2019 - 2020 | Annual Report

Ryerson Faculty of Science

Greatest Hits

Saving coral reefs in Mexico

Using drones to find missing persons

Bright ideas from the brightest minds

Supporting a hydroponics start-up in Ghana

Dean's Message

PHOTO: MIKE FORD

Greetings, FOS community members!

As I look back on my first full year as dean, I am truly amazed and inspired by the caliber and diversity of our people. Professors, staff and students — you've all shown a collective passion that simply takes my breath away. Come join me in reliving our year's successes through the pages of this playlist. I'm sure its snapshots will fill you with pride, and invigorate you as we continue exploring the future together as the Faculty of Science.

In spring 2019, we became second on campus to establish an official **Faculty Council**. Thanks to everyone who worked so hard to make this a reality. I am proud of the enthusiasm and lively discussions that resulted — another genuine testament to your ongoing commitment to our work.

Planning continues on our new **Science Discovery Complex** at 202 Jarvis. Your engagement has been fabulous and will buoy us up as we scale the challenges of this major construction project. I am excited as we envision a modern, flexible space that will bring us all together and embody our values of community, collaboration and creativity.

Last year, we welcomed into the FOS family a cohort of eight **new professors** — and we continue with ongoing searches for more creative and talented people who will help us explore new directions in research and curriculum. We also piloted **department manager roles** to strengthen the operations support base and working environment for FOS as a whole. Our support staff are second to none and I really appreciate hearing their feedback and ideas.

In September, we also had the honour of hosting Nobel Laureate Dr. Martin Chalfie. His visit marked the first time the Nobel Prize Inspiration Initiative (NPII) program had ever come to Canada, and was a fantastic reinforcement for our strategic plan to create an environment of authentic science for students.

Colleagues and friends, as we look ahead, I encourage you to draw from the focus, expertise, diversity and flair that pervades the FOS community. Let's look back on 2019 as a year when we grew — as explorers with the courage to take risks and navigate the grey zones of knowledge, as two-way communicators who really listen to learn, and as scientists who continue searching the universe for understanding, enlightenment and joy.

David Cramb

↑ 22%

more undergraduate students on the Dean's List than last year

15

new alumni awards created for students, totaling 71 for the year

including:

Durst Family Award for Indigenous Students in the Faculty of Science

Steve Naraine Early Innovation Prize

The UMA Foundation Award

> **"Science is about understanding, but it's people who do the seeking."**

6

faculty members received awards for their exceptional contributions at Ryerson

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Shattering the Math Stereotypes

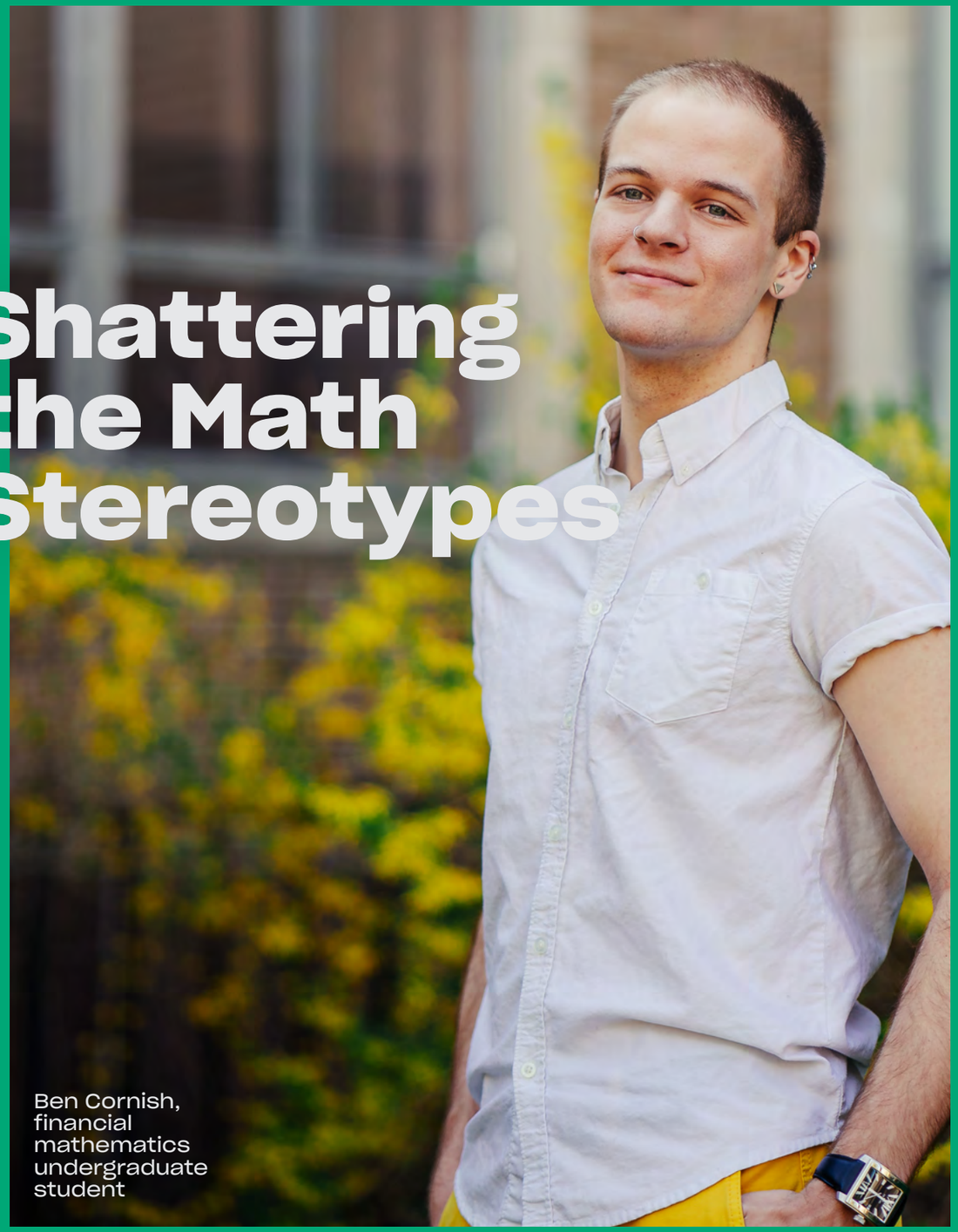


PHOTO: IAN PATTERSON

Ben Cornish, financial mathematics undergraduate student

Ben Cornish would never have pegged himself as a math guy, but he found himself thriving during math classes in his original program, geography. Since transferring to Ryerson, the financial mathematics undergraduate student can't see himself studying anything else: "Mathematics is hard even for kids in math programs, but the challenge is why we love it."

Now in his third year, Cornish continues to muster his get-up-and-go to expand his portfolio and network. While working at a Toronto winery, Cornish's customer service so impressed a TD Bank employee that he connected the young student to their recruiters to bring him on as a teller. Cornish also met a TD recruiter at a Toronto Pride parade, and landed a co-op position in the bank's largest data analytics department. "Co-op has 100% helped me appreciate my program. I'm now actually applying concepts I thought I'd never use from first year."

