

THE COLLEGE OF BIOLOGICAL SCIENCE

RESEARCH **INSIGHTS**

Vol. 2 // Winter 2021



A DIAGNOSTIC BULL'S-EYE?

Researchers use
platelets to take aim
at Lyme disease.

PAGE 16



A large, spreading tree with a thick trunk and dense canopy stands prominently in a tropical forest. In the foreground, two hikers with large backpacks are walking away from the camera on a grassy path. The background shows a lush, green hillside under a blue sky with scattered white clouds.

“When students work with me on the biodiversity living in tropical forests, it’s really important that they do more than just contribute to our understanding of the animals living there. Much better is if they can do this while learning from, and working with, the people for whom these forests are home. Not only will they then become better field and laboratory ecologists, they’ll become better global citizens.”

– Prof. Alex Smith, Associate Professor, Integrative Biology

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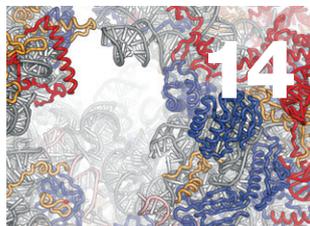
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“SCRIBE is a knowledge translation and science communication program which highlights the multi-faceted and leading-edge research taking place in the college.”

Welcome to the second issue of the College of Biological Science’s *Research Magazine*.

We are proud to share a collection of research stories and highlights that have come out of our college over the last short while. Many of these stories have been produced by graduate student in the SCRIBE (Students Communicating Research in Biology Education) program. This is a knowledge translation and science communication program which highlights the multi-faceted and leading-edge research taking place in the college.

We are also thrilled to welcome Mazyar Fallah, who has begun his five-year term as dean of the College of Biological Science in 2021. Please join me in giving him a warm welcome.

We appreciate your on-going support as we continue to navigate this especially challenging time in our history. The creativity our faculty and staff have shown throughout this time has been second to none, and I am incredibly proud of their dedication. I am equally proud of our students, who have demonstrated great resilience and perseverance in working toward their academic goals during this exceptional time.

It has been a pleasure to serve as Interim Dean.

I hope you enjoy this publication. 

Dr. Glen Van Der Kraak
Interim Dean, August 2019 – December 2020
College of Biological Science
University of Guelph

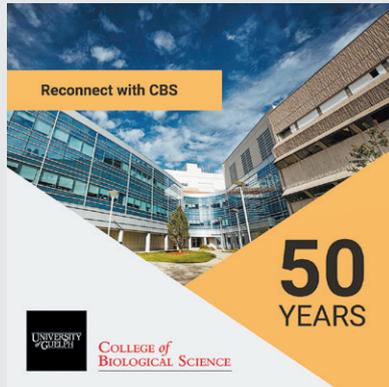
ABOUT CBS RESEARCH

Globally recognized research programs in integrative biology, human health and nutritional sciences, and molecular and cellular biology.

World-class research facilities including the Advanced Analysis Centre, the Hagen Aqualab, and the Flora Ontario Integrated Botanical Information System (FOIBIS).

Institutes and Centres include the Biodiversity Institute of Ontario, Centre for Biodiversity Genomics, the Centre for Cardiovascular Investigations, the Human Nutraceutical Research Unit, the Health and Performance Centre and the Guelph Institute for Environmental Research.





CBS 50th anniversary

2021 marks fifty years of the College of Biological Science.

In 1971, the College was created, making seven academic units on the University of Guelph campus. It has become a globally recognized academic faculty with a mission to expand the understanding of life, from DNA to cells to complex ecosystems. We produce intrepid and interdisciplinary research in a student-centred learning environment that encourages and promotes comprehensive understanding of the systems that govern life.

Our distinct college identity in the regional and global academic landscape is powered by several core elements: biology, impactful research, integrative and student-centred education, collaboration, community and continued reach for excellence.

We continue to strive for excellence and innovation in our research, teaching and learning environments.



“Our college is making great strides towards our long-term vision: to be a globally recognized hub for biological research and scholarship.”

I am honoured and delighted to have joined the University of Guelph as the 6th Dean of the College of Biological Science.

Even throughout this unprecedented time, our college is making great strides towards our long-term vision: to be a globally recognized hub for biological research and scholarship. Our unique focus on the student experience sets us apart and ensures we position our undergraduates for successful careers upon graduation. Our numerous innovations, including the CBS Office of Educational Scholarship and Practice’s teaching network, an interactive platform that enables faculty and staff to engage in meaningful dialogue around innovations in teaching and learning, further lends to our ability to provide excellence in science education.

We continue to strengthen our research enterprise through a range of innovative research programs. The COVID-19 pandemic has brought our relationship with other living organisms and our environment into sharp focus as is studied in our Biodiversity Institute of Ontario and Guelph Institute for Environmental Research. As well, our collaboration with the One Health Institute will develop curriculum and research that will equip graduates with the skills and knowledge needed to apply an intersectional approach to complex biological issues.

In 2021, we celebrate our 50th anniversary as a college, and we are proud of our standing as one of Canada’s most valued research institutions. We have been recognized for many outstanding accomplishments throughout our history and I look forward to celebrating this important milestone with all of you.

Together, we will continue to advance CBS’s leadership in innovation, scholarship and experiential education. I invite you to learn more by exploring the exciting research highlights shared in this publication.

Until we meet, I wish you the best. 

Dr. Maz Fallah

Dean, College of Biological Science
University of Guelph

How a pandemic impacted teaching and inspired innovation

As an academic institution, the COVID-19 pandemic has challenged the ways we instill learning and conduct research. It has required us to push innovation to the forefront as we launch new means of instruction and explore novel research questions to address pressing societal needs.

The College of Biological Science has helped innovate what teaching and learning can look like when shifted to online, remote learning methods. Research labs have pivoted their programs and leveraged their expertise to help develop new testing technologies and treatments, and to understand the longer-

Research labs have leveraged their expertise to help develop new testing technologies and treatments.

term health impacts of COVID-19.

Even in this new normal, we continue to see the dedication of our students, staff and faculty, and have witnessed many research successes.

