulin to the University of Toronto for $1 for production at the University's Connaught Laboratories. He famously stated, "Insulin belongs to the world, and not to me." The Connaught Laboratories embarked on the standardization and scale-up of insulin production, supplying all of Canada's insulin until the early 1980s.

The discovery of insulin was a major medical advancement by Banting, Best, Collip and MacLeod. While the 1923 Nobel Prize in Physiology or Medicine was awarded only to Banting and MacLeod, Banting acknowledged Best for his major role in the discovery and split his award. MacLeod similarly split his prize with Collip.

Today, insulin remains integral to the treatment of diabetes. The legacy of its discovery lies in the countless lives saved, alongside providing the inspiration and foundation upon which the medical research sector in Canada was built.

Insulin to Innovation Talks

Honouring the 100th anniversary of the Discovery of Insulin

by KRISTA LAMB

Thomas Fisher Rare Book Library, University of Toronto

Sam Moghadam Khamseh/UNSPLASH

In 2021, the world celebrated the 100th anniversary of the discovery of insulin by the Canadian researchers Banting, Best, Collip and Macleod—a seminal event in medical history that took place at the University of Toronto. At RCIScience, we collaborated with three partners on a series of events as part of the Insulin to Innovation Consortium.

Together with the Banting Research Foundation, the Charles H. Best Foundation and the Sir Frederick Banting Legacy Foundation, and with sponsorship from Sanofi Canada, we developed a wealth of educational and inspirational events to mark this incredible milestone.

Events included a virtual showing of the Canadian short film, *Miracle, Baby*, about NHL hockey player Cory Conacher, who lives with type 1 diabetes, as well as a series of virtual panels and conversations with researchers about diabetes on YouTube. In addition, the Sir Frederick Banting Legacy Foundation hosted an on-site event where they debuted their new monument in honour of the 100th anniversary.

The consortium also developed the 100 Lives of Insulin project, an online space that features profiles of 100 people whose lives have been impacted by insulin and diabetes. Among them are a series of historical figures such as the co-discoverers of insulin, public figures living with diabetes, and current researchers. Many of those current researchers themselves live with diabetes, including Drs. Bruce Perkins, Michael Riddell, Holly Witteman and Dessi Zaharieva.

Charles Best and Frederick Banting on the roof of the University of Toronto's Medical Building in 1922, with the first dog that received insulin. (Courtesy of Thomas Fisher Rare Book Library, University of Toronto)

This group of new researchers is a remarkable statement on the importance of insulin to those living with type 1 diabetes, once considered a death sentence prior to the discovery of insulin. Now, those who live with the condition are able to take a leading role in finding new and innovative treatments and therapies. Perhaps even a cure one day.

"When I myself got diabetes as a teenager, I was certain that the world would move ahead without me. I am humbled to say now that I was so wrong," says Perkins, the Director of the Leadership Sinai Centre for Diabetes in Toronto. "I owe so much to this discovery, and it fuels me to make meaningful contributions for future generations of people with diabetes."

For Witteman, a researcher at Laval University in Quebec, living with type 1 diabetes has been an enormous part of the direction she took with her career. Her work highlights the need to include people with lived experience at all levels of the research process. Working with the Diabetes Action Canada research network, she has helped inspire others living with diabetes to become engaged with the research process.

Witteman sees this as critical. "The reason I got involved with Diabetes Action Canada was because they needed someone who had expertise in how to involve people living with the condition in research about that condition, and I have always done that," says Witteman. "That's how you do things in human factors. If you develop tools for people without involving the people who are going to use them, then they're not going to work."

Riddell, a Professor at York University in Toronto not only lives with type 1 diabetes and researches the condition, he also has a child with type 1 diabetes. The discovery of insulin has a very special meaning to him. "It's 100 years of keeping people like me and my son and all my friends with type 1 alive. That is such a powerful emotion for me, to think about all the people I've met under this type 1 insulin-dependent diabetes. It brings tears to my eyes to think that this discovery has led to our saviour, as far as being life-sustaining," he says. "Although it wasn't a cure, it gave us the breath to keep going."

And, indeed, insulin is not a cure. While it helps those with diabetes to manage their condition, it does not free them from the constant monitoring and management that comes with the disease—or the myriad complications. Throughout the events, the consortium highlighted the work of the next generation of diabetes researchers. Scientists like Drs. Erin Mulvihill, Calvin Ke, Ananya Banerjee, and Taylor Morriseau shared updates on their work and the ways that they are looking at the condition through new and innovative lenses. From studying the nuances of diabetes in diverse populations to how cell and gene therapies could support new treatments, current research is making inroads in new and innovative ways.

This incredible milestone means so much to all those living with diabetes around the globe. It's also an important reminder of all that's still to come—and the remarkable role that Canadians have played, and continue to play, in this process. ●

Lives of 100 Insulin

LEONARD THOMPSON
(1908-1935)

by KIRSTEN VANSTONE

Leonard Thompson was born in Toronto to parents Harry and Florence. He grew up in a working class street running north-south between Kingston Road and Gerrard Streets, in an area that is now known as the Upper Beaches. By all accounts, he was a happy, active child who loved playing football and other sports.

At age 11, Thompson received a diagnosis of diabetes mellitus. His prognosis was very poor. At the time, the only method of managing the symptoms of diabetes was to keep blood sugar down by limiting food intake. He starved himself to stay alive. This worked for a few years, but by age 14, the 5'11" boy weighed only 65 pounds and was in very poor health. Harry and Florence brought Thompson to Toronto General Hospital in early December 1921 on the verge of entering a diabetic coma. Desperate to save their son, Harry and Florence agreed to allow him to participate in an experiment to test the treatment developed by Frederick Banting, Charles Best, James Collip and J.J.R. Macleod.

The first injection in mid-January did not work, but after some refinements to the process of isolating insulin, Thompson was injected again in late January. Almost immediately, his blood sugar dropped and his symptoms disappeared. He went home in May of 1922. Further refinements of the treatment continued, and he was put on insulin permanently in October of 1922.

Little else is known about him, except that he eventually died of complications from pneumonia 13 years later.

Although not widely known, Leonard Thompson was the first patient to have his life prolonged by insulin. Elizabeth Hughes, whose father was the Secretary of State in the United States of America, is arguably the most famous of the early insulin patients. And yet Thompson, coming from a humble home and whose parents would try anything to save him, represents one of the other legacies of insulin. That it be available for all who need it.

PHOTO COURTESY OF WIKICOMMONS

Lives of 100 Insulin

TAYLOR MORRISEAU

by MICHAEL LIMMENA

While still early in her career, Taylor Morriseau is no stranger to the spotlight. She has been recognized by many of North America's leading professional, media and academic organizations for her work investigating the relationship between genetics, diet and type 2 diabetes in Indigenous communities. A Cree woman of the Peguis First Nation, Morriseau is a rising Indigenous researcher who seeks to advocate for Indigenous peoples on a local and national level.

Growing up, Morriseau never envisioned herself researching diabetes; instead, she wanted to become a marine biologist. This changed after a co-op placement in pharmacology during her undergraduate studies at the University of Manitoba. Along with her experiences as a member of the Peguis First Nation, Morriseau realized the incredible value of research in empowering Indigenous youth and helping many others around the world. This passion and sense of responsibility led her to pursue her PhD at the Children's Hospital Research Institute of Manitoba to study the molecular mechanisms behind type 2 diabetes. Her research explores how a particular gene variant HNF-1aG319S, commonly found among the Oji-Cree people, interacts with diet to cause type 2 diabetes. It was only within the last few decades that type 2 diabetes has been seen among Indigenous peoples, but the condition is quickly becoming prevalent within children of these communities. Currently, the rate of type 2 diabetes among Indigenous children in Manitoba is 20 times higher than the national average.

Typically, people imagine genes like a switch that is always either turned "on" or "off". The reality, however, is much more complicated. Having a genetic risk to a certain health condition, such as type 2 diabetes, doesn't necessarily mean a person will develop diabetes in their lifetime. While lifestyle and genetic risk contribute to the development of type 2 diabetes, it is undeniable that the historical, economic, and political policies stemming from colonialism play a large role in explaining the high rates of type 2 diabetes in the Indigenous community. Due to colonialism, the Oji-Cree people's diet shifted from a high protein and fat, low carbohydrate diet to a high-carbohydrate Western diet. Researchers like Morriseau believe that this shift may contribute to the development of type 2 diabetes among Oji-Cree youth.

Outside of the lab, Morriseau has been an active voice in empowering Indigenous communities. She was previously a delegate of the Daughters of the Vote National Leadership Forum advocating for investments in Indigenous Health. In 2019, she was a keynote speaker at the 2019 Parliamentary Health Research Caucus and has testified to the Senate Committee on Aboriginal Peoples, advocating for better access to safe drinking water and equal rights for Indigenous communities. Currently, she volunteers as an Indigenous youth mentor for various organizations and is a member of the Canadian Chief Science Advisor's Youth Council.

Combining her passion for research with social advocacy, Taylor Morriseau continues to strive for a brighter future where First Nation youths have access to safe drinking water, live long, healthy lives and don't experience diabetes. For her research and work in this field, she was awarded the prestigious Vanier Scholarship in 2018, Canada's equivalent of the United Kingdom's Rhodes Scholarship. Moreover, she was recognized by the Women's Executive Network as one of Canada's Top 100 Most Powerful Women and was included in Knights Corporation's Top 30 Under 30 Sustainability in 2019 for both her research and social advocacy.

*You can hear more from Morriseau in **Beyond Insulin: Diabetes Research Across Canada**.*

PHOTO COURTESY OF TAYLOR MORRISEAU

Lives of Insulin

DESSI ZAHARIEVA

by LYNSEY BOYCE

Dr. Dessi Zaharieva has been fighting the good fight all her life. Not only does she live with type 1 diabetes (T1D), research the condition and advocate for others, but she also represents her country as a champion martial artist.