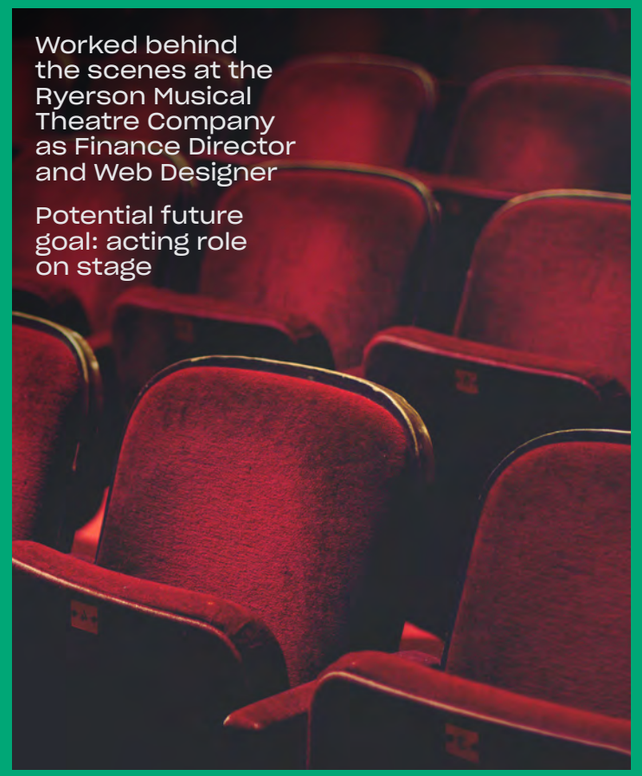
Cornish is also active in the Ryerson Musical Theater Company, first working as the Finance Director and most recently as Web Designer. Although behind the scenes so far, Cornish loves acting and has his sights set on auditioning for a role next year. "There's definitely a stereotype that math culture is antisocial, but we do put ourselves out there. We just do it in different ways."

Landed a co-op role at TD Bank in data analytics for real estate secured lending

"Mathematics is hard, even for kids in math programs, but the challenge is why we love it."

Worked behind the scenes at the Ryerson Musical Theatre Company as Finance Director and Web Designer

Potential future goal: acting role on stage



Straddling the Divide

As the first in her family to attend university, Reeda Mahmood came to Ryerson with a simple goal: study science. Now in her final year, the molecular science master's student is exiting with a 21st century STEM toolkit far broader than she'd planned on.

Mahmood is one of several students who originally formed Ryerson's Science Discovery Zone (SDZ) with supervisor Dr. Bryan Koivisto. There, she researches dye-sensitized solar cells. Unlike traditional opaque, roof-mounted panels, these cells resemble see-through stained glass. Dye-sensitized cells produce solar power even in low-sunlight conditions, making them ideal as energy-producing window replacements.

Mahmood first caught the entrepreneurial bug as an undergraduate at the SDZ, and eventually applied her learnings to scale and commercialize the lab's solar cells.

While straddling her studies and research, Mahmood founded two companies, including IdeaMosaic, an events and programs consultancy that quickly gained a steady clientele. By 2019, she and three colleagues also started May Contain, a web-based software that connects people to allergy-friendly restaurants. The start-up has already won awards, including a MITACS Accelerate grant to study how restaurants communicate food allergy risk to customers.

Blending her research skills and business acumen, Mahmood plans to take on a full-time role as May Contain's Chief Marketing Officer after completing her master's degree.

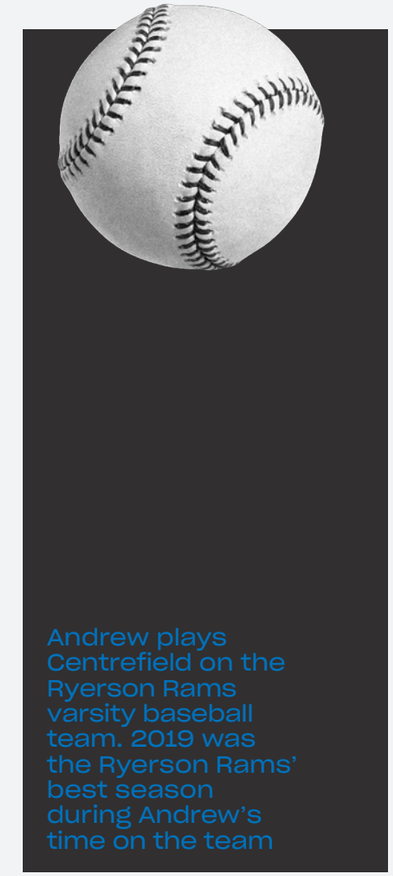
Researched dye-sensitive solar cells and also founded two separate start-ups

"If it weren't for Ryerson's ecosystem of innovation and entrepreneurship, I would probably never have started a single business."

Reeda Mahmood, molecular science graduate student and entrepreneur

Andrew Ciuffreda, chemistry undergraduate student and Ryerson Rams outfielder

PHOTO: IAN PATTERSON



Andrew plays Centrefield on the Ryerson Rams varsity baseball team. 2019 was the Ryerson Rams' best season during Andrew's time on the team

Hitting the Sweet Spot

Science and sports may not seem like a natural connection, but for Andrew Ciuffreda, they go together like ball in glove.

"I'm my happiest on a baseball field. I also had an early childhood passion for all things science. So, it all kind of came together at Ryerson."

As a kid, Ciuffreda loved playing baseball, and was also fascinated by science documentaries. By Grade 12, his interest in science swung to the side of chemistry: "Chemistry really piqued my interest. It's the perfect balance between theory and application." Meanwhile, a Ryerson Rams coach spotted Ciuffreda playing high school baseball and talked to him about the possibility of playing for the university.

Ciuffreda's path seemed clear. He came to the university and made the cut for the varsity baseball team. "Playing on a team is a big commitment, but it definitely fine tunes your time management skills." Now, in his final undergraduate year, Ciuffreda is a veteran at juggling the academic-extracurricular mix. "Last year, we played our best season during my time on the team, and I've learned an unbelievable amount of science."

Ciuffreda has also been working summers at the Halton Region Water Department. After finishing his BSc, Ciuffreda wants to earn a graduate diploma to further his career in aquatic chemistry and water quality. "Maintaining the whole water grid and meeting the daily water needs for an entire region – that's a really cool career path."

Transformational Mindset

Sometimes, discovery as a scientist happens when you expand your own borders. Medical physics undergraduate student Pursodman Ramachandran left for an overseas internship and came back with more than he'd anticipated in his 21st century STEM toolkit.

After completing a degree in financial mathematics, Ramachandran searched deep, discovered a passion for science, and came to Ryerson to study physics. In spring 2019, he was selected for the Engineers Without Borders Junior Fellowship program, and spent four months supporting communications and research teams at an innovation hub in Ghana, Africa.

Working to launch start-ups in hydroponics and waste collection, Ramachandran quickly realized the importance of interpersonal skills in scientific collaboration, research fundraising and project implementation. "Working with others and shaping my message to different audiences – that was challenging," he says. "But by working through uncomfortable situations, I learned to show empathy and find ways to move forward together."

Ramachandran now wants to use science to create not short-term fixes, but sustainable, systemic change for the world's pressing problems. "The internship was a period of exponential growth. It contributed to the person I've decided to become, and it's part of the systemic change that will help future generations see the world as one community."

Spent a four month internship in Ghana, Africa, supporting start-up projects in hydroponics and waste collection

"The internship was a period of exponential growth."

Pursodman Ramachandran (middle), medical physics undergraduate student

Seeing the Invisible

Eno Hysi, biomedical physics PhD candidate

PHOTO: IAN PATTERSON

When Eno Hysi first arrived on Ryerson campus in 2006, he was a young undergraduate student, fresh out of high school. Fourteen years later, he's finishing up with a PhD in biomedical physics.

Supervised by Dr. Michael Kolios, Hysi specializes in photoacoustic imaging, a novel technique that combines lasers with ultrasound imaging to visualize diseases. He compares the technology to lightning and thunder: "Laser is like lightning. When it strikes tissue, it produces ultrasound, like a thunderclap. We hope the technology will one day become a clinical standard, like x-ray or CT scans."