Staff and faculty successes

Prof. Paul Hebert, director of the Centre for Biodiversity Genomics at U of G, and his colleagues have applied high-throughput approaches created for DNA-based species surveillance to the detection of SARS-CoV-2, the virus that causes COVID-19. The method will potentially deliver a rapid

\$1 COVID-19 test that involves screening a large number of samples at one time.

Prof. Steve Newmaster and colleagues in the U of G's Biodiversity Institute of Ontario developed a portable,

inexpensive diagnostic test kit for COVID-19 that provides results in about an hour. The kit has been used in Europe since March to confirm coronavirus infection in patients and is now being developed to detect the virus on surfaces and products. Prior to the pandemic, Newmaster was renowned for his research in plant molecular diagnostics and authentication, but COVID-19 highlighted the potential for scientists around the globe to unite against a common threat. "This is a way to use our skills to help at a time when society needs it," said Newmaster.

Precision Biomonitoring, a Guelph-based company that licenses U of G environmental DNA technology, was one of the first companies selected by Ottawa to provide detection technology for the novel coronavirus. The company adapted its DNA technology to create a rapid, portable COVID-19 test that can be used in underserved, remote areas. "It's a U of G innovation," said Precision Biomonitoring CEO Mario Thomas.

The Guelph Family Health Study, co-directed by Prof. David Ma, Department of Human Health and Nutritional Sciences, and Prof. Jess Haines, Family Relations and Applied Nutrition, has published its findings on the impacts of the pandemic on the diet and lifestyle habits families with young children. Many families reported feeling more stress, exercising less, eating more snack foods and spending more time on screens. But more healthful behaviours have also emerged, including families cooking from scratch and spending more time eating and exercising together.



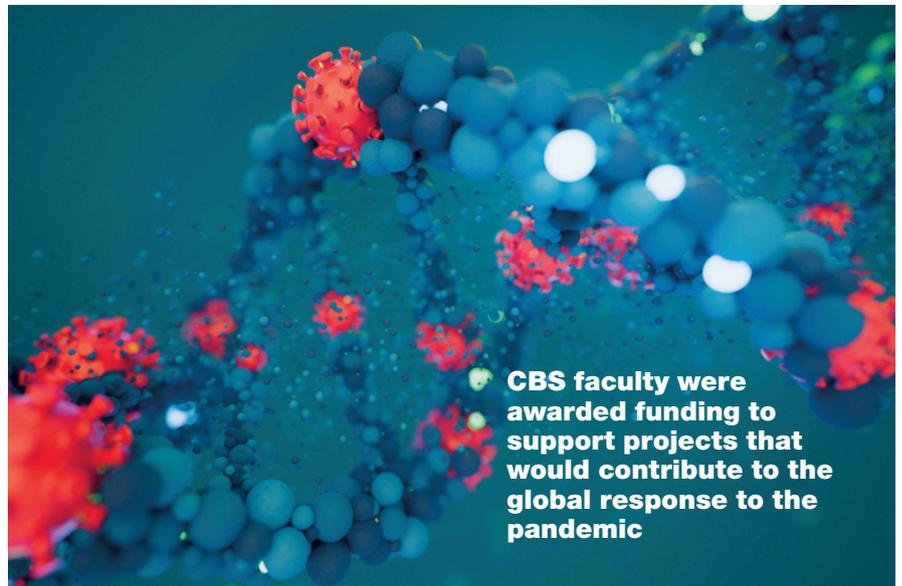
A portable Covid-19 diagnostic test kit Prof. Steve Newmaster and colleagues developed has been in use in the UK and Europe.

PHOTO: HYRIS

Research funding

CBS faculty were awarded funding from the U of G's COVID-19 Research Development and Catalyst Fund to support projects that would contribute to the global response to the pandemic.

- Prof. Wei Zhang, Department of Molecular and Cellular Biology, is optimizing and validating two FDA-approved drugs as enzyme inhibitors to block virus replication and serve as early-phase therapeutic molecules to treat COVID-19 patients.
- Prof. Jennifer Geddes-McAlister, Department of Molecular and Cellular Biology, is examining the protein-protein interactions between the virus and host that are



CBS faculty were awarded funding to support projects that would contribute to the global response to the pandemic

critical to infection, to help inform the design of a drug to disrupt these interactions.

- Prof. Scott Ryan, Department of Molecular and Cellular Biology, is developing a novel cell system that can be used to quickly screen the potential of anti-viral drugs to block viral replication.
- Dr. Melanie Wills, Director of the

G. Magnotta Lyme Disease Research Lab, is launching a longitudinal study to examine the potential long-term post-treatment complications of COVID-19 infection.

Course instruction pivot

COVID-19 significantly shifted plans for course instruction as faculty were tasked with the quick turnaround of

Instructors create at-home fieldwork kits

Sheri Hincks, a lab instructor in the department of integrative biology, has found a clever way to bring hands-on learning to online instruction.

Every year, Hincks coordinates a series of field trips for the students taking the fourth-year course, Limnology of Natural and Polluted Waters. The trips give students the chance to practice different fieldwork techniques at local lakes and rivers.

But such trips are impossible during a pandemic, so Hincks found another way for students to gain real-life experience in ecological fieldwork. Working with Carolyn Trombley, a PhD candidate in the department, she developed custom at-home kits that students could use on their own. The kits included a thermometer, magnifying glass, sorting trays, and other supplies. The kits cost \$30 apiece



and were paid for by a grant from the university's teaching and learning office.

The kits were met with rave reviews and helped preserve an important hands-on learning opportunity during an unpredictable pandemic. **R**

accessible, easy-to-adopt learning methods that not only works for their course content but ensures learning success. But COVID-19 also opened the door to an innovative learning opportunity.

In a collective response, the U of G launched a first-of-its-kind course

U of G launched a first-of-its-kind course which aims to study pandemics from scientific, cultural, historical and societal perspectives.

which aims to study pandemics from scientific, cultural, historical and societal perspectives.