Born in Sophia, Bulgaria, Zaharieva was a healthy, active child who enthusiastically took part in every sport she could access. However, only three years after immigrating to Canada, she found herself in a hospital having to translate a doctor's verdict to her worried parents. She had been diagnosed with type 1 diabetes (a condition with no known cure) and her whole life was about to change. She was just 7 years old.

Ever determined, Zaharieva took these new challenges head on and refused to be limited by them. She had been taking Taekwondo classes before the diagnosis and decided to continue her training, applying her grit to quickly progress to a competitive level. At just 16, she earned her place on Team Canada, competing at the biennial World Championships. The 2013 competition (which happened to be hosted in her birthplace and summer training ground of Bulgaria) marked a career highlight for Zaharieva. Here, in front of proud friends and family, she claimed the bronze medal for sparring. The following year she transitioned into Brazilian jiu jitsu and kickboxing where she continues fighting to this day.

But Zaharieva's fight has never been limited to the ring. As one of only a few female athletes in a male dominated sport, and one of even fewer athletes with T1D, there was no roadmap to follow. Despite taking great care, without the availability of research to inform diabetes management for an athlete who is constantly training, Zaharieva found herself in the terrifying position of being hospitalized for hypoglycemia (low blood sugar) on multiple occasions.

Knowing that she could not be the only person experiencing these problems, Zaharieva became passionate about filling the gaps in diabetes research so that all could exercise safely.

In 2011, Zaharieva embarked on a Masters degree followed by a PhD at York University in Toronto. Here she became fast friends with her supervisor Dr. Mike Riddell, a leading researcher in type 1 diabetes and exercise metabolism. Her research focused on preventing exercise-associated hypoglycemia in adults living with T1D. She then spent an intermediary period as a visiting postdoctoral fellow at the University of Melbourne, Australia, to work on novel technologies for T1D. In 2020, Zaharieva was awarded a prestigious fellowship to join Stanford University, California. Here she continues her research on type 1 diabetes management around exercise but with a focus on young people.

Zaharieva's research is being put into clinical practice to help countless people living with T1D, but she doesn't stop there. An active member of the diabetes community, she supports an even wider audience by participating in youth coaching programmes, awareness and fundraising events, and has served as a spokesperson for diabetes biotechnology companies. Her goal is to make sure that people living with type 1 diabetes are not restricted by their condition.

With dreams to one day open her own research lab and ultimately to conquer diabetes once and for all with a cure, the fight is far from over. Thankfully, Dessi Zaharieva is not throwing in the towel anytime soon.

PHOTO COURTESY OF DESSI ZAHARIEVA

Lives of 100 Insulin

CORY CONACHER

by SANDHYA MYLABATHULA

While modern diabetes management is more advanced than it was in the days of hockey great Bobby Clarke, it is still not easy for the average person to manage, let alone a professional athlete. Something Cory Conacher (born in December, 1989) knows all too well. Hailing from Burlington, Ontario, this distant relative of Canadian legend Lionel Conacher had his sights set on playing in the National Hockey League (NHL) from a young age. After experiencing some health problems as a baby and young child, Conacher appeared to flourish as he grew. But he then started to experience some of the classic symptoms of type 1 diabetes and was officially diagnosed at age 8. He credits his family with helping him become independent and responsible for his own health, while being able to educate teammates and others around him about his condition, including the signs to recognize in case of emergencies where he would need help.

In addition to the physical challenges, Conacher experienced emotional and social consequences of living with diabetes. He faced stigma as a young athlete, being underestimated and ultimately cut from his Junior AAA team. His coach at the time did not believe he would be capable of performing at a high level due to his condition and size. Conacher didn't let this situation deter him from his goal, however. He worked harder at the lower AA level to eventually return to the AAA level and prove his capabilities. It was an isolating experience for him as none of his peers experienced the same challenges he did. But a meeting with Ajay Baines, an elite hockey player with diabetes competing in the American Hockey League, helped him realize that athletes with diabetes can perform at high levels and convinced him that he did not have to let his condition hold him back. After a successful career in college hockey at Canisius College, Conacher joined the NHL's Tampa Bay Lightning franchise through their minor league affiliate team, the Norfolk Admirals, leading them to the Calder Cup as the league's MVP. He was also an important cog in the gold-medal winning Team Canada at the 2015 Spengler Cup. He currently plays for the Lausanne Hockey Club in Switzerland.

Conacher's circumstances highlight that it is still up to individuals to ensure they are following the protocols in place to keep them well and able to perform at high levels. He has experienced situations where he had dangerously low blood sugar levels and required emergency care. Preparation and responsible monitoring are key. That said, the tools that aid and improve management of diabetes can be costly, leading to inequities in access to care.

Beyond pumping up his team's fans, Conacher has made it his mission to become a role model for aspiring athletes living with diabetes. In addition to contributing to fundraising and awareness raising events, he wants to leave behind a legacy that inspires others to achieve their dreams. *DSkate*, a program that encourages and educates young hockey players living with diabetes and their families through a hockey camp, allows him to do just that. More recently, Conacher shared his story in the documentary *Miracle, Baby*, directed by Calvin Hudson Hwang. *Miracle, Baby* presents Cory Conacher's journey living with diabetes, in addition to other tribulations and joys in his life.

PHOTO COURTESY OF FRANZISKA ROTHENBÜHLER

TRIBUTE BOARD MEMBER

HELLE TOSINE

When Helle was the newly-minted President of RCI, she invited me to her house to work on planning out the next two years. It was snowing that day. Not fluffy, attractive snow that might adorn a holiday card. This was a persistent, bleak, January dump. I weighed calling off the meeting, but instead did what any Toronto-raised girl would do: dug out the good boots and clomped off to the TTC. I think Helle was a little surprised when I turfed up on her doorstep as planned, but she put on a pot of split pea soup and we got to work.

Helle was on the RCIScience Board when I started as Executive Director, became President a year later and remained on the Advisory Council until 2022. She was an incredible help to me as I settled into my role, helping to spin up the Fundraising Committee, ensuring that council meetings were productive and identifying future council members. Helle spear-headed strategic planning, using extensive experience gained from her time as a consultant to ensure that the multitude of ideas offered were captured and wrestled into a manageable entity around which consensus gelled, often through the skilled application of food and drink.

Helle provided the scientific grounding for RCIScience's first national project—a cross country discussion about how to preserve Canada's drinking water. The subject was one with which she was intimately familiar, having trained as an environmental chemist and then through working as such with both the Ontario and Federal governments. Her interest in policy led to a couple of events discussing health policy with the Friends of the Canadian Institutes of Health Research and, eventually, the joint lecture series with the University of Ottawa's Institute for Science, Society and Policy.

Beyond science policy and outreach, Helle's interests and talents are many and she always seems to be involved in a million projects. In addition to work and volunteering, at any given time, she could be planning an overseas adventure around her family's keen interest in music and Estonian culture, rebuilding a cottage's water and drainage systems and sourcing white peonies for a wedding. You name it, Helle has probably done it. Or more accurately, is probably doing it in some form right now.

In many ways, RCIScience's evolution owes itself to Helle's persistent belief that the organization is critical to Canada's success. With a healthy respect for its great history, she helped to skillfully navigate it through a modernization built on a belief the Institute was far too important to fade into that history. She gave many hours of her time to making RCIScience what it is today and I think back very fondly to the ideas we kicked around on that wintry day.

Kirsten Vanstone
Past Executive Director

Helle Tosine with fellow longtime members of the RCIScience Council.

Cloudy with a Chance of Meteorology

The Science of Weather Forecasting

by ANA de FARIA

Whether it's the art of divination or something more scientific, weather forecasting remains a mystery to many despite being a favourite topic for small talk. Over the years, predicting short-term weather, extreme meteorological events and long-term climate changes has become increasingly important, particularly with the threat of looming climate challenges. But who predicts the weather, how do they do it and what happens when they get it wrong?

"The concept of eco-anxiety is real and it's going to continue to be a challenge. I hope I can continue to step up and work with my colleagues on that communication."

JOHANNA WAGSTAFFE

Meteorologists *vs* Forecasters *vs* Weathercasters— Who does what?

Both meteorologists and weather forecasters are scientists who study the Earth's atmospheric phenomena and their effects on humans and the planet. They both have a bachelor's degree in meteorology or atmospheric science. Those who conduct research often earn a master's degree or a PhD.

Meteorologists are mainly focused on short-term weather status, while weather forecasters (also called climatologists) are more concerned about long-term climatic status.

Weathercasters, on the other hand, are individuals who report the weather on television or radio. They do not always have a scientific background and are more likely to have a communications degree. Some institutions offer a minor in broadcast meteorology, with specialized education and training for meteorologists who want a career in broadcasting.

Weather or Climate?

Weather and climate often go hand in hand but what's the difference? Time.

Weather is a short-term measurement of atmospheric conditions typically over days to months. It's the type of forecast we hear on the news or check on our phones when considering if we need an umbrella for the day or if it's time to switch to snow tires.

Climate considers longer-term predictions, often over a period of decades. Climate change refers to changes to long-term averages and trends for daily weather.

METEOROLOGY 101: HOW TO FORECAST THE WEATHER

Weather forecasting is defined as the application of science and technology to predict the conditions of the atmosphere for a given location at a future time. Johanna Wagstaffe, meteorologist and science reporter at CBC Vancouver and CBC News Network, outlines three key steps of weather forecasting:

Step 1: Measuring current weather conditions

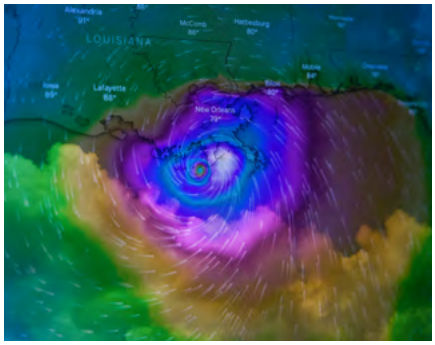
This is what meteorologists call current or initial observations. A variety of tools are employed to measure weather conditions from around the world. Most commonly used are weather stations, both official and non-official, which measure atmospheric temperature, humidity, wind speed and direction, pressure and precipitation. Scientists also use weather balloons (released twice a day), weather buoys and satellite data to sample atmospheric conditions in the sky, ocean and space, respectively. Recently, data collected from people's smartphones and from airplanes as they take off and land are also being used to assess local weather conditions. The volume of data collected improves accuracy and is stored in a network that meteorologists around the world can access.