In 2019, Hysi co-authored five journal publications and made 14 conference presentations of his work. Although he originally researched photoacoustic imaging for monitoring how cancer tumours respond to treatment, his latest work focuses the technology on testing the quality of donated kidneys for transplantation. As one of the year's highlights, Hysi submitted a high-impact paper on the algorithms he developed for measuring kidney scarring – a technology for which he has now filed a patent.

Hysi will complete his academic career as the first Ryersonian to win Canada's prestigious Banting Postdoctoral Fellowship for 2020. As he moves on to St. Michael's Hospital in Toronto to complete the fellowship, he'll lead a clinical trial of the technology to assess the quality of donated kidneys.

Tying his years at Ryerson with his future in translational research, Hysi reflects: "All of my academic successes are rooted in the support that I received here at Ryerson. I get to do what I love while helping people. I consider myself very lucky."

In 2019

Co-authored five papers, shared his work through 14 conference presentations, and submitted a high-impact paper on measuring kidney scarring

Imaging Donor Kidney Damage

PHOTO: SARAH MCINTYRE

Dr. Michael Kolios

One out of ten Canadians suffer from kidney disease. In Ontario alone, 1,000 people are currently waitlisted for a transplant. How long will donated kidneys last the designated recipient? Estimating the outcome is like spinning a roulette wheel. Dr. Michael Kolios of the Department of Physics is working to remove the uncertainty.

Together with St. Michael's Hospital nephrologist Dr. Darren Yuen and Ryerson PhD student Eno Hysi, Kolios developed the Kidney Scar Screener. It is the first time that photoacoustic imaging has been used to assess the quality of donor kidneys before transplantation. In November 2019, Kolios and Yuen pitched their invention before a celebrity panel at the St. Michael's Angels Den health innovation competition.

The technology works by shining a laser into the kidney, which in turn produces a sound wave. This ultrasonic wave can be "heard" and then converted into images. "We were surprised at the accuracy it gives in visualizing the degree of scarring," says Kolios. With kidney donations in short supply, matching the right kidney to the right recipient is crucial. Kidney Scar Screener lets doctors see scarring, and decide how to use the kidney.

At the Den, Kolios and Yuen won $25,000 to fund upcoming clinical trials. If successful, the technology may eventually revolutionize kidney transplantation, save millions in costly dialysis, and provide patients with enduring, healthy kidneys.

Collaborated with St. Michael's Hospital on the invention of the Kidney Scar Screener

PHOTO: GEORGE PIMENTEL

Competed in the 2019 Angels Den medical research competition to pitch the use of photoacoustic imaging to assess donated kidneys

Drs. Michael Kolios (left) and Darren Yuen

$

Won a $25,000 Angels Den prize to fund upcoming clinical trials

PHOTO: SARAH MCINTYRE

Dr. Costin Antonescu in his research lab at Ryerson research facility in the MaRS Discovery District

Unlocking Secrets of Cancer Cells

"If we want to be prepared for challenges of the future, the fundamental research we do in cancer is needed today."

In the fight against cancer, new drug developments may gain high visibility. But what happens when medications stop working and cancer becomes more aggressive? For cellular biologist Dr. Costin Antonescu of the Department of Chemistry and Biology, the secrets lie hidden at microscopic levels inside the body's own cellular mechanisms.

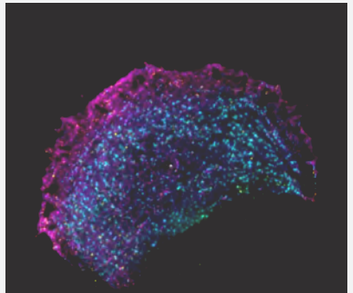
Antonescu is an expert in cancer cell biology, with particular focus on growth factor receptors and cellular metabolism. By understanding how cells grow, survive and migrate, Antonescu's lab works to identify vulnerabilities in cancer cells, which could potentially be exploited to improve therapies.

Building on funding from the Canadian Institutes of Health Research (CIHR) and the Cancer Research Society (CRS), Antonescu's lab uncovered several significant findings in 2019. After discovering that – contrary to previous theories – most cellular growth factor receptors are actually inactive, the team uncovered a new mechanism that activates the receptors and drives cancer signalling. The lab also found a new way that cells respond to the need for fuel molecules by slowing down cell migration.

Both results may prove useful in developing more effective cancer therapies. Antonescu is currently already working with a number of companies, such as Cyclica Inc, Phoenix Pharma and MD Precision, on the development of cancer drugs and ultrasound technology.

"The work is still in progress, but these are major results with exciting opportunities ahead," says Antonescu. "The goal is to contribute fundamental research that eventually improves treatments, prognoses, survival rates and quality of life."

PHOTO: MICHAEL SUGIYAMA



Discovered a new cellular mechanism that activates receptors and drives cancer signalling. (Pictured above: Epithelial cell, colour-stained to reveal receptor signalling proteins.)

Jazlyn Borges, biomedical sciences undergraduate student

Two-Time Win

When Jazlyn Borges first attended the Canadian Undergraduate Conference on Healthcare (CUCOH) in 2017, she aimed to eventually win one of its research competitions. By fall 2018, she had done it, winning the conference's poster competition. Last year, in fall 2019, she picked up her second win.

CUCOH is Canada's largest student-run healthcare conference, and Borges won for her oral presentation on the regulation of Signal Transducer and Activator of Transcription 5 (STAT5) protein in breast cancer. Specifically, her work studied how signalling by the epidermal growth factor receptor (EGFR) can either drive cancer progression – or surprisingly, actually improve outcomes.

The intrepid biomedical sciences undergraduate student developed the research bug early on after volunteering at supervisor Dr. Costin Antonescu's cell biology lab at the Ryerson MaRS Research Facility. "I had always thought I wanted to go to medical school, and I may still pursue that path," she says, "but after working in the lab, I also discovered how much I love research."

Borges has been investigating how cell proteins send and receive messages, and will complete her undergraduate thesis on STAT5. After graduation, she plans to continue researching in a master's program in cardiac or neurophysiology.

2019 1st place winner for presentation on regulation of STAT5 protein in breast cancer

"When they called my name for first prize, it felt surreal."