Pandemics: Culture, Science, and Society (UNIV*2020), is fostering knowledge of the current global pandemic as well as past pandemics that had far-reaching impacts on communities around the world. Its multidisciplinary and collaborative approach blends expertise from four U of G colleges: biological science, arts, engineering and physical sciences, and social and applied human sciences.

Taught by a number of faculty members, the course explores infectious disease and pandemics through a range of lenses, including communication (and misinformation), technology, ethics, psychology, social inequities, genetics, nutrition, and more.

“The idea for the course came from facing this topic head on in a way that takes advantage of and showcases the University of Guelph’s unique strengths as a truly comprehensive university with an exceptional community of scholars,” said Prof. Ryan Gregory, chair of the Department of Integrative Biology. **B**



Life as a PhD student during a pandemic

BY MADISON WRIGHT

In just a few short weeks last spring, the COVID-19 pandemic brought the world to its knees. Almost a year later, it is still impacting me personally and professionally.

By nature, I am an extrovert who thrives and survives on human interactions. I find happiness and energy through connecting with others, and I find peace and comfort in my daily routines. The pandemic has taken these things from me. I missed the birth of my very first niece and was unable to conduct any lab work for five months.

But for all that COVID has taken away, it has also given me a great deal. I have found new ways to connect with others. I started a weekly virtual crafting group. Our virtual lab meetings now extend beyond simply talking about research – we also discuss mental wellbeing and personal development. Our lab has banded together and supported each other like we have never done before. I have honestly never felt closer to or more connected with my lab mates.

I have attended so many more conferences this year (teaching, professional development and research-related) because they were free and online, eliminating funding and geographic barriers. I also gained experience teaching online – something I would have never had the opportunity to do otherwise.

This pandemic has changed my perspective on life and has shown me my real priorities. It has taught me that life is precious, and the people in my life and connections I have with them are my greatest asset. I will never forget this lifechanging lesson. **B**

Madison Wright is a 3rd year PhD candidate in the Department of Molecular and Cellular Biology. She is studying how the bacterial pathogen *Pseudomonas aeruginosa* is able to survive inside human lung cells.

 Discover more about innovation at U of G by visiting uoguelph.ca/cbs.

We can't direct the wind, but we can adjust the sails

Using models to predict hypoxia in Lake Erie

BY MICHAEL LIM



➔ Rising temperatures and agricultural run-off are leading to harmful reductions in oxygen levels in the waters of Lake Erie, but Integrative Biology Professor Josef Ackerman is finding new ways to predict when these damaging events can occur.

Low levels of dissolved oxygen – a phenomenon known as hypoxia – can reduce the growth of aquatic organisms or cause them to migrate to other waters. If levels are low enough, it may become fatal.

Ackerman has a deep interest in bottom-dwelling aquatic organisms and has been studying lake dynamics for nearly 30 years.

“My first foray into working with Lake Erie was in the mid-90s,” says Ackerman. “At the time, we were focused on zebra mussels, but then we came across the broader issue of hypoxia.”

Lake Erie may be the smallest of the Great Lakes by volume, but it is

the most biologically productive. This is due partly to nutrient runoff from farms, which leads to algal blooms. When the algae die, they settle on the bottom of the lake and decompose, consuming oxygen in the process. This creates a hypoxic layer of water at the bottom of the lake. But because Lake Erie is large and relatively shallow, strong winds can cause upwelling that brings hypoxic water nearer to the surface.

These hypoxic episodes directly affect not only aquatic species in the affected areas, but humans as well, reducing the quality and taste of drinking water taken from the lake.

Interestingly, it wasn't until Ackerman and post-doc Dr. Aidin Jabbari attended a regional conference that they became aware that Lake Erie hypoxia via upwelling was a shared interest across disciplines, attracting physicists and mathematicians as well as biologists. A modelling expert from National Oceanic and Atmospheric

Administration (NOAA), Dr. Mark invited Ackerman and Jabbari to join their team.

“All people, not just researchers, tend to think in isolation,” says Ackerman. “So when you're inspired to learn about something, and then find out there are several like-minded groups out there all searching and trying to understand the same thing... it is really kind of cool.”

The team used several years of meteorological data to develop a computational model that could predict future hypoxic events based on environmental conditions. They then tested their model against a set of sensors placed throughout the lake.

The model and field data revealed that temperature and wind direction are critical in creating hypoxic conditions. In particular, hypoxia is strongest during the summer months, and strong winds can trigger earlier periods of hypoxia on their respective shores. For example, a southwesterly wind results in earlier hypoxia on the southern shores of Lake Erie, while north-easterly winds reverse the pattern.

The model's accuracy hints at the unexpectedly large role that environmental conditions may play in hypoxia patterns in Lake Erie.

While little can be done to alter the weather, it is helpful to know when and where hypoxia is likely to occur. For example, drinking water treatment plants need to know when to reduce water intake, while biologists need to know which areas to avoid sampling from when trying to estimate aquatic populations.

“We've learned a lot from studying Lake Erie, and hope that people will learn and build upon what we've learned,” says Ackerman. “Only by understanding how all the different processes involved work and affect each other, can you then know how to bring positive change.” **R**



Read the full study in the *Journal of Geophysical Research: Oceans*.

Blooming change

A story of adaptation

BY HARSHINA BRIJLALL

→ Bright, beautiful blooms that attract pollinators play an essential role in the reproduction of many flowering plants. But climate change, habitat loss and other factors have led to a steady decline in pollinator populations in recent decades, and wildflowers may now need to adapt to survive in a world with fewer pollinators.

Prof. Christina Caruso and graduate student Hazel Panique from the Department of Integrative Biology are evolutionary biologists interested in how wildflowers respond to a decrease in insect pollination. In a study published in the *American Journal of Botany*, they found that *Impatiens capensis*, otherwise known as orange jewelweed, had two different responses to decreased pollinator visits.

Orange jewelweed is an annual wildflower that produces two types of flowers. The first is a non-descript closed or “cleistogamous” flower with no exposed reproductive parts, that relies on self-fertilization to reproduce. The second type of flower is bright, attractive and fragrant. These “chasmogamous” flowers have open petals to encourage pollinator visits and cross-fertilization.