Step 2: Weather modelling

Weather models are equations run by supercomputers to simulate how the atmosphere moves over time. These equations make weather estimations for places where there is no available data in order to generate predictions. One particular method of forecast modeling, which Wagstaffe likens to "Marvel's Multiverse," generates hundreds of models, each with a slight alteration. An average of these predictions is then taken. "All of the different possible multiverses are available to us," she explains, thus helping to increase the accuracy of the weather forecasted.

Step 3: Interpretation

Weather models generate a lot of data. Meteorologists need to decide what data they want to use based on audience, location, and the type of forecast they are doing, for example, weekend forecasting, severe weather or long-range climatological data.



Brian McGowan/UNSPLASH

The models used by supercomputers to predict the weather are based on historical averages. As we experience climate change, current observations do not always fit into those historical averages. In trying to find a model for these conditions, computers keep correcting and refining their models, making mid-range forecasting more difficult. Nadine Powell, meteorologist and on-camera presenter for The Weather Network, compares climate change to, "a soup where there are so many different ingredients already melted into it." She adds, "When you taste the general flavour of the soup, it's really hard to pinpoint what the specific ingredients are sometimes. What am I tasting here? Is this the dominant ingredient that's coming forth?" With more tools being employed to collect initial conditions and supercomputers becoming more advanced, weather forecasting is steadily getting more precise, despite the challenges of climate change.

Weather forecasters serve as an interface between an audience and scientists. The weather is how people experience climate change, and the decisions that broadcast meteorologists make in communicating forecasts are integral to the public's understanding of what is happening. Wagstaffe knows that communicating climate change is an integral part of her job.

"In my 15 years [working this job], we've had back-to-back extreme weather events that have devastated our communities, especially in British Columbia," she says. "The concept of eco-anxiety is real and it's going to continue to be a challenge. I hope I can continue to step up and work with my colleagues on that communication."

EXTREME WEATHER: A MIX OF FEAR AND FASCINATION

The Prairies are no stranger to extreme weather. Tornado Alley, an area reaching from central Texas to the Canadian Prairies and extending from eastern Colorado to western Ohio, is well-known for its high frequency of strong tornadoes. One of the most famous storms in Canadian history, the Black Friday Tornado, happened on July 31st, 1987 in Edmonton, Alberta. The event was one of seven tornadoes in central Alberta that day. It destroyed nearly 200 mobile homes in the area, killed 15 people and injured many others.

"I wasn't even around for this

Craig Whitehead/UNSPLASH

tornado yet, but my parents had newspaper clippings in the basement. I think I came from a place of fear of storms like this," recalls Nevin deMilliano, co-founder of the Prairie Storm Chasers, a group dedicated to targeting, documenting and reporting severe weather events across the Canadian Prairies and

Tornado Alley. "That [fear] translated into intense curiosity. Why are these storms happening? What makes them tick? And understanding that helped me not be as afraid of them."

deMilliano likens storm-chasing to the action depicted in the hit 1996 movie Twister, albeit with more long drives, waiting times and disappointments than are depicted on screen. It requires a lot of preparation, training and expert equipment to be done safely, including:

1. Supercomputers help pinpoint where storm chasers need to be upwards of a week away from when a storm might come.

2. Satellite images work like an X-ray for storms, allowing storm chasers to see the shape and size of a storm, how it is moving and if it is getting stronger.

3. Armoured storm chaser vehicles keep the team safe and help with data collection. Prairie Storm Chasers' Dominator 3, probably the world's most famous of storm chasing vehicles, is a modified Ford 350 truck with armour plating and special windows that spring up to protect its occupants from debris, and road spikes to anchor it down. Its design makes the wind go over the top of it rather than underneath it, preventing the vehicle from being flipped. These vehicles also have a rocket launcher to shoot weather instrumentation into storms and tornadoes for data collection.

Data collected by storm chases like deMilliano helps meteorologists, who typically use radar but can't see the lowest part of the atmosphere where hail, high wind and tornado events occur, to better understand these phenomena. deMilliano hopes that his and similar groups' work will contribute to better forecasting with more specific alerts in communities that will ultimately save lives.

THE IMPACT ON REMOTE LIVING

Isolated or partially isolated communities in Northern Canada are especially impacted by changing weather and climate. Alexandra Clarke worked for Temagami First Nation (TFN) as their Climate Change Researcher for two and a half years, examining how climate change has and will impact this vibrant remote island community. The TFN is accessible by ice roads during the winter. Ice roads are essential seasonal infrastructures for northern communities, providing a cheap method of transporting large and heavy goods. Weather determines when ice roads become stable enough for travel and climate determines if ice roads will form at all from year to year.

"If climate change trends towards unfavourable winter road conditions, an adaptation strategy is going to be needed," Clarke explains. Climate change impacts the integrity and availability of seasonal ice roads, which could in turn impact communities by creating physical, social, cultural and economic vulnerabilities.

Milder winter conditions also affect the spring freshet in northern communities, which is the thaw resulting from snow and ice melt. Each year, Ontario Power Generation dam operators measure the amount of snow on the ground to predict how much melt is going to happen. This data informs how much the water level in receptacle basins needs to be lowered to catch the melting water, thereby preventing floods. Drier summers also impact these communities by affecting food security and increasing the risk of forest fires. Knowing in advance if next summer will be hot and dry without significant rainfall can allow communities to prepare ahead of time and mitigate these harms.

The ability to accurately forecast weather can determine the livelihood of entire communities and even save lives. With emerging technology, scientists are able to better predict extreme weather events. As we learn to adapt to and mitigate the consequences of a changing climate, public communication of weather and climate science will be integral to how we respond to these ongoing challenges. ●

Cloudy with a Chance of Meteorology

As we learn to adapt to and mitigate the consequences of a changing climate, public communication of weather and climate science will be integral to how we respond to these ongoing challenges.

The Future

Adele Payman/UNSPLASH

# of Food

by SHIVANI SETH

With Earth's population surpassing 8 billion and continuing to grow, the question of how we sustainably feed that growing population remains pressing and ever critical. Agriculture today faces a wide variety of challenges—the climate crisis, shrinking land resources, war and global pandemics all affect food supply and security. Health Canada defines food security as "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life." In 2020, 11.2% of Canadians were considered severely or moderately food insecure, according to Statistics Canada. But help is on the horizon, as new technologies are being developed to tackle food insecurity, meeting the challenges of climate, access and cost, both at home and around the world.

FOOD SECURITY IN NUNATSIAVUT

In Nunatsiavut, an autonomous region comprising of four Inuit communities in Newfoundland and Labrador, 61.1% of households have been found to be food insecure. The government's Food Security Program Manager Lynn Blackwood, who is one of few Indigenous Dietitians in Canada and a Nunatsiavut beneficiary, explains that there many dimensions of food security contributing to this staggering statistic:

1) Accessibility of food. While Nunatsiavut is accessible by plane and ship, those channels are heavily affected by climate change. If planes are unable to land due to inclement weather conditions, residents are unable to access food and medicine. Ships are only able to sail to Nunatsiavut during the summer months, which is typically from the end of June or early July to the end of November and is dependent on the ice. Thus, stores need to stock up for the winter ahead. Accessibility on an individual level needs to be considered as well—how will the person get to the store? Is the land safe for travel? Can that person still hunt and gather on the changing land as they once did?

2) Availability of food. Food sources need to be available, not just in the stores, but also on the land. The ban on caribou hunting, put into place 9 years ago to protect decreasing herd numbers, is a huge loss to the Inuit community who rely on the animal as a main source of protein.

3) Use of food. Having the knowledge, health and ability to make use of available resources is another important dimension of food security. Many Elders, for example, are unable to participate in hunting and gathering themselves due to failing health and cannot pass on their knowledge to the younger generation.

4) Quality of food. Food needs to be nutritious, desired and culturally acceptable. While zucchinis may be available at the grocery store, they are unfamiliar to the Inuit and unlikely to be incorporated into their diets. Moose may be similar to caribou as a source of protein, but consuming moose is not culturally acceptable to the Inuit.

> Food security is a significant determinant of health care. The healthcare costs of adults from severely food insecure households are double that of adults from food secure households.

In 2021, the Inuit Nunangat Food Security Strategy was created as a framework for improving food security, with the goal of self determination over the Nunangat food system. Each region of the Nunangat has specific programming with dedicated staff and touches on different elements of food security with the understanding that one singular action is not enough to solve the problem. Cost-of-living reduction measures, harvester support, infrastructure, food security programs and support for families all intersect when considering the environment, policy and legislation.

The Strategy addresses both country food and market food, utilizing a community food model and working with Elders and youth. Elders pass on traditional knowledge of hunting and gathering, and youth learn food literacy skills. This land-based approach allows the Inuit community to connect to their cultural heritage while also providing younger generations important life skills.

Local Nunavut technicians in an arctic growth project with the Arctic Research Foundation. (Credit: Arctic Research Foundation)

In addition to the work already being done by the Nunatsiavut, new agricultural technologies could change the way the Inuit and people around the world think about food. Surprisingly, space agencies play a large role in innovative agricultural research. "Space and Northern communities face similar challenges in growing food," explains Blackwood, who has been involved in the Deep Space Food Challenge, a joint mission with NASA and the Canadian Space Agency (CSA) to explore how food could be produced in space. She points out that both space and the North have harsh climates, short growing seasons and face challenges receiving additional supplies during an emergency.