Extinguishing Cancer's Flame

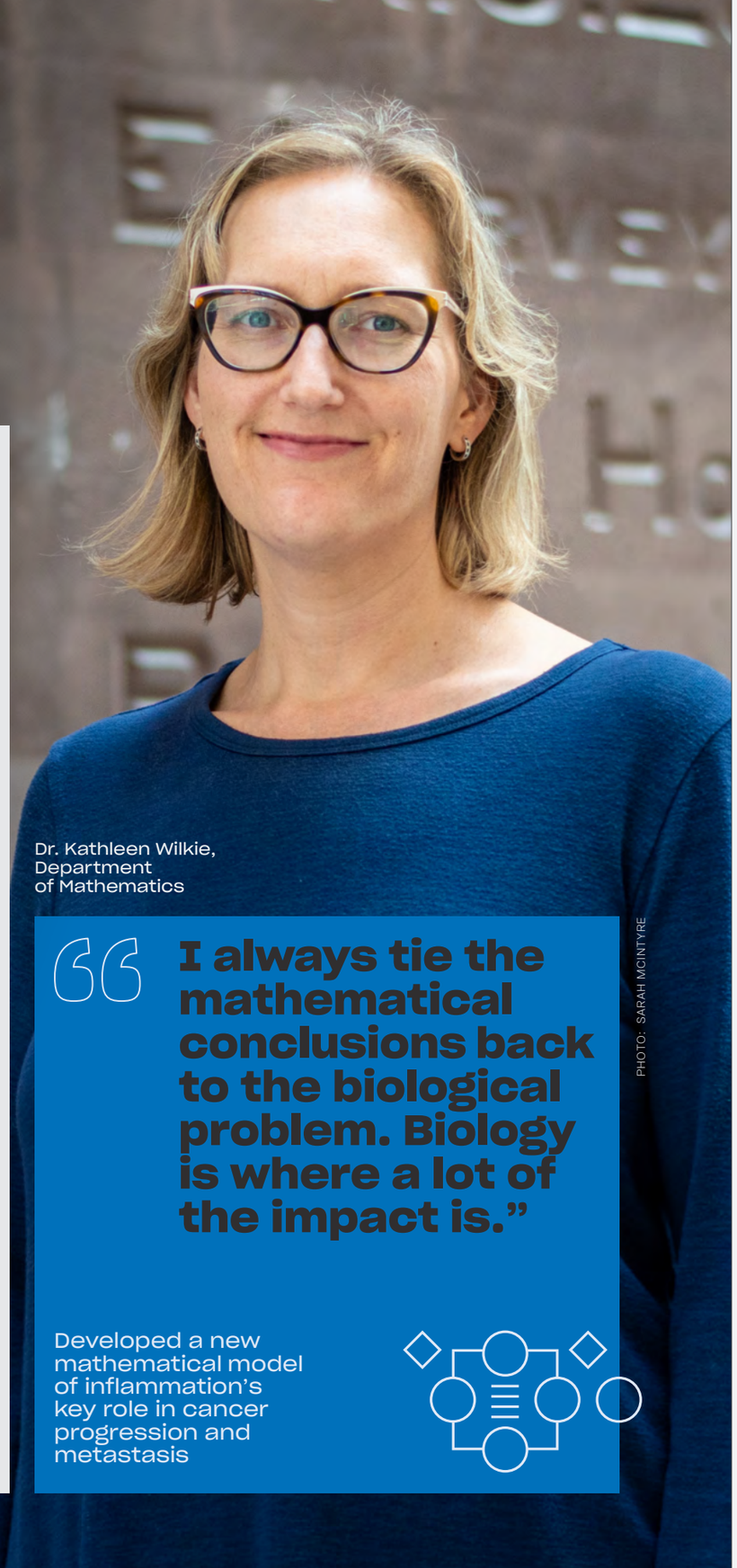
How does our body respond to a growing tumour and how does this influence the progression of the disease? How does cancer affect the rest of our body? Does our immune system help or restrict cancer growth?

Dr. Kathleen Wilkie of the Department of Mathematics specializes in using mathematics to understand the two-way relationship between cancer progression and the body's systemic response.

For years, Wilkie has been researching the mechanisms of tumour dormancy - for example when the presence of a primary tumour keeps metastases small. Once the primary tumour is surgically removed, however, metastases can become activated. In 2019, Wilkie completed work on a novel mathematical model supporting the hypothesis that inflammation plays a key role in this dynamic.

As cancer and wound healing both produce inflammation, a patient's body is highly inflamed after cancer surgery. Based on her mathematical model, Wilkie observed: "With the primary tumour now gone, inflammatory cells can move toward secondary tumours and make them grow from their dormant state."

The new understanding may be useful in developing protocols to manage post-surgery inflammation. "We already have good anti-inflammatory drugs available," says Wilkie. "If we can design treatments for inflammation and extend it during the years following surgery, we may be able to ultimately reduce the risk of the cancer returning."



Dr. Kathleen Wilkie, Department of Mathematics

PHOTO: SARAH MCINTYRE

> **"I always tie the mathematical conclusions back to the biological problem. Biology is where a lot of the impact is."**

Developed a new mathematical model of inflammation's key role in cancer progression and metastasis

Bench to Bedside

When Reyhaneh Nosrati started her PhD program in biomedical physics in 2015, bringing research to market seemed like a dream. But by summer 2019, several big names in cancer-fighting technology were reaching out to commercialize her work in MRI-guided radiation therapy.

Supervised by Sunnybrook Research Institute's Dr. Greg Stanisz and Ryerson's Dr. Ana Pejović-Milić, Nosrati developed an MRI-based workflow for radiotherapy treatment planning for prostate cancer. For cancer patients who are being treated by implanting radioactive seeds, the current practice requires combining MRI with a CT scan – MRI for soft tissue visualization, and CT for identifying and localizing implanted metallic seeds, which are not visible on conventional MRI.

Nosrati developed a new MRI post-processing method to visualize and identify metallic devices based on Quantitative Susceptibility Mapping (QSM). Using her proposed post-processing algorithm, oncologists can view both soft tissue and implanted devices clearly, with excellent contrast and spatial accuracy – all in a single MRI.

"The method requires no extra cost, no extra radiation, and only a few minutes extra MR scan time," says Nosrati. "Doctors can provide more accurate treatment and better outcomes for patients."

In 2019 alone, Nosrati published three papers in high impact journals on her research findings. By fall 2019, she completed her PhD and became Ryerson's first student from the Department of Physics to be admitted to the prestigious residency program at Harvard Medical School and affiliated hospitals.

> **"The best project for any graduate student is one that goes from theories and models to actual clinic."**

Admitted to Imaging Medical Physics Residency at Harvard Medical School, Radiology Department in summer 2019

Reyhaneh Nosrati, biomedical physics PhD candidate

PHOTO: IAN PATTERSON

Faculty of Science By The Numbers

+21%

graduate degrees awarded, compared to 2018

$5.2 million+

in total funding for graduate students

80%

of computer science PhD graduates were female

65%

of undergraduate degrees in biomedical sciences awarded to females

Doubled since 2018

Female undergraduates registered in mathematics

Biomedical physics master's program maintained their gender balance intake at 50/50

309

Total number of research publications

8743

Total number of research citations

$5.7 million+

in overall external researching funding

572

students became part of of the Faculty of Science alumni family

502

Undergraduates

51

Master's

19

PhD

6

staff and faculty members were recognized for their long service milestones

25 yrs.

Peter Danziger (Mathematics)

Denise Woit (Computer Science)

30 yrs.

Luisa Chan (Mathematics)

Debora Foster (Chemistry & Biology)

Kimberley Gilbride (Chemistry & Biology)

Sophie Quigley (Computer Science)

#WomenInSTEM

Most popular posts

18%

more followers than in 2018

152%

more user engagement than industry standard

10x

more impressions than in 2018

Doubled the number of followers from last year

Deborah Mepaiyeda, computer science undergraduate student

"During my time at Ryerson, I've been challenged in ways that brought me out of my comfort zone."

Won the 2019 Brian Segal Award for outstanding contributions to Ryerson's cultural life

Leading the Charge

Rough starts can sometimes lead to heights of extraordinary achievement. Computer science undergraduate co-op student Deborah Mepaiyeda has lived it. "When I started my program, I didn't have much coding experience, so I struggled through a difficult first year." Not to be deterred, Mepaiyeda persisted.

With support from the Ryerson computer science community, Mepaiyeda gained traction. Now in her fifth year, she's set to graduate with a BSc degree, real-world co-op experience at Scotiabank and RBC – and an impressive portfolio of extracurricular accomplishments.

Mepaiyeda had already held a number of executive roles at Women in Computer Science (WiCS), and in 2019, became Vice President of Marketing. As a Faculty of Science Student Ambassador, she has engaged with hundreds of students and their parents at key events including this year's Ryerson Fall Open House and the Ontario Universities Fair. Extending beyond campus, she's also a Fellow at Rewriting the Code, a national non-profit for females in post-secondary technology programs, and at STEMHub Foundation, where she facilitates workshops to encourage females, visible minorities and underrepresented youth to pursue STEM careers.