Both types of flowers offer certain advantages and disadvantages. For example, closed flowers ensure the plant can reproduce even if pollinators are not present. In contrast, open flowers allow for cross-pollination between plants, which increases genetic diversity and offspring vigour.

Caruso and Panique wanted to know if the presence of fewer pollinators would favour the



An orange jewelweed “open” flower.

production of one type of flower over another. In other words, would a plant rely more heavily on self-fertilization and produce more closed flowers? Or would it try to become more attractive to pollinators by producing showier and/or more open flowers?

The pair devised an unusual experiment that involved transplanting hundreds of pre-flowering jewelweed plants from a local nature trail to a study site at the University of Guelph’s Arboretum. Half of the plants were left exposed to regular or “ambient” pollination, while the other half of plants were covered in netting every other day during flowering, which reduced pollinator visits by 50%. Within just one season, they were able to measure the effects of natural selection on the plants caused by a decrease in pollinators.

Caruso and Panique discovered that fewer pollinator visits did indeed result in a greater number of closed flowers. Somewhat surprisingly,

however, it also led to the production of open flowers that were larger in size – which they believe was an effort by the plant to help draw in scarce pollinators.

This is double-edged response is good news for pollinators, says Caruso.

“There would be grave consequences for pollinators if wildflowers were to completely turn to selfing and produce only closed cleistogamous flowers, as many pollinators rely on the nectar and pollen that wildflowers provide. The world would also look a lot greyer as plants would not produce big, showy flowers to attract pollinators.”

The study adds a complex but important layer to our understanding of how human impacts on the environment are affecting the evolution of wild species. **B**



Read the full study in *American Journal of Botany*.

Caring for caribou

Understanding how logging affects survival of a threatened species

BY BARBORA HUCIK



It is hard to be a woodland caribou in Northern Ontario. They must clamber through marshes and bogs in summer and deep snow in winter, living off nutrient-sparse lichen when the temperatures plunge. The odds of survival are not in their favour, and human activities are threatening to tip the balance further.

“Caribou prefer to dwell in mature coniferous forests, but commercial logging shifts the landscape to a younger, regenerating forest that favours competitors such as moose, and predators such as wolves,” explains John Fryxell, a professor in the Department of Integrative Biology and executive director of the Biodiversity Institute of Ontario

Understanding exactly how human disturbance impacts caribou survival is critical to conserving this culturally and ecologically important species, says Fryxell, and can help the forest industry develop more sustainable logging plans.

With a large team of university and government collaborators, Fryxell set out to determine the influence of the environment on the survival rate of this threatened species – and found that landscape characteristics can accurately predict the survival of a caribou population.

The study was based on data collected from 122 adult female caribou over three years from two locations in Northern Ontario. The first location, Nakina, has been the site



Woodland caribou wearing a radio collar.

of logging for many decades, while the second location, Pickle Lake, remains undisturbed by human activity.

Caribou in both locations were tracked using GPS radio collars and video cameras. This allowed researchers to retrace the caribou’s steps to try and understand how the animals made decisions as they moved about their environment. The team also paid close attention to factors such as the surrounding landscape, presence of predators, and availability of food.

The undertaking was “kind of like a military operation,” says Fryxell, with team members “chasing wolves and moose and counting lichen on hands and knees”.

They used the data to develop a model called a population viability analysis, or PVA, which can be used to predict growth in a specific population of caribou based on the local environment.

The model revealed that caribou populations located in areas with a

history of commercial forestry have lower annual growth rates than those in undisturbed area, and the difference is heavily linked to changes in wolf density.

The study brought together a diverse team from different fields that are not necessarily used to working with each other, notes Fryxell. “Sometimes you have to put aside some of your personal interests, and it was quite amazing to see the degree to which people could pull together for a common goal.”

Conserving threatened or at-risk species is almost always fraught with social, economic and ecological considerations. While much work remains when it comes to protecting Ontario’s woodland caribou, the team’s efforts provide a valuable tool to help bring sustainable management of this iconic species one step closer. **R**



Read the full study in *Journal of Wildlife Management*.

Study proves DNA metabarcoding effective for monitoring biodiversity

BY UNIVERSITY OF GUELPH

→ University of Guelph-developed DNA metabarcoding technology has been found to be more effective at monitoring biodiversity of ecosystems than traditional methods.

The science has been used in a study of the Peace-Athabasca Delta in northern Alberta, a vast ecosystem threatened by environmental pollutants from mining and hydroelectric projects.

One of the greatest challenges faced by environmental scientists and ecologists is accurately detecting changes in the biodiversity of natural ecosystems caused by human activity. The advent of new DNA-based biodiversity detection methods developed at U of G to address this challenge is highlighted in a recent study focused on the large wetland complex in northern Alberta.

“For more than a decade, we have been working closely with scientists from Environment and Climate Change Canada to develop and apply high-throughput, DNA-based biodiversity analysis for monitoring key ecosystems across Canada,” says Prof. Mehrdad Hajibabaei, Department of Integrative Biology and a co-author of the study. “This study is a key contribution from this collaborative effort to bring cutting-edge genomics to ecological analyses.”

Between 2011 and 2016, aquatic macro-invertebrates were sampled across the Peace-Athabasca Delta using both traditional microscope-based identification and DNA metabarcoding, a method introduced by Hajibabaei in 2011. Metabarcoding allows the simultaneous identification of many species in a single environmental sample.

The study found that DNA metabarcoding identified a much broader range of biodiversity per sample than the traditional method, and detected significant responses to floods and variations in water temperature. Simulations used in the study demonstrated that metabarcoding was much more efficient at providing statistical evidence at a much broader scale.

“By using massively parallel sequencing and advanced computational analysis, DNA metabarcoding overcomes critical choke points in biomonitoring,” says Hajibabaei.

Metabarcoding, he says, allows the processing of a large number of samples without the need to separate and sort tiny larvae. It uses sequences from the DNA barcoding gene to make species identification often at a better resolution than is achievable through examining organisms.