Nunavut's first harvest: butter lettuce and microgreens. (Credit: Arctic Research Foundation)

TO THE MOON AND BACK

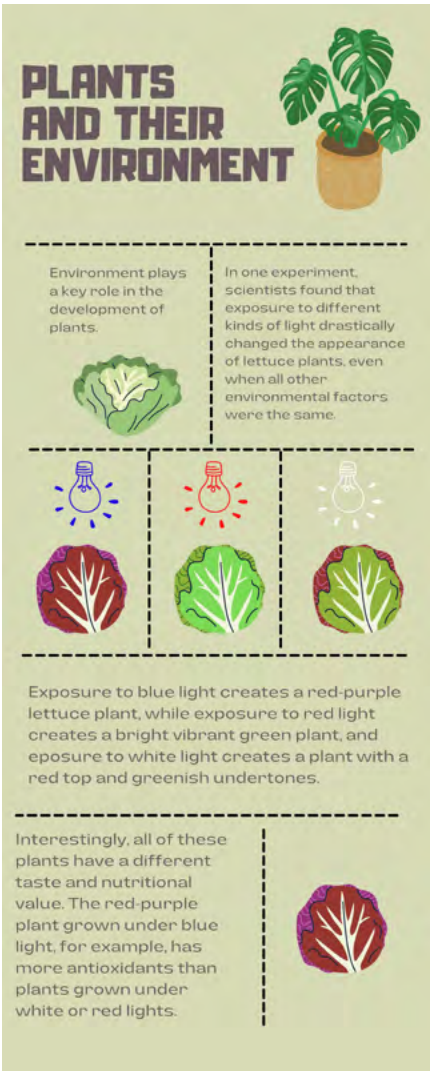
An inhospitable climate is the challenge faced by astronaut Mark Watney in popular science fiction novel and film, The Martian. Stranded on Mars, Watney finds a way to make his limited food supply last by creating a controlled agricultural environment. These environments use technology to create agricultural spaces where crops are grown under a modified and highly conditioned environment, such as greenhouses. Although The Martian is a work of fiction, controlled environment agriculture is a growing field of research that includes both indoor agriculture and vertical farming.

Dr. Thomas Graham, Assistant Professor in the School of Environmental Sciences at the University of Guelph, notes that growing plants in a controlled environment provides several advantages. Plants are protected from extreme weather conditions, bugs and pathogens. Controlled environments like vertical farms can allow farmers to grow a variety of vegetables regardless of the season.

Northern communities have benefited from vertical farming—the process of growing plants in layers stacked one on top of the other. Vertical farms can be housed in a variety of structures, such as shipping containers. In Churchill, Manitoba, where vegetables are expensive and often wilted by the time they arrive, fresh vegetables can now be grown in one of these container systems. This has reduced the cost of lettuce by half, from $7 to $3.50 for a fresh head.

> Elders pass on traditional knowledge of hunting and gathering, and youth learn food literacy skills.

The German Space Centre, located in the Antarctic, has also successfully implemented a growth container for vertical farming. This system ensures that their researchers remain fed while working at the Centre. Similarly, in the sweltering heat of Kuwait, where the heat prevents agricultural viability, vertical farming has allowed the country to grow their own food and decrease their dependency on exports from other nations.



The Inuit Nunangat comprises four regions: Nunavut, Nunavik (northern Quebec), Nunatsiavut (northern Labrador), and the Inuvialuit Settlement Region (northern Northwest Territories).

The majority of the Inuit live within Inuit Nunangat.

CULTIVATED MEAT

While controlled environment agriculture is excellent technology for growing plants, meat presents a different challenge.

From 1961 to 2017, global meat consumption has grown significantly. As an economy gains more disposable income, meat consumption rises—a trend that researchers expect will continue. This poses a huge environmental problem. Currently, 50% of the Earth's habitable land is utilized for agriculture, and 77% of the agricultural land is used for livestock. Increased demand for meat would result in the conversion of more forests to farmland. Additionally, meat production emits huge amounts of greenhouse gases and utilizes significantly more water than other crops.

> Agriculture and food production has always been an evolution.

Scientists like Dr. P. Ravi Selvaganapathy, Professor of Mechanical and Biomedical Engineering at McMaster University, are looking for other ways to sustain the global demand for meat. He advocates for cultivated or "lab-grown" meat—meat that has been grown in an industrial setting. "The amount of land that you require is going to be considerably less," Dr. Selvaganapathy explains. "You can cultivate things faster in this kind of format." Countries that are land deficient or have land unsuitable for cultivation can improve food security by utilizing lab-grown meat.

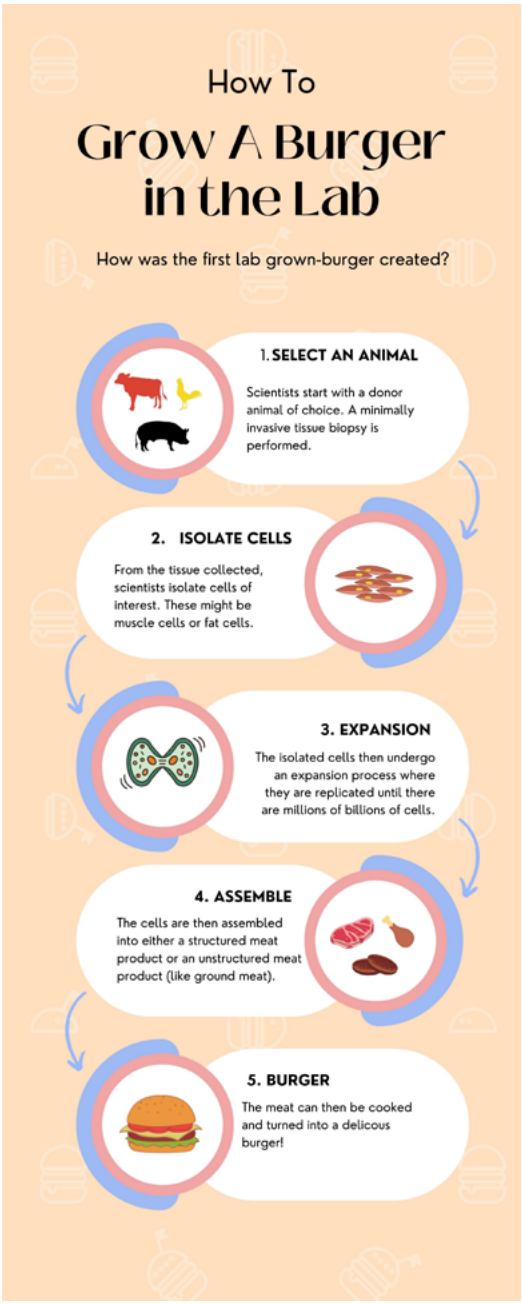
The science for lab grown meat began in the early 1970's with the cultivation of muscle cells and skeletal fibers in the lab. These early experiments were done with biomedical research in mind—scientists were looking to mimic human cells to study the effects of disease and biological conditions. Dutch scientist Dr. Willem Van Eelen, however, thought this research could be used as a way of, "growing meat without inflicting pain." Van Eelen became an advocate for cultivated meat in the 80's and 90's and patented many of these technologies. In 2005, a centre in the Netherlands funded cultivated meat research, leading to the first lab-grown burger in 2012 and the subsequent creation of a multitude of lab-grown meat companies.

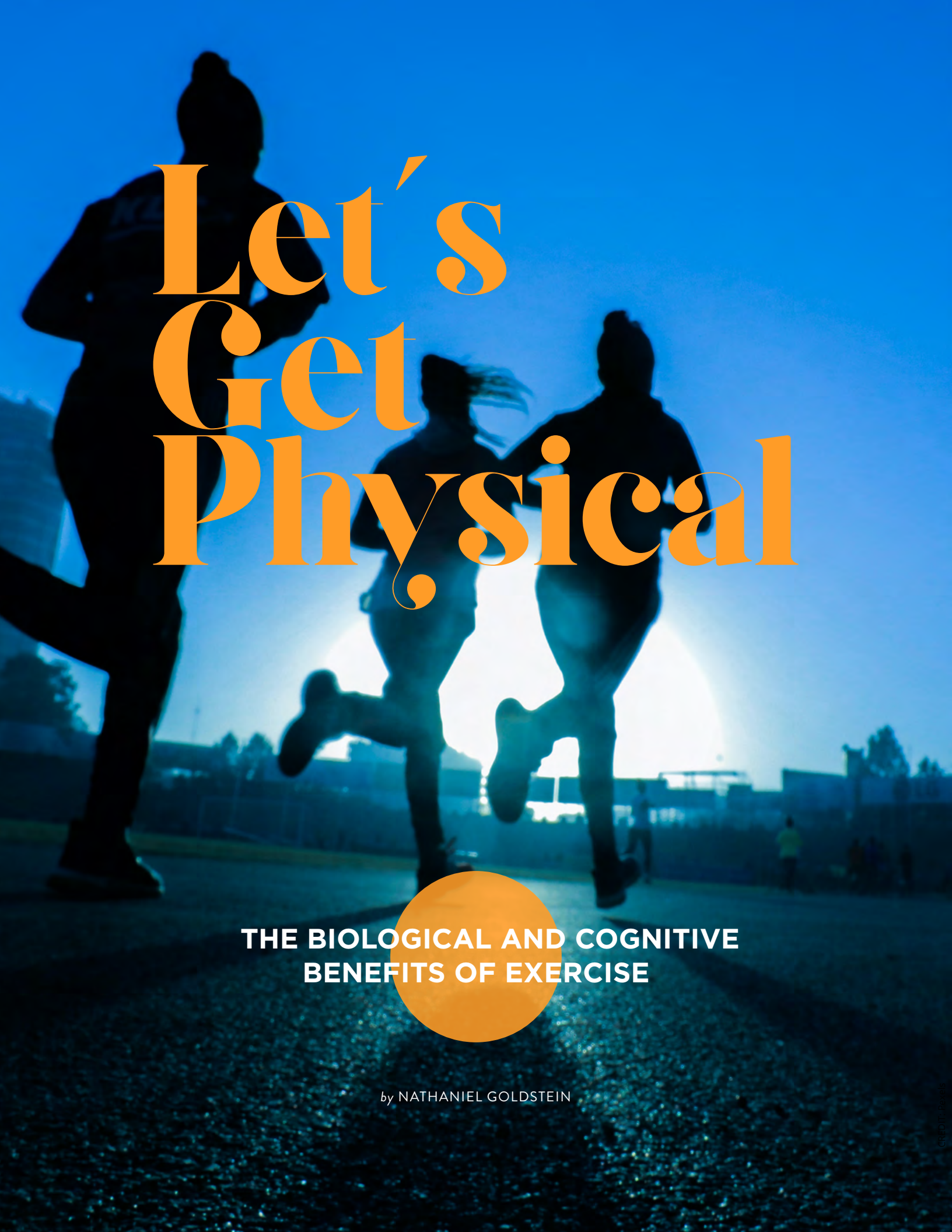
The field of cultivated meat still has many scientific and economic challenges to tackle before it can become mainstream. It is difficult to create cell lines that can be divided indefinitely, for example. And production costs are astronomical. The first lab-grown burger in 2012 cost between $300,000-400,000 to make. While costs have been reduced considerably since, a single lab-grown burger remains around $1,000. Historically, cultivated meat is not an area that has been well-funded, although Dr. Selvaganapathy is advocating for government and funding agencies to invest in and support this research moving forward.