With her record of student leadership and passion for promoting women in STEM, Mepaiyeda won Ryerson's 2019 Brian Segal Award for outstanding contributions to the cultural life of Ryerson University. After finishing her program with a foreign exchange at England's University of Surrey, Mepaiyeda plans to work in industry, and eventually develop her own tech or non-profit start-up.

New Horizons

During high school, after her mother died of cancer, Pamela Huntley hit deep, dark spots and struggled with mental health. But encouraged by inspiring, female math teachers, she found new direction, moved to Toronto, and enterred the undergraduate program in Math and Its Applications at Ryerson.

Now in her fourth year, Huntley is thriving in academic and student life: "I used to be a shy, little kid. But when I came to Ryerson, I thought: 'Why not try to put myself out there and make a fresh start?'"

Huntley's spunk paid off. She has since held executive roles in student governance, promoted women in mathematics, and organized a slew of student activities – all while balancing her studies and on-campus job.

In 2019, Huntley's agenda was full. She served as President of Women in Mathematics, Vice President of her course union, mathematics representative for the Association of Undergraduate Women in Science, and also played key roles in planning Pi Day, the Mathematics social and the Faculty of Science formal.

With confidence built over the last few years, Huntley is now contemplating teachers' college or graduate school. "I want to show young people – especially females – how useful math is, and that they have a place in STEM."

Pamela Huntly, undergraduate student in Math and Its Applications

PHOTO: IAN PATTERSON

Organized multiple events throughout the year, including: Pi Day, Mathematics Department social, and Faculty of Science formal

"I want to show young people – especially females – how useful math is, and that they have a place in STEM."

Meeting of Minds

In November 2019, four students from Ryerson's computer science program descended on New York City to attend Hopperx1.

The one-day event champions females across the spectrum of technology careers within academia, research and industry. Modelled after a larger celebration of Grace Hopper – a 20th century computer programming pioneer, mathematician and U.S. Navy rear admiral – the local conference was a meeting place for women of all ages to learn, share and showcase their successes.

The program featured a smorgasbord of perspectives and strategies on career development, diversity, entrepreneurship and industry trends such as machine learning, blockchain and data science. "It was motivating to network with successful women in STEM and to learn how they got to where they are now," says third-year computer science undergraduate student Nivetheka Kumarathas.

Classmate Sara Jahanzad agrees: "It was interesting hearing about the hurdles other women had to overcome. It made me think about the power of hard work and pushing yourself beyond barriers and glass ceilings."

The Ryerson delegates returned with their confidence fortified for the path ahead. Jahanzad reflects: "I bring best practices for sharing my passion and encouraging other females to reach out for careers in STEM." Both women plan to specialize further in graduate school – Kumarathas in games development, and Jahanzad in computer vision and artificial intelligence.

"The event was truly a unique experience. It's amazing to meet other women who are successfully overcoming the same struggles as yours."

Sara Jahanzad

Taking a Deep Dive into Coral Research

Jacklyn Cunningham, biology undergraduate student

Spent two weeks in Akumal, Mexico on the Riviera Maya helping to map endangered coral reefs

Jacklyn Cunningham still remembers first becoming fascinated with conservation while watching nature documentaries as an eight-year-old girl. Now a biology undergraduate student, Cunningham found herself diving in Mexico's Riviera Maya to study endangered coral reefs during the summer of 2019.

Cunningham took the initiative to search out undergraduate research opportunities abroad. Operation Wallacea (Opwall) resonated. "Opwall was exactly what I was looking for: an academic, research-based program in conservational biology."

Already a certified open water diver, Cunningham underwent additional training in reef ecology before coming face-to-face with coral reefs for the first time. "The marine world was mesmerizing – so many colourful fish, stingrays and sea turtles," she recalls. "But coral reefs there are diminishing quickly compared to other parts of the world. We could lose many over the next 20 years."

Cunningham's part involved scientific diving to map corals. She surveyed their health, size and abundance – all in an effort to measure how quickly the reefs are dying and inform the development of conservational strategies.

"The field placement really boosted my confidence. There's so much in the oceans to conserve. If there's anything we can do to help, I want to be part of that change."

"The marine world was mesmerizing – so many colourful fish, stingrays and sea turtles."

Became a certified open water diver

"There's so much in the oceans to conserve. If there's anything we can do to help, I want to be part of that change."

Global Team Science

Dr. Stephanie Melles, Department of Chemistry & Biology

Participated in an international collaboration of 37 scientists to study the impact of forest fragmentation on biodiversity

Understanding complex environmental issues can sometimes resemble a puzzle – nothing is clear until individual pieces come together. In December 2019, Ryerson spatial ecologist Dr. Stephanie Melles of the Department of Chemistry and Biology was among an international team of 37 scientists to shed light on forest fragmentation's impact on biodiversity. Their collective findings were published in *Science*.

Fragmentation occurs when an expanse of pristine forest is broken into smaller bits – because of major disturbances such as fire, flood or human activity. While some scientists observed severe impacts of forest fragmentation, others found minimal impact on animal populations. The Oregon State University-led study provided clarity amid the contradictory reports.

By pooling global data on over 4,400 species in 73 different forested regions, a composite picture emerged. A history of major land disturbances in the past determined current species' resilience. Species that failed to adapt became extinct. The rest were hardier against new disturbances. The results confirmed the previously untested extinction filter hypothesis. With this insight, global conservation efforts can now be tailored to specific regions, with special focus on tropical forests near the equator where animals are the most vulnerable.

With fragmentation expected to accelerate over the next half century, Melles has mixed feelings: "Animals will have to adapt a lot faster than is realistically possible. But through team-based science, we're now addressing major problems that ecology faces on an international scale."

PHOTO: MATTHEW G. BETTS

Unfragmented tropical forest in Costa Rica

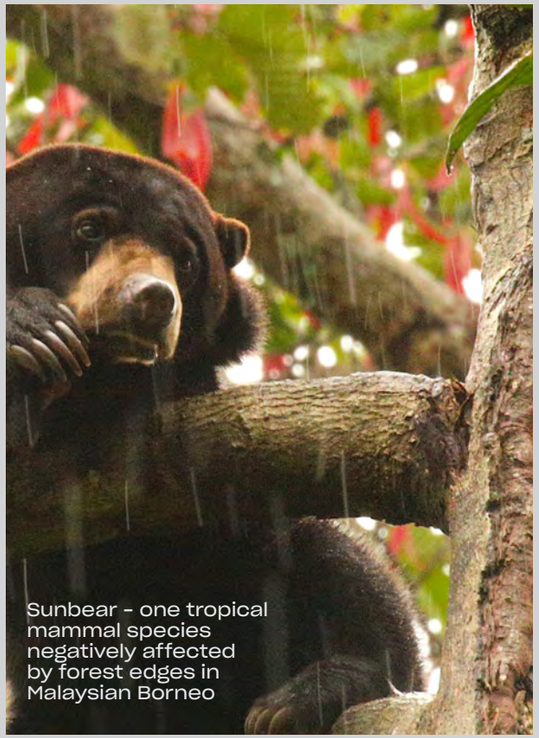


PHOTO: MATTHEW G. BETTS

Sunbear – one tropical mammal species negatively affected by forest edges in Malaysian Borneo

"Animals will have to adapt a lot faster than is realistically possible."

Travelling at the Speed of Math

In December 2019, Ryerson University entered a new collaboration with PSE Innowacje, the research and innovation arm of Poland's national power supplier. The move is another step forward in establishing Ryerson's research collaborations with organizations around the globe.

Dr. Pawel Pralat of the Department of Mathematics leads the research in modelling dynamic behaviour within Poland's power grid. "There are so many problems to solve that we're identifying which to tackle first," says Pralat. "Potential areas include digitalization, simulations, big data, artificial intelligence, blockchain and smart systems for the energy sector."