“Until now, our ability to make consistent and accurate identifications of the hundreds of species which comprise these hyper-diverse and dynamic communities has limited our ability to make broad statements about how resource developments are degrading critical goods and services needed by migratory birds and wildlife,” says Donald Baird, federal scientist with Environment and Climate Change Canada, and study co-author.

Hajibabaei says demonstrating that DNA metabarcoding is an effective tool in ecological analyses in ecosystems such as the Peace-Athabasca Delta is an important steppingstone to broader applications of this approach. He is currently partnering with WWF-Canada, Living Lakes Canada, and Environment and Climate Change Canada to launch a DNA-based biomonitoring program to assess key Canadian watersheds. **R**



A section of the Peace-Athabasca Delta in northern Alberta.

 Read the full study in *PNAS*.



“We can only manage what we can measure. The growing magnitude of global biodiversity loss highlights the critical role of biomonitoring, and metabarcoding techniques can support improved monitoring of multispecies assemblages in different ecosystems.”

– Mehrdad Hajibabaei, Associate Professor, Centre for Biodiversity Genomics

Ribosome royale

A specialized secret agent in the fight to detect cancer

BY HARSHINA BRIJLALL

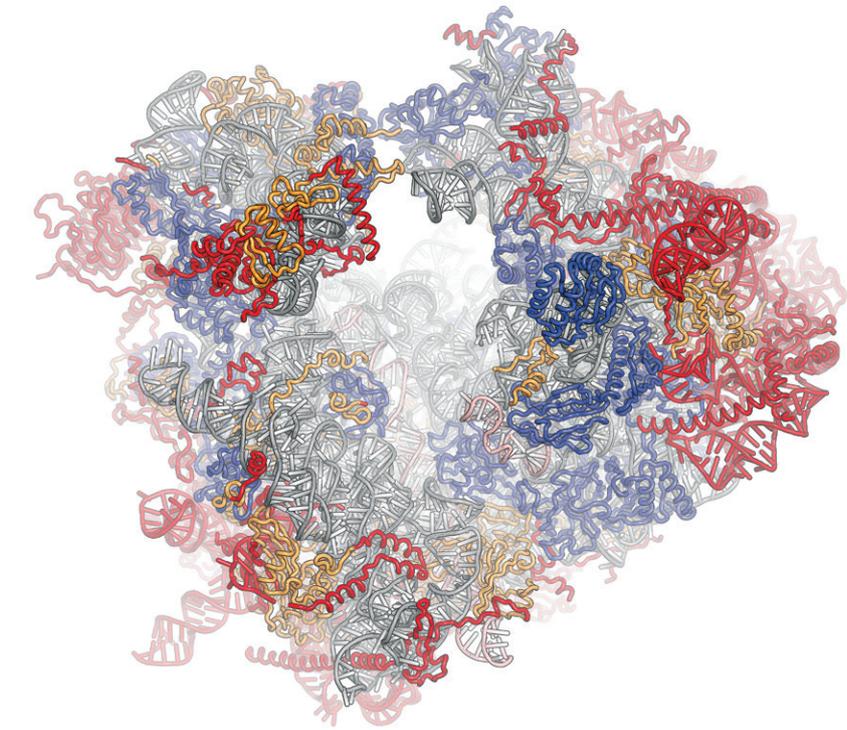


Inside every living cell are millions of tiny machines called ribosomes that manufacture the proteins critical to normal cell function. For decades, scientists believed that ribosomes shared a similar protein composition because their role in the cell was too important to tolerate variations. In recent years, however, evidence has accumulated that there may be important differences lurking in the proteins that make up the ribosomal machinery, and these differences may hold the key to improving cancer diagnosis and treatment.

Prof. Jim Uniacke is a molecular biologist in the Department of Molecular and Cellular Biology with a special interest in the protein make-up of ribosomes and how it is affected by cellular stresses like low oxygen (hypoxia), a common condition in tumours which have outgrown their blood supply.

“Some ribosomal proteins act differently and/or are produced in different quantities under certain conditions such as hypoxia. These protein changes have the potential to tell physicians and scientists if tumours have become hypoxic and will subsequently become malignant and resistant to treatment,” says Uniacke.

Uniacke and PhD student Andrea Brumwell designed an experiment to investigate differences in ribosomal proteins in non-cancerous cells grown under normal and hypoxic conditions. They also compared ribosomal



A model of a ribosome in a eukaryotic cell.

proteins in cancer cells from the brain, colon and prostate. The cells were then analyzed to determine the amount and type of ribosomal proteins present.

Ultimately, the team found that hypoxia led to different variants or “specialized” versions of two ribosomal proteins in particular: RPS24 and RPS12.

RPS24 is a protein variant found at increased levels in hypoxic prostate cancer cells. However, there is still a mystery around how exactly this ribosomal protein affects cell function.

“Without knowing exactly what RPS24 does for the cell, we don’t know if the protein has a function independent of the ribosome and/or to produce specialized ribosomes that aid in hypoxic adaptation,” says

Uniacke. However, the increased levels of RPS24 suggest it could be used a biomarker to determine if a tumour is present.

In contrast, researchers have a much stronger inkling of the role of RPS12 in the hypoxic tumour environment,

and it is a role that makes this protein of particular interest to Uniacke and his colleagues.

“We think that RPS12 helps cells synthesize more proteins to avoid cell death. This lack of ‘programmed’ or normal cell death is a hallmark of cancerous tumours where cells live much longer than usual and grow uncontrollably,” explains Uniacke.

One application of this research is the potential development of therapeutic treatments that reduce the synthesis of RPS12 and hence its role in preventing cell death.

“With this type of research, we can figure out how specialized ribosomes help hypoxic cancer cells become dangerous,” says Uniacke.

He and his team hope that their findings will aid in the development of improved diagnostics and therapeutics for what remains one of modern medicine’s greatest challenges: defeating cancer. **R**



Read the full study in RNA Journal.