LOOKING TO THE FUTURE

Technologies such as vertical farming and cultivated meat are just two ways that agriculture is tackling food insecurity and sustainability. "Agriculture and food production has always been an evolution," says Renée-Claude Goulet, Science Advisor at the Canada Agriculture and Food Museum. "It's never been a stasis." The future of food remains ever-changing if it is to continue to meet the daily demands of the Earth's growing population. ●

The Future of Food





Let's Get Physical

THE BIOLOGICAL AND COGNITIVE BENEFITS OF EXERCISE

by NATHANIEL GOLDSTEIN

Maintaining a physically active lifestyle has profound implications for not only our own wellbeing, but the wellbeing of those around us as well. It's no surprise then that the Government of Canada ranks it as one of the most important lifestyle decisions in achieving optimal health. The benefits of physical activity are vast and varied, affecting not just our physical health but our mental and cognitive wellbeing as well.

AGING AND MITOCHONDRIA

Regularly engaging in exercise has well-documented positive effects on the natural biological process of aging. Systematic physiological changes occur as we get older, with one common condition among older adults being sarcopenia—an involuntary loss of muscle mass and strength. When sarcopenia sets in, it becomes difficult to carry out everyday functions such as walking up and down stairs or lifting objects. The condition is caused by a variety of factors, including a loss of neurons, degradation of proteins, DNA damage, fewer or less active stem cells and dysregulated protein sensing—all of which may be associated with mitochondrial dysfunction.

Sarcopenia affects 10% of individuals over the age of 70 and 30% of individuals over the age of 80. The disease is estimated to cost about $40 billion a year in the United States and that number is expected to rise.

Famously nicknamed "the powerhouse of the cell", mitochondria are integral to keeping us going during rigorous physical activity. Regular exercise induces mitochondrial biogenesis, where mitochondria become more interconnected with each other, growing larger and becoming more efficient at delivering energy to your cells.

According to Dr. Mark Tarnopolsky, a Professor in the Department of Pediatrics and Division Head of Neuromuscular and Neurometabolic Disorders at McMaster University, one of the most tried and true methods to prevent or delay the onset of sarcopenia and related mitochondrial-based conditions is to keep your muscles active and to incorporate exercise into your daily routine. A recently published longitudinal study conducted by researchers at Stanford University revealed that people over the age of 50 who regularly exercise gain an average lifespan increase of about four years. Another study examining over a million adults also revealed that those who lead habitually active lives were associated with a lower risk of many forms of cancer.

In weight training, especially in older adults, muscle mass increases in a process known as muscular hypertrophy, which is also associated with an increase in mitochondria in these cells. Muscular atrophy, a decrease or wasting away of muscle mass, is often associated with mitochondrial dysfunction.

New Year, New You: Let's Get Physical

Through his own research, Dr. Tarnopolsky's team found that active individuals over the age of 65 have better mitochondrial and skin health compared to a sedentary 20-year-old. Additionally, weight training in older individuals was able to reverse the decrease in mitochondrial function and increase in inflammation associated with aging. Exercise releases factors that benefit the entire body, not just the heart and muscles.

"We've been trying to show some of these benefits with various nutritional supplements and other things for our patients," Dr. Tarnopolsky explains, "but nothing will mimic the multi-systemic benefits of exercise."

IN YOUR HEAD

In addition to the physiological advantages of physical activity, there is uncontested evidence demonstrating that exercise improves mental health, according to Dr. Catherine Sabiston, a Professor in the Faculty of Kinesiology and Physical Education at the University of Toronto and a recognized expert in sport and exercise psychology theory.

"Make sure you're intentional with your exercise and movements."

For individuals diagnosed with mental health conditions such as anxiety or depression, physical activity can be used in conjunction with treatment or therapy and can drastically improve wellbeing and overall quality of life. In some circumstances, Dr. Sabiston emphasizes, routine physical exercise may even offer cognitive benefits that perform just as well or even outweigh the use of medication, cognitive-behaviour therapies or techniques such as mindfulness training and meditation.

There are several hypotheses for why physical activity is beneficial to mental health:

The Anthropomorphic Hypothesis: Our ancestors were believed to have been much more active with activities like hunting, foraging for food and fighting off predators being integral for survival. Some contend that the dramatic shift to our present-day sedentary lifestyles has contributed to the emergence of mental health concerns; perhaps we are less active nowadays than we are meant to be.

The Thermogenic Hypothesis: During exercise, our muscles produce energy that is converted to heat which circulates around the body. This increase in body temperature is believed to contribute to mindfulness and relaxation, as well as a sense of warmth and comfort.

Exercise is a Distraction: Physical activity is a coping mechanism. It gives us an opportunity to get away from the troubles in our lives and can allow us to get outdoors.

Building Confidence: Physical activity allows us to gain a sense of mastery and accomplishment. These feelings of confidence can improve mental health.

The Social Environment: Being active with others or feeling like others are supporting us through our exercise promotes a sense of belonging.

Brain Chemistry: Being active releases neurotransmitters such as dopamine and endorphins, starting a cascade of chemical reactions that help to improve mental wellbeing.

"Make sure you're intentional with your exercise and movements," Dr. Sabiston advises. "Pay attention to how you feel after [your exercise] and try to avoid feeling self critical."

It can often be difficult to set aside time to take care of our physical health. As Dr. Sabiston emphasizes, it's important to not get too bogged down on elements such as how often or intensely you are exercising. Any form and level of physical activity can result in changes in our brain and body from a neurochemical level.

FREEPIK

SET UP FOR SUCCESS

It can be tough to adhere to exercise routines alongside juggling busy work or school schedules, maintaining relationships and tending to other needs. But it's important to keep in mind that many people set fitness goals for themselves that are incredibly unrealistic. "[People] often set goals about the outcome rather than the behaviour," explains Dr. Mary Jung, an Associate Professor at the School of Health and Exercise Sciences at the University of British Columbia. "Real success is when you enact a behaviour that you know will lead to the desired outcome and you focus on tracking that behaviour."

By setting goals that are impractical and likely unattainable, we become distraught when we don't succeed—and there's nothing more disheartening than setting ourselves up for failure. Motives rooted in shame and self-judgement are often derailing. Focusing on what brings you joy can be much more motivating. It's also helpful to break up a goal into smaller steps to conquer which can build self-confidence and self-efficacy, and to recognize the common humanity—understanding that we are all going through similar challenges and sharing in the successes and failures of others.

In addition to setting goals that are specific, concrete and achievable, one often overlooked technique is being self-compassionate. Dr. Jung advises that having an empathetic mindset can lead to greater attainment of goals and can better foster exercise habits that you can stick to.

The link between physical activity and its associated benefits at the physiological, psychological and social levels are remarkable. When we move our bodies, we not only induce physical changes that impact how we age, but also how we feel mentally and emotionally. By acting with a realistic and self-compassionate mindset when we exercise, we can begin to see some major improvements in our lives and open the door to potentials we never knew we could reach. ●

FUNGI

by DARREN CHENG

The Good, the Bad & the Ugly

Mathew Schwartz/UNSPLASH

You might know them best as a polarizing pizza topping or toadstools on a forest walk, but mushrooms are just a few of the organisms that make up the fungal kingdom. Fungi are very diverse in how they look, what they do and where they live. They often play important roles in ecosystems across the globe and in our daily lives, both in helpful and harmful ways.

A fungus in Oregon, affectionately referred to as the "Humongous Fungus," is estimated to be over 2,500 years old and weigh over 440 tonnes! This fungus is believed to be the largest living organism on Earth. Most of its mass is hidden underground in the root-like structure called mycelium, estimated to stretch over 2,400 acres. This is an example of a macro fungus, an easily visible organism made up of many cells. On the other end of the spectrum, micro fungi are some of the smallest organisms on Earth and are only clearly visible under a microscope.

WHAT ARE FUNGI?

Fungi are eukaryotic organisms. Like plants and animals, their cells have a nucleus. Early scientists believed fungi were types of plants and it wasn't until a few decades ago that we learned they are a completely separate group of living things. In fact, they are more closely related to animals (including humans) than they are to plants. Like animals, fungi need carbon from the environment to live, and they often obtain their carbon by absorbing it from their surroundings. Animals, on the other hand, obtain carbon by eating plants, other animals, and fungi.

There are many different kinds of fungi including mushrooms, yeasts and molds. "What's really cool is the vast diversity of them," explains Dr. Amanda Veri, a microbiologist at the University Health Network. "Fungi are actually the largest organism on the Earth."

"Over the last 10 years, many estimates have been made about the number of fungal species in the world. This ranges from 700,000 to 5 million!" explains Dr. Jianping Xu, a Professor at McMaster University. "These estimates differ because of the different assumptions and specific concepts used by different people." Only ~150,000 of these species have actually been identified and named, which leaves over 93% of fungi still undiscovered.