Throughout the year, Pralat was busy crisscrossing the globe to collaborate with mathematicians. Among his travels, he continued ongoing work funded by the Polish National Agency for Academic Exchange. The project fosters cooperation with the Warsaw School of Economics (WSE) in studying hypergraphs – a specialty area for which no scalable algorithms or tools currently exist. Pralat is also among the foreign talent invited to join China's Project 111, an initiative to create innovation centres with renowned, international scientists.

Beyond official partnerships, Pralat travels extensively within his own worldwide mathematics network of 120+ collaborators. "Mathematical problems are becoming increasingly complex," he says. "The unique portability of mathematics and cloud-based computational tools make for diverse exchanges of international perspectives and expertise. It's like we're pollinating the world with the latest developments in mathematics."

"Mathematicians don't need special equipment – just a pencil and paper, and we can work on problems in any country."

Leading a new research collaboration with Poland's national power supplier

Dr. Pawel Pralat (far right) at Gdansk University of Technology in Poland

Flights of Science

In 2019, the Faculty of Science added a new destination to its Global Science Citizen Program. Building on an already-existing relationship, Ryerson University now offers a science-based exchange option with City University of Hong Kong.

"Students were asking for more Asian destinations and City University has a great reputation for exchanges," says Recruitment and International Engagement Officer Salwa Saeed. "There's a lot of research going on there, so it will be a fantastic opportunity for our students."

Saeed emphasizes the feasibility of exchange opportunities: "There's an exchange destination for every budget. Students can pay Ryerson tuition and still access student loans, but also go abroad, gain different perspectives and build their professional network." Funding is offered by the Faculty and Ryerson International.

Six students in 2019 benefited from the program. Biology undergraduate student Thi Duyen Nguyen shadowed researchers in the School of Pharmacy during her time at the U.K.'s University College London. "I learned the basics of x-ray crystallography and grew crystals of different designs under various chemical conditions. It made me realize my passion for cancer research," she says. "I also made some new friends and had fun travelling around Europe."

Fourth-year biomedical sciences student Kayla Johnson studied at the University of West England while also researching contractions in pig bladders. "It broadened my view on the various options available out there, and I learned that motivation and determination are key," she recalls. "I also made so many friends in various countries. It was an experience I will never forget."

9 academic exchange countries

- Australia
- China
- France
- Germany
- Hong Kong
- India
- Netherlands
- Singapore
- United Kingdom

PHOTO: IAN PATTERSON

"The exchange taught me that I don't need to limit myself to Toronto, or even Canada. There's so much more to explore!"

Thi Duyen Nguyen

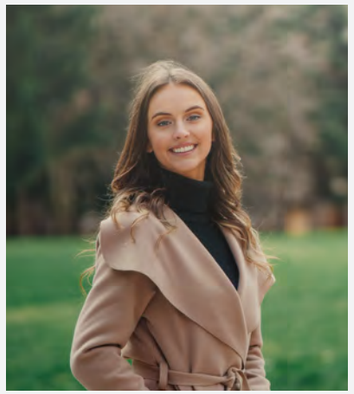


PHOTO: IAN PATTERSON

"It was an opportunity of a lifetime, and simply the highlight of my undergrad career."

Kayla Johnson

Drones to the Rescue

Dalia Hanna, computer science PhD candidate

PHOTO: SARAH MCINTYRE

Over 25 years ago, Dalia Hanna's aunt Lucy wandered from home and was never found. "When a loved one goes missing and doesn't return, you never get closure," says Hanna. The PhD candidate now researches human-robotic interactions under Dr. Alexander Ferworn of the Department of Computer Science. Her special focus: using drones to find missing dementia patients.

At the 2019 IEEE Information Technology Conference, Hanna presented findings on the feasibility of programming drones to automate search-and-rescue operations. Using an international database, Hanna mined over 3,000 missing-persons reports to find patterns that might help predict the path of lost dementia patients and their chances of being found alive.

While total automation remains elusive, Hanna's work confirmed that drones can be quicker, cheaper and more agile than conventional ground searches. Her work may eventually lead to advancements in algorithmic design for drone technology, simulated game-based training for emergency responders, and the development of missing-persons policy and protocol.

Currently, 60 per cent of dementia patients will eventually wander off. If not found within 24 hours, one in five will suffer injury. Hanna wants to improve the numbers. "Life depends on the search. If I can make even a small difference – helping families find loved ones faster – that's meaningful."

Researched the use of drones to find wandering dementia patients

Drone research included live field tests with police, industrial partners and drone experts

Master of the Games

Somnath Kundu, master's and PhD student in mathematics

PHOTO: SARAH MCINTYRE

Growing up in a rough neighbourhood in Calcutta, India, Somnath Kundu witnessed firsthand the gap between rich and poor, prosperous and underprivileged. In 2019, as a master's student in mathematics at Ryerson, Kundu produced mathematical findings that may one day play a part in helping society achieve a better, more stable equilibrium.

Under the supervision of Dr. Konstantinos Georgiou, Kundu published new results in game theory. His work examined strategies that competing individuals use to maximize their own gains and minimize their losses – a common and understandable human tendency. Yet, Kundu proved mathematically that when individuals are over-focused on self interest, they ultimately harm society – and themselves in the process.

Kundu's paper further revealed mathematically the point at which self-interested parties can actually contribute to society, but still optimize their own gains as a result – a true win-win for all. Although theoretical, Kundu's results could show up anytime in concrete applications for economics, business, politics or social science. "A mathematician's work is not always immediately tangible," he says, "but we view them as new discoveries – stepping stones that others may eventually use in solving problems and benefiting society." In fall 2019, Kundu continued on to the PhD mathematics program at Ryerson.

> **"As a mathematics student, my job is to unlock hidden insights that could eventually be applied in ways that benefit society."**

Discovered a mathematical threshold to achieve win-win, in which individuals can contribute to society while still maximizing their own interests

Eye on Intelligence

Dr. Mikhail Soutchanski, Department of Computer Science

PHOTO: SARAH MCINTYRE

Far below the surface, underlying the robotics and complex machinery, a fundamental question continues to roil among artificial intelligence (AI) experts: How should the principles and robust algorithms of intelligence be developed? By recognizing patterns among billions of bits of data? By reasoning logically about events and causes? Or should both directions be explored?

Dr. Mikhail Soutchanski of the Department of Computer Science champions a synergistic approach – one that combines the strengths of both machine learning and symbolic AI. Soutchanski specializes in the latter, a broad approach that teaches computers to reason and solve problems through symbol manipulation and cause-and-effect models.

In 2019, Soutchanski's lab published two new developments to move symbolic AI forward, including an advanced version of situation calculus (SC). The upgrade allows computers to now reason effectively about actions in the presence of continuous processes that may change over time – such as controlling traffic lights to alleviate traffic jams arising from unexpected events.

Soutchanski also created logical semantics for PDDL+, the standardized computer language for AI planning which, until now, has been hampered by an overly complicated structure. Using a principled approach from his version of SC, Soutchanski cleaned up the underlying concepts. The results now facilitate research in AI planning for hybrid systems that include both discrete and continuous components.

Looking ahead, Soutchanski is optimistic that AI research will eventually develop a unified approach: "We're working in very large state spaces. Domain-independent techniques from both AI directions can contribute. I think it won't be long before people realize that."

$\int f(t)\,dt$

Formulated an advanced version of situation calculus for AI reasoning

Rising Stars in the Faculty of Science

PHOTO: SARAH MCINTYRE

SEAN CORNELIUS

Physics

Dr. Sean Cornelius joins Ryerson after holding research positions at Harvard Medical School and Boston's Network Science Institute (NetSI). He specializes in complex systems, with particular focus on cascading failures – processes like power blackouts and multi-species extinctions in ecosystems, in which small amounts of damage propagate through the system in a "domino effect." Having worked on applications ranging from infrastructure networks to diseases in subcellular systems, Cornelius predicts: "Complex systems is an infinitely large sandbox in which you can apply the tools to virtually any field."