Together we stand, divided we fall

How microbes cooperate in the human gut

BY SIERRA ROSIANA

→ Gut dwelling microbes and how they keep us healthy have long been a source of fascination to microbiologists. But it is only in the last decade or so that scientists have been able to truly delve into the complex microbial ecology of the human gut, thanks in part to the invention of bioreactors that can mimic the conditions found in the intestine. These game-changing machines were developed by Prof. Emma Allen-Vercoe, Department of Molecular and Cellular Biology, and continue to play an essential role in her lab's research.

Kaitlyn Oliphant is a recent PhD graduate from the Allen-Vercoe lab who took advantage of the lab's "robogut" technology to explore how different species of gut microbes interact in a healthy individual.

"Therapeutics that help restore an altered microbial community in the gut have a lot of potential to treat gastrointestinal disorders and other conditions," says Oliphant. "But in

order to design effective therapeutics, we have to first understand the ecology of a healthy gut environment, including how different microbes interact with each other."

Oliphant obtained a fecal sample from healthy individual and isolated the different species of microbes it contained. She then recombined the individual strains in a bioreactor to recreate a healthy gut microbial community.

An identical community of microbes was formed in another bioreactor but with a twist: each species of microbe was obtained from a different person, rather than all coming from one individual.

"If all the species come from one person, it should mean they are able to work together and coexist," explains Oliphant. But if the species come from different individuals, they may not cooperate in the same way.

Oliphant cultured the two communities under identical conditions in media that replicated

conditions in the human gut.

When the microbial communities reached a "steady state" after several days, the researchers discovered that over all the species composition was similar between the communities. However, the by-products resulting from microbial activity in each community were a little different. In the microbial community constructed from multiple donors, the microbes appeared to be degrading primarily protein instead of carbohydrates.

This preferential breakdown of protein has important consequences. The by-products of carbohydrate degradation are the preferred energy source for the epithelial cells lining the gut. Protein degradation, on the other hand, produces by-products such as phenols, biogenic amines, and ammonia, which can potentially be pro-inflammatory or toxic. This doesn't mean consuming protein is bad, but it is likely not ideal as a lone energy source.

The difference may be due to the fact that gut microbes rely on cooperation for carbohydrate degradation, and microbes obtained from different people may simply not cooperate as well. When microbes grow together over an extended time period, they "co-adapt" to their environment and may work together to produce different enzymes to break down energy sources efficiently. But when microbes do not have a history of growing together, they don't cooperate as effectively and resort to degrading proteins.

It is clear that for both gut microbiota and the person housing them, cooperation is important – and future therapeutics may need to be based on co-adapted, cooperative microbes for the best results.

"My hope is that this research will provide new insights into the gut and help with future development of therapeutics for those struggling with GI disorders," says Oliphant. **B**



Bioreactors used to culture gut microbes in the Allen-Vercoe Laboratory.



Read the full study in the *ISME Journal*.

A diagnostic bull's-eye?

Researchers use platelets to take aim at Lyme disease

BY MICHAEL LIM

→ An estimated ~300,000 individuals are diagnosed with Lyme disease each year in the US alone, a number that is predicted to grow as the climate warms. The disease is caused by the transmission of bacteria from the genus *Borrelia*, typically via tick bites. Infections are usually associated with a distinctive “bull’s-eye” pattern rash, but individuals may also have no rash at all, or display a mix of different symptoms including headaches, fever, and joint pain. Now, a study by Dr. Melanie Wills, Scientific Director of the G. Magnotta Lyme Disease Research Lab in the Department of Molecular and Cellular Biology, has developed a new approach to Lyme disease testing that may improve our ability to detect this complex and potentially devastating disease.

Existing diagnostic tests are far from perfect. They typically test a patient’s blood for antibodies produced in response to *Borrelia* infection. Unfortunately, the sensitivity of these tests is limited by several factors, including the patient’s level of immune response, the stage of the infection, and the specific strain of *Borrelia*.

Combined with inconsistent symptoms, this makes early detection difficult, which is critical to successful treatment with antibiotics. Without early intervention, patients can develop serious long-term issues including arthritis, nerve pain, facial palsy, and an irregular heartbeat.



Recent MSc graduate Tori Sanderson handling blood samples.

“When I first tell individuals about the state of Lyme disease testing, they often ask ‘how are we still at this stage?’” says Wills. “By the 1990s, there was a sense in some circles that the case was closed on Lyme disease research. Researchers thought, ‘we know the bacteria, we have the antibiotics to treat it. What’s the problem?’ Since then, we have learned just how broad and long-lasting the effects of Lyme disease can be, and how many cases are potentially mis- or undiagnosed.”

To help spearhead the development of a better diagnostic test, Wills recruited MSc student Victoria Sanderson. In a twist of fate, Lyme disease had a personal connection for Sanderson, as someone close to her had recently been diagnosed, and she was eager to join the project.

Sanderson was particularly interested in what blood fraction offered the best chance of detecting *Borrelia*. After collecting blood from healthy subjects, she experimentally infected the blood with *Borrelia* and incubated the samples for several weeks. She then used high speed centrifugation to separate

infected blood into three different fractions: whole blood cells, plasma and platelets.

Subsequent testing of the different fractions revealed that the platelets had the highest amount of detectable *Borrelia*, with nearly 10 times the amount of the next highest fraction. In other words, platelets appear to be a natural reservoir for *Borrelia*, and focusing testing on this particular blood fraction could vastly improve our ability to accurately detect infection.

While additional research is needed to validate this new methodology for clinical use, the results offer new hope that a much-needed improvement in Lyme disease diagnostics may be on the horizon.

“We were really just trying to question the status quo,” says Sanderson. “To take a step back, and make sure that diagnostics are based on a solid foundation. We may not have solved the problem just yet, but science is incremental. We’re making progress.” 



Read the full article in the *Journal of Biology*.

There's nothing fishy about it

Omega-3's in fish oils reduce inflammation

BY ALEAH KIRSH

➔ Omega-3 fatty acids found in fish oils may help prevent chronic inflammation in fat tissue, says a new study from the Department of Human Health and Nutritional Sciences.

Fat tissue – also known as adipose – is a dynamic and metabolically active tissue is made up of both fat and immune cells. But when the body is stressed from obesity or a high fat diet, this dynamic tissue is home to more immune cells that are linked to inflammation. These cells produce inflammatory signals that can be a key step in the development of insulin resistance and type 2 diabetes.