THE FUNCTION OF FUNGI

Many fungi help to break down dead and decaying things in the environment, a crucial step in returning nutrients to the soil. These nutrients feed growing plants, which in turn support other living things in their ecosystem. Some fungi even form symbiotic relationships with plants by exchanging resources and nutrients between a plant's root system and the fungi's mycelial network.

MUSHROOMS

About 10,000 macro fungi, which produce the fleshy, spore-bearing fruiting body called mushrooms, have been identified. Jessie MacAlpine, a PhD candidate in Dr. Leah Cowen's lab at the University of Toronto, explains that while mushrooms like portobello, shiitake and oyster mushrooms often find themselves on our dinner plates, others like chanterelles, morels and lion's mane mushrooms are less commercially available and more often foraged. Other species of mushroom have also been used for medicinal purposes, though not enough scientific study has been conducted to strongly support their purported health benefits.

While many delicious fungi are found in the wild, unfortunately an even greater number can be harmful, or even deadly, if eaten. Of the known mushrooms, about 2,000 cause irritation to the digestive system when eaten, and another 100 are highly poisonous. Dr. Xu explains that it can be very difficult to identify mushrooms based solely on how they look. One type of mushroom called *Amanita phalloides*, or death caps, are believed to have been used as poisons for killing historic figures. Since poisonous mushrooms can easily be mistaken for edible ones, foraging should always be done with an expert, and with absolute certainty of a fungi's identity before consumption.

Nico Baum Psulk/UNSPLASH

MICRO FUNGI

The other 140,000 fungi that we know about are microscopic and don't produce mushrooms. Many microscopic fungi are used to make food products like bread, fermented meats, cheese, soy sauce and miso. Fungi also help in fermenting alcohol, both the kind we drink as beer and wine, and as rubbing alcohol.

Medicines and vaccines are now being developed with the help of fungi. For example, a modified version of baker's yeast is widely used in the production of insulin to treat diabetes and *Penicillium chrysogenum* is used to create antibiotics like penicillin. Psilocybin, a component of certain species of mushrooms, is also being investigated for its potential benefits in treating mental health conditions like PTSD and depression.

With climate change in mind, there has been a large shift in developing more sustainable materials. Companies like Ecovative Design have been using fungi to develop packaging material to replace styrofoam and working with IKEA to get it in stores. Additionally, fungi are being used in sustainable decor (replacing plastic in items like light fixtures), building materials like bricks, and in the fashion industry as vegan leather in shoes and handbags.

> "There are about 350 species that are currently eaten, but scientists predict that this is actually an underestimate as it can be quite difficult to get a grasp of the entire global consumption of fungi, especially in Indigenous communities," explains Jessie MacAlpine.

THE DARK SIDE OF FUNGI

For all the good that fungi do for us and the planet, some species can also wreak havoc. Some species of parasitic mushrooms (which sadly includes the Humongous Fungus) literally suck the life out of living trees, often killing them. Other groups of parasitic fungi called *Cordyceps* attack insects like ants and snails. After infecting their hosts, these fungi eventually take over their bodies and control their movements to help spread spores.

Jehoshua Sharma, a PhD candidate in the laboratory of Dr. Rebecca Shapiro at the University of Guelph, explains how fungal pathogens are also a huge concern for plants and humans. In agriculture, fungal outbreaks can kill many crops that humans rely on including wheat, rice, bananas and coffee. Human fungal infections are becoming a real cause for concern, with an estimated 1.5 million lives lost each year as a result. With rising global

Kulli Kittus/UNSPLASH

temperatures due to climate change, it's predicted that fungal outbreaks and disease will only increase. While some anti-fungal treatments exist to kill these pathogens in both crops and humans, their widespread use could lead to fungal resistance, much like bacteria have developed antibiotic resistance.

While we'll likely never know just how many kinds of fungi exist on Earth or the interesting and revolutionary things they can do, we can appreciate the vast diversity of this kingdom, and keep searching for new ways to adapt, consume and live alongside them. ●

Fungi: The Good, the Bad & the Ugly

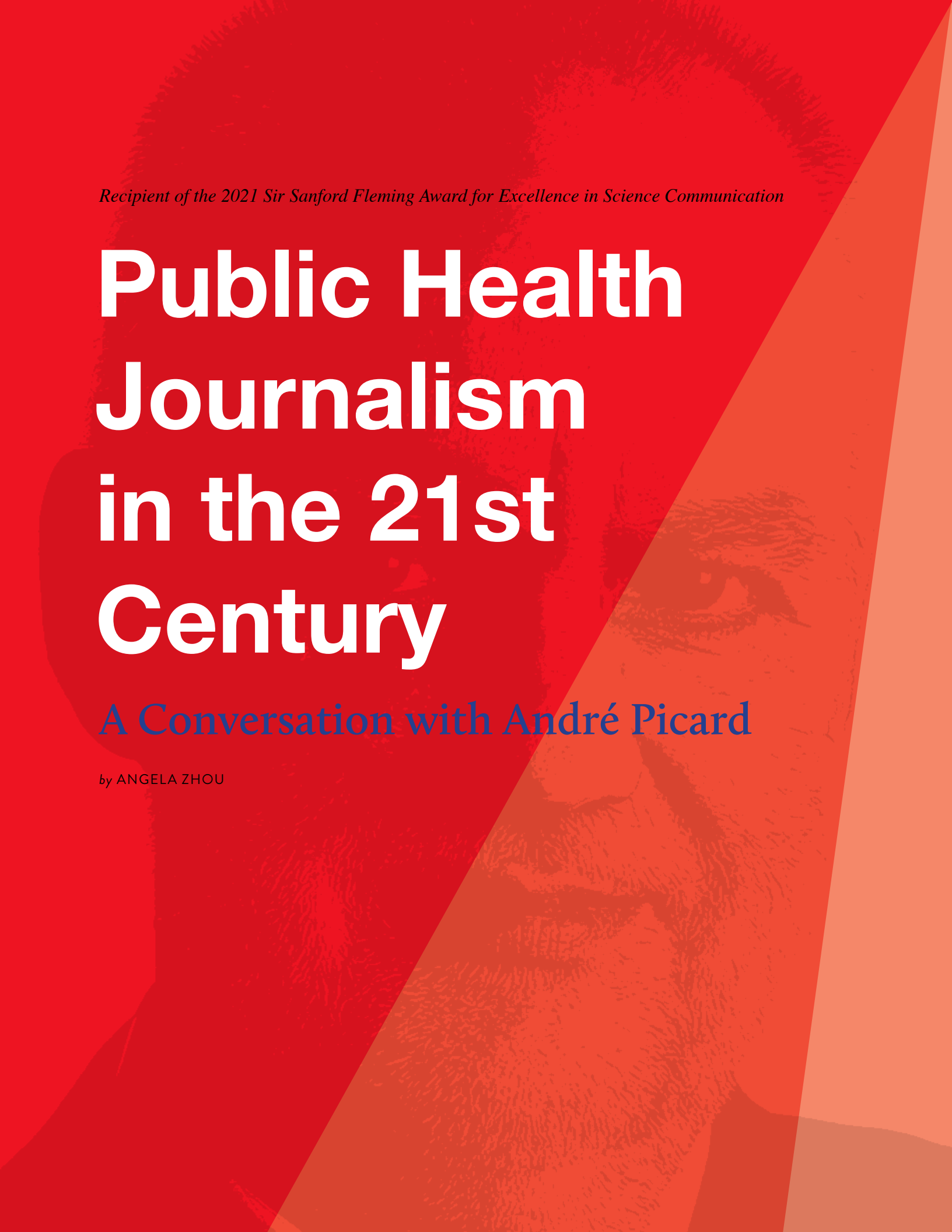
> *Amanita phalloides*, or the death cap mushroom, is one of the most poisonous mushrooms known to mankind. A mere half of one mushroom is enough to kill a full-grown adult and it's believed to be responsible for 90% of deaths caused by mushrooms around the world. In fact, historians hypothesise that it may have been used to kill Roman Emperor Claudius in AD 54 and Holy Roman Emperor Charles VI in 1740.

Recipient of the 2021 Sir Sanford Fleming Award for Excellence in Science Communication

Public Health Journalism in the 21st Century

A Conversation with André Picard

by ANGELA ZHOU



The past few years have shone a spotlight on science and its intricate interplay with policymaking. Understanding where and how the two interact can be frustrating and, occasionally, polarizing. As we continue to navigate through a global pandemic and a national healthcare crisis, it is more important than ever to be aware of how policies affect the most vulnerable in society and hold our elected officials accountable for their decision-making.

Journalist André Picard was awarded RCIScience's Fleming Medal for Excellence in Science Communication in 2021 for his 30+ years of work highlighting some of Canada's most difficult and complex healthcare-related issues. From the HIV/AIDS epidemic and blood crisis in the mid-80s, to addiction and mental health, the current COVID-19 pandemic and the neglect of seniors in long-term community care, Globe and Mail health columnist André Picard never fails to tell the human story, providing a voice for the people affected by issues in medical and science policy. The nation's most trusted healthcare and health policy reporter and author of 6 best-selling books, Picard reflects on his illustrious career, science journalism and the importance of skepticism.

NO LONGER OBSCURE

Picard started his career in 1987 as a staff writer for the Globe and Mail. Over the course of his long career, Picard has seen firsthand how technology and public health emergencies have affected science and healthcare journalism.

"Science journalism has changed in the same way journalism has," Picard asserts. "The good journalism has gotten way better and the bad journalism has gotten way worse. A lot of the middle has fallen out." That middle, once occupied by community papers, has since been replaced by new platforms such as Vox, ProPublica and other sources of scientific information (many strictly web-based) that never used to exist. "It's a very different world," he muses, recalling a time when a journalist had one deadline a day and no social media to worry about.

That social media has also impacted how science is communicated. While science itself hasn't changed very much for Picard, researchers have become much more accessible to journalists and the public alike, taking to social media like the rest of us and participating in public discourse. And with previously obscure fields like knowledge translation and risk communication in science burgeoning, there is now much more attention and support for researchers to share their work with the public.