PHOTO: SARAH MCINTYRE

ERIC DEGIULI

Physics

Dr. Eric DeGiuli researches disordered systems and amorphous materials. He extracts principles found in foam and glass and uses them to understand neural networks, natural language processing and artificial intelligence. Previously, DeGiuli researched within the European theoretical physics community, at École polytechnique fédérale de Lausanne (EPFL) and the prestigious École normale supérieure in Paris, France. DeGiuli returned to Canada to further Ryerson's expertise in complex systems.

2019 was a year of tremendous growth for the Faculty of Science. We welcomed eight new faculty members distributed among three departments. Some will help pioneer new directions in our academic programs. Others add scope to our longer-established fields. All are excellent additions to the Faculty's diversity and expertise.

PHOTO: SARAH MCINTYRE

MICHELLE DELCOURT

Mathematics

Dr. Michelle Delcourt enjoys the highly visual aspects of her research in structural graph theory, extremal combinatorics and graph colouring. She incorporates skills from mathematics, computing and data science to solve problems such as optimizing transportation and radio networks. Delcourt has worked as a Research Fellow at the University of Birmingham in the U.K., and most recently as an Adjunct Professor at the University of Waterloo. She carries a strong service record in promoting mathematics among females and underrepresented populations.

PHOTO: SARAH MCINTYRE

JAVAD (JAKE) DOLISKANI

Computer Science

As a post-quantum cybersecurity expert, Dr. Javad (Jake) Doliskani will add the latest in applied cryptography to our academic programming. Keeping information safe will become ever more challenging once the massive processing power of quantum computers becomes widespread. Doliskani is now working to build the foundations of next-generation security protocols and cryptosystems implementation. He aims to form a research group focused on developing high-quality solutions in post-quantum cryptography and quantum computing.

PHOTO: SARAH MCINTYRE

YOU LIANG

Mathematics

Dr. You Liang holds a PhD in statistics and is an accredited statistician with the Statistical Society of Canada. She researches time series analysis, Markov decision processes, risk management and statistical learning. “Data is one of the most valuable and superabundantly available resources,” she says, “but for it to be useful, we need statistical experts who know how to extract, refine and interpret it.” Liang adds statistics-based expertise to Ryerson’s academic programming. “In a competitive job market, graduates need to be equipped with skills to model, analyze and interpret complex data.”

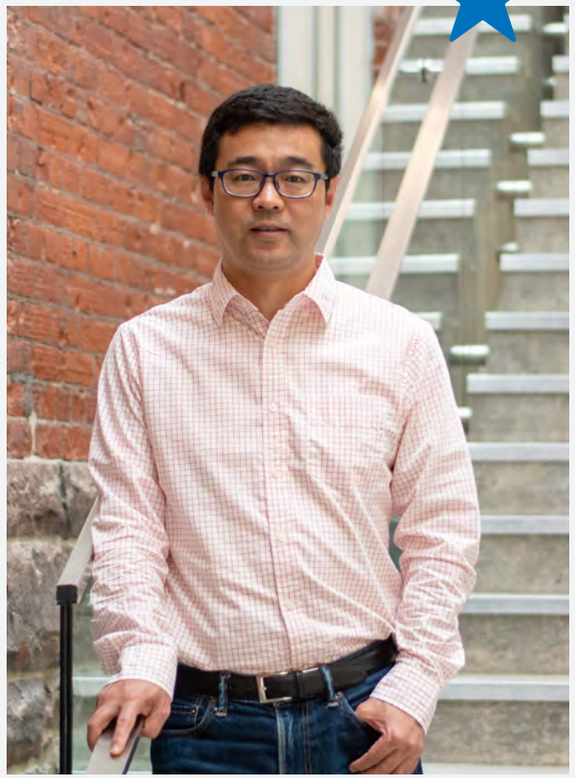
PHOTO: SARAH MCINTYRE

SADAF MUSTAFIZ

Computer Science

Dr. Sadaf Mustafiz specializes in using model-driven engineering for the analysis and design of complex systems. She researches methods for making software and systems engineering more productive and efficient. Before joining Ryerson, Mustafiz worked at McGill University with NECSIS, a national collaboration between GM, IBM and eight universities to research model-driven engineering for automotive systems. She also researched at Concordia University with the NSERC/Ericsson Industrial Research Chair in Model-Based Software Management for the telecommunications sector. Looking ahead, Mustafiz says: “Industrial relevance is key, and it will continue to be a major factor driving my research agenda.”

PHOTO: SARAH MCINTYRE



WEI (DAVID) XU

Mathematics

Dr. Wei (David) Xu’s portfolio blends academic, research and industry experience in financial mathematics. He was an Associate Professor at Tongji University in Shanghai, China and researcher at the University of Waterloo and the Global Risk Institute, a Toronto-based risk management think tank. Xu is interested in applying machine learning to portfolio optimization, valuation and risk management. He imparts valuable insights from financial sector experience: “Companies tell me they want graduates who can solve actual problems, not just read textbooks and answer questions. Financial people don’t want to hear complicated methods, so graduates need to communicate the math as efficiently as possible.”

PHOTO: SARAH MCINTYRE

NA YU

Mathematics

Dr. Na Yu comes from a tenure-track position at Lawrence Technical University in Michigan. She brings expertise in math biology, and currently researches human gait analysis. She uses mathematics to analyze body parts involved in walking and falling. “Right now, we have a simple mathematical model,” says Yu, “but I’m working on one that’s complex enough to accurately reflect factors that cause falling.” As her research develops, Yu sees potential for developing industrial collaborations in biomedical engineering, healthcare, footwear manufacturing and sports organizations.

Celebrating Indigenous Science

Hide tanning in Kerr Hall Quad

2019 was a pivotal year for the university in advancing two-way scientific engagement with First Nations. Using a two-pronged approach to sharing, promoting and integrating traditional and western science, SciXchange debuted two initiatives: Stoodis Science and hide tanning.

As part of Science Literacy Week in September 2019, Indigenous knowledge and science outreach coordinator Amber Sandy, brought tanning demonstrations to campus. Complete with fur-scraping, hide conditioning and stretching-drying-smoking demonstrations, the hide tanning workshops brought Ryerson community members up close with the science of traditional practices. "Indigenous science comes from knowledge found in nature," says Sandy, "and underneath hide tanning, there's a lot of biology and chemistry going on – such as how lipids used during conditioning break down skin fibres and makes hides more pliable, or how resins released from burning wood coat the hide and waterproof it."

True to its name – Indigenous slang for "let's do this" – Stoodis Science brings science and STEM learning to Indigenous communities. First stop in the program was Tyendinaga Reserve – home community of SciXchange's own Student Outreach Lead and fourth-year biomedical sciences student Jenna Barnhardt. Together, Sandy and Barnhardt organized a full-day program to explore neuroscience and traditional salve-making with students on the reserve. "We're communicating the message to Indigenous students that science is attainable and that the knowledge these students hold is already scientific," says Sandy.

After a successful 2019 kickoff, Stoodis Science will continue to support both underrepresented populations in STEM and the university's path to reconciliation with First Nations.

New Slices in Scientific Outreach

Another initiative launched during 2019 was the computer literacy program. The program provides in-demand digital skills to primary and secondary school students. The program offers six different activities, in topics such as robotics, front- and back-end game development, pixel colouring and computer coding logic. During the program's first year, SciXchange brought the computer literacy program to schools across Ontario.