Given the widespread health impacts of obesity, researchers such as Prof. Lindsay Robinson are working to better understand the physiology of obesity development and how to reduce the domino effects of chronic inflammation.

“We want to look at the early changes in adipose tissue seen with obesity and try to prevent further metabolic problems,” says Robinson. Her ultimate goal is to understand how these metabolic changes occur in order to develop translatable interventions.

“Finding simple dietary interventions that can help people is the goal. This is why omega-3 fatty acids are of particular interest.”

Omega-3's belong to the family of “healthy” fats known as omega-3 polyunsaturated fatty acids. These fatty acids are celebrated for their anti-inflammatory properties and beneficial impacts on cognition and metabolism. They are found at high levels in fish, seeds, and nuts, and omega-3 and fish oil supplements



have become a staple item in many health food stores.

To investigate the impact of omega-3 consumption on adipose inflammation, Robinson's group fed mice a high fat diet with or without omega-3's in fish oil. They then took immune cells from the spleen of the mice and cultured them with adipocytes (fat cells) before being “challenged” by the addition of a toxin that mimics the cellular stress caused by a high fat diet.

This novel “co-culture” approach reproduces the adipose cell and immune cell interaction and the inflammatory microenvironment, explains Robinson, allowing cellular processes to be examined in ways that would otherwise not be possible.

The results showed that the omega-3's lived up to their healthy reputation. There were fewer signs of inflammation in the cell cultures from mice supplemented with omega-3, even after they were challenged with

the toxin. They also found increased levels of anti-inflammatory immunity cells (T cells) and anti-inflammatory cellular signals (cytokines) in the mice fed omega-3's.

And for those of us wondering how much omega-3 supplementation would be needed to realize this health benefit, there is good news. The mice consumed just over one percent of their daily calories from omega-3's, a level of supplementation that can be readily met with a supplement or eating more fish.

“If someone should take away one thing from this research it is the importance of omega-3's in a healthy diet,” notes Robinson. She is looking forward to continuing to evaluate the impact of omega-3's on adipose tissue and uncovering the mechanisms behind adipose inflammation. **B**



Read the full article in the *Journal of Nutritional Biochemistry*.

No more “use it or lose it”

New discovery may stave off muscle loss during post-injury recovery

BY LEAH TURNER

→ If you’ve ever broken a bone, you may be all too familiar with the loss of muscle that can occur while your limb is in a cast. But there’s good news ahead for the injury-prone among us: researchers in the Department of Human Health and Nutritional Sciences have found a new way to help reduce muscle loss or “atrophy” during recovery.

“Muscles are very much ‘use it or lose it,’” says Prof. Jamie Burr, who leads the Human Performance and Health Research Lab. “It takes as little as two weeks of immobilization to lose a significant amount of muscle mass and strength.”

To date, injury rehabilitation has focused on reversing atrophy through load-bearing exercise after the injury

has healed. But this can be challenging for people with chronic mobility issues or a serious injury, which dramatically reduces their ability to recover.

“The maintenance of muscle mass and strength is essential for maintaining one’s quality of life,” explains Joshua Slys, a recent PhD graduate and lead author of the study.

Slys and Burr wanted to see if they could find a way to prevent muscle atrophy during limb immobilization by adapting techniques that are currently used to rehabilitate muscles after atrophy has already set in, as well as to enhance athletic training.

One such technique is blood flow restriction, which applies a low level of pressure to a muscle using a tourniquet similar to a blood pressure

cuff. Another technique is to apply an electrical impulse to the affected muscle, causing it to involuntarily contract. This method is called electrical muscle stimulation.

When used alone, the level of electrical stimulation required to be effective is too intense for most patients, but when combined with blood flow restriction, “a very light stimulation intensity suddenly becomes very effective as a training tool,” Burr explains. “To us, combining blood flow restriction and muscle stimulus was a logical next step to determine if we can prevent atrophy in unused muscles.”

Before they could test how well this combined approach could stave off atrophy, the team needed to find 30 volunteers willing to have their left leg immobilized in a brace for two weeks.

“It was hard to find people willing to do it,” Burr chuckles. “It took us two years to get enough people through. It was a lot to ask!”

Ten of the volunteers acted as the control group and received no treatment. The remaining volunteers received either blood flow restriction alone, or in combination with muscle stimulation twice a day, five days a week.

The researchers discovered that the combined treatments preserved muscle mass more effectively compared to both the control group and blood flow restriction alone.

The results are an exciting development in the field of injury rehabilitation. In fact, the lab is working on a patent for an apparatus that would allow physiotherapists to easily treat their patients using blood flow restriction and muscle stimulation together.

In the meantime, Burr is busy fielding calls from the likes of the Toronto Raptors, the Toronto Maple Leafs, and even an English Premier League soccer team. “We’re definitely on the radar for sports medicine,” he says with a smile. **B**



A study participant receiving blood flow restriction and electrical muscle stimulation to prevent muscle atrophy.

Read the full study in the journal *Medicine & Science in Sports & Exercise*.



GARY SWANSON

MSc, Neurobiology, Class of 1982

We value profiling the success of our alumni, and would love to highlight yours. Get in touch with Taline Artinian, Alumni Advancement Manager, at artinian@uoguelph.ca.

What has been your career path since graduation?

After graduating, I began working for a pharmaceutical manufacturing company as an organic chemist in quality control, applying many of the principles of lab spectrometry and spectroscopy to analysis of pharmaceutical/nutritional ingredients and products. I was promoted to Quality Manager, then to Operations Manager. By 1989 I became the General Manager of the company in Canada, overseeing several departments. Later, I was transferred to the US to oversee Operations, Quality and R/D for the corporate group.

In 2009, I joined the company Herbalife International, as Corporate Vice President of Quality. We transformed from having 35 personnel to now having upwards of 400 quality personnel worldwide, with four manufacturing facilities and seven laboratories worldwide. Each lab is ISO17025 accredited, and we have developed a partnership with the University of Guelph through the Natural Health Products Research Alliance (NHP Research Alliance).