The importance of quality science communication has never been more evident than during the ongoing COVID-19 pandemic. At a time of uncertainty, Picard has been a crucial voice in providing the nation with a trusted source of scientific information. "What I do is fairly obscure," says Picard. "Not a lot of people write about health policy specifically and it's become far more important." While acknowledging the immense pressure of reporting on COVID-19, Picard felt in his element, writing about infectious disease, the intersection of policy and medicine and social reality.

"I have a lot of sympathy for all those people thrown into [the intersection of health and policy], whether they're scientists, journalists, or everyday people." Picard expresses, citing his decades of experience in helping him understand bureaucracies and structures. "These systems are complicated and complex, sometimes deliberately so. [...] It's something you learn over time."

While this experience and deep knowledge has made him much more sophisticated in covering health and policy, it has also made him much more skeptical. Not one to parrot what's published in medical journals or announced during a press release, it is Picard's dedication to finding the truth and the people at the centre of it that set him apart as a respected and trusted journalist.

> **"Throughout his illustrious career, André has brought [...] incisive and accessible commentary to bear on some of our nation's most difficult and complex health-care-related issues. In this endeavour, he has provided Canadians with reliable information and has helped tell our stories to one another, offering the human dimension and building empathy."**
>
> The Honourable Elizabeth Dowdeswell, Lieutenant Governor of Ontario

THE MOTION PICTURES

An author of 6 best-selling books, Picard has tackled big issues that have left a legacy on Canadian healthcare. His 1995 book, *The Gift of Death: Confronting Canada's Tainted-Blood Tragedy*, explored the Canadian public health crisis of the 1980s where thousands of people were exposed to HIV and hepatitis C through contaminated blood products. "It had a lot of impact," explains Picard. "It has changed the way we regulate drugs. It has changed our perception of the HIV/AIDS epidemic." He

saw an opportunity to bring together his reporting into something bigger.

"My daily work is snapshots, sometimes you think this merits a motion picture—an in-depth look," he says.

Fast forward to 2021, Picard's latest book, *Neglected No More: The Urgent Need to Improve the Lives of Canada's Elders in the Wake of a Pandemic*, examines the treatment of seniors living in long-term care facilities. The lack of homecare and community support is an issue that is very personal to him as his parents lived in care with dementia for a long time. As seniors in congregate settings and long-term care became the hardest hit by COVID-19, there was finally public appetite and interest from publishers for an issue he had wanted to write about for years.

"You don't [write books] to make money," says Picard, elaborating that Canada is a small market and joking that he hopes this book will break even. "It has to be something you're passionate and care about."

"I think skepticism is one of the best qualities a journalist can have," he explains. "But we often go too far and have cynicism. We have to balance and walk that line. Being cynical is not going to be helpful."

APPROACH WITH SKEPTICISM

In an era where science is increasingly politicized and misinformation runs rampant, Picard advises nuance and balance. "I'm not big on black and white; there isn't black and white in science, and there shouldn't be in policy," he says. "People don't really like that. They like to be dogmatic and politicize things."

His approach is to give people the benefit of the doubt, but with a lot of skepticism. "I think skepticism is one of the best qualities a journalist can have," he explains. "But we often go too far and have cynicism. We have to balance and walk that line. Being cynical is not going to be helpful."

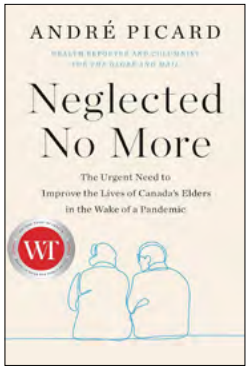
A big fan of medical and health history, Picard is quick to remind us that misinformation is not new. Recalling that a fifth of the population of Montreal turned out for an anti-vaccine march in 1905, he maintains that it is important to contextualize the problem: there are not that many anti-science and anti-vaccine people out there, but they are loud and organized, especially with the megaphone that is the internet. Through it all, Picard wants us to remember those vulnerable to misinformation are often well-intentioned and being taken advantage of. "I try to not be critical of people who are out protesting," he says. "I'm critical of those who are spurring them on with misinformation and lies, and worst of all, profiting immensely from it."

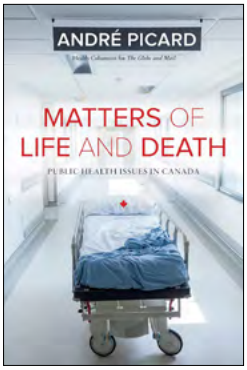
Despite the spread of misinformation on social media, Picard is optimistic to see the next generation of technology savvy science communicators taking to these platforms to provide reliable, trustworthy information. He credits groups like Science Up First for creating shareable content to debunk health misinformation.

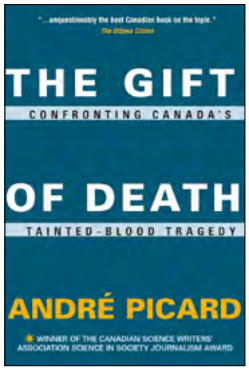
An inspiration to the next generation of science communicators, Picard continues to play an integral role in the public's understanding of health policy in Canada, navigating us through one crisis after another. Commenting on Picard's win, The Honourable Elizabeth Dowdeswell, Lieutenant Governor of Ontario, muses, "[T]he value of scientific literacy of a well-informed public is not optional, it's essential. Essential for progress. Essential for building trust and resilience. Essential for the health and wellbeing of democracy. Essential work is never easy work." ●

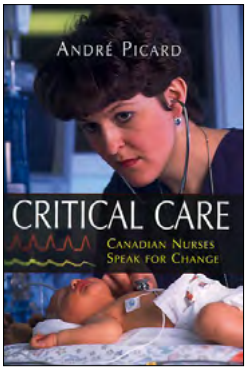
Public Health Journalism in the Era of Twitter and Trump

BOOKS BY ANDRÉ PICARD









Macrovector/Freepik

Lessons Learned?

After more than three decades of carefully observing, analyzing and reporting on healthcare in Canada, Picard understands the frustrations of only seeing incremental change. "One thing Canada does better than anything in the world is write reports," he notes, referencing the Commission of Inquiry on the Blood System in Canada (also known as the Krever Inquiry) and its subsequent report after the Tainted Blood Scandal as one of the most comprehensive on how to fix the healthcare and blood services system. "We learn the lessons but don't apply them. [...] We always make a little bit of progress, but we don't do it quickly enough."

As we approach the end of year three of the COVID-19 pandemic, Picard muses that despite the reports generated after the 2002 SARS outbreak in Toronto, we continue to make the same mistakes over again. "There is not enough implementation of science," says Picard. He points out that while Canada punches above its weight in medical research, we don't prepare our healthcare system to integrate these breakthroughs. "What's the point of a new drug if no one can access it?" he asks, adding that we also don't study why we fail at this, often leaving implementation to industry.

WORDS OF WISDOM

For those young and aspiring health and science journalists, André Picard offers some advice.

Take the time to do it right.

As a reporter from an older generation with one deadline a day, Picard advises that it's more important to get a story right than to be the first one to report it.

The most important things are not just what I write, but what I don't write.

While Picard recognizes that his career has allowed him the privilege to pick and choose, he advises young journalists to write about what they're passionate about. Don't write about something where you don't have a point of view.

The three most important words in medicine are 'I don't know.'

People are not bothered if you don't know something, they are bothered if they're given dubious information. It's comforting to people to not be lied to. "If you're true to yourself and admit what you do and don't know, you better serve your audience," he advises.

THE SCIENCE OF CHARITABLE GIVING

by CHERYL RODDICK

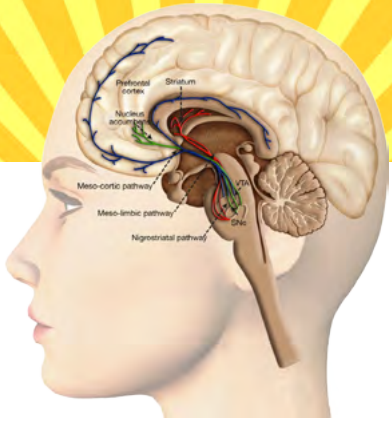


ILLUSTRATION: Oscar Arias-Carrión et al.

Have you ever wondered why making a donation to a charity, volunteering or even doing a good deed, like shoveling the sidewalk for your elderly neighbour gives you that "warm fuzzy" feeling? Or what prompts people to want to participate in these behaviours in the first place?

Over the past decade, scientists have been digging into the scientific, biological roots of our philanthropic inclinations. Here's what we're learning about what motivates one of our most complex, profound human behaviours and why charitable giving doesn't just make the world a better place—it benefits the giver, too.

WHEN IT COMES TO INSPIRING A CHARITABLE GIFT, NOTHING IS MORE COMPELLING THAN A GREAT STORY.

For years, fundraisers have known that storytelling—usually profiling an individual positively impacted by a charity's work—is much more effective at inspiring support than sharing facts and statistics.

There's an evolutionary reason for that. Storytelling is an effective tool in fundraising because we humans are biologically drawn to stories—whether it's the latest binge-worthy series on Netflix or neighbourhood gossip. Evolutionary biologists hypothesize that our love of a good yarn is hardwired into our DNA because it was a crucial part of our evolutionary success. Before humans could write, communicating about life threatening dangers and social norms was dependent on storytelling. Our ancestors who were most successful at telling and comprehending the meaning behind stories were the ones that survived the hazards of the sabre tooth tiger and the social shun, both potentially deadly in their own ways.

POWERFUL CHEMICALS SPUR ON CHARITABLE GIVING

Stories aren't just effective in charitable communications because we're drawn to them by nature. Listening to or reading a compelling story creates changes in our brain chemistry, including temporarily increasing the production of powerful chemicals, like oxytocin, associated with empathy, trust and kindness—key emotions that prompt charitable giving.

In a remarkable study that suggests a strong connection between the compelling tale, the production of oxytocin and the charitable gift, neurology professor Dr. Paul Zak found that subjects who were given a synthetic dose of oxytocin were 56% more inclined to donate to charities, and make larger gifts, after watching a series of public service announcements compared to a control group that was given a placebo.