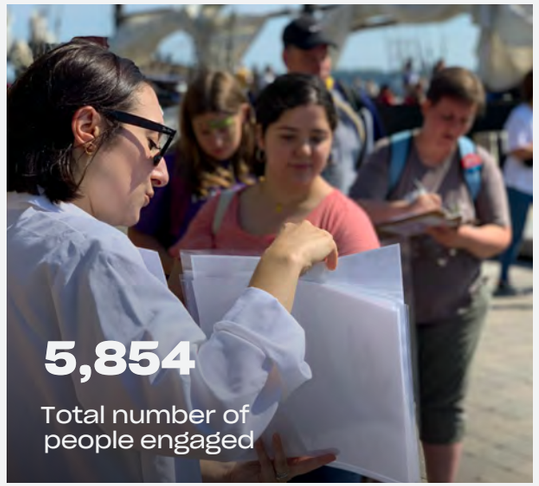
SciXchange also hosted 100 high school students during the one-day Let's Talk Cancer symposium. Among the activities were segments from representatives of the departments of physics and biology, including workshops on microscopy and radioisotopes, and a segment on the emerging cancer-fighting technology of ultrasound-assisted microbubbles.

110

Total number of hosted events and activities

149

Total Number of volunteers and partners



5,854

Total number of people engaged

Nobel Encounter

Dr. Martin Chalfie, Ph.D.

Winner of the 2008 Nobel Prize in Chemistry

"Enjoy what you're doing. Are you excited about doing the science? If that's what you get out of it, that's perfect."

PHOTO: A. MAHMOUD, NOBEL MEDIA

First-ever Nobel Prize Inspiration Initiative in Canada, bringing Nobel Laureates to scientific communities around the world

Crossing paths with a Nobel Laureate isn't your everyday occurrence. But on September 24, 2019, the Faculty of Science hosted not one, but two such world-renowned scholars: Dr. Martin Chalfie as speaker and VIP guest Dr. John Polanyi.

As part of the Nobel Prize Inspiration Initiative (NPII) bringing Laureates closer to scientific communities around the world, Chalfie's visit to Ryerson marked the program's first occurrence ever in Canada.

Chalfie was joint-recipient of the 2008 Nobel Prize in Chemistry for developing one of bioscience's most important tools: green fluorescent protein (GFP) as a biological marker in organisms. Researchers now use the naturally glowing tags to follow cellular activity that had never before been possible.

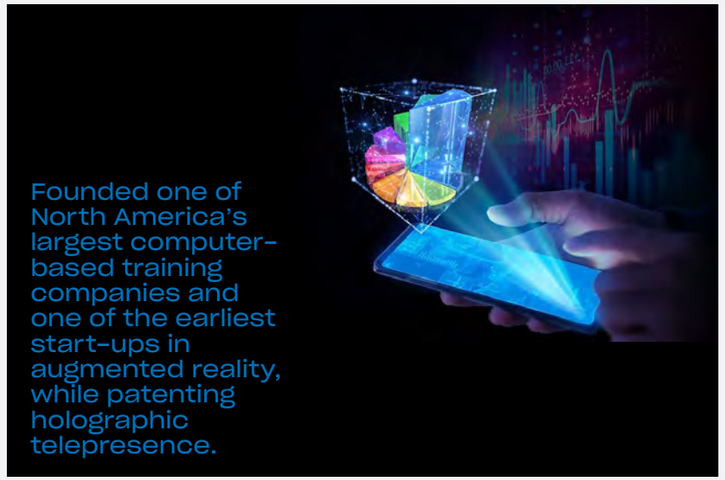
Hosted at the Centre for Urban Innovation, the event opened with an on-stage chat and audience Q&A with Chalfie and Dean of Science, Dr. David Cramb. A smaller group of graduate students gathered afterward for a Round Table discussion with Chalfie. Under the central theme of Authentic Science, a strong message dominated: get students into the labs; let them experience science as it's done in the real world – with all its twists, turns and unknowns.

Chalfie spoke candidly about the realities of contemporary science and his own ups and downs along the path. He offered words of wisdom for next-generation scientists: Failure is an obvious part of exploring problems yet to be solved because "you're the first person in the world doing it." Wary of popular slogans to simply 'follow your passion,' Chalfie instead encouraged lifelong curiosity, continuous sampling of new ideas, and being awake to the simplest, often overlooked possibilities for scientific exploration all around us.

Chalfie also talked of the need to redefine student success – balancing the relative importance of GPAs and past accomplishments with other more telling factors: letters of recommendation, working style, initiative, enthusiasm, and curiosity-driven goals.

Asked if it's more difficult being a scientist in the 21st century, Chalfie responded: [The question] is more: 'If we had the choice, would we like to just keep going?' The answer is: Absolutely!"

Ride of a Lifetime



When Paul Duffy (Computer Science '89) places himself back to his undergraduate days, he's astonishingly level-headed. "I graduated middle of the pack," he says, "no one special, really." Thirty years later, the successful Ryerson alumnus has enjoyed the ride of a lifetime – and is still raring for more.

Duffy embodies the quintessential Ryersonian spirit. Blending technical know-how with an insatiable appetite for innovation, he's become a serial entrepreneur who incubates the latest in digital experiences. He's already started and sold a string of successful technology businesses, and is now growing his next venture in 3D hologram technology.

Duffy initially began in a Programmer Analyst role at TD Bank, but quickly realized it wasn't for him. "I quit my job and lived on a few hundred dollars a month. People thought I was crazy."

Reaching out to six fellow Ryerson graduates from his days as course union president, he joined their team at the Hay Group to develop software at the dawn of the micro-computing era. The early departure from a typical day job soon led Duffy onto a path lined with new adventures.

By age 23, Duffy had developed a program to walk Canadian snowbirds through virtual real estate listings in Florida. An AT&T tech illustrator saw his work, connected him to key decision-makers, and Duffy walked away from the meeting with $15,000 to build a multimedia computer-based training tool for a data communication product. "I didn't even have business cards at the time," Duffy reminisces.

By the following year, CNN featured Duffy's invention. The exposure led to a five-year exclusive deal with AT&T, and the creation of Duffy's first business, Corporate Communications Interactive (CCI). It went on to become one of the largest computer-based training companies in North America. "Our clients included almost every major Fortune 500 company around," says Duffy. "IBM, Microsoft, Honeywell, GE, FedEx, Manulife, RBC..."

Since then, Duffy also created a telepresence platform to remotely beam people as live, life-sized holograms into multiple meetings simultaneously. "Tony Robbins was one of my first clients," says Duffy. Others include Justin Trudeau, Warren Buffett and Stephen Hawking.

Duffy is now president of NexTech AR Solutions, a fast-growing tech business that creates 3D holographic experiences for advertising, eCommerce, retail, education and entertainment.

Throughout his successes, Duffy has always maintained a close connection to his Ryerson roots. Over the years, he's called on his old professors for subject matter expertise on breaking technologies, sponsored co-op placements, and hired numerous Ryerson graduates.

"People from Ryerson spend as much time applying knowledge as hearing it," he says. "I've built a lot of training technology, so I understand the pedagogy. After working extensively across the globe, I can truly say that Ryerson has a first-class group of educators."

Looking ahead, Duffy hopes to help the university expand augmented reality and virtual reality in its computer science program. "Ryerson was very formative in my life, and I've had a fantastic ride since I graduated," he says. "Now, I see so many opportunities in the next decade, so we need to embrace the future. It's going to be a great, great time!"

PHOTO: IAN PATTERSON

Paul Duffy, computer science alumnus, class of '89

"When the training wheels come off, Ryerson graduates are already running."

"Somewhere, something incredible is waiting to be known."

Carl Sagan

Ryerson Faculty of Science

2019 - 2020
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