What inspired you to work in your field?

What began early in my career as a means to an end created

so many opportunities years later. Working in a manufacturing facility allowed me to apply many of the academic principles I learned to the workplace. I was fascinated by working with people from many different disciplines to create products that a customer wanted and was only one of a handful of people with a similar background to my own. I became a mentor to different operations personnel to help them pursue their goals and have continued that mentorship philosophy while still pursuing excellence and learning in my own discipline.

What brought you to the U of G and how did your degree help you achieve your career ambitions?

The University of Guelph was where I wanted to pursue graduate work in reproductive endocrinology. After College, I used the learnings from that graduate work to generate reports professionally and to investigate situations to a meaningful conclusion. The benefits of the graduate degree, along with my accomplishments at the manufacturing companies, helped me advance my career. Graduate work taught me to be focused on the details of a task or investigation and make sure that I could always defend my position or decision with conviction.

What did you enjoy most about U of G?

The University of Guelph was like a city within a city. I had some very supportive student friends on campus and spent a lot of time in the graduate lounge. U of G provided me

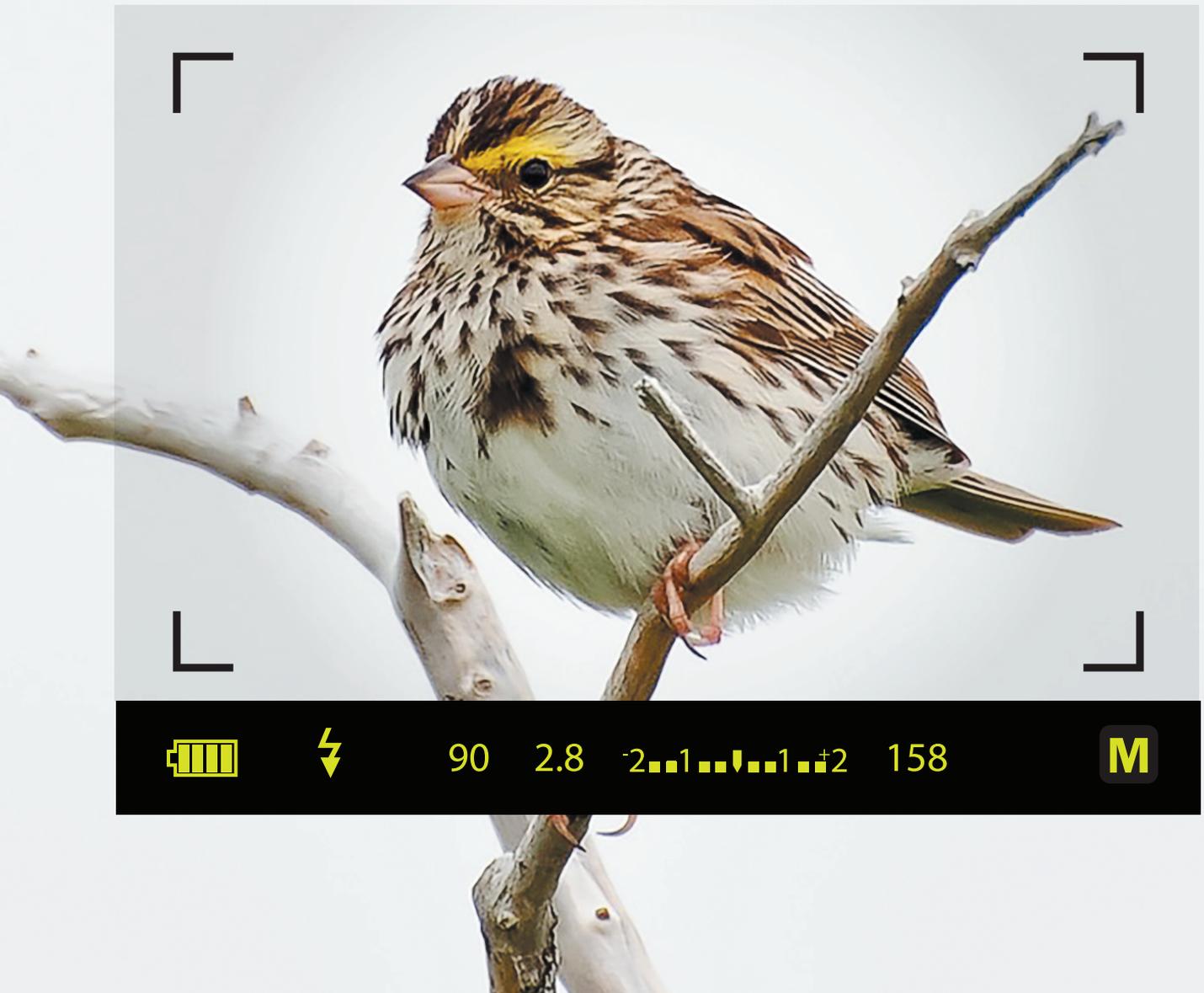
the confidence in developing good relationships and was a fundamental steppingstone into the real world. The university lifestyle taught me to be tolerant, inclusive and most of all, honest with myself and those around me.

What trends are you seeing in your industry?

Increased regulations have been introduced into the food and dietary supplement industry. In the US and Canada, we are required to have strong food safety plans providing greater assurance of compliance as it relates to sourcing, manufacturing and distribution. The regulations will only be more disciplined in the future. There is more science being applied to the development and creation of food products to satisfy consumer demand, for example vegan products, clean label, allergen free etc. This new generation of consumers has high expectations for product quality.

What advice would you give to current students or recent CBS Grads?

Pursue the goals that you have set with eyes wide open. Education has provided each of us with one very important function: how to think. You are capable of pursuing a career that may have many opportunities, but they may not always resemble the title on your degree. Keep an open mind and think about how you can improve yourself and those around you. **B**



SAVANNAH SPARROW PHOTOGRAPHED BY STÉPHANIE DOUCET



COLLEGE of
BIOLOGICAL SCIENCE

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