THERE'S A BIOCHEMICAL REASON BEHIND THAT "WARM FUZZY FEELING"

Those who are philanthropically inclined will often say that "giving feels good" or "gives you a warm fuzzy feeling." A landmark 2006 fMRI study offered glimpses into the neurochemistry of giving by showing the regions of your brain that "light up." It provided some of the first scientific evidence that giving involves several brain regions, including the mesolimbic reward system and the decision-making prefrontal cortex. The researchers wrote that, "human altruism draws on general mammalian neural systems of reward, social attachment, and aversion." Researchers hypothesize

this so-called "helpers' high" not only feels good in the moment but may also spur on more acts of generosity.

GIVING IS GOOD FOR YOU

A significant body of research shows a link between charitable giving and improved physical and mental health. A 2016 study found that blood pressure scores among a group of older adults lowered after just three weeks of charitable giving. Volunteerism, another form of altruism, is positively related to lower depression and anxiety rates. One study found that adults aged 55 and older who consistently volunteered had a 44 percent decrease in mortality rates.

Where do we go from here? For decades, the for-profit sector has been leveraging neuroscience and cognitive science to understand consumer behaviour and decision making. "Neurofundraising" is an emerging field in the charitable sector that seeks to use these same principles to and increase the effectiveness of fundraising practices.

Whether you make a charitable gift because it's good for your health, to get better acquainted with your mesolimbic reward system, experience a temporary surge in your oxytocin levels or just can't resist a good story, we hope you'll consider a gift to RCIScience. Your gift supports all our work connecting Canadians to science—and there's scientific evidence that it'll make you feel good, too.

Click here to donate to RCIScience.

ASTRONOMY

ADAEZE IBIK

by KAUSAR PANCHBHAYA

The vastness of outer space leaves many puzzles and mysteries to be solved. Adaeze Ibik is on a mission to understand one mystery in particular—explosions referred to as fast radio bursts (FRBs). A doctoral candidate in Astronomy and Astrophysics at the University of Toronto's Dunlap Institute, she studies major explosions in the universe.

Fast radio bursts are bright radio signals from outer space that last short amounts of time, often only milliseconds. First detected less than 20 years ago, we now know these explosions occur around 800 times a day across our skies. The hope is they can provide insights into what exists beyond our galaxy since FRBs carry data about their intergalactic travels, providing information about galaxies and the material in between. But as new discoveries are made, scientists are left with more questions to answer.

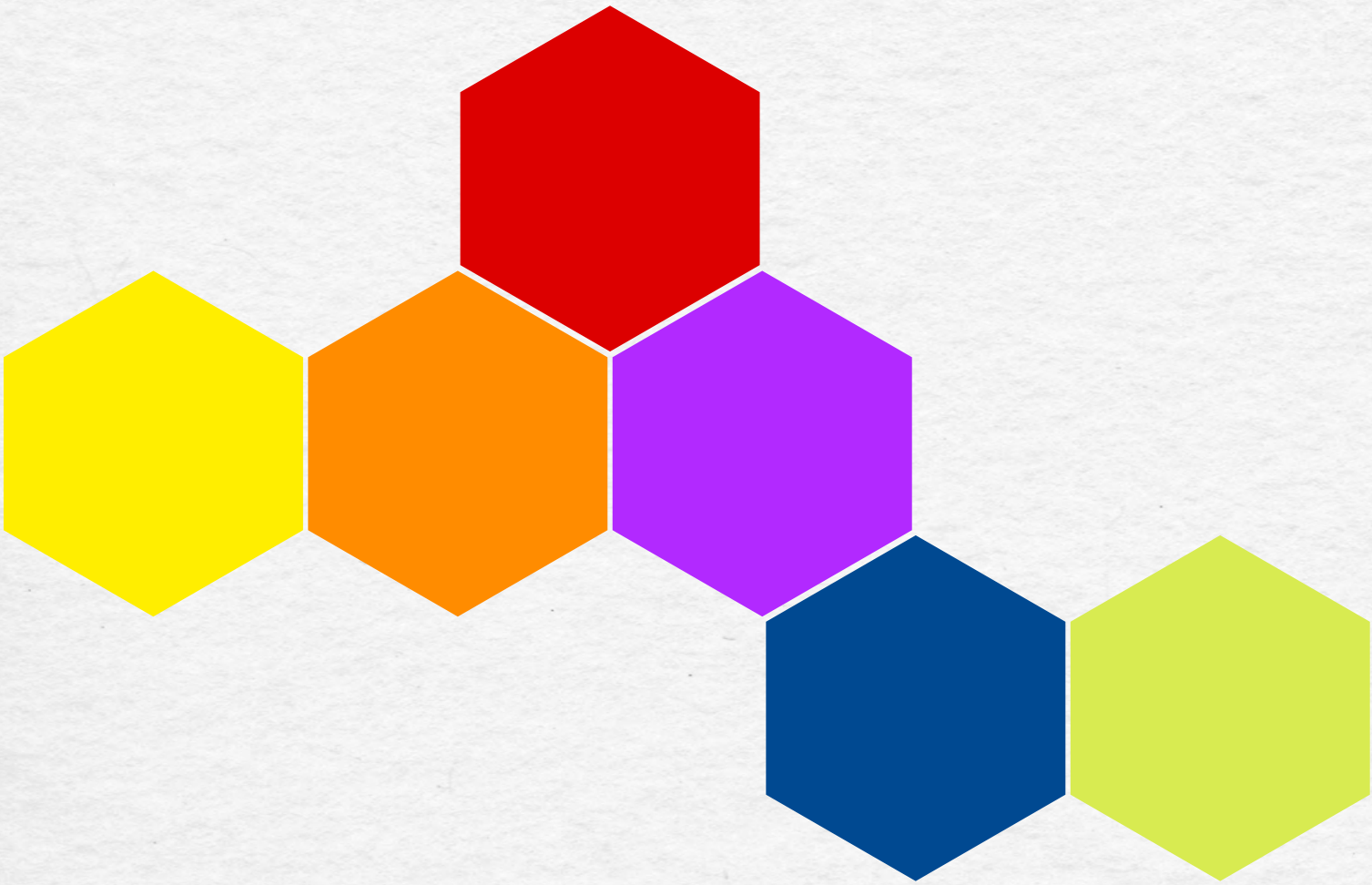
FRBs have been mostly detected within the frequency range of radio waves but researchers like Adaeze are determined to track them down in other frequencies. She believes that more research can only help to better understand these explosions, even if there are failed attempts along the way.

To conduct her research, Adaeze uses the Canadian Hydrogen Intensity Mapping Experiment (CHIME) telescope which has been involved in detecting most of the known FRBs to date. Once a day, it scans the northern sky for signals. If CHIME successfully detects any signals, Adaeze studies them further using other telescopes like the Karl G. Jansky Very Large Array (VLA) and the Gemini Observatory.

The Karl G. Jansky VLA consists of twenty-eight 25 metre radio telescopes connected together. She uses this telescope to look deeper into the vicinity of the detected FRB, in search of other radio emissions. By doing so, she is also able to detect the host galaxy. Made of two 8 metre optical telescopes, the Gemini Observatory provides detailed information about where the FRB is coming from, and its galaxy.

Combined data from the optical and radio telescopes provides Adaeze with greater insight into the nature of fast radio bursts. However, the raw data produced by telescopes isn't in itself meaningful. It must undergo data reduction, a series of cleaning in a defined sequence of operations. The final data can then be outputted in the form of images or arrays of numbers. To organize, store and represent the data she obtains through her research, Adaeze uses Python and various other astronomical softwares and data analytical techniques including image plotting, graphical representation, model fittings and statistical modeling.

Through this journey to better understand outer space's great mysteries, Adaeze has discovered a love for science communication and enjoys giving talks on her research. Explore Adaeze's RCIScience Instagram Takeover where she shares more about her research (saved in the ***Highlights***).



RCIScience
Royal Canadian Institute for Science

2022 FINANCIAL STATEMENTS

STATEMENT OF FINANCIAL POSITION (AS AT JUNE 30)

	2022	2021
ASSETS		
Cash, receivables & prepaid expenses	**95,636**	161,225
Investments	**1,117,131**	1,301,046
Portraits	**3,200**	3,200
	$1,215,967	$1,465,471
LIABILITIES		
Current		
Accounts payable and accrued liabilities	**42,348**	134,782
Deferred grants	**23,217**	65,880
	65,565	200,662
Loan payable	**40,000**	40,000
	$105,565	$240,662
NET ASSETS	**$1,110,402**	$1,224,809
	$1,215,967	$1,465,471

STATEMENT OF OPERATIONS AND CHANGES IN NET ASSETS (YEAR ENDED JUNE 30)

	2022	2021
REVENUE		
Sponsorship	**475**	102,000
Grants	**92,163**	79,374
Investment income	**27,194**	43,219
Donations and membership fees	**25,238**	25,738
Government assistance	**-**	10,000
Fundraising and events	**316**	5,811
	$145,386	$266,142
EXPENSES		
Staffing costs	**160,506**	133,997
Lectures and events	**26,075**	128,107
Professional fees	**21,554**	19,147
Office expense	**6,208**	9,965
Investment management fees	**9,349**	9,094
Insurance	**5,917**	5,473
Space rental	**4,364**	2,767
	$233,973	$308,550
Excess of expenses over revenues before other item	**(88,587)**	(42,408)
Unrealized gain (loss) on investments	**(25,820)**	(136,702)
Excess of revenue over expenses (expenses over revenue) for the year	**(114,407)**	94,294
Net assets, beginning of year	**$1,224,809**	$1,130,515
Net assets, end of year	**$1,110,402**	$1,224,809

“INSULIN DOES NOT BELONG TO ME,
IT BELONGS TO THE WORLD.”

DR. FREDERIK BANTING

ON THE SALE OF THE PATENT FOR INSULIN
TO THE UNIVERSITY OF TORONTO FOR $1

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